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Diseases of Pacific Madrone

Marianne Elliott

Abstract: Pacific madrone (*Arbutus menziesii*) is host to a variety of pathogenic fungi. At least 21 species are identified. Isolation and identification of these fungi is done from symptoms on the tree and by culturing the fungi in the lab. Many are foliar pathogens that are not a serious threat to the tree's health. In recent years several canker fungi have caused damage, and even death, of large madrone trees in urban areas. Three pathogens most likely to cause tree death are *a* root rot (*Phytophthora cactorum*), *Arbutus* canker (*Nattrassia mangiferae*) and madrone canker (*Fusicoccum aesculi*).

Diseases of Pacific madrone (*Arbutus menziesii*) are classified into root rots, stem and branch cankers, branch dieback, wood decay and foliage diseases. The fungi that cause the diseases are also taxonomically organized by class (Table 7-1). Many of the fungi in a given class affect the same parts of the tree. An understanding of the life cycles of fungi is necessary in learning how to control diseases (Alexopoulos, *et al*. 1996).

Many fungi that attack madrone are foliar pathogens that are not a serious threat to the tree unless repeated defoliation occurs. In recent years several canker fungi have caused damage, and even death, of large madrone trees in urban areas. In this paper I discuss identification, life cycles and disease symptoms on madrone of the 3 pathogens [*Phytophthora cactorum* (Plates 7-1 and 7-2), *Nattrassia mangiferae* (Plates 7-3, 7-4 and 7-5) and *Fusicoccum aesculi*] most likely to cause tree death. In addition, techniques for isolating and culturing the fungi are discussed.

Plate 7-1 (page 49, upper). A tree that was killed quickly by *Phytophthora*. This tree had small *Nattrassia* cankers on the branches and sunscald injury. The leaves are wilted and still attached. Union Bay Gardens, University of Washington, Seattle. Photo 1995.

Plate 7-2 (page 49, lower). Cross section of tree trunk shown in Plate 7-1. The canker was located just above the root crown, and the infection spread into the roots and trunk. The tree was wounded. Later, *Phytophthora* infested soil was probably splashed into the wound. Photo 1995.

Plate 7-3. Arthrospores and conidia of *Nattrassia mangiferae* taken from a Pacific madrone canker. Magnification ~1500X.

Table 7-1. Madrone Fungal pathogens. Fungal classes are Oomycetes (O), Basidiomycetes (B), Deuteromycetes (D) and Ascomycetes (A). References: 1, McDonald and Tappeiner 1991; 2, Hunt and Funk 1992; 3, Stuntz and Seliskar 1943; 4, Sinclair, et al. 1987; 5, Hepting 1971.

	Common name	Where found	Class	Reference
Root rots				
Pythium spp.	Damping-off	General	O	1
Phytophthora cactorum	*Phytophthora* root rot	Seattle	O	2,1,3
Heterobasidion annosum	Annosus root rot	Ca.	B	1,4
Stem and branch cankers				
Phytophthora cactorum	-	-	O	5
Nattrassia mangiferae	*Arbutus* canker	BC to s. Or.	D	2,1
Branch dieback				
Fusicoccum aesculi	Madrone canker	BC to n. Ca.	D	1
Wood decay				
Phellinus igniarius	White rot	BC to n. Ca.	B	5,1
Fomitopsis cajanderi	Brown top rot	BC to n. Ca.	B	5,1
Poria subacida	Yellow root rot	BC to n. Ca.	B	5,1
Foliage diseases				
Ascochyta hanseni	Leaf spot	Ca., Tx.	D	5
Coccomyces quadratus	Tar spot	BC	A	2
Cryptostictis arbuti	Leaf spot	Or., Ca.	D	5
Didymosporium arbuticola	Leaf spot	General	D	5,2
Diplodia maculata	Leaf spot	BC	D	5,2
Disaeta arbuti	-	-	D	5
Elsinoe mattirolianum	Spot anthracnose	s. Ca.	A	5
Exobasidium vaccinii	Blister blight	General	B	5,2
Mycosphaerella arbuticola	Leaf spot	General	A	5
Phyllosticta fimibriata	Leaf spot	Ca.	D	5
Pucciniastrum sparsum	Rust	-	B	5
Rhytisma arbuti	Speckled tar spot	General	A	5,2

ISOLATION AND IDENTIFICATION METHODS

To isolate fungi that cause madrone diseases pieces of infected tissue are removed from the plant, washed in a dilute solution of Clorox and water, then rinsed in water. The tissue is put in a petri dish with a suitable nutrient medium (*e.g.*, 2% malt agar) and incubated at room temperature. After about a week, colonies form and are observed with a microscope. Fungi of interest are transferred to another petri dish to

Plate 7-4. A madrone tree with *Nattrassia* cankers that have rough raised calluses. The type of cankering is probably related to the vigor of the tree. More healthy trees can form the callus ridge each year and keep the fungus from spreading rapidly. Seattle, Washington. Photo 1995.

Plate 7-5. A smooth, rapidly spreading *Nattrassia* canker. This type of canker looks similar to a *Fusicoccum* infection, but is on the main trunk of the tree. *Fusicoccum* infections start at the branch tips and work inwards. Bellevue, Washington. Photo 1995.

obtain a pure culture. Isolating *Phytophthora* is more difficult (Ribeiro 1978).

Nattrassia is easy to identify as it has a distinctive hyphal structure (Plate 7-3) (Sutton and Dyko 1989). Barnett and Hunter (1972) and Carmichael, *et al.* (1980) are useful for identifying Deuteromycetes. Stuntz and Seliskar (1943) described *Phytophthora cactorum* isolated from madrone. Some fungi are more easily identified by their symptoms on the tree than in culture; thus, inoculating a healthy tree with a fungus isolated from a diseased tree and observing the symptoms may help with identification.

MADRONE TISSUES AND THEIR DISEASES

Root Rots

The most common root disease in mature madrone trees is a root rot caused by *Phytophthora cactorum*. It infects the roots and tree trunk. Cankers are usually at the tree base, although they also occur farther up on the stem (Plate 7-1) (Stuntz and Seliskar 1943). Trunk cankers sometimes appear water soaked. The infected bark is discolored brown which contrasts with the healthy, cream colored inner bark (Plate 7-2). The sapwood may also be discolored to a depth of 1–2 mm. Crown symptoms include a loss of upper foliage and abnormally small leaves with curled margins. If the disease kills the tree quickly, the leaves remain attached and wilted. Trees in poorly drained soil are the most susceptible (Sinclair, *et al*. 1987). Madrone seedlings are susceptible to damping-off and root rot fungi.

Phytophthora and damping-off fungi are Oomycetes. Oomycetes have aseptate mycelia, chlamydospores (resting structures which survive harsh conditions), sexual oospores and swimming zoospores. The spores require free water to germinate and exist in soil and on diseased plant debris. They spread through running water and rain splash. The most likely places for infection are wounds and succulent portions of shoots and feeder roots. Oomycetes have no fruiting bodies. Their reproductive structures are microscopic; thus, identification of the disease is largely based on symptoms and examination of the fungus in culture.

Annosus root rot (*Heterobasidion annosum*) is a Basidiomycete. This fungus is known as a problem on conifers, but it attacked and killed madrones in Amador County, California (McDonald and Tappeiner 1991). If the soil contains a large amount of conifer roots colonized by *H. annosum*, the conifer roots are a food source for the fungus to

overcome the defenses of hardwood trees in the area (Sinclair, *et al*. 1987). *Heterobasidion annosum* also causes a butt rot. The decay is a white pocket rot or a white stringy rot, varying with the type of host. The fruiting body is a flat and buff colored conk. The conks occur on the underside of roots, inside hollow stumps and rarely on exposed surfaces. The spores of *H. annosum* are spread by the wind to infect wounds or freshly cut stumps.

Stem and Branch Cankers

Cankers usually develop after a bark injury (Hunt and Funk 1992). The wound is infected with a fungus that grows in the cambium and resists the host response. If the tree is vigorous enough, it can callus over the tissue killed by the canker. Where the fungus kills the cambium, the area appears sunken. Canker fungi can kill a branch or the whole tree by girdling. They also provide an entry court for decay fungi. Branches and trunks become weak at the location of cankers and may snap off in the wind.

Arbutus canker (*Nattrassia mangiferae*) has a wide host range, occurring on many tropical plants and orchard trees (English, *et al*. 1974). It even causes infections of human nails (Moore 1988). In madrones, these cankers first appear as areas of bark discoloration. The bark peels off, revealing dark masses of fungal spores and longitudinally cracked wood. Asexual spores are present all year in dead wood of the canker and are carried by the wind to infect new hosts (Hunt and Funk 1992). A callus ridge forms around the margin of the canker. In some cases this ridge is very raised and knobby in appearance (Plate 7-4). More rapidly spreading cankers have a smooth margin and no callus (Plate 7-5). Cankers most commonly occur on tree parts exposed to strong sun or injured by pruning or other mechanical causes (Davison 1972). Cankers can be prevented by minimizing wounding and by preventing sudden exposure of trunks to the sun (Anonymous 1987, Hunt and Funk 1992). If the cankered branch is removed, it should be cut well beyond the canker margin, as the fungus spreads some distance into the wood.

Nattrassia mangiferae is a Deuteromycete or "fungi imperfecti" (reproduce with conidia with no known sexual stage). Deuteromycetes cause many foliage and canker diseases. Some Deuteromycetes form chlamydospores or sclerotia (also a resistant form) to survive adverse weather.

Branch Dieback

Branch dieback works in conjunction with canker fungi

[*Fusicoccum aesculi* (Deuteromycetes)] (also called madrone canker). Its sexual stage, *Botryosphaeria dothidea* (Ascomycetes), is a pest in orchards and tropical plantations (Gilbert and DeSteven 1996). The disease begins at the branch tips and moves inward. The bark is a dark red that turns black and looks burned after the branch dies. Rapidly growing *Nattrassia* canker is mistaken for *Fusicoccum* infection because both cause cracked, blackened bark. The 2 fungi occur in the same canker on almond (*Prunus Amygdalus*) (English, *et al*. 1974). Tiny, pinhead sized fruiting bodies appear in the succulent parts of branch tips and on leaves. The spores are spread by rain, wind and possibly insects (McDonald and Tappeiner 1991).

This fungus does not attack vigorous trees. Its hosts are trees that are weakened by other canker fungi or other causes of water stress. Fungal growth stops when the host is receiving sufficient water (Boyer 1995); however, when the host is under water stress, photosynthesis decreases and fungal growth increases. This disease is prevented by watering the tree during the growing season and during dry periods; however, do not waterlog the soil. Dead branches should be removed and destroyed.

Wood Decay

Many wood decay fungi utilize the dead wood of madrone. A few species decay the heartwood of living trees (Plate 7-6). Wood decay fungi are Basidiomycetes that form conks, or perennial fruiting bodies. Basidiospores land where the wood is dead (usually killed by a canker fungus). The wood is cracked, crumbly and structurally weak. Damage by these fungi causes the tree to weaken and be a potential hazard in urban areas.

Basidiomycetes include all the wood decaying fungi, the root and butt rot *Heterobasidion annosum* and the foliar pathogen *Exobasidium vaccinii*. Rusts are Basidiomycetes with a complicated life cycle involving several hosts. Only one is reported on madrone (Hepting 1971). Its alternate host is a European spruce (*Picea abies*).

Foliage Diseases

Leaves are a prime target for pathogenic fungi because they have high concentrations of simple sugars. Leaves generally remain on the plant for 2 years, then abscise when new leaves are forming in the spring. Because madrone is a broadleaf evergreen, it has many foliar fungi. Foliar pathogens are more successful at colonizing senescent leaves than new leaves. In madrone, new foliage is rarely infected until fall (Hunt and Funk 1992). The spores are produced on infected

Plate 7-6. Fungal damage to madrone heartwood. This tree had three large trunks. One failed due to cankering and heart rot. Dampwood termites (*Zootermopsis angusticollis*) were present in the decayed wood. Seattle, Washington. Photo November 1996.

leaves from the previous year or in lesions on the branches. They are spread by wind and rain. Leaf pathogens are mostly Ascomycetes or Deuteromycetes. Foliage diseases intensify during periods of warm, wet weather. In some years, there is heavy damage to the foliage and most is lost. The infected foliage is replaced by new leaves in the summer, and the trees look healthier than others around them that may be suffering from summer drought.

Coccomyces quadratus and *Rhytisma arbuti* attack only madrone (Hunt and Funk 1992). They both reproduce by means of sexual spores that are released when wet. The fruiting body of *R. arbuti* is a speckled tar spot. Early in the season, the fungus produces pycnidia with single celled asexual spores. The infected tissues later become sclerotia. It also forms apothecia with sexual spores that are long and narrow. This fungus is one of the most damaging as it can overwinter on attached foliage. *Coccomyces quadratus* forms a large tar spot.

Most foliar pathogens (including the sexual stage of *Fusicoccum aesculi*) are Ascomycetes. They all have a similar life cycle. The sexual spores (ascospores) are released from the fruiting body on the leaf. This usually happens during wet weather, particularly in the spring. The ascospores land on another leaf of a suitable host and germinate. They colonize the leaf and form another fruiting body and asexual spores (conidia). In the summer the conidia are dispersed by wind and rain splash, infecting more leaves. The mycelium continues to produce conidia as long as conditions are favorable, and large quantities are produced in a season. The same mycelium then produces asci, and genetic material is exchanged between mycelia of compatible mating types. The ascospores overwinter on dead leaves and begin the cycle again in the spring.

Didymosporium arbuticola and *Diplodia maculata* are asexual fungi found only on madrone. Their fruiting bodies are small leaf spots. *Didymosporium arbuticola* forms brown spots 3–6 mm in diameter with purple to reddish margins (Hepting 1971).

Blister blight (*Exobasidium vaccinii*) forms pinkish blisterlike galls that make the leaves distorted and twisted. It attacks the fruit, making it turn red and swell to several times its natural size. Basidiospores are formed on the underside of the leaf blisters and on the surface of

the infected fruits in a thin layer of fungal tissue. They are ejected during wet weather.

Foliage diseases rarely threaten the survival of the tree; however, persistent foliage disease may predispose trees to attack by other fungi. Inoculum can be reduced by removing dead leaves and pruning infected twigs. Unraked leaves are a source of inoculum in the late summer or early fall. Splashing the foliage when watering spreads spores.

CONCLUSIONS

Damage by fungal pathogens can be reduced by providing conditions favorable to growth and vigor of madrones and by removing sources of inoculum, such as diseased limbs and foliage. Drought stressed trees and those in humid environments, such as in a forest understory, are the most disease-prone. Heavy, waterlogged soils and damage to the roots has the same effect as drought on the tree. Pathogenic fungi are most readily identified from their symptoms on the tree. Examination in the lab provides a more positive identification.

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