



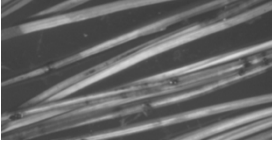





Select Forest Pathogens of California's Klamath Mountain Region

Page(s)	Disease	Description	Select Image
2-10	Wood Decay Fungi	<p>Most fungi are <i>saprotrophic</i>: feeding on non-living organic matter (= "decomposers"). Basidiomycetes and ascomycetes, as saprotrophs, are the primary decomposers of plant materials in terrestrial environments.</p> <p>Decomposition of plant materials is an important aspect of forest pathology:</p> <ol style="list-style-type: none"> 1) nutrient and energy cycling in forest ecosystems 2) stand structural heterogeneity 3) habitat/resources for microorganisms 4) habitat for cavity-nesting vertebrates 5) impacts on standing timber: heart rots, cull factor, etc. 6) disease organisms increase amount of plant materials available for decomposition 	
11	Rusts	<p>Diseases caused by fungal pathogens of the order Pucciniales. About 7800 species are known. The taxonomy of Pucciniales is complex and the darker coloured smut is often mistaken for rust. Rusts are so named after the reddish rusty looking sori and the disease is usually noticed after the first rains. The group is considered as one of the most dangerous pathogens to agriculture and horticulture.</p>	
12-13	Cankers	<p>General terms for a large number of different plant diseases, characterized by broadly similar symptoms including the appearance of small areas of dead tissue, which grow slowly, often over a period of years. They cause Localized necrosis of the bark and cambium on stems, branches or twigs. They are often sunken because the stem continues to get bigger elsewhere.</p>	
14	Oomycetes	Sudden oak death and Port Orford-cedar root disease	
15-16	Foliar Diseases	<p>Any number of fungi that infect the leaves of plants—usually conifers—and cause needle loss and/or casting. Characterized by small apothecia on the needle which ultimately causes red to brown discoloration, may turn to gray. Discoloration is often regular, the needle dying and turning color uniformly. In some cases, needles retain short green basal portions; in others, irregular discoloration occurs.</p>	
17-20	Mistletoes	<p>A group of hemi-parasitic plants in the order Santalales that grow attached to and within the branches of a tree or shrub. There are two groups. Phorodendron are larger with more photosynthetic material and on angiosperms and gymnosperms while arceuthobium are more parasitic and only on conifers. Northwest California is quite diverse in its dwarf mistletoes (Arceuthobium).</p>	

ROT TYPE	ROT FEATURES	FUNGAL SPECIES	
	 <p>cubical in pockets (brown pecky rot), live, top</p>	<p><i>Oligoporus amarus</i></p> 	<p>Host: incense-cedar Symptoms/indications: little outward symptoms on living trees rot: elongated pockets of cubical brown rot in heartwood of living trees; pockets remain discrete with sharp demarcations from intact heartwood (“pecky rot”) appears faint yellowish brown in the heartwood, confined to heartwood, estimated 30% cull factor in trees. Signs: soft annual conks (usually 1 per tree) with tan, moist top; yellowish hymenophore; hoof-shaped, annual. (Henkel)</p>
	<p>cubical in pockets, on <i>Sequoia</i>, live, top ↑</p> <p>Host: coast redwood</p>	<p><i>Poria sequoia</i></p> 	<p>Symptoms/indications: no outward symptoms on living trees rot: elongated pockets of cubical brown rot of the inner heartwood of living trees, pockets may coalesce in advanced stages so that much of central heartwood decayed; most prevalent in old growth; not transferred to stump sprouts in second growth. Dull dark stain in central heartwood, in thinly distributed pockets, with age eventually effect outer heartwood, fire scars are main route of entrance, Signs: White, resupinate, poroid fruiting body up to 2 inches in diameter; found in fire scars, bark crevices, and ends of down logs. Note: <i>Poria sequoiae</i> was responsible for 75% of the cull of original cut, old-growth. (Henkel)</p>
	<p>cubical, conifer, live, root/butt</p>  <div data-bbox="504 714 735 901" style="border: 1px solid black; padding: 5px;"> <p>Host: <i>Picea, Pinus, Pseudotsuga, Abies, Cedrus, Larix</i>; rarely on hardwoods in our region</p> </div>	<p><i>Phaeolus schweinitzii</i></p> 	<p>Symptoms: May lead to “bottle butt” phenomenon particularly Sitka spruce The heartwood often disintegrates completely leaving a hollow butt. A characteristic licorice-like odor is often associated with the advanced decay. Decay proceeds upward in butt usually less than 3 m above root collar, but decay columns may extend to 20 m in Douglas fir & ponderosa pine. Signs: butt rotter in heartwood, dark brown and velvety in texture above, often with yellow margin; hymenophore poroid, yellowish-green; imbricate brackets (on stumps) or pileate with stipe when on ground fruiting above infected roots has concentric rings and is red-brown and velvety, hence the common name “velvet top fungus”-- might be confused with <i>Fomitopsis pinicola</i>. (Allen et. al & Henkel)</p>
	<p>cubical, heart rot, conifer, live, top ↑</p> <p>Host: Found in Pinaceae, douglas-fir or old pines, increasingly rare.</p>	<p><i>Fomitopsis officinalis</i></p> 	<p>Sign: Can grow to be very old since on old-growth, fruiting body bitter to the tongue, perennial and vary from hoof-shaped to long pendulous structures, The lower surface is white when fresh, drying to light brown, and is poroid; the pores are relatively small and uniform in outline. The context is white or grey, relatively soft when young, toughening with age, and distinctly bitter in taste. Symptoms/indications: -little outward indication of top-rotting activity -rot: dark brown cubical rot with thick mycelial felts in upper bole of living trees -“top snap” of upper tree trunk or branches due to mechanical destabilization may be evident. (Allen et. al & Henkel)</p>
	<p>cubical, conifer, live, top ↑</p> <p>Host: <i>Pinaceae</i> (esp. Douglas fir), rarely hardwoods in our region.</p>	<p><i>Fomitopsis cajanderi</i></p> 	<p>Symptoms: Top breaks 2.5-15 cm diam are indicators for potential subsequent decay; regeneration of infected crowns with whorled branches. Advanced decay: yellowish-brown cubical rot with no mycelial felts in shrinkage cracks; confined to heartwood of living trees. “Top snap” of upper tree trunk or branches due to mechanical destabilization may be evident. Signs: Fruiting bodies (brackets) imbricate, effuso-reflexed, blackish above with pinkish, poroid hymenophore below; perennial; abundant in regions of occurrence. Infected trees shed branches and may eventually top-snap or fall from stand; thus fungus is rare in old growth stands. (Henkel)</p>

cubical, heart rot, conifer, slash (wound), occasionally live rotter.

Hosts: *Pinaceae* primarily; other conifers, some hardwoods to a much lesser extent in our region



Fomitopsis pinicola
(red-ring fungus)



Indications: light brown cubical brown rot with white mycelial felts in shrinkage cracks; on both sapwood (where it begins) and heartwood of standing or fallen dead trees **Signs:** highly variable in form; perennial shelf or hoof-shaped conks, to 60 cm width, upper surface gray to black with reddish orange outer margin (“red belt”), hymenophore poroid, white, often forming thick, rounded lip at margin often red-brown and lighter than other portions of the upper surface, does not stain brown with pressure The upper surface is usually zoned and has a wide range in color from dark brown through grey to black., The lower surface is white to cream and poroid; the pores are circular,, They are perennial, leathery to woody, and hoof-shaped or shelved. Might be confused w/ *phaeolus schweinitzii*, (lighter brown) **Note:** one of the most important saprotrophs in conifer forests of the northern hemisphere, contributing large amounts of brown-rot residue to soils. ([Allen et. al](#) & Henkel)

cubical, slash

host: montane conifers, particularly red fir (*Abies magnifica*) and lodgepole pine (*Pinus contorta*)

Oligoporus leucospongia



Signs: annual, effused-reflexed, shelving, 4.0-13.0 cm long, up to 5.0 cm in width; cap shell-shaped, the margin persistently incurved, arching over, and partially covering the pore surface; upper surface when young covered with a whitish matted-tomentum, becoming buff to pale-tan in age. **Comments:** snowbank species found throughout the montane regions of the western United States. It occurs commonly in the spring at higher elevations of the Sierra Nevada and presumably the Coast Ranges as well. ([Wood and Stevens](#))

cubical, slash

host: conifers

Gleophyllum saepiarium



Signs: small, annual, leathery and shelf-like. Upper surface is light-to-dark cinnamon, velvety at first aging to leathery. Decay yellow to yellow-brown pockets at first of sapwood or outer heartwood. ([Kuo](#))

Sap rotter, slash

Hosts: primarily conifers

Gleophyllum Sepiarium



Signs: The fruiting bodies are small, annual, leathery, shelf-like structures that generally form in cracks and checks on fallen logs. The upper surface is light-to-dark cinnamon brown, zoned, at first velvety but becoming roughened with maturity. The lower surface is light brown and consists of tough, radiating lamellae or gill-like structures (15-20/cm, counted at margin). **Symptoms:** The decay appears first as yellow to yellow-brown pockets of discoloration in the sapwood or outer heartwood. The advanced decay is a typical brown cubical rot, with yellow to yellow-brown mycelial felts in the shrinkage cracks. **Remarks:** This fungus is occasionally found on living trees, and on dead sapwood under scars, but most commonly on fire-killed trees and slash. Similar to *T. abietinum*. ([Allen et. al](#))

cubical, slash

Hosts: partial to birch, willow, and many other hardwoods, but only rarely on oak; very rarely on conifer wood





Daedalea confragosa








Signs: highly variable species--or cluster of species, perhaps--recognized by its elongated, maze-like pores; its thin, whitish to brownish cap with zones of color; and the tendency of its pore surface to bruise reddish. Fruit w/ grayish-brown with yellow-brown bands, surface shallowly grooved, radially wrinkled. **Symptoms:** a white delignifying decay of the sapwood ([Kuo](#))






	<p>cubical, heart rot, slash (wound, butt) Hosts: conifers (<i>L. conifericola</i>) and hardwoods (<i>L. gilbertsonii</i>). In our region, <i>L. conifericola</i> is usually found on natural stumps of coastal hemlock, while</p>	<p><i>Laetiporus conifericola</i> </p>	<p>Indications: The incipient state of the decay appears as a light brown stain. Later the wood breaks into small, red-brown cubes, sometimes having a rippled appearance with white mycelial felts in shrinkage cracks Signs: basidiocarps are large annual brackets, often imbricate, bright orange-yellow above, soft, spongy; hymenophore poroid, sulphur-yellow Notes: <i>Laetiporus</i> spp. occasionally establish on basal wounds of living trees, leading to compartmentalized butt rot. The decay of <i>L. sulphureus</i> is similar to that of <i>Fomitopsis officinalis</i>, but the mycelial felts are not bitter. Edible. (Allen et. al)</p>
	<p>cubical, slash, Brown Pocket Rot Hosts: in B.C. as a butt and trunk decay in Sitka spruce (Always w/l range of this species). In Washington and Oregon found on western hemlock,</p>	<p><i>Laetiporus gilbertsonii</i> </p>	<p>See above, very similar. Hosts: stumps or basal wound areas of planted <i>Eucalyptus</i> or hardwood fruit trees (e.g. <i>Prunus</i>)</p> <p>Sign: small pinkish-tan mushrooms that usually form on exposed advanced decay on fallen or split dead trees. Pockets of advanced decay are sharply delimited by apparently sound wood but adjacent pockets may occasionally coalesce to form a continuous column of decay. In pockets, wood breaks down into small brown cubes that are soft and friable in texture. In advanced stages, decayed wood crumbles away completely leaving well-defined hollow pockets Remarks: Decay cannot be detected in standing timber as the fruiting bodies form only on infected wood exposed to air. Known to survive in Sitka spruce logs that have been on the ground for more than 50 years. (Allen et. al)</p>
	<p>cubical, slash Hosts: <i>Abies</i></p>	<p><i>Pholiota abietis</i> </p>	<p>Hosts: on <i>Abies</i> and dead trees, logs, etc. Signs: Gilled, hypahe yellowish, smooth, walls thin, Lamellae pallid when young, becoming cinnamon and when dried rusty-fulvous. Similar to <i>P. aurivella</i>. Has been seen rotting a live <i>A. concolor</i> but most likely rotting deadwood in tumefactions. (Ammirati & Trudell)</p>
<p>White (selective delignification)</p>	<p>red stringy, heart rot , conifers, live, top ↑ Hosts: true firs (<i>Abies</i>), hemlock, rarely Douglas-fir and spruce (not <i>Pinus</i>). In our area expect to find it most often on old, large white fir (<i>Abies concolor</i>) in the mountains.</p>	<p><i>Echinodontium tinctorium</i> </p>	<p>Symptoms: little outward indication of top-rotting activity rot. Chemically a white rot but rot appears red and stringy due to fungal pigments. “top snap” of upper tree trunk or branches due to mechanical destabilization may be evident. Signs: woody, perennial, hoof-shaped conks up 1 foot in width; upper surface dull black and rough; toothed hymenophore gray to black; interior of conk bright brick-red (used as paint by Indians); fruit bodies usually found on underside of branch stubs, usually on old, standing dead trees. Hoof shaped fruiting body, brown and historically used for ochre colored paints, hymenophore can be sharply pointed when dried. Enters tree through branch snap and waits for heartwood to grow around it. (Allen et. al & Henkel)</p>


<p>selective</p>	<p>stringy, conifers, live root/butt</p> <p>Hosts: wide range—conifers and hardwoods</p>	<p><i>Heterobasidion annosum</i></p>  <p>sharp edge on fruit</p>	<p>Signs: perennial, woody to leathery, and vary from effused-reflexed or resupinate to bracket-like, upper surface is zoned, dark brown to black, acute margin (looks like giant <i>Trametes versicolor</i>). The lower surface is white to cream, and poroid; the pores are small and irregular in outline. The context is white to cream. Young fruits may be confused w/ <i>F. pinicola</i>. Most often found on the underside of decayed roots of living and standing-dead trees. On standing trees, look around the root collar to locate them. Can be on REDWOODS! Indications: expose the roots and root crown: a) bark separates from wood easily b) look for characteristic rot features (yellowish stringy rot from selective delignification) Disease centers common, spread by root to root contact, can survive underground for 20 years, enters through spores on fresh cut stumps. (Allen et. al & Henkel)</p>
<p>selective</p>	<p>stringy, conifers, live root/butt</p> <p>Hosts: conifers (<i>A. amabilis</i>, <i>A. grandis</i>, <i>A. lasiocarpa</i>, <i>L. occidentalis</i>, <i>P. engelmanni</i>, <i>P. contorta</i>, <i>P. ponderosa</i>, <i>T. plicata</i>, <i>C. lawsoniana</i>, <i>T. brevifolia</i>, <i>T. herterophylla</i>, others)</p>	<p><i>Armillaria ostoyae</i></p> 	<p>Symptoms: crown symptoms typical of root diseases; that is, reduced leader growth and foliage discoloration and thinning. On trees where the fungus is present at the root collar, resin exudes through the bark of the lower bole. On diseased trees and those that have been dead for several years, impressions of mycelial fans may be seen on the inner bark. The fruiting bodies of <i>A. ostoyae</i> are cream to brown-coloured mushrooms with a 5-10 cm wide cap and a distinct ring on the stem. Signs: are produced from late summer to mid-autumn around the base of infected, living trees, killed trees, and colonized stumps. Disease centers—openings in canopy—common (Allen et. al)</p>
<p>selective</p>	<p>stringy, hardwoods, Live root/butt (honey mushroom)</p> <p>Hosts: wood of hardwoods (and occasionally on conifers);</p>	<p><i>Armillaria mellea</i> complex</p> 	<p>causing a white, pulpy rot in the wood; spreading through wood, and from tree to tree, by means of long black rhizomorphs; mushrooms typically appearing in large clusters on wood in the fall after rains, but found nearly year-round in warmer climates; Cap: 3-15 cm, convex to broadly convex or flat in age; the margin often arched in maturity; dry or tacky; color extremely variable, but typically honey yellow; smooth, or with a few tiny, dark scales concentrated near the center and vaguely radially arranged. Gills: Attached or beginning to run down the stem; nearly distant; whitish, sometimes bruising or discoloring darker. Stem: persistent ring at maturity and a white partial veil covering the gills when young. (Henkel)</p>
<p>selective</p>	<p>pocket, heart rot, live, top ↑</p> <p>Hosts: most Pinaceae, especially Douglas fir in western North America, and including Pinus; occasionally Cupressaceae. In our area you will find it most often on Douglas fir.</p>	<p><i>Porodaedalea pini</i></p> 	<p>Symptoms/Indication: Little outward indication of top-rotting activity; resinous around infected branch stubs may be evident Rot: red stain in the heartwood. In cross section, a well-defined ring often forms, hence the common name "red ring rot." Selective delignification white rot of heartwood, with discrete, small, white decay pockets scattered through sound wood; these may coalesce with time into continuous decay column "top snap" of mid- to upper tree trunk due to mechanical destabilization may be evident Signs: woody, perennial conks, highly variable in shape; 2-10 inches wide, from thin and bracket-like to thick and hoof-shaped; upper surface dark gray with concentric rings; hymenophore porose, maze-like, and rich reddish-brown. Produced directly under or around old branch stubs. A vegetative sign consists of "punk knots" of golden brown hyphae packed inside branch stubs. (Allen et. al & Henkel)</p>


<p>White (simultaneous)</p>	<p>Pitted sap rotter, lacy, slash</p> <p>Hosts: conifers, particularly conifers where it is a quick colonizer which only rots sapwood.</p>	<p><i>Trichaptum abietinum</i></p> 	<p>Sign: rarely form on living trees but may be produced in great abundance on dead trees and forest litter. Embricate fruiting with jagged hymenophore, purple when fresh, white lacy rot. They are small (1-3 cm across), annual, thin, effused-reflexed, or shelf-like, forming abundantly in bark crevices. The upper surface is zoned, light grey and somewhat hairy in texture. On older specimens the upper surface may appear green from algal growth, or black. Symptoms: the wood becomes light-yellow to tan and soft. In the advanced stage, small pits develop, elongated in the direction of the grain, which may at first be filled with white fibrous material but later become empty. The cross section of the decay has a honeycomb appearance. (Allen et. al)</p>
<p>(simultaneous)</p>	<p>laminated pitted, conifers, live (root/butt) basidiomycete</p> <p>Hosts: <i>P. menziesii</i>, <i>A. grandis</i>, <i>A. amabilis</i>, <i>A. concolor</i>, <i>T. mertensiana</i> highly susceptible. Other Pinaceae susceptible with low mortality</p>	<p><i>Phellinus (Poria) weirii</i></p> <div data-bbox="730 527 919 669" style="border: 1px solid black; padding: 5px; width: fit-content;"> <p>Fruiting body rare, gill-like</p> </div> 	<p>Infected trees may be randomly dispersed throughout a stand or may occur grouped in "disease centers," which are often visible from the air as openings. Symptoms: rounded crowns, chlorosis, distress cones. The bark of the lower bole sometimes has a darkened, water-stained appearance shortly before or after tree death. Basal resinosis is rare. The annual fruiting bodies are brown, crust-like layers on upturned roots and on the underside of decayed logs. When fresh, they are light buff with narrow white margins; they turn a uniform dark brown when old and may remain in place for 2-3 years. Disease last for many years spread by root to root contact (symptoms ~15 years to appear after infection and persists for 10+. Southern most discovered disease center is on horse mountain. Two forms recognized (DF and Cedar) (Allen et. al & Henkel)</p>
<p>(simultaneous)</p>	<p>mottled, heart rot, slash (sometimes live)</p> <p>Hosts: hardwoods (primarily) and conifers. In our area expect to find it on California bay, big leaf maple, and rarely on Douglas fir.</p> <p>artist's conk</p>	<p><i>Ganoderma applanatum</i></p> 	<p>Symptoms/indications: white, mottled spongy rot (simultaneous) on hardwoods, and white pocket rot on conifers. Note that in our area living California bay and bigleaf maple with persistent wound entry butt rots by <i>G. applanatum</i> may exhibit "reiterative physiognomy" Signs: medium to large perennial conks that are dull brown and zonate on top, with a grayish-brown hymenophore that when fresh scratches into dark brown lines instantly. Light brown lower is white turning brown with age. Note: similar to <i>G. oregonense</i> which is more common on conifers. (Allen et. al & Henkel)</p>
<p>(simultaneous)</p>	<p>mottled, hardwoods, slash</p>	<p><i>Pleurotus ostreatus</i></p> 	<p>Hosts: can be found that vary from white and relatively thin-fleshed on oaks to thick fleshed, grey-brown shelves on cottonwood and willow, rarely conifers. Fruit: Cap 5-25 cm broad, fan-shaped, broadly convex to sometimes nearly plane at maturity; margin lobed to wavy, especially when young; surface smooth, white to greyish-brown; flesh white, odor of anise. Decay is mottled with lateral white banding in contrast to vertical vascular tissue of host. (Wood and Stevens)</p>



(simultaneous)	<p>pocket, live</p> <p>Hosts: wide range of conifers</p>	<p><i>Inonotus tomentosus</i></p> 	<p>Symptoms: reduced leader and branch growth, thinning of the foliage, stress cone crops, and death of the tree. Although rare, cankers and resinosis may be present at the base of stems and near the root collar. Signs: small, usually less than 10 cm in diameter, stalked, and are found on the ground around infected trees annual and leathery. The upper surface is yellow-brown to rust-brown and velvety. The whole fruiting body becomes dark brown with age. Decay: red-brown discoloration in the heartwood. The advanced decay has large, elongated to rectangular spindle-shaped pits, separated by red-brown firm wood. (Allen et. al)</p>
(simultaneous)	<p>pocket, conifers, live Butt/ROOT</p> 	<p><i>Pseudoinonotus dryadeus</i></p> <div data-bbox="667 435 850 574" style="border: 1px solid black; padding: 5px; width: fit-content;"> <p>Amber liquid exudes from fresh fruiting body</p> </div> 	<p>Hosts: firs in the Pacific Coast Region and Southwestern U.S. Symptoms: White rot of heartwood in butts and roots of living oaks and true firs Range: Pacific Coast conifer forest ecosystems with true firs . Typically develop at the ground line at the base of infected trees or from roots and some distance from the base. Damage: in our region, causes extensive crown root and butt decay, leading to premature windthrow in white fir; degree of actual cambial necrosis involved is unclear; often co-occurs on individual trees with Armillaria infections. Root ball in tip-ups. (Henkel)</p>
(simultaneous)	<p>pocket, true firs, live, canker/sapwood, Canker</p>	<p><i>Porodadaelea cancriformans</i></p>	<p>Dark brown when old, clustered conches in sunken depressions. Establish themselves, destroy cambium, alter inner bark and spread radially. Appears as dark, sunken pockets in the trunk of the tree (for more see Canker section)</p>
(simultaneous)	<p>spongy, slash, white mottled rot</p> <p>Hosts: <i>Pinaceae</i>, especially Douglas fir in our area, slash.</p>	<p><i>Ganoderma oregonense</i></p> 	<p>Signs: Conks, though they are annual and relatively soft in texture, can reach 40 cm in width, and are shiny red-brown (“varnished”) unlike the dull brown basidiomata of <i>G. applanatum</i>. an be covered with spores. Annual some specimens may have a small lateral stem-like attachment to its host tree. The cap surface is smooth, with a thin and brittle crust, and shines as if varnished (laccate), dark reddish brown in color Indications: white spongy rot (simultaneous) with some pocketing Red, varnished, lacquered looking fruit. (Henkel)</p>
(simultaneous)	<p>Yellow pitted spongy rot, heart rot, slash</p> <p>hosts: <i>A. amabilis, grandis, lasiocarpa, Tsuga spp., P. engelmanni, P. menziessi.</i></p>	<p><i>Hericium abietis</i></p> 	<p>Signs: soft, annual, fleshy, white w/ many downward-directed spines. Symptoms: yellow to brown heartwood stain. Later elongated pits form which orient longitudinally in the wood. Pits usually empty but may contain yellow to white mycelium. Rot similar to <i>Phellinus pini</i>. Notes: fruiting bodies usually on slash at the end of cut logs but may form on wounds of living trees. Because of fleshy nature, short lived. (Allen et al.)</p>
(simultaneous)	<p>spongy, slash</p> <p>Hosts: Hardwood</p>	<p><i>Stereum ochraceo-flavum</i></p> 	<p>Signs: upper surface even to undulate with dense, mostly erect hairs, faintly-zoned, buff to tan-brown, indistinctly-zoned, and uniformly hairy (compare to <i>S. hirsutum</i>), the margin paler, senescent material greyish-white; hymenial surface glabrous with shallow bumps and depressions grayish hymenophore, favors sticks and small branches. (Ammirati & Trudell)</p>


<p>(simultaneous)</p>	<p><i>Stereum hirsutum</i></p>  <p>spongy, slash Hosts: Hardwood</p>	<p>Signs: orange-brown to greyish-orange, conspicuously-zoned with hairs which weather away on at least some of the concentric rings. Hymenophore orange and with no magnification can one see pores. Compare to <i>Trametes versicolor</i>. Usually found on logs. (Ammirati & Trudell)</p>
<p>(simultaneous)</p>	<p><i>Stereum sanguinolentum</i></p>  <p>spongy, heart rot, slash Hosts: pinaceae</p>	<p>Signs: common on the lower side of fallen dead branches, log ends and on the face of infected wounds, annual, leathery, and resupinate often forming thin, crust-like layers. Upper surface is grey to light brown and zoned the lower surface is wrinkled, grey to light brown, turning blood red when bruised, hence the common name "bleeding fungus." Symptoms: initially firm and appears as a red-brown heartwood stain, advancing to light brown to red-brown and soft and fragile in texture. Thin white mycelial fragments may develop in association with advanced decay. Finally, the wood becomes a brown, fibrous, stringy mass Remarks: <i>S. sanguinolentum</i> is commonly associated with runing wounds, logging scars, and lesions formed as a result of climatic injury. It has also been reported to gain entry through root injuries. (Allen et al.)</p>
<p>(simultaneous)</p>	<p><i>Trametes hirsute</i></p>  <p>spongy, slash hosts: dead hardwoods</p>	<p>Upper surface: Densely hairy; grayish to yellowish or brownish, often with brownish margin; zonate or not; usually concentrically grooved. exhibits a good amount of variation in the appearance of the cap and pore surfaces, making identification sometimes uncertain. It is found on dead wood of deciduous trees, especially beechwood. It is found all year round.</p>
<p>(simultaneous)</p>	<p><i>Trametes versicolor</i></p>  <p>spongy, slash hosts: dead hardwoods, sometimes conifers</p>	<p>Signs: variable, but tend to stay in the buff, brown, cinnamon, and reddish brown range. The mushrooms are strikingly "zonate" with sharply contrasting concentric zones of color, and the surface of the cap is finely fuzzy or velvety. Alder-turkey tail fungus. Cap usually a combination of grey, brown or cream, rarely with orange tones (which <i>S. hirsutum</i> has) White hymenophore which you can see pores. Compare to <i>Stereum hirsutum</i>. (Kuo)</p>
<p>(simultaneous)</p>	<p><i>Xylaria hypoxylon</i></p>  <p>spongy, hardwood, slash candlestick fungus</p>	<p>Signs: cylindrical or flattened with dimensions of 3–8 centimetres (1.2–3.1 in) tall × 2–8 mm thick. The erect ascocarps are often twisted or bent, and typically sparsely branched, often in a shape resembling an antler's horns, blackish, thin, wiry and branched with white tips. (Wood and Stevens)</p>

(simultaneous)	<p>spongy, hardwoods, slash (live)</p>	<p><i>Bjerkandera adusta</i></p> 	<p>Hosts: wide diversity of hardwoods. In our area usually encountered on red alder near the coast. Signs: thin, shelf-like annual bracket fruiting bodies, imbricate in dense clusters; upper surface white to grayish-tan, zonate; hymenophore poroid, distinctly gray. Symptoms: white spongy rot, often with numerous black “zone lines”, in dead wood; when occurring on live trees, decay may contribute to top snap of bole Disease cycle: Bjerkandera adusta occurs primarily as a slash rotter on standing dead or nearly dead hardwood trees in our region. (Henkel)</p>
(simultaneous)	<p>spongy, hardwoods, live, top ↑</p>	<p><i>Phellinus arctostaphyli</i></p> 	<p>Hosts: <i>Arctostaphylos</i> spp. (manzanita) Branch break entry Symptoms/indications: little outward indication of top-rotting activity on older, larger <i>Arctostaphylos</i> individuals; individual branch breakage may occur due to heart rot. Rot: white, spongy from simultaneous white rot Signs: small- to medium-sized, hard conks with brown, porose hymenophore. (Henkel)</p>
(simultaneous)	<p>spongy, heart rot, live, top ↑</p> <p>Hosts: Hardwoods, esp. Salix and cottonwood. many deciduous tree species.</p>	<p><i>Phellinus igniarius</i></p> 	<p>Symptoms/Indications: little outward indication of top-rotting activity rot: The early stage of the decay appears as a yellow-white zone in the heartwood, usually surrounded by a yellow-green to brown margin. a highly bleached rot resulting from simultaneous white rot; areas of brown setal hyphae characteristic of the <i>Hymenochaetaceae</i> may be present In the advanced stage the soft yellow-white wood usually contains fine black zone lines running throughout Signs: The fruiting bodies perennial, hard, woody, and generally hoof-shaped, The upper surface deeply zoned, grey-black and roughened when old. The lower surface is brown and poroid; the pores are small and regular in outline. (Allen et al.)</p>
(simultaneous)	<p>spongy, hardwoods, slash</p> <p>hosts: hardwoods and, occasionally, conifers</p>	<p><i>Lenzites betulina</i></p> 	<p>Signs: annual; growing alone or in overlapping clusters on logs and stumps; producing a white to straw-colored rot of the sapwood; summer and fall; widely distributed in North America, often radially bumpy or ridged; with zones of whitish, grayish, and brownish colors; flexible (Kuo)</p>
(simultaneous)	<p>spongy, slash</p> <p>hosts: hardwoods and conifers</p>	<p><i>Hypholoma fasciculare</i></p> 	<p>common, often found fruiting in large, striking clusters on the wood of conifers or hardwoods. Signs: When fresh, the clustered caps are bright yellow to greenish yellow--as are the gills and stems. Bright sulfur yellow to greenish yellow when fresh, sometimes yellowish orange when young, often with a darker center; the margin sometimes with small partial veil fragments. (Kuo)</p>

<p>(simultaneous)</p>	<p>spongy, mottled, slash, wound, on live trees though not live rotter Hosts: hardwoods, primarily oaks (<i>Quercus</i>). In our area found usually on California black oak (<i>Q. kelloggii</i>) and occasionally canyon live oak (<i>Q. chrysolepis</i>), White oak (<i>Q. garryana</i>)</p>	<p><i>Inonotus dryophilus</i></p> 	<p>Signs: medium to large annual to sub-perennial hoof-like conks, dark brown throughout, irregular porose hymenophore, with dark reddish brown internal tissues, borne on host trunks in vicinity of decay zones. 3-6 feet up the trunk Symptoms: white spongy rot with some mottling; decay zones may induced branch or trunk breakage exposing hollow heartwood decay zones in oaks (Henkel)</p>
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<p>white sap rots</p>	<p>hard gray saprot, conifers, recently dead—arrives and extracts sugars from heartwood quickly Hosts: conifers, primarily <i>Pinaceae</i>.</p>	<p><i>Cryptoporus volvatus</i></p> 	<p>In our area most often encountered on recent standing dead Douglas fir or recently bark beetle- or fire-killed Ponderosa pine Signs: Annual, leathery, pouch-like, up to 4 cm wide. Upper surface is smooth, and yellow to light brown (later white). Poroid hymenophore at first covered with a hard membrane continuous with the upper surface. Later an opening forms at the base of the membrane to permit the release of the spores, usually by the action of beetles. Symptoms: cream to light grey discoloration in narrow bands in the outer sapwood; the discoloration is particularly evident in a radial or tangential section. In the advanced stage, the affected wood is light brown, cubical and crumbly. (Henkel)</p>
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<p>Black Stain Root Disease</p>		<p><i>Leptographium wagnerii</i></p> <p>Mycelium follows trachiads</p> 	<p>Host/Range: Western United States, particularly here. DF, JP, PP— 5- needle pines, firs, hemlocks resistant. Incidence increasing as forest management increases—stress from human activities. Symptoms: 1. Crown thinning 2. Reduced terminal growth 3. Chlorosis 4. Stress cones 5. Death (tree is girdled via clogging of sapwood. In the root/butt zone witness black stain. Symptoms distinctive in fresh material but may be masked in trees dead for a while. Digests soluble sugars and eventually girdles the tree. Watch for significant basal resinous. Often in areas disturbed by humans. It is a vascular wilt, meaning fungus grows through infected roots in the trachiads preventing water conduction. May extend up to 3m up the stem. Long distance spread via root-feeding insects Associates with <i>P. weirrii</i>, <i>A. ostoyae</i>. (Allen et. al & Henkel)</p>
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<p>Sooty molds charcoal black fungus that appears as a black coating on the surface of leaves, fruits, twigs and branches of many deciduous and evergreen shrubs and trees. This fungus is not pathogenic to plants but obtains its nourishment from insect honeydew.</p>	<p><i>Arthrobotryum spongiosum</i></p> 	<p>Causal Agent: incense-cedar scale <i>Xylococcus macrocarpae</i></p>	<p>Scales are abundant under loose, flaky bark of small (~20-cm. b.h.) cedars, and on limbs of larger cedars. Sooty Molds will grow wherever honeydew from incense-cedar scale insects accumulates. In dense forest stands these molds will cause the branches of suppressed incense-cedars to turn black—resembling a tree scorched by fire. Sooty molds are not harmful to trees unless they become so heavy on the foliage they impair net photosynthesis. Because they are not parasitic they do not receive much attention from pathologists however, underlying infestation of scale insects is a direct threat to tree vigor. (Morrison et al.)</p>
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Rusts






Diseases caused by fungal pathogens of the order **Pucciniales**. About 7800 species are known. The taxonomy of Pucciniales is complex and the darker coloured smut is often mistaken for rust. Rusts are so named after the reddish rusty looking sori and the disease is usually noticed after the first rains. The group is considered as one of the most dangerous pathogens to agriculture and horticulture.







<p><i>Calyptospora goeppertiana</i></p> <p>Fir huckleberry rust.</p>		<p>Found on grand fir. Demicyclic rust w. spermagonial and aecial stage on true firs and telial stage on Huckleberry. Uredenial stage lacking. Throughout NA. Signs in firs: late summer mature on firs chlorosis in needles and aecia on underside (slender white column). Huckleberry: aeciospores onto plant in summer results in hypertrophied branches—swollen, spongy, and reddish brown. Infection perennial. (Henkel)</p>
<p>White Pine Blister Rust</p> 	<p><i>Cronartium ribicola</i></p> 	<p>5-needle pines, northern hemisphere. Heterocious, macrocyclic rust w. spermagonial and aecial stage on pines and Uredenial and telial stages on Ribes. Basidiospores to pines in late summer, fungus grows into branches causing swelling, spermagonia formed 1-several years later, fertilization, aecia formed next spring, aeciospores released, necrotic bark and cambial death, rust moves into healthy tissue, enlarges, cont. Symptoms on pines: orange aeciospores in spring, old cankers w/ rough, ruptured bark, may become resinous, flagging, top die-back ribes: yellow uredinial pustules on underside of leaf in summer, late summer telial columns—dies each year w/ leaf loss. (Allen et. al, Worrall & Henkel)</p>
<p><i>Endocronartium harknessii</i></p> <p>Western gall rust</p>		<p>2-3 needle pines (Bishop, lodgepole, ponderosa, Jeffrey, ghost). Native, across NA. Autoecious, microcyclic producing spermagonial and aecial and telial stages on pine. Symptoms: conspicuous perennial globose galls (tumefactions) on branches and stems. May-July: powdery, orange-yellow aecial teliospores produced on gall. With enlarging gall, branches girdled and die. Possible witches broom formation. (Allen et. al & Henkel)</p>
<p><i>Gymnosporangium libocedri</i></p> <p>Incense-cedar broom rust</p>		<p>Demicyclic w/ spermagonial and aecial states on Rosaceae (hawthorn, service, apple, etc.) and telial on incense-cedar. Found in Pacific states. Symptoms on cedar: spindle-shaped tumefactions and dense fasciculations. Telia small, gelatinous, yellowish-orange. On Rosaceae: spermagonia as pustules on upper leaf surface, aecia on undersides, annual infection. Mortality from rust is uncommon. (Henkel)</p>
<p><i>Melampsorella caryophyllacearum</i></p> <p>Fir Broom Rust</p>		<p>Macrocytic rust w/ spermagonial and aecial stages on true firs and uredinial and telial stages in chickweeds (<i>Stellaria</i> spp.). Ranges throughout NA. Symptoms on fir: dense fasciculations, swelling w/ canker development, perennial, aecia yellow, blister like on needle undersurfaces. On Chickweed: leaf blight, uredinial as tiny orange-red pustules on both sides of leaves, telia are orange. Damage includes loss of height, breakage and death in firs. (Allen et. al & Henkel)</p>
<p><i>Cronartium comandrae</i></p> <p>Comandra Rust of Pine</p>		<p>Hosts: Macrocytic rust with spermagonial (0) and aecial (I) stages on <i>Pinus contorta</i> and <i>Pinus ponderosa</i> in California; uredinial (II) and telial (III) stages on bastard toadflax (<i>Comandra umbellata</i>; <i>Santalaceae</i>). Distribution: Throughout North America on 2&3 needle pines; primarily Sierras in California Symptoms, signs, & diagnosis:-on pine, fusiform swellings in young stems, and wide cankers on older trunks (<4:1 length to width ratio) -aecia orange Damage: -average number of years for canker to girdle and kill trunk equals the diameter of the trunk in centimeters-topkill common. (Henkel)</p>
<p><i>Cronartium coleosporioides</i></p> <p>Stalactiform Rust of Pine</p>		<p>Hosts: Macrocytic rust with spermagonial (0) and aecial (I) stages on <i>Pinus contorta</i> (lodgepole pine); uredinial (II) and telial (III) stages on scrophulariaceous hosts (e.g. Indian Paintbrush; <i>Castilleja</i> spp.) in the Sierras; many 2-3 needle pines Distribution: Northern North America; most important in California in Sierra Nevada (native) Symptoms, signs, & diagnosis:-on pine, aecial main stem cankers are long (> 10 m!) and narrow; these develop white aecia in spring (length to width ratio of cankers >10:1) -aecial filaments are pendant, hence the name "stalactiform" Damage: Saplings girdled; older trees not girdled; resin content of wood increased, but still commercially valuable. (Henkel)</p>

Cankers



General terms for a large number of different plant diseases, characterized by broadly similar symptoms including the appearance of small areas of dead tissue, which grow slowly, often over a period of years.

They cause localized necrosis of the bark and cambium on stems, branches or twigs. They are often sunken because the stem continues to get bigger elsewhere.


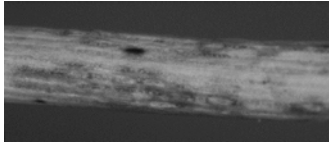

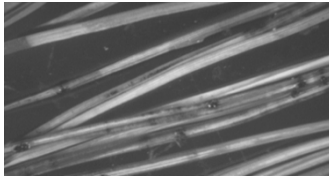
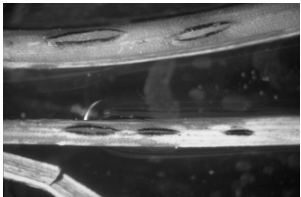
<p><i>Atropellis piniphila</i></p> <p><i>Atropellis canker</i></p> <p>Host: <i>P. contorta</i></p>		<p>Symptoms and signs:-large, sunken perennial cankers on branches and stems -resinosis, distortion in growth, blue-black stain of the sapwood & heartwood -cankers centered around branch stubs, where infection occurs -pycnidia in young cankers small (1-2 mm), round, slimy - apothecia stalked, black, disc-shaped, 2-5 mm diameter Damage: Mortality if stems girdled by multiple cankers; otherwise increment reduction and reduced wood quality. Trees between 15-30 years old most likely to be attacked; younger or older trees have very low incidence of <i>Atropellis</i> canker. Notes: A closely related fungus, <i>Atropellis pinicola</i>, attacks only branches of young or stressed sugar pine and western white pine in our region, causing little damage of mature trees. (Henkel)</p>
<p><i>Cytospora abietis</i></p> <p>Hosts: true firs in our region; Douglas fir in other western regions</p>		<p>Signs: resinous cankers, w/ distinct margin between infected and non-infected areas. Spores dispersed by raindrops. Symptoms-<i>numerous brick-red flagged branches in spring and summer</i>; these tan later in year -tops of young trees attacked; lower branches of older trees -often associated with dwarf mistletoe infection, in established fasciculation branches (witches' brooms) - cankers are dark, sunken, dead patches of bark with resinosis -small, pimple-like fruiting bodies in cankers exuding thread-like conidial spore masses Damage: considerable in environmentally-stressed fir stands; particularly so in trees infested with <i>Arceuthobium abietinum</i>, where <i>C. abietis</i> preferentially infects mistletoe-infected branches, accentuating branch mortality and overall decline. (Henkel)</p>
<p><i>Pseudomonas pseudotsugae</i></p> <p>Bacterial Gall/ Canker of Douglas Fir</p>		<p>Very common bacteria found on suppressed/susceptible trees. Causes odd shaped black galls usually on lower suppressed branches but can be on larger trees. Wind throw hazard when canker gets too big. Vectedored by sucking insects. Symptoms and signs-cankorous galls (tumefactions) up to several inches in diameter on branches and boles of Douglas fir -no signs – bacterial Damage: minimal to large trees; individual branches may die Note: bacterium is transmitted by sucking insects (Henkel)</p>
<p><i>Porodaedalea (Phellinus) cancriformans</i></p> <p>Porodaedalea Canker Rot of True Fir</p> <p>Hosts: <i>Abies</i></p>		<p>Symptoms, signs, indications: broad sunken perennial cankers on mid-large diameter <i>Abies</i> trunks, these usually barked-over with somewhat raised margins, usually clearly associated with branch stubs-signs are brown, imbricate brackets usually clustered around the canker margin; emerging through the bark Note : <i>P. cancriformans</i> is termed a canker-rot because it essentially acts a live-rot heart rotter on fir, but has the capacity (and does) emerge from the heart wood through the live sapwood into the cambium, where it can then spread laterally via cambial necrosis, leading to the perennial canker. Thus, it apparently has the capacity to overcome active sapwood defense unlike the majority of heart rot fungi when on living trees. Infection biology apparently is like that of <i>P. pini</i> – entry via branch stubs, then proliferation in the heartwood. (Henkel)</p>
<p><i>Fusicoccum</i></p> <p>Fusicoccum Canker of Madrone. <i>A. menziesii</i></p>		<p>Symptoms and signs:-infection begins at outer tips of the branches → bark wine-red initially, eventually turning black when the branch dies, giving the appearance of fire damage-as infection advances → wedge-shaped canker eventually girdles the branch -individual infected limbs sharply demarcated from healthy limbs-old infected limbs appear sooty-signs: only seen in culture (not field)Damage: progressive die-back of crown branches; top death. (Henkel)</p>



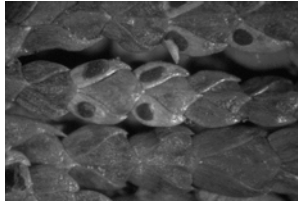
Proliferation	<p><i>Hendersonula sp.</i> Hendersonula Canker of Madrone <i>A. menziesii</i></p>		<p>Symptoms and signs:-sunken black cankers with reddish raised callus margins on stems and branches Signs: pycnidia borne in black stroma on canker, spores extruded in tendrils. Damage: die back of affected branches; occasional whole tree death. (Henkel)</p>
	<p><i>Dibotryon morbosum</i> Black Knot Canker of Cherry Hosts: <i>Prunus</i> spp.</p>		<p>Symptoms, signs, damage:-gall-like hypertrophies which open into cankers, eventually covered with masses of black, stromatic pseudothecia-cankerosus swellings lead to limb die-back; these can be important in fruit orchards (cherry, plum)-trunks galls reduced quality of black cherry lumber in eastern US. (Henkel)</p>
	<p><i>Dermea pseudotsuga</i> Host: <i>P. menziesii</i>, <i>A. grandis</i></p>		<p>Symptoms -cankers on limbs have characteristic reddish margin; lead to die back of limbs & tops signs: yellowish apothecia appearing one year after death of affected limb Damage: limb dieback and trunk cankers can occasionally kill young trees, even in natural stands; damage more significant in plantations. Bacteria spread by midge. (Henkel)</p>
	<p><i>Phomopsis lokoyae</i> Phomopsis canker on Douglas-fir <i>P. menziesii</i></p>		<p>Symptoms and signs: -young trees: sunken branch and trunk cankers, several times longer than wide, often with dead twig or branch at center -signs: pycnidia black, born in stroma, oozing - apothecia of teleomorph discoid, black, sessile in cankers (<i>Diaporthe</i> stage) Damage: leader and branch dieback; young and suppressed trees susceptible; problematic in drought-stressed stands. (Henkel)</p>
	<p><i>Fusarium circinatum</i> Pitch canker Hosts: <i>P. radiata</i>, <i>P. murricata</i>; reports on <i>P. menziesii</i> in California</p>		<p>Symptoms and signs: copiously resinous, sunken cankers which retain bark on trunk and large branches-underlying wood deeply soaked with resin ("pitch")-cambium & young phloem turn bright red; streaks running to pith-infection courts appear to be mechanical wound sites; in California there is some evidence that insects (e.g. bark beetles) vector the fungus-flagging and shoot die-back on cankered stems and branches Damage: top dieback leads to mortality in overstocked stands in southern part of Monterey pine range; perennial stem cankers may girdle tree → mortality. Introduced Species, threatening native Monterey pine populations. (Henkel)</p>
	<p><i>Taphrina occidentalis</i> Taphrina Proliferation of Alder Catkins</p>		<p>-causes proliferative growth in "scales" of pistillate catkins of alder -severe infections can lead to reduced vigor and delayed spring bud burst. (Henkel)</p>



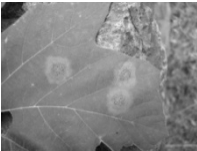
Oomycetes | Other non-native Cankers

<p><i>Phytophthora</i></p> <p>Root Rotters</p> <p>Live Rotters</p> <p>cankers</p>	<p><i>Phytophthora ramorum</i></p> <p>Sudden oak death</p>		<p>The leaves and twigs of susceptible hosts are readily colonized by zoospores. Leaves and twigs then develop black lesions (which spread to branches in some species, causing dieback). In conditions of high humidity (close to 100%) and moderate temperature, new sporangia and resting round structures (chlamydospores) will be produced on the lesions in approximately 48 hours. Infectious propagules accumulate in the soil beneath the plant in water bodies. In the final disease phase, the main stems of tanoaks and oaks may be infected. The pathogen preferentially colonizes the sugar-rich phloem of the host, only marginally colonizing the outer bark and xylem. As a result of phloem colonization a canker develops under the bark, and sappy exudates will flow outside the bark. In tanoaks multiple cankers often occur on tanoaks at different heights (thought to be caused by sporangia produced on leaves of the infected host tanoak or on the leaves of adjacent infected hosts). On the less susceptible coast live oaks cankers normally only occur near the soil line. As oak leaves are rarely colonized by <i>P. ramorum</i> re-infection from the host tree is not likely. This is why infection in oaks is epidemiologically linked to, and depends on, the presence of adjacent infected foliar hosts (such as bay laurel). If girdling occurs the irreversible death process is started (although it may take a year or more for browning of the tree's crown to occur). Girdling leads to the establishment of secondary organisms and opportunistic pathogens. (Henkel)</p>
	<p><i>Phytophthora lateralis</i></p> <p>Port Orford Cedar Root Disease</p>		<p>Damage: Aboveground symptoms include generalized crown decline as in other root diseases. -rapidly colonizes fine root phloem -grows to through inner bark and cambium to root crown, butt -root/shoot conductivity destroyed, tree girdled, mortality -creates a sharp demarcation zone between reddish, infected phloem below and white, healthy tissue above. is cool-climate species-active in mild, wet winters-inactive in warm, dry summers-carried upslope in mud and debris-carried downslope in water-Chlamydospores: form within two weeks in infected roots; remain infective for ~6 years-these are transported in mud during wet weather-these germinate and produce motile zoospores in vicinity of POC roots in streams and saturated soils-zoospores swim to roots and infect ("host species-specific chemotactic homing")-zoospores may be transported down watersheds. (Roth et. al)</p>



Foliar Diseases



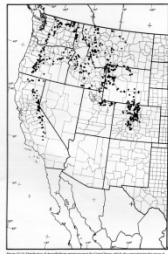


<p>Most pines</p>	<p><i>Lophodermium pinastri</i> Lophodermium Needle Cast</p> <p>Most pines, including <i>P. jeffreyii</i>, <i>P. ponderosa</i></p>	<p>No image</p>	<p>Symptoms: 2nd year needles brown and droop; 3rd year needles often cast Signs: conspicuous ascomata on 3rd year needles; these clypeate apothecia shiny, black, ovoid to ellipsoid, scattered over needle surface; subepidermal; black transverse zone lines may be present (Henkel)</p>
<p>Lodgepole pine</p>	<p><i>Davisomycella Montana</i> Davisomycella Needle Casts</p> <p><i>P. contorta</i> plus other 2-3 needle pines in CA</p>		<p>Symptoms: browning areas on 2-year old needles; dead areas of needles separated from green areas by orange-brown band Signs: black clypeate apothecia, subepidermal, scattered on all surfaces of dead needles</p> <p>Damage: similar to <i>Lophodermella</i> Note: how to differentiate from <i>Lophodermella</i>: <i>Lophodermella</i> apothecia concolorous subhypodermal; <i>Davisomycella</i> apothecia black, subepidermal (Henkel)</p>
<p>Lodgepole pine</p>	<p><i>Lophodermella concolor</i> Lophodermella Needle Casts</p> <p><i>P. contorta</i> pine plus <i>P. lambertiana</i> and <i>P. monticola</i> in NW Cal.</p>		<p>Symptoms: Current year needles infected and turn brown, ascomata produced; needles drop off 2nd year → "lion's tail" branches Signs: small, inconspicuous clypeate apothecia, ovoid, concolorous with dead needles Note: <i>Lophodermella arcuata</i> occurs in sugar pine and western white pine (5-needled) in our region (Henkel)</p>
<p>5-needle pine</p>	<p><i>Lophodermium nitens</i></p> <p>pine needle cast</p> <p><i>Pinus</i> spp.</p>		<p>Abundant black zone lines</p>
<p>5 needle pines</p>	<p><i>Lophodermella arcuata</i></p>	<p>White pine needle cast</p>	
<p>2/3 and 5 needle pines</p>	<p><i>Mycosphaerella pini</i> Red band needle disease Can lead to mortality</p> <p><i>Pinus: muricata, radiata, jeffreyi, ponderosa, attenuata, monticola.</i></p>		<p>Symptoms: all age needles: yellow to tan spots → chlorotic bands → red bands (hence name) → coalesce into long necrotic areas → premature needle cast. Signs: asexual conidia borne in black, erumpent stromata in necrotic areas; = "pycnidia" Disease cycle: conidial infection (spring-fall) → reddish brown necrotic lesions (0-6m above ground) → pycnidia erumpent in late summer → conidia dispersed in rain splash and wind-driven mist → infections re-established on 1st and 2nd yr needles (continues throughout fall/winter in mild Pacific climates. (Henkel)</p>
<p>2/3 needle pines</p>	<p><i>Elytroderma deformans</i> Elytroderma needle cast Can lead to mortality</p> <p>Systemic: <i>P. ponderosa, jeffreyi, attenuata</i> Non-systemic: <i>P. contorta</i></p>		<p>Across western NA, common in N. Sierra. Early symptoms: red-brown discoloration of 1-year old needles on individual branches, flagging in spring, casting in winter, brown necrotic flecks on inner bark. Signs: long, narrow, black clypeate apothecia abundant on all needle surfaces, transverse zone lines absent. Disease cycle: early spring pycnidia produce conidia (function unknown) → May-June: apothecia develop on all surfaces of 1-yr needles (hypodermal) → ascospores released late summer/fall and spring → current season or older needles infected → asymptomatic until following spring. -locally favorable conditions occur in sheltered, moist places. (Henkel)</p>

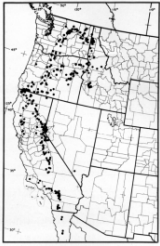


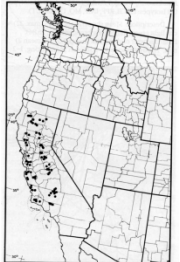
<p>True fir</p>	<p><i>Phacidium abietis</i> Snow Blight</p>	<p><i>No image</i></p>	<p>Host: white fir in our region -attacks needles of all ages during winter under snow cover; needles brown and die; only those that are snow covered attacked; dark brown, oval apothecia in two rows ("phacid") on lower needle surface. (Henkel)</p>
<p>True fir</p>	<p><i>Virgella robusta</i></p>	<p>Compare to <i>Lirula abietis-concoloris</i></p>	<p>Signs <i>V. robusta</i>: continuum of black clypeate apothecia on lower needle surface; concolorous to brown pycnidia in <i>two rows</i> on upper needle surface. (Henkel)</p>
<p>True fir</p>	<p><i>Lirula abietis-concoloris</i> True Fir Needle Casts <i>Abies grandis, concolor, magnifica, nobilis</i></p>		<p>Symptoms: scattered, browning current-year needles Signs: <i>L. abietis-concoloris</i>: continuum of black clypeate apothecia on lower needle surface; brown pycnidia in <i>single row</i> on upper needle surface. (Henkel)</p>
<p>Douglas-fir</p>	<p><i>Rhabdocline pseudotsugae</i> Rhabdocline Needle Cast</p>		<p>Symptoms: chlorotic to red-brown patches on current year needles; needles later brown entirely and abscise Signs: light-colored, elongate clypeate apothecia in rows on needle undersurface; subepidermal Disease cycle: ascospores released May/July → fungus penetrates cuticle → colonization and cellular disruption slowly during summer on current year needles → tiny chlorotic spots late summer → purple-brown bands late fall-spring, necrosis coalescing → apothecia produced May/June next year Damage: greatest in dense, moist plantation. (Henkel)</p>
<p>Calocedrus</p>	<p><i>Seynesiella (Stigmatea) sequoia</i> Seynesiella Leaf Blight (Incense-cedar)</p>	<p><i>No image</i></p>	<p>-this disease is characterized by browning foliage of incense cedar featuring black, "volcano - shaped" ascomata on upper foliage surfaces. (Henkel)</p>
<p>Calocedrus</p>	<p><i>Didymascella thujina</i> Cedar Leaf Blight <i>Calocedrus decurrens, Thuja plicata</i></p>		<p>-foliage of lower branches attacked, foliage appears brown, scorched; apothecia black and round, on upper foliage surface; these fall off leaving diagnostic "pits" -damage of little commercial importance. (Henkel)</p>



Brown felt blight	<i>Neopeckia coulteri</i> pines		-macroscopically, these two fungi are indistinguishable -envelope needles and branches under snow in dark brown, felt-like mycelial growth -needles within felt are infected and killed -limited to smaller trees and lower branches of larger trees (snow-covered). (Henkel)
	<i>Herpotrichia juniper</i> conifers other than pines		
angiosperms	<i>Mycosphaerella arbuticola (=Rhytisma arbuti)</i> Mycosphaerella Leaf Spot of Madrone		-causes leaf spot on madrone. Small black pustules clustered around round disease center (Henkel)
	<i>Rhytisma punctatum</i> Small Tar Spot of Big-leaf Maple. <i>Acer macrophyllum</i>		Host: big-leaf maple in Pacific Northwest -light green spots on leaves → chlorotic spots → groups of raised black stromata with apothecia. (Henkel)

Mistletoes

Phorodendron Sessile berry, not forcefully ejected, stem not jointed, 8-10 years in length, Larger, more photosynthetic material Damage: primarily water & mineral parasites; deformation and weight of parasite can cause branch breakage; a few species (e.g. <i>Phorodendron juniperinum</i> var. <i>libocedri</i>) can cause branch die back due to more extensive systemic infection	<i>Phorodendron flavescens</i> var. <i>villosum</i>	Quercus	Black Oak, white oak
	<i>Phorodendron bolleanum</i>	White fir	Mostly in Sierra Nevada
	<i>Phorodendron juniperinum</i> var. <i>libocedri</i> Mostly on <i>Calocedrus decurrens</i> with single reports on <i>Abies concolor</i> (Yosemite) and <i>Chamaecyparis lawsoniana</i> (Del Norte County)		Plant 20-80 cm tall, woody only at base. Pinkish-white to straw colored fruit. native to western North America from Oregon to Baja California, producing greenish erect, hanging, or drooping branches from a woody base where it grows attached to the tree. The smooth, noded branches have flattened, scale-like leaves. The plant is dioecious, with male and female individuals producing different forms of inflorescence with knobby flower clusters. Female flowers yield light pink or yellowish spherical berries each 3 or 4 millimeters wide. (Geils et al.)
	<i>Phorodendron juniperinum</i> var. <i>ligatum</i> <i>j. occidentalis, j. grandis, cupressus?</i>		Plant 20-40 cm tall, globose, green. Leaves reduced to minus scales, pinkish –white fruit. Identification-- Round clusters of the olive green mistletoe plants are seen on branches throughout the juniper crown (fig. 144). These mistletoe clusters are commonly 6 to 15 inches in diameter. The leaves of this true mistletoe plant are barely discernible. They are tiny (1 mm), scalelike leaves produced in opposite pairs along the smooth stem of the plant. Branching of the plant is opposite. The male and female flowers are produced on separate plants (dioecious). (Geils et al.)

<p>Arceuthobium</p> <p>Stipitate, forcefully eject, always scale-like, usually jointed, mostly pines, 2-6 years, devastating to trees,</p> <p>Smaller, thinner, lighter green</p>	<p><i>Arceuthobium abietinum</i> ssp. <i>concolor</i></p> <p>White Fir Dwarf Mistletoe <i>A. concolor</i>, <i>A. amabilis</i>, <i>A. Grandis</i>, <i>P. breweriana</i></p>		<p>symptoms: flat witches' brooms, branch <i>and</i> trunk tumefactions, and branch flagging on broom shoots caused by <i>Cytospora abietis</i> canker (Henkel). Native to western North America from Washington to New Mexico to northern Mexico, where it lives in coniferous forests as a parasite on various species of fir. The leaves of the mistletoe are reduced to knobby scales on its surface. It is dioecious, with male and female mistletoe plants producing spikes of staminate and pistillate flowers, respectively. The fruit is a sticky berry a few millimeters long which explodes to disperse the seeds it contains several meters away from the parent plant and its host tree. (Geils et al.) (map from Hawksworth et al.)</p>
	<p><i>Arceuthobium abietinum</i> ssp. <i>magnificae</i></p> <p>Red Fir Dwarf Mistletoe <i>A. magnifica</i></p>	 <p><small>Figure 16.6 - Distribution of <i>Arceuthobium abietinum</i> f.sp. <i>magnificae</i>.</small></p>	<p>See above. (map from Hawksworth et al.)</p>
	<p><i>Arceuthobium americanum</i></p> <p>Lodgepole Pine Dwarf Mistletoe But also many other Pinus, rarely Abies and Picea</p>	 <p><small>Figure 16.7 - Distribution of <i>Arceuthobium americanum</i>.</small></p>	<p>Symptoms: witches' brooms, branch tumefactions, with systemic endophytic system extending into fine branches. note: <i>A. americanum</i> does not occur on shore pine (<i>P. contorta</i> var. <i>contorta</i>) in our region! (but does in coastal B.C.) (Henkel) Induces characteristic systemic witches' brooms on <i>Pinus contorta</i>. Mean shoot height 5 to 9 (maximum 30) cm. Shoots yellowish to olive green, with verticillate branching (fig. 4-2). Basal diameter of dominant shoots 1 to 3 (mean 1.5) mm. Mature fruit 3.5 to 4.5 (mean 4) mm long, 1.5 to 2.5 (mean 2) mm wide; proximal portion about 2.5 mm long. Seeds 2.4 by 1.1 mm. (Geils et al.) (map from Hawksworth et al.)</p>
	<p><i>Arceuthobium californicum</i></p> <p>Sugar Pine Dwarf Mistletoe Primary: <i>P. lambertiana</i>, secondary: <i>P. monticola</i></p>	 <p><small>Figure 16.11 - Distribution of <i>Arceuthobium californicum</i>.</small></p>	<p>symptoms: large, compact witches' brooms; branch tumefactions (Henkel) Mean shoot height 8 cm (maximum 12) cm, greenish to bright yellow, turning brown at base of older shoots, branches flabellate. Basal diameter of dominant shoots 1.5 to 4.0 (mean 2) mm. This species is distributed from Mount Shasta southward through the North Coast Range, and through the Cascade Range south to Lake County. (Geils et al.) (map from Hawksworth et al.)</p>
	<p><i>Arceuthobium monticola</i></p> <p><i>Pinus monticola</i>, <i>Picea breweriana</i></p>	 <p><small>Figure 16.12 - Distribution of <i>Arceuthobium monticola</i>.</small></p>	<p>Closely related to <i>A. californicum</i> (map from Hawksworth et al.)</p>

<p>Arceuthobium</p> <p>Damage:</p> <ul style="list-style-type: none"> -nutrient and water parasite -reduced vigor and growth of host -decrease in host reproductive output and wood quality -tumefactions and fasciculations related to penetration and nutrient absorption by parasite -eventually, parasite nutrient absorption and branch die-back may reduce photosynthetic output below level required to keep host alive → <i>mortality</i> -host predisposed to bark beetle attack -local proliferation of infection centers can lead to progressive declines in tree health and timber quality within stands 	<p><i>Arceuthobium campylopodum</i> Western Dwarf Mistletoe</p> <p><i>P. jeffreyi, P. ponderosa, P. attenuate, P. coulteri.</i></p>	 <p><small>Figure 10.24 - Distribution of <i>Arceuthobium campylopodum</i></small></p>	<p>symptoms: moderate brooming (upturned), branch tumefactions (Henkel) Mean shoot height 8 (maximum 13) cm, olive green to yellow, branches flabellate. Staminate plants brownish, and pistillate plants greenish. Mature fruit 5.0 by 3.0 mm. <i>Arceuthobium campylopodum</i> is a serious pathogen of <i>Pinus jeffreyi</i> and <i>P. ponderosa</i>. Our observations suggest that host damage is more severe in the southern or drier parts of the distribution. (Geils et al.) (map from Hawksworth et al.)</p>
	<p><i>Arceuthobium siskiyouense</i> <i>P. attenuata</i></p>	 <p><small>Figure 10.25 - Distribution of <i>Arceuthobium siskiyouense</i></small></p>	<p>Is a closely related but distinct species from <i>A. campylopodum</i>. <i>A. siskiyouense</i> produces no witches' brooms on knobcone pine, and can occur rarely on Jeffrey pine. (Henkel) (map from Hawksworth et al.)</p>
	<p><i>Arceuthobium douglasii</i> Douglas-fir <i>P. menziesii</i></p>	 <p><small>Figure 11.43 - <i>Arceuthobium douglasii</i> showing the typical parasitic infection.</small></p>	<p>Symptoms and damage: systemic infection tracking apical and cambial growth; producing large, drooping witches' brooms, with severe growth loss and mortality; tree growth reduced > 50% in heavily infested stands (SW US) (Henkel). Plant less than 4cm, scattered along host stem near apex. Mean shoot height 2 (maximum 8) cm, olive green, branches flabellate (fig. 4-3). Basal diameter of dominant shoots 1.0 to 1.5. Mature fruit olive-green 3.5 to 4.5 (mean 4) mm long, 1.5 to 2.0 mm wide. It seems to coat branches almost entirely, forming a cylinder of mistletoe, although the branches individually are short and weak. Its color is brownish green. Distribution. Canada (British Columbia), United States (Washington, Idaho, Montana, Oregon, California, Nevada, Utah, Colorado, Arizona, New Mexico, and Texas) and Mexico (Chihuahua, Durango, Coahuila, and Nuevo León). (Geils et al.)</p>
	<p><i>Arceuthobium littorum</i> Coastal Dwarf Mistletoe</p> <p><i>P. muricata, radiata, contorta</i> <i>spp. bolanderi,</i></p>	<p>Description. Shoots 8 to 20 (mean 12) cm, brown to yellow-brown, branches flabellate. Basal diameter of dominant shoots 2 to 5 (mean 3.5) mm. Third internode 10 to 20 (mean 15) mm long, 2 to 2.5 (mean 2.2) mm wide, mature fruits 4 to 5 mm long; staminate flowers mostly four-merous. United States (California: Mendocino, Sonoma, Marin, Monterey, and San Luis Obispo). <i>Arceuthobium littorum</i> is restricted to a region within 10 km of the Pacific Ocean from Fort Bragg south to Point Reyes on <i>Pinus muricata</i> and along the central coast at Monterey and Cambria on <i>P. radiata</i>. Previously, Hawksworth and Wiens (1972) include <i>Arceuthobium littorum</i> in <i>A. occidentale</i>. (Geils et al.)</p>	
	<p><i>Arceuthobium occidentale</i> Digger Pine Dwarf Mistletoe</p> <p><i>Pinus sabiniana</i></p>	 <p><small>Figure 11.45 - Distribution of <i>Arceuthobium occidentale</i></small></p>	<p>symptoms & damage: witches' brooms <i>lacking</i>, but causes branch tumefactions, crown die-back and loss of vigor. Note: widely-spaced infected trees often occur in savannas; regular bird dispersal strongly suspected (Henkel). <i>Pinus sabiniana</i> is the most common and only principal host. <i>Pinus coulteri</i> and <i>P. attenuata</i> are secondary hosts where they occur with infected <i>P. sabiniana</i>. Mean shoot height 8 (maximum 17) cm, yellowish, glaucous, branches flabellate. Basal diameter of dominant shoots 1.5 to 5.0. Mature fruit 4.5 by 3.0 mm; proximal portion 3.0 mm long. Seeds 2.6 by 1.0 mm. (Geils et al.) (map from Hawksworth et al.)</p>

Arceuthobium	<p><i>Arceuthobium tsugense</i> <i>ssp. mertensianae</i></p> <p><i>T. mertensiana</i>, <i>P. breweriana</i></p>	 <p><small>Figure 25.104 - Distribution of <i>Arceuthobium tsugense</i> ssp. <i>mertensianae</i>.</small></p>	<p>Pacific crest westward, basal internodes of mature plant rounded, staminate spikes in summer over 5mm long. <i>Arceuthobium tsugense</i> differs from <i>A. abietinum</i> by shorter (7 cm), green to purple shoots compared with the longer (10 cm), yellowish shoots of <i>A. abietinum</i>. (Geils et al.) (map from Hawksworth et al.)</p>
	<p><i>Arceuthobium tsugense</i> <i>ssp. tsugense</i></p> <p><i>T. heterophylla</i></p>	 <p><small>Figure 25.102 - Distribution of the western hemlock host of <i>Arceuthobium tsugense</i> ssp. <i>tsugense</i> in Washington, Oregon, and California.</small></p>	<p>See <i>ssp. mertensianae</i> above (map from Hawksworth et al.)</p>

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