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Schweinitzii Root and Butt Rot of Western Conifers

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Schweinitzii root and butt rot also has been called brown-cubical butt rot, red-brown butt rot, or red-brown rot. The disease is caused by the fungus *Phaeolus schweinitzii* (Fries) Patouillard which is often called the velvet-top fungus or cow-pie fungus because of the various forms of the conks. The species was named by the mycologist Fries to honor his colleague, Lewis David de Schweinitz, who some consider the "Father of North American Mycology." His namesake fungus causes extensive butt rot in older trees. It also can cause a tree-killing root disease in young trees. Merchantable losses can be extensive in older trees because the most valuable part of the tree, the butt log, is most seriously affected. Schweinitzii root and butt rot often is associated with trees also affected by Armillaria root disease. From a hazard-tree context, failure potential can be high because of structural weakening at the lower stem and roots. Management of older forests with Schweinitzii root and butt rot has become increasingly important where hazard trees need to be removed in recreation sites or along roads.

Figure 1. Fresh conks have tops with a velvety texture and a yellow margin.

Hosts and Distribution

Schweinitzii root and butt rot has an extensive conifer-host distribution in western North America (Table 1). The fungus occurs in eastern North America, Europe and Asia but is most damaging in western North America, especially in Douglas-fir and Sitka spruce. Western larch, western hemlock and western white pine can

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have considerable damage when they are old. Hardwoods affected include isolated incidences in Oregon white oak (*Quercus garryana*), *Acacia*, *Betula*, *Liquidambar*, *Fraxinus*, *Prunus*, *Ulmus*, and *Eucalyptus*. It commonly occurs on hardwoods in Hawaii and the South Pacific.

In Montana and northern Idaho, the fungus causes the most widespread root disease, occurring across a broad range of site conditions. In western Oregon and Washington and coastal British Columbia and Alaska it is one of the most common causes of butt rot of Douglas-fir and Sitka spruce >150-years old. No reliable estimates of impact caused by *Phaeolus schweinitzii* are available, in part because it is often difficult to detect and is often masked by Armillaria root disease which is easier to diagnose.

Fungus Biology and Conks

The most obvious sign of the fungus is the distinctive conk that is usually only found on or near large trees (Figure 1). Large (up to 10 inches in diameter) annual conks occur on the ground near or growing from the base of infected trees and stumps. Conks on the ground are circular with depressed centers and taper to short, thick stalks and presumably emerge from infected

Table 1. Conifer-host distribution for Schweinitzii root and butt rot in western North America

Cedar
- Alaska (*Chamaecyparis nootkatensis*)
- incense (*Calocedrus decurrens*)
- Port-Orford (*Chamaecyparis lawsoniana*)
- western red (*Thuja plicata*)

Douglas-fir (*Pseudotsuga menziesii*)

Hemlock
- mountain (*Tsuga mertensiana*)
- western (*T. heterophylla*)

Larch
- tamarack (*Larix laricina*)
- western (*L. occidentalis*)

Pacific Yew *(Taxus brevifolia)*

Pine
- Coulter (*Pinus coulteri*)
- gray (*P. sabiniana*)
- jack (*P. banksiana*)
- Jeffrey (*P. jeffreyi*)
- knobcone (*P. attenuata*)
- limber (*P. flexilis*)
- lodgepole (*P. contorta*) -->

Pine (continued)
- Mexican white (*P. pseudostrobus*)
- pinyon (*P. edulis*)
- ponderosa (*P. ponderosa*)
- Scots (*P. sylvestris*)
- singleleaf pinyon (*P. monophylla*)
- sugar (*P. lambertiana*)
- western white (*P. monticola*)
- whitebark (*P. albicaulis*)

Spruce
- black (*Picea mariana*)
- Engelmann (*P. engelmannii*)
- Norway (*P. abies*)
- Sitka (*P. sitchensis*)
- white (*P. glauca*)

True Fir
- balsam (*Abies balsamea*)
- California red (*A. magnifica*)
- grand (*A. grandis*)
- noble (*A. procera*)
- Pacific silver (*A. amabilis*)
- subalpine (*A. lasiocarpa*)
- white (*A. concolor*)

roots. Conks may also occur on infected trunks, appear as thin brackets (Figure 2), and often emerge from wounds or cracks. Conks appear in late summer and fall. When fresh, the tops of conks are velvety in texture (hence the common name, velvet-top fungus) and reddish-brown, greenish-brown, or yellow-brown, often with a yellow edge (Figure 1). The conk undersurface is poroid and green when young and turns brown with age. Conks die after a few weeks, become dark brown and brittle, and resemble cow feces; hence the other common name, cow-pie fungus (Figure 3). Conks are less common on dry sites, although the disease may be present. Dead conks will persist for a year or two on or around affected trees and are often the sole indicator of infection and decay.

Conks produce microscopic basidiospores when conditions are optimum in the fall. The spores are deposited on and subsequently percolate into the soil. Fine roots are the main infection court for basidiospores. Fresh trunk wounds caused by mechanical injury or fire probably are not infected directly by spores but instead the wounds exacerbate decay in previously infected roots and butts (Figure 4). Infection of Douglas-fir and possibly other species results from direct invasion of root tips. Once in the xylem, the fungus can grow axially within the roots. Adventitious root production is stimulated in infected roots. Subsequent infections of adventitious roots by the fungus result in gall-like swellings that eventually become stubbed and often infected by *Armillaria* spp. In northern Idaho and Montana, *Armillaria* spp. probably often kills Douglas-fir that has been infected by *P. schweinitzii*. The converse also appears to occur: research in Europe has shown that *P. schweinitzii* readily infects wood previously colonized by *Armillaria.*

Figure 2. Conks are most frequently found on the ground but may also occur on lower tree boles.

Spread of *P. schweinitzii* within the forest is not significantly facilitated by root contacts as are other root pathogens. Douglas-fir and grand fir are tolerant of extensive root infection by the fungus. Ponderosa pine and western larch are more resistant to infection than the firs. The fungus probably can persist for decades in dead or cut trees and infect roots of adjacent developing trees. Although the fungus has been reported to

Figure 3. As conks age, they become dark brown and brittle, and resemble "cow-pies."

Figure 4. Fresh wounds probably exacerbate decay in previously infected roots and butts as shown in this grand fir. Note the old Schweinitzii conks at lower right of tree base.

persist for decades in stumps of slash pine (*Pinus elliottii*) and longleaf pine (*P. palustris*) in Florida and spread to plantation trees, this has not been reported in other species or areas, and *P. schweinitzii*-infected stumps are considered unimportant sources of inoculum.

Root disease caused by *P. schweinitzii* in forest stands or plantations does not resemble infection by other root-disease-causing fungi. Instead, *P. schweinitzii*-killed or windthrown trees more often are scattered throughout a stand rather than located in discrete pockets or centers as is Armillaria root disease or laminated root rot. Scattered diseased or decayed trees imply spore infections of roots rather than mycelial spread via root contacts or grafts with adjacent infected trees or stumps. This is further supported by observations that adjacent infected trees often are colonized by a different strain of the fungus via infection from a single basidiospore. There also is some evidence that the fungus can live saprophytically in the duff and subsequently infect fine roots. Similar to other root pathogens, *P. schweinitzii*-infected trees often are attacked by bark beetles, at least in Idaho and Montana. *P. schweinitzii* root infections in young trees cause root decay and death with loss of tree increment proportional to the percentage of root infection.

After initial infection, there may be no signs of early root decay, or it may show as a yellow to reddish-brown discoloration of the wood a few inches to several feet ahead of advanced decay (Figure 5). Small roots near decay in the root collar often develop dark reddish-brown and resinous heartwood (Figure 6). These roots are useful for diagnosing the disease in large trees where extensive excavation is difficult. Wood becomes soft just before the advanced stage is reached. Advanced decay is a distinctive dry, crumbly, brown-cubical rot (Figure 5). Thin, resinous, crust-like mycelial layers often are found in shrinkage cracks of the decayed wood. Decay in living trees appears limited to the heartwood and normally confined to roots and butts. The fungus, however, has been found in wood surrounding bird cavities in western larch 30 feet above the ground.

Crown symptoms seen in trees with extensive root decay include shortened terminal growth which gives the crown a rounded appearance, a thin crown with scattered dead branches, slight chlorosis, and an overall unthrifty appearance. Diseased trees often have

Figure 5. Advanced decay caused by P. schweinitzii *is a brown cubical rot.*

pronounced enlarged bases or butt swell (Figure 7). Roots often become truncated, and thick callous tissue gives the roots a club-like appearance (Figure 8). Severe decay and truncated roots can result in tree breakage or windthrow. After decayed butts and roots disintegrate, the brown-rot residues are very stable and provide important properties to the organic component of forest floors where they may comprise up to 30% of the soil volume in the upper layers. Conks are presumed to be produced after trees have developed considerable decay. Conks are produced on or near living trees but will continue to fruit on or near dead trees, stumps, and logs.

Figure 7. Decayed trees often have pronounced butt swell as seen in this Douglas-fir.

Figure 6. Small-diameter roots with a dark red resinous heart can help diagnose disease caused by P. schweinitzii.

Young conks of *Phaeolus schweinitzii* resemble the conks of another root and butt rot fungus, *Inonotus tomentosus*, once called the false velvet-top fungus. Conks of *I. tomentosus* usually are much smaller (1 to 3 inches in diameter) than conks of *P. schweinitzii* (up to 10 inches in diameter). Even when fresh, conks of *P. schweinitzii* usually are much darker than conks of *I. tomentosus*.

Estimating Extent of Decay

The amount of decay caused by *P. schweinitzii* is quite variable in

Figure 8. Roots with Schweintzii rot commonly are truncated with ends covered by thick callus, producing a club-like appearance.

infected trees, even if butt swell, wounds, or conks are present. If conks alone are found on the ground near the base of a tree, or on the tree at the base, decay length averages 8 feet above ground in older trees. If both conks and wounds/cracks are present at the base of a tree, decay length averages 16 feet above ground in older trees and 8 feet above ground in younger trees. If both conks and wounds/cracks are present 8 feet or more above the ground, decay length averages 32 feet. Without conks, as is common on dry sites, amount of decay can be estimated in suspect trees by drilling at the root collar or butt (see management section). If infected trees are dead, add 4 feet to the above estimates. Decay columns are conical, tapering upward from the ground level.

Management

Managing stands and sites with *P. schweinitzii* requires careful consideration of the disease expression. Although other tree species may become infected and die or decay, Douglas-fir, Sitka spruce, and perhaps larch, are most seriously affected by Schweinitzii root and butt rot. Consequently, the following are some common situations for these species and recommended management:

Douglas-fir <150-years old with mortality >1 tree/acre

Young stands with mortality caused by Schweinitzii root and butt rot usually are found on harsh sites for Douglas-fir and may be only marginally productive for timber. It is difficult to manage young forests with potential infection and decay caused by *P. schweinitzii* because there are usually no above-ground signs or symptoms of the disease. The presence of large residual trees or stumps with typical decay or conks may be an indication that infection is present in young surrounding trees. Younger or smaller-diameter stands generally will not have sufficient butt decay to cause impact; however, volume lost to growth loss and mortality may be excessive. Such stands often have a history of insect-caused defoliation or bark-beetle activity that will further weaken or kill trees. Partial-harvest methods should be avoided where Douglas-fir is a major component. If Douglas-fir seed trees are used, they usually windthrow and should be readily salvable or expendable. If adapted, other species should be encouraged as well. Ponderosa pine and lodgepole pine are more resistant to Schweinitzii root and butt rot and should be managed with Douglas-fir. Maintaining good stand growth through density management may be difficult on these sites, but it is essential to minimize root-disease impact.

A more serious situation occurs where young Douglas-fir with notable mortality also has Armillaria root disease. *Phaeolus schweinitzii* and *Armillaria ostoyae* are commonly found together damaging stands in northern Idaho and Montana and possibly other areas. Stands or plantations with both root diseases should be managed as Armillaria root disease problems. Planting or favoring the more Armillaria-resistant pines or larch is recommended.

Douglas-fir or Sitka spruce >150-years old with butt rot but low mortality

Commercial forests: Concern for infection and mortality of Douglas-fir or spruce regeneration following harvest of older trees is probably

unwarranted if the replacement stand is intended for harvest before reaching 150 years of age. However, butt rot in the older trees probably is associated with considerable root rot. Seed tree or shelterwood regeneration methods may result in windthrow of leave trees. If the trees are readily salvable or expendable, this may be of little consequence unless they fall before sufficient seeding has taken place.

Developed sites and roadsides: Schweinitzii root and butt rot is a major safety concern in older Douglas-fir or Sitka spruce forests in developed sites. Trees near conks, whether on the ground or on the tree, should be examined closely for obvious additional defect indicators such as leans, ground heaving or root lifting within 2-3 feet of the butt, butt swell and wounds, shake or cracking of the butt, or evidence of carpenter ant or woodpecker activity in the butt.

The butt and major roots should be drilled to determine the extent of internal decay. Trees with a sound-rind thickness <15% of the butt diameter are considered high-failure potential and should be removed immediately if within striking distance of valuable targets (Figure 9). If butt wounds are present, a 25% or greater sound-rind thickness is required. Because of the high variability in the location of decay in butts and roots, it is important to drill these trees at multiple locations to determine if decay is present. Trees with decay but with adequate sound-rind thickness should be monitored frequently depending on decay extent.

From a danger-tree context along roadsides or in the workplace, one or more conks on or near a tree indicate likely failure potential, and such trees should be removed within 1 to 3 years depending on frequency and duration of road traffic or work activity. Trees with one or more conks and considerable decay (<15% sound-rind thickness) indicate imminent-failure potential and should be removed within one year of evaluation.

Wildlife habitat: Although wildlife values related to Schweinitzii root and butt rot have not been reported, hollows in infected butts created by the fungus probably provide

Figure 9. Decayed trees with a poor sound-rind thickness may have a high-failure potential and should be removed if within striking distance of valuable targets.

good habitat for a variety of living organisms both in standing trees and in down logs. Infected trees can be retained in thinned or partially harvested stands if enhancing wildlife habitat is the primary forest-management objective, especially if mostly down wood is desired.

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Assistance

Private landowners can get more information from County Extension Agents, State Forestry Departments, or State Agriculture Departments. Federal resource managers should contact USFS Forest Health Protection (www.fs.fed.us/foresthealth/). This publication and other Forest Insect and Disease Leaflets can be found at www.fs.fed.us/r6/nr/fid/wo-fidls/.

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