Annosus Root disease

Infects fresh stumps and spreads root-to-root

Pathogen—Recent studies show that annosus root disease is caused by two closely related fungi, both formerly known as *Heterobasidion annosum*. The two pathogens are *H. annosum* (in the strict sense) and *H. parviporum*. These are North American variants of species in Europe and Asia. The North American variants may be recognized and named as separate species in the future.

Hosts—*Heterobasidion annosum* is a pine specialist. In this Region, it has been found to cause disease only on pines and eastern redcedar and only in the Bessey District of the Nebraska National Forest. However, it occurs in Arizona, New Mexico, Idaho, and the Midwest, so it may occur undetected elsewhere in the Region.

Heterobasidion parviporum favors spruce and fir species but has been found only in mixed conifer forests within the range of white fir in southern Colorado. It is common on white fir and occurs occasionally on associated subalpine fir, Douglas-fir, and blue and Engelmann spruce. It has not been found in our spruce-fir forests outside the range of white fir in this Region.

Signs and Symptoms—In some cases, resin flow may be evident near the root collar as the tree defends itself against attack. Diseased pines may eventually show crown thinning and yellowing. In pines, the disease is most active in the sapwood, killing tissues as it progress. In other hosts, the fungus grows first in inner wood once it reaches the root collar, so butt rot is a more prominent feature of the disease.

Figure 1.The pore surface of *Heterobasidion parviporum* from a white fir stump. *Photo: Jim Worrall, USDA Forest Service.*

Decay may be preceded by a pink to dull violet stain of the wood. Later, small, poorly defined pockets or pits are often evident. Small black flecks can often be found in well-developed pockets, and wood may separate along the annual rings (laminated rot). Finally, the pockets are lost as the entire mass of wood becomes spongy or stringy.

Conks are frequently found in white fir disease centers but usually in protected, moist microsites such as under litter, inside hollow stumps, and even down in hollow root channels. Perennial and tough, they can be up to a foot wide. Depending on where they form, they may have an irregular brown cap or bracket or be completely flat on the substrate. The pore surface is whitish with small pores; the flesh is creamy tan (figs. 1-2). In some cases, especially with *H. annosum*, only tiny "popcorn" conks may be found. Fresh conks have a strong mushroom aroma.

Disease Cycle—The disease cycle in pines begins with freshly cut stumps. Wind-blown spores infect stumps of live trees within a few weeks of cutting. The fungus grows down into the stump roots. Where there are root contacts, the fungus may grow across and infect neighboring trees, eventually creating a root disease center. Centers typically have a stump in the middle, old dead and downed trees nearby, recent mortality farther out, and live trees that may have crown symptoms on the outside. The fungus fruits on stumps and infected trees, produces spores, and completes the cycle. The fungus may survive many years in dead root systems and can infect successive tree generations.

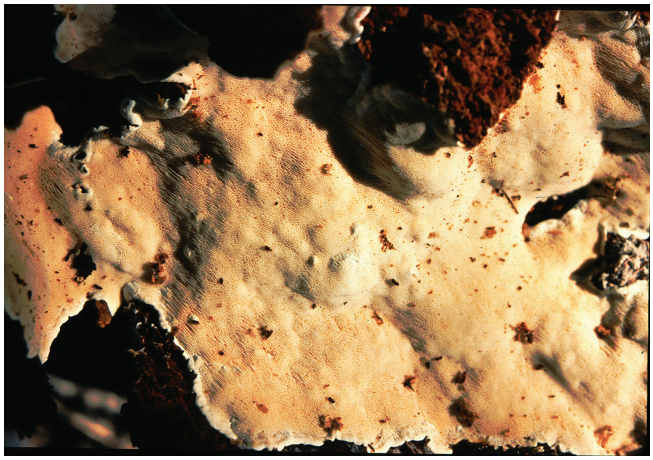

Figure 2. Closer view of the pore surface of Heterobasidion parviporum from a white fir stump. *Photo: Jim Worrall, USDA Forest Service.*

The disease cycle may work similarly in true firs, but evidence suggests that stump infection may not be the only way for new disease centers to be initiated. New infections may occur through basal scars and even through direct infection of roots by spores in the soil.

Impact—In pines, *H. annosum* impact in this Region is geographically restricted and is not a significant concern,

Figure 3. Typical pattern of decay from Heterobasidion parviporum in a white fir stump in Colorado. *Photo: Jim Worrall, USDA Forest Service.*

Figure 4. Butt-rotted, live white fir after failing due to Heterobasidion parviporum in Colorado. *Photo: Jim Worrall, USDA Forest Service.*

Figure 5. Decayed hollow in white fir stump with residual branch tracesk caused by Heterobasidion parviporum in Colorado. *Photo: Jim Worrall, USDA Forest Service.*

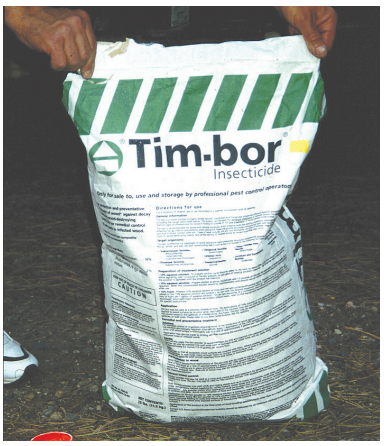

Figure 6. A commercial borax product. *Photo: Pete Angwin, USDA Forest Service.*

although the pathogen could conceivably move into and cause substantial damage to important pine forests elsewhere in the Region. In white fir, disease centers and mortality are common and the impact is substantial. Ecologically, the abundance of white fir and this disease in formerly pine-dominated forests is due to fire exclusion and early harvest of seral species. Thus, restoration to a more open, pine-dominated forest maintained by fire would greatly reduce the disease's impact.

In pines, the sapwood and cambium are often killed before extensive decay occurs, and trees tend to die standing. In firs and spruces, especially in larger trees, extensive root and butt rot often occur to the point that live trees may fail mechanically before dying (figs. 3-5). However, the fir engraver, *Scolytus ventralis*, is attracted to diseased firs and may kill them before direct mortality or failures occur.

Management—Management of annosus root disease is based on two approaches: using resistant species and preventing primary infection. (See comments on white fir ecology under "Impact.")

- Manipulating species composition. Recent advances in understanding the pathogen species and their host specialization provide greater opportunity for management through species composition. Where pines or eastern redcedar are infected, other species may be planted or favored, and should generally be resistant. Where white fir is infected, species other than true firs and spruces will likely be successful.
- Chemical protection of stump tops. When applied shortly after cutting, borax powder (available commercially as Sporax or Tim-bor) effectively prevents establishment of *H. annosum* and *H. parviporum* in stump tops (figs. 6-7). This prevents establishment of new disease centers but will neither eradicate existing infections nor prevent wound infection on residual trees.
- Biological control of stump tops. Several benign fungi are aggressive stump colonizers and can colonize the wood before the pathogen, preventing the pathogen from effective establishment. They

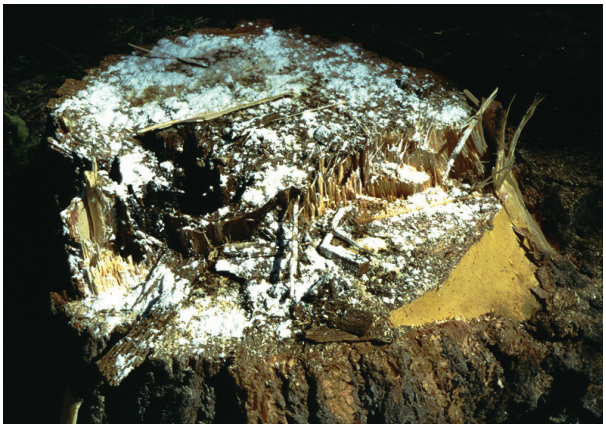

Figure 7. Commercial borax product application on a stump.
Photo: Pete Angwin, USDA Forest Service.

are applied as stump top treatments, like borax. The most widely tested fungus is *Phlebiopsis gigantea*.

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1. James, R.L.; Gillman, L.S. 1979. Fomes annosus on white fir in Colorado. Tech. Rep. R2-17. Golden, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Region, Forest Insect and Disease Management. 9 p.
2. Sinclair, W.A.; Lyon, H.H. 2005. Diseases of trees and shrubs. 2nd ed. Ithaca, NY: Cornell University Press. 659 p.
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4. Worrall, J.J.; Harrington, T.C.; Blodgett, J.T.; Conklin, D.A.; Fairweather, M.L. 2010. *Heterobasidion annosum* and *H. parviporum* in the southern Rocky Mountains and adjoining states. Plant Disease 94:115-118.