

Introduction to Decay Diseases

Wood decays of roots and stems

Many fungi decay wood of live trees in the Rocky Mountain Region. The diseases are often called heart rots, but frequently the decay is not restricted to heartwood. They are generally divided into stem decays (trunk rots) and root and butt rots.

Decay Types—Each fungus causes one of two types of decay: white rot or brown rot. These are easily distinguished (table 1, fig. 1) and are features used to diagnose the disease.

Table 1. Features of white and brown rot.

	Chemistry	Color	Texture	Other
White rot	All wood components removed, either simultaneously or lignin preferentially, in early stages	Generally white, but can be yellowish to reddish brown	Varies: spongy, stringy; some types are called laminated, pitted, or pocket rot based on texture/appearance	Texture types vary among white rot fungi; some produce zone lines in wood; there may be mats or rhizomorphs; pocket rots may have black flecks in pockets
Brown rot	Cellulose and hemicellulose chains broken early, then removed; lignin remains	Brown, often with a sheen on split surfaces early on	When advanced, wood shrinks with cubical checks and can be crumbled to a powder	Decay is fairly uniform; some fungi produce white mats or felts or wispy fine cords in checks, causes rapid strength loss

Stem Decay Disease Cycle—Stem-decay fungi release wind-disseminated spores. Some infect through wounds, but other more specialized pathogens do not require obvious wounds. They can infect small twig or branch stubs, and then either grow into the stem and inner wood or become dormant and wait until the tree grows around them and they become embedded in heartwood. When sufficient food is available through decay, a fruiting body (conk) is produced. Spores from the conk repeat the cycle.

Root Disease Cycle—Root and butt rots often have a more complex disease cycle. As with stem decays, wind-blown spores can be the initial inoculum. Spores may infect wounds in the butt or root crown, or they may percolate through the soil to infect roots. In general, these pathogens kill and decay roots, decay inner wood in the butt, and often kill sapwood and cambium in the root crown.

An important difference from stem decays is that most, but not all, of these diseases can also spread locally. The pathogen grows from infected roots to roots of neighboring healthy trees at contacts and grafts or, in one case, through soil. Root disease centers result in the stands characterized by older mortality in the middle and more recent mortality, symptomatic live trees, and apparently healthy trees toward the outside. The pathogen may survive for many years in dead root systems, infecting future tree generations. In many cases, this local spread is much more common than spores initiating new infections.

Impact—Impacts of decay diseases vary greatly, depending on the disease type and the specific disease. They may include: loss of fiber to decay (cull), growth loss,



Figure 1. Dead, decaying stem with white rot in the outer wood and brown rot in the inner wood caused by two different fungi. The white rot is stringy-fibrous; the brown rot breaks easily across the grain, has no fibrous strength, and is crumbly when dry. *Photo: Jim Worrall, USDA Forest Service.*

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direct mortality, predisposition to bark beetles, uprooting or snapping of live trees, and provision of wildlife habitat (figs. 2-6).

These diseases may affect various values, including timber, wildlife, aesthetics, and recreation. In developed sites, the potential for failure of live trees can significantly threaten safety and property.



Figure 2. Irregular snap of live spruce due to butt rot. Photo: Jim Worrall, USDA Forest Service.



Figure 3. Uprooting of blue spruce brought up large root plate. This is typical of windthrow, but some roots are rotted by *Armillaria ostoyae*. Photo: Roy Mask, USDA Forest Service.



Figure 4. Aspen stem with aspen trunk rot (note the conks) has begun to fail. Photo: Jim Worrall, USDA Forest Service.



Figure 5. Typical failure associated with mottled root rot of aspen: roots are stubbed near the root collar and are almost all rotted. Also note the conk above the root crown. Photo: Jim Worrall, USDA Forest Service.



Figure 6. Typical failure associated with mottled root rot of aspen: roSnapping of spruce with white pocket rot; only a few centimeters of sound wood remain. Photo: Jim Worrall, USDA Forest Service.

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Three important factors that contribute to the abundance and severity of these diseases are stand age, stand composition, and a history of wounding. Age, in particular, is closely correlated with amount of stem decay. Species composition is a major influence because, though some pathogens are fairly host-specific, in general there is a range of susceptibility of tree species to opportunistic, wound-infecting decay fungi. Ponderosa pine may represent the most resistant extreme, while true firs and aspen are among the Region's most susceptible species. A history of wounding is also associated with these opportunistic decay fungi in that there is generally a correlation between the size of wounds and their likelihood of infection.

Wood-decay diseases in this Region are listed in tables 2 and 3. Note that one root disease, black stain root disease, is not listed; it is the only major root disease in the Region that does not involve wood decay. These lists are not exhaustive, but include most decays that have been documented in the Rocky Mountain Region.

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1. Sullivan, K. 2003. Decay of living conifers in spruce-fir forests of the central Rocky Mountains. LSC-03-04. Golden, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Region, Renewable Resources. 19 p. Online: http://www.fs.fed.us/r2/fhm/bugcrud/decays_lsc-03-04.pdf.
 2. Worrall, J.J.; Fairweather, M. 2009. Decay and discoloration of aspen. Forest Insect and Disease Leaflet 149. Washington, DC: U.S. Department of Agriculture, Forest Service. 7 p.
 3. Worrall, J.J.; Nakasone, K.K. 2009. Decays of Engelmann spruce and subalpine fir in the Rocky Mountains. Forest Insect and Disease Leaflet 150. Washington, DC: U.S. Department of Agriculture, Forest Service. 12 p.



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Table 2. Root and butt rots of Region 2. Host abbreviations: DF = Douglas-fir, ES = Engelmann spruce, F = true firs, P = pines, QA = aspen, S = spruces, SAF = subalpine fir, WF = white fir. Uncommon hosts are in parentheses.

Pathogen	Disease	Common hosts	Decay	Indicators
<i>Armillaria solidipes</i> and other crown fading, mushrooms, fans species (honey mushroom)		Armillaria root disease	All	White rot; stringy-spongy, wet, zone lines
<i>Coniophora puteana</i>		ES, SAF	Brown rot; thin, pale, brown cords in checks	Butt may show checks or collapse, indicating partial failure; fruiting inconspicuous after tree dies
<i>Flammulina populicola</i>		QA	White rot; yellow, stringy	
<i>Fomitopsis pinicola</i>	Brown crumbly rot	S	Brown rot; thick fungal mats	Conk
<i>Ganoderma applanatum</i> (artist's conk)	White mottled rot	QA	White rot with mottled white/light tan areas; infrequent zone lines	Conks usually present
<i>Heterobasidion annosum</i>	Annosus root rot	P	White rot; may appear laminated, or with pits/pockets	Disease center, conks
<i>Heterobasidion parviporum</i>		Annosus root rot	WF (SAF, S) or with pits/pockets	White rot; may appear laminated, stringy, Disease center, conks
<i>Lentinellus montanus</i>		SAF, (ES)	White rot	None; fruits during snowmelt on downed logs
<i>Onnia tomentosaleporina</i>		Red root rot (tomentosus)		S (other conifers)
Basal resinosis, conks				Reddish stain becoming white pocket rot
<i>Phaeolus schweinitzii</i> (cow-pie fungus)	Schweinitzii butt rot	DF (other conifers)	Brown rot	Possible ephemeral fruiting on or around tree
<i>Phellolus nigrolimitatus</i>	Big white pocket rot	S (other conifers)	White pocket rot with large pockets	Usually none
<i>Pholiota alnicola</i>		SAF, ES	White rot; stringy	Mushrooms
<i>Pholiota squarrosa</i> (scaly Pholiota)		SAF, QA, (ES)	White rot; in aspen a gray-brown stain becoming soft and light tan, then stringy	Mushrooms
<i>Pleurotus populinus</i>		QA	White rot	Mushrooms
<i>Sistotrema raduloides</i>		QA	White rot	None
<i>Vesiculomyces citrinus</i>		SAF, ES	White rot, yellowish, stringy	None; usually fruits on downed trees



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Table 3. Stem decays of Region 2. Host abbreviations: DF = Douglas-fir, ES = Engelmann spruce, F = true firs, LPP = lodgepole pine, PP = ponderosa pine, QA = aspen, S = spruces, SAF = subalpine fir, WF = white fir. Uncommon hosts are in parentheses.

Pathogen	Disease	Common hosts	Decay	Indicators
<i>Amylostereum chailletii</i>		SAF, S	Whiter rot; stringy	None (fruiting inconspicuous, ephemeral, and uncommon)
<i>Antrodia serialis</i>		SAF	Brown rot	None (usually fruits after tree dies)
<i>Cryptosphaeria lignyota</i>	Cryptosphaeria canker	QA	White mottled rot	Canker
<i>Dichomitus squalens</i>	red ray rot	PP	White pocket rot, but sometimes difficult to recognize as such; decay often in radial, star-like pattern	Dead, often fallen branches with conks
<i>Echinodontium tinctorium</i> (Indian paint fungus)	rust-red stringy rot	WF (other conifers)		Conks
<i>Fomitiporia hartigii</i>		SAF	White rot	Conks may appear on undersides and base of branches
<i>Laurilia sulcata</i>		ES	White pocket rot; yellowish, may be wet and spongy	
<i>Peniophora polygonia</i>		QA	White rot; yellow-brown, stringy	White rot; laminated, may have
<i>Phellinidium ferrugineofuscum</i>		ES	ES small pits with black flecks and white transverse streaks	Conks are rare
<i>Phellinus tremulae</i>	aspen trunk rot (white trunk rot)	QA	White rot; firm to spongy, yellowish tan in some areas	Conks, bird cavities
<i>Porodaedalea pini</i>	red ring rot	ES, LPP, DF, SAF	White pocket rot; sometimes with abundant zone lines; decay may progress into roots	Conks, punk knots
<i>Stereum sanguinolentum</i> (bleeding Stereum)	red heart rot	SAF, ES	White rot; initial red stain, becomes light brown, dry, friable, with white fungal sheets when advanced	Usually none, fruits on slash and logs
<i>Veluticeps abietina/fimbriata</i>		S, F	Brown pocket rot	Conks