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Heart Rots of Balsam Fir

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Balsam fir (*Abies balsamea* (L.) Mill.), because of its wide range, abundance, rapid growth, and the qualities of its wood, is a most important pulpwood species. Its natural range is from the Atlantic Provinces of Canada and the New England States westward to British Columbia and the Yukon, and southward into Pennsylvania and Virginia. However, balsam fir is very susceptible to diseases and decay fungi. Because of the importance of balsam fir in the pulpwood industry, the decay fungi and their effects upon this species have been studied intensively.

Studies in Canada, the Lake States, and the Northeast have clarified the relationship of decay in balsam fir to site, age, and size, and management practices have been developed to reduce losses caused by decay.

Extensive data, based on three studies of balsam fir in widely separated localities, showed that 67.4 percent of the trees were infected by at least one decay-producing organism. White rots occurred in 44.9 percent of the trees and brown rots in 10.1 percent, indicating a far greater preponderance and importance of the white butt rots. Some kind of trunk rot was found in 37.9 percent of the trees.

For convenience, the decays of balsam fir can be divided roughly into three groups: (1) White root and butt rots, (2) brown cubical root and butt rots, and (3) top or trunk rots. A few butt rots may also occur as trunk rots.

White Root and Butt Rots

No clear distinction can be made between root rots and butt rots because root rots often spread into the butt of the tree.

Wood decayed by different white rot fungi may vary in appearance. This variability (figs. 1 and 2) is shown by the various descriptive names applied to the rots: White rot, yellow stringy rot, white spongy rot, white pocket rot, and feather rot.

The white rots show various degrees of mycelial development. Some may include fluffy bits or platelike patches of mycelium, and others small pockets of mycelium. Small black specks are often associated with several white rots.

Zone lines are formed in some white rots. Often they are present in mixtures of two or more rot-producing fungi, even though the individual organisms when occurring alone do not produce them.

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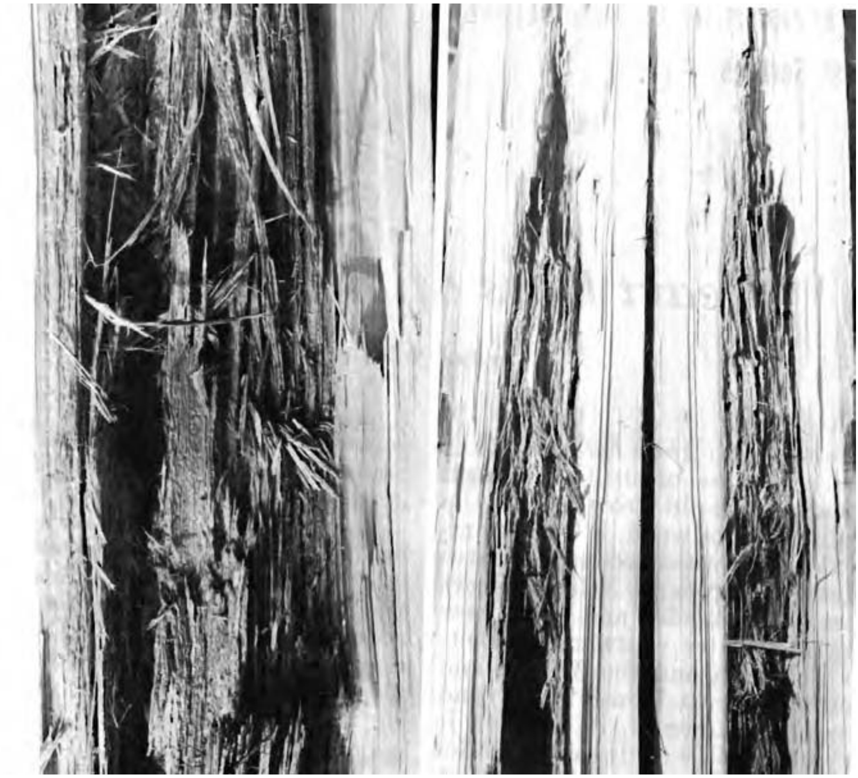

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Figure 1.—White butt rots in balsam fir bolts: *Left,* Caused by *Poria subacida; right,* caused by *Odontia bicolor.* Note the stringiness of the rotted wood.

The rot produced by *Armillaria mellea* luminesces in the dark. This characteristic is a reliable indicator of the presence of this fungus, because no other organism known to affect balsam fir possesses this ability.

To identify a rot-causing fungus, it is necessary to isolate and culture the fungus. The characteristics of white rots are seldom distinct enough for reliable identification. Nor can the fruiting structures of the fungus be relied upon for rot identification because many of the white butt-rot fungi seldom fruit on living trees.

The five most common white butt- and root-rot fungi affecting balsam fir can be ranked in importance as follows:

	Frequency of occurrence (percent)	*Average extent above ground (feet)*
Corticium galactinum (Fr.) Burt	54.1	5.2
Odontia bicolor (Fr.) Bres.	17.3	4.1
Poria subacida (Pk.) Sacc.	11.1	4.8
Armillaria mellea (Fr.) Quél	11.1	2.4
Omphalia campanella (Fr.) Quél.	4.2	5.1

The average extension of all white rots was 5.1 feet above ground and the maximum extension 20 feet.

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Figure 2.—Cross and longitudinal sections showing advanced stages of white butt rot caused by *Armillaria mellea*. *Stereum chailletii*, another white rotter, was isolated from the faint discolored streaks, seen in both sections, in the wood between the *A. mellea* rot and the bark.

Before present culture-identification methods were developed, *Poria subacida* was believed to be the cause of practically all loss by white butt rots in balsam fir trees.

Brown Cubical Root and Butt Rots

The so-called brown rots usually are buff to chocolate brown (figs. 3 and 4). These rots produce considerable longitudinal and radial shrinkage, causing the rotted wood to fracture into roughly cubical shapes.

Brown rots occur commonly as butt rots in balsam fir trees, although less frequently than white rots. Many brown rot fungi attack dead sapwood, as well as heartwood. However, they are found rarely as trunk or top rots in living balsam firs.

The seven most common brown cubical root- and butt-rot fungi

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Figure 3.—*Polyporus balsameus: Left*, A typical brown cubical rot in balsam fir; *right*, fruiting bodies of the fungus on rotted sections.

affecting balsam fir trees are as follows:

	Frequency of occurrence (percent)	Average extent above ground (feet)
Polyporus balsameus Pk.	42.1	2.9
Coniophora puteana (Fr.) Karst. . . .	41.4	4.7
Merulius himantioides Fr.	12.8	3.6
Fomes pinicola (Fr.) Cke.	1.5	—
Polyporus schweinitzii Fr.	.7	—
P. guttulatus Pk.	.7	—
P. resinosus Fr.	.7	—

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Figure 4.—*Coniophora puteana*: *Left*, Brown cubical butt rot; *right*, fracture pattern on end of bolt. This rot extended 4 feet through stem.

Some doubt exists as to the relative importance of *Merulius himantioides*, because it generally attacks overmature trees in the older age classes and may be only a secondary fungus that follows other infections, according to some evidence. The average extent above ground for all brown butt rots examined was 3.7 feet.

Prior to 1922, *Polyporus schweinitzii* was considered to be the cause of nearly all brown butt rot in balsam fir. As new knowledge has been gained through culture-identification methods, the relative importance of the organisms causing brown butt rots is more clearly understood.

Top or Trunk Rots

Usually top rots are caused by different fungi than those that affect the roots and basal parts of the tree. Butt rots extend upward; top rots extend both downward and upward. However, the two types of rot rarely meet to form a continuous rot column.

Stereum sanguinolentum is by far the most important trunk-rotting fungus that affects balsam fir (fig. 5). Sometimes more than one

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Figure 5.—Rot caused by *Stereum sanguinolentum*, the most important cause of trunk rc in balsam fir.

S. sanguinolentum infection occurs in the same tree. Decay studies show that this fungus, which causes "red heart," is responsible for 93.9 percent of all balsam fir trunk rots.

Trunk rots are more important than butt rots in causing cull. The average extent of rot by *Stereum sanguinolentum*, based on the combined results of three studies, was 18.7 feet compared with an average extent for all white and brown butt rots of 5.1 and 3.7 feet, respectively.

The importance of *Stereum sanguinolentum* in relation to other top rots is shown in the following tabulation:

	Frequency of occurrence (percent)
Stereum sanguinolentum Fr.	93.9
Fomes pini (Fr.) Karst.	1.3
Corticium galactinum (Fr.) Burt (as top rot)	1.3
Fomes pinicola (Fr.) Cke.	1.3
Stereum chailletii Pers. (as top rot)	1.0

Recent evidence has shown that most infections of *Stereum sanguinolentum* occur through injured parts of living trees, mainly broken tops and broken branches. Winter storms are responsible for many injuries to living trees, but other agents such as lightning, falling trees, frost cracks, logging wounds, or possibly some insects can produce injuries that serve as infection courts for the entry of this fungus. Dead branch stubs and old dead leaders are not important infection courts.

Other nonrotting fungi cause various discolorations in association with top-rotting fungi. The importance of the relationship of these staining fungi to tree-rotting fungi is unknown; further research is necessary to clarify this relation and to determine the importance of these organisms.

Recommended Utilization and Management Practices

Direct control of heart rots is impossible. However, better utilization can conserve much of the wood now lost as cull, and good management practices will reduce losses from decay.

Much of the wood infected with white rot can be used as pulpwood. White butt rots, especially in incipient stages, do not appreciably reduce wood-fiber strength, and little bleaching is needed to offset the wood discoloration produced by, or associated with, these rots. On the other hand, brown rots greatly reduce wood-fiber strength; and if wood infected by brown rots is used for pulping purposes, both strength and volume losses in the finished product can be expected. Heavy bleaching is also required when such wood is used.

Much of the wood rotted by *Stereum sanguinolentum* can be used for pulpwood without appreciable loss in product strength. This fungus produces a comparatively firm rot that, even in its advanced stages, is not so destructive to wood-fiber strength as are the majority of the balsam fir decay fungi. A relaxing of cull restrictions on "red heart" of balsam fir by paper manufacturers would conserve much raw material.

Volume loss from butt rots, which seldom extend far above ground, probably has been overestimated. Windthrown trees weakened by root rots probably account for greater loss than the amount of wood loss due to butt rots. The amount of cull can be reduced materially by bucking short lengths from the basal parts of butt-rotted trees, especially since a third to a fifth of the average extent of the butt rot remains in the stump.

Decay becomes evident in balsam fir at about 40 to 60 years, and increases with age. At 70 to 80 years, losses from decay are usually slight; but after 80 years decay volume increases rapidly and the net periodic increment begins to decrease. Balsam fir trees 80 years old range from about 6.5 to 11 inches d.b.h., with an average of about 7 to 8 inches. Therefore, short rotations and early harvest provide a practical means of salvaging trees before root, butt, and top rots develop excessively.

Stands with relatively large numbers of wound defects should be cut as soon as practical. These defects include frost cracks, lightning scars, limb and top breakage from storms, damage done by falling trees, and logging injuries. In laying out roads, felling trees, and other woods operations, care should be taken to prevent wounding trees.

Trees killed by insect defoliators should be salvaged in the first year or two after death of the tree. Dead balsam firs deteriorate so rapidly that salvage may become unprofitable within 3 years.

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