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Red Rot of Ponderosa Pine

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Red rot caused by the fungus *Polyporus anceps* Peck is the most important heart rot of ponderosa pine (*Pinus ponerosa* Laws.) in the Southwest (in Arizona and New Mexico), the Black Hills of South Dakota, and some localities in Colorado, Montana, and Idaho. It causes only insignificant losses to this species elsewhere in the West. The red rot fungus rarely attacks other living conifers, but it is a common scavenger of dead softwood material throughout North America.

Significance

Although ponderosa pine is remarkably decay-free over most of its range, as much as one-fifth of the gross volume cut in virgin sawtimber stands in the Southwest and the Black Hills has been culled because of red rot. A great deal of rot has been eliminated by first cuttings, but until the bulk of the overmature timber has been removed, red rot will continue to cause significant losses. It will still be a problem in second-growth stands, because it gets into young, healthy trees and has 50 to 100 years to develop, even in short rotations.

Continuing studies may reveal that several butt rots and other heart rots can also damage the younger stands. For example, brown rots, including one caused by *Veluticeps berkeleyi* Cooke, have recently been observed causing considerable cull in ponderosa pine sawtimber in the Black Hills.

Virtual limitation of the heart rot problem to the Southwest and the Black Hills may be a matter of both climate and economics. Summer rainy seasons and accompanying high temperatures favor fruiting, spore germination, and vegetative development of the red rot fungus. Red rot is economically significant in these two regions, because it is the major heart rot in the principal commercial tree species.

In the Southwest and the Black Hills, the red rot fungus is effective in decaying ponderosa pine slash. It develops rapidly in the larger pieces of slash and the sapwood of cull logs, causing a soggy rot that does not burn readily or form lasting embers.

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Life History and Methods of Attack

The red rot fungus fruits abundantly on the lower side of decaying dead material in close contact with the ground (figs. 1 and 2). The flat, white fruiting bodies appear about 4 years after such material is infected and develop annually during the rainy season for about 6 years. Their size varies but, if they develop on cull logs, they may cover an area of 15 to 20 square feet and produce billions of spores.

The spores are carried by the wind. Those that lodge in cracks or insect tunnels in the bark of dead branches may germinate and lead to the development of white, feltlike mycelial pads between the bark and the wood. The fungus invades the wood of branches directly from these pads. Infection often takes place toward the outer ends of branches, but rapid extension of the mycelial pads may establish red rot close to the trunk.

The outer ends of infected branches decay rapidly. Rot in the branch base is localized in slender columns that penetrate the knot, some through the pith cavity and others through the pitch-infiltrated knotwood (fig. 3, *A*). Eventually the rot reaches the heartwood of the trunk (fig. 3, *B*). Not all cases of branch decay result in heart rot; sometimes the red rot fungus is blocked by other fungi, and sometimes it becomes inactive or dies.

Branches are susceptible to attack by the red rot fungus from the time they have dead parts, such as secondary branches, until they have been completely dead for about 20 years, provided they have retained

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Figure 1.—Scattered large red rot fruiting bodies on the lower side of a cull log. The log was rotated about 90 degrees to expose the fruiting surfaces.

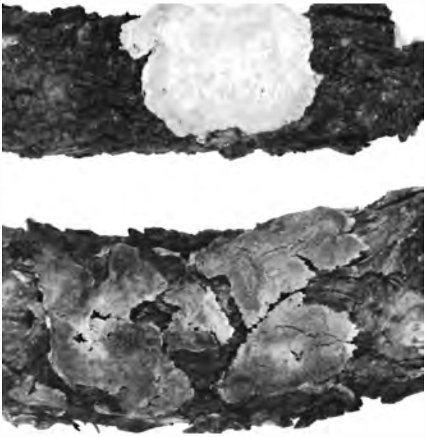

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Figure 2.—Small light (upper) and dark (lower) fruiting bodies on detached dead branches. Color differences show up after drying.

their bark. Branches with basal diameters greater than 1 inch are about 10 times more likely to become infected than smaller branches. Infections do not occur through branch stubs or broken tops, nor do they start on exposed sapwood or on the surface of knots left after pruning.

Appearance

The red rot fungus causes a white pocket rot in ponderosa pine. Like other wood decays, it may be considered as having two distinct stages: incipient and advanced.

The incipient stage is characterized by a reddish-brown discoloration of the affected wood, unaccompanied by any obvious changes in structure or strength.

The advanced stage is characterized by small, often poorly defined, white pockets in the discolored wood, accompanied by progressive changes in structure and reduction in strength. The pockets are of variable sizes and shapes, with their long axes parallel to the grain, and they appear to be filled with a lintlike substance. Sometimes they contain small, black spots. As decay progresses, the pockets become more and more numerous until they merge and give the affected wood the appearance of a fibrous white mass. Finally the white lintlike material disappears, leaving the bleached, grayish-brown, decayed wood in either a stringy or a somewhat amorphous condition.

On the ends of logs, areas of incipient decay are often fan shaped or radiate out from the center like the spokes of a wagon wheel (fig. 4, *A*). The advanced stage is usually surrounded by brownish, fanlike areas of incipient decay. Ultimately the stringy or amorphous mass of this stage falls away, creating a cavity (fig. 4, *B*). Both stages of red rot are usually visible in a board sawed from a decayed log (fig. 4, *C*). At the point where rot started in the trunk heartwood, advanced decay often results in a cavity around the knot. Extending in both directions from this point are more or less continuous columns of advanced decay, bordered by incipient decay.

Development

Red rot is rare in trees less than 20 years old because few, if any, dead branches are large enough to be susceptible to infection. Branch size tends to increase directly with height above ground, and tree susceptibility increases as additional branches die. Consequently, trees are much more likely to be infected

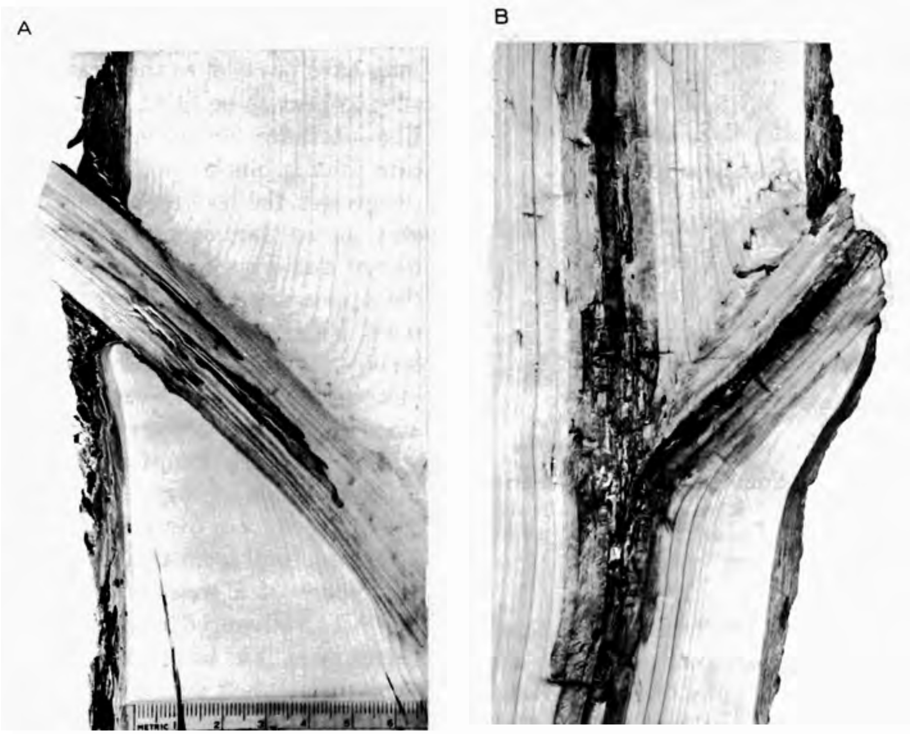

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FIGURE 3.—Radial-longitudinal sections of the trunks of immature trees showing: *A,* Red rot that extended into the knot—the central position of the longest column indicates that the red rot fungus made more rapid progress through the pith cavity than in the wood; *B,* red rot that reached the trunk heartwood through the pith cavity of the knot.

by the time they are 40 years old than 20 years old.

The incidence of red rot as judged by the presence of one or more decayed branches is higher in immature stands in the Southwest than in those in the Black Hills. In 41- to 100-year-old stands, 29 percent of the trees were determined to be infected in the Southwest as compared to only 15 percent in the Black Hills. Within this broad age class, infection is more closely related to the size of dead branches and of trees than to age.

The amount of heart rot in immature stands is usually small. Of 31 infected trees in the 21- to 40-year age class that were carefully studied in the Southwest, only 6 percent had heart rot and it averaged 0.01 foot in linear extent. In contrast, of 39 infected trees in the 41- to 60-year age class, 32 percent had heart rot and it averaged 1.5 feet in linear extent. In the 61- to 80-year age class, 43 percent of the 30 infected trees had heart rot and it averaged 2.8 feet. In the 81- to 100-year age class, 42 percent of 26 infected trees had heart rot, but the average linear extent was 7.2 feet.

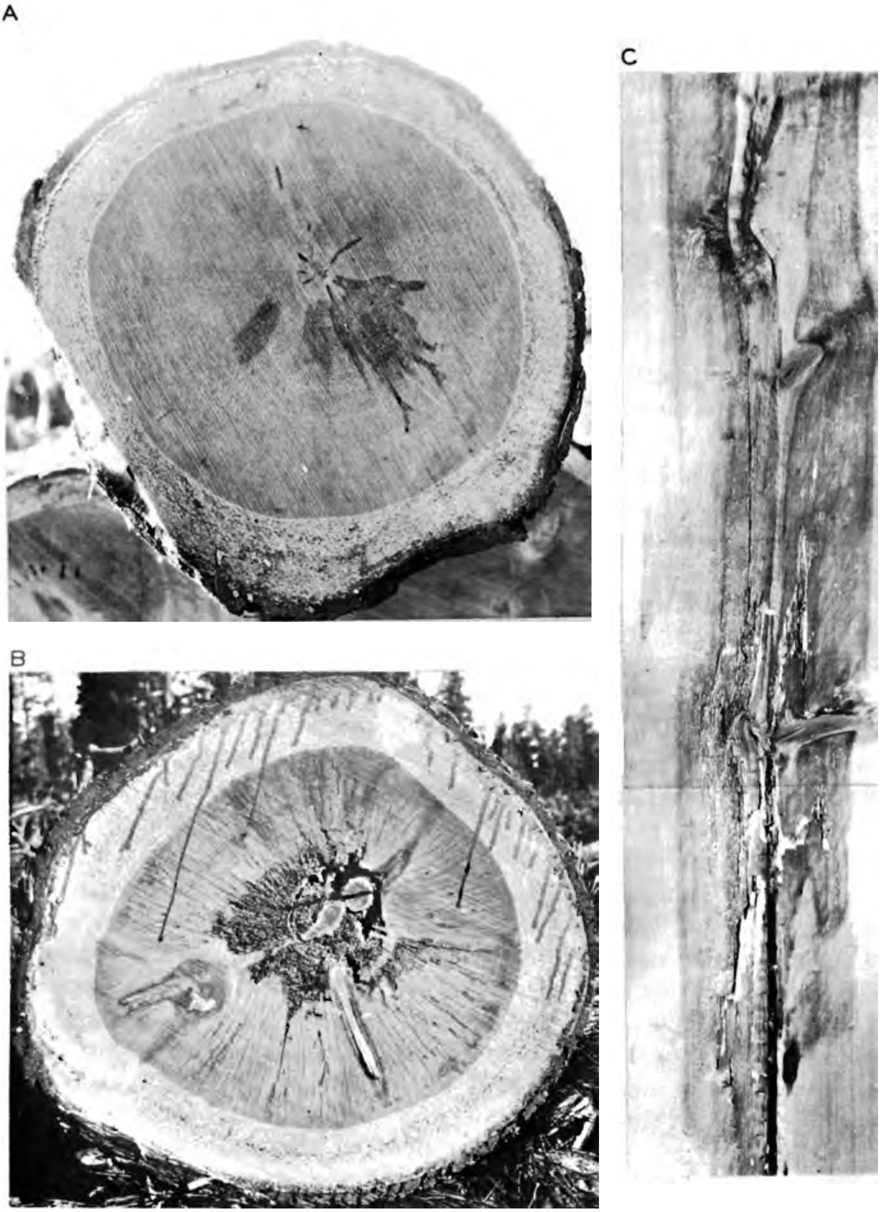

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FIGURE 4.—Appearance of red rot: *A,* Incipient decay showing at the end of a saw log; *B,* advanced decay showing at the end of a saw log; *C,* advanced decay bordered by incipient decay in the heartwood of a board—the centrally located area of disintegration probably indicates where rot entered the trunk.

The average length of rot columns in heart-rot affected trees increases about 1.5 feet per decade of tree age between 41 and 100 years. At this rate the total length of rot columns in the butt logs can be expected to average about 9 feet in 100-year-old affected trees and at least 15 feet in 150-year-old trees. Heart rot seems to develop in about 50 to 75 percent of the trees that have decaying branches.

The ultimate severity of red rot in second-growth ponderosa pine cannot be determined until immature stands have attained cutting age. Available estimates of future losses are based on studies made during commercial timber sales or studies of lumber-grade recovery. Probably the most serious limitation of data from these sources is that today's merchantable sawtimber stands developed under conditions that will not prevail during the lifetime of the present immature stands.

In general, red rot in butt logs is potentially more severe in unmerchantable-size young trees than in merchantable-size older trees. The reason for this is that uncontrolled fires in virgin stands eliminated many potential entrance points as well as some established branch infections, thus limiting red rot to upper logs.

The volume of red rot cull in the Southwest does not exceed 16 to 22 percent in first cuttings of virgin sawtimber and 6 to 15 percent in second cuttings. It will probably not exceed 2 to 5 percent in 150-year-old, second-growth sawtimber or 1 to 3 percent on a 100- to 120-year rotation. Somewhat smaller losses can be anticipated in the Black Hills.

Percentages of cull estimated for sawtimber merely suggest that red rot will be significant in future stands. This may not be the case if ponderosa pine stands are managed for nonlumber products or uses.

Detection

Red rot is difficult to detect in living trees because fruiting bodies develop on them rarely and only on dead branches, where they merely indicate branch decay. The problem of recognizing decayed trees is doubly difficult because the fungus does not require conspicuous entrance courts, such as wounds, fire scars, or dead tops. For many years some method of distinguishing decayed mature and overmature trees and estimating volume losses before cutting has been sought as a guide to marking systems. No practical method has been found.

The problem of detection is different in immature trees. Even though there are no obvious indications of red rot, most dead branches are still attached to the trees and can be removed for close examination. Whole or broken dead branches can be tested by breaking them before pruning close to the trunk. Undecayed branches resist pressure or break with a crack. Branches in the advanced stage of decay offer little or no resistance and break as though water logged. Suspected branches must then be pruned flush with the trunk to determine whether the knots have been penetrated; heart rot is likely if red rot occurs in the pith.

In a tree 61 to 100 years old, bark-covered branch stubs are quite reliable indicators of whether red rot is present. The broken parts often can be found on the ground at the base of the tree and examined. Pruning is necessary, however, to determine whether the trunk has been penetrated.

Red rot can be distinguished from two similar branch decays caused by *Fomes tenuis* Karst. and *Polyporus abietinus* Fr. by its characteristic rot pockets in the pitchy base of the branch, if rot has progressed that far. In the incipient stage of branch decay, red rot can be distinguished by the white mycelial pad that binds the bark so tightly to the wood that the bark cannot be pulled from the branch without particles of wood adhering to it. *F. tenuis* forms a tan mycelial pad between the bark and the wood, and *P. abietinus* forms a white to brownish netlike pad; neither of these pads binds the bark to the wood.

Control

Harvest operations have automatically reduced the total volume of red rot in ponderosa pine sawtimber in the Southwest and the Black Hills. Except in light selection cuttings, more red rot has been removed from the stands than will develop in the remaining trees before a second-harvest cutting. The second and subsequent cuttings will further reduce the volume of red rot infected wood. Also they will indirectly help to control future losses by leaving less potentially infectious cull logs and slash on the ground.

The Southwest still has commercially operable stands of virgin ponderosa pine. The volume of red rot infected wood in these stands can be greatly reduced in heavy first cuttings that remove a high proportion of the mature and overmature trees. The main drawback to this approach is the difficulty of recognizing the oldest trees. Fortunately, bark color and thickness have proved to be even better criteria of red rot than actual age; the more yellowish and thinner the bark, the older the tree.

Future losses from red rot can be reduced by using good silvicultural practices in second-growth stands. In general, a precommercial thinning should favor small-branched trees and discriminate against large-branched trees that are either poor risks or already infected. Since thinning favors the development of larger branches, potential crop trees should then be pruned to a height of 17 feet in several operations spaced about 10 years apart. Pruning eliminates future entrance points and branch infections that have not entered the trunk. It can also inactivate or kill the red rot fungus in decay columns that have already extended into the knots.

A commercial thinning provides an opportunity to dispose of trees that are likely to have red rot in the trunk heartwood. For example, small pockets of red rot would not cause any loss in pulpwood cut in a commercial thinning. However, if rot pockets continue to expand in uncut trees until the final harvest, they could result in culling of trees for utility poles or in appreciable deductions from the gross scale of saw logs.

Little is known about the need for red rot control in ponderosa pine managed primarily for uses other than timber production. In general, however, severely decayed, overmature trees are hazards in heavily used areas and should be removed as soon as they are recognized.

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