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Rust-Red Stringy Rot

By James W. Kimmey[1]

Hosts

Rust-red (brown)[2] stringy rot of the heartwood of living conifers in the Western United States and Canada is caused by the Indian paint fungus, *Echinodontium tinctorium* E. & E. This heart rot is most prevalent in grand fir, white fir, and western hemlock, but it is also common in California red fir, Shasta red fir, Pacific silver fir, subalpine fir, and mountain hemlock. Other hosts in which it is less commonly or even rarely found are Douglas-fir, western white and Engelmann spruces, western redcedar, and western white pine. It has also been reported in Japanese and eastern hemlocks.

Occurrence

Both the distribution of the fungus and the frequency of its occurrence vary greatly, even though the organism has many hosts whose natural ranges overlap to provide an opportunity for uniform distribution in the West. None of its hosts are attacked in all their natural habitats. Abundance of this fungus appears to be influenced as much by the summer climate at any location as by the susceptibility of its hosts. High average summer temperature in combination with sustained high humidities favors its occurrence. Consequently, its frequency in a highly susceptible host generally increases from west to east and from north to south within that host's range. Hence, it is absent or occurs rarely in coastal forests and northern forests but is most abundant in the forests of the interior of British Columbia, northern Idaho, and the Blue Mountains.

The Fungus Conks

The Indian paint fungus produces interesting and unique fruiting bodies or conks quite abundantly on infected trees (figs. 1 and 2). The hard, woody, hoof-shaped perennial conks range from a few inches to 1 foot or more in width. The upper surface is black, dull, rough, and cracked; the under surface is level and thickly set with hard, coarse spines. The spines are

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[1] Forest pathologist, Intermountain Forest and Range Experiment Station, Forestry Sciences Laboratory, Moscow, Idaho. The Laboratory is maintained in cooperation with the University of Idaho.

[2] The common name "brown stringy rot" frequently used for decayed wood has been confusing to workers because the rot is not correctly classed in the "brown rot" type; hence the use here of the more distinctive and accurately descriptive name "rust-red stringy rot."

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Figure 1.—Grand fir tree with medium-sized conks of the Indian paint fungus. Note the typically black upper surface of the conks, and the newly formed gray under surface.

gray when newly formed (fig. 3), turn black when old (fig. 4), and have reddish centers. The color of the interior of the conks is a striking rust red or brick red, often seen in wood in the late stages of decay. The Indians made a pigment from the conks, hence the name of this fungus. Conks develop on the tree bole, usually on the underside of dead branch stubs, and normally the rust color extends from the decayed heartwood into these stubs or knots.

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Figure 2.—Mountain hemlock tree with two large and two small conks of the Indian paint fungus. The under surface of the conks has turned black, which is the usual color of inactive conks.

Description

Rust-red stringy rot is of the general white rot type; i.e., the fungus first destroys the lignin constituents of the heartwood. In its earliest visible (incipient) stage the decay appears as slightly darkened water-soaked spots or larger areas of discoloration in the heartwood; however, when the wood dries, this water-soaked discoloration almost completely disappears. The wood from 1 to 5 feet (longitudinally) in advance of the faintest discolora-

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Figure 3.—Cross section of a white fir log at conk location showing typical late stage of rust-red stringy rot and lower surface of the conk bearing a newly formed gray spine layer.

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Figure 4.—Cross section of western hemlock tree bole at a conk location shows the entire heartwood decayed. The attached Indian paint fungus conk shows the spiny under surface that has turned black after maturity.

ı contains an earlier but invisible stage of decay.

The earliest sign of breakdown in the invaded wood is accompanied by a softening of the wood and a faint yellowish to golden-tan discoloration that gradually deepens to a pale reddish brown. Next, fine rust-red streaks appear following the grain. The wood still seems strong and only slightly softened; but boards sawn from such wood may, upon drying, fall apart along the growth rings. In the advanced stage of decay (figs. 3 and 5), the wood becomes soft, stringy, and tan to rust red, and narrow brown to red zone lines are often present. Frequently trees show a tendency to ring rot or a separation of the wood along the annual rings (fig. 6). In the final stages of decay, cellulose constituents are also destroyed and some of the stringy mass of rotten wood may be completely disintegrated, leaving a hollow in the tree.

Damage

Rust-red stringy rot is typically a trunk rot that usually forms a regular circular pattern in the center of a cross section of the tree bole (fig. 7). The rot column is elliptical near the upper limits and in

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Figure 5.—Broken-over grand fir tree showing the stringy nature of rust-red stringy rot in the late stage.

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Figure 6.—Longitudinal section of a broken grand fir log containing a late stage of rust-red stringy rot, showing separation of the wood along the annual rings.

older trees often occupies the entire heartwood (fig. 4), extending into the roots and larger branches. In the early stages of development, the rot is elliptical in both directions from the area of greatest decay or from a conk. The extent of rot in the trunk varies from a few feet in recent infections in younger trees to almost the entire length of the trunk in old or multiple infections in older trees (fig. 7).

In the aggregate, damage from this rot is great: The gross board-foot volume of mature stands of white fir and Pacific silver fir is commonly reduced 25 percent or more. Stands of grand fir and western hemlock in northern Idaho and the interior of British Columbia are often found to be one-third to one-half cull, principally from this heart rot. The losses are generally greater in older and over mature stands and at times may approach 100 percent of the board-foot volume in the oldest stands.

Estimating Extent of Rot in the Bole

Rust-red stringy rot is not confined to any particular part of the tree bole. On standing trees, its extent and location within the bole are indicated by the location, distribution, and size of the conks. On a felled tree, extent and location of rot can be estimated more accurately by the location and distribution of "rusty knots." This is done by knocking off branch stubs or chopping about an inch into the

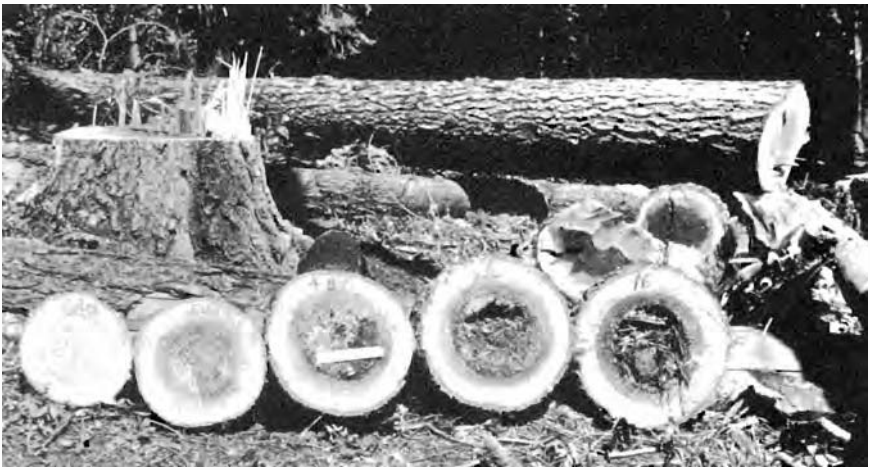

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Figure 7.—Cross section cuts at log-length intervals in the bole of a white fir tree containing rust-red stringy rot show the circular pattern of decay in the heartwood and the longitudinal extent of the rot column. *Left to right:* Cuts at 80 feet, 64 feet, 48 feet, 32 feet, and 16 feet above the stump. A split section of the stump is directly behind the 16-foot cut, and a conk is attached to the 48-foot section.

knots. Heart rot is present beneath the rusty knots and extends 6 to 8 feet above the highest knot containing rust-red color.

resence of a single average-sized conk, or of two or more such conks in a compact group, usually indicates that the heart rot extends about 16 feet above the highest and 16 feet below the lowest conk. When such conks occur near either the lower or the upper end of the bole, the opposite end of the bole usually contains sound logs. However, the presence of exceptionally large conks (fig. 2) or of several conks spaced far apart and scattered along the bole usually indicates that the tree is unmerchantable for saw logs.

Control

Young trees are usually free from rust-red stringy rot because the fungus cannot enter a tree until heartwood begins to form—at 25 to 40 years of age for most host species. Furthermore, heartwood must be exposed before fungus can enter it; such exposure usually occurs in stubs of branches suppressed by shade. But stubs occur less frequently in shade-tolerant species (as hemlocks and true firs) because these species retain living branches in the lower bole longer than intolerant species. On the other hand, most branches on shade-tolerant species often contain heartwood by the time they are eventually killed by suppression.

From this it follows that pruning young trees (before heartwood forms in the lower branches) should provide an excellent means of preventing entry of the fungus. Crop trees thus pruned could conceivably reach rotation age before rust-red

stringy rot significantly reduced their merchantable volume.

Hemlocks and true firs usually grow in natural mixed conifer stands as all-age components because they are tolerant to shade. When stands containing appreciable amounts of rust-red stringy rot are harvested, advanced reproduction consisting of hemlock and fir saplings and poles should not be left after logging. These small, but not always young, trees may contain rust-red stringy rot that will provide some decay volume early in the next rotation. To reduce the fungus source in new stands to a minimum, all cull trees containing conks of the Indian paint fungus should be cut or otherwise killed at the time of logging or soon afterward as a sanitation measure. Conk survival on felled trees can be further reduced by bucking these cull trees into logs.

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