U.S. DEPARTMENT OF AGRICULTURE FOREST PEST LEAFLET 88
Forest Service August 1964

White Trunk Rot of Hardwoods

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The white trunk rot of hardwoods, caused by *Fomes igniarius* (L. ex Fries) Kickx (including the varieties *populinus* and *laevigatus*), is the single most important rot in the hardwood forests of North America. The fungus is common and abundant throughout North America, Europe, and Asia, and it has also been reported in the Congo and Australia.

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Hosts

Nearly all North Temperate Zone hardwoods are susceptible to the disease. In North America it is especially destructive to quaking aspen, bigtooth aspen, yellow birch, paper birch, American beech, sugar maple, and red maple.

Symptoms

Fruiting bodies or conks of *Fomes igniarius* are produced on the stems of both living and dead trees, usually at knotholes where branches have died and dropped off, at the base of

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Figure 1.—Applanate (shelflike) conk of *Fomes igniarius* at an old sunscald scar on yellow birch.

dead branches, or at various types of injuries that extend deeply into the wood. The conks are variable in shape, ranging from shelflike to hooflike to flat even on the same host (figs. 1, 2, and 3). The upper surface of shelflike and hooflike conks is gray to black, concentrically ridged, and divided into irregular squares by numerous cracks. The lower side or pore surface of all types is medium brown and pitted

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Figure 2.—Ungulate (hooflike) conk of *Fomes igniarius* at a seam covering an old branch stub on American beech.

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Figure 3.—Nearly resupinate (flat) conks of *Fomes igniarius* at bases of branch stubs on bigtooth aspen.

by numerous tiny pores visible to the unaided eye.

A conk of this fungus is best identified by splitting it radially and examining the interior, revealing a dark brown context with conspicuous white flecks and usually with more than one layer of pores visible (fig. 4).

Not all infected trees bear conks, but most trees with advanced decay do. A Canadian study has shown that 60 percent of the aspen in the 41- to 60-year age class that had *Fomes igniarius* rot bore fruiting bodies, and in older trees, 79 to 98 percent did. In Colorado over 75 percent of all aspen infected by *F. igniarius* bore conks.

On yellow birch the fruiting bodies are usually flat but occasionally shelflike. They are often found near the margin of single or multiple stem cankers caused by the fungus. On yellow birch, conks

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Figure 4.—Radial section of *Fomes igniarius* Conk. The white flecks in the dark brown context and the several pore layers are characteristic of this species.

are usually produced after death of the host, but they sometimes form on living trees. The cankers are characterized by sunken areas of considerable size over which the bark, impregnated with hard black mycelium, remains firmly attached. They generally occur only on trees with advanced decay, and they result from localized death of the cambium caused by the fungus (fig. 5).

Punk knots (rotten knots filled with dark brown material similar to the interior of the conks) are often present in trees with advanced decay, especially quaking aspen.

The heart rot caused by *Fomes igniarius* is centrally located in the stem, and it is soft and yellowish white with a distinct dark zone next to the surrounding healthy wood. In later stages, a number of irregularly concentric fine black lines, called zone lines, are formed in the spongy, decayed wood inside the dark zone. No cracks or separations occur in the decayed wood. Figure 6 illustrates the appearance of the rot in radial and cross sections of various hosts.

The presence of fruiting bodies and punk knots on all host species and the cankers described on yellow birch are the only reliable external indications of internal decay by *Fomes igniarius*.

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Figure 5.—Surface and radial views of a canker on yellow birch caused by *Fomes igniarius*: *A*, Surface view; *B*, radial view. Note darker bark impregnated by the fungus mycelium in surface view. (Photos courtesy of R. P. True, West Virginia University.)

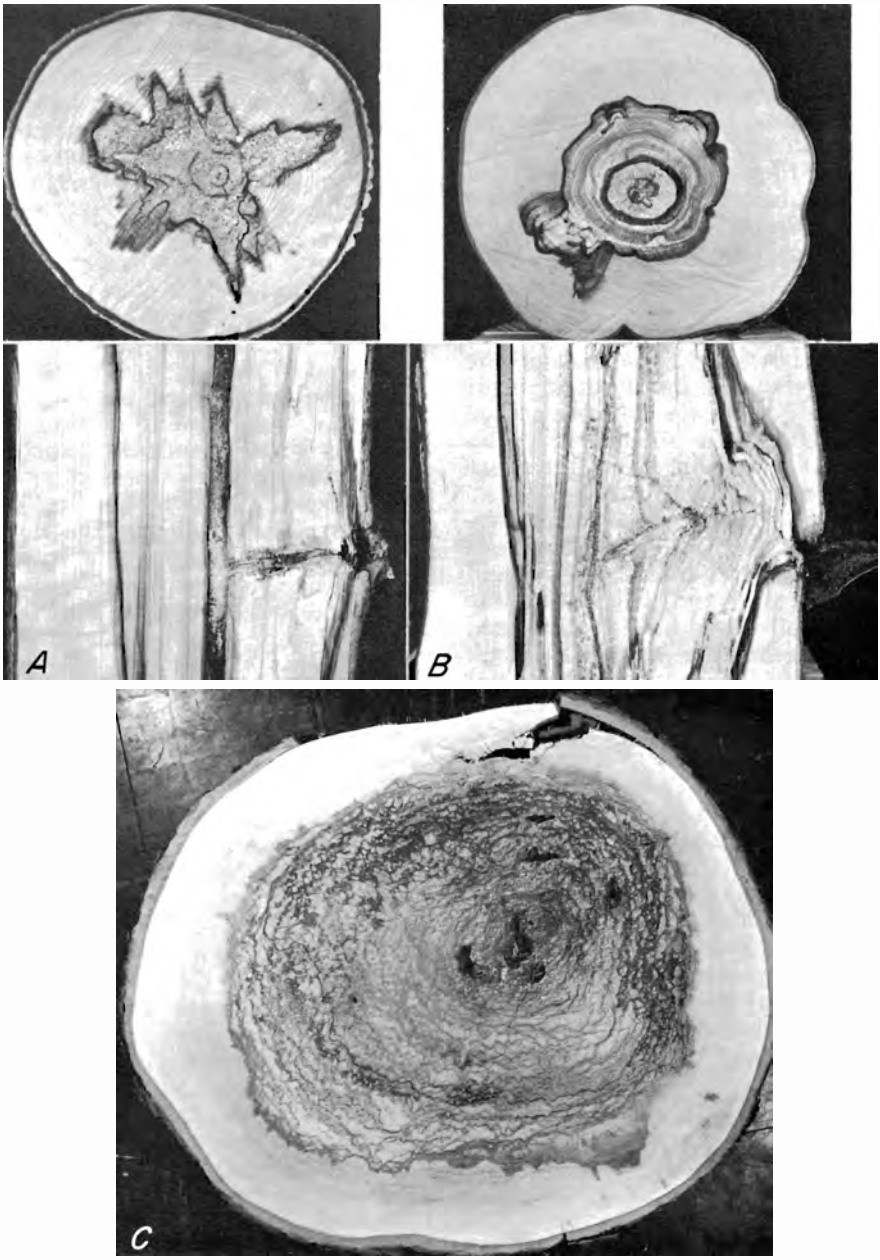

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Figure 6.—Radial and cross-sectional appearance of rot caused by *Fomes igniarius* in: *A*, Bigtooth aspen; *B*, American beech; *C*, yellow birch. Note the fine black zone lines present in the areas of advanced decay toward the center of each and the dark zones next to healthy wood. (Yellow birch photo courtesy of R. P. True, West Virginia University.)

Damage

In aspen, *Fomes igniarius* is by far the most important cause of heart rot. Recent studies in Colorado and Canada showed that 59 and 75 percent, respectively, of the volume lost through decay were caused by this fungus. In Minnesota 31 percent of the merchantable volume in 80-year-old aspen was found to be affected. In another Canadian study *F. igniarius* was responsible for 5.5 percent of the cubic volume of heart rot in sugar maple. Exact data on losses caused by the fungus in other host species are not available, but they are believed to be high.

Guides on board-foot cull percentages for northern hardwoods (sugar and soft maple, yellow and paper birch, and beech) in the Northeast have been determined for trees bearing conks of *Fomes igniarius*. Cull amounts to about 50 percent in sugar maple and 50 to 100 percent in yellow birch and beech. Where conks are present, soft maple and paper birch are usually a total loss. For aspen in the same study, a single conk indicated about 50 percent cull, and multiple conks a total loss. A detailed study of quaking aspen in Colorado showed that board-foot cull in trees bearing one to three conks at any height or any number of conks below 16 feet averaged 59-percent cull. Trees with sporophores not in these two classes (that is, with more than three conks above 16 feet) were complete losses.

Life History

Spores produced within conks are released and move out into the air through pores located on the undersides of the conks. Except for irregular periods of 1 to several days, spores are produced continuously from early spring to late fall, with each conk releasing millions of spores daily. Sporulation is favored by high relative humidity and warm temperatures, but it has been observed at temperatures as low as 40° F. in the fall. Spores are probably produced during warm periods in winter as well.

Spores are light enough to remain suspended in the air for some time and to be transported by air currents for considerable distances. Many are long lived and capable of infection for more than 2 months after release. To infect a host, a spore must fall and germinate on a wound that exposes the wood. Germination requires that the spore remain moist for 30 to 40 hours at 68° to 95° F. Spores germinate by rupturing their outer cell wall and pushing out fine extensions (germ tubes), which soon branch to form a network of fungal threads, or mycelium. The mycelium continues to spread and develop by penetrating the wood. The cell walls are penetrated through small bore holes produced in advance of the mycelium by enzymes secreted from the hyphal tips.

As the fungus develops, the cell walls continue to disintegrate until most of their constituents have been digested. Usually enough of the cell walls remain so that the wood does not disintegrate completely but becomes soft and punky. The fungus continues to spread and develop in the wood until it has accumulated enough food reserves to produce fruiting bodies. These are perennial, and each year they form a new tube layer over the old; these layers or zones are clearly seen on a radial section (fig. 4).

The fungus continues to grow and sporulate after the death of its host.

Control

In aspen, a definite relationship has been shown between stand age and amount of *Fomes igniarius* decay. Pathological rotation ages (the age at which stands should be cut to avoid serious decay losses) have been determined for aspen in various localities. These ages are as follows: Colorado in excess of 120 years on the better sites and somewhat less on poorer ones, Utah 90 years, Ontario 90 years, and Minnesota 40 to 50 years.

For other species, control recommendations are more difficult to formulate since detailed information on relationship of decay to factors, such as tree age, stand history, and site, is not available. The following measures will help reduce losses in any species:

(1) Protection from fire and control of other disturbances that create wounds on the stem, such as logging and animal damage, are essential.

(2) Maintenance of well-stocked stands to encourage natural pruning will reduce the number and size of dead branches that may serve as infection courts for the fungus.

(3) Trees bearing conks, cankers, scars, large branch stubs, broken tops, etc., should be removed during improvement cuttings.

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U.S. GOVERNMENT PRINTING OFFICE: 1964—O—728-335