by M. D. Ostrander

Identification & Evaluation of DEFECTS IN EASTERN WHITE PINE Logs & Trees

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INTRODUCTION

THE GRADE of eastern white pine lumber is determined primarily by the condition, size, and frequency of natural blemishes characteristic of the species. These include bark pockets, cross grain, rot, knots, pitch pockets, and shake. Mismanufacture and seasoning defects also affect lumber grade.

Many of the natural defects in lumber can be related to external indicators on the log or tree. For example, limby logs result in knotty lumber, and crooked logs result in cross-grained lumber. Objective measurement and evaluation of these external indicators are essential for accurate application of any log- or tree-grading system.

This guide, based on our latest knowledge about the identification and evaluation of surface blemishes on eastern white pine logs and trees, was prepared for use as an aid in applying the standard eastern white pine log grades.

Unless otherwise stated, the significance of the various blemishes or imperfections defined and described in this guide apply over the commercial range of the species. The end product considered in evaluation is standard yard lumber as defined by the Northeastern Lumber Manufacturer's Association and the Northern Hardwood and Pine Manufacturer's Association.

FACTORS THAT AFFECT QUALITY

Several measurable log factors affect the quality and value of lumber that can be cut from eastern white pine logs. These are (1) log diameter and length, (2) log straightness, and (3) visible imperfections on the surface of the log.

Log diameter and length.—Longer lengths and wider widths of lumber usually command premium prices. Certain lumber grades carry minimum length and width restrictions. Such premium-price material cannot be produced from small or short logs. In addition, restrictions on percentages of short or narrow

lumber in a shipment are often imposed upon the lumber producer.

Straightness.—Straight logs generally yield both the greatest volume and the highest quality of lumber. Crooked logs yield less volume and lower quality.

Visible imperfections on log surface.—These log defects can be divided into two main categories: grading defects and scaling defects. *Grading defects* are imperfections that affect the quality of lumber produced from a log. They include all imperfections relating directly to knots and other lumber defects that are generally not removed in lumber manufacture. *Scaling defects* are imperfections that reduce the quantity of sound wood in a log. These defects are usually removed in primary manufacture of lumber and are considered in determining net volume of a log or tree.

The distinction between the two types of log defects is not always clear. Reduction of volume scale does not necessarily remove the total effect of certain scalable defects such as red rot or shake. Limited amounts of these defects are permissible and often are left in lumber, consequently lowering its utility or value. Therefore, when such imperfections are not limited to certain portions of the log they must also be considered as grading defects.

In general, the seriousness of a log surface imperfection depends on the specifications for the product (lumber, veneer, etc.) into which the log is to be manufactured. Eastern white pine lumber is graded under yard lumber rules, in which each recognized grade within the system has a somewhat different end use. For this reason, nearly all measurable log-surface imperfections that result in degrading the underlying lumber are considered grade defects. A few, because of their minor effects on lumber quality, can be disregarded in log-grading. Examples of such minor imperfections are pin knots and bird peck.

Log imperfections are divided into three major classes: (1) those that generally affect log quality (grading defects); (2) those that generally affect net log-volume determination (scaling defects); and (3) those that can usually be ignored in both grading and scaling.

GRADING DEFECTS

The most important grading defects are those that directly and consistently influence the quality of lumber that can be produced from a log. They include log knots; holes and overgrown log knots usually related to lumber defects such as knots, bark pockets, and holes; and to other less frequent but damaging imperfections such as sweep, crook, rot, and shake. The various visible grading defects common to eastern white pine are discussed individually and in descending order of importance.

Log Knots

The term "log knot" is used to describe live limbs, dead limbs or dead limb stubs, limb sockets or holes, overgrown limbs, or any other indication of where a limb grew. All these conditions result in a knot in the underlying wood and consequently a knot in the lumber produced from the log.

Log knots with average diameters of ½ inch or less are not considered as grading defects (fig. 1). Such knots result in pin knots in lumber, which are permissible in all grades of lumber. Although all log knots over ½ inch in diameter are degraders, their size, condition, and position significantly influence the grade of the log.

Log knots are the most common and important grading defect

Figure 1.—Dead log knot ½ inch in diameter on a 14-inch log. All knots of this size or smaller are disregarded in grading.

in eastern white pine. The grader must be able to accurately evaluate the types of log knots common to the species. For purposes of evaluation in log-grading they are classified as follows:

Live log knots.—These are knots intergrown with the surrounding wood at the surface of the log, giving no indication of decay (fig. 2). They result from living or recently dead branches or limbs. In standing timber the latter are usually identifiable by the presence of bark and small twigs still adhering to the limbs. Size measurement of live log knots includes only the average diameter of the red or heartwood portion of the limb at a point flush with the bark surface of the log.

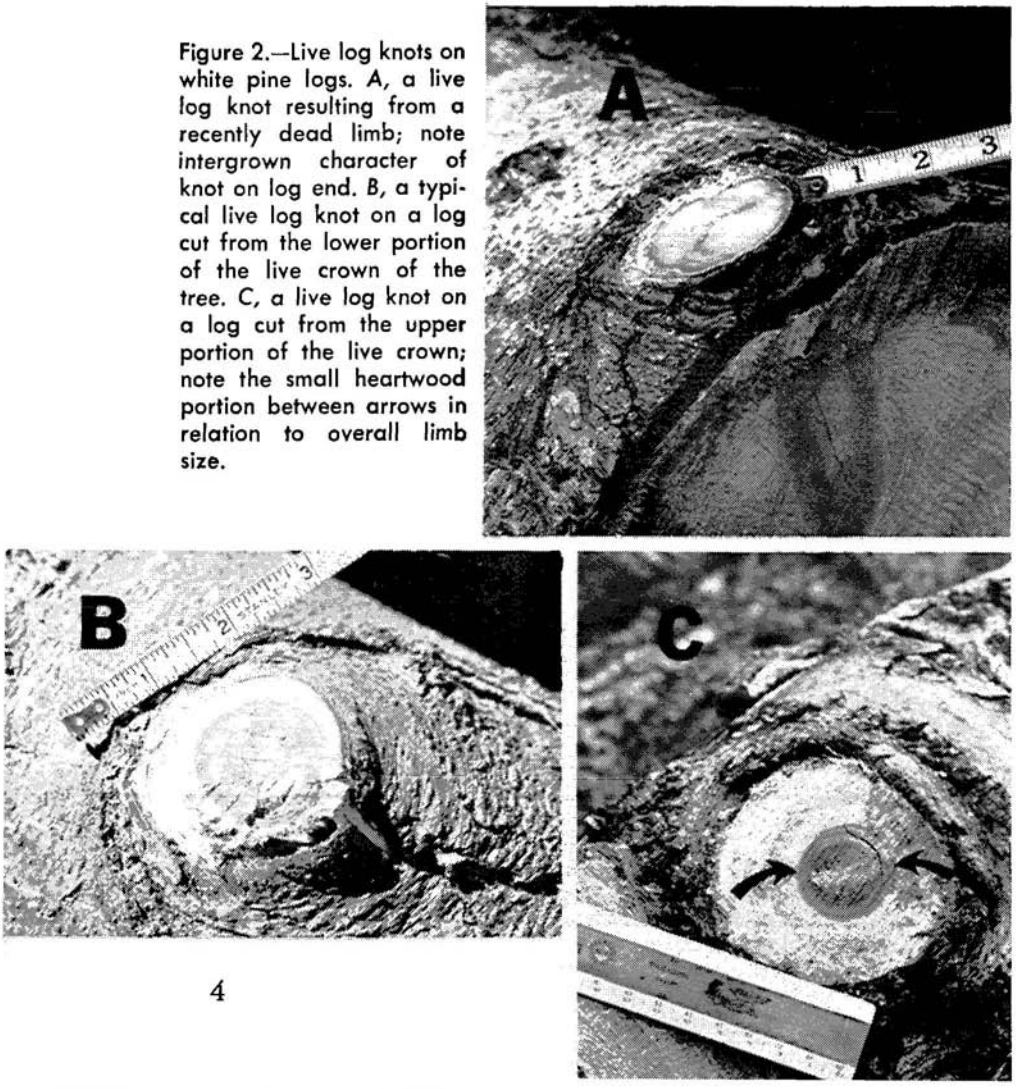


Figure 2.—Live log knots on white pine logs. *A*, a live log knot resulting from a recently dead limb; note intergrown character of knot on log end. *B*, a typical live log knot on a log cut from the lower portion of the live crown of the tree. *C*, a live log knot on a log cut from the upper portion of the live crown; note the small heartwood portion between arrows in relation to overall limb size.

In grading *butt* logs in standing trees for tree-grading purposes, these diameters must be estimated. As a guide, the knot size of recently dead limbs can be approximated closely by estimating the average diameter inside bark at a point just beyond the limb collar. Seventy-five percent of this diameter will closely approximate the knot size of live limbs. This same approach should also be applied to any epicormic limbs that are found on the grading section of a tree.

Dead log knots.—These result from dead limbs or stubs not completely intergrown with the surrounding wood at the log surface (fig. 3). They may be sound, with little or no sign of deterioration; or they may show moderate to severe signs of deterioration due to weathering and decay. The latter are sometimes classified as unsound dead log knots. However, because of difficulty in consistently differentiating between the two, and the resulting knot character in the underlying wood, they are lumped together as dead log knots. Live log knots containing rot should also be treated as dead knots for grading purposes.

Size of dead knots is defined as the average diameter of the entire dead limb material present, excluding any surrounding callus tissue. Dead log knots usually result in black or encased knots in the lumber.

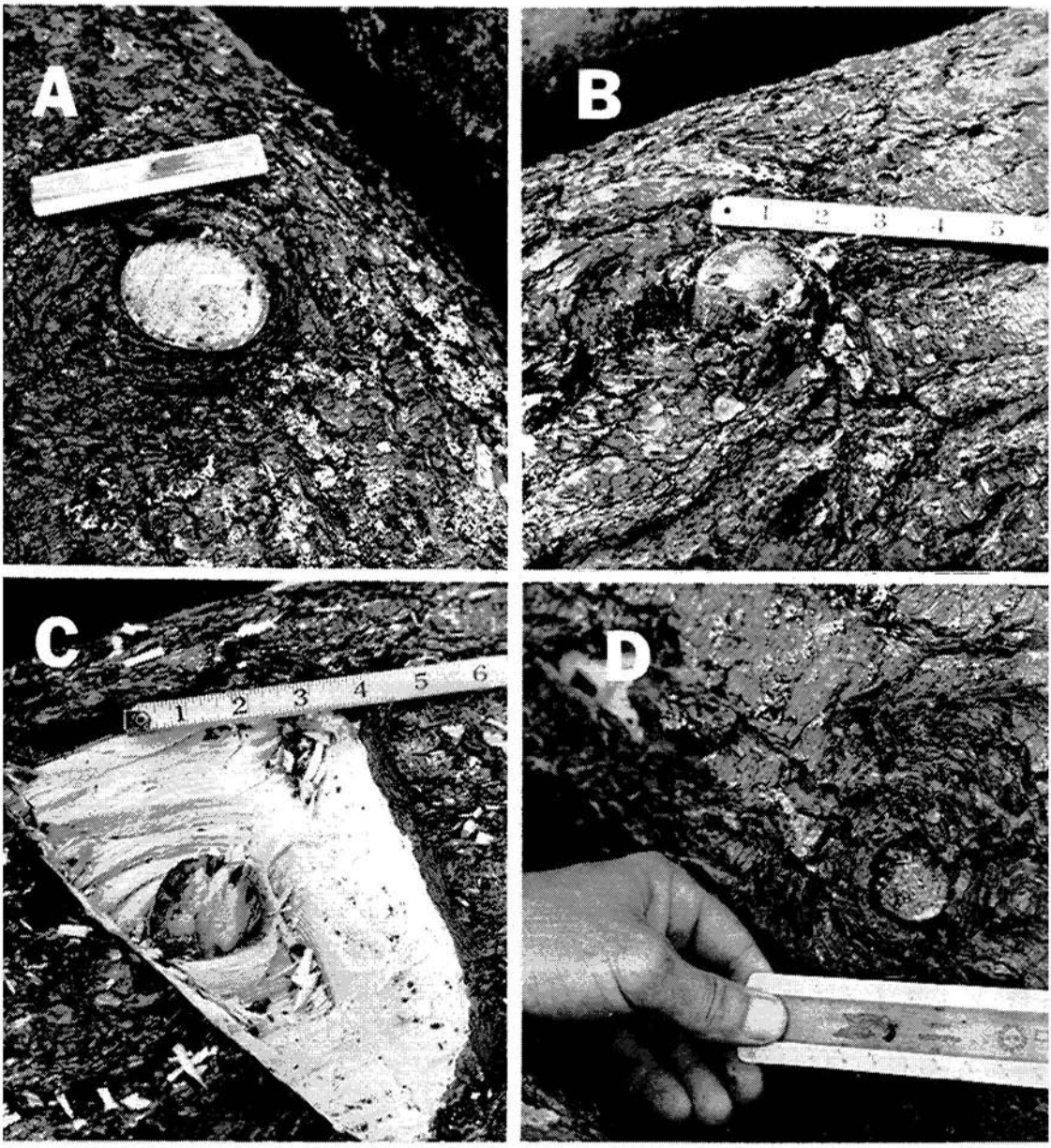


Figure 3.—Dead log knots on white pine logs. *A*, a sound dead log knot showing no signs of deterioration. *B*, a dead log knot showing moderate signs of deterioration. *C*, the same knot chopped out to a depth of 3 inches and still showing encased condition. *D*, an unsound dead knot showing advanced deterioration.

Overgrown log knots.—These are scars left in the bark by a limb that has been completely overgrown but is clearly outlined by circular or similar configurations in the bark (fig. 4). Overgrowths caused by other bark injuries usually do not possess the typical circular pattern or pucker in the bark. They can either be ignored or can be treated as a scaling defect only.

Because white pine does not develop much clear bole length in early maturity, all but the smaller limbs (up to 1 inch diameter)

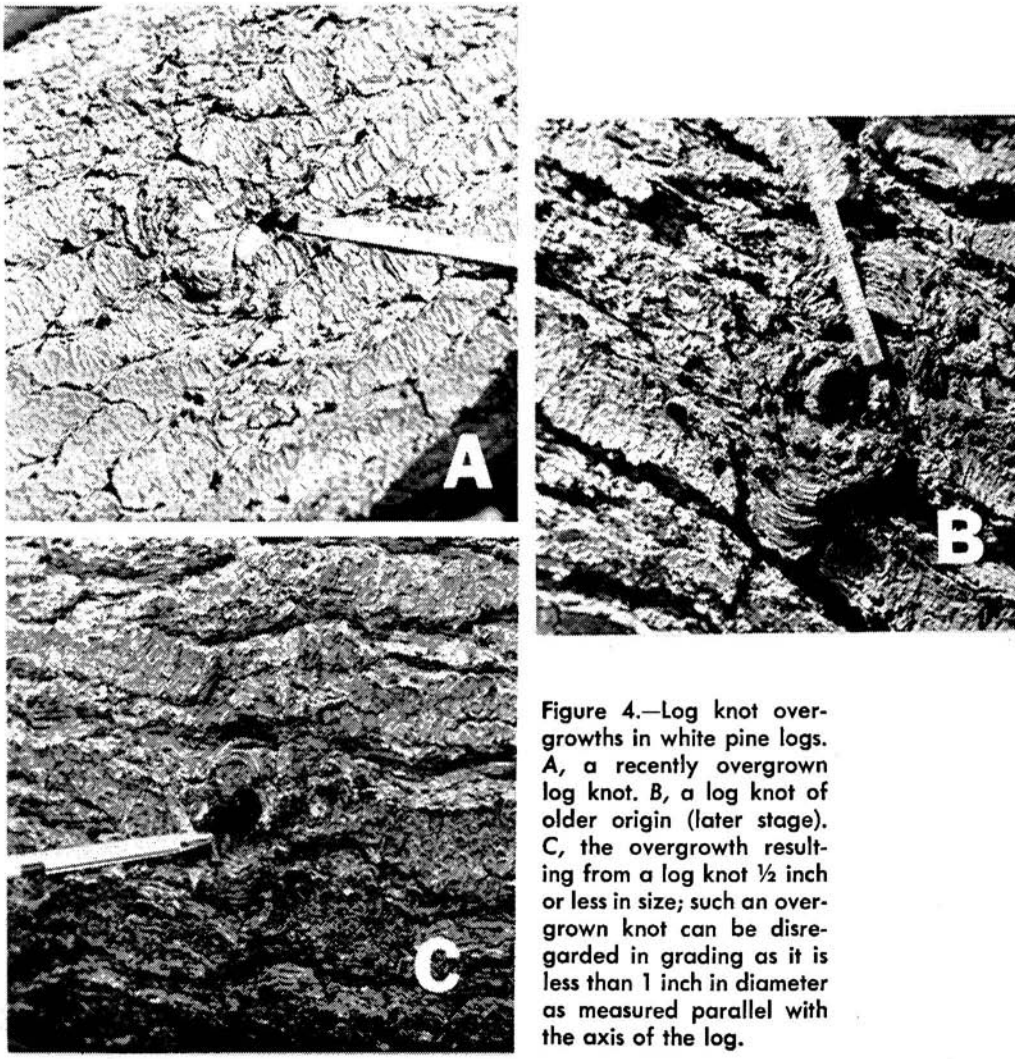


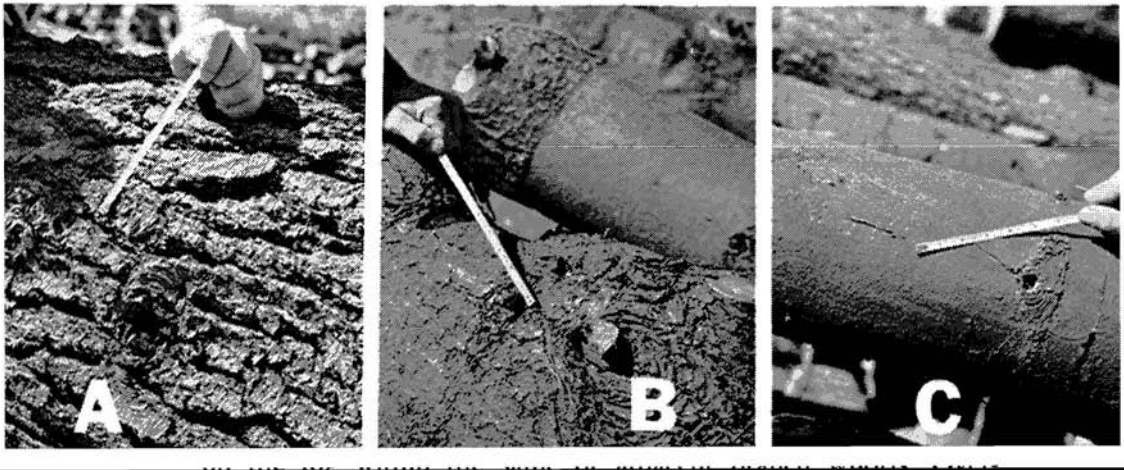
Figure 4.—Log knot overgrowths in white pine logs. *A*, a recently overgrown log knot. *B*, a log knot of older origin (later stage). *C*, the overgrowth resulting from a log knot ½ inch or less in size; such an overgrown knot can be disregarded in grading as it is less than 1 inch in diameter as measured parallel with the axis of the log.

persist for many years unless pruned. Even under excellent growing conditions, many trees retain a few limb stubs in the butt log. It is generally safe to assume that the size of a knot underlying an overgrowth is no larger than limbs or limb stubs still present on the log within the same or adjacent branch whorls. Overgrowths or puckers 1 inch or less in diameter (measurement made parallel with the long axis of the log) can generally be considered as indicators of underlying knots ½ inch or less in diameter, and should be disregarded. Overgrowths measuring more than 1 inch in diameter should be treated the same as 1-inch dead log knots in grading unless visible adjacent limb stubs indicate otherwise.

General log-knot considerations.—The occasional dead log knots encountered beyond the first whorl of live log knots should be considered as live log knots in grading. To qualify as a live knot whorl, at least ½ the log knots in the whorl must qualify as live. Subsequent whorls must also meet the same limitation.

Bark character is sometimes useful in a quick evaluation of log-knot condition in eastern white pine (fig. 5). Generally the majority of log knots in rough-bark white pine logs are dead. In logs with an intermediate type of bark, log knots vary from dead to live. And in smooth-bark logs the majority of log knots are live.

Figure 5.—Bark character is usually related to knot condition. A, a rough-bark white pine log with dead log knots. B, an intermediate-bark white pine log with both live and dead log knots. C, a smooth-bark white pine log with predominately live log knots.



Weevil Injury

Injury caused by the white-pine weevil (*Pissodes strobi*), particularly in the Northeastern United States, is a serious and common grading defect of eastern white pine. It is unusual to find a stand of white pine timber in this area that has not suffered significant losses in quality due to weevil injury.

Weevil attack in white pine is usually limited to the terminal leader (growing tip) of the tree. It causes death of the growing tip and subsequent deformity (fig. 6). Evidence of weevil injury in logs or trees can usually be recognized by moderate to severe crook or fork at the point of injury, combined with abnormally large and acute-angled branching. Crook is usually more severe in small logs or trees, and is less evident in larger logs (fig. 7).

Figure 6.—White-pine weevil injury. A, weevil injury in the terminal growth of a sapling; the dominant lateral branch has turned upward to replace the dead tip. B, weevil injury in the bole of a white pine as evidenced by a crook and abnormal branching at the point of injury.

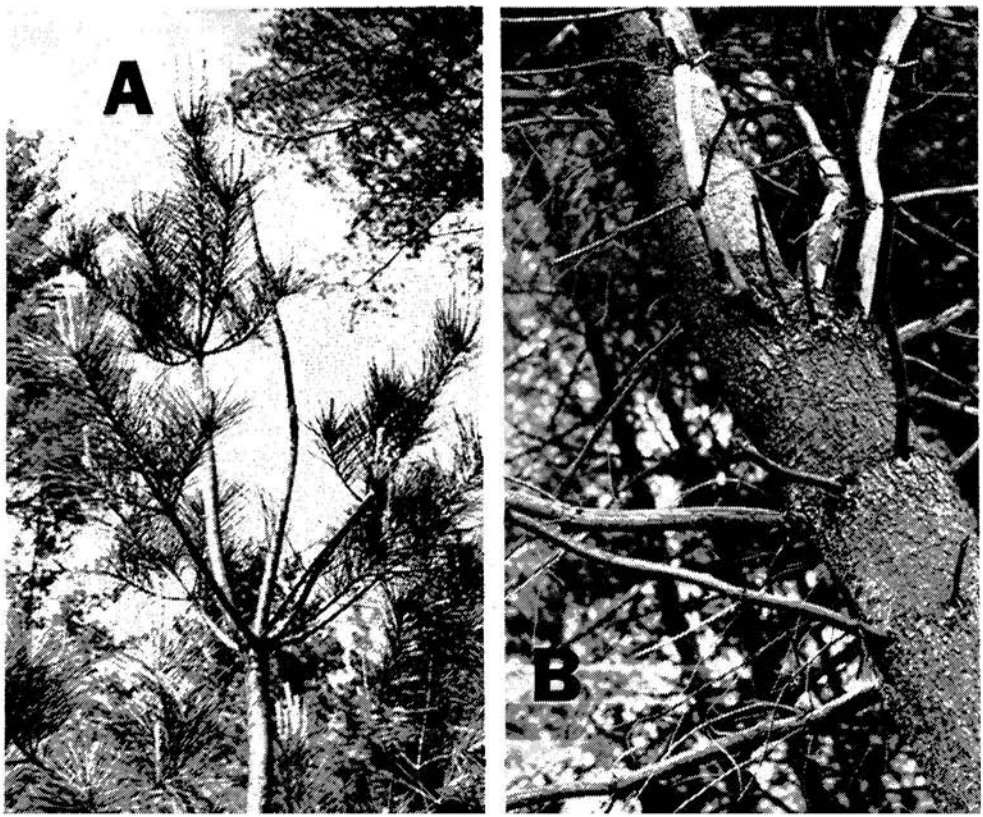


Figure 7.—Weevil crook in white pine logs. *A*, a severe crook in a small log. *B*, a moderate crook in a larger log.

Occasionally the dead leader persists for many years as a small branch stub, recognizable by larvae galleries in the pith and surrounding wood. Logs showing any of these characteristics are considered weeviled, and they are automatically limited to grade 3 or poorer.

Weevil injuries in white pine logs lower resulting lumber values in several ways (fig. 8). The coarse acute-angled knots and severe cross grain at weevil crook often reduce lumber grade, and red ring rot entering through the dead weeviled tip often causes additional lumber degrade.

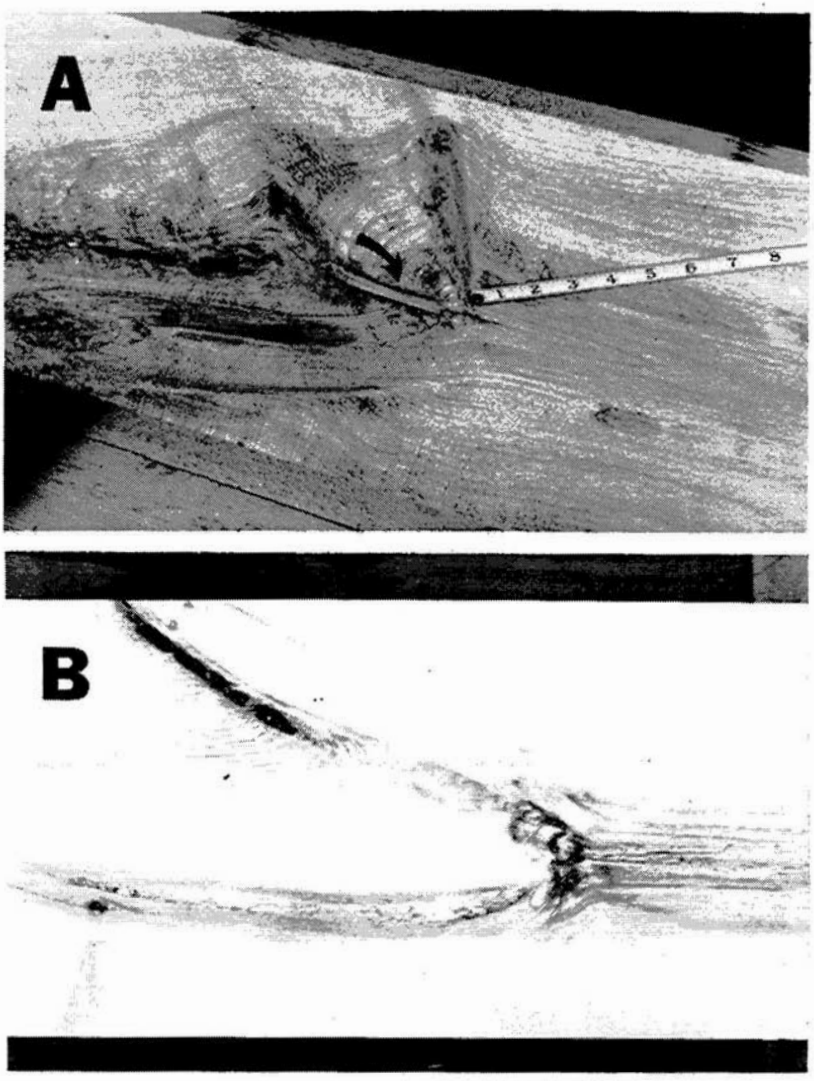


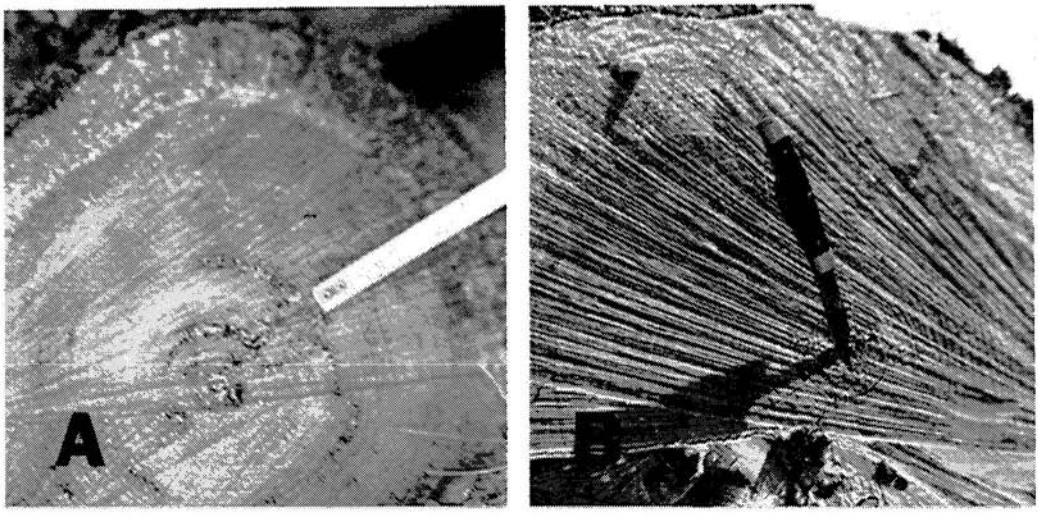
Figure 8.—Lumber defects due to weevil injury. *A*, severe cross grain and large coarse angular knots occurring at the point of weevil injury; the old weeviled tip is indicated by the arrow. *B*, red rot streak surrounding the pith at the point of weevil injury.

Red Ring Rot and Rot Indicators

Red ring rot (*Fomes pini*) causes serious degrade in eastern white pine, particularly in older trees and those that have been attacked repeatedly by white-pine weevil. Although scaling deductions are necessary for measurable advanced stages of decay, less advanced stages of the fungus decay and discoloration are often left in the lumber, thereby lowering its grade and value.

Red ring rot is usually detected in logs by inspecting log ends (fig. 9). Scale deduction is made on the basis of Forest Service standard scaling procedures; reduction of log grade depends upon the location and extent of the affected area. If visible signs of the rot—incipient or advanced—are limited to the heart center of the log (the central core of the log, having a radius equal to 1/5 of the log diameter) or extend beyond the heart center in only one quarter of either end of the log, no grade reduction is necessary. If evidence of rot extends outside the heart center in two or more

Figure 9.—Red ring rot (*Fomes pini*) showing on ends of white pine logs. *A*, typical formation following annual growth rings. *B*, red ring rot confined to heart center of log. Evidence of weevil injury was present on this log.



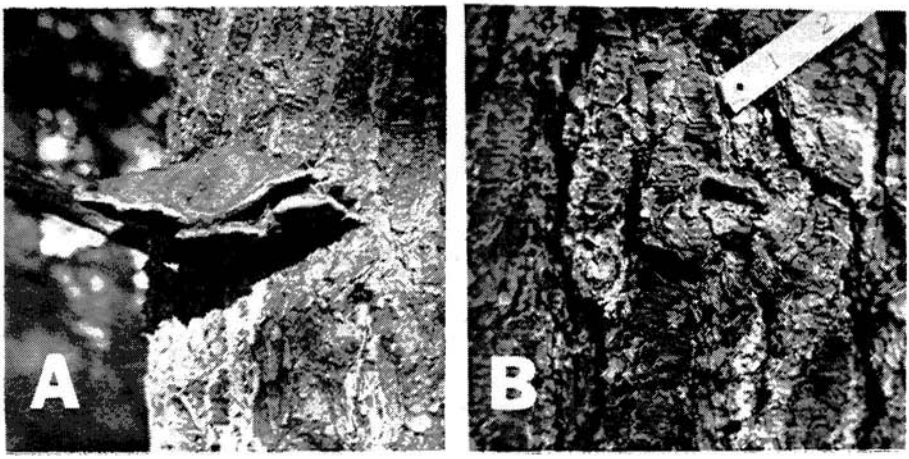


Figure 10.—Conk forms of red ring rot fungus (*Fomes pini*) on eastern white pine. *A*, a bracket-shaped perennial sporophore. *B*, a small scab-shaped conk with narrow bracket line margin. The latter form, the most common in the Northeastern States, is difficult to detect in the upper portion of standing trees.

quarters of the log ends, grade reduction is necessary in accordance with the log-grade specifications.

In standing trees and occasionally in bucked logs, the presence of red ring rot may not always be evident—particularly in its early stages. However, advanced stages of the rot are usually indicated by the presence of conks—the fruiting bodies of the fungus. Such conks, found on the bole of the tree (fig. 10), are fibrous or fleshy protrusions of variable shape and structure. Other evidence of this fungus is the punk knot or blind conk, a nonfruiting tissue of the fungus (fig. 11).

Both of these conditions usually signify advanced stages of red ring rot in the tree or log, the extent of which depends on the age of the infection and age and vigor of the tree. Serious volume loss is usually indicated, and the presence of numerous conks or punk knots throughout the bole of the tree usually indicates a cull tree. The presence of conks or punk knots on the bark surface of logs—regardless of whether rot is in evidence on log ends—constitutes a grading defect.

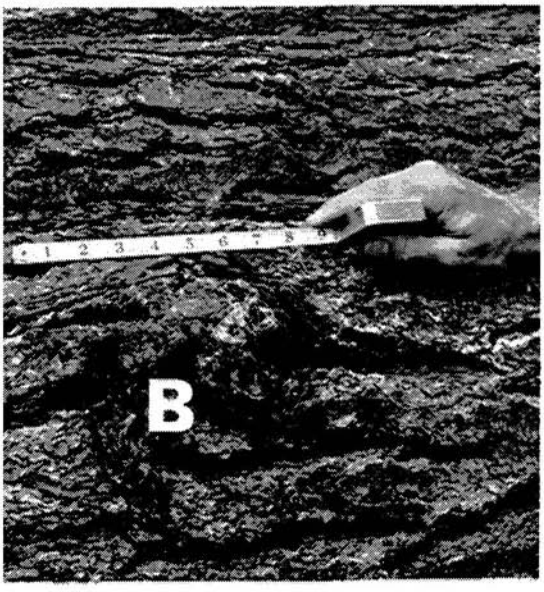


Figure 11.—Punk knots or blind conks of *Fomes pini* on eastern white pine. *A*, a blind conk on a mature tree, indicated by arrow; note the pitch streak from the base of the swollen knot overgrowth. *B*, a close-up of a punk knot. C. the punky fungus material underlying a punk knot.

Although not infallible, the presence of bleeding log knots or limb stubs in standing trees is often a reliable indicator of moderate to advanced stages of red ring rot infection. Whenever several to many bleeding limb stubs are in evidence, recognizable by white pitch streaks on the bole of the tree, the grader should carefully inspect the bole of the tree for possible presence of conks or punk knots (fig. 12).

Holes over 1 inch in diameter caused by woodpeckers are good indicators of red rot infection (fig. 13). If other evidence of rot is lacking, the effect of such holes can be treated the same as conks in grading. Woodpeckers making such holes are usually in search of carpenter ants or other insects that have invaded the rot-infected portion of the tree bole. These holes usually occur below the live crown of the tree.

Figure 12.—Whitish pitch streaks caused by bleeding limb stubs are often a good indicator of red ring rot infection.

Figure 13.—Holes caused by woodpeckers in search of insects. They usually indicate presence of red ring rot or other rot-causing fungi.

Ring Shake

Ring shake is a tangential separation of fibers along the annual growth rings. It may be found as a complete or partial circle in or outside the heart center of the log (fig. 14).

White pine trees less than 100 years old are usually free of

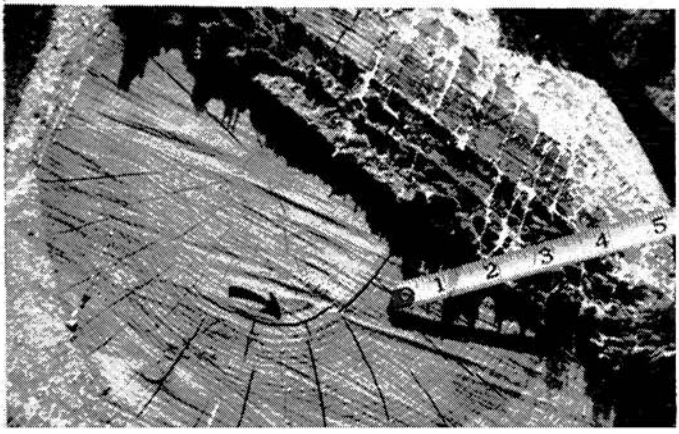


Figure 14.—Ring shake in eastern white pine—a serious degrading defect in old-growth timber.

serious ring shake. In older trees, particularly in the Lake States, shake is a serious grading defect in old-growth timber. Severe shake, characterized by readily discernible openings between growth rings, requires scale deductions because much of the affected lumber is low grade or cull. In many cases, however, ring shake is barely detectable; and affected lumber, although intact, has less strength and utility and therefore must be reduced in grade.

Whenever ring shake occurs outside the heart center of the log it is considered as a grading defect and is treated in the same manner as red rot. Grade reduction depends on the number of log end quarters affected. In standing trees it is impossible to detect and its occurrence must be based on knowledge of timber in the area under consideration.

Sweep and Crook

Sweep is a gradual bend in a log or tree: crook is an abrupt bend (fig. 15). Both may originate from the damaging effects of wind, snow, sleet, or other mechanical causes, or from damage or loss of terminal growth as in white-pine weevil injury.

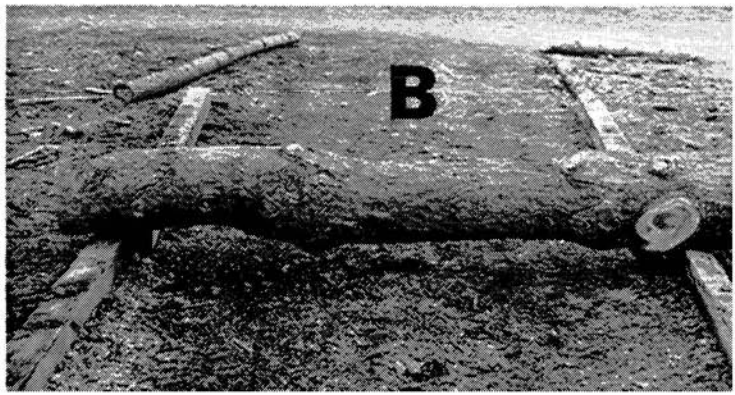


Figure 15.—Lack of straightness in white pine logs seriously affects lumber quality. A, sweep of 6 inches in this otherwise grade 2 log has lowered it to grade 3. B, crook due to weevil injury seldom further reduces grade unless total scale deduction exceeds 50 percent.

Sweep, in addition to being a scaling defect, is a grading defect whenever it exceeds the limits indicated by the grade specifications.

Crook may be a grading defect as well as a scaling defect if the limitations of grade are exceeded.

Lumber sawed from logs with sweep or crook is usually of lower grade because of the abnormal distribution of heart center defects and the effect of cross grain, which affects the strength of the piece. If crook is due to weevil injury, it does not further affect log grade unless is exceeds the merchantability limits of the log.

Insect Damage and Stain

Various bark- and wood-boring insects such as ambrosia beetles, pine borers, pine sawyers, carpenter ants, and bark beetles attack injured or decadent white pine trees or infest freshly cut logs in spring and summer. In many cases blue stain accompanies these infestations.

Carpenter ants generally make their initial attack in unsound butt wounds of living or dead trees and in such instances do not further degrade the logs or trees. Initial damage is often un-

Figure 16.—Carpenter ant damage in logs and lumber. A, carpenter ant galleries in the sound heartwood of white pine lumber. B, carpenter ant "windows" at breast height in a white pine tree.

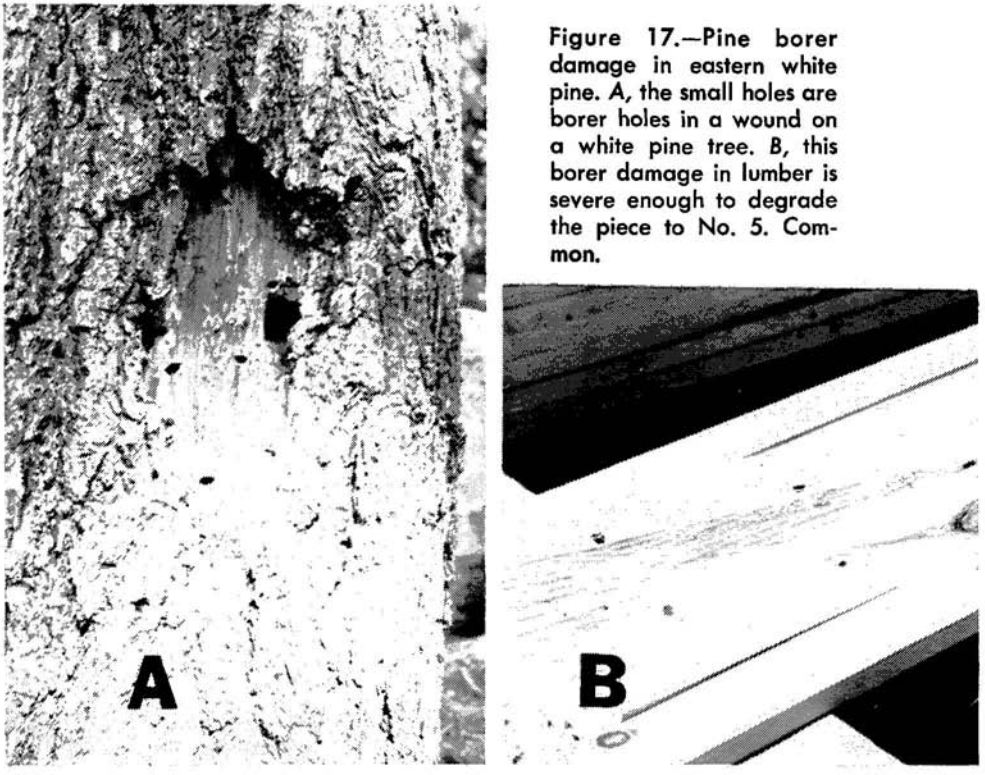


Figure 17.—Pine borer damage in eastern white pine. *A*, the small holes are borer holes in a wound on a white pine tree. *B*, this borer damage in lumber is severe enough to degrade the piece to No. 5. Common.

detected by inspection. However, as further development of the ant colony continues, concentric longitudinal galleries are cut into adjacent sound heartwood, which may add to the original damage (fig. 16). In advanced stages their presence can usually be detected by small access holes, called windows, leading to underlying nests.

Ambrosia beetles attack dying trees and freshly cut logs. Although difficult to detect in standing trees, unless the infestation is severe, they can be identified readily in the resultant lumber by small pin holes surrounded by fungus-darkened wood. Initial attack in trees or logs is through the bark or at old wounds.

Pine sawyers and other flat-headed wood borers usually attack recently killed trees and freshly cut logs. Evidence of infestation is usually apparent by entrance channels and accumulation of frass. The holes are 3/16 to 1/2 inch in diameter (fig. 17).

Wood-boring insect damage on white pine logs usually lowers the grade of the infected lumber to No. 4 or 5 Common, whereas carpenter ant damage usually results in complete loss of affected areas and therefore requires scale deduction.

Bark beetle damage caused by *Ips* and *Dendroctonus* beetles is usually limited to the inner bark and slab zone. However, moderate to heavy blue stain usually results from such attacks, and lumber from such logs may be lowered in grade because of stain.

The evidence of insect infestation or heavy blue stain in the log ends outside the heart center should be dealt with in the same manner as red rot and shake. When evidence of insect damage is apparent from the bark surface, degrade the log as if a conk or punk knot were present. Whenever damage results in cull material, a log scale deduction must also be made.

SCALING DEFECTS

In addition to those imperfections resulting in quality losses (degrade) as well as possible volume losses in white pine logs or trees, there are several common imperfections in white pine that usually require scale reduction without degrade.

Brown Cubical Rot

This heart rot, also known as red brown butt rot, is caused by the fungus *Polyporus schweinitzii.* It usually enters through the roots of white pine trees and progresses upward into the heartwood of the butt of the tree (fig. 18). It seldom extends up the tree more than 8 or 10 feet. There may be no external evidence of the rot in its early stages. but in advanced stages conks may be evident on the butts of infected trees, or on the ground nearby, coming up from decayed roots. A conk appears as a thin bracket, circular in shape, sunken in the center, with a velvety upper surface when fresh.

Incipient stages of decay in the wood may be inconspicuous; but as decay progresses, the color darkens and the wood becomes red-brown in color, and brittle; and on drying, it breaks into large cubes. The rot column is normally conical from the base of the tree upward and is generally circular in cross-section.

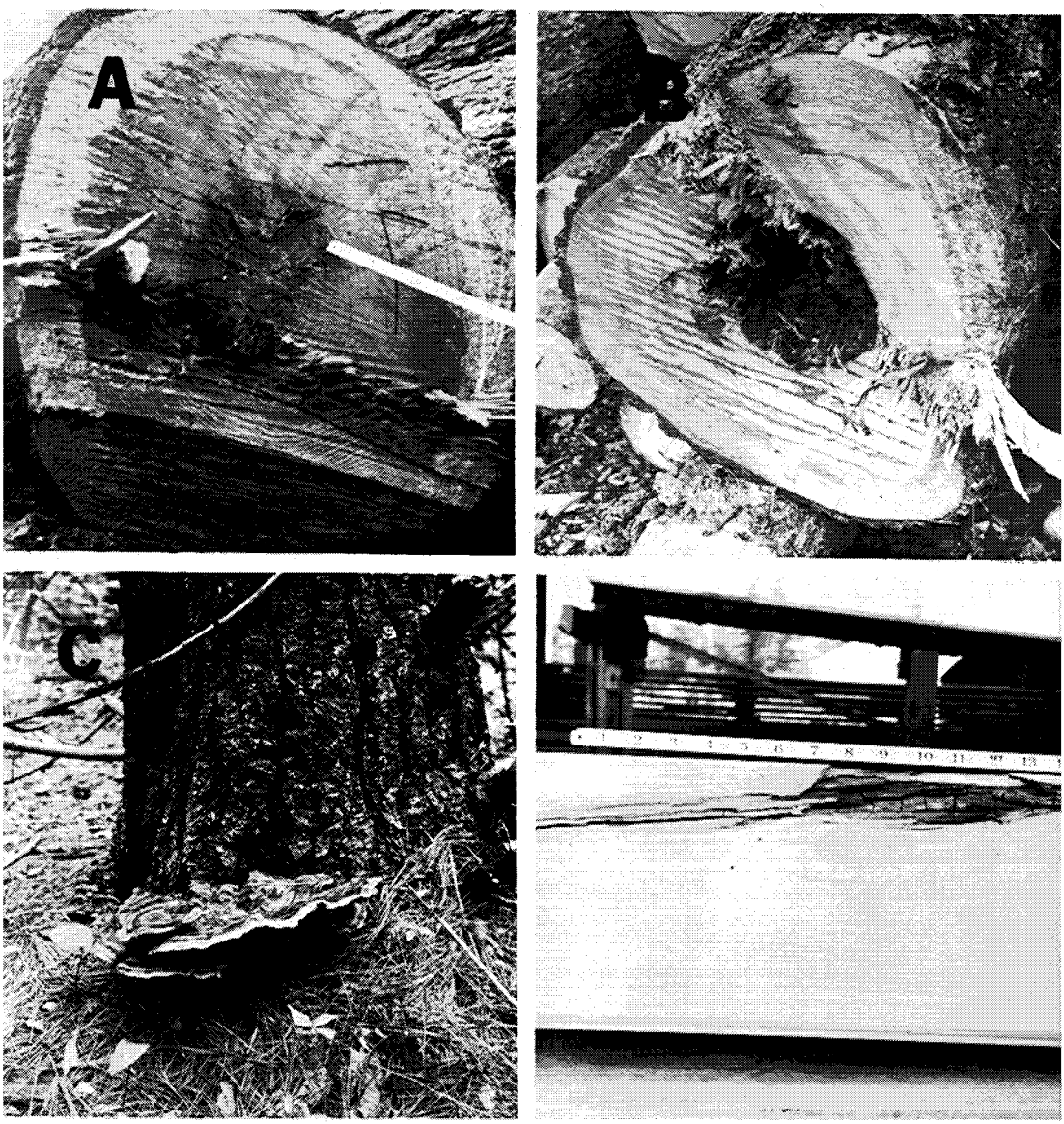


Figure 18.—Brown cubical rot (*Polyporus schweinitzii*) in white pine is usually limited to the heart of the butt log and can be treated as a scaling defect only. *A* and *B*, typical appearance of moderate to advanced stages of rot in the butt ends of butt logs. *C*, fruiting bodies of the fungus at base of tree. *D*, brittle cube-like appearance of rotted wood in lumber section. Normal sawmilling practice removes such affected areas from lumber during processing.

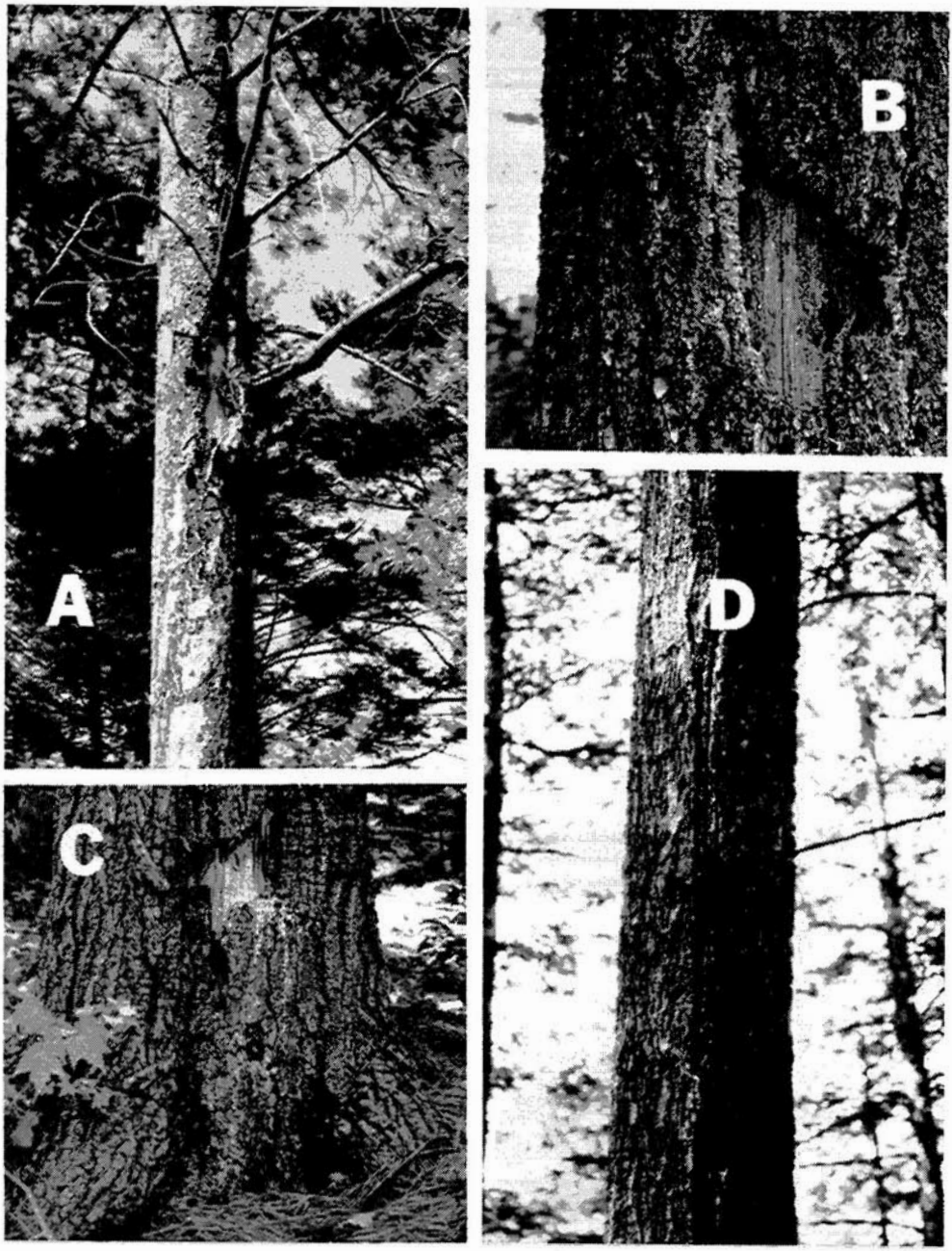


Figure 19.—Sound wounds and scars on eastern white pine logs or trees can usually be treated as scalable defects only. *A*, sun scald injury in lower crown of immature white pine—a common injury on severely exposed smooth-bark portion of upper stem. *B*, a shallow sound logging wound for which no scale deduction is necessary. *C*, a deeper sound wound for which scaling deduction is necessary. *D*, a lightning scar.

When brown cubical rot is present in a felled tree it is easily identified by inspecting the butt end of the butt log. Scale deduction is usually made for the entire cross-sectional area affected and for the estimated penetration up the log. Usually the affected portions of the resultant lumber are trimmed off, thereby causing no degrade in lumber, and thus no degrade in the log.

Other Scaling Defects

Sound open wounds and the scars or seams caused by injuries due to lightning, sun scald, logging, or other mechanical causes, and which show no evidence of rot, heavy stain, or insect damage in the underlying wood, may require a scale deduction, but are not considered as grading defects (fig. 19).

Splits caused by careless felling or bucking, or resulting from wind or ice damage, are scaling defects only. They require no reduction in grade. Forked trees, usually resulting from weevil injury, can be bucked into logs having minimum volume scale deduction due to bark seams (fig. 20). No further grade reduction is necessary. Standard Forest Service scaling procedures cover volume deductions for these common scaling defects.

Figure 20.—Bark seam in log, caused by forked tree.

Figure 21.—Blister rust infection (*Cronartium ribicola*) on the bole of a white pine may cause deformity requiring volume scale reduction.

Bole deformity caused by white pine blister rust (*Cronartium ribicola*) may sometimes require a scale deduction because of an abnormally small or flattened cross-section (fig. 21). Although heavy pitch accumulation is sometimes evident in the deformed portion of the log, it is not a grading defect.

IMPERFECTIONS DISREGARDED IN GRADING AND SCALING

The recognition and inclusion of *all* minor measurable log or tree imperfections that occasionally affect lumber quality would result in a reliable but impractical log- or tree-grading system. In addition, certain infrequent but serious blemishes still require additional research before consistent predictions can be made about their effects on lumber values.

The most serious but infrequent imperfections that can be disregarded include compression wood and pitch concentrations. Other frequent but insignificant imperfections include bird peck

and bark distortions. At present they are all disregarded in both grading and scaling.

Compression Wood

White pine logs cut from trees having lean in excess of 5 degrees usually contain areas of abnormal growth known as compression wood (fig. 22). Lumber cut from such logs is usually difficult to finish, and it developes severe warp in seasoning. Future tree-quality studies may result in reliable methods of

Figure 22.—Compression wood is common in leaning and crooked white pine trees. A, severe lean in a white pine tree. B, a cross-section of the leaning portion of the tree, showing eccentric growth rings with compression wood.

evaluating the effect of this defect. It is now disregarded in grading and scaling, although sweep that occurs in connection with tree lean is considered in grading.

Pitch Pockets

A relatively small volume of clear white pine lumber suffers degrade because of pitch accumulations. This can sometimes be detected from the log ends: pitch pockets are clearly defined accumulations of pitch following along annual rings of growth, or clearly defined areas of wood saturated with pitch. Because of the infrequency in occurrence of these imperfections and the difficulty in predicting their effect on lumber quality, they are disregarded in grading and scaling white pine logs. Pitch pockets greater than 3 inches in width are called pitch rings; they are considered the same as ring shake in grading.

Bird Peck

Bird peck refers to the small holes made by sapsuckers in the bark of the tree bole. These holes are usually found in horizontal bands or rows, but occasionally they are scattered over the smooth-bark area of a white pine tree. They may be deep enough to have injured the inner bark, thus causing a dimpled grain distortion and occasional flecks of ingrown bark in the underlying wood. However, they are not as serious as in hardwoods, where they result in darkly stained areas with ingrown bark.

Normally, sapsucker damage in white pine is in the knotty portion of the tree, where no further degrade results from the blemishes. Therefore they are disregarded in grading and scaling.

Bark Distortions

Breaks or alterations in the normal pattern of the bark, but which have no definite cause, are defined as bark distortions. They may result from deeply buried overgrown knots or small wounds (fig. 23). They are ignored in grading.

Figure 23.—Bark distortion on a mature white pine. In all probability this was caused by a deeply buried overgrown knot. Ignore it in grading.

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