GRADE DEFECTS IN HARDWOOD TIMBER AND LOGS

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GRADE DEFECTS IN HARDWOOD TIMBER AND LOGS

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Introduction

The appraisal of hardwood timber and grading of hardwood logs were for a long time held to be a mysterious art, with most of the deep secrets shared only by oldtime timbermen. Even they were not infallible, however; when moving to a new locality, many suffered financial reverses through failure to judge timber quality accurately. Consequently, the idea developed that there are invisible basic features in hardwood timber of the same species found in widely separated tracts, and that without highly localized experience a good appraisal is no more than a lucky guess. The truth is that although these regional variations exist, quality determinants can be isolated, evaluated qualitatively, and systematically described for universal application to both standing timber and logs.

The need for complete understanding of all factors affecting hardwood timber quality is great. Many appraisal problems formerly unimportant because of low stumpage values for generally high-quality timber have recently become pressing and formidable. The reality here is the acknowledged widespread decrease in average level and increase in variability of hardwood timber quality. Perfect trees are rare; poor trees have become abundant. Volume per acre is lower and the trees are smaller than in the past. Tree size is markedly important because the factors that reduce quality take a greater toll in small timber than in large timber. For example, the same number of overgrown log knots is obviously less damaging when scattered through a log averaging 3 to 4 per thousand board feet than when contained in logs averaging from 6 to 10 per thousand board feet.

Loggers especially are in dire need of a basic understanding of hardwood timber quality. Log making in high-priced timber of variable quality which fails to allow for and treat intelligently those factors affecting quality often results in material losses. The determination of the lower limit of log or tree merchantability becomes one of the most vital points. Merchantability of hardwood timber can no longer be judged simply on size, straightness, superficial smoothness, and freedom from rot and shake. It is known to be equally influenced by type, location, and concentration of log defects, including many which are so inconspicuous as to be almost unnoticeable.

To utilize presently high-priced stumpage most profitably, it is increasingly necessary to prepare the harvest from a given hardwood stand for several markets rather than for only a single use. This means that the logging operation might produce veneer logs, factory lumber logs, logs for structural items, logs for low-grade construction lumber, stave bolts, dimension bolts, fence posts, pulpwood, charcoal or chemical wood, and fuelwood. An understanding of hardwood timber quality is essential for such multiproduct logging operations.

Another important need for definition of hardwood timber quality arises from the current widespread application of scientific forest management. A forester, marking timber under a program designed not only to feed the proper raw material to individual plants but also to maintain and improve the forest growing stock, must have a very thorough knowledge of the factors which govern quality.

This publication is especially intended to describe the least understood determinants of log quality: those indicators, on the surfaces or ends of the logs, of quality-degrading blemishes in the interior.

Factors Affecting Quality

To isolate and examine the basic determinants of the quality of a log and thus of a tree, it is necessary to set up a standard. A theoretical standard would be a straight, cylindrical tree trunk consisting entirely of absolutely perfect wood. Such a phenomenon is never found in nature, if only because every tree has taper and a pith center.

A more practical standard for quality comparison is a log with the following specifications:

1. It is a butt log, round or only slightly oval in cross section.
2. It is 16 feet long and about 24 inches or more in diameter at the top end.
3. It is straight, but with slight taper and butt flare.
4. The wood is straight grained. There is no requirement as to other characteristics of the wood, i.e., whether heart or sap, uniform or variable in density or color.
5. The log has a "heart center" within a central cylinder of diameter not more than 40 percent of the log diameter. This heart center contains limb stubs and pith center only; it is free from rot, shake, stain, and similar imperfections.

6. Between the heart center and the slab is a quality zone in which there are no imperfections such as knots, holes, bark pockets, mineral stain, or rot.

Standard products of high value will be cut from such a log. Any deviation from these specifications, except for a moderate one in size, will reduce average value of potential products. The deviations that are most important, occur most frequently, and—for all practical purposes—determine quality are (1) change in position of log in tree, (2) reduction in size of log, (3) crookedness, and (4) imperfections in either the heart center (except for knots and pith) or in the outer rim of wood.

Position affects quality because the farther up the tree the log is, the larger the heart center, and the coarser the limb stubs in it are likely to be.

Change in size, especially in diameter, is very important. A decrease in diameter will cause a rapid increase in the proportion of products containing the coarse heart-center blemishes. If made into standard factory lumber, the logs of the larger diameters will yield wider and more valuable boards; and the wider the boards, the greater the possibility of raising values by primary ripping to eliminate or segregate blemishes. Similarly, large timbers, which obviously can be cut only from large logs, are more valuable per unit than smaller ones. Changes in length are not so important in the individual log, for the highest grade of lumber permits pieces of all lengths down to 8 feet. Nevertheless, there are definite limitations on the percentages of short lengths that can be included in large shipments of a given grade, and there is sometimes a premium on shipments containing all long lengths (14 feet and 16 feet).

For logs of a given position and size, *crookedness* is an important cause of reduced product value. There are two variations of this. One is *sweep*, a gradual curvature from a straight line drawn from one end of the log to the other. The other is a sharp deviation within the log, called *crook*. The immediate effect of either is to bring the low-grade center nearer the surface when the log is sawed. Sweep and crook are sometimes caused by a broken fork or heavy limb and, thus, may be related to abnormally coarse product characteristics. The effect of crookedness on quality is complex, but in all kinds of logs it reduces the value of the product by causing an abnormal distribution of core defects. Besides reducing the value, sweep and crook inevitably reduce the recoverable volume of the product. They also increase production costs, for crooked logs are hard to handle on rollways, are difficult to fit into loads, and frequently reduce the rate of sawing.

Final common deviations take the form of *imperfections in the slab zone, quality zone, or the heart center*. Such imperfections are broadly called defects. Of all the factors affecting wood quality, they are unquestionably the most important. They fall into two main categories: (1) Those which reduce the volume of sound wood or lower its durability, and (2) those which lower its strength or otherwise limit its utility. The first category comprises the so-called *scalable defects* (chiefly rot, shake, and checks), and their product-loss effect is allowed for in scaling. The second comprises the *grade defects*—e.g., knots, stains, holes, and bark pockets, which are generally not removed in primary manufacture. Grade defects control the quality of the part of the log expected to yield unblemished wood, and are basic determinants of strength, durability, or fine appearance.

The term "defective timber" popularly connotes rotten or overmature trees, even though these may contain much usable material. The amount of scalable defect, together with size limitation, is often the main criterion limiting merchantability of logs or trees in commercial practice. Actually, timber from which unusable material (scalable defect) will be removed in manufacture is not necessarily defective; there may be no serious blemishes (grade defects) in the remaining usable wood.

On the other hand, perfectly sound trees (without scalable defect) may be worthless because of the prevalence of grade defects which cannot be eliminated in manufacture. Since a defect that reduces volume (e.g., rot) is entirely different from a defect that reduces utility (e.g., knot), the terms "scalable defect" and "grade defect" are good ones to express this difference. The latter should be applied only to those imperfections that lower the quality of the product into which sound wood in the tree or log will be converted.[1] It is from this viewpoint that grade defects are discussed herein.

Usage gives the term "grade defect" to abnormalities or irregularities on the log surface as well as to imperfections in the wood. These outside features are really indicators of imperfections in the underlying wood and could be termed "grade defect indicators." For example, a branch stub is an indicator of a knot in the product to be sawed from the log. Nevertheless, because timber appraisers deal with logs or tree stems as such, and not as sawn products, this publication designates these surface features as *log grade defects* or *degraders*. On the other hand, imperfections in the wood are designated as *product grade defects*.

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[1] This distinction is not always clear cut; scalable defects, when affecting only small areas may be left in the product, where they impair strength or utility and thus become grade defects.

Abnormalities and Grade Defects

Whether a log surface or end abnormality is a log grade defect, and whether the indicated blemish in the wood is a product grade defect, are determined by the specifications for the product into which the log is to manufactured. Thus, log and product grade defects can be defined and evaluated only in relation to product requirements.

For example, mineral streaks would ruin the utility of maple lumber for fine clear finish tabletops and, thus, would be considered product grade defects. They would not, however, affect the strength of a piece to be used as a tie, and for this use would not be regarded as degraders. An unsound knot, say 2¾ inches in diameter, in the middle of a floor joist 2 inches by 8 inches by 16 feet would render the piece useless for the intended purpose and, therefore, would be a serious product grade defect. The same knot in an otherwise clear 16-foot board from which it was desired to cut two 7-foot clear pieces for bedrails would be a degrader only if it prevented the cutting out of the required clear pieces. Its degrading effect would be equaled by a sound ¼-inch knot that would pass unnoticed in a floor joist. For the bedrail use the piece would actually be of the highest recognized grade.

RELATION OF LOG GRADE DEFECTS TO USE

Thus, in examining the various degraders and other factors that determine the quality of a hardwood log, the nature and expected use of the end products must be given prime consideration. Each use has its own technical requirements, which are reflected in varying tolerances for type, number, and distribution of imperfections permitted in the product. Over the years the sawmill trade has found that hardwood products can be grouped according to basic use into one of three broad classes. These are (1) standard factory lumber, (2) construction lumber, and (3) miscellaneous low-grade or local-use products. In this handbook the terms factory log, construction log, and local-use log refer to logs suitable for the production of items falling into one of these classes.

At first, this handbook may appear to give too much attention to sawmill products and not enough to veneer, cooperage, dimension and handle stock, or other specialities. Although these may assume considerable local importance, they are minor in the total utilization of hardwoods. Probably 80 percent of commercial hardwood sawtimber is cut into products for the three general uses described. Furthermore, the specifications for specialty products are closely related to those for factory lumber in that relatively short, clear pieces of almost perfect wood or veneer sheets with few defects are desired. It is probable that studies in any locality will show that the significance of grade defects of specialty products can be judged on about the same basis as those for factory lumber.

Factory use is based upon producing lumber that is to be recut into pieces free or relatively free from blemishes and imperfections. Figure 1 shows a log suitable for production of factory-class lumber. The grade of such lumber is determined by specifications of the standard grading rules of the National Hardwood Lumber Association.[2] Application of these specifications controls the yield of high-quality pieces that can be cut from any board of a given grade. The technical base for the grading is the clear-face and sound cutting. High-grade boards are those which will yield high percentages of clear-face cuttings, with individual cuttings relatively large. Low-grade boards are those which yield low percentages of clear-face or sound cuttings, generally only in the smaller sizes. Tabular statements of basic specifications for factory lumber are found in the appendix, page 38.

Construction use is that in which the pieces are to be used intact for structural or weight-bearing purposes. A log suitable for producing this class of lumber is shown in figure 2. Specifications for construction lumber are contained in the National Hardwood Lumber Association's 1943 "Standard Specifications for Structural Stress Grades of Hardwoods and Cypress," in the tie specifications of the American Railway Engineering Associ-

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FIGURE 1.—*Factory lumber class log.* This type of log is relatively straight and will permit much center defect. Blemishes present in outer rim (quality zone), however, must be so spaced that certain minimum amounts of blemish-free cuttings can be obtained. Distribution, rather than size and character of log grade defects, is the most important quality factor.

[2] Rules for the measurement and inspection of hardwood lumber, cypress veneers and thin lumber. National Hardwood Lumber Association, Chicago, Ill. Jan. 1962.

ation, and in the standard specifications of the American Society for Testing and Materials for structural wood joists and planks, beams and stringers, and posts and timbers. These specifications in general control strength. Additional products in this class are *construction and utility boards* as defined in the current rules of the National Hardwood Lumber Association.[2]

In construction use, knots and other blemishes are limited to sizes that will keep impairment of piece strength within satisfactory limits, causing log requirements to differ from those for factory lumber use. Construction use specifications are rigid on this point, compared with factory lumber use that allows for progressively more product degraders from high to low grades. In factory use, for example, enough boards can often be cut from the outside of a log that has a rotten, shaky interior and large but widely spaced individual surface abnormalities to obtain a high average quality of product. Such a log might be worthless as a source of construction material.

Miscellaneous or local use is that not generally covered by any standard specifications (fig. 3 shows a good local use log). High strength, great durability, clear yields, or possibility of use intact is not required. The products are of low value and are mostly sold in local or restricted markets for such purposes as material for secondary farm buildings, crating, pallet stock, mine ties, industrial blocking, and miscellaneous construction. Whereas the products for the first two classes are usually sold over a wide area on generally accepted specifications through a variety of marketing channels, local-use materials are generally sold direct to the user by the producing mill on basis of mutual understanding as to specifications.

Any system of log classification represents a sort of one-way street. That is, all logs are allocated to the highest class to which they are naturally adapted, regardless of any suitability for the purposes of a lower class. This high use may be for factory lumber or for construction lumber, depending upon local situations. The lowest class as shown by average sale value is usually local-use. Strictly speaking, no log suitable for local use is also suitable for construction use. Neither can logs suitable for construction material be economically manufactured into factory lumber. On the other hand, higher class logs often are used for production of lower-class products. It is common to observe logs best adapted to factory lumber being cut into ties and, vice versa, to see mills producing standard lumber from logs best suited for timbers. At both tie and lumber mills can be found logs unsuited for either type of production. The reasons for this are quite complicated. One reason is that operators lack knowledge of available research-based log class specifications that can guide them in allocating these three types of logs to the most appropriate use.

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FIGURE 2.—*Construction class log.* This type of log is essentially straight and internally sound. Grade defects can be numerous if they are not bunched but are scattered and small. Products are judged on strength.

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FIGURE 3.—*Local- or miscellaneous-use class log.* This type of log, because of size, placement, and character of degraders, scalable defects, or crookedness, will yield only small percentages of defect-free wood from the quality zone or of standard construction material. It will yield a variety of low-quality items for which strength or appearance is not important. The evident "bump" indicates a high proportion of scalable defect.

So far this discussion has dealt with log use classes. The next step is to evaluate wood blemishes in relation to each log use class. In factory lumber logs the most important wood blemishes are those in the outer rim of wood (quality zone).[3] Few, if any, of the surface indicators of blemishes located in this zone can be disregarded; most are degraders. This is true regardless of the size or soundness of the abnormality and the underlying blemish. In construction logs the reverse may be true. In one construction log, size of degrader may be the controlling factor; in another, the critical degraders may be only those unsound ones in the heart center. In local-use logs the low-grade nature and unexacting waste tolerances of the products make log quality requirements unexacting. In these logs the main consideration is

[3] Defined generally as the area under the slab zone and outside a heart center, which is itself defined as a central core with a diameter 40 percent of average log diameter (inside bark) at point of measurement.

excessive size of log defects or excessive amounts of scalable defects which arbitrarily disqualify the log for the class.

CLASSES OF LOG ABNORMALITIES

Log abnormalities can be divided into two general classes: those found on the surface of the log, and those found on the ends. Beyond this there can be no general classification. One reason is that, although most of the important blemishes in wood are associated with abnormal features visible on the log surface or end, some visible irregularities do not reflect imperfections in the wood. Another reason has already been discussed: whether or not the blemish is a product defect depends upon the class of log in which it is found, for its effect depends upon the specifications of the product to be made from the log.

It will be shown that certain abnormalities indicating wood blemishes may be disregarded as log grade defects in any type of log under certain conditions, and that some may never be disregarded. Certain kinds of abnormalities that may have been included in the logs through operational error can sometimes be disregarded.[4] When evaluating quality in standing timber, an abnormality may be disregarded if it will not be included in the logs that are to be cut out. Also, size and character of the abnormality are important conditions, particularly in construction logs. Concentration, too, is important in judging significance, particularly of end degraders and especially in factory logs. Position of degrader within the log is another consideration, depending on log use class. In factory logs the effect of product defects and imperfections confined to the heart center is minimum; in construction logs it is maximum, particularly in small and medium diameters. In local-use logs there are fewer degrading or disqualifying defects than in other classes. The important items here are unsound scalable defects which are taken into account only in the aggregate to determine net scale and which, if excessive, disqualify the log.

Other types of abnormalities are often superficial. This means that they are in the slab zone, they extend into the log for a distance less than one-tenth of the log diameter, and do not enter the milling frustum or an inscribed square timber deeply. In such cases they can be disregarded.

Since the conditions which make a surface abnormality a log grade defect in one case and not in another vary so much, there can be no general classification covering all abnormalities and all log types. Therefore, the following discussions of individual log abnormalities cover not only the description of the abnormalities but also their significance as degraders judged in relation to use classes or other variables. No mention is made of the *degree* of degradation caused by log and wood abnormalities classed as defects. Within a given class of log some defects are more damaging than others, but the effect may be conditioned by such other factors as log diameter and straightness, or position relative to other log grade defects. The degree of effect is discussed under the heading "Evaluation of Timber and Logs," p. 34.

Log Surface Abnormalities

Log surface abnormalities are unquestionably more important than end abnormalities. There is a better chance of observing indicators of wood blemishes on the surface than of seeing the blemishes themselves on the log end. Moreover, the distribution and frequency of product grade defects can be judged best from the surface indicators. All of the following discussions of surface indicators of log grade defects are complete and inclusive; an overgrown product blemish associated with a log surface defect is not discussed again as a log grade end defect.

BULGE

Definition.—A bulge is a general enlargement of the stem of a tree or log, in the nature of a "barreling" effect, often without an obvious cause such as knot or callus formation. It may be near a wound, rotten knot, knothole, or other point of entry for rot. It generally indicates a cull section with the extent of the rot shown by the extreme limits of the deformation. There are two types of bulges, butt bulge and stem bulge (figs. 4 and 5).

Butt bulge is nearly always accompanied by hollow butt. Rot generally extends beyond the hollow, and the upper tapered-off limit of the bulge usually indicates the approximate upper limit of serious rot. Butt bulge has no special relation to species, although it is most frequently conspicuous in the oaks.[5] In species like sweetgum, elms, and ashes, even considerable butt rot may not cause a clearly defined butt bulge. In

[4] In judging logs in standing timber the appraiser has a certain latitude concerning the inclusion of grade defects. He can assume that cutters will use reasonable judgment and eliminate a rotten section, bad crook, or fork. When the log has been cut, however, it must be judged "as is." The authors have followed this principle in their judgments on log grade defects, except in the case of features which are obviously included through operational error and the actual elimination of which is still practical. It may be argued that *any* degrader that can be removed from the log or product without undue chopping of cutting could be disregarded, provided a loss in scale were taken. Although there is merit to this argument, the nature of log grade defects cannot be adequately discussed unless it is understood that they will not normally be removed from the log or product.

[5] A list of common and scientific names of species mentioned is provided in the appendix, p. 38.

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FIGURE 4.—Butt bulge.

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FIGURE 5.—Stem bulge.

these species the bark over even a slight bulge often becomes smoother and darker and scales off faster than in a sound stem. This is especially true in sweetgum.

Stem bulge is not as common as butt bulge, but may be found in any species.

Significance.—As indicated above, bulges are evidence of internal rot and under good operating practice are not included in logs. Butt bulges can generally be so treated. If a stem bulge occurs in the middle of a log, where it cannot be cut out, then that section involved must be scaled out and thus is a degrader *in factory lumber logs.* A stem bulge will disqualify a log otherwise suited for *construction material. In local-use logs* the bulges can be overlooked, provided the accompanying rot does not exceed the scaling deduction limits set for the class. The identification and evaluation of bulges is most important in dealing with standing timber.

BUMPS

Definition.—A bump is a protuberance on the log which is overgrown with bark (fig. 6). It may be abrupt or it may be a smooth undulation which gradually tapers back in all directions to the normal contour of the log. A minimum bump is arbitrarily defined as a swell on the surface with a taper steeper than 1 to 6, i.e., it is a bump if the distance from the center to the edge is less than six times the height from the normal contour to the top. If it has a taper flatter than 1 to 6, it is classed as a surface rise (p. 25). Low bumps have tapers from 1 to 6 to 1 to 3; high bumps have a taper sharper than 1 to 3. Abrupt bumps taper less than 1 to 1½.

Occurrence.—Bumps are likely to occur on any species. Low bumps are particularly noticeable in hard and soft maple, tupelo, soft elm, birch, and the ashes, magnolias, and white oaks. High bumps are conspicuously frequent in cedar elm and white oaks on poor sites.

Significance.—About nine-tenths of all bumps indicate projecting sound or rotten limb stubs, a cluster of adventitious buds, or an excessive folding or ingrowing of the bark over a scar.

In factory logs low bumps can be disregarded in soft maple, tupelo, soft elm, birch, and the ashes, magnolias, and more valuable white oaks; but high bumps in these species are degraders. In other species all bumps are degraders, for even low ones cover blemishes that are usually in the quality zone where they limit clear cuttings.

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FIGURE 6.—Bump.

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FIGURE 7.—Burl.

In construction logs the effect will depend upon the size of the underlying blemish. If the diameter of a high bump is less than one-third of the diameter of the log at the point where the bump occurs, or if the diameter of the feature underlying the bump is estimated to be less than one-fourth of the width of a face of the largest included timber (judged from the small end of the log), then the abnormality can be disregarded as a grading defect. If the underlying feature is larger, it is a degrader. In the case of a low bump it is difficult to estimate the size of the underlying blemish. Generally, however, the blemish will be so large that a low bump must be considered a log grade defect in overcup, chestnut, pin, scarlet, and black oak, and in the water oaks and cedar elm. In construction logs of other species low bumps can be disregarded.

In local-use logs bumbs of both kinds are degraders if their diameter exceeds one-half of the diameter of the log at point of occurrence; otherwise they can be disregarded.

BURLS

Definition.—A burl is a sound, hard, woody protuberance on the bole, more or less rounded or horizontally ridged in form, with no protruding limbs, twigs, stubs, or indications thereof (fig. 7). It is sometimes related to aborted adventitious buds.

Occurrence.—Burls, while uncommon, are most often found on hard maple, cow oak, walnut, the magnolias, and occasionally yellow-poplar, northern red oak, and yellow birch.

Significance.—A true burl is a surface indication that the grain in the wood is distorted into a wavy, curly, or bird's-eye effect. Other similar apparently sound abnormalities such as incipient cankers, popularly classed as burls, may contain considerable amounts of bark, rot, twig knots, and even insect channels. In factory logs the true burl, if it can be identified, technically is not a degrader. Nevertheless, because of the difficulty of identifying true burls, all features popularly considered as burls are classed as grading defects in *factory lumber logs*. Since burls would unquestionably weaken *construction material*, they must be considered degraders in these logs. *In local-use logs*, however, they can be disregarded unless they extend half way across the circumference of the log at point of occurrence.

BUTT SCAR

Definition.—A butt scar is a generally triangular or wigwam-shaped opening at the base of the bole, from a few inches to several feet high (fig. 8). It may show weathered or stained sapwood, rotten heartwood, or may be the opening into a rotten hollow butt. When associated with advanced rot or hollow, it may be accompanied by a

butt bulge (p. 5). It is caused by anything that "skins" the base of the tree. Fire is the most common cause; other causes are logging and cattle. Pin- and shot-worm damage (pp. 29 and 31), which are defects in factory logs, are closely associated with butt scars.

Occurrence.—Butt scars may be found on all species.

Significance.—Since severe rot is generally associated with butt scars, the log is usually started above the butt swell. Sometimes, however, a butt scar of recent origin with a limited amount of rotten or stained wood is left on the log. *In factory logs* the area involved is a grading defect even though scale deduction is made for it. *In construction logs* a butt scar may be disregarded if it and the associated rotten wood are superficial and do not enter the included tie or timber. In standing trees butt scar and associated rot may be disregarded if the logs can be cut so as to meet the minimum requirements of the log class. Otherwise a butt scar is a degrader. Butt scar is not a degrader *in local-use logs.*

BUTT SWELL

Definition.—A butt swell is an enlargement of the bottom end of the tree trunk, over and beyond the normal stump flare generally found in all species (fig. 9). It is a normal development, apparently related to wetness of site, but *not* to injuries. Trees with butt swell are sometimes called "churn-butted" or "bottle-butted."

In standing timber butt swell may be confused with butt bulge. Butt swell is related to site and confined to species listed below. Butt bulge, which is due to injury and internal rot, is found in other species (especially oak) and is distributed more widely. Sounding the butt with an ax or carefully searching for wounds or butt scars will aid in identification. In the log there will be no question, for the wood in the butt swell will be sound, whereas it is likely to be very rotten in a butt bulge.

Occurrence.—Butt swell is found in tupelo, swamp blackgum, red maple, and green ash. Within the species the degree of butt swell varies

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FIGURE 8.—Butt scar.

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FIGURE 9.—Butt swell.

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FIGURE 10.—Canker.

according to depth, duration, and seasonal occurrence of water.

Significance.—Butt swell is not a reflection of and is not related to recognized imperfections in the underlying wood. It does not lower lumber grade and thus is not a log grade defect *in factory logs*. Nevertheless, the wood in the swell is often soft enough to limit the use to which the lumber can be put. For instance, green ash lumber cut from swelled butts, although graded by standard rules, is classed in the trade as "cabinet ash" and does not command the high price obtainable for "firm or better" taken from farther up the same tree. For *construction* and *local-use logs* the tupelos are the only species to consider, and in them the swelled section may be so soft as to be worthless for any purpose at all. The species is usually cut above the butt swell.

CANKER

Definition.—A canker is a definite, relatively localized necrotic lesion, primarily of bark and cambium (fig. 10). It is usually an entrance for decay fungi and, when conks are present, is evidence of serious heart rot.

Occurrence.—It is most common on the red and water oaks, hickories, the ashes, and black cherry.

Significance.—In good operating practice a canker is not included in the log. Should it be included, it is a definite degrader in a *factory log*. It is a grading defect which will disqualify a log otherwise suitable for *construction material*. An included canker can in itself be disregarded in a *local-use log* unless it contributes to scaling deduction beyond the limit allowed for the class.

CONK

Definition.—A conk is a fibrous but sometimes fleshy excrescence of definite form and structure on the bole (fig. 11). It is the fruiting body of a wood-rotting fungus contained in the tree.

Occurrence.—Conks may occur on all species.

Significance.—A conk generally indicates an amount of rot, usually close to or in excess of the percentage of gross log volume allowed in a merchantable log of any type. If the log qualifies as a *factory log*, the conk, together with the associated rotten area, becomes a grading defect. It will limit cuttings outside of the heart center even though scale deduction is made. In a log otherwise suitable for *construction material* conk is a definite degrader, for it is evidence of rot in the log interior which will disqualify the log. In a *local-use log* the conk can be disregarded, provided the rot with which it is associated does not exceed the scaling deduction limit for the log class.

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FIGURE 11.—Conk.

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FIGURE 12.—Epicormic branch and adventitious bud cluster.

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FIGURE 13.—Flanges.

EPICORMIC BRANCHES AND ADVENTITIOUS BUD CLUSTERS

Definition.—Epicormic buds (fig. 12) are abnormal buds found at points on the stem unrelated to the crown. They arise from latent or dormant buds originating in the leaf axil and thus may persist within the cortical-cambial zone indefinitely and can be activated at any time in response to various stimuli.

Adventitious bud clusters, similar but independent in origin, may arise at any time during the life of a tree. They often originate in the callus tissue resulting from wounding or bruising the cambium layer, but may develop independent of any such mechanical action. Very often they develop into clusters of fine twigs of short life, and in this case they are commonly accompanied by small bark pockets. They are not necessarily repititious and are less common on most species than epicormic branches.

Occurrence.—They are found most frequently on all species of elm, oak, and maple, and on sweetgum.

Significance.—Underlying the epicormic branch scar are very small knots, small bark pockets, or both. The twig or branch stub that is apparent on the surface may not extend very far into the wood. However, a succession of others of similar origin often appears deeper within the log. Wood blemishes caused by either epicormic branch or adventitious branches or bud clusters stop clear cuttings and are log grade defects *in factory logs.* The knots and bark pockets that the bud clusters indicate do not constitute degraders *in construction logs* and *in local-use logs.*[6]

FLANGES

Definition.—Flanges are buttress- or wing-like formations at the base of the tree (fig. 13). They are exaggerated projections or convolutions of the normal stump flare and usually extend up the bole beyond normal stump height, sometimes for 4 or 5 feet from the ground. They appear to be related to wetness and softness of ground.

[6] Epicormic branches and adventitious bud clusters are treated together because the blemishes and defects which they reflect are very similar. Often they occur together, with the adventitious buds surrounding the epicormic branch as shown in figure 12.

Occurrence.—Flanges are common in elms, water oaks, and soft maple.

Significance.—The wood in flanges is, by definition, outside the milling frustum or included timber. Furthermore, flanges have no relation to blemishes or imperfections in the underlying wood. Therefore, flanges are not log grade defects *in any type of log.*

FLUTES

Definition.—Flutes are folds or convolutions of the surface of the trunk running up and down and generally confined to the base (fig. 14), but occasionally extending up into the second log. They generally include ingrown bark. They appear to be of normal origin, related to softness of site, much as flanges are.

Occurrence.—They are commonly found in soft and cedar elm, soft maple, and occasionally in water oaks, pecan, and magnolias. The most exaggerated flutes are found in the elms.

Significance.—Flutes usually do not extend deeply into the log at the small end. When they do not, they may be disregarded *in all classes of logs. In local-use logs* they may be disregarded in any case.

FORK

Definition.—A fork is a crotch between double tops (fig. 15). It is sometimes included when logs are bucked to arbitrary lengths.

Significance.—A hidden effect of a fork is double pith and, generally, a bark pocket. In the fork portion grade outturn and volume yield are both lowered significantly. Including a fork on a log is an operational error. *In construction logs* a scaling deduction for a section should be made back to a point behind the separation. *In factory logs* the seam and any enclosed bark should be scaled out following the standard practice for deducting for interior scaling defect; but if the portion scaled out is so large that it precludes cuttings, then the fork is a log grading defect. In standing timber, however, a fork is not a degrader if logs that fulfill the minimum requirements for the log class can be cut. Forks can be disregarded *in local-use logs* except for a scaling deduction.

GUM LESIONS

Definition.—Gum lesions are groups of abnormal small wounds on the main stem that exude gum. In black cherry they are the result of the work of at least two species of cambium mining insects.[7] They heal over each year, and new ones appear in the same general area year after year. In sweetgum a fungus (*Botyryosphaeria ribis*) kills and dissolves strips of cambium tissue, and black liquid storax oozes out of the bark fissures. Healing results in coarse vertical folds of in-

[7] A gum lesion which has a definite structure should not be confused with "gumosis," a condition not evidenced by such a characteristic.

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FIGURE 14.—Flutes.

F–503354

FIGURE 15.—Fork.

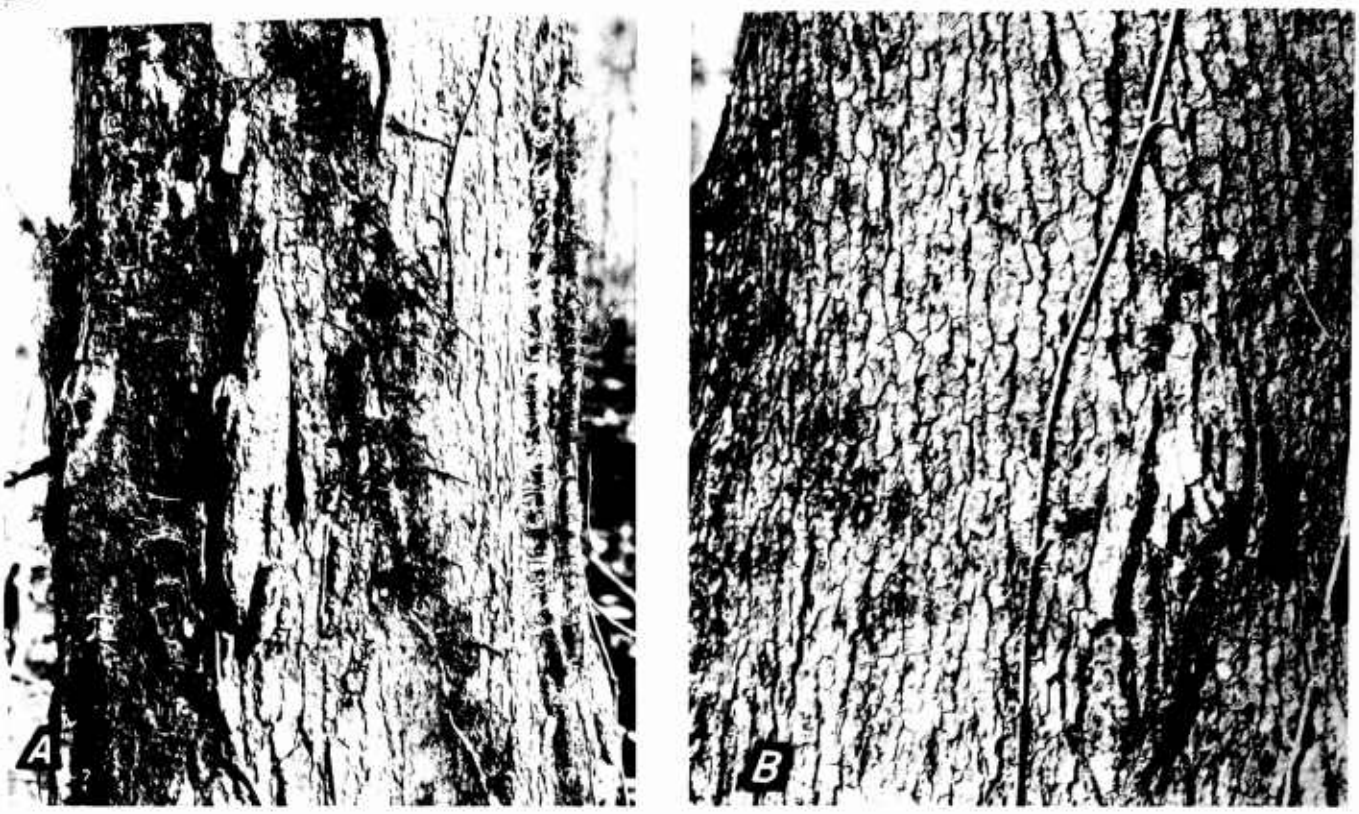

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FIGURE 16.—*A*, Healed bark lesion in sweetgum of the lower Coastal Plains showing prominent rib of abnormal wood and folded bark projecting above surface of log. These ribs become buried and hidden in large trees and result in encased bark pockets—serious defects when the trees are cut into veneer and factory lumber. *B*, Older healed bark lesions in Coastal sweetgum partially buried in the trunk. These indicate areas of abnormal wood, ingrown bark and black-stained wood which seriously degrade veneer and factory lumber. Much more dense concentrations and/or coarser lesions occasionally occur which make short sections of bole unfit for construction logs and, sometimes, even for pulpwood.

grown bark. "Gum spots" in sweetgum wood, in contrast, are probably basically similar in origin and nature to those in cherry, but much less frequent and less distinct. Also, they are *seldom* related to *ingrown bark*.

Occurrence.—Gum lesions are found most frequently on sweetgum at the southern extremity of its range, and on black cherry. Ashes, persimmon, and tupelo gums are also occasionally affected.

Significance.—Underlying the gummy surface are many small bark pockets and gum streaks in the wood. Figure 16 shows the distinctive nature of *bark* lesion of sweetgum. Wood blemishes caused by all of these lesions stop clear cuttings and are grade defects *in factory logs* in sweetgum. The highest grades of black cherry lumber, however, admit gum in the "clear face" cuttings, and the lumber is graded "sap and gum—no defect." Therefore, gum lesions are not degraders in black cherry factory lumber logs. They may be disregarded *in construction* and *local-use logs* of both species.

LARGE HOLES

Definition.—Large holes are unoccluded openings over one-half inch in diameter (fig. 17). Among their causes are rotten knots, woodpeckers' removing insect larvae or excavating rotten spots, and mechanical damage.

Occurrence.—Large holes may be found in all species.

Significance.—*In factory logs* all large holes are log grade defects. *In construction logs* they are degraders if their size is over one-third the diameter of the log at the point of occurrence, or if, regardless of size, they extend more than 3 inches into the included timber. If they are smaller or shallower than this, they may be disregarded, provided they are surrounded by sound wood. Otherwise, they are grading defects. *In local-use logs* large holes may be disregarded unless their size is over one-half the diameter of the log at the point where the hole occurs.

MEDIUM HOLES

Definition.—Medium holes are unoccluded openings, $\frac{3}{16}$ to $\frac{1}{2}$ inch in diameter, through the bark which may or may not continue into the wood. They include entrance and emergence holes of grubs, bark scarrer holes, tap and increment borer holes, and openings made by sapsuckers.

It is not difficult to determine the origin of the holes. Grub holes are caused by roundheaded

F–455595

FIGURE 17.—Large hole.

borers and carpenter worms. The grub galleries are cleancut and usually stained; they are always more than 1 inch deep in the wood, are irregularly spaced, and ramify upward through the wood. If these holes have remained open, there has been subsequent activity by other insects, usually carpenter ants. In such cases decay fungi enter, and the ants excavate the rotten wood, increasing the size of the galleries to make their nest cavities. Associated with these will be ingrown bark and callus tissue (fig. 18).

Recent or fresh bark scarrer attacks appear as open holes about one-fourth inch or less in diameter. They can be identified by their round, irregular outline and by their not entering the wood. The work of bark scarrers and grubs results in frothy exudation on the bark which turns a dirty brown.

Increment borer holes are of the same general character as grub holes but do not ramify. Sapsucker holes are usually found in rows or bands, although occasionally the entire log may be freckled with them. The individual holes usually extend slightly, if at all, into the wood.

Occurrence.—Medium holes are found on trees of any species. Sapsucker work, which results in the familiar bird peck, is most often found in the hickories, elms, sweetgum, yellow-poplar, and water oaks, but occasionally in the other oaks, and in maples and birch. Insect work is more prevalent in the oaks. Tap holes will be found only in sugar maple butt logs.

F–502325–26

Figure 18.—Carpenter ant work within grub gallery: *A*, Old carpenter worm scar on Nuttall oak with exit hole kept open by carpenter ants; *B*, interior of Nuttall oak under scar in *A*. Ants kept hole open for 30 years after grub adult left tree. Arrow shows location of bark at time of grub attack. Dark heartwood at right is rotted and was being removed by ants for a nest cavity.

F–455639

FIGURE 19.—Grub hole.

Significance.—Except for extreme concentrations of grub holes or associated carpenter ant work, medium holes can be disregarded *in construction* and *local-use logs*. *In factory logs* they may be extremely important defects, but significance varies with origin, age, or concentration.

Grub holes (fig. 19), increment borer holes, and tap holes are definitely grading defects *in factory logs*, for the hole or channel in the lumber limits the length of cuttings. Carpenter ant work sometimes enlarges these openings and this increases the degrading effect.

Both increment borer and tap holes are generally accompanied by severe stain. In addition, tap holes so often contain forgotten dangerous metal spouts that butts are usually "jumped" when a metal detector is not used at the mill.

Bark scarrer holes (fig. 20), if definitely identifiable, may be disregarded in all three classes of logs because the holes are inherently superficial, and often actually not in the wood at all. Fresh holes show exudations and stained bark. Caution is necessary here because where holes are present earlier attacks are very likely to have occurred. Further treatment will take place under the discussion of insect-caused overgrowths.

Significance of sapsucker holes depends primarily upon age and concentration. Fresh or light bird peck (fig. 21) may be disregarded *in all types of logs*. Test for freshness is lack of associated similar holes that are occluded (filled with callus tissue) after injury to the cambium. Measure of lightness is four pecks per square foot. There are two cautions in connection with light and fresh bird peck. One is that trees so damaged have generally been subject to previous and often repeated attack, and in such cases will have occluded holes (Overgrowths, p. 17). A second caution relates to the hickories; here even light bird peck often results in circular columns of purple stain running for considerable distances down the tree. This stain is not a defect on lumber, but does constitute a degrading influence on handle stock. The degree of bird peck is not the test for degradation. The test is occlusion.

Heavy bird peck (fig. 22) may be older and usually is accompanied by occlusions. The effects extend into the wood in the form of bark flecks or callus pockets. Thus, the chances are good that in most species heavy bird peck is a log grade

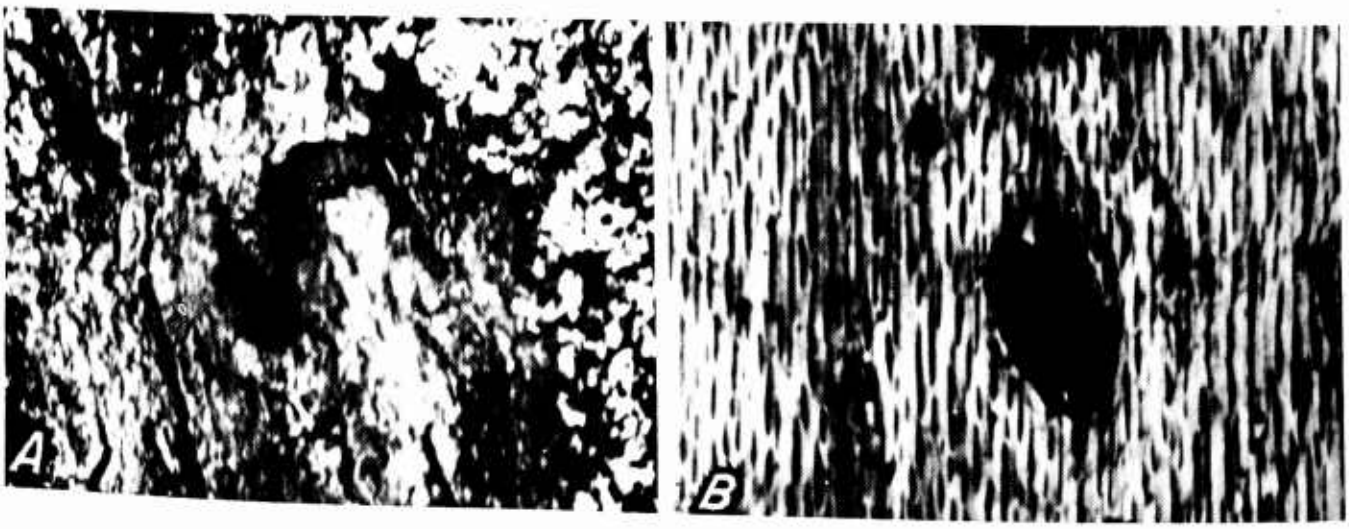

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FIGURE 20.—Bark scarrer damage: *A*, recent bark scarrer beetle attack in Nuttall oak; *B*, stained wood surface beneath scar. Inner bark was destroyed but no penetration of the wood occurred. (Scar is 1 by 1½ inches.)

F–455951

FIGURE 21.—Light bird peck.

F–455593

FIGURE 22.—Heavy bird peck.

defect *in factory logs* (fig. 23), but not *in construction* and *local-use logs*. In yellow-poplar, however, especially on good sites, bird peck is often not a degrader even though occluded. A test to determine this must be made locally.

SMALL HOLES

Definition.—Small holes are unoccluded openings less than three-sixteenths inch in diameter leading into the wood (fig. 24). They are often associated with rot or wounds and confined to the immediate vicinity thereof. They are made by several genera of beetles, including ambrosia, and larvae of the shot worm beetle.

Occurrence.—There appears to be no significant relation to species. Ambrosia beetle damage occurs more often and is generally heavier in the softer and "sappier" species such as sweetgum, but is also found to a damaging degree in the harder species. Shot worm holes are most prevalent in red oaks, ashes, and sweetgum and, generally, in the heartwood.

Significance.—Small holes on the surface are often accompanied by other features, such as wounds or rot which may or may not be log grade defects. *In factory logs* the usual effect of small holes is to increase the already defective area containing the wound or rot. Nevertheless, even if not otherwise defective, the area in which the insects work is definitely a degraded area. Small holes may be disregarded *in construction logs* and *in local-use logs.*

LOG KNOTS

Definition.—Log knots are cut or broken-off limbs or sprout branches, green or dead, protruding, flush, or depressed, but with exposed sound or rotten wood (figs. 25 and 26). If the exposed wood is sound, the log knot is "sound"; if rotten, it is "unsound."

Occurrence.—Log knots are common to all species, but the frequency depends upon the habit of the species. In cottonwood, tupelo, yellow-poplar, and the ashes and basswoods, for example, occurrence is conspicuously limited. Pin oak, scarlet oak, and (on poor sites) black oak are conspicuously knotty.

Significance.—A log knot on the surface of the log or a branch on a tree represents a knot in the underlying wood.

F–455583

FIGURE 23.—End view of hickory log showing stain caused by bird peck.

F–455594

FIGURE 24.—Small holes.

In factory lumber the degrading effects are determined by the distribution (which affects the yield of clear cuttings) rather than from size, character, and condition of the individual knots. Obviously, large knots will limit cuttings more than small knots. But a knot in lumber, no matter how small, will limit a cutting under standard hardwood lumber grades. Thus, any log knot is a degrader *in factory logs*. Even "surface" log knots, arising from epicormic or sprout limbs, cannot be discounted. Although a particular log knot of this origin may taper out at a shallow depth, it generally indicates successive layers of lumber knots for an indefinite depth into the wood.

In construction logs the degrading effect of a log knot depends upon an entirely different set of circumstances. If the underlying lumber knot is larger than one-fourth of the face of the largest included timber (measured on the small end of the log), or if it is very rotten, it is definitely a defect because it will affect the strength of the piece. Guides to the breaking point between the two conditions are as follows: A sound log knot is a defect in a construction log if the diameter of the log knot collar at the point of occurrence is greater

F–455596

FIGURE 25.—Sound log knot.

F–455597

FIGURE 26.—Unsound log knot.

than one-third the diameter of the log at that point. For log knots from epicormic branches which can be absolutely identified as such, this limitation can be increased to one-half the diameter at the point of occurrence. This is because of the extremely rapid taper which takes place between the log surface and the point of origin.

Log knots smaller than one-third to one-half of the diameter can be disregarded as degraders if they do not occur in whorls equaling the effect of the larger log knot, and provided they are sound. If they are in whorls, then the combined effect must be considered, and a whorl of small log knots the sum of whose collars exceeds the limit for the single large one is a log grade defect.

Unsound log knots are judged by the same rule as sound ones, so far as size is concerned, but the rot cannot extend more than 3 inches into the included timber. In practice this means that an unsound log knot of acceptable size is a degrader if the rot extends into the log for a distance exceeding one-fifth of the log diameter.

In local-use logs the only limitation on lumber knots is that they must not extend across individual pieces of lumber. A good rule is that a log knot is a grading defect if the collar diameter exceeds one-half the diameter of the log at point of occurrence or if the aggregate of a whorl of smaller log knots is of equal effect. Other log knots, even if unsound, may be disregarded.

LIMBS

Definition.—A limb is a branch or subdivision of the stem or an outgrowth from the stem (fig. 27). It may have been one of the original branches, starting at the pith of the main stem, or it may have started later from dormant buds at varying distances from the pith. These epicormic limbs may be identified by their tendency to grow almost vertically parallel to the main tree stem, and often by an abrupt increase in diameter at the base. They retain a smooth or juvenile appearance of the bark to a much larger size than a primary limb.

Occurrence.—Limbiness varies with growth or development habit of each species. It also varies with conditions of growth such as spacing and site, age and size, competitive position, and health or vigor. Species generally most free from limbs are cottonwood, tupelo, yellow-poplar, and the ashes and basswoods. Oaks—particularly black oak on poor sites, scarlet oak, pin oak, and sometimes the water oaks—are very limby.

Significance.—Limbs will be reflected in generally sound knots in the sawed product. Since they degrade factory lumber regardless of size, condition, and character, they are log grade defects *in factory logs*. *In construction logs* and *in local-use logs* the same rules apply that relate to log knots; namely, there is a size limitation. If the limbs are above the size limitation or if smaller and arranged in whorls, they are defects which may prevent a log otherwise qualified from being put in one of these two classes. Otherwise, they may be disregarded.

F–455598

FIGURE 27.—Limbs.

OVERGROWTHS

Many log surface abnormalities appear to be only breaks in the normal bark pattern of the tree. Log knots (resulting from broken or cut branches), mechanical wounds (as from ax blaze or logging), and discrete holes such as those made by sapsuckers or insects are common causes of this type of abnormality. As the tree develops, they are covered over by callus tissue and finally engulfed in the wood. As the years pass, the bark reforms over larger ones and the presence of a blemish in the wood is shown only by a deformation of the general normal surface contour. A bump (p. 6) is an extreme example of this.

Deeply buried smaller features may leave no external evidence. For many years, however, most features—until they become so deeply buried in the heart as to lose significance as product defects in the quality zone—leave on the surface of the tree or log either a definite structure of callus, or an identifiable break in the normal bark pattern. *Such features are classed as overgrowths.* They actually are phases of other log abnormalities described elsewhere. Yet, because many of them

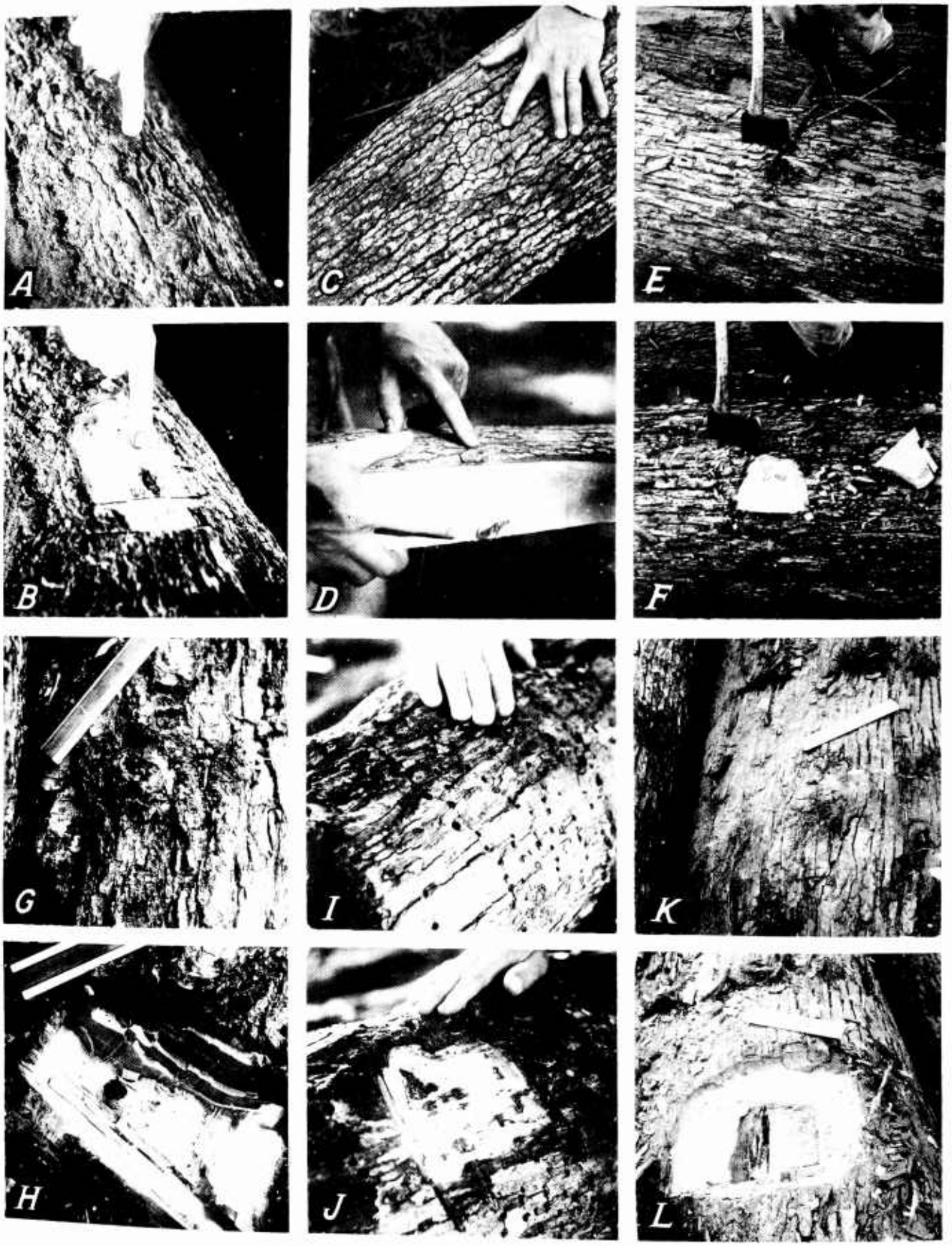

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FIGURE 28.—Overgrown features are of fundamental importance in judging the quality of hardwood timber: *A* and *B*, Overgrowth in water oak caused by small log knot just recently buried; *C* and *D*, overgrowth in blackgum due to deeply buried log knot; *E* and *F*, small epicormic limb on white elm leading to lumber knots; *G* and *H*, overgrown epicormic buds surrounding an epicormic branch; *I* and *J*, bird peck in forked-leaf white oak; *K* and *L*, large grub-caused overgrowth in overcup oak.

F—455628—30

FIGURE 29.—Overgrowths caused by knots.

are inconspicuous and easily overlooked, and because they are the least understood of all the hardwood log surface abnormalities, they are considered together for emphasis.

A recently overgrown log knot is an example of a very conspicuous and easy-to-recognize feature in this class. Less easily recognized are evidences of old insect work. Such damage may be so hidden that the only indication of its presence is a general appearance of the bark, which to the trained eye signifies a need for close search for individual overgrowths. The importance of overgrowths in the evaluations of hardwood factory lumber logs in particular cannot be overemphasized. *Appraisal on the basis of all other log grade defects would, in most situations, be fallacious if overgrowths were not consistently recognized and given full weight as product defect indicators* (fig. 28).

Overgrowths may be grouped into four relatively distinct classes, three reflecting origin (knots and associated bark pockets, insect work, sapsucker damage), and a fourth (bark distortions) of uncertain origin.

Overgrowths Related to Knots and Associated Bark Pockets

Definition.—The most obvious overgrowths are those indicating overgrown or buried log knots and associated ingrown bark (fig. 29). Where single log knots are involved, the overgrowth in the early stages of development takes the form of the underlying log grade defect. Whether the log knot is covered over with callus tissue or there is a circular excrescence of callus tissue around it, there still is a separation between this tissue and the normal bark. The log knot is gradually engulfed as time goes on, but for many years definite swirls or lines form on the bark, making a characteristic pattern of roughly concentric circles most distinct at the base.

These patterns, which are so definite that there can be no mistaking their cause, persist until the log knot becomes a lumber knot so deeply buried that it will not be found in the quality zone. From this stage on the characteristic bark signs gradually disappear, and the deeply buried lumber knot is evidenced by a bark distortion which may be merely a faint break in the normal bark pattern. When clusters of small log knots (generally from sprout growth) with associated bark pockets are involved, a small rise or slight bump may be formed during the early stages of overgrowth. The bump or rise resembles that covering a large single log knot. These small bumps sometimes run together to form a sort of rosette. The final stages are similar to those of the single log knot, except that the bark distortion is apt to be wider and more irregular.

Occurence.—There is no relation between such overgrown log knots and species except that some species are limbier than others. This class of defect is often overlooked in well-stocked stands of rapidly developing, well-cleaned second growth and especially in upper logs. Recognizing overgrowths in such stands is particularly important because, although general appearance may be one of clearness of bole, the underlying knot is just beneath the slab.

Significance.—Each log knot-caused overgrowth indicates an imperfection (knot) in the quality zone of the underlying wood. *In factory logs* each is a log grade defect. *In construction logs* the overgrowths can be disregarded except when they are of abnormally large size or, if small, when whorled. Overgrowths of this class can be disregarded *in local-use logs.*

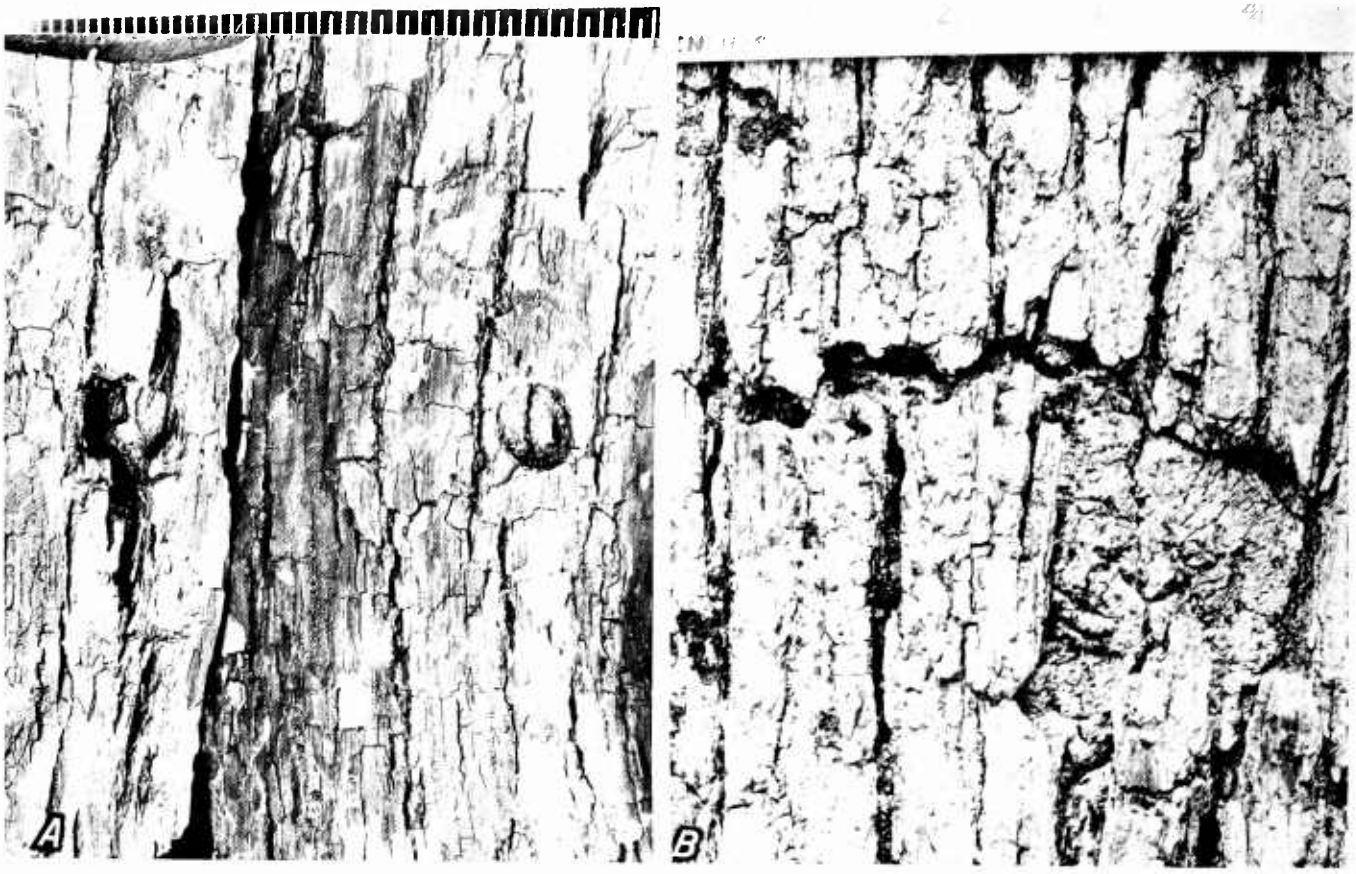

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FIGURE 30.—Overgrowths caused by borers: *A*, Roundheaded borer exits; *B*, carpenter worm entrance and exit or borer entrance.

Overgrowths Related to Insect Attack

Large Borer and Bark Scarrer Work

Definition.—Common and extremely important distinctive bark irregularities are those covering holes caused by the work of such insects as wood borers (fig. 30) and bark scarrers (fig. 31). The latter results in irregularly puckered scars covering the entrance hole and surrounding area of bark destroyed by the feeding larvae. The size of overgrowth varies from 2 inches to 3 by 5 inches in dimension. Roundheaded borer exit holes will be covered by a sharp pucker consisting of a pitted core with callus tissue and distorted bark extending over an area ¾ to 2 inches in diameter. Generally, borer-caused overgrowths in the bottom lands involve carpenter worm work, while in the uplands they involve roundheaded borer work.

The covering of bark scarrer work usually shows as a vertical slit from ¾ to 3 inches long with callus area on both sides. The total maximum affected area is typically about 2½ inches wide and 6 inches long. The most extreme development of this type often looks like a small healed blaze wound. In late stages projecting scales of normal bark from surrounding areas may hide these distortions. These concealing bark scales, particularly in mature trees, may contain holes ⅛ to ¼ inch in diameter, or exhibit numerous transverse breaks, cracks, or ridges which indicate that overgrowths are present (fig. 56, p. 36).

Another type of bark scarrer overgrowth (fig. 32) closely resembles the overgrowth of the roundheaded borer exit hole, making a precise distinction between the two difficult. Moreover, in some situations this general type of scarrer injury causes numerous breaks in the cambium, many of which are little larger than coarse bird peck and which result in finely puckered overgrowths that are hardly as conspicuous as individual coarse bird pecks. Nevertheless, the usual overgrowth of this sort is slightly larger than that associated with roundheaded bore exit holes and is generally less regular and clean cut with more radiating lines in the pucker.

Occurrence.—This general class of insect-caused overgrowths is definitely related to species, and within species to site and history. Although widespread over the entire East, it is most prevalent in the South, especially in the valleys of the lower Mississippi River system and the lower Coastal Plains. Occurrence is closely related to sites, being affected not only by the sharp differences between the alluvial and upland situations, but also by the widely varying growth conditions in the lowlands.

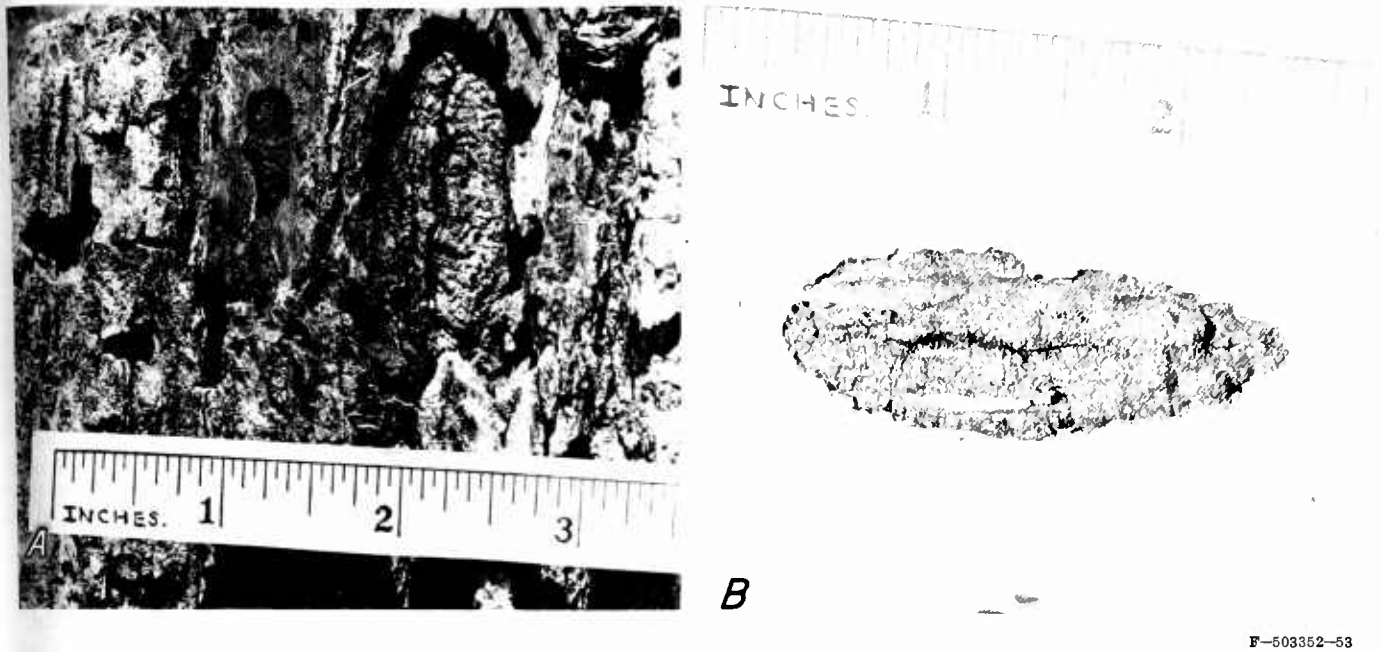

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FIGURE 31.—Overgrowths caused by bark scarrers: *A*, Surface; *B*, interior; bark pocket but no hole.

The oaks and some of the hickories are the species most susceptible to attack. Of the hickories, sweet pecan is an exception and is almost entirely free. Within the other hickories occurrence is likely to be most important on poor, dry sites, whether lowland or upland.

In the oaks three groupings can be made. In the first group are those usually free from this type of overgrowth. They include cow, Delta post, northern red, Shumard, swamp white, and cherrybark oak. (Damage to cherrybark and cow oak is mainly confined to bark scarrer work, which is occasionally serious in overmature trees or on poor sites.) In the second group are those rather generally infested—laurel, scarlet, overcup, blackjack, chinkapin, and chestnut oak.[8]

[8] For discussions of these relationships see Putnam, John A., Furnival, George M., and McKnight, J. S. Management and inventory of Southern hardwoods. U.S. Dept. Agr., Agr. Handbk. 181. 1960.

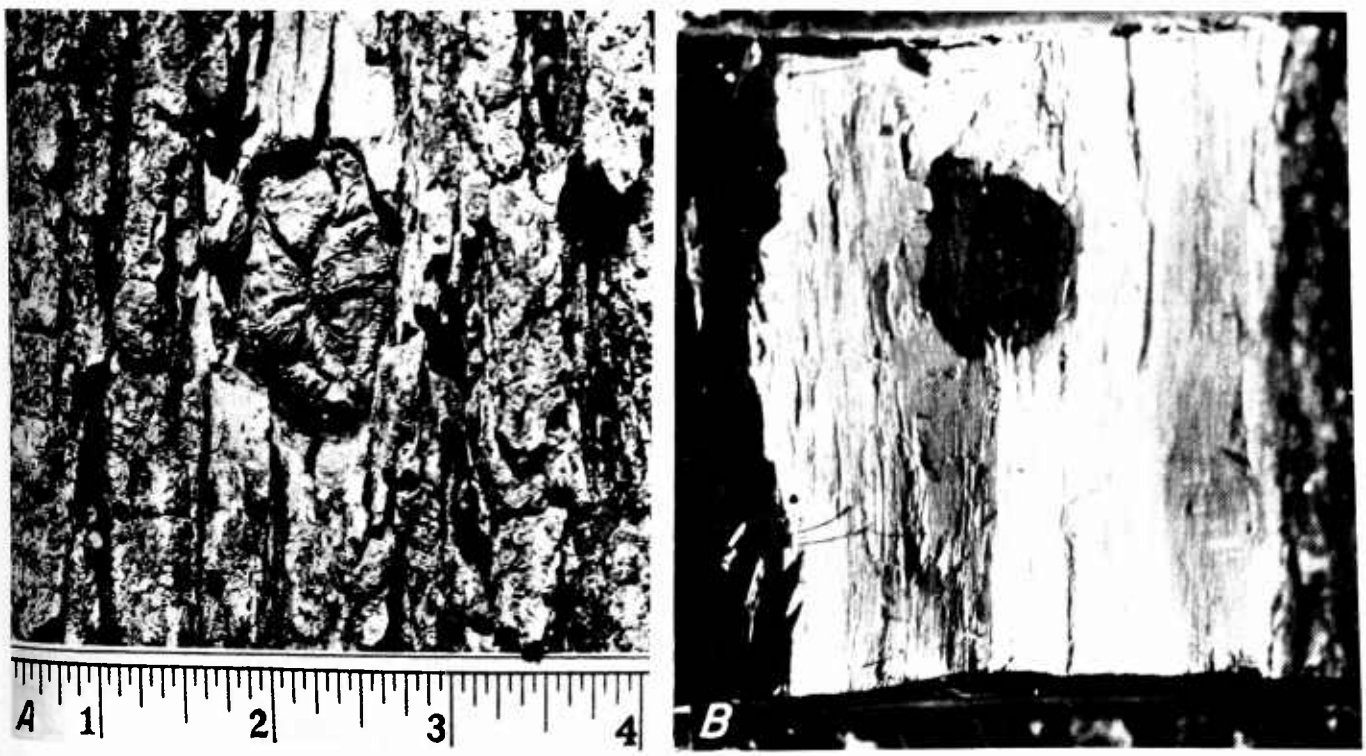

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FIGURE 32.—Another type of bark scarrer overgrowth, easily confused with borer exits: *A*, Healed scar (1 by 1⅔ inches); *B*, surface of wood beneath scar shows ingrown bark but no penetration of wood.

The third group includes those in which the degree of damage is dependent upon the specific nature of the site. The group may be divided into two subgroups. The first includes those often found both on better drained lowlands (principally terraces and second bottoms) and on rich upland sites. It includes forked-leaf white, black, southern red, post, and shingle oak. Insect-caused overgrowths in this subgroup are most likely to be found in timber from dry, poor sites, such as exposed high slopes, ridge tops, and *most* Coastal Plain pine sites. On normally good hardwood sites insect damage is usually slight or absent in these species. White oak is especially free on true hardwood sites, but on pine sites of the lower Coastal Plain it is usually badly damaged.

Occurrence of these overgrowths in the second subgroup (Nuttall, bur, willow, pin, and water oak—typical flood plain species) usually varies more widely than in the terrace and upland species. The timber is likely to be very bad when the trees are growing in hardpan flats on terraces, in back-water areas where there is prolonged inundation and tight clay soils, and on dry upland sites away from alluvial soils. Site variations in general and soil variation in particular, together with degree of freedom from fire injury, may drastically reduce or increase occurrence in these species. These species are likely to be relatively free from such defects on good flood plain sites, but *only* on such sites.

In this third group are many other hardwood species in which insect-caused overgrowths may be found, particularly in trees on unfavorable sites. However, the definite relationships or the plain indicators found in the oaks are not present, except that green ash in poor, deep swamp sites may show serious borer infestation over wide areas. Insect-caused overgrowths are also likely to be important in extra large, overmature, and decadent sycamore and cottonwood on poor dry sites. Table 1 gives a general summary of these complicated relations.

Significance.—Grub- or borer-caused overgrowths mean channels in the wood and generally bark pockets at the points of entrance, emergence, or both. The holes indicated by this type of overgrowth are rarely under ¼ inch in diameter and are often associated with rot and stain. In factory lumber each channel or hole in a board is a product defect, and *in factory logs*, therefore, each overgrowth is a log grade defect. *In construction logs*, unless the holes are very numerous (in which case there are usually accompanying defects of other nature, such as loose heart, shake, and rot), the holes and channels are not considered in grading the product and therefore can be disregarded. They can also be disregarded *in local-use logs.*

Bark scarrer-caused overgrowths, on the other hand, indicate bark pockets which degrade factory lumber. The uncertain feature is the plane in which the imperfection lies. Although the particular bark pocket indicated by the overgrowth may affect only one or two boards (the result of cambium excavation), the presence of any such abnormalities indicates the strong probability of additional similar lumber defects in different planes. Bark scarrer-caused overgrowths, therefore, are log grade defects *in factory logs* but may be disregarded *in construction logs* and *local-use logs.* It should be noted, however, that heavy bark scarrer work is commonly associated with check, shake, and incipient rot. The combination

TABLE 1.—*Probability of insect damage in the southern oaks*

Species practically free from damage	Species generally damaged. Degree of damage dependent upon—			
	General site quality, fire history, or age		Specific nature of site [1]	
Cow [2] Delta post Cherrybark [2] Northern red Shumard Swamp white	Laurel Overcup	Chestnut Scarlet Chinkapin Blackjack	White Black Southern red Post Shingle	Nuttall Bur Willow Pin Water
	Damage slight on good sites and heavy on poor ones, if burned, if overmature.	Damage medium on good sites and heavy on poor ones, if burned, if overmature.	Damage slight on terraces or second bottoms and good upland sites; heavy on dry or sterile upland sites.	Damage slight on well-drained alluvial soils and good upland sites; heavy on hardpan flats, backwater areas with tight soils and prolonged inundation and dry upland sites.

[1] Applicable according to natural site distribution of each species; that is, Nuttall oak is never found on sites other than alluvial.

[2] Cherrybark and cow oak, if overmature or damaged, may be badly infested with bark scarrer on poorly drained sites.

often makes the log worthless for any purpose, just as in the case of grub damage.

Horizontal Bark Scarrer

Definition.—Another boring insect defect produces a channel ⅛ to ¼ inch in diameter that generally follows a horizontal direction across one-fourth of the tree circumference. The overgrowth is typically a narrow band of callus tissue from 3 to 10 inches long.

Occurrence.—This insect-caused overgrowth is found universally in white oak in the southern Coastal Plains, except on the best hardwood sites, and sporadically in overcup oak (fig. 33).

Significance.—It is a degrader *in factory lumber logs* and can be disregarded in the other classes.

Overgrowths Related to Sapsucker Work

Definition.—Overgrowths that cover the peck holes of sapsuckers (not the usual woodpeckers) may be recognized by the conspicuous, horizontal row or belt pattern of occluded holes about one-fourth inch in diameter (fig. 34). Occasionally the entire log is freckled with such bird peck. Where the holes are continuous, a horizontal crack often forms.

Occurrence.—Species most susceptible to attack by sapsuckers are hickories, elms, sweetgum, yellow-poplar, and water oaks. The other oaks, maples, and birches are damaged moderately.

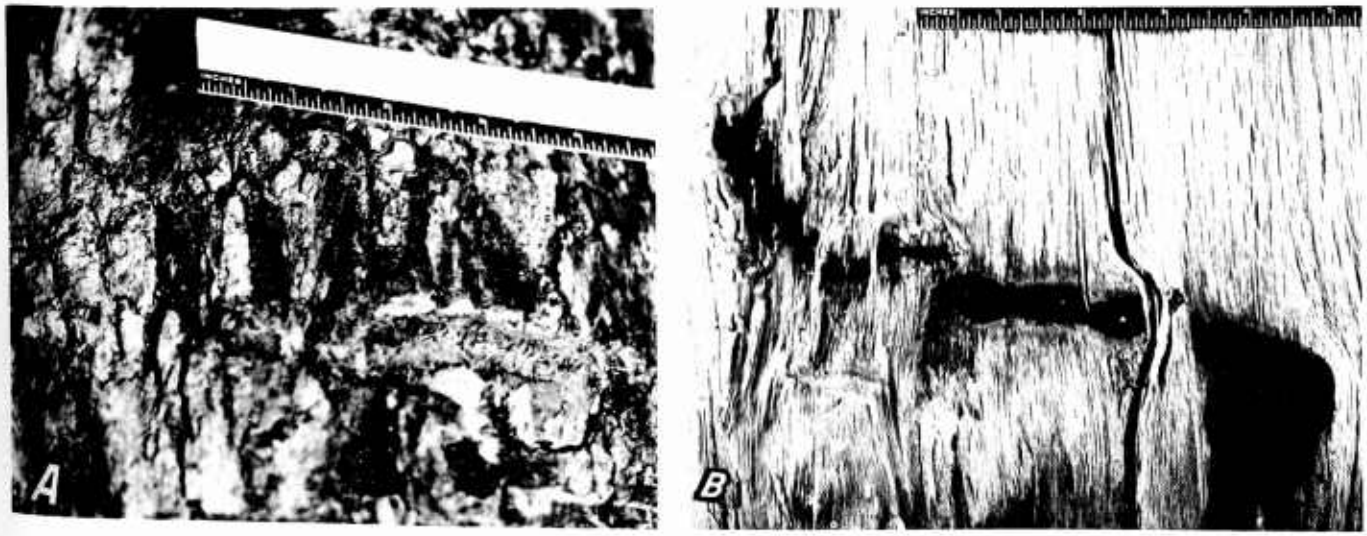
Significance.—Overgrowths from sapsuckers indicate imperfections in the wood consisting of small holes or groups of holes filled with callus tissue. One attack would cause imperfections in only one plane and would thus affect only a few boards in factory logs. However, most trees exhibiting such features have been damaged repeatedly over a number of years. The various degrees of occlusion and occurrence of horizontal cracks indicate how long ago the injury occurred. The variability of damage makes it difficult to predict the exact extent. Nevertheless, except for very large butt logs, it is safe to assume that damage extends far into the tree and affects a large part of the volume. Thus, these overgrowths must be considered as log grade defects *in factory logs.* Usually the damage does not weaken large pieces of wood and, therefore, this type of overgrowth can be disregarded *in construction logs* and *local-use logs.*

Overgrowths of Uncertain Origin

Definition.—Overgrowths of uncertain origin are called bark distortions. These are faint or indistinct but still discernible breaks in the normal pattern of the bark (fig. 35). As opposed to other types of overgrowths, they exhibit no characteristic formation which will enable the cause to be established definitely from bark appearance alone. They are the result of the burying of any of the log grade defects already discussed. They may cover insect damage, wounds, bird peck, or—most commonly—knots.

Occurrence.—Bark distortions (as defects) have the same relationship to species as do their causes. A smooth-bark tree, such as beech, carries the evidence of these deeply buried defects on the bole much more clearly than does a rough-bark tree like soft elm. Bark distortions are relatively prominent on young sweetgum, yellow-poplar, cottonwood, and second-growth red and water oaks.

Significance.—Bark distortions reveal the presence of deeply buried blemishes. It is important



F–502330–31

FIGURE 33.—Effect of unknown trunk-boring insect in overcup oak: *A*, Horizontal bark scar; *B*, typical gallery. A similar defect in white oak is distinctly finer, being only ⅛ inch or less in width. This defect seriously degrades most of the white oak in the Coastal Plains piney woods and is the principal cause of prevalent low quality in that area.

F–455599

FIGURE 34.—Overgrowths caused by sapsucker work.

F–455637–38

FIGURE 35.—Bark distortions.

to direct especial attention to them because they are inconspicuous in their later stages and, consequently, easily overlooked by untrained eyes. In all stages they can be disregarded as defects *in construction* and *local-use logs*, but must be regarded as degraders in *factory logs* under 15 inches in diameter. Significance in larger logs is another matter. In about half of the logs over 15 inches in diameter the underlying defects are buried in the heart center. In the other half the wood blemishes are in a degrading position in the quality zone. The significance varies with species also. It is greatest in beech, for example, and least in hard maple. Altogether, *in large factory logs* bark distortions are of such variable degrading effect that they can be disregarded.

SEAMS

Definition.—Seams are longitudinal radial separations of the fibers in a log or tree, either open or overgrown with callus tissue (fig. 36). If the seam is overgrown, bark is usually encased. Seams are generally caused by wind, lightning, or frost. They are likely to be found in trees with cross or spiral grain, or which are buttressed or leaning, or internally stressed from other special causes.

Occurrence.—Seams may be found in any species, but are common in the oaks, ashes, maples, elms, poplar, birch, beech, and honeylocust.

Significance.—The significance of seams depends upon their depth. Often a rot is associated with a seam; if so, consideration must be given not only to the seam but to the extent of the rot. *In factory logs*, if a seam together with any associated rot extends into the log for less than one-fifth of the log diameter, it can be disregarded as a degrader. If it goes deeper, even though scale is reduced to allow for loss of lumber, it is still a degrader in that it stops cuttings. *In construction logs* it can be disregarded if it enters the largest included timber (as measured on the small end of the log) only slightly, say one-half inch. If a sound or unsound seam enters the timber deeply, however, it must be classed as a log grade defect which will eliminate the log from or degrade it for this class of use. *In local-use logs* most seams can be disregarded.

SPLIT

Definition.—A split is a longitudinal separation of fibers extending deeply into the milling frustum of a factory log or into the included tie or timber of a log designated for construction use (fig. 37). A split is generally caused by operational accident or carelessness. Sometimes it results from the release of internal stresses when the tree is felled; such splits are usually called "checks."

Occurrence.—The pecans, especially bitter pecan, and the hickories are likely to split at any time because of release of internal stresses after cutting; cottonwood, willow, ash, and overcup oak often split badly at the peak of the growing season. Accidental splits can, of course, occur in a log of any species, but most trouble is encountered in the pecans, the ashes, the hickories, and the red oak group.

Significance.—By definition, superficial minor splits can be disregarded. *In factory logs* splits extending more than one-fifth the diameter into the log are degraders even though the portion of the lumber ruined be scaled out. *In construction logs* end splits which do not extend lengthwise more than 5 inches beyond the trimming allowance can be disregarded. Other splits must be considered as degraders. *In local-use logs* splits can be disregarded.

SURFACE RISE

Definition.—A surface rise is a notable, smooth undulation in the surface of the log or tree bole which gradually tapers back in all directions to the normal contour (fig. 38). Because of the nature of this abnormality there can be no minimum height specification other than the ability of the eye to notice it. One with the maximum height, however, has a taper of 1 in 6. When the taper is steeper, the abnormality is classed as a bump (p. 6). A surface rise is usually the effect of a small limb stub, a cluster of adventitious buds, or a deeply buried knot or wound. Sometimes a rise reflects an earlier crook in the stem.

Significance.—The underlying lumber defects are so deeply buried that their degrading influence cannot be assessed with consistent accuracy. Surface rises, therefore, can be disregarded as log grade defects *in logs of all types.* It is important to differentiate between a surface rise and a bump because the latter is an important degrader. This is particularly hard to do when skidding has rubbed off some of the bark.

WOUNDS

Definition.—Wounds are openings in the bark that expose sapwood and sometimes heartwood (figs. 39 and 40). Wounds may be either *new* or *old.* A new wound is essentially a surface injury in which the exposed adjacent sapwood is apparently sound. An old wound is a similar injury either completely open or only partially healed over. It is generally recognized by unsound sapwood, local hollow, much callus tissue, insect damage, and often stained or actually rotten heartwood.

FIGURE 36.—Seam. F—455600

FIGURE 37.—Split. F—455601

Significance.—In a new wound deterioration is usually not serious, for any insect damage or stain will be quite superficial. Therefore, under most conditions and for *all types of logs*, new wounds can be disregarded as log grade defects. However, with such species as cottonwood, sweetgum, hickories, willow, hackberry, magnolias, and basswoods, early deterioration of wounds is apt to occur; if it does, this must be considered.

The seriousness of an old wound varies considerably with locality and with species. In some species exposed heartwood may completely heal over before serious injury occurs. Nevertheless, since old wounds are usually associated with stain, rot, and insect damage, the affected area is a grading defect in both *factory logs* and *construction logs*, except in the rare cases where it is superficial. In the factory logs, even if scale deduction is made to cover the area involved in worthless wood, the area will stop a cutting. Old wounds can be disregarded *in local-use logs.*

F–455603

FIGURE 38.—Surface rise.

F–455604

FIGURE 39.—New wound.

Log End Abnormalities

The log abnormalities discussed heretofore have been those visible on the surface. As has been pointed out, these usually reflect imperfections in the wood. Sometimes the cross sections of these will show in the end of the log. For example, the effects of bird peck, grub work, advanced rot, knots, bark pockets, wounds, seams, flutes, and many other surface abnormalities can often be seen on the ends. These and similar blemishes for which there are surface indications are not reconsidered in connection with so-called "end abnormalities," with one exception. This exception is made for grub channels, the cross or longitudinal sections of wood-boring insect channels with definite and recognizable entrance and exit holes on the surface.

The log end may also reveal imperfections which normally have no surface indicators. These are the so-called "hidden" defects that demand local experience for their appraisal in standing timber.

Many of these end features are somewhat different from other product defects in that they are often admitted to a certain degree in the products, and in that their degrading effect is often based on concentration rather than presence alone. Sometimes their effect is covered by special grades which admit the blemish in the product without qualification, but which bring a reduced product price. Also, their location is important. Some which occur in the heart center only may be disregarded in one type of log; in another type of log the same imperfection in the same position will mean a drop in log class or require culling the log.

F–455605

FIGURE 40.—Old wound.

Many of these features are difficut to judge because they are found on one end of the log only, and the observer must use considerable judgment in determining how far into the log the blemish extends. Many are in the class of the scalable defects, and in judging their significance as a log grade defect, the relation to the particular product for which the log is best suited must be carefully considered.

DOUBLE PITH

Definition.—When a tree bole forks and a log is cut just at the base of the fork, the end of the log will seem swollen; the top will have two separate pith centers, often separated by a bark pocket. This condition is called double pith (fig. 41).

Significance.—Double pith leads to cross grain in sawn products, together with a split or potential split from the bark pocket. The general approximate effect is that of two large knots. *In factory logs* double pith is not a degrader; nevertheless, the related seam and any enclosed bark should be treated as in the case of fork (p. 11). *In construction logs* double pith is a degrader. Double pith is not a degrader *in local-use logs.* In standing timber double pith may be disregarded if the section including it can be cut out so as to leave logs of sufficient length to fulfill the minimum requirements of the log class.

F–455606

FIGURE 41.—Double pith.

GREASE SPOTS

Definition.—Grease spots are limited, shadowy streaks with a dirty "greasy" look. They are sooty or brown in color and surround oval, frass-filled insect channels 1/16 inch in diameter (fig. 42).

Occurrence.—Grease spots occur principally in overcup oak and locally in chestnut and white oaks. They are generally found in overcup oak in backwater flooded areas of the larger river bottoms and in the other species on poor, dry sites with a bad fire history.

Significance.—In factory logs they are log grade defects if in the quality zone; in the other classes they can be disregarded.

GRUB CHANNELS

Definition.—Grub channels are round holes or irregular channels of varying length, from 3/8 to 1 inch in diameter (fig. 43). They are made by wood-consuming grubs that hatch from eggs laid in the bark of the living tree and work their way into the log and later back to the surface. The holes are cross or longitudinal sections of the channels.

Occurrence.—A single hole or channel may show, or the end of the log may be literally riddled. Although grub channels may occur in any species, they are found most often in the oaks, particularly in overcup oak, chestnut oak, and the water oaks. As discussed under insect-caused

F–502327

FIGURE 42.—Grease spot. Cross section of 28-inch overcup oak log with signs of "grease spot" damage. Dark lines and spots indicated flatheaded borer galleries and associated stained wood. All lumber from this log graded "sound wormy" from grease spot defects.

overgrown abnormalities (p. 22), species-site relationships are important clues to their probable occurrence.

Significance.—When grub channels are few and scattered or when a concentration is confined to the heart center, they may be disregarded *in factory logs*. Careful search, including thorough examination of the log surface, should be made to ensure that the concentration is so confined. When it is not, it is a grading defect. In extreme cases and when found in conjunction with other degraders, grub channels may cause the log to be culled. *In construction logs* concentrated grub channels in any part of the log are a log grade defect; scattered ones are not. Grub channels can be ignored *in local-use logs*.

GUM SPOTS

Definition.—Gum spots are accumulations of gum occurring as small patches, streaks, or pockets. They may be related to bird peck or other injury to the growing wood or, as in sweetgum, may be simply impregnations of the wood fibers, related to presently unidentified pathological disturbances. In sweetgum they can seldom be identified except on the end of the log.

Occurrence.—Gum spots are found chiefly in black cherry and sweetgum. Probability of occurrence in sweetgum seems greatest on sites within the lower Coastal Plain.

Significance.—*In sweetgum factory logs* gum spots are log grade defects when found in conspicuous concentration, for they reduce otherwise higher grades of lumber. Gum spots in cherry lumber are admitted to the "clearface" cuttings without limit and are not a defect *in factory logs* of this species. Gum spots, since they do not affect strength, are not grading defects *in construction logs* and *local-use logs*.

LOOSE HEART

Definition.—Loose heart is the tangential separation of fibers completely around a growth ring within the heart center or core of the log, in an area generally not over 6 to 12 inches in diameter (fig. 44).

Occurrence.—Loose heart is most likely to be found in bitter pecan, the elms and honeylocust, and in overcup, chestnut, scarlet, and the water oaks.

Significance.—The area affected is well defined and must be scaled out. When loose heart is confined to the heart center, it may be disregarded *in factory logs*. Although the volume yield will be greatly reduced, the loose heart will in such cases have a minimum effect on average lumber grade yield. Loose heart prevents taking a *tie or timber* out of the center of the log and is a degrader in logs designed for this use. It may be disregarded *in local-use logs* if the scale deduction is within limits. Loose heart is frequently derived from the release of crooked, suppressed saplings and follows the original stem form. Thus, it may have a disastrous effect on small, crooked, or sweepy logs, often necessitating culling the log.

MINERAL STREAK AND STAIN

Definition.—Mineral streak or stain is an abnormal discoloration—black, blue, brown, or olive

F–455609

FIGURES 43.—Concentration of grub channels.

F–455610

FIGURE 44.—Loose heart.

F–455611

FIGURE 45.—Mineral streak and stain.

green—usually in variegated or streaky patches confined to the heartwood (fig. 45).

Occurrence.—It is very conspicuous in soft and hard maple, yellow-poplar, willow, and the magnolias. It is found generally throughout the oaks, especially the water oaks, and particularly on poor sites.

Significance.—In factory logs it is a log grade defect when conspicuously concentrated outside the heart center. A small amount there may be disregarded. In the maples, magnolias, and yellow-poplar mineral stain itself is not a lumber defect. Heavy concentrations (mineral streak), however, are often associated with fine check and shake, which are product defects. Mineral streak and mineral stain can be disregarded *in construction* and *local-use logs.*

F–455612

FIGURE 46.—Pin worm holes.

PIN WORM HOLES

Definition.—These are small round holes made by ambrosia beetles and always somewhat less than one-sixteenth inch in diameter (fig. 46). Certain types are exceedingly minute. Those found in some species, notably overcup oak, are so small that they would easily be overlooked if it were not for accompanying faintly discolored threads or spots.

Occurrence.—They are most prevalent in, but not confined to, post oak, overcup and chestnut oaks, ashes, and yellow birch. Black cherry, elms, hickories, pecan, yellow-poplar, beech, sweetgum, tupelo, magnolias, cottonwood, and willow are relatively free. When pin worm holes occur, they are invariably numerous; practically all of the wood in the log will be affected.

Significance.—In factory logs pin worm holes are log grade defects, and special grades of lumber with lowered value are used for the species in which occurrence is most common. Pin worm holes may be disregarded *in construction* and *local-use logs.*

RING SHAKE

Definition.—Ring shake is a tangential separation of the wood fibers along parts of the annual rings (fig. 47). Sometimes it is confined to definite sections along the outer rim of wood, sometimes it is confined to the center, and sometimes it is found all through the log. Important ring shake is often so fine as to be invisible in green wood, and shows up only when the wood is dry.

Occurrence.—Although ring shake is definitely related to species, it is not found on all trees of any species. On the other hand, it may be found in some trees of every species. It seems especially prevalent in overmature, leaning, toppy, sweepy timber. Ring shake is most common in the butt log and may result from a serious butt injury. As good second-growth timber stands develop, the occurrence of ring shake will be greatly reduced. Today, however, much of the old-growth bitter pecan is shaky. Ring shake is also serious in overmature sycamore, tupelo, and elms, and in overcup and chestnut oak from poor sites.

Significance.—In factory logs ring shake confined to the heart center or to definitely localized areas in the periphery can be scaled out. Ring shake confined to the heart center is not a grading defect, but peripheral ring shake is a degrader because it will stop cuttings. When ring shake is

F-455614

FIGURE 47.—Ring shake.

F-455607

FIGURE 48.—Incipient rot.

general throughout the log, it is a good reason to cull the log. It is a grading defect *in construction logs*. Localized shake can be disregarded *in local-use logs* up to the point where the scale deduction for it exceeds that permitted in the class.

ROT

Incipient Rot (Dote)

Definition.—Incipient rot is an early stage of decay. The wood is discolored and weakened, but does not lose its structure (fig. 48).

Occurrence.—Incipient rot can be present in all species. In woods of low density such as the magnolias, tupelos, or sweetgum, the decay process advances rapidly.

Significance.—In both scaling and manufacturing, incipient rot is less consistently recognized and taken care of than is advanced rot (p.—). Incipient rot is generally scaled out, particularly if extensive or outside the heart center. *In factory logs* such rotten areas when contained in the heart center or inner half of the quality zone may be disregarded as a degrader, whether scaled out or not, whereas incipient rot in the outer half of the quality zone is a grade defect. *In construction logs* incipient rot is a grade defect, regardless of location within the log. Incipient rot may be disregarded as a log grade defect *in local-use logs*, provided scale deduction for it does not exceed that allowed for the class.

Advanced Rot

Definition.—As opposed to the early or intermediate stages of decay, advanced rot is wood characterized by a breakdown in the structure to the point where it is useless (fig. 49).

Occurrence.—There is no particular relationship to species. Advanced rot generally occurs in definite areas in the tree. A frequent location is the center. Rot resulting from wounds or knots is commonly found in the outer rim of wood.

Significance.—The significance varies with use and location. *In factory logs* advanced rot confined exclusively to the heart center can be overlooked as a log grade defect. The affected section will, of course, be scaled out. Even though scale deduction is made for rot, rotten areas in the quality zone are log grade defects if they occupy over one-half the cross-sectional areas in any quarter of the quality zone.

In construction logs advanced rot in the center is a log grade defect that, except in large diameters, probably will eliminate the log from the class. Rot in the periphery is also a degrader, unless it is so superficial that it will extend into the included tie or timber in only a few minor spots not more than 3 inches deep. *In local-use logs* advanced rot can be disregarded providing the scale deduction does not exceed the limits for the class.

SHOT WORM HOLES

Definition.—Shot worm holes are clean-cut round holes about one-eighth inch in diameter (fig. 50). They are generally concentrated in and about rotten heartwood, especially open butt wounds and hollows.

Occurrence.—They are commonly found in oaks, hickories, ashes, and occasionally in sweetgum heartwood.

Significance.—Since shot worm holes are generally associated with rotten wood, they are not a degrader *in factory logs* if confined to the already degraded area. If they extend beyond the bad section and increase the area damaged, they become log grade defects. They can be disregarded *in construction* and *local-use logs* if the permitted allowance for associated rot is adequate to cover the deduction.

SOAK

Definition.—Soak is a moderately discolored area, dirty mustard yellow, bleached brown, or dull gray (fig. 51). The wood looks dull, dead, rough, spongy, and often water soaked or weathered. Although it is considered by some as incipient decay, soak actually is not accompanied by a softening of the fibers; in fact, they are sometimes embrittled.

Occurrence.—It is most common in overcup and water oaks on poor sites.

Significance.—Ordinarily no scale deduction is made for soak. *In factory lumber* it is regarded as equal in effect to mineral stain or localized incipient rot. When heavy enough to be so considered, soak becomes *a factory log* grade defect, but can be disregarded *in construction* and *local-use logs.*

SPIDER HEART

Definition.—Spider heart is a multiple radial separation of the wood fibers starting at the pith center and running out in at least three directions (fig. 52).

Occurrence.—Spider heart is related to species, size, and degree of maturity. It is common in scarlet, overcup, and water oaks and is likely to be found in chestnut oak. It is most prevalent in large, fully mature or overmature trees.

Significance.—Spider heart will ruin the products in which it occurs. If it is confined to the heart center, it is not a log grade defect *in factory logs* and *in local-use logs.* When it extends beyond the heart center *in factory logs*, and when it

F–455613

FIGURE 49.—Advanced rot.

F–455617

FIGURE 50.—Shot worm holes and associated rot.

F–455608

FIGURE 51.—Soak.

F–455615

FIGURE 52.—Spider heart.

occurs to any degree *in construction logs*, it is a degrader.

SPOT OR FLAG WORM HOLES

Definition.—Spot or flag worm holes are clean-cut holes about 1/32 to 1/16 inch in diameter, typically occurring in pairs (fig. 53). They are invariably surrounded by an oval or elongated stained or (in oaks and elms) bleached area or "flag."

Occurrence.—In red and silver maple, post oak, and chestnut oak, spot worm will be found in almost every tree over certain extensive areas within the range of the species, but intensity will vary from tree to tree. In soft elm, beech, and white oak occurrence is spotty and in most localities absent. White oak over most of its range is free, but damage is likely to be found on sites that are dry or lacking in lime.

Significance.—In factory logs spot worm holes with their accompanying flags are log grade defects except in heavily damaged oaks and soft maple. In these species the lowered value of such lumber is recognized by special grades, and the holes need not be considered as log grade defects when WHND grades (Worm Holes No Defect) are used. Spot worm can be disregarded *in construction* and *local-use logs*.

WIND SHAKE

Definition.—Wind shake is a single radial split extending to both sides of the pith (fig. 54). Sometimes it is confined to the heart center, but often it will go to the perimeter of the heartwood, well into the quality zone. Damage is usually most serious in butt logs, but many times the split extends the entire length of both the butt and upper logs.

Occurrence.—Wind shake is most serious in black oak, southern red oak, scarlet oak, and northern red oak growing on upland sites in the south central United States west of the Mississippi River. It is most prevalent on older trees and possibly will occur much less often as site conditions improve and good second-growth stands develop. Wind shake is also found in some of the white oaks, particularly chestnut oak, on upland sites throughout the Appalachian region and the remainder of the South. It becomes serious near the middle of slopes and is worst on the ridgetops.

Significance.—In factory logs wind shake can be scaled out, and that which is confined to the heart center is not a degrader. Where it extends to the perimeter of the heartwood in logs with a narrow sapwood band, it is a degrader because it will stop cuttings. Most wind shake is so serious that it disqualified the log for *the construction class*. Wind shake may be disregarded *in local-use logs* unless it is severe enough to cause the log to split open in handling.

F–455616

FIGURE 53.—Spot or flag worm holes.

F–456029

FIOURE 54.—Wind shake.

Table 2 summarizes the log abnormalities, both surface and end, by listing the effect of each for each log class as defined in the previous discussion.

TABLE 2.—*Summary classification of log abnormalities*

LOG SURFACE ABNORMALITIES

Abnormalities	Factory logs	Construction logs	Local-use logs
Bulges:			
Butt	(1)	(1)	No defect.
Stem	(1)	(1)	Do.
Bumps:			
High	Defect	(2)	(2).
Low	(3)	(3)	(2).
Burl	Defect	Defect	(2).
Butt scar	(1 4)	(1 4)	No defect.
Butt swell	No defect.	No defect.	Do.
Canker	(1)	(1)	(4).
Conk	Defect	Defect	No defect.
Epicormic branches and adventitious bud clusters.	(2 4)	No defect.	Do.
Flanges	No defect.	do	Do.
Flutes	(4)	(4)	Do.
Fork	(1)	(1)	Do.
Gum lesions	(3)	No defect.	Do.
Holes:			
Large	Defect	(5)	(2).
Medium:			
Bark scarrer, fresh.	No defect.	No defect.	No defect.
Bark scarrer, old.	Defect	do	Do.
Birds, light	No defect.	do	Do.
Birds, heavy	Defect	do	Do.
Grub	do	do	Do.
Increment borer.	do	do	Do.
Tap	do	do	Do.
Small	(4)	do	Do.
Knots:			
Sound	Defect	(2)	(2).
Unsound	do	(5)	(2).

LOG SURFACE ABNORMALITIES—Continued

Abnormalities	Factory logs	Construction logs	Local-use logs
Limbs	do	(2)	(2).
Overgrowths:			
Knots and bark pockets.	do	(2)	No defect.
Insects	do	No defect.	Do.
Bird peck	do	do	Do.
Bark distortions	do	do	Do.
Seams	(4)	(4)	Do.
Splits	(4)	(4)	Do.
Surface rise	No defect.	No defect.	Do.
Wounds:			
New	do	do	Do.
Old	(4)	(4)	Do.

LOG END ABNORMALITIES

Double pith	(1)	(1)	No defect.
Grease spots	(7)	No defect.	Do.
Grub channels	(7)	(7)	Do.
Gum spots	(3)	No defect.	Do.
Loose heart	(6)	Defect	Do.
Mineral streak and stain.	(7)	No defect.	Do.
Pin worm holes	Defect	do	Do.
Rot:			
Incipient (dote)	(6)	Defect	Do.
Advanced	(6)	do	Do.
Shake:			
Ring	(6)	do	Do.
Wind	(6)	do	Do.
Shot worm holes	Defect	No defect.	Do.
Soak	(7)	do	Do.
Spider heart	(6)	Defect	Do.
Spot or flag worm holes.	Defect	No defect.	Do.

[1] Defect if not cut off. [2] Defect if large. [3] Defect if certain species involved. [4] Defect if not superficial.
[5] Defect if large and deep. [6] Defect if not confined to heart center. [7] Defect if concentrated.

Evaluation of Timber and Logs

LOG CLASSES AND LOG GRADES

The preceding discussion of log grade defects can now be applied to timber and log evaluation. A log examiner evaluates a stand, tree, or log within his particular frame of reference. *Log classification* is the first step. This is either a screening or a grouping operation. In screening, the objective is to isolate the trees or logs (a class) that are suitable for a single purpose. In grouping, the objective is to sort the trees or logs into groups (classes), each of which is suitable for a discrete purpose.

In either case suitability refers to intended use. In spite of the wide range of qualities in product yields from individuals within each class, the log classes outlined in the preceding discussions are useful in making broad sortings of timber and logs. If nothing further is done, however, economic evaluation of either use classes or defects can be little more than a guess.

The next step is a grading system. It is a series of specifications that, *for each class*, place all included individuals in logical subgroups or grades. Each of these represents a small range of economic values (or indicators of these, such as product grades), has an average value higher or lower than that of any other grade, and contains individuals with values that are within a stipulated range. Practically, the number of these grades must be limited; and is so by the total value range within the class. In hardwood timber three to six grades will usually stratify the class to the point where significantly different determinations of probable average value of each grade can be made. The grading specifications usually consist of class specifications factors with additional quantitative limitations.

DEFECT EVALUATION IN GRADING

Grade defects are influential in most log or tree grade specifications. Heretofore, in this publication each log grade defect was discussed independently of log grade consideration. The implication may have been that each defect bears equal weight as a quality determinant; that is, a small log knot is equal to a large log knot; a large log knot is equal to a seam; a seam is equal to a burl; and a burl is equal to a concentration of grub channels in the end. With local-use logs this question is unimportant because there are so few degraders.

For construction logs the implication that one grade defect is of equal weight with another will also probably hold, for the major influence of log grade defects appears to be either to admit or exclude the logs from the class. For example, the effect of an extremely large log knot or of loose heart would be equal in that either would render the log unsuitable for construction use.

In factory logs, however, the situation is less simple. Here the major effect of log grade defects and associated lumber defects is to limit the area of clear-face cuttings. The effect of not observing the cutting limit is to degrade boards which, without the particular blemishes, would be of higher grades. Relation of degraders to log size is important because it is common practice to eliminate or segregate lumber defects in wide boards by ripping. The effect of blemishes can be minimized in this way only if the resulting boards are within the width limit for the grade specified in the rules (see appendix, p. 38).

In principle, a very tiny lumber knot is equal in degrading effect to a large one. Nevertheless, a run of factory logs may yield enough wide boards from which small lumber knots can be eliminated, so that the mere presence of small log knots may not actually mean low-grade boards. Thus, it may be necessary in logs of large diameters to discount log grade defects that indicate very small lumber knots, whereas full weight may have to be given to large log knots on logs of all sizes. Other grade defects in factory logs may have the effect of degrading all of the lumber in the log to a very low point. For example, if bird peck is very heavy, the procedure might be to give it the ultimate significance and consider that, even in the absence of all other log grade defects, it would relegate the log to the lowest factory grade, if not to a lower class. The same would be true for mineral stain.

Thus, evaluation of the degrading effect of log surface abnormalities, that is, whether the effect is partial or full, or whether the abnormalities are considered individually or collectively, must be based in a log grading system that will incorporate not only individual log defects, but also their relation to distribution or size requirements of the product specification and to the other major quality determinants such as size, crookedness, or position of the log in the tree.

General Appearances That Warn of Log Defects

LOG GRADING SYSTEMS

Research-based specifications for factory class logs are contained in the Forest Products Laboratory publication D 1737 titled "Hardwood Log Grades for Standard Lumber." Copies of this and references to other publications dealing with specifications and grading systems for other log classes and for trees can be obtained upon request from any Forest Service forest experiment station.

Sometimes a log or tree can be evaluated by general appearances; certain conspicuous warning signs may herald the presence of specific log grade defects.

SIGNS IN STANDING TIMBER

There is a definite relationship between timber quality and site condition or history of the stand. Poor site, past fire damage, and overmaturity are often clues to the presence of such defects as insect damage, shake, or stain.

General condition and appearance of individual trees in any given locality serve either as specific guides to lumber defects that give no other external indication of their presence (shake or mineral stain, for example) or as a warning to intensify search for important log grade defects (such as bark distortions) which cannot be seen at a glance. To appraise basic differences in appearance of standing timber requires training and familiarity with each species over a wide range of conditions. But keen observation and practice will enable one to determine and recognize the characteristics of sound healthy trees and, by comparison, those of trees likely to be defective.

Obvious clues to decadence are stagheadedness, bad fire scars, and large open wounds. Less conspicuous but of the same nature are dry tops, dead limbs, healed scars, and rotten knot holes, often overgrown except for a gaping oozing center. Such features indicate decadent timber that may carry inconspicuous and unheralded defects like bark pockets, stain, and spot worm holes. When such obvious general features are present, degraders may be expected in great numbers. Evidence of these in the form of small overgrowths, often partially hidden under extended but broken bark scales, will generally be plentiful and easily located upon close examination.

In addition to the obvious features indicating decadence, less obvious general appearances are very important signs of probable log grade defects. Color, thickness, and configuration of bark, particularly if coupled with evidence of lack of vigor (dead limbs, thin top, and poor foliage), are among these (fig. 55).

In general, abnormally dark or abnormally light bark is a bad sign. In hickories, cherrybark

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FIGURE 55.—Good, medium, and poor conditions of three willow oak trees, as indicated by bark characteristics.

oak, and the water oaks, early stages of deterioration are evidenced by a darkening of the bark, usually accompanied by a thickening and roughening. In extremely advanced stages of deterioration the color trend in these species reverses, and the bark bleaches out to a dead, light gray and scales off to some extent.

In species with bark normally soft and corky, such as yellow-poplar and sweetgum, the darkening is accompanied by a "plating" and smoothing out of the bark. On the other hand, defective white oak timber in all stages of deterioration is indicated by a lightening of color and a thinning and scaling off of bark.

In all species bark looks dry and lifeless when vigor is lost. Where such conditions attract attention, close inspection is necessary if important log grade defects are not to be overlooked. The relation of timber condition to appearance is definite and sometimes so extreme and positive that an experienced observer has no difficulty in appraising the degree of deterioration solely on this basis.

Nevertheless, poor general appearance of bark is not an absolute indication of degraders of any specific kind. Yellow-poplar, sweetgum, basswoods, and tupelos are rarely subject to insect attack (yellow-poplar in some localities is liable to severe attack by ambrosia beetles, the damage being referred to at times as spot worm, grease spots, black hole, calico poplar). In these species poor bark appearance generally indicates slow growth, approaching maturity, or if localized, rot. In fact, an area of poor bark in these species is as good a sign of rot as is a butt or stem bulge.

On the other extreme are the oaks and the hickories. Here poor appearance, although a sign of lower vitality, does not reliably indicate specific location or extent of unusable material. It is, however, an almost invariable clue to hidden or obscure bark distortions. Close inspection of the bark of poor trees of these species will often reveal scattered, medium-size, dry holes that penetrate the bark scales but do not lead into the wood. It may also reveal that abnormal roughening is an effect of numerous horizontal breaks or cracks in the bark ridges or scales. In other cases bark cracks and scales containing holes will generally indicate insect-caused log grade defects (fig. 56). In most cases other log grade defects will have been noted before the examination has gone that far.

In other species such as sycamore and the ashes, tupelos, and maples, the significance of bark appearance is quite variable. In all species, however, poor or abnormal appearance should lead to intensive search for degraders.

At least two types of local bark discolorations deserve notice. One is the so-called "tobacco juice" exudation—a small, usually damp dark brown splotch with a drying gray border and found up and down the bole. It is unmistakable

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FIGURE 56.—In the oaks and hickories holes like this one (*left*) call for careful search for the actual degrader. The hole was made by an emerging adult insect, and beneath the scale (*right*) is the overgrown evidence of its presence.

evidence of fresh insect damage and can be disregarded unless the splotches are very numerous, underlain with holes extending into the wood, or accompanied by bark distortions typical of long-established infestations.

The other type of local discoloration is a large patch or streak beginning at a broken top, or an open wound or knot hole in the main stem and running down the stem. When coming from a broken or hollow top of the major stem, the discoloration is usually an overflow of rainwater. When the discoloration begins elsewhere, it is caused by water seeping from a pocket of rot. However, the mere seeping or running usually indicates that decay is not far advanced, or at least that the affected section is not an extensive hollow. Ordinarily the rot will not pass the next lower fork or body node. When the discoloration is found on the merchantable stem, however, it is a log grade defect if not cut out.

SIGNS ON END OF LOG

The lumber defects underlying surface abnormalities sometimes show up in the end of the log. This fact is particularly useful where logging operations have scraped the log so that overgrowths, in particular, are hard to find. If previous inspection has found no surface indication of the associated lumber defects, grub channels and bark pockets in the end of the log call for a recheck of the surface. The ends of very large logs may give positive indication of heavy insect infestation, the external signs of which have been overgrown so long as to be obliterated. In such cases, because the affected area in the quality zone represents such a large source of the potential high-grade lumber, the end features themselves must be evaluated in appraising quality. Otherwise, they merely warn that a recheck should be made.

Indications of Deterioration in Dead Timber or Stored Logs

Since timbermen frequently are concerned with dead trees, or with logs that have been left in the woods or stored for a lengthy period, it is important to discuss briefly the indications of deterioration found in such material, so that they can be distinguished from those found on live trees or freshly cut logs.

Hardwood logs, particularly in the South, are highly susceptible to deterioration from insects and fungi. In summer logs left more than 2 weeks begin to deteriorate so rapidly in some areas that even "hot logging" will not prevent damage to some species. Operations for hickory, ash, and persimmon for dimension specialties are frequently suspended in late spring and early summer because of borer activity. For all other species hot logging is a necessity during this period. In the deep South insects may cause damage the year round.

Among the first to infest logs are the ambrosia beetles. They start working almost at once in exposed sapwood on the ends, or on spots where the bark has been knocked off. Later, they may go through the bark and attack the remaining sapwood and sometimes the heartwood. Their holes are so very small that it is easier to spot a pile of flourlike "frass" than to see the holes themselves. Ambrosia beetles are particularly bad in sweetgum, maples, oaks, and yellow-poplar. Their work degrades the lumber. Like shake, any indication of it ("worms" in the trade) generally renders a shipment suspect in the eyes of the buyer and puts the seller in an awkward position.

Other insects, especially bad in the ashes and hickories, pecan, and persimmon, are the roundheaded borers. The grubs of these insects cause degrade by making medium-sized holes throughout the wood and often require culling the log.

Stain-causing fungi come simultaneously with, and some are introduced by, the ambrosia beetles. The first effect is a rather even, sooty blue-gray or black discoloration of the wood. Later a felty surface may develop. Stain proceeds under the bark from the ends and through wounds. In very early stages it does not degrade lumber, although it affects its salability. In later stages stain definitely degrades lumber unless it is specifically permitted by the grading rules.

After stain come "flowers." These are whitish, yellowish, brownish, or grayish variegated mosaic efflorescences, usually—though not necessarily—superimposed on the stain. They are often evidence of separate fungi which cause rot. Since they are commonly accompanied by light mustard-colored or gray bleached streaks in the wood, flowers are considered in the trade as incipient rot and will not be admitted into cuttings. It is general practice to trim 1 to 2 feet off the ends of boards cut from logs that show flowers and yellow streaks on the end. Although sweetgum and the tupelos are most susceptible to stain and flowers, sapwood of most species will be attacked. The water oaks are also hit hard because of their open pores.

On soft maple and on the hickories, elms, and hackberries a fungus causing an inconspicuous internal rot starts quickly. This fungus gives no surface evidence of its presence until it has caused such advanced interior rot that the log is worthless. At this time the wood is weak, yellowish, exhibits black, threadlike lines, and looks dry and bleached out. The surface of the log may still appear sound and merely weathered. Other fungi betray their presence by fruiting bodies (toadstools and brackets). These generally indicate advanced rot and a large scaling deduction, if indeed the log is usable at all (fig. 57).

The ends of any logs left out in the weather will check or split. Ashes, hickories, pecans, and overcup oak are prone to end-check throughout the year; in other species degree of end-checking

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FIGURE 57.—Brackets are a sign that rot has made at least the sapwood useless. The heartwood may remain sound for a considerable time, but very careful examination is needed to determine the extent of the rot.

varies with the season. In good drying weather end-checking in cottonwood, the pecans, the hickories, and the oaks is particularly bad. Generally, end-checking is progressive, with the speed and severity related to rate of drying.

In most logs of most species end checks are not serious, for they generally go less than 1 foot into the log. On logs of susceptible species they may extend well into the center and cause serious damage. Such extreme checks are equal in effect to splits. The importance of checks is also related to log size. Small logs may be completely ruined by checks which in larger logs would be unimportant.

Appendix

BASIC SPECIFICATIONS FOR STANDARD HARDWOOD LUMBER GRADES

[Adapted from the rule book of the National Hardwood Lumber Assoc., Chicago, January 1962; published by permission of the Association]

Grade	Minimum requirements				
	Length [1]	Width	Yield of rough lumber in clear-face cuttings	Size of cuttings	Cuttings [2]
	Feet	*Inches*	*Percent*		*Number*
Firsts and seconds	8	6	83⅓	4″×5′ or 3″×7′	1–4.
Selects [3]	6	4			
1 Common	4	3	66⅔	4″×2′ or 3″×3′	1–5.
2 Common	4	3	50	3″×2′	1–7.
Sound wormy [4]					
3A Common	4	3	33⅓	3″×2′	No limit.
3B Common	4	3	[5] 25	1½″×(variable length).	To give 36 square inches.

[1] Percentage of short lengths limited by grades; e.g., in firsts and seconds, only 15 percent can be 8 feet to 9 feet; in 2C, 10 percent can be 4 feet to 5 feet.

[2] Number varies with surface measure (s.m.) of piece; e.g., 1C with s.m. of 5 feet to 7 feet, 2 cuttings allowed; in 1C with s.m. of 11 feet to 14 feet, 4 cuttings allowed.

[3] Better face 91⅔ percent clear, 1 cutting; reverse side of cuttings sound for pieces 2 feet and 3 feet (s.m.). Better face is seconds; reverse side of cuttings sound for pieces 4 feet + (s.m.). Better face is seconds; reverse side of board 1C.

[4] Full log yield of 1C and Better, with worm holes, knots, etc., not over ¾ inch and stain, admitted into cuttings.

[5] Sound cuttings.

COMMON AND SCIENTIFIC NAMES[1] OF SPECIES MENTIONED

Lumber or local name	*Recognized common name*	*Scientific name*
Ash	Green ash	*Fraxinus pennsylvanica.*
	White ash	*F. americana.*
Basswood; linden	Basswood	*Tilia* spp.
Beech	American beech	*Fagus grandifolia.*
Birch, yellow	Yellow birch	*Betula alleghaniensis.*
Blackgum	Black tupelo	*Nyssa sylvatica.*
Blackgum, swamp	Swamp tupelo	*N. sylvatica var. biflora.*
Chestnut	Chestnut	*Castanea dentata.*
Cherry	Black cherry	*Prunus serotina.*
Cottonwood	Eastern cottonwood	*Populus deltoides.*
Cottonwood, swamp	Swamp cottonwood	*P. heterophylla.*
Elm, soft	American elm	*Ulmus americana.*
Elm, cedar	Cedar elm	*U. crassifolia.*
Elm, white	American elm	*U. americana.*
Hackberry	Hackberry	*Celtis occidentalis.*
	Sugarberry	*C. laevigata.*
Hickory	Hickory	*Carya* spp.

[1] According to "Check List of Native and Naturalized Trees of the United States (Including Alaska)" U.S. Dept. Agr., Agr. Handbk. 41. 1953.

Lumber or local name	*Recognized common name*	*Scientific name*
Honeylocust	Honeylocust	*Gleditsia triacanthos.*
Magnolia	Magnolia	*Magnolia* spp.
Maple, soft	Red maple	*Acer rubrum.*
	Silver maple	*A. saccharinum.*
Maple, hard	Sugar maple	*A. saccharum.*
Oak, black	Black oak	*Quercus velutina.*
Oak, blackjack	Blackjack	*Q. marilandica.*
Oak, bur	Bur oak	*Q. macrocarpa.*
Oak, cherrybark	Cherrybark oak	*Q. falcata var. pagodaefolia.*
Oak, chestnut	Chestnut oak	*Q. prinus.*
Oak, chinkapin	Chinkapin oak	*Q. muehlenbergii.*
Oak, Delta post	Delta post oak	*Q. stellata var. mississippiensis.*
Oak, laurel	Laurel oak	*Q. laurifolia.*
Oak, northern red	Northern red oak	*Q. rubra.*
Oak, Nuttall	Nuttall oak	*Q. nuttallii.*
Oak, overcup	Overcup oak	*Q. lyrata.*
Oak, pin	Pin oak	*Q. palustris.*
Oak, post	Post oak	*Q. stellata.*
Oak, scarlet	Scarlet oak	*Q. coccinea.*
Oak, shingle	Shingle oak	*Q. imbricaria.*
Oak, Shumard	Shumard oak	*Q. shumardii.*
Oak, southern red	Southern red oak	*Q. falcata.*
Oak, swamp chestnut or cow	Swamp chestnut oak	*Q. michauxii.*
Oak, swamp white	Swamp white oak	*Q. bicolor.*
Oak, water	Water oak	*Q. nigra.*
Oak, white or forked leaf white	White oak	*Q. alba.*
Oak, willow	Willow oak	*Q. phellos.*
Pecan, sweet	Pecan	*Carya illinoensis.*
Pecan, bitter	Water hickory	*C. aquatica.*
Persimmon	Persimmon	*Diospyros L.*
Redgum	Sweetgum	*Liquidambar styraciflua.*
Sapgum	Sweetgum	*L. styraciflua.*
Sycamore	American sycamore	*Platanus occidentalis.*
Tupelo	Water tupelo	*Nyssa aquatica.*
Walnut	Black walnut	*Juglans nigra.*
Willow	Black willow	*Salix nigra.*
Yellow-poplar	Yellow-poplar	*Liriodendron tulipifera.*

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