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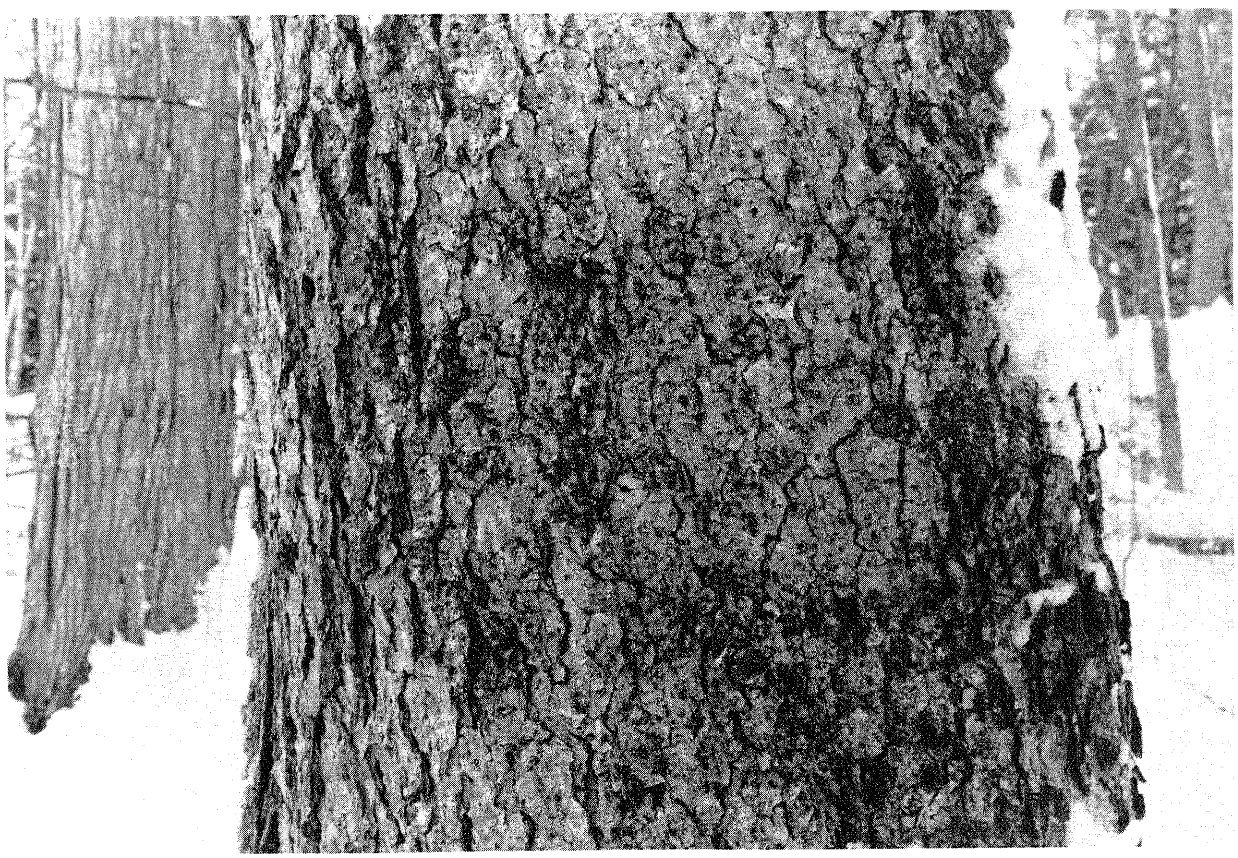

Developed in conjunction with *Stand and site factors associated with birdseye sugar maple*, a cooperative study between the School of Forestry and Wood Products, Michigan Technological University, and the USDA, Forest Service, North Central Forest Experiment Station.

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Birdseye grain distortions in sugar maple must be identified to capture the full value of a timber sale throughout the economic range of birdseye's occurrence. Even when relatively common, birdseye veneer typically makes up less than 1 percent of the harvested volume, but may account for one-half of the value of the sale[1]. With prices[2] recently reaching $50,000 per Mbf for prime logs[3], omission of birdseye (when present) from cruise data could cause significant economic loss for the forest landowner. But figured wood can sometimes be detected in standing timber (Pillow 1955). Field identification of birdseye sugar maple is critical for two principal reasons: (1) it allows for the enumeration of a valuable resource that may influence management decisions, and (2) it may prevent improper manufacturing of logs at the job site. Both factors should help increase overall timber sale return. The objective of this paper is to provide a background on birdseye sugar maple and a detailed sequential methodology for field identification of birdseye in standing trees.

BACKGROUND

Little is known about birdseye, from its geographical range to regenerative capabilities to causative factors, although various hypotheses have been proposed since at least the turn of the century. Some authors (e.g., Wangaard 1950) believed that birdseye resulted from birdpeck, but other researchers have discounted this theory (Anonymous 1929, 1987; Pillow 1930; Record 1921). Others have attempted to link it to the production of adventitious buds or adventitious root primordia (Betts 1944, Borthwick 1905, Edlin 1969, Fink 1982, Strasburger *et al.* 1898, Werthner 1935), but these references appear to misinterpret the phenomena (Beals and Davis 1977, Davis 1961[4], Pillow 1930, Stokke 1992[5]). Many texts have suggested that birdseye formation may be attributed to localized deactivation of the cambium due to fungi (Hale 1932, 1951; Harris 1989; Jane 1970; Record 1934), yet this has apparently never been substantiated. Shigo (1986) noted a similar condition in grafted fruit trees called stem pitting that is associated with viruses. Holmberg (1933) believed birdseye formation was a result of suppression early in the tree's existence. His examination of logs at a veneer mill found that trees with birdseye grew slower in the first century of life than non-birdseye specimens. Righter (1934), unconvinced that suppression had resulted in the diameter discrepancy that Holmberg (1933) found, felt that genetics or environmental factors could just as likely have caused the diameter differences. Mroz *et al.* (1990) did not detect the slower growth rate that Holmberg (1933) noted, but did find that birdseye maple trees tend to grow in stands that have higher basal area in the immediate vicinity of the birdseye trees. Mroz *et al.* (1990) also found statistically significant differences ($p < 0.10$) in the

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[1]*Reed, D.D. 1992. Personal communication with D. Bragg.*

[2]*Prices on birdseye veneer logs typically range from $10,000 to $20,000 per Mbf. Price quoted here represents an exceptional quality and size log.*

[3]*Dougovito, J. 1993. Personal communication with D. Bragg, March 24.*

[4]*Davis, E.M. 1961. Some observations on bird's-eye maple. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. Unpublished manuscript on file with: Forest Products Laboratory Library, One Gifford Pinchot Drive, Madison, WI 53705-2398.*

[5]*Stokke, D.D. 1992. Birdseye figure in sugar maple. Carbondale, IL: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. Unpublished manuscript on file with: Forestry Sciences Laboratory, Southern Illinois University at Carbondale, North Central Forest Experiment Station, Carbondale, IL 62901-4630.*

percentages of sand (p = 0.073), silt (p = 0.055), and organic matter (p = 0.054) between paired birdseye and non-birdseye maples, but did not find differences in levels of soil nitrogen, phosphorus, calcium, magnesium, or potassium. Boyce (1961) noted that a similar grain abnormality of birch in northern Europe was believed to originate from climate or soil conditions. These settings resulted in "...an internal gummosis...in which the cell walls or contents are not dissolved."

Birdseye has been described in a number of species, including other maples (*Acer campestre* (Boulger 1902), *A. rubrum* (Brown *et al.* 1949, Panshin and deZeeuw 1980, Pillow 1930), *A. mandschuricum*, *A. platanoides*, and *A. pseudoplatanus* (Korovin and Zuikhina 1985)), yellow birch (*Betula alleghaniensis* [*Betula lutea*]), white ash (*Fraxinus americana* L.) (Brown *et al.* 1949, Panshin and deZeeuw 1980, Pillow 1930), *Betula pubescens*, *B. kylowii* (Harris 1989), black walnut (*Juglans nigra* L.) and Cuban mahogany (*Sweitenia mahogani*) (Beals and Davis 1977), and probably in American beech (*Fagus grandifolia*) (Shigo 1986), and Karelian birch (*Betula pendula* var. *carelica*) (Korovin and Zuikhina 1985). The occurrence of birdseye in these species, while not as common or valuable as in sugar maple, may indicate that a particular sugar maple birdseye subspecies does not exist, even though certain trees may be genetically more susceptible to the formation of birdseye. Birdseye would then seem an acquired feature attributable to environmental or pathological conditions.

ANATOMY OF BIRDSEYE

Birdseye figure is due to a pattern of indentations in the growth rings. If the wood is split tangentially (i.e., the plane of the split is essentially parallel to the growth rings), conical projections or elevations are revealed, with corresponding indentations on the matching piece (figs. 1a-1b). These projections and indentations extend inward toward the pith, generally beginning in the bark and extending through the wood for an indeterminate number of growth rings. Birdseye is classified by Beals and Davis (1977) as a "figure related to indented growth rings," and indeed, close examination of the cross-sectional surface of birdseye reveals that the growth rings do appear to be indented (fig. 2). It is as though a blunt conical instrument were used to cause a localized indentation in the bark, cambium, and wood. These areas contain the same types of cells as found in the surrounding "normal" wood, but the longitudinal cells are not vertically oriented as their counterparts in the normal tissue (fig. 3). Because these projections and indentations generally

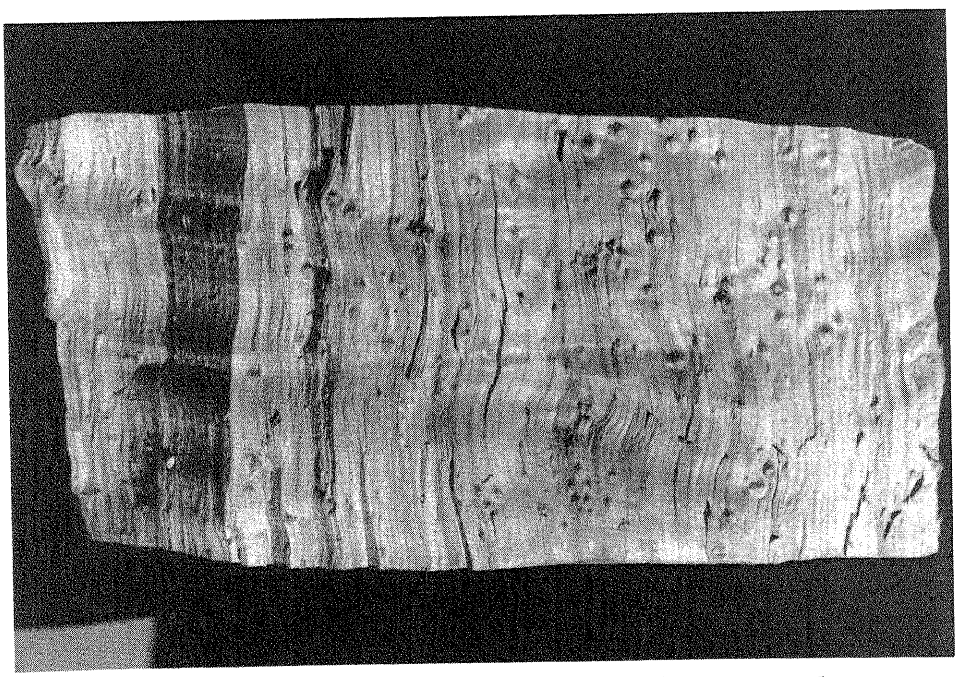

Figure 1a.—*Split piece of sugar maple showing birdseyes as indentations (tangential view).*

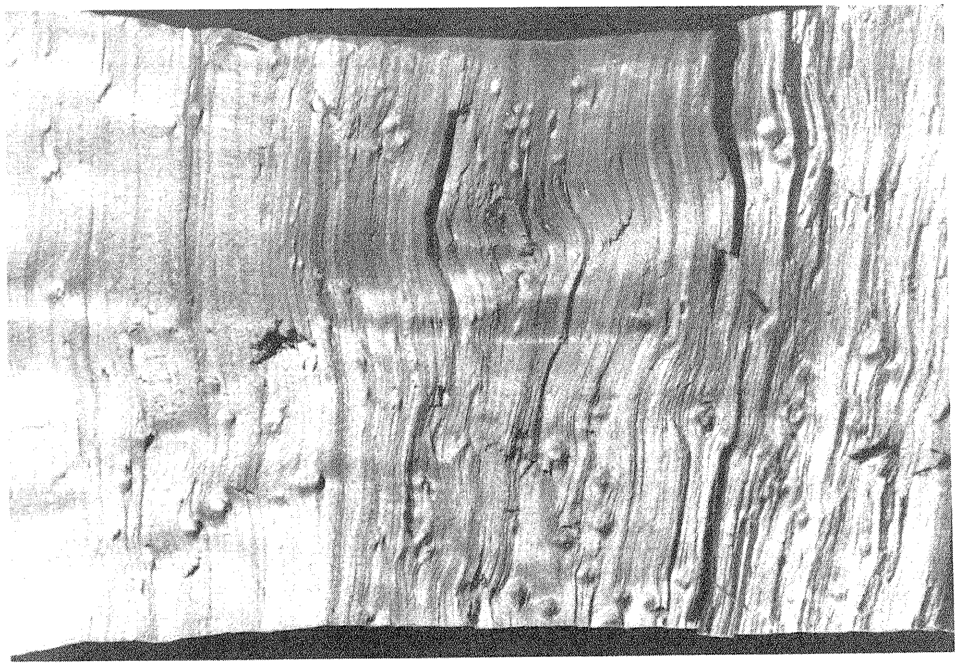

Figure 1b.—*Split piece of sugar maple showing birdseyes as conical elevations. This piece matches the one in figure 1a.*

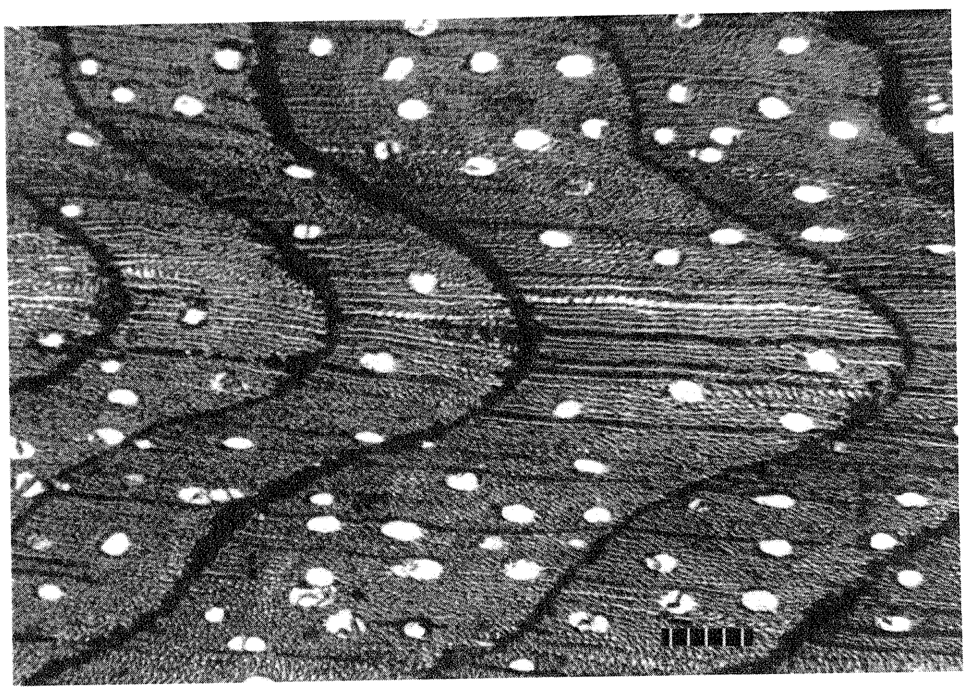

Figure 2.—*Cross-sectional micrograph of birdseye figure. Scale bar = 0.01 in. (0.25 mm).*

extend into the bark, trees can be examined for the presence or absence of birdseye with little physical damage.

A variation of birdseye called "fingernail" or "thumbnail" is also found in sugar maple. Fingernail birdseye appears as long grooves in the bark and xylem of sugar maple (fig. 4), which look like a fingernail has been dragged across the surface of a piece of wood. It is unknown how similar this type of birdseye is to "normal" birdseye, but this variation apparently does not add ornamental value.

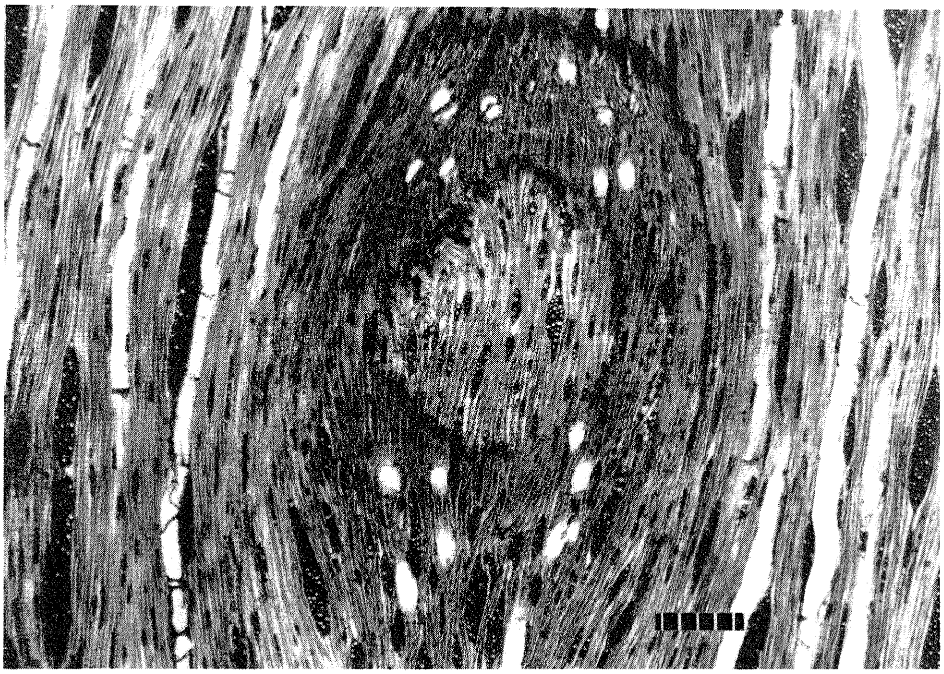

Figure 3.—*Tangential section of a birdseye figure. Scale bar = 0.01 in. (0.25 mm).*

Figure 4.—*"Fingernail" or "thumbnail" birdseye in sugar maple, with a few "normal" birdseyes scattered among the fingernails.*

Table 1.—*Summary of stages and steps for determining birdseye sugar maple*

Stage 1: External examination.

Step 1: Surface observation of lower bole form and bark surface. Presence of a "Coke-bottle" base to the maple or birdseye configurations expressed on the surface of the bark may indicate the presence of birdseye in the wood.

Stage 2: Exocambial examination.

Step 2: Removal of loose fragments of outer bark to possibly reveal birdseyes underneath or the resulting conical elevations on the interior of the bark flake.

Step 3: Extraction of outer bark (rhytidome) to display the phloem tissues that may exhibit birdseyes not yet expressed in the rhytidome. This step may be accomplished by examining the phloem *in situ* or, more efficiently, by removing a sample to also examine the interior face of the tissue.

Stage 3: Xylemic examination.

NOTE: Although steps 4 and 5 are the most thorough means by which to identify birdseye, they are also the most damaging to bole quality. **Use them cautiously**.

Step 4: Removal of all bark and vascular cambium tissues (a palm-sized section), exposing the surface of the xylem.

Step 5: Removal of layers of wood to ensure that birdseyes are not present beneath layers of "normal" xylem.

IDENTIFICATION PROCEDURES

We suggest three basic stages (see table 1 for a summary) for determining birdseye sugar maple: the external, exocambial, and xylemic investigations. These stages represent different degrees of examination of an individual tree for the presence (or absence) of birdseye. The procedures were developed and found to be reliable as a means of birdseye identification in standing sugar maple during research into stand and site factors that may influence birdseye production, and are similar to methods used in many millyards to identify birdseye in logs.

The stages can be further subdivided into five distinct steps, depending on the depth of the research. Any one stage or step by itself is not necessarily sufficient to identify a tree containing birdseye—all should be performed to achieve a reasonable level of certainty. *The inconsistent nature of birdseye's occurrence within a tree makes it difficult to unconditionally guarantee the quality or distibution of figured wood in the stem.* Birdseye often occurs at inconsistent distributions within trees and at varying degrees at different locations within individual trees (Brown *et al.* 1949, Panshin and deZeeuw 1980), making identification difficult at times. For example, birdseye figure may be present on one side of a log but not the other, may be found in the butt log but not the second log, or vice versa, or may be present internally in the tree but not evident on the surface. Another point to consider is that while a tree may exhibit birdseye, the expression may not be extensive (or intensive) enough to add ornamental value, or tree quality may be too low to provide the desired product. In these cases, birdseye may provide little to no additional value, or could actually represent a degrade in log value.

Stage 1: External examination

Stage 1 is a preliminary examination of the bark's surface and general tree form for useful indications of birdseye. External examination begins by observing the sugar maple's stem from a distance of a few feet, allowing the viewer to determine the presence (or absence) of the "Coke-bottle" lower bole form noted by many field foresters and Mroz *et al.* (1990) as a possible birdseye indicator (figs. 5a-5b). However, not all birdseye maples exhibit this bole form, and some diseases of sugar maple may cause a bole form that imitates this "Coke-bottle" appearance. One may, in certain cases, notice birdseyes at this distance, especially if the lighting is appropriate (fig. 6). Birdseye maples that can be identified at short distances typically reflect a substantial birdseye presence in the wood, but these trees are relatively rare. The bark must usually be viewed at close range for birdseye identification. In most cases, at least some of the birdseyes have been expressed through the bark and are visible on the surface (figs. 7a-7b). Note that the number of birdseyes on the bark's surface does not necessarily reflect the frequency present in the xylem, and that the presence (or absence) of birdseyes in any section of the bark is not a guarantee of what exists on the surface of the wood (fig. 8).

Stage 2: Exocambial examination

Stage 2 requires the removal of outer bark tissues (rhytidome) to further establish the presence of birdseye. The first step involves the extraction of loose fragments of outer bark, which may be removed by hand but sometimes need to be loosened by force (fig. 9). The exterior and interior of the removed fragments should then be examined for signs of birdseye, expressed externally by indentations (fig. 7a) and internally by protuberances (fig. 7b). This step may not prove sufficient, however, if the birdseyes have just begun to form and do not reveal any expression through the phloem tissues (fig. 10). Further sampling of phloem tissues to the cambium is then done to determine if birdseyes are present at the cambial level. Birdseyes at this level will also appear as conical elevations on the internal face of the phloem (fig. 7c) and typically have a brownish color, contrasting with the lightly colored fresh inner bark (fig. 11). Disruption of phloem tissues, however, provides an avenue for infection to the tree, so care must be taken (see cautionary section in stage 3).

Stage 3: Xylemic examination

Stage 3 provides the most conclusive evidence of the presence or absence of birdseye, but it does damage the tree and should be implemented cautiously. **This stage should only be used on standing timber immediately before harvest or on harvested trees because exposure of the phloem and xylem tissues to pathogens can result in substantial decay and lost log value.**

In this stage, it is necessary to remove all bark and cambial tissues to view the surface of the wood. Birdseyes will appear as indentations in the wood from a tangential viewpoint (figs. 12b-12c), and as faint traces in the radial and cross-sectional views (figs. 13a-13b). Birdseye size may range (figs. 12a, 12b, and 12c) from small dimples in young (Pillow 1955) and newly initiating trees, to indentations a half inch or more in diameter in advanced cases.

No guarantee can be made that exposing the xylem will reveal birdseyes because normal tissue growth will at times obscure previously figured wood, and layers of wood may have to be removed before figure is found. Pillow (1930) noted that veneer manufacturers occasionally find birdseyes only after removing several inches of the outer layers of a log. Bark samples, however, may sometimes indicate the presence of birdseye when no evidence can be found on the surface of the wood. This would appear to reflect the discontinuance of birdseye production, with normal tissue being layered over figured wood. The birdseyes still present in the bark are artifacts that have yet to slough off the tree.

CONCLUSIONS AND RECOMMENDATIONS

Further research is needed to determine the cause of birdseye in sugar maple and to ensure that this resource is properly maintained. Attempts to grow birdseye maple from seedlings (Anonymous 1929) or to vegetatively propagate using root cuttings (Bailey 1948) have been unsuccessful to date, suggesting the need to investigate the cause of birdseye as a function of manageable stand or site characteristics rather than an inheritable phenomenon.

Field identification of birdseye in sugar maple should be a component of timber cruising in regions where birdseye is historically significant. Substantial timber revenues may be lost if birdseye is not identified, especially when wood's-run birdseye may bring more than 40 times the value of comparably graded non-birdseye timber (Mroz *et al.* 1990). This field identification guide has been developed to give foresters the means to identify birdseye maple in standing timber, maximizing the potential of their sugar maple resource.

Figure 5a.—*Normal bole form of sugar maple.*

Figure 5b.—*"Coke-bottle" bole form of birdseye sugar maple.*

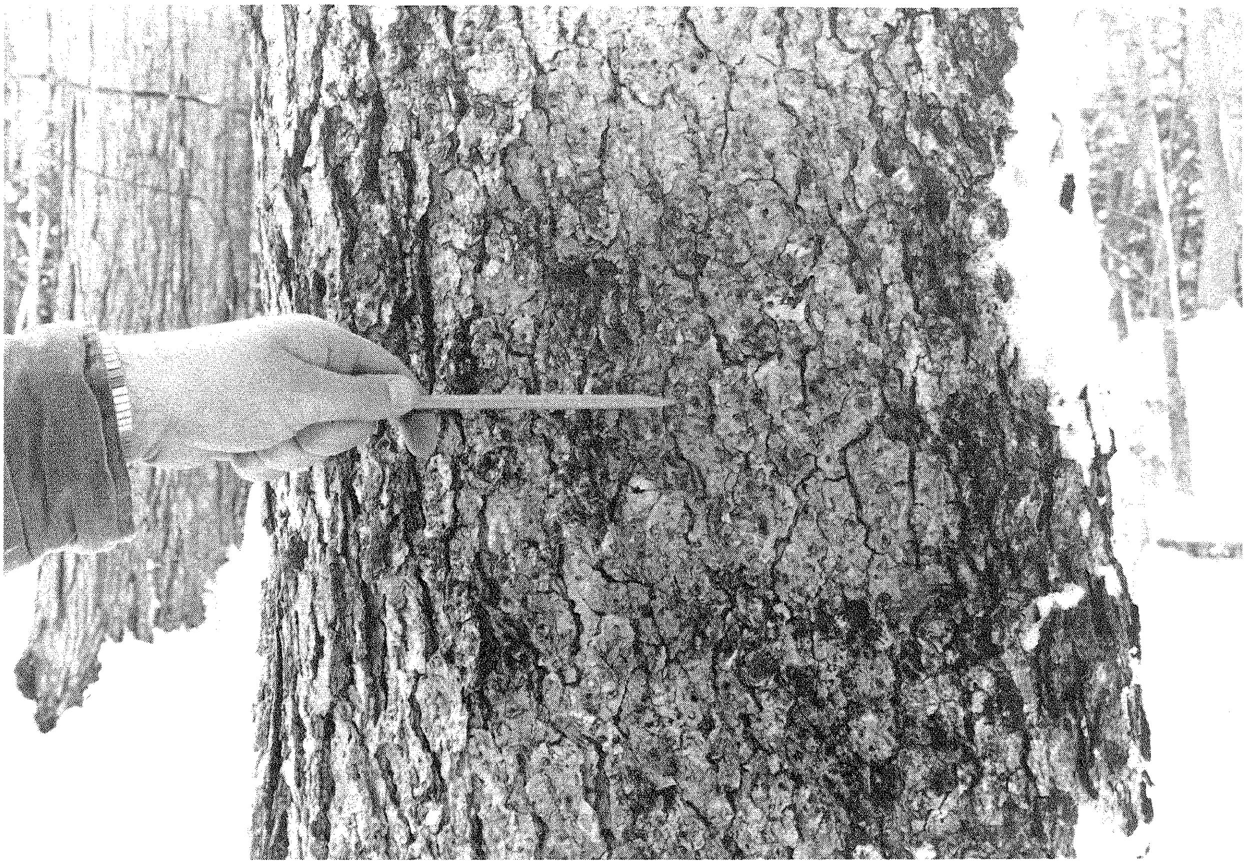

Figure 6.—*Extensive birdseye in a sugar maple's bark. Birdseyes show as dark-colored dots in this picture, taken about 6 feet from the tree.*

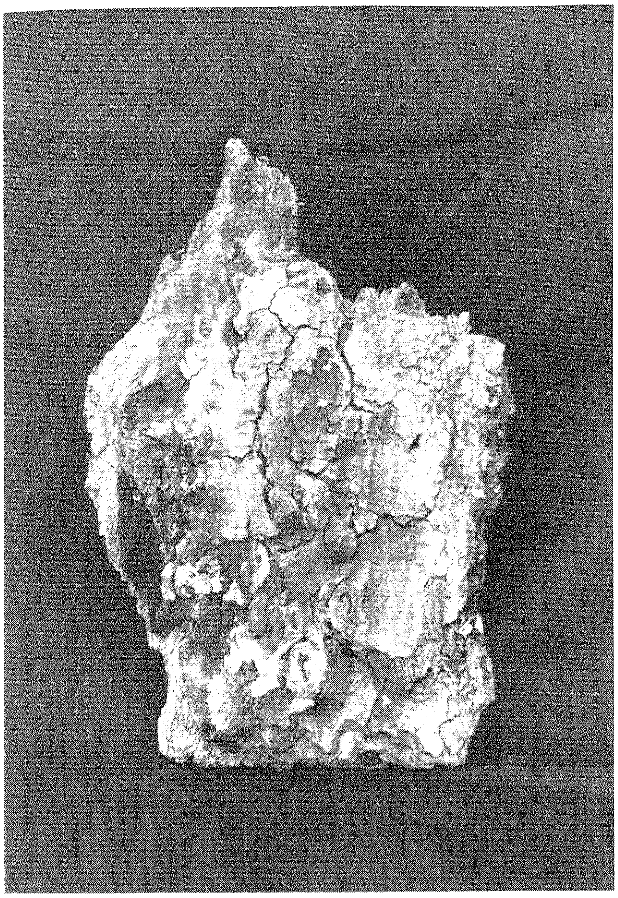

Figure 7a.—*Close-up of birdseyes extending through bark: indentations on outer surface.*

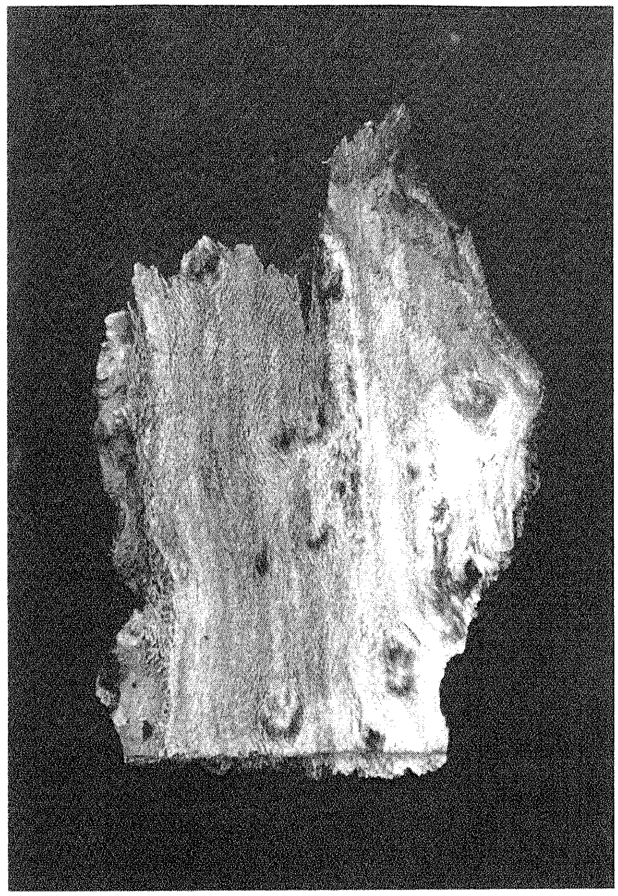

Figure 7b.—*Conical elevations on inside of bark face. Figures 7a and 7b are taken from the same bark sample.*

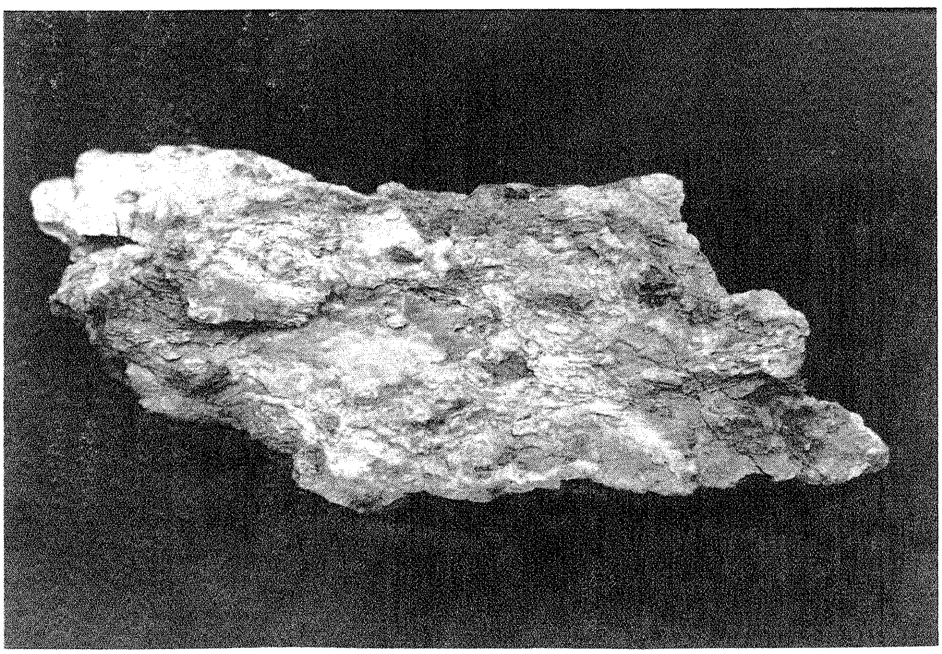

Figure 7c.—*Sample of outer bark piece with conical elevations.*

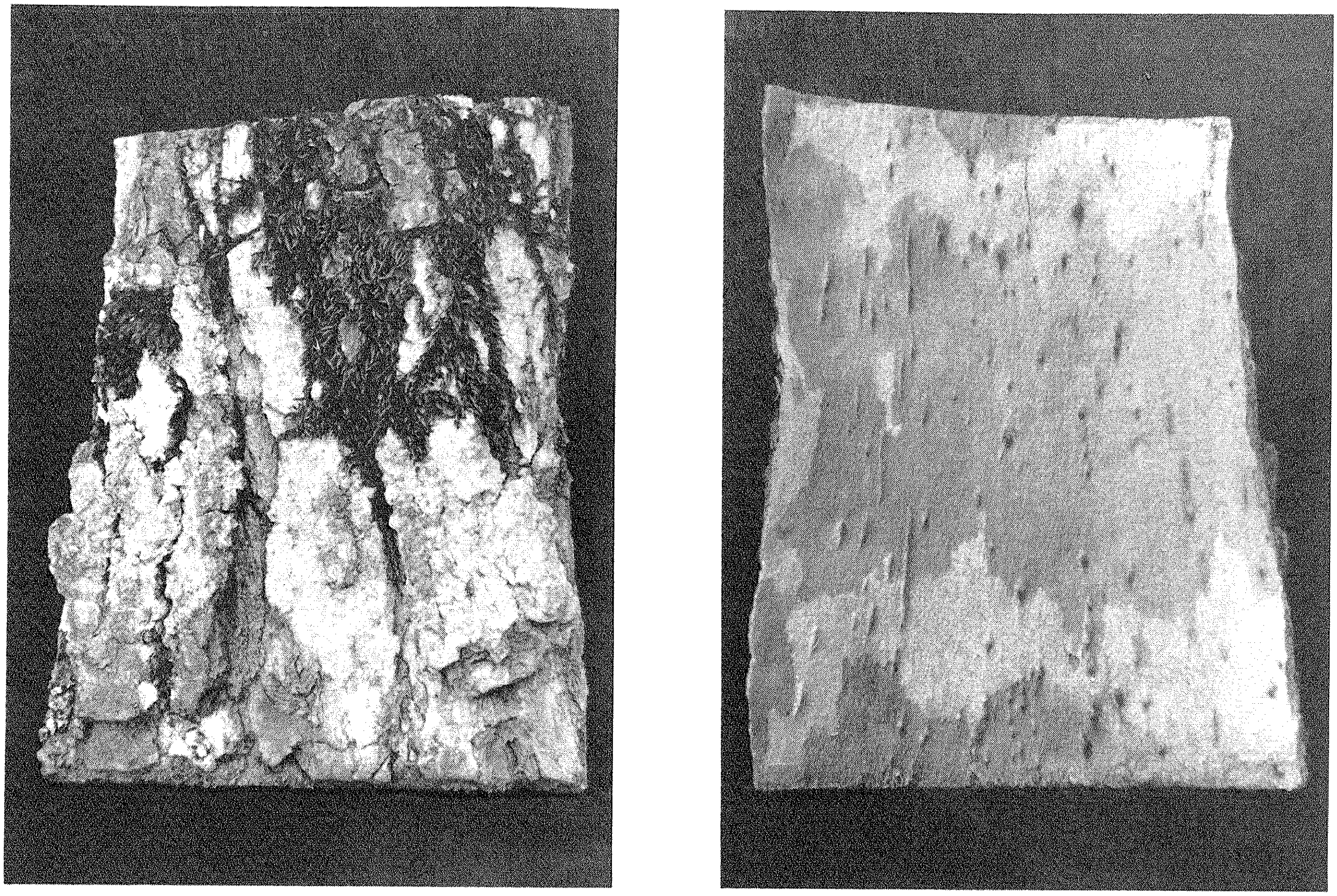

Figure 8.—*In some instances, the outer surface (left) of the bark may not show any sign of birdseye when the inner surface (right) has a considerable amount.*

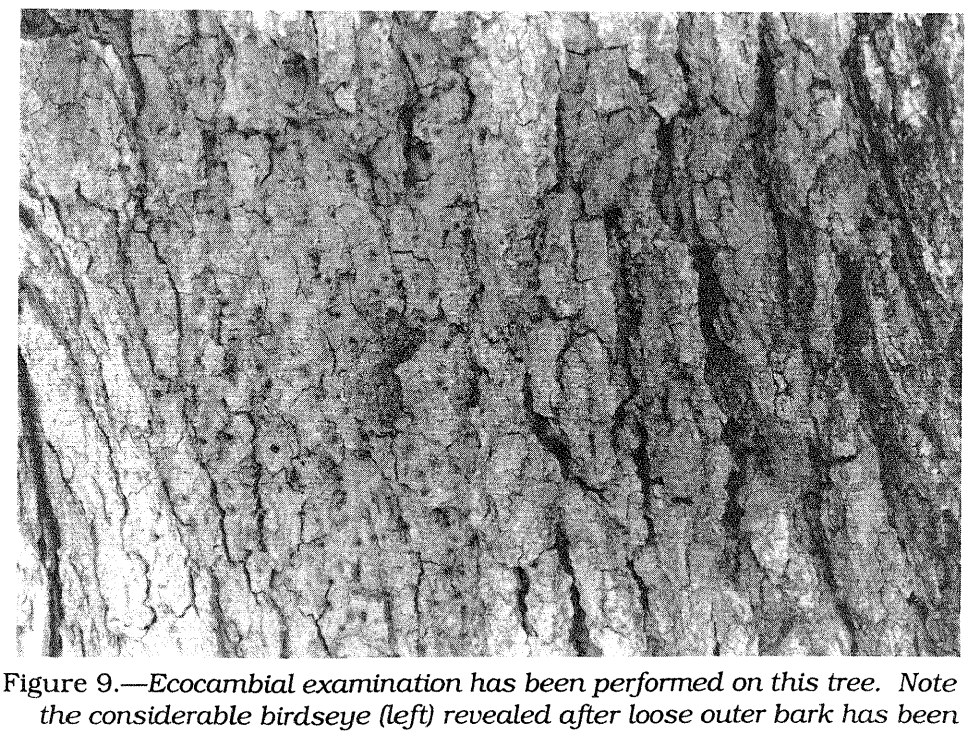

Figure 9.—*Ecocambial examination has been performed on this tree. Note the considerable birdseye (left) revealed after loose outer bark has been removed.*

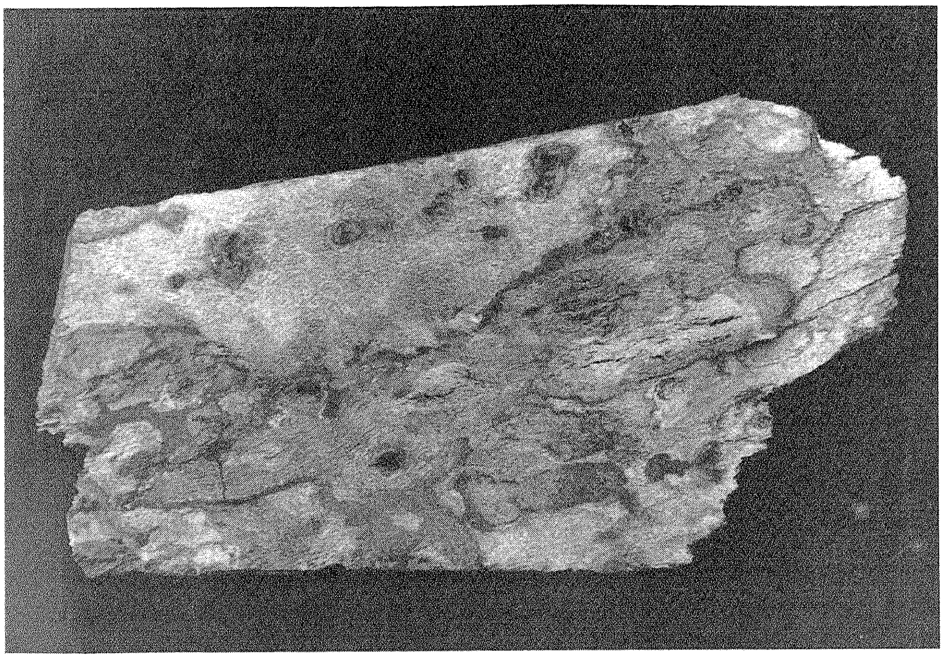

Figure 10.—*Outer view of phloem tissues displaying circular birdseye traces through them. Newly formed birdseye may not show any of these traces on this face, yet have them on inner surfaces.*

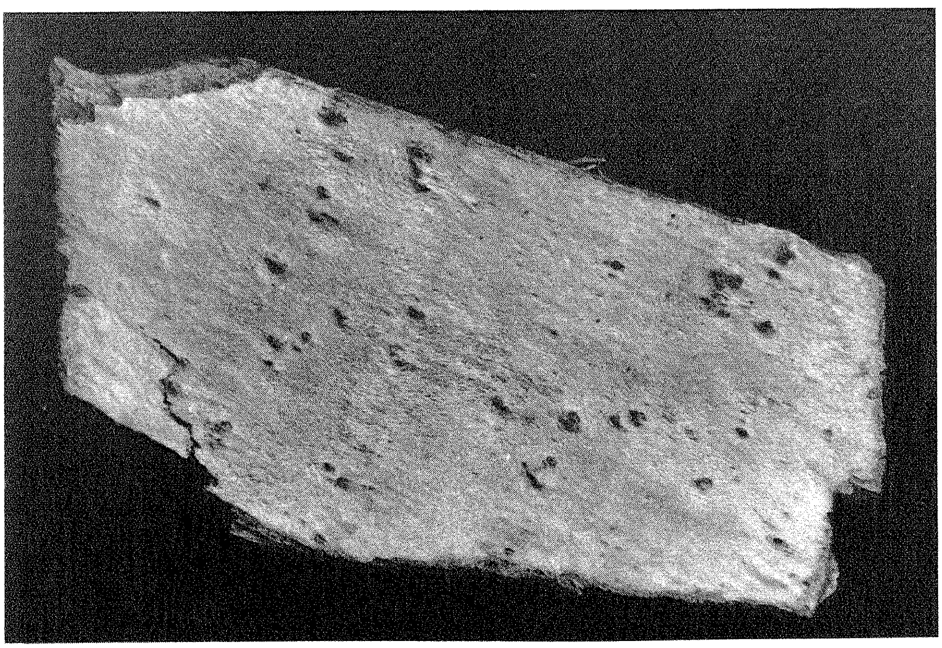

Figure 11.—*Freshly removed section of phloem. The dark conical elevations on the surface of this sample are a dark brown, sharply contrasting with the white of the phloem. Chemicals in the phloem will soon oxidize to a brown, too, eliminating the sharp contrast.*

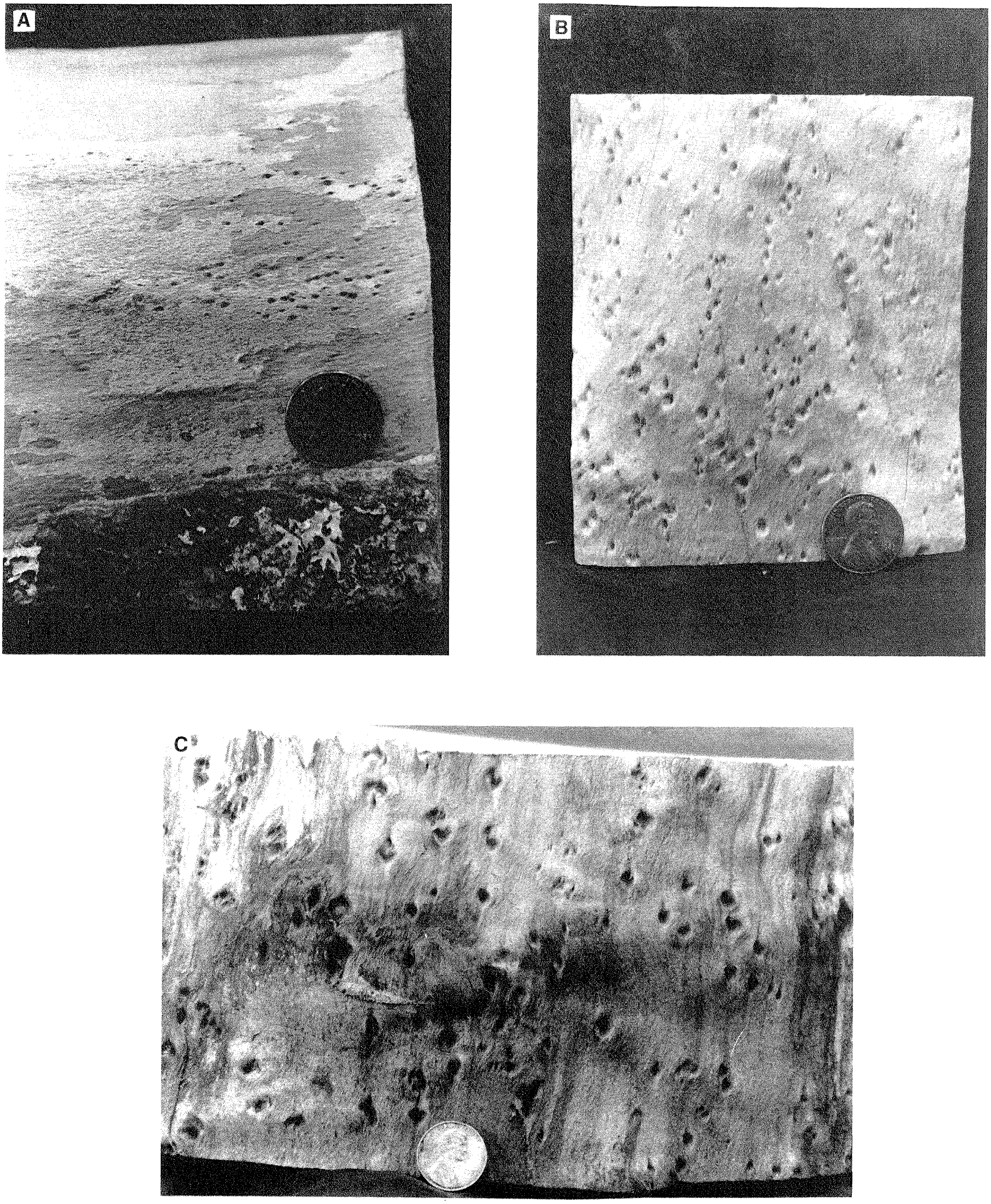

Figure 12.—*Appearance of birdseye on the outer surface of the xylem. Relatively small (a), medium (b), and large (c) birdseyes (note penny for scale).*

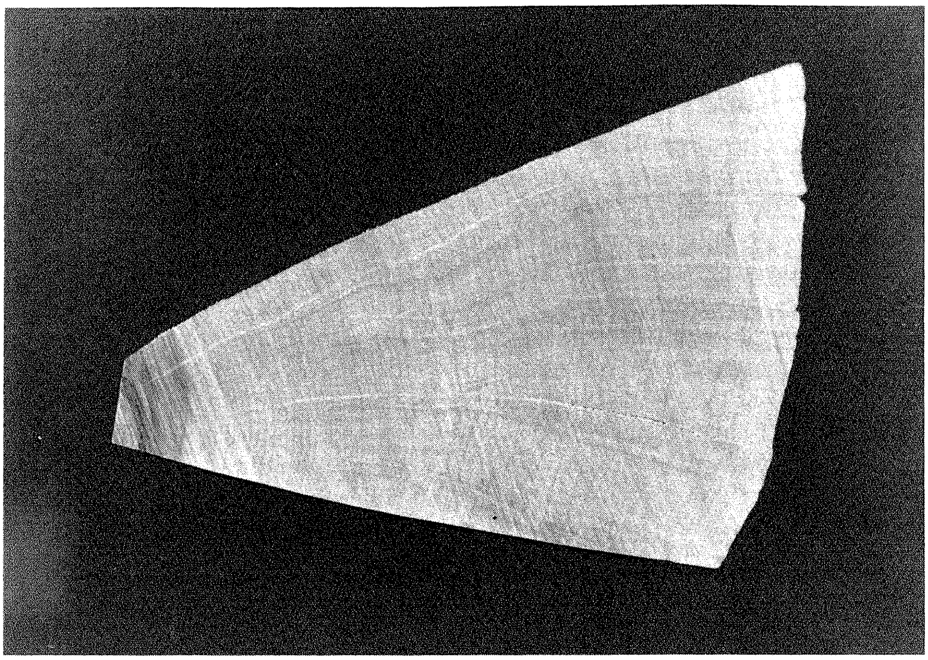

Figure 13a.—*Cross-sectional view of birdseyes. Note the conical depressions present on the outer surface of the xylem. Birdseye traces in this picture appear to randomly begin early in the tree's life.*

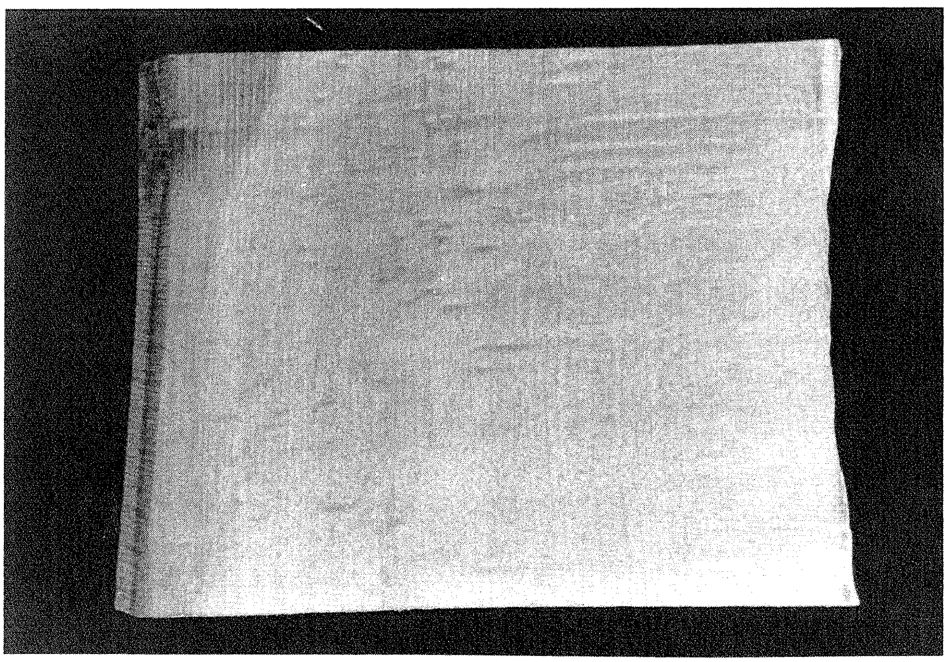

Figure 13b.—*Birdseye traces in a radial view of a piece of wood. The variation in size across the piece is due to the angle of the cut, not to actual birdseye length.*

Localities in which birdseye maple is relatively common should modify cruising practices to account for the value differences presented by birdseye veneer. Foremost, these adjusted cruising methods should include identification of birdseye in standing sugar maples. The forest manager should also realize that increased monetary return is not guaranteed by locating the trees with birdseye—the bole quality and size of the tree must be sufficient (grade 1 saw logs or veneer, usually) to provide high value logs. In lower quality logs, birdseye can actually be a defect in the wood and downgrade its value. Logging crews should also take care to separate birdseye logs from non-birdseye material to avoid decreasing birdseye's value through improper bucking of the logs. Suspect logs can be inspected by using the methods previously described and by searching for the faint birdseye traces that may be seen in the cut face of the log (fig. 14).

Pickens *et al.* (1992) demonstrated that improved bucking practices can achieve 39 to 55 percent gains in northern hardwood log gross value, which can substantially increase financial return when applied to valuable birdseye maple logs. Harvest methods should also be modified to protect the residual stand from logging damage. For example, a simple method to minimize logging damage is to switch from stringer-length skidding to forwarding of timber.

Consumer demand has significantly increased the value of birdseye over the past century. There is no guarantee that prices will keep rising (or even remain stable), making it necessary to maximize the current value of the timber. Birdseye maple has provided an economic boom to the northern hardwood timber industry, especially in the Upper Peninsula of Michigan, yet many forest resource managers remain unaware of the potential value of this unique figured wood. Identification is relatively quick and easy; and where birdseye is somewhat common and quality logs are found, it is also very cost effective.

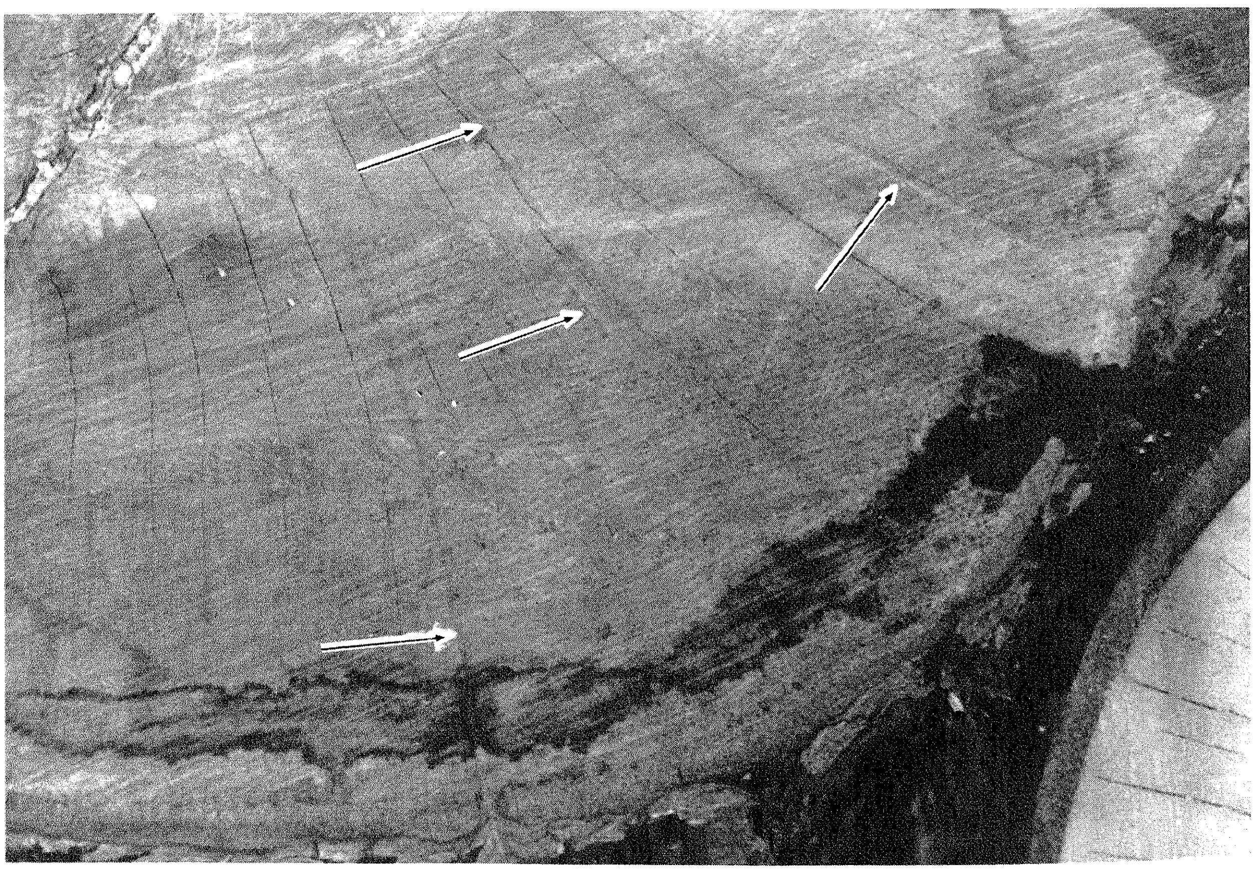

Figure 14.—*Cross-section of a cut face in a log, with arrows pointing at birdseye traces.*

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Gives procedures for the field identification of birdseye in standing sugar maple (*Acer saccharum* Marsh.) trees.

KEY WORDS: Birdseye sugar maple, figured wood, identification of figured wood, sugar maple, sugar maple management.

Our job at the North Central Forest Experiment Station is discovering and creating new knowledge and technology in the field of natural resources and conveying this information to the people who can use it. As a new generation of forests emerges in our region, managers are confronted with two unique challenges: (1) Dealing with the great diversity in composition, quality, and ownership of the forests, and (2) Reconciling the conflicting demands of the people who use them. Helping the forest manager meet these challenges while protecting the environment is what research at North Central is all about.

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