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Damage From Increment Borings in Bottomland Hardwoods

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THIS PAPER REPORTS a study of the amount of stain and decay that developed from increment-borer holes in five species of bottomland hardwoods. Though the 0.2-inch holes made by conventional borers are often considered insignificant, it appears that they may result in serious defect.

Methods

In September 1956 and again in March 1957 four borings 3 to 6 inches deep were made in each of 10 trees of Nuttall oak (*Quercus nuttallii* Palmer), green ash (*Fraxinus pennsylvanica* Marsh.), sugarberry (*Celtis laevigata* Willd.), sweetgum (*Liquidambar styraciflua* L.), and eastern cottonwood (*Populus deltoides* Bartr.). The trees, on the Delta Experimental Forest near Stoneville, Mississippi, were 10 to 14 inches in d.b.h. Usual increment-borer practice was followed. The holes were not slanted, nor were disinfectants used. Plugging was not tested, as studies elsewhere [1, 2] have indicated that it is ineffectual. The autumn holes were all installed 20 degrees to one side of the cardinal directions, that is, at azimuths of 20, 110, 200, and 290 degrees, and about 3½ feet above ground. The spring holes were at azimuths of 340, 70, 160, and 250 degrees, and about 5 feet above ground. Healing and surface defect were measured at 6-month intervals.

In September 1958, two growing seasons after installation, the trees were felled and dissected, and discoloration and visible decay measured. Cultures were made from representative samples.

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[1]Hepting, G. H., E. R. Roth, and B. Sleeth. Discolorations and decay from increment borings. Jour. Forestry 47: 366-370. Illus. 1949.

[2]Lorenz, R. C. Discolorations and decay resulting from increment borings in hardwoods. Jour. Forestry 42:37-43. Illus. 1944.

Results

After two growing seasons the great majority of wounds in all species except sugarberry were callused over (Table 1). Cambial dieback around the holes accounted for the slower rate of healing with sugarberry. In Nuttall oak and sweetgum, holes made in spring healed faster than those made in the fall. In general, the rates of healing were much faster than those reported by Hepting et al.[3] in the southern Appalachians.

When the trees were sectioned, nearly all of the holes were found to have discolorations or stains around them (Table 2). The horizontal spread of discoloration was only slightly wider than the diameter of the holes (Fig. 1*D*). The vertical range was considerably greater, and extended about the same distance above the holes as below. The stains varied from black to light gray and brown.

The data on extent of stain were subjected to analysis of variance, which showed highly significant differences among tree species, and between seasons. In addition, the interaction between species and season was highly significant.

For autumn and spring holes combined, sugarberry had a mean vertical stain extent of 9.8 inches with a maximum of 56 inches;

[3]Op. cit.

TABLE 1.—CLOSURE OF INCREMENT BORER HOLES[1]

Species	Holes made in fall		Holes made in spring	
	Healed after 1 growing season	Healed after 2 growing seasons	Healed after 1 growing season	Healed after 2 growing seasons
	Percent			
Eastern cottonwood	98	100	100	100
Green ash	100	100	100	100
Nuttall oak	81	97	98	100
Sweetgum	75	98	100	100
Sugarberry	20	78	18	75

[1]Each percentage based on 40 holes, except that Nuttall oak bored in fall was represented by 36 holes.

TABLE 2.—DISCOLORATIONS TWO GROWING SEASONS AFTER INCREMENT BORING

Species	Holes made in fall		Holes made in spring	
	Holes with stain	Mean vertical extent[1]	Holes with stain	Mean vertical extent[1]
	Percent	*Inches*	*Percent*	*Inches*
Eastern cottonwood	92	8.2	73	7.6
Green ash	100	3.2	100	3.0
Nuttall oak	100	9.1	100	11.0
Sweetgum	100	10.7	100	9.5
Sugarberry	100	13.1	100	6.4

[1]Holes with no stain were excluded from the computations.

Nuttall oak a mean of 10.1 inches and a maximum of 40 inches; sweetgum a mean of 10.1 inches and a maximum of 28 inches; eastern cottonwood a mean of 7.9 inches with a maximum of 20 inches; and green ash a mean of 3.1 inches and a maximum of 12 inches. A "t" test showed no significant differences between sugarberry, sweetgum, and Nuttall oak; but these species had significantly more stain than cottonwood and green ash; and ash had significantly less stain than all other species.

In sugarberry, but not in other species, holes made in the fall had significantly more stain than those made in the spring (significance at the 1-percent level by "t" test).

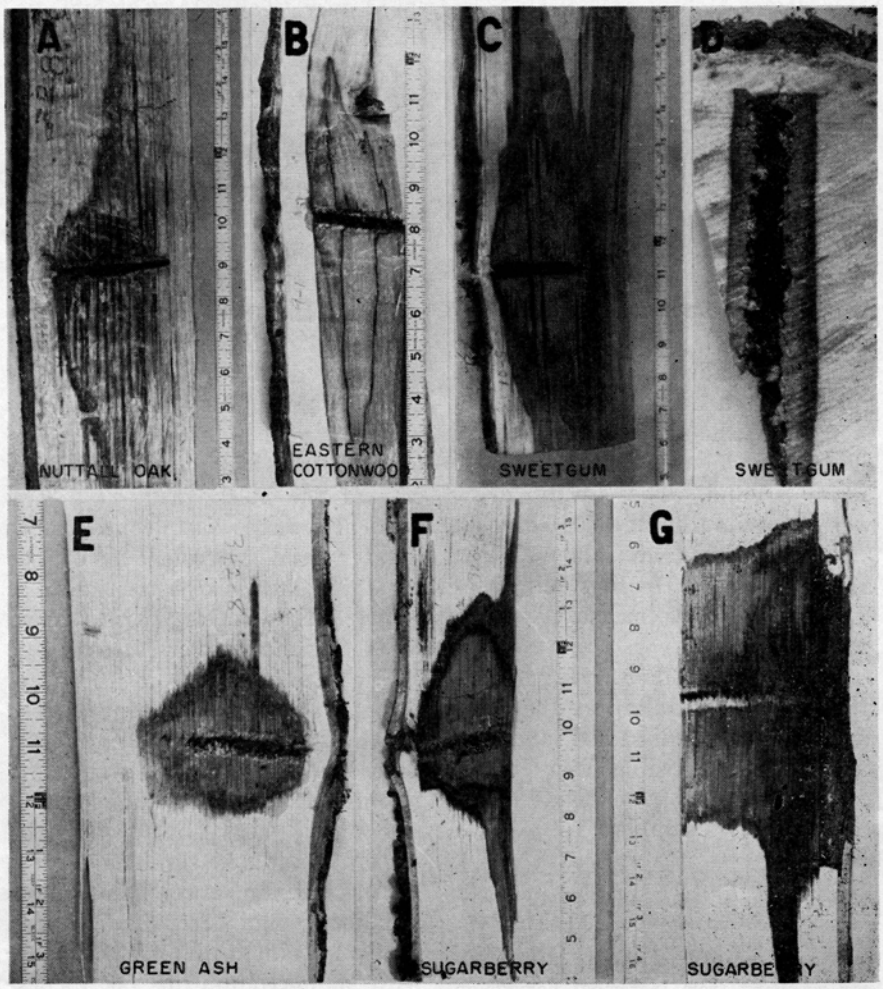

FIG. 1.—Sections through increment-borer holes after two growing seasons. All except D are longitudinal sections.

Cultures were attempted from some of the stained wood. Many samples yielded no organism, but *Phialophora* spp., *Fusarium* spp., *Penicillium* spp., *Curvularia* spp., *Nigrospora* spp., and *Diplodia*-like cultures were isolated. Identifications were made by Ross W. Davidson of the U. S. Forest Disease Laboratory at Beltsville, Maryland. The variety of organisms isolated indicates that no one fungus or small group of fungi is specifically adapted to invasion through increment-borer holes. Although these fungi have been found associated with stain in lumber, they are not the commonest lumber stainers.

The mean and maximum vertical extents of rot in the infected trees varied with species (Table 3). For autumn and spring borings together, means and maxima were 6.4 and 10 inches for cottonwood; 4.7 inches and 8 inches for sugarberry; 2.5 and 6 inches for sweetgum; 1.7 and 3.5 inches for Nuttall oak. In ash, only one hole showed rot. An analysis of variance of the amount of rot showed highly significant differences among tree species. The species-season interaction was significant.

When sound as well as rotten holes were considered, a "t" test found that sweetgum had significantly more rot than all other species; sugarberry had significantly less than sweetgum and more than the others; cottonwood significantly less than sweetgum and more than ash and Nuttall oak. The last two species were not significantly different.

Five rot fungi were isolated. The

Forest Disease Laboratory identified two as *Peniophora* sp., one as *Xylaria* sp., one as *Polyporus dryophilus*, and one as *Polyporus adustus*.

Discussion and Summary

Though the borer holes callused over rapidly, stain developed around most of them. The average vertical extent of discoloration was 3 to 13 inches in 2 years, depending upon the tree species and whether the holes were made in spring or in fall. Horizontal spread was very small. These findings are within the range reported by Hepting *et al.* from other areas where healing was slower.

Lorenz, working with hardwoods in the Lake States,[4] concluded that the stain arising from borer holes is primarily physiological in origin. In the present study, the lack of isolates from many samples of stained wood was consistent with this proposition. However, the six stain fungi that were isolated probably caused part of the discoloration.

The exceptional rot infection of sweetgum bored in spring cannot readily be explained. Possibly the borings coincided with a heavy release of spores in the vicinity of these trees, which were about two miles from the others. The spring-bored sweetgums apart, incidence of rot was less than that reported by Hepting et al., perhaps because the holes closed more rapidly in this study.

With or without the rot, the stain that developed from nearly all borer holes would constitute a defect in logs intended for factory lumber or veneer. Where valuable hardwoods are involved, it appears that increment borings should be held to a minimum and holes made no deeper than necessary.

TABLE 3.—DECAY TWO GROWING SEASONS AFTER INCREMENT BORING

Species	Holes made in fall		Holes made in spring	
	Holes with rot	Mean vertical extent[1]	Holes with rot	Mean vertical extent[1]
	Percent	*Inches*	*Percent*	*Inches*
Eastern cottonwood	12.5	6.4	0	0
Green ash	2.5	4.0	0	0
Nuttall oak	20.0	1.5	5.0	1.8
Sweetgum	15.0	2.3	80.0	2.6
Sugarberry	22.5	5.1	12.5	4.2

[1]Holes with no decay not included in these figures.

[4]Op. cit.