A NOTE ON EFFECTS OF WOUNDS ON HEARTWOOD FORMATION IN WHITE OAK (*QUERCUS ALBA* L.)[1]

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ABSTRACT

Heartwood formation was retarded by wounds on white oaks in Maine and Missouri. Maine samples with fire wounds had 22–23 rings of sapwood near the wound whereas control trees had 9. Missouri samples subjected to frill and herbicide treatments averaged 16–17 rings of sapwood near the wound, whereas control trees averaged 12. The effects of wounding on Missouri trees were pronounced at heights of 1, 2.5, and 6 m.

Additional keywords: Wounding, sapwood, heartwood, fire wounds.

INTRODUCTION

Heartwood formation was retarded in the wood tissues that formed around wounds in *Quercus alba* L. and *Q. rubra* L. (Shigo 1972). Shigo and Larson (1969) pointed out that differences exist between discolored wood formed first after wounding and normal heartwood in the xylem altered by the usual aging processes. Because normal heartwood is often colored, it is sometimes confused with discolored wood, which is xylem altered by injury processes (Shigo and Hillis 1973). This note gives additional observations and data on the effects of wounds on heartwood formation in white oak.

EXPERIMENTAL

The studies were done on white oaks, *Quercus alba* L., grown in Missouri and Maine.

Maine oaks

In October 1947 a serious forest fire burned many trees on the Massabesic Experimental Forest in Alfred, Maine. Basal fire wounds are common on many of the trees that survived. Details on the discoloration and decay associated with these wounds after 22 years in *Q. alba* and *Q. rubra* have been reported (Shigo 1972). The number of sapwood rings at the base of 10 white oaks with 22-year-old fire wounds was compared with the number of sapwood rings at midbole and at the base of 5 white oaks of comparable age from the same area that were not wounded. This work led to the Missouri study, in which details of wounds made some twenty years ago were known, along with the subsequent history of the forest, enabling further investigation of heartwood formation after injury.

Missouri oaks

In 1952 and 1953 more than 14,000 trees, *Quercus* spp., were injected with herbicides on the Mark Twain National Forest near Rolla and the Clark National Forest near Salem. The objective of this study was to determine the effects of eight chemical-mechanical treatments on killing undesirable oaks; details of the study and the results are given by Brinkman (1960). One of the eight treatments was a frill of

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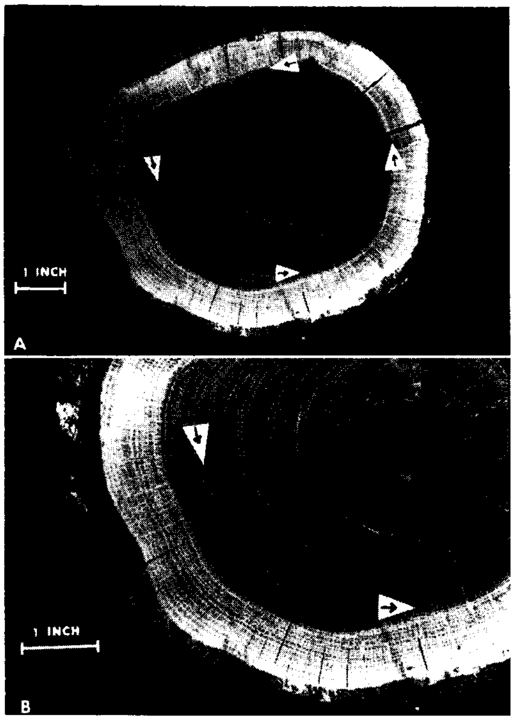

FIG. 1. A sample disk (A) of white oak from the Missouri study area. Arrows indicate herbicide treatment year and show that year of heartwood formation is not constant tangentially around the tree; (B) is an enlargement of a disk portion showing sapwood-heartwood boundary.

deep axe cuts completely encircling the base of the tree in combination with 2,4,5-T in No. 1 fuel oil applied at the rate of 12.5 pounds chemical in one hundred gallons of solution. After 20 years (October 1972) 15 of these frilled white oaks that were still alive were felled, dissected, and examined. A disk was cut from each trunk at 10 cm above the frill, midbole height (approximately 2.5 m above ground), and just below the base of the crown (approximately 6 m above ground). The disks were taken to the laboratory, where they were sanded and photographed and the rings of sapwood and heartwood were determined by projection of the photographs (slides) upon a screen. The same procedure was used for 10 white oaks from the same area that were not wounded for the 1952 study. In addition to the sapwood ring count, the average ring widths for the 10-year period 1952–1961 and the 10-year period 1942–1951 were also determined.

The influence of other factors (age, genetics, growth rate, etc.) on heartwood formation was hopefully randomized by sampling trees ranging from 16.5 cm to 36.8 cm in diameter at the 2.5-m level with ring counts of 44–165 at this same height level. These ranges, for ring count and diameter, were applicable for both control and injured trees.

Number of sapwood rings for each disk sample was based on average of four readings some 90 degrees apart as shown by arrows in Figure 1A. This was necessary because the sapwood-heartwood boundary was not constant (same rings) at any sampled height for most trees.

RESULTS AND DISCUSSION

Wounds retarded heartwood formation in the trees. The effects of the fire wounds were dramatic: 22–23 rings of sapwood at the bases of all trees compared with 9–13 rings of sapwood at the bases and upper portion of the boles of the five control trees. In the Missouri oaks the effects of wounds on heartwood formation were probably due to the range of severity of the frill wounds and chemical treatment and the abilities of the trees to heal the wounds. Note (Table 1) an increase in ring width after wounding at ground level (1 m) and at midbole height. This increase is significant (5% level) at ground level.

The wood that forms after wounding is not infected by microorganisms unless additional wounds are inflicted. Defects are compartmentalized in living trees (Shigo and Larson 1969; Shigo 1972; Shigo and Hillis 1973). In trees that have heartwood, such as the white oaks, the column of infected discolored wood could be confused with the column of healthy colored heartwood. In some oaks with severe fire wounds, the column of decay was surrounded by 22 rings of clear sapwood and then the tree showed 9–10 rings of sap-

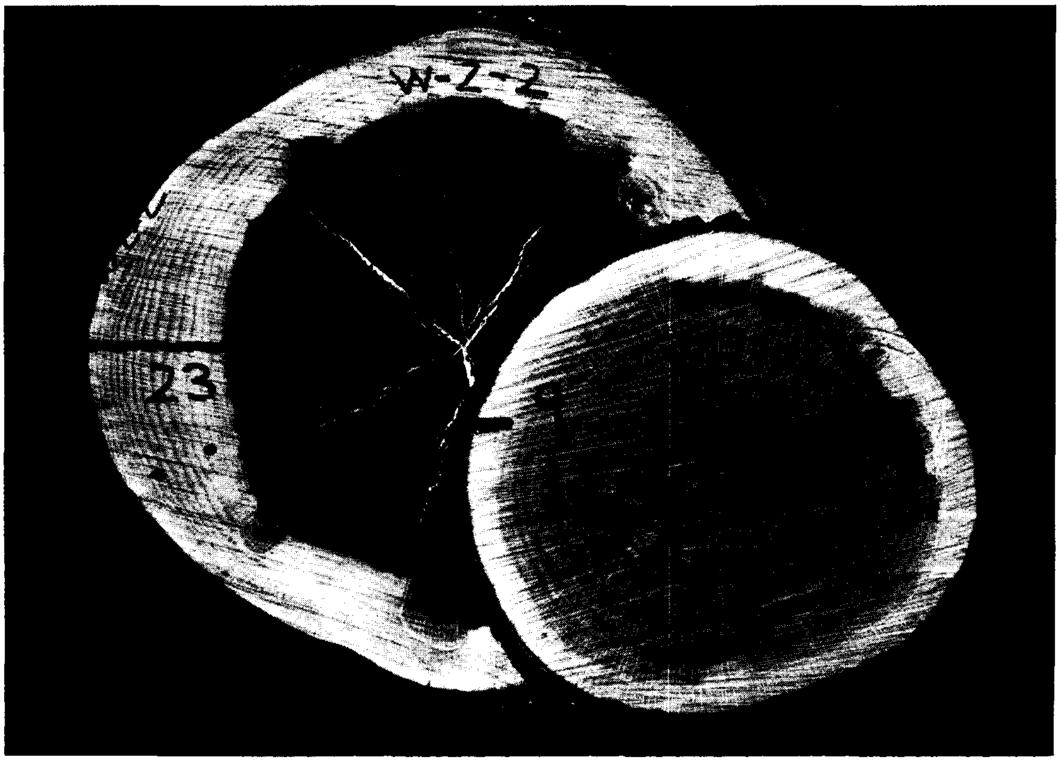

FIG. 2. Sample disks of white oak from the Maine study area. Sample W-2-2 from the base of a fire-wounded tree had 23 rings of sapwood, whereas, sample W-1-22 (control) from 1.5 m above ground had only 9 rings of sapwood.

TABLE 1. *Average number and range of rings of sapwood plus average ring width for ten-year periods before and after injury at three height levels*[a] *(meters) for Missouri-grown white oaks*

Statistic	For ten Control trees			For fifteen Chemi-mechanically Injured trees[b]		
	1m	2.5m	5m	1m	2.5m	5m
Sapwood Rings (number)						
average[c]	12	11	10	16	15	15
range	(9-21)	(7-17)	(8-15)	(10-22)	(10-21)	(10-21)
Average Ring Width (mm)						
from 1942-1951	2.67	1.91	2.20	1.81	1.41	1.83
from 1952-1961	2.13	1.56	1.85	2.45[d]	1.43[d]	1.68

[a]Height levels are approximate since trees were sectioned above the injury, at mid-bole height, and just below the base of the crown.

[b]See text for details.

[c]Difference between Control and Injured trees significant (5 percent level) for any height.

[d]Increase in width after injury contrary to control condition and is significant (5 percent level) for 1 m level.

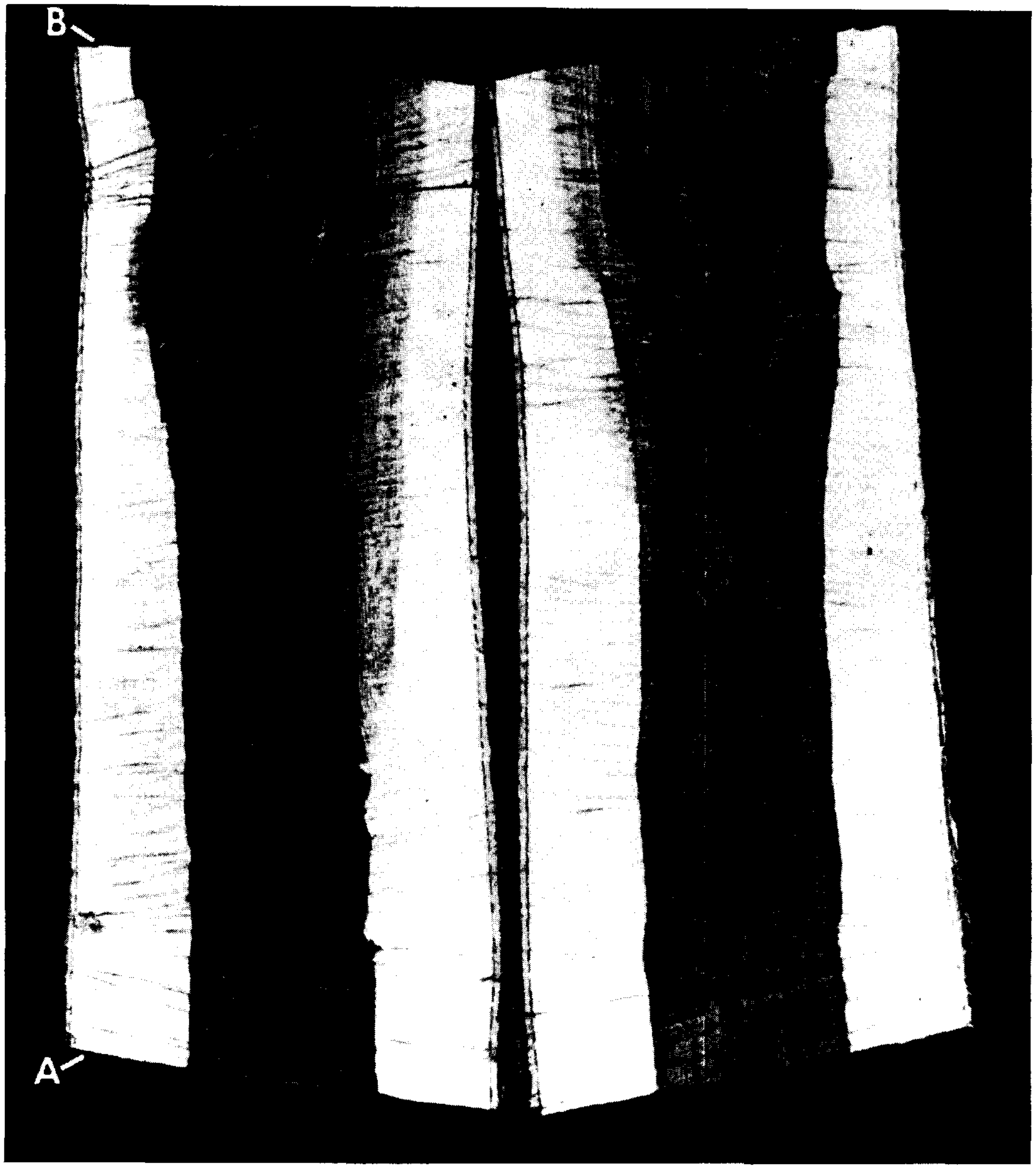

FIG. 3. Dissection of white oak sample (fire-wounded tree) from Maine showing central column of decay surrounded by 23 rings of sapwood at A, and 9 rings of sapwood only 1 m higher at B.

wood only 1–1.5 m farther up the bole (Figs. 2–4). Often this situation is misinterpreted to indicate that the entire heartwood core was decayed by a heartwood-rotting fungus. The correct interpretation is that the decay fungi decayed the wood present when the wound occurred, and the wood that formed after the wound was not infected. Because the wound retarded heartwood formation, all wood that formed after the wound was clear sapwood. This situation is common in oaks with severe basal fire wounds.

It is not well understood what factors

FIG. 4. Three successive white oak disks, from a fire-wounded tree, approximately 0.5 m apart from stump height showing decreasing amounts of sapwood with distance above fire wound at tree base.

initiate the formation of heartwood, but the results given here indicate that wounds indeed retard heartwood formation in white oaks. Wounding has also been shown as a cause of included sapwood formation (actually a zone of xylem tissue that never obtains heartwood coloration) in red cedar (McGinnes et al. 1969) and in eucalyptus (Hillis 1962).

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