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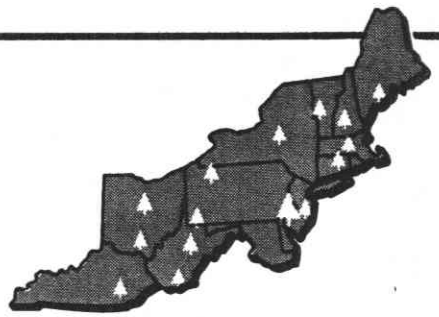

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TAPHOLES DRILLED INTO FROZEN SUGAR MAPLES CLOSE SLOWLY

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Abstract. Tapholes drilled into frozen maple tissues remain open longer than tapholes drilled into trees that have not frozen. Taphole closure was not affected by the speed of the tapper drill bit.

INTRODUCTION

Sugar maple (*Acer saccharum* Marsh.) sap is collected from tapholes drilled into the trees. It is necessary to drill new tapholes each spring. The cambial tissues adjacent to the taphole often dies, causing an elliptical wound (Fig. 1) much larger than the original taphole (Gibbs and Smith 1973). Possible causes of cambial damage are drilling tapholes and inserting sap spouts when the tree tissues are frozen, and using high-speed drills, such as a gasoline-powered chain saw equipped with a drill chuck.

My investigations show that tapholes drilled when the trees were frozen had adjacent areas of cambial dieback more frequently and closed more slowly than tapholes drilled in trees that were not frozen.

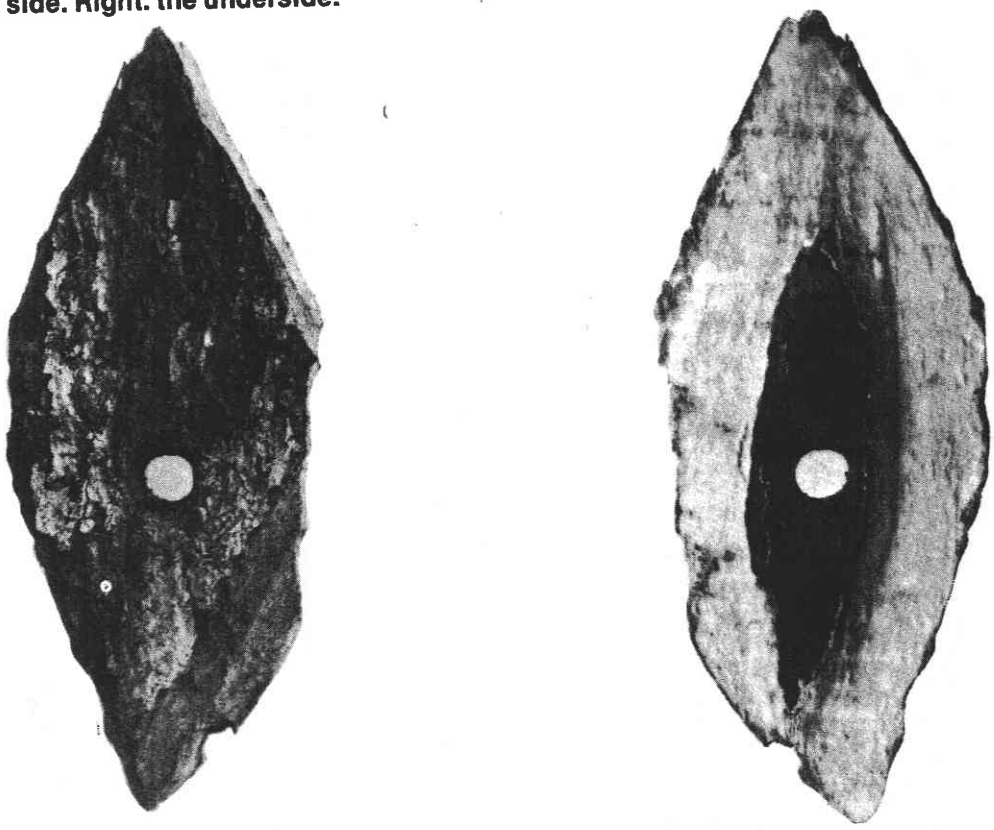
The study also demonstrates that the speed of power-driven drills did not affect the rate of taphole closure.

This information is useful to the maple syrup industry because it helps to explain why cambial dieback might develop adjacent to tapholes, and suggests methods to prevent it.

This study was conducted in a sugarbush located in Jericho, a town in northern Vermont.[1] Fifty trees, ranging in dbh from 42 to 73 cm, were used. Four taphole locations were selected on each tree; taphole treatments were then assigned at random. Two tapholes were drilled on a very cold day, and two more were drilled on a warmer day. Of the two tapholes drilled at the same time, a high-speed tapper was used on one; the other was drilled by hand, using a brace and bit. Extreme care was taken to make all tapholes the same size and conform to industry standards. A drill bit 1.11 cm in diameter was used; the holes were 6.5 cm deep; tapholes were spaced at least 15 cm apart, and, as nearly as possible, were on the

[1] The sugarbush is located within the boundaries of the Ethan Allen Test Firing Range, and is available for forestry research by permission of the Adjutant General, Vermont National Guard.

Figure 1.—Section of bark and wood removed from a sugar maple to reveal the dieback of cambium adjacent to a taphole. Left: the bark side. Right: the underside.



south side of the tree. A plastic sap spout was inserted in each taphole after it was drilled.

The gasoline-powered tapper was an ordinary, small chain saw with the guidebar and chain removed, and a special drill chuck was attached to the drive shaft. This type of saw required a left-hand twist drill bit; its speed was approximately 6,600 rpm. The brace and bit was a regular woodworking tool; its estimated speed was 120 rpm.

The tapholes in the first group sampled for this study were drilled on 5 February 1974. On that day, the average temperature was − 18 °C, and the temperatures for the preceding 4 days had not been higher than − 11 °C. The tree tissues were definitely frozen at the time of drilling. Tapholes in the second group were drilled on 7 March 1974, when the average tempoerature was 9 °C. That day was preceded by 3 days when temperatures did not go below freezing.

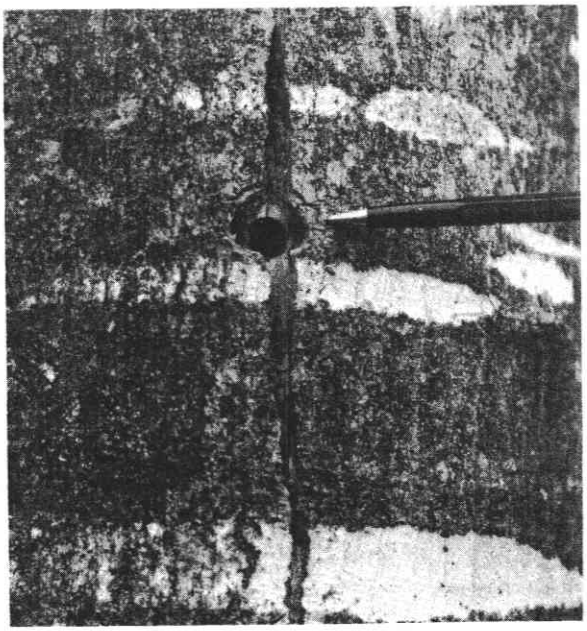
Following the end of the second and third growing seasons after tapping, each taphole was inspected for cambial dieback and classified as open or fully closed (Fig. 2). The data were analyzed, using the chi-square test of independence (Freese 1967).

Table 1.—Percentage of closed tapholes 2 and 3 years after tapping with a gasoline-powered tapper and by hand on a cold day and a warm day.

Drilled by	Temperature when taphole drilled	
	Low	High
	After 2 years	
Power	8	57
Hand	2	43
	After 3 years	
Power	31	80
Hand	20	82

Figure 2.—When cambium does not die back from a taphole as a result of tapping, callus tissue forms quickly, closing the taphole.

Figure 3.—Cambial dieback can be seen through the drill hole and crack in the bark.



RESULTS

Two years after drilling, half of the warm-day tapholes were fully closed with callus tissue. In contrast, only 5 percent of those drilled on the cold day had closed. This difference was highly significant (.01 level of probability). After 3 years, the number of closed warm-day tapholes had increased to 80 percent, and only about 25 percent of the cold-day tapholes had closed. Again, this difference was highly significant. The percentage of closed tapholes for each treatment combination 2 and 3 years after tapping is shown in Table 1.

It appeared that power-drilled tapholes closed sooner than hand-drilled tapholes, especially after the second year. However, in neither the second nor the third year was there a significant difference in closure between power- or hand-drilled tapholes.

DISCUSSION

This study shows that drilling tapholes and inserting plastic spouts in frozen trees usually result in slower taphole closure. A tapered spout driven into a taphole compresses the adjacent tissue. Frozen tissues are brittle, so this wedging action can rupture fragile cambium cells around the taphole, and will often cause the bark to split longitudinally above and below the taphole (Fig. 3).

Tapholes are closed over by successive layers of callus tissue that develop from live cambium on each side of the taphole. The smaller the area of dead cambium, or wound, the sooner closure is effected. When tapholes close rapidly, new layers of wood form over them, and the same area of the bole may be tapped again sooner. Rapid closure also tends to inhibit the advance of any aerobic decay organisms invading the taphole, and there is less chance for decay organisms to invade the tree's tissues (Shigo and Larson 1969).

In the past, tapholes were usually drilled by hand, using a brace and bit. Now, portable power-driven equipment is often used. This includes the gasoline-powered chain saw fitted with a drill chuck that revolves at a very high speed. It was thought that the vibration or the weight of the engine might cause the fast-revolving drill bit to hit the bark at the edge of the taphole and rupture the cambium cells. The results show that high- speed drilling did not affect taphole closure, and indicate that such equipment can be safely used for tapping maple trees. This conclusion is further

supported by an earlier study (Smith and Lamore 1971) showing that high-speed drilling did not affect subsequent sap yield from a taphole.

Early tapping, which often means drilling taptholes in frozen trees, might be done to take advantage of that first sap flow. Tapping frozen maples can definitely cause tissue damage. However, we do not suggest that tapping be done only on very mild days, when temperatures are above freezing, or perhaps even waiting for the sap-flow season to start. Our experience indicates that tapping is successful when temperatures are about $-5°$ or $-4°C$, or above. However, care should always be exercised in setting the spouts: driving spouts too hard into the taphole can severely damage the tree, even under mild weather conditions.

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