

# Phloem Thickness in Lodgepole Pine: Its Relationship to Dwarf Mistletoe and Mountain Pine Beetle (Coleoptera: Scolytidae)<sup>1</sup>

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**ABSTRACT** A generally accepted hypothesis is that lodgepole pines infected by dwarf mistletoe, *Arceuthobium americanum*, are less susceptible to mountain pine beetle, *Dendroctonus ponderosae*, because they have thinner phloem than uninfected trees. This Colorado study, based on 1,051 trees, indicates that there is little relationship between dwarf mistletoe intensity and phloem thickness. Therefore, we conclude that there is little correlation between dwarf mistletoe and mountain pine beetle activity, at least in Colorado.

The interrelationships between dwarf mistletoe, *Arceuthobium americanum* Nutt., and mountain pine beetle, *Dendroctonus ponderosae* Hopkins, in lodgepole pine, *Pinus contorta* Dougl., have long been a subject of debate. Some reports suggest that mistletoe-infected trees are more susceptible to bark beetle attack (Hutchinson et al. 1965, Parker and Stipe 1974). In contrast, the generally accepted current hypothesis is that dwarf mistletoe-infected trees are generally less susceptible to the beetle and have lower brood production because they have thinner phloem (Amman 1978, Kulhavy et al. 1978, McGregor 1978). However, lodgepole pines with bole infections may be more susceptible because of the local swellings and thicker phloem (McGregor 1978).

Little information has been available on the relationship between dwarf mistletoes and phloem thickness in lodgepole pine. Roe and Amman (1970) reported a small random sample of 20 trees with medium to heavy infection and 20 noninfected trees from the Targhee National Forest, Idaho. The infected trees had phloem averaging  $0.28 \pm 0.06$  cm thick, compared with  $0.43 \pm 0.05$  cm for the uninfected trees. The results were statistically significant ( $P = 0.05$ ).

An intensive survey of mountain pine beetle in lodgepole pine in Dillon, Colo., provided an opportunity to compare phloem thickness in relation to tree diameter and dwarf mistletoe intensity (Cahill 1973).

## Materials and Methods

Survey lines were located at ca. 1.6-km intervals through a 4,455-ha area surrounding Dillon Lake, Colo., in April 1972. This area has a long history of mountain pine beetle epidemics (Cahill 1973). Variable plots were taken at 100-m intervals along each line. The following data were taken for each lodgepole pine larger than 12.7 cm in diameter at breast height (dbh) in the plot: dbh (1.4 m), crown class, and mistletoe rating (Hawksworth 1977). Phloem thickness to the nearest 0.25 mm was measured on two small bark pieces removed with an axe from the opposite sides of the tree at breast height. Fourteen lines averaging about 1.6 km long and 281 plots were established.

## Results and Discussion

The stands averaged 236 trees per acre in lodgepole pine. The average diameter of the measured trees was 18 cm dbh. A total of 1,301 trees were examined, but only the 1,051 with complete information on diameter, mistletoe rating, and phloem thickness were used in these analyses. As has been shown for other studies, there is a direct relationship between dwarf mistletoe intensity and tree diameter, and crown class. Dwarf mistletoe infection increases with diameter, and dominant trees are most heavily infected. The results (Table 1) do not show a direct relationship between phloem thickness and dwarf mistletoe intensity class. However, as a group, uninfected trees and those lightly infected (infection class 1) had slightly but significantly ( $P = 0.05$ ) thicker phloem than trees in higher infection classes (classes 2 through 6). However, the correlation between phloem thickness

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Table 1. Mean phloem thickness (cm) in relation to diameter class and dwarf mistletoe rating in lodgepole pine, Dillon Colo., 1972; number of trees measured shown in parentheses

dbh Class (cm)	Dwarf mistletoe rating							Avg (total)
	0	1	2	3	4	5	6	
<20.0	0.14 (202)	0.20 (8)	0.15 (47)	0.18 (22)	0.18 (46)	0.17 (55)	0.14 (73)	0.17 (453)
20.1-30.0	0.22 (173)	0.25 (7)	0.20 (36)	0.22 (18)	0.19 (71)	0.21 (52)	0.18 (116)	0.21 (473)
>30.0	0.27 (57)	0.33 (4)	0.20 (9)	0.15 (3)	0.17 (8)	0.20 (5)	0.21 (39)	0.23 (125)
Avg or total	0.21 (432)	0.24 (19)	0.17 (92)	0.19 (43)	0.18 (125)	0.19 (112)	0.18 (228)	0.20 (1051)

and diameter, when computed for 2.5-cm dbh classes (such as reported by Cole and Amman [1980]) was  $R = 0.85$ . When computed for individual trees,  $R = 0.04$  for uninfected and class 1 trees, and  $R = 0.15$  for infected trees in classes 2 through 6.

This Colorado study indicates a much less significant relationship between phloem thickness and dwarf mistletoe intensity than that reported by Roe and Amman (1970) for Idaho. If, as has been shown for other areas, brood production of mountain pine beetles is correlated with phloem thickness in lodgepole pine (Amman 1972), little correlation would be expected between bark beetle activity and dwarf mistletoe intensity in Colorado. Our observations tend to confirm this, although quantitative data are not available.

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