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DOES THE MOUNTAIN PINE BEETLE CHANGE HOSTS IN MIXED LODGEPOLE AND WHITEBARK PINE STANDS?

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ABSTRACT

*Lodgepole pine (*Pinus contorta *Dougl.) and whitebark pine (*P. albicaulus*, Engelm.) losses attributable to the mountain pine beetle (*Dendroctonus ponderosae *Hopkins) were compared in three study areas within two mixed species stands at high elevations. Results suggest that this beetle displays host specificity for the tree species in which it completed larval development because extensive mortality in one host species did not result in comparable mortality in an associated species.*

The mountain pine beetle (*Dendroctonus ponderosae* Hopkins) causes serious mortality in many lodgepole pine (*Pinus contorta* Dougl.) forests. This beetle also inflicts mortality in whitebark pine (*P. albicaulis* Engelm.) and limber pine (*P. flexilis* James) (McCambridge and Trostle 1970). Instances where this beetle caused significant mortality to whitebark pine while surrounding lodgepole pine stands remained relatively uninfested were reported by Evenden (1933). Indications that the beetle preferred whitebark and limber pine to lodgepole pine where these species were growing in mixed stands were noted by Evenden and others (1943). The purpose of our study was to determine whether a mountain pine beetle population in lodgepole pine would infest nearby whitebark pine trees and vice versa. The need for answers to these questions is obvious to land managers confronted with beetle infestation situations.

STUDY SITUATIONS

Three study areas containing stands of mixed species were selected to meet the requirements of two situations (see fig. 1). The first situation involved adjoining study areas, which were located near Togwotee Pass on the Teton National Forest. The

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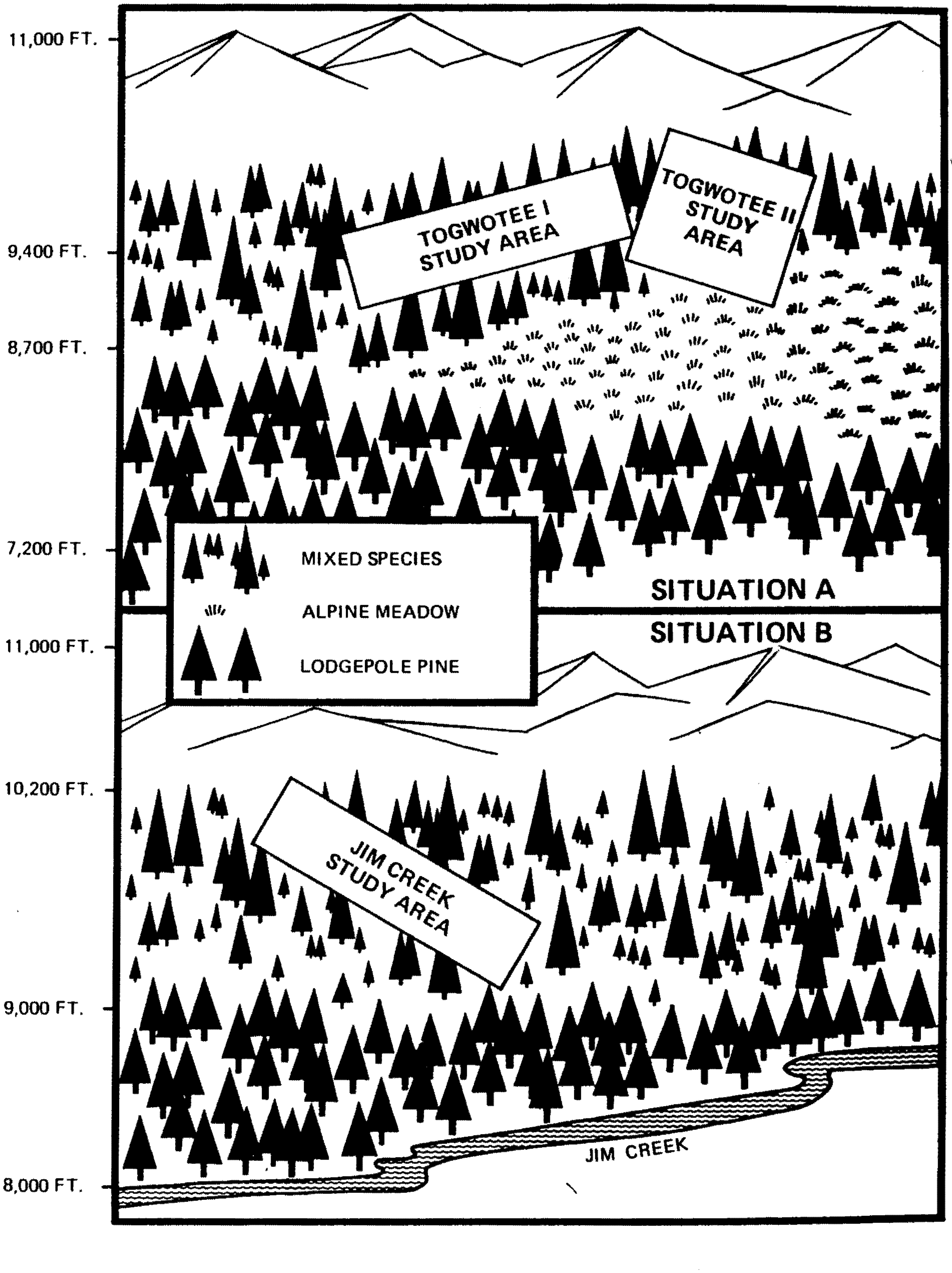

Figure 1.--Sketch depicts the basic field conditions studied.

first study area was called Togwotee I; it was located within elevations ranging from 8,700 to 9,300 feet. The second study area, called Togwotee II, was located within elevations ranging from 8,900 to 9,400 feet. Immediately below Togwotee I was an extensive stand of lodgepole pine that had been infested by the mountain pine beetle over an 8-year period, 1960 to 1968.

Situation 2 involved only one study area, called Jim Creek; it was located on the Bridger National Forest within elevations ranging from 9,000 to 10,200 feet. Unlike the species mixture on the first two study areas, whitebark pine predominated on this study area. Furthermore, the stand had been infested by the mountain pine beetle over a 3-year period, 1961 to 1964. This study area also was located above an extensive stand of lodgepole pine; however, the stand had not been infested by the beetle.

In the three study areas, each of which covered approximately 4 square miles, fixed 1/10-acre plots were established in a grid pattern: 20 in Togwotee I and in Jim Creek; 30 in Togwotee II. We counted all trees 4 inches and larger in diameter at breast height (d.b.h.); the species mixture in the sample is reflected in the following tabulation:

Species	*Togwotee I*	*Togwotee II*	*Jim Creek*
Lodgepole pine	198 (42)[4]	84 (16)	14 (3)
Whitebark pine[5]	111 (23)	160 (31)	321 (75)
Engelmann spruce and subalpine fir	163 (35)	275 (53)	93 (22)

Trees were recorded as follows: (1) alive; (2) killed by mountain pine beetle; (3) killed by other causes, such as tree suppression, other insects, or disease.

Stems that forked at diameters below breast height were recorded separately. A multiple-forked candelabrum-like bole often develops in whitebark pine. All trees counted were categorized into 1 inch d.b.h. classes--4.0 to 4.9 inches, 5.0 to 5.9, etc.

For each of the two species, phloem thicknesses were measured in hundredths of inches. These measurements were taken at d.b.h. on opposite sides of the bole from two living trees in each diameter class on each 1/10-acre plot.

RESULTS AND CONCLUSIONS

Situation 1.--In the Togwotee I study area, the mountain pine beetle killed 15.2 percent of the lodgepole pine trees as compared to 3.6 percent of the whitebark pine trees (fig. 2). Mortality in this study area had been very low prior to 1965, after which the trees in this area were infested by beetles emerging from the lodgepole pine stands below the study area. In these lodgepole pine stands, the mountain pine beetle had killed approximately 25 percent of the trees by 1968 (Amman and Baker, in press). By 1970, the peak of the infestation within the study area had passed.

The large amount of mortality of lodgepole pine (in contrast to that occurring in whitebark pine) indicates that adult beetles from broods maturing in lodgepole pine prefer to infest the same species of pine in which they completed their larval development.

[4]Figures in parentheses show percent each species is of the total number of trees in each area.

[5]Also includes some limber pine on four Jim Creek plots.

The big differences between these mortality figures might be attributed to diameter distribution or phloem thickness. Past work (Amman and Baker, in press; Cole and Amman 1969) showed that the mountain pine beetle kills a higher percentage of the large-diameter trees than it does of the small-diameter trees. Although some differences did exist in diameter distributions between the two species, the mountain pine beetle killed more (proportionately) lodgepole pine trees than whitebark trees. For example, 39.9 percent of the trees in the 14- to 16-inch diameter class were lodgepole pine and 30 percent were whitebark pine. Therefore, if the kill had been equal for both species, the mountain pine beetle would have killed 6.4 percent of the lodgepole pine trees, based upon the 4.8 percent mortality of whitebark pine [(39.9/30.0) 4.8 = 6.4 percent]. However, the actual mortality of lodgepole pine was 30.6 percent; this demonstrates that the mountain pine beetle killed a proportionately higher number of trees for this species.

Phloem thickness is another factor that might have been responsible for the differences in mortality between the two species. Amman (1969) showed that survival of mountain pine beetle brood was associated with phloem thickness. However, average phloem thickness (in inches) was greater in whitebark pine as shown in the tabulation below:

Diameter class (Inches)	*Lodgepole pine*	*Whitebark pine*
8-10	0.097	0.107
11-13	.106	.119
14-16+	.108	.134

We would have expected greater mortality in whitebark pine if the mountain pine beetle had selected trees on the basis of phloem thickness. Therefore, this is additional evidence that the mountain pine beetle demonstrated a preference for lodgepole pine on the Togwotee I study area.

In the Togwotee II study area, mortality that could be attributed to the mountain pine beetle remained at low levels for both lodgepole pine and whitebark pine: 2.4 and 3.1 percent, respectively (fig. 2). The overall effects of mountain pine beetle infestation pressure at lower elevations were not evident because Togwotee II was separated by Togwotee I from the infested lodgepole pine stands. There were not any consistent differences in mortality by diameter class between species (table 1). Furthermore, average phloem thickness (in inches) indicates that the food supply in all diameter classes was ample for both species, as shown in the following tabulation:

Diameter class (Inches)	*Lodgepole pine*	*Whitebark pine*
8-10	0.112	0.101
11-13	.116	.113
14-16+	.100	.122

The lower mortality experienced in Togwotee II probably can in part be attributed to the cool temperatures prevailing at higher elevations. It has been proven that cooler temperatures disrupt beetle development.[6] However, the temperatures at Togwotee I

[6] G. D. Amman. Variations in the biology and their significance in dynamics of mountain pine beetle populations. Intermountain Forest and Range Experiment Station, Ogden, Utah (in preparation).

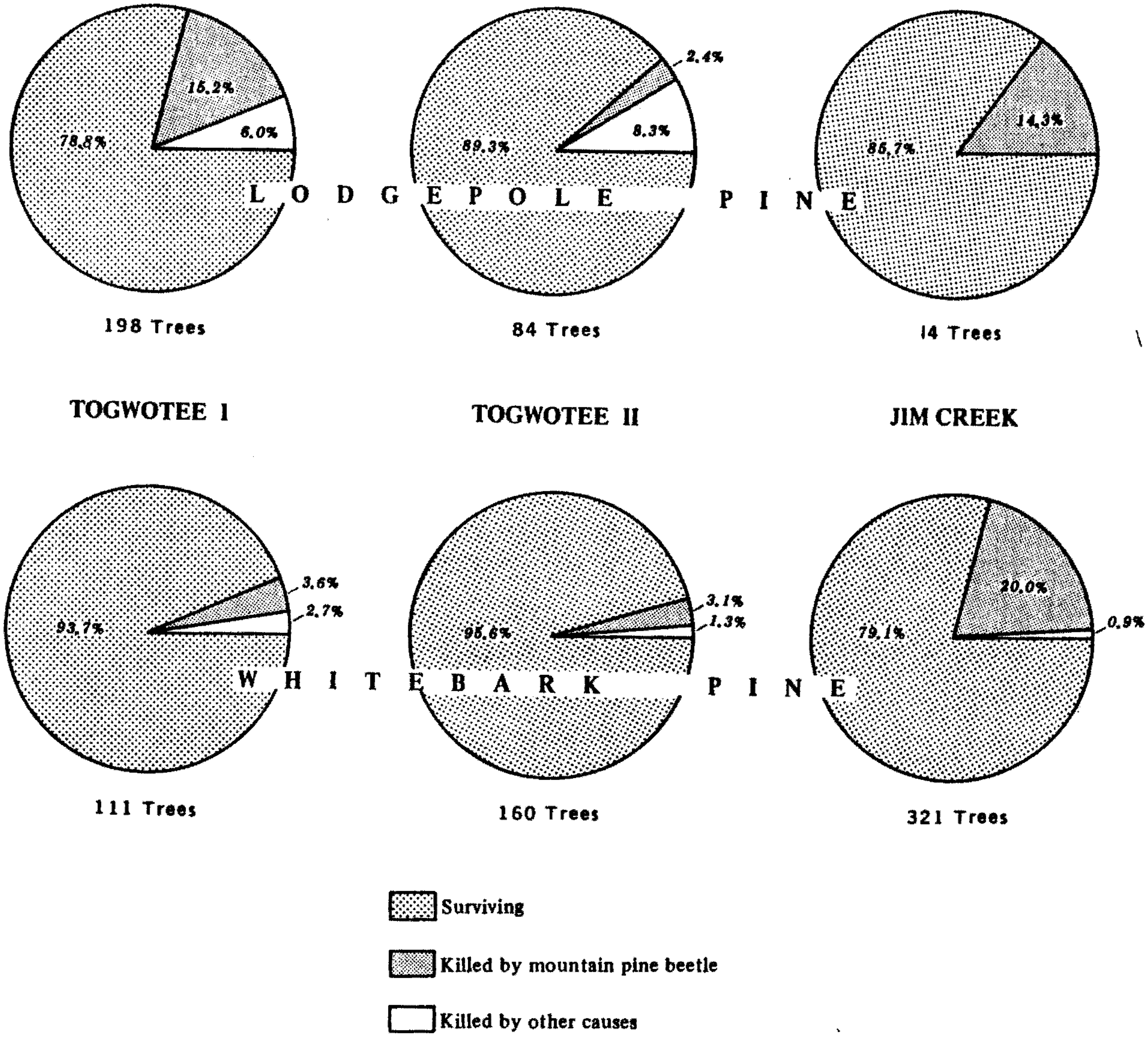

Figure 2.--Living and dead lodgepole and whitebark pines 4 inches d.b.h. and larger in three study areas.

and Togwotee II study areas are so similar that we can only conclude this lower mortality can be directly related to the fact Togowotee II was not located adjacent to the infested lodgepole pine stand. Moreover, conclusions could not be drawn regarding host specificity because of the low amount of tree mortality on the Togwotee II study area.

Situation 2.--An infestation occurred in Jim Creek between 1961 and 1963, which produced heavy mortality (20 percent) in this predominantly whitebark pine stand (75 percent). The lodgepole pine component in this study area was so negligible (3 percent) that the only meaningful comparison of the effects of infestation pressure from beetles reared in whitebark pine on lodgepole pine trees could be made with the trees in the pure lodgepole pine stands located immediately below the study area. Mortality in the lodgepole stands remained low, apparently unaffected by beetles from the whitebark pine broods. Neither tree sizes nor phloem thicknesses appeared to have limited beetle activity in the study area as well as in the uninfested lodgepole pine stand. It is believed that the beetle population increased during years when temperatures were favorable, then declined when temperatures became adverse. Beetle activity should have been enhanced in the lodgepole pine stands because of warmer temperatures. The failure of adult beetles to migrate from the whitebark pine stands to the lodgepole pine stands suggests specificity for the tree species in which the beetle completed its larval development.

Table 1.--*Percent of lodgepole and whitebark pine trees 8 inches d.b.h. and larger killed by the mountain pine beetle, in three diameter classes on Togwotee I and Togwotee II study areas*

D.b.h. (inches)	Species	Trees in sample[1]	Mortality
		TOGWOTEE I	
8-10	Lodgepole pine	40 (28.0)	12.5
	Whitebark pine	25 (35.7)	4.0
11-13	Lodgepole pine	46 (32.1)	13.0
	Whitebark pine	24 (34.3)	8.3
14-16+	Lodgepole pine	57 (39.9)	31.6
	Whitebark pine	21 (30.0)	4.8
Totals	Lodgepole pine	143	--
	Whitebark pine	70	--
		TOGWOTEE II	
8-10	Lodgepole pine	24 (53.3)	0.0
	Whitebark pine	51 (47.2)	2.0
11-13	Lodgepole pine	13 (28.9)	0.0
	Whitebark pine	29 (26.9)	6.9
14-16+	Lodgepole pine	8 (17.8)	12.5
	Whitebark pine	28 (25.9)	3.6
Totals	Lodgepole pine	45	--
	Whitebark pine	108	--

[1]Figures in parentheses represent percent of total number of living and dead trees 8 inches d.b.h. and larger for each species.

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