A DESTRUCTIVE INFESTATION IN LODGEPOLE PINE STANDS BY THE MOUNTAIN PINE BEETLE[1]

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This paper gives a brief history of the destruction of standing timber resulting from an epidemic of the mountain pine beetle (*Dendroctonus monticolae* Hopk.) in the lodgepole pine stands of the Beaverhead National Forest, Mont. During the past decade the outbreak has swept through this area of 1,341,860 acres, killing approximately 57,756,000 trees above 3 inches in diameter. The total loss of merchantable trees 9 inches d.b.h. and above is estimated to be 77.3 percent.

IN 1925 the Beaverhead National Forest, in southwestern Montana, was known for its extensive stands of mature lodgepole pine. Today it is known for its forests of dead trees, which in a few years will become an impenetrable tangle of fallen snags that will remain a fire menace for several decades. This widespread destruction of timber is an appalling example of the destructiveness of the mountain pine beetle (*Dendroctonus monticolae* Hopk.) when it becomes epidemic. The history of this epidemic, which has destroyed stand after stand of lodgepole pine, shows the tremendous force of such outbreaks and illustrates the need for an awakening to the necessity for their prevention.

The first available record of insect damage within this forest reported the occurrence of an outbreak of the mountain pine beetle in the lodgepole pine stands on the west side of the Big Hole Basin in 1911. Prompt action was taken against this outbreak, and control measures were conducted in 1912 and 1913. As a result the condition returned to normal, and no further reports of insect damage were received until the present infestation appeared some twelve years later.

In 1924,[2] during an extensive insect survey of what is now the western portion of the Deerlodge National Forest, a severe epidemic of the mountain pine beetle was discovered on the east fork of the Bitterroot River about fifteen miles south of the territory then being surveyed. Although the origin of this outbreak is uncertain, it is believed that it was an advanced portion of the epidemic that for the preceding ten or twelve years had been moving southward from the Flathead National Forest. However, as this paper deals only with the effect of this infestation upon the lodgepole pine stands of the Beaverhead National Forest, the origin is of no concern.

In the spring of 1926, and again in 1927, a few thousand dollars were spent in treating the infested trees along the southern edge of the severe infestation in the Bitterroot drainage area, the little hope of control being based on the remote chance that the continued spread of the beetles might be halted. As during these two operations only a small percentage of the infested trees were treated, the effort proved to be a failure.

The first important spread of the beetles into the Beaverhead National Forest occurred in 1925, when small groups of infested trees were reported along the west side of the Big Hole Basin across the Continental Divide and immediately south of the heavy infestation in the Bitterroot area. Control measures were directed against this infestation in the hope that the Continental Divide would act as at least a partial barrier to the additional spread of insects into the Beaverhead National Forest. In undertaking this so-called "barrier plan" of control, it was fully realized that if the movement of the Bitterroot infestation into the Big Hole Basin occurred in any great force, the effort would be useless. As the values at stake, however, seemed to justify the chance offered for success, the project was instituted under a plan of treating the infestation within the Big Hole Basin until such time as the source of annual reinfestation in the Bitterroot area was exhausted.

The work was begun in the spring of 1926 and continued through the two subsequent seasons. The following tabulation shows the steadily in-

[1]References to control projects and annual surveys are from unpublished reports in the files of the Coeur d'Alene, Idaho, laboratory of the Bureau of Entomology and Plant Quarantine. Control reports are by Forest Service officers C. A. Burdick (1926) and C. S. Webb (1927 and 1928). Survey reports are by Evenden (1926-28) and Gibson (1929-35). The data relative to the destruction of timber have been compiled by the junior author, who has conducted the study of the Beaverhead epidemic for the past six years.

[2]Evenden, J. C. The beetle beats the pine. Amer. Forests and Forest Life, 31:593-595, illus. 1925.

creasing infestation against which this project was directed:

Year of control	Acres treated	Trees treated	Cost
1926	15,000	5,271	$11,984
1927	19,000	17,500	31,500
1928	69,800	55,000	98,403

Had the project been continued, 585,227 trees over an area of 1,341,864 acres would have required treatment in the spring of 1929.

The work in connection with this project was thoroughly conducted, and each year there was practically no infestation left within the areas covered by control. Little apparent benefit resulted from this excellent work, however, for each year the treated areas were heavily reinfested as the beetles moved southward from the Bitterroot area across the Continental Divide, extending the zone of infestation farther to the south and east. The severe annual reinfestation of the areas covered by control, as well as the fact that in 1926 the beetles had crossed the 12 or more timberless miles of the Big Hole Basin, which lies in the northern portion of the Beaverhead Forest, indicated very forcibly that in formulating the plan of control the powers of flight of the mountain pine beetle had been underestimated.

During the season of 1927 a new source of infestation for the southern areas of the Big Hole Basin was discovered in some severely infested areas along the east side of the Salmon National Forest. These areas extended along the west side of the Continental Divide and bordered the Jackson and Bloody Dick units, and certain other southern units of the Beaverhead National Forest that are not shown in Figure 1. Though the importance of these centers of infestation as a source of reinfestation cannot be accurately evaluated, there is reason to believe that they did contribute materially to the infestation on adjacent Beaverhead areas. The source of the Salmon National Forest outbreak is a matter of conjecture, but it was so extensive in 1927 that it could not have originated from the newly developed Beaverhead infestations.

Though in the spring of 1928 the sources of reinfestation were recognized as being of such force as to make the continuation of control within the Big Hole Basin a seemingly hopeless operation, the values at stake warranted a final effort to check the southern spread of this destructive outbreak. This final operation was necessarily on a much larger scale than those of the two previous seasons, treatment being extended to all pine stands surrounding the basin. This effort again proved futile, for the subsequent survey, which for the first time was extended into all pine stands of the forest, showed that the treated areas had been more heavily reinfested than ever before and that the infested acreage was materially increased.

The knowledge of the extent and severity of the 1928 infestation within this forest made further control inadvisable, not only on account of the expense, but also because of the near certainty of failure. Though control measures were discontinued, it was hoped that the wide, timberless Beaverhead River valley, which bordered the Beaverhead National Forest on the east, would serve as a barrier to any extensive spread of the beetles to the southeast. In 1930, however, infested areas were recorded on the Sheep Canyon Hills, an area of public domain (not shown in Figure 1) some 35 miles from the nearest Beaverhead infestation, and on the headwaters of Backtail Creek on what was then the Madison National Forest. In 1931 control measures were instituted within these areas as a means of protecting the valuable timber stands to the south. Though all

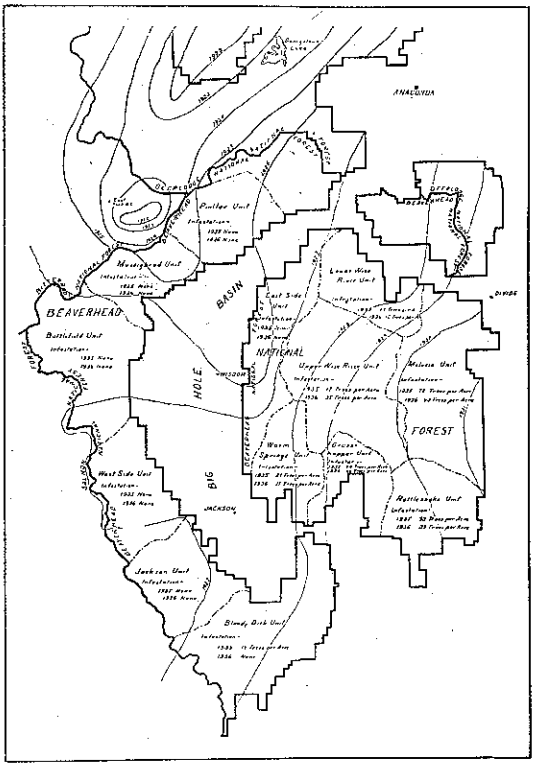

Fig. 1.—Spread of the mountain pine beetle through the northwest portion of the Beaverhead National Forest.

known infested areas to the east of this hoped-for barrier were covered by control measures, the effort was again futile, as the beetles apparently continued to cross this timberless area and the following season killed several times as many trees on the treated areas as the number previously treated. This condition seemed to demonstrate the impossibility of preventing the continued southeastward spread of the epidemic, and all attempts at further control work were discontinued.

Since the beginning of the Beaverhead project in 1926, an annual survey has been conducted to record the development and progress of the infestation within the different areas. The spread of this infestation as it swept across the lodgepole pine stands of the northwest portion of the Beaverhead National Forest is graphically presented in Figure 1. In this figure the annual extensions of this infestation are represented by the dated meandering lines. The status of the 1935 and 1936 infestations within the different units is also shown.

Figure 2 shows graphically the total and annual losses in lodgepole pine stands within the Beaverhead National Forest during the 10 years 1927 to 1936, inclusive. It is estimated that a total of 57,756,000 trees 3 inches d.b.h. and over were killed during this period. The greatest loss in any one year occurred in 1932, when 17,586,000 trees were killed. The marked decrease in the 1933 infestation was in some areas due partially to the lack of host material, but primarily to the mortality in the overwintering broods of the mountain pine beetle caused by unseasonably low temperatures. In those units where an ample supply of host material still existed, the infestation began to rebuild in 1934, but the broods from the 1934 attacks were again subjected to similar low temperatures, which caused a marked decrease in the 1935 attack. In 1936 no losses were caused by the mountain pine beetle on seven of the forest units, while on the other eight the infestation was materially reduced. In some units there still remain a rather large number of mature trees; and as in 1937 and 1938 the in-

Fig. 2.—The total and annual losses in lodgepole pine stands within the Beaverhead National Forest, 1927 to 1936 inclusive.

festation continued to decrease in severity, a large percentage of them will undoubtedly escape the present infestation.

Though a number of secondary bark beetles are associated with all mountain pine beetle epidemics, *Pityogenes knechteli* Sw. is perhaps the most important, and during the decline of such epidemics it is always responsible for the death of small trees. As there are at least two generations of this insect each season, the green tops of trees killed the previous season by the mountain pine beetle are attacked by the first generation, and the tops of newly attacked trees by the second. Though this beetle played an important role in the destruction of timber on the Beaverhead National Forest, under normal conditions its population would have decreased concurrently with the decrease of the primary insect. In 1933, however, the abnormally sudden reduction in the number of trees killed by the mountain pine beetle materially limited the supply of such host material for subsequent Pityogenes attack. As these insects were apparently not affected so severely by the low temperatures, the broods that emerged in 1934 were forced to attack uninjured green trees. Though primary attacks of these beetles are usually confined to trees of small diameter, during this period many large trees were killed. In 1937 and 1938 the losses from Pityogenes attacks, which were greatest in 1934, returned to a status normally characteristic of gradually decreasing mountain pine beetle epidemics. The numbers of trees killed by this normally secondary insect during the years 1933 to 1936 inclusive are shown graphically in Figure 2.

If we consider the total stand as including all trees of 3 inches d.b.h. and above, the residual stand in 1936 shows an average stocking of 59.7 trees per acre. If, however, only merchantable trees 9 inches d.b.h. and above are considered, the residual stand will average only 3 trees per acre. As the acreage used in arriving at these figures included untimbered areas, the number of trees per timbered acre will be considerably higher for some of the areas. The loss varies materially for the different units, depending upon the number of years the infestation has been present. For example, within the units around the Big Hole Basin approximately 93 percent of the merchantable trees have been killed, while on the southern and eastern units this loss has been only 57 percent. The total loss of merchantable trees is estimated to be 77.3 percent of the original merchantable stand. Table 1 shows the character of the losses in tree diameter classes for the 12-year period 1927 to 1938, inclusive, but includes only those areas of the Beaverhead National Forest which border the Big Hole Basin, or a total area of 543,700 acres. As the infestation was at its height when it swept through these areas, the destruction of timber has been more severe than in other portions of the forest. These figures are shown as a depiction of the maximum seriousness of the outbreak.

Although there was no dislocation of timber-using industries as a result of the epidemic on the Beaverhead National Forest, the killing of merchantable trees has virtually destroyed the potential values of this forest. In a few areas as much as 40 percent of the commercial timber is still living, with very light losses from 1936 to 1938. There still remains a fair stocking of poles

TABLE 1.—LOSSES IN LODGEPOLE PINE, BY DIAMETER CLASSES, ON 543,700 ACRES BORDERING THE BIG HOLE BASIN, DUE TO THE MOUNTAIN PINE BEETLE INFESTATION DURING THE PERIOD 1927 TO 1938, INCLUSIVE

D.b.h. classes	Trees prior to infestation	Trees			Trees killed by—	
		Killed	Living in 1938	Trees killed	*Dendroctonus monticolae*	*Pityogenes knechteli* and associated bark beetles
Inches	*Number*	*Number*	*Number*	*Percent*	*Number*	*Number*
3.0-4.9	26,083,490	2,895,012	23,188,478	11.1	1,688,757	1,206,255
5.0-6.9	16,642,840	6,416,250	10,226,590	38.6	4,963,611	1,452,639
7.0-8.9	12,819,743	6,026,142	6,793,601	47.0	5,435,847	590,295
9.0-10.9	6,288,972	5,061,138	1,227,834	80.5	4,927,680	133,458
11.0-12.9	2,048,583	1,905,182	143,401	93.0	1,867,079	38,103
13.0-14.9	1,134,908	1,106,535	28,373	97.5	1,105,470	1,065
15.0-16.9	130,378	120,600	9,778	92.5	120,600	———
17.0-18.9	91,367	91,139	228	99.8	91,139	———
Total	65,240,281	23,621,998	41,618,283	36.2	20,200,183	3,421,815

for which there is a constant local demand, and the cutting of these will be the only timber industry within the forest for many years.

The future of the residual stand within these beetle-killed lodgepole pine forests is problematical. A serious fire hazard has been created which will last for several decades. When fires occur in such areas, they usually develop into serious conflagrations owing to the tremendous accumulation of inflammable material. If no fires occur, the residual stand, with additional seeding from the larger trees, will produce a second crop of commercial timber in the shortest possible period of time.

The lesson to be drawn from this situation has to do with its cause rather than with theorizing upon the effect, and emphasizes the fact that forest-managing agencies should concern themselves with the prevention of future bark beetle epidemics. Bark beetles cannot be eliminated from an area, nor can the application of control be considered as a panacea for all future insect problems. A definite forest-insect program, however, will reduce their depredations to a point where the loss no longer becomes a serious factor in the destruction of timber resources. All bark beetle infestations must be regarded as potential epidemics, and when they are severe, prompt and adequate control is the only known method of preventing the development of destructive outbreaks. An organized, permanent system of forest-insect surveys offers the only effective means of discovering incipient insect outbreaks. Such information permits the institution of artificial control at a time when it is most effective and least expensive. The problem introduced by insects in the management program of the Beaverhead National Forest emphasizes the need for a more thorough appreciation of their importance, and provision for the detection and control of incipient outbreaks, regardless of their location, must be made if future losses of timber are to be reduced to a point where they are no longer a disturbing factor.

Girdling Hardwoods Promotes Growth of Conifers

EXPERIMENTS carried out in New Brunswick over the past ten years by the Dominion Forest Service of the Canadian Department of Mines and Resources, Ottawa, indicate that the growth of valuable young conifers can be stimulated through killing overtopping hardwoods by girdling.

The girdling experiments were initiated in 1928, when two 50-acre areas were established in mixed wood stands with a 10-acre control plot being set aside in each area. Seventy-five percent of the hardwoods present at the time of establishment were girdled. Healthy, well-formed hardwoods of high economic value were left but these, although serving to protect reproduction, have not yet shown any response to release.

At five year intervals two remeasurement surveys were made, the results of the latest showing that the composition of the stands is slowly changing towards a coniferous type and there are now ample conifers (two thirds of them spruce) to provide a future cut. Growth of the residual conifer stand has increased rapidly as a result of the girdling of the hardwoods, having advanced from 87.6 to 115.0 cubic feet per year on one area and from 33.3 to 57.7 cubic feet per year on the other. On one area there is now sufficient coniferous reproduction to warrant an immediate cut of from 5 to 10 cords per acre, but reproduction is not yet established on the second area.