The Influence of Insects on Ponderosa Pine Silviculture[1]

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THE LIFE history and general characteristics of forest trees and stands are determined by environmental, climatic, and edaphic factors. In other words, the silvics of any forest type are determined by the interaction of environmental factors on the tree species involved. This law is well recognized by foresters, but how often is it recognized that insects may be the dominant environmental factor which determines the silvics of a forest species?

In the early days, before the American silviculturist arrived on the scene, the ponderosa pine forests of the West grew under the influence of climate, soil, and water. They were thinned and felled by fire, wind, and insects. These were the factors that produced the native ponderosa pine forests as they were found by early settlers. No European or American system of silviculture determined stand structure, density, rate of seeding, or selection of trees to be cut. Yet in spite of this lack of silvical science, nature did a pretty good job and presented American foresters and lumbermen with some 250 billion board feet of ponderosa pine ready for utilization.

In many parts of the ponderosa pine region, bark beetles were nature's principal silvical agent in regulating, thinning, and harvesting the stand. Since the products of their cuttings were not utilized, the waste was tremendous. Billions of feet of merchantable timber have been felled by beetles instead of lumbermen over countless centuries. Even so, the residue at any given time included some excellent-quality pine timber—probably all that the ground would support. What impresses many of us today is that the silvical process applied by the beetles is often indicative of the best natural system of silviculture to be applied to these trees. What did the beetles do?

First of all, we must recognize that there are several different kinds of beetles at work in different parts of the ponderosa pine region, and they do not all follow the same rules. On examining the distribution of insect species in the ponderosa pine region, we find certain species following the range of the Pacific Coast form of *Pinus ponderosa* and different species associated with the Rocky Mountain form of *Pinus ponderosa scopulorum*. The differences are so marked as to indicate that, from the silvical standpoint, we are really dealing with two different trees. Baker and Korstian *(1)*, Korstian (*2*), and Weidman (*3*) have shown consistent differences in climate, tree characteristics, and hereditary traits between the subregions of the ponderosa pine region, particularly between the *ponderosa* and *scopulorum* forms. The insects found in each of these subregions tend to confirm the validity of these different races or forms of ponderosa pine. Consequently, we cannot generalize about the silviculture of the ponderosa pine region, but must consider its component parts.

Throughout the range of the Pacific Coast form of *Pinus ponderosa* the mountain pine beetle (*Dendorctonus monticolae*, Hopk.), the western pine beetle (*Dendroctonus brevicomis* Lec.), and the California flatheaded borer (*Melanophila Californica*, VD.) are important silvical factors.

Mountain Pine Beetle

The mountain pine beetle plays an interesting and important silvical role in converting young, even-aged stands of pondersoa pine into uneven-aged forests. Sometimes it assists forest succession by completely changing a temporary type forest to a climax forest. For example, over large areas in the north plateau subregion young, fully stocked, even-aged stands of ponderosa pine may be found on what were once old burns. These even-aged stands do very well and produce high yields up to about 150 years of age. At this point they become overcrowded; the mountain pine beetle moves in and shoots them full of holes. The holes fill in with reproduction and from then on the forest develops as an uneven-aged stand of even-aged groups.

It is typical of the mountain pine beetle to wipe out temporary-type forests such as lodgepole or white pine, which have come up in old burns and thus aid the natural ecological succession to the climax type, but sometimes it also does this in ponderosa pine stands. For instance, within the borders of an old burn on the north slope of Sugar Hill in the Warner Mountains of northeastern California, a dense mixed stand of ponderosa pine and white fir came in. When this stand reached pole size, crowding commenced. The mountain pine beetle moved in, swept through this young stand—confining its epidemic to the borders of the old burn—and removed all the ponderosa pine, thus converting this stand into a pure white fir type for which the site was probably best suited.

Western Pine Beetle

In the interior ponderosa pine type of forest in the north plateau subregion, the western pine beetle appears to be the dominant silvical agent. Here its silvical function seems to be to thin overcrowded stands by taking out weak, crowded, slow-growing trees and those of declining vigor owing to drought, root troubles, or other causes. In its work, it applies what might be regarded as a "shelterwood system" of cutting. In overcrowded stands it makes "preparatory cuttings" by "thinning from below," taking out slow-growing, intermediate, codominant, and suppressed trees. Then it makes "re-

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moval cuttings" by taking out whole groups of overmatured trees, leaving holes in the forest. These holes fill in with reproduction. As the advance reproduction begins to crowd the older trees, the overstory gives way and the process of removal continues with young trees replacing the old. This process tends to maintain an uneven-aged stand, because the olders trees are killed and replaced in a groupwise fashion.

For many years the western pine beetle was combated without conspicuous success by the direct control measures of felling and burning infested trees. Then, when the role this beetle was playing in the silvics of ponderosa pine was realized, the beetle was tackled silviculturally. High-risk, beetle-susceptible trees were thinned from the stand before the beetles attacked them. By "beating the beetles to it," we have had remarkable success in reducing beetle-caused losses by over 90 percent in the first years after cutting, and over 70 percent for periods of more than ten years after cutting. Many foresters are familiar with the experiment in beetle control through sanitation-salvage logging, which was first applied in 1937 at Blacks Mountain Experimental Forest in California. It since has been applied on several privately owned timber tracts and on many national forest and Indian reservation timber sales. The principle of selecting high-risk trees as the first elements to be removed from the stand under any system of marking has been generally accepted and applied through the north plateau subregion. Too often it is believed that the same system can be applied throughout the entire ponderosa pine region; but this belief is not valid, for we are dealing with other insects whose behavior is not the same as that of the western pine beetle.

In the California subregion, lying mostly west of the Sierra Nevada, the western pine beetle is also present; but its behavior is very different, or at least the aggressiveness of its attack is slowed to the point where it is no longer a dominant element. Normally, it is present in endemic numbers, killing a few weakened or injured trees every year. Then, after a drought, fire, or an outbreak of Ips beetles, a sudden epidemic may develop. Large groups of trees of all ages and degrees of vigor are killed, apparently indiscriminately. No method of selectively removing the weaker trees in the stand would appear to have much chance of stopping these epidemics. For this reason, sanitation-salvage logging for western pine beetle control never has been advocated by the entomologists working on this problem as applicable to west-side stands of the California subregion.

The silvics of the California subregion are complicated by several important tree species, a great variety of mixtures and types, and a number of different primary insects associated with each tree. The insects behave differently on every acre, depending upon the tree species, age classes, and stand densities involved. No wonder that Ducan Dunning has developed his "unit area control" system of applying silviculture to this perplexing assortment! That's what the insects do, too.

Black Hills Beetle

In the eastern Rocky Mountains and central plateau subregions, the Black Hills beetle (*Dendroctonus ponderosae* Hopk.) has been the most influential insect working on the *scopulorum* form of ponderosa pine.

In habits and character of attack it is very different from the western pine beetle. Normally, it is scarce and found breeding only in a few unthrifty trees. Its outbreaks are sporadic and exceedingly aggressive. When outbreaks occur, they usually start in localized centers and quickly spread and increase in intensity. Then all classes of trees are attacked with no preference shown for understory, slow-growing, or weakened trees. In fact, it seems to prefer the thriftier, fast-growing trees to the slow-growing ones. In general, fully stocked to dense stands of trees over 75 years of age seem to be preferred. Stands younger than this, trees grown in the open, and those around the margin of openings seem to be avoided.

It appears to make selection cuttings, taking out large groups of trees which have reached a certain age. The large openings left by its group-kills fill up with seedlings and a new even-aged group develops. The forests of this region are characteristically more even-aged by large groups than the Pacific Coast form, and this beetle may be largely responsible.

Studies have been conducted to correlate outbreak cycles with stand conditions, tree growth, and precipitation. So far, no really significant correlation has been found; nor is it possible to select high-risk, susceptible trees, for this beetle apparently does not base its attacks on tree selection and shows no predilection for unthrifty trees.

Other Insects

In the Southwest a different set of bark beetles is found working on ponderosa pine, but they do not seem to be as important in dominating the silvics of ponderosa pine in that region as they do elsewhere. The late G. A. Pearson was more impressed with the importance of lightning, mistletoe infection, twig cutting by squirrels, or stagnation as causes of mortality than of bark beetles, although admitting that in many instances bark beetles dealt the final blow which killed the trees (*4*). He also stated, "It is possible that variations in bark beetle activity may account in large degree for the erratic death rate." The fact that bark beetles are generally of less importance in the Southwest than in the Northwest may explain why some foresters and forest-entomologists were not able to see eye to eye with Pearson on many silvicultural problems of the ponderosa pine region. From a silvical standpoint, they were really not dealing with the same tree.

Other insects which have an influence on the silviculture of ponderosa pine "from cradle to grave" should be mentioned. The ponderosa pine reproduction weevil often exerts decisive pressure on plantations and on the natural restocking of burns. Some plantations which have been attempted outside the tree's optium range have all but been wiped out by its attacks.

The engraver beetles, Ips, may become destructive when loggers make sporadic cuttings in the spring of the year and leave their slash unlopped and unscattered. The penalty may be the wholesale killing of second-growth stands. It is well to treat these Ips beetles with respect in cutting and thinning practices.

The defoliators, such as the pine white butterfly, the Pandora moth, and the pine variety of the spruce budworm, may flare up at any time and cause extensive damage. Six townships of ponderosa pine were leveled by the pine white butterfly on the Yakima Indian Reservation about 1893—an example of what this insect can do and may do again. So far, no one has been able to point out the silvical significance of pine defoliators. They are just as destructive as fire, and just as erratic. Until we know more about them, we will not try to control them with silvicultural practices, but will depend upon airplanes and DDT.

Where certain insects play a dominant role in ponderosa pine silvics, the answer to silvicultural problems can be found by studying the natural systems which the insects apply. To paraphrase Solomon's advice, "Go to the ant, thou sluggard; consider her ways, and be wise," my advice to the silviculturist is to study the insects and learn of their ways.

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Reproduction of Ponderosa Pine[1]

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REPRODUCTION is by no means a universal problem in ponderosa pine, but practically all western regions contain sizable areas where lack of regeneration presents a challenge to forest managers. The one outstanding exception is the Black Hills region of South Dakota where seedling crops come in regularly barring destructive fires or complete denudation (*5*).

Two rather distinct problems are involved, one characteristic of mixed stands and the other confined mainly to pure or almost pure stands. In pine mixtures, the overall restocking is usually good but seedlings of the more tolerant and less valuable associates—white fir, Douglas-fir, and incense cedar—often outnumber and outgrow those of ponderosa pine. In many instances the continued existence of the pine in these mixed stands is seriously threatened under selection cutting.

This paper deals entirely with the problem of the pure pine stands which reproduce sparingly or at long or irregular intervals. Here the need is one of securing new seedlings frequently enough to maintain a well-stocked stand.

Many investigators have studied and reported on various phases of ponderosa pine regeneration but probably no one has studied the problem as intensively or for as long a period as the late G. A. Pearson. After almost forty years of work in northern Arizona, he concluded that five factors call for special consideration in analyzing the causes of poor restocking and in developing a plan of management that will provide an orderly supply of new recruits (*12*). These are: seed supply, rainfall, seedbed, cutting practice, and protection. Reports from other regions indicate that these same factors are important wherever ponderosa pine grows, although their relative weight varies from region to region.

Seed Supply

Since ponderosa pine seed rarely remains viable more than one year on the ground, germination in any one growing season hinges mainly upon the quantity of seed produced the previous fall. Cone crop production varies greatly from year to year but it follows a very irregular pattern, and the factors that determine the size of the crop are imperfectly understood.

In the Southwest, there is a complete failure about one year out of every four, a good crop about one year out of every three or four, and usually a bumper crop about one year out of six or seven. When allowance is made for damage by cone beetles and losses from seed-eating rodents, the light cone crops of intervening years are largely ineffective since there is seldom a surplus for regeneration. A similar irregular pattern of cone crop production has been reported for California (*15*) and for the Northwest (*17*).

Early interest in seed production centered on the determination of the minimum number of seed trees that should be reserved from cutting to provide a satisfactory stand of seedlings. Their number was placed at four large trees per acre in the Southwest (*7*), three in California (*15*), and two in the Northwest (*17*). In the light of more recent experience, these estimates appear to be optimistic. Under the much lighter cuttings that now pre-

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