SOME INSECTS INJURIOUS TO FORESTS.

THE WESTERN PINE-DESTROYING BARKBEETLE.

BY

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ENTOMOLOGY,

SIR: I have the honor to transmit herewith the manuscript of a contribution, by Mr. J. L. Webb, on the Western Pine-destroying Barkbeetle. It has special reference to the results of investigations by Mr. Webb in central Idaho in 1905, but relates also to the results of other investigations and to available information on the insect and methods of combating it. I recommend its publication as Part II of Bulletin No. 58 of this Bureau. The figures and plates are necessary for the illustration of the text.

Respectfully,

L. O. HOWARD,
Chief of Bureau.

Hon. JAMES WILSON,
Secretary of Agriculture.
# CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>17</td>
</tr>
<tr>
<td>Death of the pine caused by the western pine-destroying barkbeetle</td>
<td>18</td>
</tr>
<tr>
<td>Character of the insect and its work</td>
<td>18</td>
</tr>
<tr>
<td>Distribution</td>
<td>19</td>
</tr>
<tr>
<td>Extent of damage and losses</td>
<td>19</td>
</tr>
<tr>
<td>Possibilities of preventing losses</td>
<td>20</td>
</tr>
<tr>
<td>Early history of the species</td>
<td>20</td>
</tr>
<tr>
<td>Observations by Hopkins, 1899-1904</td>
<td>21</td>
</tr>
<tr>
<td>Observations by H. E. Burke, 1904</td>
<td>23</td>
</tr>
<tr>
<td>Observations by the writer, 1905</td>
<td>23</td>
</tr>
<tr>
<td>Life history and habits of the insect</td>
<td>23</td>
</tr>
<tr>
<td>Hibernation</td>
<td>23</td>
</tr>
<tr>
<td>First generation</td>
<td>24</td>
</tr>
<tr>
<td>Second generation</td>
<td>24</td>
</tr>
<tr>
<td>Habits</td>
<td>25</td>
</tr>
<tr>
<td>Natural enemies</td>
<td>27</td>
</tr>
<tr>
<td>Insects</td>
<td>27</td>
</tr>
<tr>
<td>Birds</td>
<td>27</td>
</tr>
<tr>
<td>Methods of combating the insect</td>
<td>27</td>
</tr>
<tr>
<td>First recommendations</td>
<td>27</td>
</tr>
<tr>
<td>Trap trees</td>
<td>28</td>
</tr>
<tr>
<td>Summary</td>
<td>29</td>
</tr>
<tr>
<td>Habits and life history</td>
<td>29</td>
</tr>
<tr>
<td>Remedies</td>
<td>30</td>
</tr>
<tr>
<td>Trap trees</td>
<td>30</td>
</tr>
<tr>
<td>Storm-felled and lightning-struck trees</td>
<td>30</td>
</tr>
<tr>
<td>Publications relating to the western pine-destroying barkbeetle</td>
<td>30</td>
</tr>
</tbody>
</table>
ILLUSTRATIONS.

PLATES.

PLATE II. Work of the western pine-destroying bark beetle in bark, removed from killed tree; also faint marks on surface of wood. ............................................. 18

III. Work of the western pine-destroying bark beetle, removed from killed tree. ................................................................. 18

TEXT FIGURES.

FIG. 7. The western pine-destroying bark beetle (*Dendroctonus brevicomis*): adult male and female and details. ............................................. 18

8. The western pine-destroying bark beetle (*Dendroctonus brevicomis*): galleries in the inner bark. ............................................. 19

9. The western pine-destroying bark beetle (*Dendroctonus brevicomis*): larva. ................................................................. 20

10. The western pine-destroying bark beetle (*Dendroctonus brevicomis*): pupa. ................................................................. 22

11. The western pine-destroying bark beetle (*Dendroctonus brevicomis*): pitch tubes on bark of tree. ............................................. 25

12. The western pine-destroying bark beetle (*Dendroctonus brevicomis*): hibernating or transformation cell, exit burrow, exit holes, pitch tubes. ............................................. 26
THE WESTERN PINE-DESTROYING BARKBEETLE.

(Dendroctonus brevicomis Lec.)

By J. L. Webb,

Special Field Agent, Forest Insect Investigations.

INTRODUCTION.

The object of this paper is to give available information on this insect and methods of combating it, with special reference to the results of investigations by the writer during the summer of 1905 in central Idaho.

The need of the investigations was suggested in a letter dated August 10, 1904, from Mr. Gifford Pinchot, forester of the U. S. Department of Agriculture, to Dr. L. O. Howard, chief of the Bureau of Entomology, as follows:

I learn from the Payette Lumber and Manufacturing Company, one of the Weyerhaeusers, whose land lies on the Payette River north of Boise, that the pine in their holdings is said to be dying from the attacks of insects. If it were possible for you to assign Doctor Hopkins, or one of his assistants, to make examination of this region, unless it has already been done, I should greatly appreciate it, and I should likewise appreciate your sending to Mr. Edgar M. Hoover, general manager of that company at Boise, any information you may have bearing on this subject.

In response to this request the matter was referred by Doctor Howard to Dr. A. D. Hopkins, in charge of forest insect investigations, for attention, and Mr. H. E. Burke, an assistant, was instructed to make preliminary investigations in October of the same year. In May, 1905, the writer was assigned to this work, with instructions from Doctor Hopkins to make a detailed study of the forest insects of the region, with special reference to determining the following points: (1) The relation of the several species of insects to the dying of the trees; (2) the number of species involved, the relation of each to primary and secondary attack, and the life histories of the primary and secondary enemies; (3) the extent of the infested area, the percentage of timber killed each year during the past two or three years within given areas, the approximate losses, etc.; (4) the relation of logging operations to

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*a Order Coleoptera, family Scolytidae.
depredations by insects in adjoining forests, and the relation of time of felling timber in regular logging operations to attack by Dendroctonus and other bark and wood boring insects.

Accordingly, investigations were begun by the writer on May 17, 1905, with headquarters at Centerville, Idaho, and continued until October 10, 1905.

DEATH OF THE PINE CAUSED BY THE WESTERN PINE-DESTROYING BARKBEETLE.

Observations by the writer served to confirm the conclusion of Mr. Burke that the primary enemy was a barkbeetle identified by Doctor Hopkins as the western pine-destroying barkbeetle (*Dendroctonus brevicomis* Lec.).

CHARACTER OF THE INSECT AND ITS WORK.

The adult insect is a stout, brownish-winged beetle (fig. 7) from one-eighth to three-sixteenths inch in length, which attacks the living trees in swarms, and burrows into the living bark, through the inner layer of which each female excavates winding galleries (fig. 8 and Pls. II, III) in which to deposit eggs. These galleries serve to cut off the natural movement of the sap and completely girdle and kill the tree. In the vicinity of Centerville, Idaho, the eggs, deposited during June, July, or August, in little niches in the sides of the galleries, hatch within 4 or 5 days into small whitish larva (fig. 9), which mine at right angles from the primary gallery through the outer layers of the inner bark until they have completed their growth, which requires from about 20 to 30 days. They then bore into the outer corky bark (fig. 12, a) where they excavate little cells in which to transform, first to the pupa (fig. 10) and later to the adult. When the broods of the first generation have thus developed—in about 60 or 70 days—they bore out through the bark and fly to other trees to repeat the process and continue their depredations.

The presence of this destructive insect in a forest is indicated (1) by dead and dying trees scattered about or in clumps or large patches. (The dying ones, with fading yellowish and reddish foliage, are called
WORK OF THE WESTERN PINE-DESTROYING BARKBEETLE IN BARK, REMOVED FROM KILLED TREE; ALSO FAINT MARKS ON SURFACE OF WOOD. (ORIGINAL.)
Work of the Western Pine-Destroying Barkbeetle, Removed from Killed Tree. (Original.)
"sorrel tops," and the dead ones, with reddish-brown foliage, are called "red tops," or, if with bare branches or broken tops, are known as "black tops" or "broken tops;" a) by small masses of resin (pitch tubes, figs. 11 and 12, c) in the crevices of the bark of recently attacked living trees, as well as in those of the dying and dead ones; and (3) the presence of the species is determined by removing the bark from the dying and dead trees and finding the characteristic galleries (fig. 8 and Pls. II, III).

It must be remembered, however, that there are many different kinds of insects, some of them closely resembling the destructive species, always found in dying pine trees. Therefore, for the general observer to be positive in the matter, specimens of insects and work should be sent to the Bureau of Entomology for authentic identification.

DISTRIBUTION.

The insect is found in southern Idaho throughout, and its range extends to the northern part of the State. It is recorded from California, Oregon, and eastern and western Washington, and, according to Doctor Hopkins, a variety occurs in Arizona and New Mexico and attacks the western yellow pine (Pinus ponderosa) and the sugar pine (Pinus lambertiana).

EXTENT OF DAMAGE AND LOSSES.

With our present knowledge of the destructive work of this insect, it is evident that a vast amount of timber has been killed by it during the past ten years within the range of its distribution. It is estimated that each year for the past two or three years, from 2 to 5 per cent of the matured standing bull pine timber within the section investigated in the summer of 1905 has died as the result of its ravages.

POSSIBILITIES OF PREVENTING LOSSES.

With our additional knowledge of the life history and habits of the beetle, we are able to suggest practical methods of controlling it and of preventing a large percentage of the losses heretofore caused by its depredations.

SOME INSECTS INJURIOUS TO FORESTS.

EARLY HISTORY OF THE SPECIES.

LeConte, in 1876, described the species under the name *Dendroctonus brevicomis* from a single specimen collected in middle California. Dietz, 1890, considered *D. brevicomis* the same as the southeastern species, *D. frontalis* Zimm. Hopkins, 1899, concluded that it was distinct from *D. frontalis*, and therefore that the old name should be retained.

It appears that previous to 1899 nothing had been recorded in regard to the habits and life history of this insect, and that, therefore, the earliest records were made in 1899 by Hopkins, who found it associated with dying sugar pine and western yellow pine at McCloud, Cal., on April 21, 1899, and the next day at Grants Pass, Oregon, with several hundred pine trees which had evidently died from its attack. On May 20, also, at Buckeye (near Spokane), Wash., many trees were found which were dying, or had died, as evidenced by the abundance of the insects and the extent of their work, and on June 6, at Cedar Mountain, Idaho, Doctor Hopkins found it in the bark of pine trees which had been defoliated the previous year by the caterpillars of the pine butterfly (*Neophasia menapia* Feld.). He found also that this beetle was quite intimately associated with the destruction of a large amount of timber only partly defoliated by the caterpillars.

Under his discussion of the principal scolytid enemies of the forests in the Northwest, Doctor Hopkins refers to this species as follows: a

*Dendroctonus brevicomis* Lec. was found to be a most destructive enemy of the yellow pine (*Pinus ponderosa*) in northern California, southern and eastern Oregon, northeastern Washington, and western Idaho. A large amount of some of the finest timber in all of these localities had died within the past seven or eight years, evidently as a direct result of attacks by this bark beetle. It was also found to attack and prevent the recovery of trees injured by defoliating insects and other causes. Its habits and the character of its galleries appear to be identical with those of *Dendroctonus frontalis*, which is noted for its destruction of vast quantities of pine and spruce timber in West Virginia and adjoining states between 1890 and 1893. It is killing the western yellow pine just as *D. frontalis* commenced to kill the eastern yellow pine (*Pinus echinata*) before it spread to all the other pines and spruce. Therefore, just as *D. frontalis* has proven to be the most destructive enemy of eastern conifers, the western representative of this species will doubtless prove to be, under similarly favorable conditions, equally as destructive to the western forests in which the conifers predominate.

Among the most important features observed regarding the habits of this beetle was the fact that it is attracted to trees girdled by settlers and farmers in the process of clearing land, and that in the bark of such trees it breeds and multiplies in sufficient numbers to enable it

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to attack and kill the timber in adjoining healthy forests. Indeed, my observation leads me to conclude that a considerable number of girdled pine trees may easily form a nucleus for a destructive invasion by it.

In the same bulletin, under the head of "The western yellow pine," he says:

It has in *Dendroctonus brevicomis* a most pernicious enemy, which penetrates and excavates winding galleries through the living bark of the finest trees, thus speedily causing their death. Very many trees have died and are dying from this cause, and the dead ones are contributing to the spread of forest fires.

Specimens of the insect and its work occupied a prominent place in the exhaustive exhibit of insect enemies of forests and forest products at the Louisiana Purchase Exposition at St. Louis, in 1904, and the Lewis and Clark Centennial Exposition at Portland, Oregon, in 1905, and were referred to in the catalogues of the exhibits by the Bureau of Entomology.

**Observations by Hopkins, 1899-1904.**

The following summary relating to this species, prepared by Doctor Hopkins from his field notes, includes many facts which have not been published and which have a direct bearing on the life history and habits of the species in different sections of the country where it is found:

McCloud, Cal., April 21, 1899.—Work and dead adults were discovered in a sugar pine log, evidently from a tree which was dying when felled; also dead parent adults in primary galleries, and larvae and pupae abundant in outer bark of large dying western yellow pine with the characteristic appearance of eastern pines when dying from the attack of the destructive pine bark-beetle, *D. frontalis*. A few immature adults were found in the outer bark, and evidence that some had emerged. This evidence was in the form of apparent exit holes in the bark, which may have been ventilating holes from main galleries, for with our present knowledge it is not likely that any adults could have emerged so early.

Grants Pass, Oregon, 1899.—On April 24 numerous dying western yellow pine trees were found here scattered through the forest where a severe windstorm had blown down much large timber on September 24, 1895. Young adults, larvae, and pupae were found in the outer bark of the standing trees which had evidently been attacked and had commenced to die the previous fall. April 25, numerous trees were observed which died the fall before and others which were not yet dead. One group of 30 young trees about 2 miles north of town were dying at the top, the leaves turning yellow and brown. All trees, without exception, were either infested or had been infested with *D. brevicomis*, and every indication pointed to this species as primarily to

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blame for the trouble. There were many trees which had been dead for from 3 to 10 years, and in the bark of those dying within the past 4 years traces of the characteristic galleries of *D. brevicomis* were found. No large bodies of timber had died, but the dead and dying trees were scattered all through the forest. A few examples of adults were found mining in living bark of a dying tree, where they had evidently passed the winter, since none of the broods had sufficiently matured to emerge. April 26, eight large trees—five western yellow pine and three sugar pine—which had evidently died in 1897, were observed in the Slate Creek Valley. The western yellow pine exhibited abundant work of *Dendroctonus brevicomis*, and the sugar pine the work of both this and a larger species of the same genus (*D. monticola*).

**Buckeye, Wash. (near Spokane), May 22.**—A small western yellow pine tree, evidently killed by the insects, was found. None of the brood had emerged, having died in the bark, possibly from the effects of unfavorable climatic conditions. In another tree killed by this species at this place, young living adults were found.

**Cedar Mountain, Idaho (near Moscow), June 4.**—The bark of western yellow pine trees defoliated by pine butterfly larvae was found to be infested by larvæ and pupæ of *D. brevicomis*. Dead parent adults, also, were found in the primary galleries.

**Mariposa County, Cal., June 9, 1904.**—Fragments of dead adults were found in primary galleries in bark of a large western yellow pine tree, evidently killed by this species.

**Yosemite Valley, California, June 13, 1904.**—Western yellow pine trees cut between September 20 and 24, 1903, were found to be thickly infested with larvæ of this species from eggs evidently deposited in September or October.

**Observations by H. E. Burke, 1904.**

From October 20 to 26, 1904, Mr. Burke found the work of this species on western yellow pine quite abundant in the region of Smiths Ferry, Idaho. Under date of October 26 he records observations regarding this barkbeetle in a western yellow pine tree 3 feet in diameter felled some time during that summer; the foliage and bark were living, but red borings on the bark showed where insects had entered. Adults of the *Dendroctonus* were present in short winding galleries.
in the living inner bark, two adults to a gallery. Eggs occurred singly in niches on the sides.

He estimated that as a result of the work by this insect near Smiths Ferry 30 per cent of standing timber was dead and 5 per cent was dying. This was at the worst point of infestation, but scattered dying timber was found all over Boise and Payette basins. The same condition extended into the Bitter Root Forest Reserve.

OBSERVATIONS BY THE WRITER, 1905.

The investigations by the writer during the summer of 1905, so far as they related to this species, were mainly for the purpose of determining the principal facts in its life history and habits in the vicinity of Centerville and Smiths Ferry, Idaho. The results may be summarized as follows:

LIFE HISTORY AND HABITS OF THE INSECT.

HIBERNATION.

While it is probable, as observed by Hopkins at Grants Pass, Oregon, that a few parent adults which enter the bark in the fall may pass the winter in that stage, it appears that it is in the young to matured larval stages that the insect normally passes the winter, each individual in a separate mine or cell in the outer corky bark of the tree in which it developed the previous summer and fall. The earliest observations at Centerville were made on May 18, when larvia, pupae, and young adults were found. Some of the larvia were small, but the majority of them were mature and ready to change to pupae. The pupae and adults had evidently transformed from larvia since the beginning of activity in the spring.

The latest date on which larvia of the hibernating broods were found was June 13. Pupae were found as late as July 3, and adults July 7. It is therefore evident that the majority of the over-wintering broods develop to the adult stage by about the middle of June, but broods from eggs deposited late in the fall may not develop until nearly the middle of August. Adults begin to emerge in the latter part of May and continue to do so through June and July and into August. Thus the period of activity of the hibernating broods at Centerville is probably from the first warm days in April and May until about the last of July—approximately 90 days—the majority, however, coming out in June and in early July.

FIRST GENERATION.

The first generation at Centerville begins with the first eggs deposited, apparently about the last of June, by the adults developed from hibernating larvia and pupae. These eggs hatch in about 4 days after deposition. The principal egg-laying period for this generation is evidently between the latter part of June and the first part of August.
It would appear that the length of time spent in the larval state is from 31 to 35 days. Sometimes, however, a few individuals of this first generation, either from retarded development or other causes, do not go through their transformations with the rest of the broods, but remain as larvae all through the fall and winter, evidently changing to pupae in the following spring.

The length of time spent in the pupal stage is approximately 15 days. Pupae of this generation were observed in different broods from August 14 to September 6.

The first adults, evidently of this generation, were observed in the bark August 14. The length of time spent in the bark after reaching this stage appears to be from 7 to 14 days. It is difficult to tell just when the emergences cease, as the last individuals of the brood come out scatteringly. Thus, on October 10 a few adults were still found in the bark. As this was the last observation, it is not known whether adults emerged later in the fall or whether they passed the winter in the bark before emerging; but the latter was probably the case. In one tree under observation eggs were deposited July 6 and the broods developed and emerged by August 28, a period of 53 days. Thus it appears (1) that the first generation begins with eggs deposited probably in the latter part of June; (2) that the majority of the broods develop and emerge by the first part of September (a period of about 60 days), but that some may continue to develop and emerge until in October; and (3) that possibly some pupae and young and matured adults may hibernate along with the larvae. Thus it may require 300 to 390 days or more for the complete development and emergence of some individuals of the first generation.

SECOND GENERATION.

Eggs deposited by adults of what appears to have been the first generation were found August 26 and as late as September 13. It will therefore be seen that there is a partial overlapping of the periods of the two generations.

Larvae were found as early as September 4, and on October 10, when the last observation was made, some larvae were apparently full grown.

No pupae or adults of this generation were found up to the time of the writer's last observations—on October 10, 1905. Mr. Burke found adults, but probably of the first generation, excavating galleries and depositing eggs as late as October 26, 1904. Thus it appears that the second generation, beginning with the first eggs deposited by adults of the first generation, passes the winter in the larval stage and develops and emerges by the middle of the following June to the first part of July. It therefore occupies a period of about 315 to 330 days, including about 60 days of activity in the fall, 165 days of hibernation, and 90 to 105 days of activity in the spring and early summer.
It is probable that at higher elevations and farther north the majority of the broods would not develop in much less than a year's time and that at more southern and warmer localities in the Pacific Coast region there would be two complete generations and possibly a partial third.

**HABITS.**

When first transformed, in May and June, the young beetles have very soft, delicate tissues. They therefore remain in their pupa cases until their bodies are fully hardened or chitinized. When nearly ready to emerge, the adults bore their way almost to the surface of the bark (fig. 12, a), but pause before emerging, appearing to rest in the burrows they have just made. They do not, however, hollow out the space immediately adjoining the pupa case, as is the habit of another species of this genus. When quite ready to emerge, the beetles continue their burrows out through the remaining portion of the bark. The individuals of a brood do not appear to emerge simultaneously, but they come forth at irregular intervals until all are out, leaving the bark thickly punctured with small, round, clean-cut holes, as shown in figure 12.

After leaving the tree or trees in which they went through their transformations the beetles fly away to find trees in which to deposit eggs. They may select trees close at hand or may fly quite a long distance before making a selection. They will also enter the living bark of recently felled trees. Large numbers of
the beetles usually settle upon a few trees close together and crawl about upon the bark from near the base to about two-thirds of the distance to the tree's top, seeking suitable places for entrance. Crevices in the bark are favorite places with them for this purpose. The female appears to bore the entrance hole in the bark, and may or may not be closely followed by her mate. In some cases where galleries had just been started, females were found alone, that is, one female to a single gallery. In others, the female was followed by the male. As the first incision is made into the living inner bark, the tree begins exuding pitch to cover the wound made by the intruding beetle. This pitch or resin collects at the mouth of the entrance hole in the form usually known as a pitch tube (figs. 11 and 12, c). Where the attacking force of beetles is small, the efforts of the tree to heal these wounds not infrequently succeed, the flow of pitch being so great as to overcome and suffocate the beetles. In such cases the dead beetles may be found in the pitch masses after the tree has recovered. Where the attacking force is large, however, the flow of pitch does not seriously hinder the beetles. After completing the egg laying, the parent adults remain for some time in the galleries and excavate irregular branching burrows toward the end farthest from the entrance, where they remain until they die.

After successfully effecting their entrance into the bark, the females excavate, through the inner layer of bark, winding, irregular galleries, which run into and cross each other many times (fig. 8). The eggs are laid at the sides of the gallery, each in a little niche hollowed out to receive it and packed in with the borings made in excavating the gallery.

Almost immediately after hatching the larva begins feeding upon the cambium surrounding the niche in which it hatched. For a few days it remains in the cambium, then bores out toward the outer bark. As it progresses, it is at the same time growing, and this growth is indicated by its constantly widening mine or burrow, which

![Diagram of the western pine-destroying bark beetle](image-url)
is made larger to accommodate the size of the body. Having reached the outer bark, it hollows out an oval space or pupa case, in which to go through its transformations.

NATURAL ENEMIES.

INSECTS.

Larvae of the predaceous beetles of the genus Clerus, which are known to prey upon Dendroctonus larvae, were quite common in and under the bark of the infested trees, and they doubtless help to some extent in keeping down the numbers of the barkbeetles.

BIRDS.

Birds contribute their part also in destroying larvae and pupae. The work of woodpeckers was found upon most of the trees which had been killed by D. brevicomis, and these birds had evidently destroyed a large percentage of the insects in some of the trees.

METHODS OF COMBATING THE INSECT.

FIRST RECOMMENDATIONS.

The following information and recommendations relating to this insect and methods of preventing losses from its ravages were conveyed by Doctor Hopkins to Mr. E. M. Hoover, of Boise, Idaho, manager of the Payette Lumber and Manufacturing Company, in a letter dated January 23, 1906, and afterwards published, with Mr. Hoover’s reply, in a local newspaper.

Our special field agent, Mr. J. L. Webb, has submitted his report on forest insect investigations in the vicinity of Centerville and Smiths Ferry, Idaho, during the past summer, and it will interest you no doubt to know that the insect which is primarily to blame for the death of pine trees was located and thoroughly studied by him.

He found that the broods of the destructive species pass the winter in the grub state in the bark of trees which died during the late summer and fall and that they do not transform to the winged form and emerge until after the 1st of May. Therefore the method of combating the pest is simply to cut the infested trees any time between the 1st of October and the 1st of May and to remove the bark from the main trunk and burn it.

It is necessary to burn the bark in order to kill the broods of this insect, because they occupy the intermediate portion between the inner surface and the outer scale portion; hence the drying of the removed bark will not kill them as it would if they occupied the inner moist portion.

The infested trees can be located (1) by the yellowish and light reddish brown color of the foliage; (2) by cutting into the bark as high up on the trunk as a man can reach with an ax to determine whether the middle portion of the bark is infested with the small white grubs, which are about three-sixteenths of an inch long. If these are found, it will be conclusive evidence that the tree has been killed by the beetle and is infested with its broods. It must be remembered that there are hundreds of other kinds of insects which occupy the inner portion of the bark and wood of such trees, but none of the smaller ones pass the winter in the outer bark.

Perhaps the most important thing for you to do as a preliminary to any definite action you may take in the matter is to have a number of intelligent cruisers make a survey of your holdings for the purpose of locating the principal sections in which trees have died during the
past summer and the location of the larger clumps and patches of infested trees within such
sections; then, if the locations of the infested areas and clumps are indicated on a map, it will
aid materially in planning effectual operations. If you could conduct your logging opera-
tions in these sections and utilize the infested trees the desired results would be accomplished
without much expense. It is not necessary that all scattering infested trees should be felled
and barked, but it is of the greatest importance that all of the larger clumps and patches
within the worst infested areas should be thus treated within the period mentioned. If this
can not be done this year, the work of locating infested areas should be conducted next sum-
mer (1906), in order that the more important sections may receive attention next fall and
winter.

We shall hold ourselves in readiness to give you further information and suggestions on
subjects which may not be clear to you, and whenever there is doubt about the insect or its
work specimens should be sent to us for authentic identification.

In response to this letter, Mr. Hoover wrote:

We are most gratified with the information given us and feel that it will be of much value
to us in our woods operations. * * *

The ferreting out of the insect pest and advising a way to combat it is a work of great value
to the country and of especial interest to all persons interested in forests, and we wish to add
our word of appreciation of the service of your Bureau.

Your letter is clear and explicit, and we will be glad to take advantage of your suggestions
in our logging operations and have conveyed the information to other lumber companies
operating in this vicinity.

Doctor Hopkins has, since then, prepared the following additional
recommendations and summary:

TRAP TREES.

With our present knowledge of the life history of the western pine-
destroyer and its habits of attacking girdled and felled trees, it is evi-
dent that trap trees a may prove effective in keeping the insect under
control, especially in localities where only a few trees are being killed
each year or after a large number of the infested trees have been felled
and barked in a badly infested locality.

The time to girdle and fell trees to catch the first generations would
be about the middle of June, the bark to be removed and burned in
about 20 to 25 days, or before the broods emerge. Girdled or dead-
ed trees are prepared by the "girdle to heartwood" method—that
is, cutting through the sapwood all around the trunk 3 or 4 feet above
the base or as high above the base as convenient to chop; for this pur-
pose large, inferior trees should be selected.

Felled trees should be lodged or allowed to fall on logs, rocks, etc.,
so that the prostrate trunks will be as far as possible from the ground.
Trees prepared in this manner will usually be attacked by swarms of
the beetles, which will excavate galleries in the bark and deposit their
eggs. After the eggs have hatched and the larvae are about full grown,
the removal and burning of the bark will effectually destroy the broods
and thus contribute greatly to reducing the numbers of the beetles—

a Living trees girdled or felled at the proper time to attract the flying beetles to them and
away from healthy trees.
which must occur in large numbers before they can attack and kill a tree. Some of the living trees in the immediate neighborhood of the trap trees may be attacked by beetles attracted to the vicinity by the felled or girdled trees. These should be felled and treated the same as trap trees.

If the conditions appear to warrant it, additional trees should be girdled or felled about the first part of August to catch the second brood. These may be barked, to kill the broods, any time between the first part of October and the first part of the following May.

**SUMMARY.**

**HABITS AND LIFE HISTORY.**

The western pine-destroying barkbeetle usually attacks and kills the best examples of western yellow pine and sugar pine.

If neglected and under certain conditions favorable to the species, it is capable of devastating the pine forests over large areas. The broods of the beetle pass the winter in the outer bark of trees killed by it the previous summer. The adults of the overwintering broods emerge and fly in May, June, and July, the beginning and ending of the period varying with the seasons, latitude, and altitude.

The first eggs from the first generation are deposited in June or July, and in some of the warm localities possibly as early as the middle of May. In localities intermediate between the colder and warmer regions the majority of the adults of the first generation evidently develop and emerge in August, but some individuals may remain in the trees until June of the next year.

The first eggs of the second generation are evidently deposited in August and September, depending on locality, and it would appear that in intermediate localities all of the broods of this generation pass the winter (hibernate) in the larval stage in the outer bark. In the warmer localities some of them may develop and emerge in the fall, while in the colder localities there may be but one generation.

The first evidence of attack on living trees is the presence of pitch tubes (figs. 11 and 12, c) on the bark or of reddish borings lodged in the crevices and around the base of the tree.

During the fall, winter, and following spring, after a successful attack, the infested trees will be indicated by the fading yellowish and reddish leaves.

The work of the insect will be indicated by the winding galleries through the inner bark (fig. 8). Trees from which the broods have emerged will be indicated by large numbers of small holes through the outer bark (fig. 12).

**REMEDIES.**

The principal areas of infestation and the principal patches of infested trees should be located in September and October.
Beginning with the first part of October, the infested trees should be felled and the bark removed from the main trunk and burned; these operations to be completed by the first part of the following May.

If all of the trees within a given area cannot be thus felled and treated, the work should be concentrated on the larger clumps and patches of infested trees.

The cost per tree for cutting, barking, and burning the bark will range from about 30 cents to $1, depending on locality and accessibility.

Summer cutting, except in regular logging operations, is undesirable, since the cutting of a few trees in the midst of a large forest may attract the insects from a long distance, and thus result in extensive depredations in bodies of timber which it is most desirable to protect.

**TRAP TREES.**

In sections where it is known that the beetle is killing some of the timber, trap trees should be provided in June and August. Ordinarily, 4 or 5 inferior living trees within each section, on which there is evidence of the work of the beetle, should suffice.

Trap trees should not be prepared unless it is reasonably certain that the bark will be removed and burned before the broods of the beetles develop and emerge, otherwise such trees may contribute to the destruction of a larger amount of timber.

**STORM-FELLED OR LIGHTNING-STRUCK TREES.**

Storm-felled and lightning-struck trees are a menace to a healthy forest within the distribution of this insect, since they serve as breeding places and centers of infestation. Therefore, whenever practicable, such trees should be watched, and if found infested with broods of this beetle, they should be treated as recommended for infested and trap trees.

**PUBLICATIONS RELATING TO THE WESTERN PINE-DESTROYING BARKBEETLE.**


