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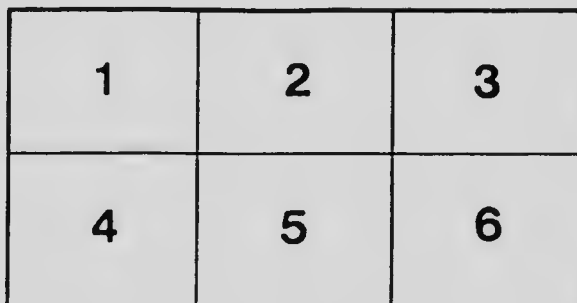
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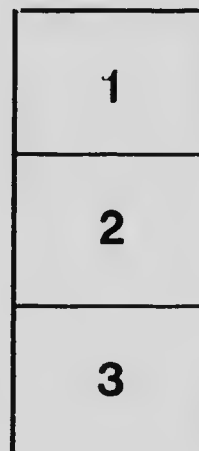
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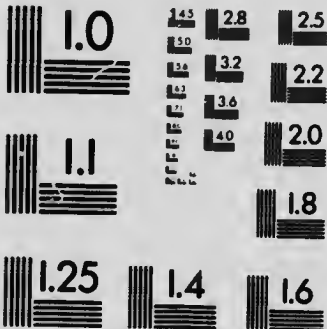
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DIVISION OF ENTOMOLOGY
Entomological Bulletin No. 7

FOREST INSECT CONDITIONS
IN
BRITISH COLUMBIA
A PRELIMINARY SURVEY

BY
J. M. SWAINE
Assistant Entomologist for Forest Insects

BULLETIN No. 17—SECOND SERIES

Bulletins of the Second Series (of the Bulletins of the Experimental Farms) treat of such subjects as are of interest to a limited class of readers and are mailed only to those to whom the information is likely to be useful.

Published by direction of the Hon. Martin Burrell, Minister of Agriculture, Ottawa

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1914

DOMINION EXPERIMENTAL FARMS.

DIRECTOR, J. H. GRISDALE, B. Agr.

DIVISION OF ENTOMOLOGY.

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NOTE.

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In all cases where it is possible, living specimens of the insects should be sent inclosed in a strong wooden or tin box to prevent damage in transit. Living insects should be supplied with a liberal quantity of their food plant, and in all cases they should be carefully packed.

The name and address of the sender should be written on the outside of the package, and a letter giving as full details as possible should in all cases accompany insects sent in for report.

The Honourable
The Minister of Agriculture,
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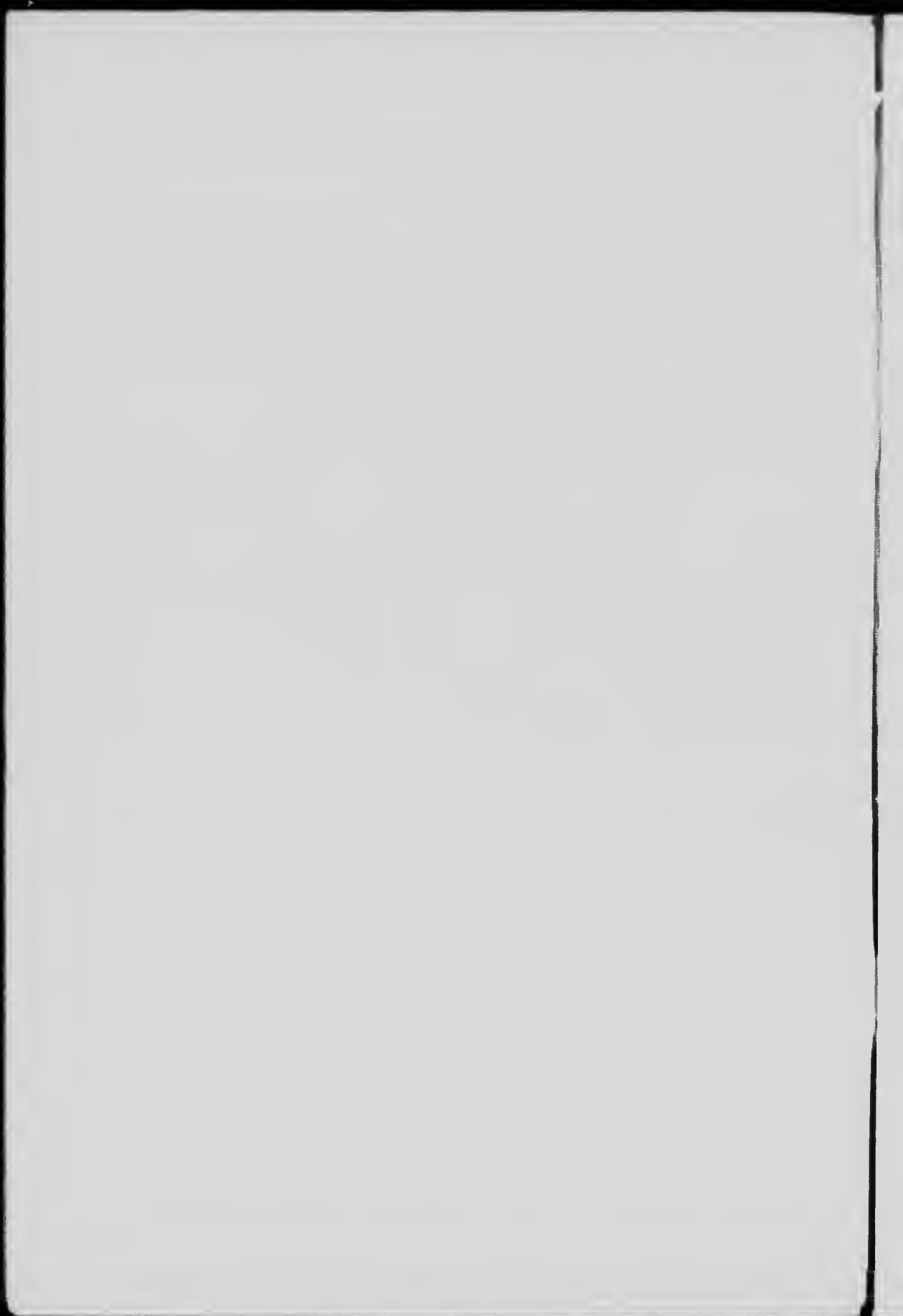
SIR,—I have the honour to submit herewith bulletin No. 17, of the Second Series, entitled, "A Preliminary Survey of Forest Insect Conditions in British Columbia," which has been prepared by Mr. J. M. Swaine, Assistant Entomologist for Forest Insects.

It is hoped that the studies of forest insects in British Columbia, here reported upon, and the methods suggested as to their control, will prove of value in the effort to conserve the timber resources of that province.

I have the honour to be, sir,
Your obedient servant,

FRANK T. SHUTT,
*Assistant Director,
Dominion Experimental Farms.*

OTTAWA. February 18, 1914.



February 11, 1914.

J. H. GRISDALE, Esq., B.Agr.,
Director, Dominion Experimental Farms,
Ottawa.

SIR,—I have the honour to submit herewith the manuscript of a bulletin on "A Preliminary Survey of Forest Insect Conditions in British Columbia," which has been prepared by Mr. J. M. Swaine, M.Sc., by whom the investigation was undertaken. It is recommended that this manuscript be published as a Bulletin of the Second Series.

Frequent reports of serious forest insect depredations in British Columbia have been received during the last few years, and in view of the high commercial value of the merchantable timber in the province, an investigation was projected. A request from the Minister of Lands of the province that such an investigation should take place coincided with our own wishes, and enabled us to arrange for the work to be carried on in co-operation with the provincial forestry officers. The Provincial Government contributed to the expenses of the investigation by defraying Mr. Swaine's expenses while in the province. I wish to acknowledge the assistance which Mr. H. R. MacMillan, Chief Forester of British Columbia, with whom the details of the work were arranged, rendered on all occasions.

The present bulletin has been written with a view to assisting immediately the lumbermen and owners of timber limits in the matter of recognizing the commoner species of injurious beetles, and their injuries, with a view to the adoption of the control measures which are described. The cost of the carrying out of these control measures is very frequently more than covered by the sale of the logs in addition to checking the outbreak of beetles which might result in the destruction of a large amount of timber.

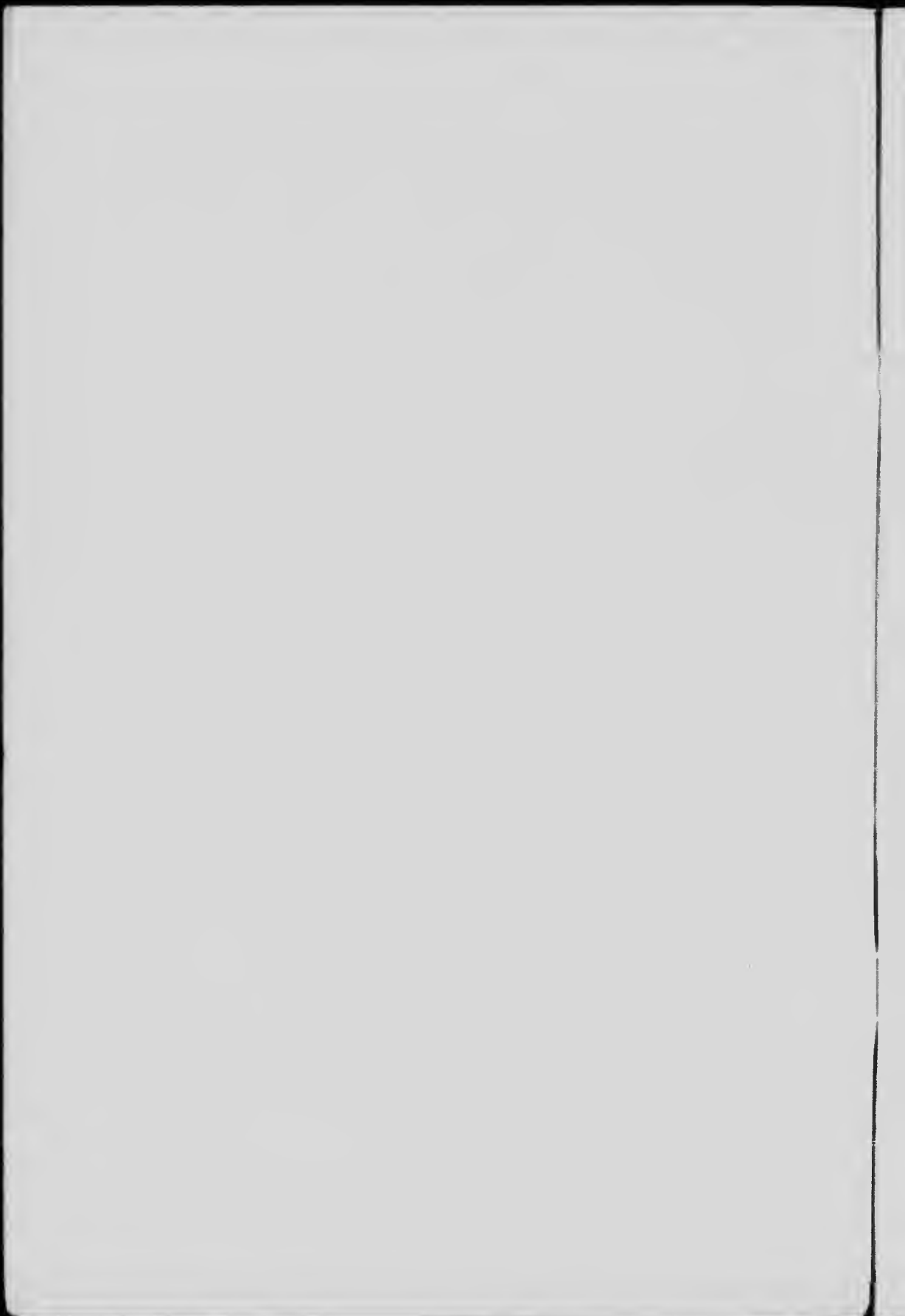
I have the honour to be, sir,
Your obedient servant,

C. GORDON HEWITT,
Dominion Entomologist.

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A PRELIMINARY SURVEY OF FOREST INSECT CONDITIONS IN BRITISH COLUMBIA.

BY J. M. SWAINE,

Assistant Entomologist for Forest Insects.

For several years reports have been received from various points in British Columbia indicating considerable loss from Bark-beetle attack to standing timber and logs. The lumber industry of the province is of such importance, and the destruction by forest insects in the States to the south has been reported as so serious in recent years, that it was thought advisable to make a survey of the actual conditions in regard to injurious forest insects in British Columbia forests. The Forestry Branch of the Department of Lands of British Columbia had in the meantime requested the Division of Entomology to undertake such an investigation. Accordingly, with the assistance and co-operation of the Provincial Forestry Branch, a survey was made during the summer of 1913 the object of which survey was to determine the location and extent of the chief forest insect injuries, and to decide upon proper control measures for the more serious outbreaks.

The territory covered included parts of the Kootenays, Okanagan, Similkameen, Lower Coast and Vancouver Island regions. Several destructive outbreaks of forest insects were located and studied, and much practical information was obtained for future control work with a variety of injurious species. A large collection was made of forest insects and their work, which will be of much practical as well as scientific value.

The forest area of British Columbia is so enormous that but a small portion of the southern part could be covered.

Reports previously received by the Provincial Forestry Branch and by the Division of Entomology from their officers and from lumbermen indicated the points to be visited.

Reports were received during the summer of apparently serious injury by Bark-beetles to spruce up the coast, and to spruce, pine and larch in the interior, at points which could not then be visited.

Much work of the kind attempted this summer remains to be done within the boundaries of the country now lumbered, and there is a large amount of injury in timber outside the present commercial area. It is highly important to have these outbreaks located and studied. We should know which species of insects are the primary enemies of the forests, and how they may be controlled; so that when it is found that serious injury is being done to valuable timber, as now occurs in several regions, the proper control measures may be applied without loss of time.

The assistance of lumbermen, cruisers and all travelling the forests, in reporting insect injuries and sending specimens of injurious forest insects and their work, will be of the greatest value.

The officers of the Provincial Forest Branch, especially Mr. H. R. Macmillan, Chief Forester, have rendered every possible assistance in the work, by furnishing information of infested districts and aiding in investigations. Mr. George Verdee, of Campbell River, rendered invaluable assistance in the work about Seymour Narrows and Campbell River, and has since forwarded material for study. Mr. Tom Wilson, of Vancouver, Inspector of Indian Orchards, assisted on a portion of the survey, and has supplied a large amount of valuable material for study from various parts of British Columbia forests.

The United States Bureau of Entomology have successfully controlled serious outbreaks of destructive Bark-beetles in several of the western states. They have proved that the destructive Bark-beetles can be controlled, when taken in time, and often at little expense; and have perfected methods of control. Their publications, chiefly those by Dr. A. D. Hopkins, will be of great assistance to us in the control of the same or allied species in British Columbia, and have helped to settle doubtful points in connection with the life-history of several of our species.

GENERAL REVIEW OF FOREST INSECT CONDITIONS.

THE LOWER COAST AND ISLAND.—The Lower Coast, from Seymour Narrows south, and the lower two-thirds of the Island, were included in the survey. There were many destructive forest insects in this region; but no extensive outbreaks of Bark-beetles, comparable to that in the bull pine of the Interior.

The Sitka spruce is attacked and killed by a destructive Bark-beetle and the western white pine is attacked and killed by the Mountain Pine Bark-beetle. Any valuable stands of spruce and pine in this region should be watched for outbreaks by these beetles, and the necessary control measures applied in time to prevent serious injury.

The Douglas fir, throughout this region, appears on the whole to be in fine condition. A moderate number of ringshaken trees occur locally on the ridges, and more or less injury by ground rot and shelf-fungi (conchs) was noticed. The fungi collected have been referred to the Dominion Botanist.

The Douglas Fir Beetle was found killing green timber in small amount at Cowitchan Lake, and near Campbell River.

Beetles of the genera (*Hylesinus*) and *Eccoptogaster* were found in several places killing balsam fir, and hemlock.

The Sitka Spruce Gall Aphis is causing serious injury, in places, to isolated trees, and to isolated clumps and small areas of spruce. There is a very serious infestation in Stanley park, Vancouver, and in the environs of the city.

The Vancouver Island Oak Looper, a small caterpillar, has caused serious injury to oaks on Vancouver island.

The Western Hemlock Looper, an allied species, has apparently killed numbers of hemlocks in Stanley park, and has very seriously injured many others.

Caterpillars were found in places destroying large numbers of cones of the Douglas fir.

The Larger Wood-borers and Ambrosia-beetles cause considerable injury to fire-killed timber and injured trees, and to logs left in the woods over summer.

THE INTERIOR:—The southern portion of the interior, from the Railway Belt south to the boundary, harbours a large number of destructive forest insects. Bark-beetles of several species are specially injurious. They have killed large quantities of bull pine, western white pine, and lodgepole pine, and lesser amounts of spruce, Douglas fir and larch. In several places the outbreaks by these beetles are so serious that vigorous control measures will be required to prevent extensive loss. The injuries to Engelmann's spruce and western larch will be discussed in later publications.

Twig-boring Bark-beetles and twig-girdling caterpillars are particularly common on the bull pine. Usually such injury is of little importance; but in places, numbers of trees were being killed in this way this summer. An interesting outbreak occurs between Okanagan Landing and Fairview.

The *Pissodes* Beetles, spruce and pine weevils, are abundant locally, destroying the terminal shoots of young growth. No very serious outbreaks were located last summer.

Throughout the Okanagan and Similkameen many bull pines are stag-headed. All such cases examined had been caused by bark-boring caterpillars destroying the inner bark in patches about the trunk and bases of the branches, working downwards from the top. These dead tops were covered with resin, and perfectly sound.



Fig. 1—Galls of the Sitka Spruce Gall Aphis, on Sitka Spruce; Stanley Park, Vancouver. (Original)

The cones of the bull pine and Douglas fir are frequently infested by boring caterpillars, which mine through the scales and axis and later destroy many of the seeds. These are in some places sufficiently numerous to seriously affect reproduction.

The larger wood-borers, of the families *Cerambycidae* and *Buprestidae*, are causing much loss to fire-killed or injured timber, and to felled timber and logs which are left in the limits, out of water, during two seasons or more.

The Ambrosia-beetles (Timber-beetles, or Pin-hole Borers), are also responsible for considerable loss under like conditions.

DETAILED ACCOUNT OF THE CHIEF INJURIES.

INJURY TO BULL PINE.

The bull pine, or western yellow pine, *Pinus ponderosa* Laws., occurs in British Columbia only in the southern part of the Interior. It is specially subject to attack by destructive Bark-beetles, Ambrosia-beetles, the larger wood-borers, and a variety of other injurious forms. Its thick sap-wood is rapidly attacked and destroyed by boring beetles and stained by bluing fungi; so that the timber of beetle-killed trees should be utilized at once.

Throughout its range in British Columbia, the bull pine is subject to attack by three destructive species of Bark-beetles, and a number of lesser importance. The Western Pine Bark-beetle, *Dendroctonus brevicomis* Lec., is one of the two most injurious; the Western White Pine, or Mountain Pine Bark-beetle, *D. monticola* Hopk., is as serious an enemy to the bull pine in British Columbia as it is to the western white pine, or mountain pine, from which it derives its name; and the Red Turpentine Bark-beetle, *D. valens* Lec., works in the inner bark about the base of green pines attacked by the two more destructive species just mentioned. Dying trees are also found in which this last species seems the chief cause of the injury.

Serious injury by these beetles, as evidenced by isolated trees and smaller or larger patches of dying and dead trees, is to be noticed in many places; but the most important and extensive outbreak known to us is that about Princeton, in the southwestern portion of the Bull Pine area in British Columbia.

BARK-BEETLE INJURY ABOUT PRINCETON.

The trouble there is noticeable from the clumps of recently dead trees, "red-tops," which are now becoming numerous throughout the valleys and upon the mountain-sides. When they were examined this summer, these clumps of red-tops contained from five or six to about thirty trees; but will now be considerably larger. The injurious beetles had then largely left the dead trees, and were to be found in immense numbers cutting their tunnels and depositing eggs in the inner bark of the trunks of green healthy trees surrounding the clumps of red-tops.

The boring of the beetles and their larvae through the inner bark cuts off the sap-flow and seriously weakens or, more usually, rapidly kills the trees attacked. Some trees survive attack for two or more seasons, particularly when only part of the tree is first infested; but in most cases the infested trees are killed in one year. From a 1,500 to 2,000 pairs of beetles were cutting tunnels and depositing eggs in the lower fifty feet of many of the infested trunks examined there this summer.

Hundreds of trees have been killed by the beetles since the outbreak commenced about three years ago, and a large number are now infested with the adults and larvae. Throughout the whole area affected, the number of killed and dying trees must be very large. The trouble may be noticed from Vernon through to Nicola, a distance of 250 miles. It appears to be widespread throughout most of the Bull Pine area; but a few localities are more seriously affected. The valleys of the Similkameen and Tulameen, in particular, are threatened with serious loss.

THE WESTERN PINE BARK-BEETLE.

(Dendroctonus brevicomis Lec.)

This is one of the two injurious species concerned. It is a cylindrical, hard-shelled beetle, from two to three-sixteenths of an inch in length, and varies in colour from light-brown, when recently transformed, to nearly black when mature. It is clothed above with *very short* inconspicuous hairs. The young are small, whitish, footless grubs, with powerful jaws, found boring chiefly in the outer portion of the inner bark.



Fig. 2.—The Western Pine Bark-beetle.
(*Dendroctonus brevicomis* Lec.) Greatly enlarged.
(Original.)

THE LIFE-HISTORY AND HABITS.—The beetles enter the green bark of healthy, injured, or recently felled trees in pairs during the summer months, and excavate long, irregularly winding egg-tunnels, mostly upwards from the entrance-hole, through the inner bark, upon the wood-surface. A portion of the red boring-dust and excrement is thrust from the entrance-hole and lodges in the bark crevices below; the remainder blocks the egg-tunnels. When the attack is made upon green trees, the exuding resin forms in irregular masses about the entrance-hole, and drops fall and adhere to the bark below. The male beetle keeps the entrance free through this mass of gum, which is known as the "pitch-tube" or "gum-tube." The presence of these gum-tubes upon the bark of injured trees indicates positively that the tree was attacked while the bark was green and full of fluid resin.



Fig. 3.—Dying Bull Pine showing gum-tubes of *Dendroctonus* on the bark,
Princeton, B.C. (Original)

The eggs are deposited singly in shallow niches cut by the female along the sides of the egg-tunnel at intervals of a half-inch or more; and the young larvæ, or grubs, which hatch in about eight days, bore irregularly, mainly in the outer layers of the inner bark. When nearly full-grown the grubs bore outwards deep into the middle layers of bark, enlarge the ends of the tunnels to form "pupal-cells," and there transform to the resting-stage or pupa. The adult beetles, which appear later from the pupæ, bore round holes through the outer bark and escape to spread the infestation to green trees, or to increase the numbers in the trees already infested.



Fig. 4.—Larva or grub of the Western White Pine Bark-beetle. Greatly enlarged. (Original).

Many of the beetles attack the trees near the red-tops from which they escape: but swarms, spreading from the old infestations, attack isolated trees and small clumps of trees at a considerable distance. The outbreak thus spreads by the increase in the number of the clumps and scattered infested trees, as well as by the enlargement of the individual clumps.

THE SEASONAL HISTORY OF THE BROODS.—There are, at least about Princeton, one brood and a partial second one each season. During the winter there may be found in the bark: the parent adults of the fall brood; young, light-coloured adults still in the pupal-cells; and many larvæ, or grubs in various stages.

The over-wintered parent adults extend their tunnels, or start new ones, when the weather becomes warm in spring, and deposit eggs. The adults developed from these eggs appear, apparently, early in August and start tunnels in the trees already attacked by the broods of over-wintered young adults. At Princeton this year these over-wintered parent adults largely left the bark and started new tunnels.

The over-wintered young adults emerge from the red-tops during July and attack green timber about the old red-tops or spread to isolated trees or clumps. About Princeton this season they apparently appeared largely during the first half of the month. By the middle of August the bark of the trees attacked by them was filled with their larvæ, of all sizes up to nearly full-grown; and the foliage, while not yellow, appeared slightly faded, so that such trees could usually be picked out as unthrifty. They could usually be distinguished by the gum-tubes which studded the bark by hundreds. It often happens that most of the gum-tubes are high up in the trees and are difficult to distinguish from below. This fact should be remembered when marking infested trees for cutting. The larvæ of this brood pupated and had in most cases left the bark as adults before the end of September. These adults apparently started fresh tunnels in the same trees, and deposited eggs, the larvæ from which are to be found in the bark during winter.

The over-wintered larvæ complete their transformations, emerge from the bark as adults, from the middle of July onwards, and start their egg-tunnels, probably at once, in the trees already infested.

At Princeton, this season, practically all the broods had emerged from the red-tops examined (trees attacked the previous summer) by the latter part of August.

The exact time of emergence of the different over-wintered broods will depend to some extent upon the altitude, location of the trees in regard to sunlight, and upon the lateness of the season.

SUMMARY OF SEASONAL HISTORY.

Over-wintering Forms.—Parent adults; young adults; larvæ of the second brood.

Seasonal History of Over-wintered—

Parent Adults.—Eggs, April and May; adults appear during August.

Young Adults.—Attack timber, and eggs laid early in July; larvæ maturing and adults emerging from late August onwards; egg-tunnels cut and eggs laid for a second brood, which winters as larvæ in the middle layers of bark.

Over-wintered larvæ.—Transform to pupæ in late April and May, according to season, and emerge from the trees as adults during July and August.

PRACTICAL ASPECTS OF THE LIFE-HISTORY.

This species over-winters in the *middle layers* of the bark of the recently-infested trees, those with yellowing foliage. The adults appear in large numbers from June onwards, and spread the infestation to green timber. When green trees are attacked, the exuding resin forms in gum-tubes about the mouths of the entrance-holes, and the presence of these gum-tubes upon the bark serves to distinguish the infested trees before the foliage has faded. The foliage of the infested trees begins to fade from the middle of August onwards, turning yellow during the winter and early spring and becoming red by early summer. The trees with red foliage are known as "red-tops." The treatment of the red-tops is useless in control measures against the Bark-beetles; for, by the time the foliage is red, the beetles have already escaped, or are rapidly emerging, and they invariably enter logs or timber recently infested, dying, or green and sound, never trees with red and, therefore, dead foliage.

CONTROL MEASURES FOR THE WESTERN PINE BARK-BEETLE.

Outbreaks of this and other injurious Bark-beetles in British Columbia if taken in time, can be controlled by logging operations modified so as to include the trees containing the brood, and employing proper means for destroying the latter. The beetles and grubs pass the winter in the bark of the trunk of trees attacked that season, on which the foliage is still pale-green or yellow, with the bark studded with gum-tubes. If over three-fourths of the infested trees can be handled so as to kill the contained brood before they emerge in the early season, the outbreak can be checked; and by similar work upon the relatively few trees attacked the succeeding season, can be brought under nearly complete control.

When it becomes necessary to undertake direct control measures, the broods in the bark of the infested trees can be destroyed by whichever of the following methods are best suited to local conditions:—



Fig. 5.—Dying Bull Pine, showing egg-tunnels of the Western Pine Bark-beetle on the wood surface. Princeton, B.C. (Original).

FLOATING THE LOGS.—Where water is available, the simplest method is to cut during winter and float the infested logs as soon as cut or as early in spring as possible. This will kill the greater part of the brood.

SAWING DURING WINTER AND BURNING THE SLABS.—Where it can be done profitably, the infested logs may be sawn during winter, and the slabs, which will contain the brood, burnt before spring opens.

BARKING THE TREES.—It is always possible to fell and bark the infested trees during winter and, when this species is concerned, to burn the infested bark before spring opens. The presence of the greater number of the grubs in the middle layers of bark, renders burning the bark necessary in the control of the outbreaks involving the Western Pine Bark-beetle. Control operations must be completed during the period between the first of November and the following June; but should be finished as early in spring as possible.

When it is not possible to utilize the timber profitably, and control measures are necessary to protect valuable holdings against ravages of the beetles, the infested trees should be treated by the cheapest effective method so as to destroy the contained brood. The infested trees may be cut and burnt before spring opens, frequently at less expense than by removing and burning the bark. By means of a special barking tool, the bark may be removed from a sufficient number of the standing infested trees to effect partial control. The bark should be burnt.

This control work has reference solely to the freshly-infested trees, with green, yellowish, or moderately reddened foliage, having the bark filled with the beetles and their grubs, and not to the old "red-tops" which have been dead for from one and a half to several years, and from which the beetles have emerged.

It will often be best to combine two or more of these methods in order to complete the control work during late fall, winter and early spring.

The control measures outlined above should be followed in control work with the Princeton outbreak, together with the barking of infested stumps, as recommended under the "Red Turpentine Bark-beetle."

THE RELATION OF SLASH TO BARK-BEETLE OUTBREAKS.

In order to control the bark-beetles known to be injurious in British Columbia, it is only necessary to reduce the numbers so that the normal amount of dying bark to be found in the woods will suffice for breeding purposes. So far as we know at present all our bark-beetles prefer dying bark, and it is only when their numbers are very great that green timber is attacked in quantity. It therefore follows that so long as extensive cutting in a district continues, the slash and stumps serve as a breeding-place and to a considerable extent, or for a time often entirely protect the healthy trees. But unless the amount of slash increases from year to year, certain species are bound to develop to such numbers that additional breeding-places are required; and then, or, with certain species, before that stage is apparently reached, they attack the surrounding green timber. When cutting ceases suddenly there is always danger that an outbreak may develop in the neighbourhood.

It will be seen from the above that while slash may serve for a longer or shorter time as a protection to the standing timber, it may become a nuisance, in as much as it offers abundant food supply for the beetles, in which they may breed to immense numbers.

The slash can be made to serve as an effective trap. Many injurious species will pass the winter mostly as young adults or larvæ in the bark. If the slash of the previous summer's cutting is burned during winter and early spring a sufficient number of the beetles will usually be killed to hold the injurious species in check. When there is but one brood each season, as with the Mountain Pine Bark-beetle, winter burning of slash of the previous winter's



Fig. 6—Inner face of bark from a dying Bull Pine at Princeton, B.C., showing tunnels of the beetles which have killed the tree.—1. Egg-tunnels of The Red Turpentine Bark-beetle.—2. Larval-chambers of the same, excavated by the young larvae working in congress.—3. Egg-tunnels of The Western Pine Bark-beetle, showing egg-niches, and a few larval-tunnels. The boring-dust has been largely removed. (Original).

cut will be effective. When the Western Pine Bark-beetle is concerned, summer slash burning in early August would assist in its control, in addition to winter burning for the summer's cut.

THE WESTERN WHITE PINE BARK-BEETLE (*Dendroctonus monticolæ* Hopk.)

The Western White Pine Bark-beetle is very similar in appearance and habits to the species just discussed. A fuller account of the beetle and of its work in western white pine is given later in this report. When found working in bull pine it may be distinguished from *brevicomis* by its larger size, being one-sixth to one-quarter of an inch in length, and by the long sparse hairs on the hinder part of the wing-covers. The pubescence on the wing-covers of the Western Pine Bark-beetle is denser and very short, and the sides of the pronotum are longer and more nearly straight.

The egg-tunnels of the Western White Pine Bark-beetle are usually distinctly larger than those of the Western Pine Beetle. They are vertical, nearly straight or slightly winding and elongate, with the eggs placed singly in niches, which are cut a few in a group at short intervals along the sides.

The two species are found working in the same trees in the infested bull pine about Princeton, and appeared this season to be about equally responsible for the injury, although there are indications now that the Western White Pine Beetle is in some places the more destructive.

When the Western White Pine Beetle is the only species involved in an outbreak it is not necessary to burn the bark; the broods of this species are found almost solely in the inner bark and are exposed when the bark is removed. The simple removal of the bark from the infested trees during winter and early spring is sufficient to effect control. When, however, as is the case at Princeton, the Western Pine Beetle is also concerned, the bark must be burned, if bark removal is the control method adopted.

Before undertaking control work an exact determination should be made of the species of beetles primarily responsible for the death of the trees.

THE RED TURPENTINE BARK-BEETLE (*Dendroctonus valens* Lec.)

This species, the largest of our bark-beetles, is from one-fifth to one-third of an inch in length, yellowish to reddish-brown in colour; epistomal process broad, with the sides oblique; pronotum with large punctures, rather regular in size; the elytra sparsely clothed with long hairs which extend nearly to the base.

It is found in British Columbia in stumps and dying trees of bull pine, Engelmann's spruce and probably other pines and spruces.

This species confines itself chiefly to the base of the tree, within a few feet of the ground. A pair of adult beetles excavate a wide egg-tunnel through the inner bark, upon the wood surface. This tunnel is more or less elongate, irregularly widened above the entrance-hole and usually vertical at first in standing green trees. Later the tunnel is frequently branched and often extended downwards. The eggs are laid at intervals in layers or irregular elongate masses against the widened side of the egg-tunnel and covered more or less completely with boring-dust.

The larvæ hatch in about ten days, and feed in congress away from the egg-tunnel through the inner bark, leaving a wide, flat cavity, largely filled behind them with reddish excrement.

This species is not so destructive as the two just discussed. It commonly breeds in the bark of stumps and in the base of trees dying from other injury. It does, however, attack and even kill apparently healthy trees, and renders able assistance to the more destructive species in killing the bull pine in British Columbia. Its work in sound trees often results in irregular scars about the

base, without involving the death of the trees. Its work in green trees results in large masses of gum, gum-tubes, about the base of the tree. The species is very widely distributed. It occurs across Canada from the Yukon and British Columbia to Newfoundland and Nova Scotia, and throughout the eastern and western United States and the western portion of Mexico.

CONTROL MEASURES.

This species will probably not be found in British Columbia as the sole cause of extensive trouble. When it is assisting more destructive species in killing timber, control work for the outbreak should include the removal of the bark from the stumps of the infested trees during the winter following the infestation.



Fig. 7.—The Red Turpentine Bark-beetle, (*Dendroctonus valens* Lec.) Greatly enlarged. (Original).

In a region where extensive cutting is in progress, sufficient breeding-places are provided by the dying bark of the stumps. When cutting ceases the beetles may attack the sound trees and cause more or less injury. When the species becomes very abundant in a locality, as evidenced by its borings in the base of spruce and pine stumps, its numbers should be reduced by the removal of the bark of the infested stumps *during the winter following the infestation*.

SPREAD OF INFESTATION ABOUT PRINCETON.

We have not yet sufficient information to enable us to determine definitely the rate of spread; but the number of infested trees is increasing very rapidly. The dying trees have been noticed about Princeton for two or three years. The trees attacked in 1911, or before, (which became red-tops the following summer), have lost nearly all their leaves; those attacked in 1912 are now red-tops, and those attacked this season, 1913, have the foliage fading from yellow to green.

By counting the trees attacked in each year in each of a sufficiently large number of clumps of "red-tops," and estimating the annual percentage of newly-infested acreage it is possible to arrive at a fairly definite estimate of the rate of spread.

Mr. H. H. Thomas and Mr. J. B. Gareau, of the Provincial Forest Branch, have been in close touch with the outbreak about Princeton, and have made careful and valuable observations during the late summer and fall. Counts of the infested trees in and about five isolated clumps of red-tops, made by them after the flight of the beetles was over, gave the following results:—

Group of Red-tops.	Trees Killed in 1911.	Trees Killed in 1912.	Trees Killed in 1913.
1.....	1 or 2	11	9
2.....		1	5
3.....	1	3	7
4.....	3	17	6
5.....	3 or 4	37	33
	8 or 10	69	60

It is found that about some clumps of red-tops there are no trees attacked this season, indicating that many of the beetles emerging therefrom this summer had migrated some distance. In other places streaks of recently infested timber are found at some distance from any red-tops, and isolated groups of red-tops and isolated trees are frequently seen. Many of the emerging beetles migrate in swarms to some distance and thus either increase the number of the clumps, or settle about those already started. It will be seen that in the five typical instances detailed above, the number of infested trees has increased from 10, in 1911, to 139 in 1913. Mr. Thomas considers a conservative estimate of the annual increase in acreage infested at approximately one to three.

POSSIBILITY OF NATURAL CONTROL.

Bark-beetles are preyed upon by various parasitic and predaceous insect enemies which destroy the eggs or brood, as well as by fungous diseases. Insect-feeding birds help to some degree in keeping down their numbers. There was no indication of any effective natural control in connection with the Princeton outbreak.

RECOMMENDATIONS FOR THE CONTROL OF AN OUTBREAK SUCH AS THAT AT PRINCETON, B.C.

When bull pine is found dying as isolated trees and clumps of trees, with the foliage fading during winter and turning red in early summer, with the bark of these trees filled with bark-beetles and their grubs, and the trunks studded with gum-tubes, a more or less serious bark-beetle outbreak is indicated. Before control measures are adopted a forest entomologist should be consulted for the exact determination of the species concerned; for the details of the control measures will depend upon the life-history and habits of the beetle or beetles, and the reaction of the trees to their attack.

The infested area should be cruised for dying trees, and the infested trees (containing the broods) marked for cutting. If the area is extensive, a rough map should be made to locate the badly infested parts. The trees may be

marked during the fall months, after the main attack by the beetles is over.

Plans should be made to handle the work most effectively. If sufficient water is available, many of the logs may be floated as they are cut, or early in the spring, and left for later sawing.

If mills are available, portable or stationary, the remainder of the infested logs should be sawn and the slabs burned before the first of June. The control work may begin in November and should be completed by the first of June or earlier. If mills are not available for the profitable use of the timber, or if it is found impossible to saw all the infested logs within the time limit, a sufficient number should be cut and barked, and, if necessary, the bark should be burned within the proper time.

Infested timber which cannot be used profitably for lumber should be cut and barked or burned outright during winter, under proper supervision.

The object should be to destroy the broods in as many of the infested trees as possible. If over three-fourths of the infested trees of an isolated district can be handled properly in one winter, the outbreak will be checked for several years, and a little similar work the following winter should bring it under complete control. If control work is undertaken in a section of an infested region, some annual work will be required to hold in check reinfestation from neighboring timber. Co-operation of the holders of adjoining timber lands will often be necessary.

Whenever the Red Turpentine Beetle is seriously involved, the infested stumps should be barked before spring opens.

MINOR INJURIES TO BULL PINE.

In addition to the three species discussed, many bark-beetles breed in the bark of the diseased and dying trees and logs. Certain of these enter the bark shortly after the attack by the Western Pine Bark-beetle or the Mountain Pine Bark-beetle, and are important secondary enemies; but they apparently attack perfectly sound timber only rarely in British Columbia. They assist the primary enemies in hastening the death of the trees, and cause further injury by killing trees more or less weakened by storms, fires, or other causes. Certain species breed only in the bark of rapidly dying trees and recently felled logs or stumps.

Among these secondary enemies are numbers of species belonging to the genus *Ips* (or *Tomicus*). Of these the most interesting are *Ips integer* Eichh., *I. emarginatus*, *I. interpunctus*, *I. oregonis*, and several undescribed species. These beetles are readily distinguished by their rather elongate cylindrical form, with the declivity, or hinder face of the elytra, steep, usually deeply excavated, with the margin of the excavation more or less acute and armed with spines.

They are true bark-beetles, rearing their broods in the inner bark; but cutting tunnels quite different from those of *Dendroctonus*. One male and from two to several females inhabit each set of egg-tunnels. The entrance-hole opens into a flat "nuptial-chamber" situated between the inner bark and the wood surface, usually engraving both. In this chamber the male is usually found removing the boring-dust produced by the tunnelling of the females. Each female excavates for herself an elongate egg-tunnel opening from the nuptial-chamber, and deposits eggs singly in niches cut alternately at intervals along the sides. The larvæ bore through the inner bark away from the egg-tunnels, pupate in the ends of the larval mines, and finally escape through round holes cut through the bark. There are usually two broods each season.



Fig. 8.—*Ips emarginatus* Lec.; female, greatly enlarged.
(Original).

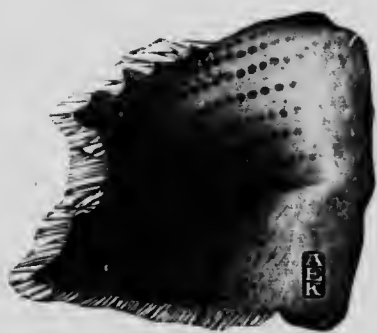


Fig. 9.—*Ips emarginatus* Lec.; female; hind
portion of elytra from the side. Greatly
enlarged. (Original).

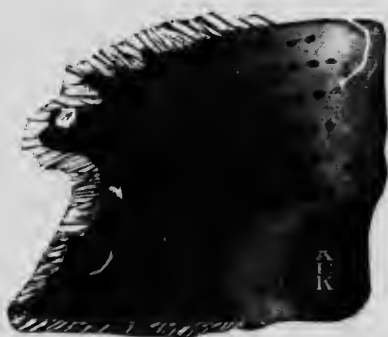


Fig. 10.—*Ips emarginatus* Lec.; male; hind
portion of elytra from the side.
Greatly enlarged.
(Original).

The tunnels of these species are found in the bark of the trunk and branches. They are always abundant in slash, and sometimes enter trees in which the resin is still fluid, so that gum-tubes are found about the tunnel openings. Several species were working in the fading trees at Princeton this summer, and we may yet find some of this genus acting as primary enemies in British Columbia.



Fig. 11—*Ips integer* Eichh.; greatly enlarged.
(Original).

INJURIES TO WESTERN WHITE PINE.

The mountain pine, or western white pine, *Pinus monticola*, occurs in British Columbia from the valley of the Columbia river to Vancouver Island. It is subject to attack from several species of bark-beetles; and one, the Mountain Pine Bark-beetle, or Western White Pine Bark-beetle (*Dendroctonus monticolae* Hopk.), is particularly destructive both in the Interior and on Vancouver island.

THE WESTERN WHITE PINE BARK-BEETLE (*Dendroctonus monticolae* Hopk.).

This species probably occurs throughout the range of the white pine in British Columbia. It was found this summer killing white pine timber in the Sugar Lake region, at Cowichan Lake, and about Seymour Narrows and Campbell River. It has already been referred to in connection with the injury to bull pine.



Fig. 12—The Western White Pine Bark-beetle.
(*Dendroctonus monticolae* Hopk.).
Greatly enlarged. (Original).

It is a cylindric black, rather stout beetle, somewhat larger than the Western Pine Bark-Beetle, ranging from 4 mm. to 6.5 mm., (one-eighth to one-quarter of an inch) in length, with the pronotum wider than long, distinctly narrower in front, punctured and hairy on the sides and above; the elytra with striæ of medium-sized punctures, the interspaces roughened, sparsely clothed with short hairs and with scattered long hairs behind. It is distinguished from the Western Pine Bark-Beetle by its larger size (usually), the wider pronotum narrower in front, the long hairs of the sides and hinder part of the elytra, and by the different shape of the egg-tunnels.

LIFE-HISTORY AND HABITS.—The adult beetles leave the red-tops from the latter part of June onwards, and start their egg-tunnels in the bark of the trunks and larger branches of dying trees, logs, or of healthy timber. Each pair of beetles cuts an entrance-tunnel through the bark to the wood-surface and excavates an elongated somewhat straight egg-tunnel upwards through the inner bark, slightly engraving the wood. The eggs are placed singly in shallow niches, which are arranged along the sides in small groups of three or four niches, with a space of about half an inch between the groups. The eggs composing a group are close together and often covered by a common layer of boring-dust. The grubs or larvæ which hatch from the eggs bore the larval-mines mainly through the *inner* bark. They finally enlarge the end of the mine to form an oval pupal cell, usually between the bark and the wood. After changing to pupæ in the pupal cells and later transforming to adults they finally bore round holes through the bark and escape.

Much red boring-dust is extruded from the entrance hole, and, in green trees, gum-tubes form about the opening.

This species prefers dying bark, and when such is obtainable from fires, storms, or slash, the green timber is less likely to be attacked; but when the beetles are in large numbers they readily enter and kill green trees of all sizes.

DETAILED HISTORY OF THE BROODS.—The winter is passed in the bark of the trees infested during the previous summer, as larvæ, young adults and parent adults.

The over-wintered parent adults lengthen their tunnels, or excavate new ones in the infested trees in spring, and deposit eggs which develop to adults probably in July and August.

The over-wintered young adults emerge from the "red-tops" and start egg-tunnels during late July, August and early September. The red-tops at Sugar Lake in the last week in July, 1913, had the bark filled with larvæ, pupæ and young adults; and numbers of adults had escaped and were starting tunnels in near-by green timber. The larvæ of this generation in part develop to adults; but the greater number winter in the bark as larvæ.

The over-wintered larvæ transform to adults which, in British Columbia, apparently emerge during late summer. There is thus one complete brood each season.

THE EFFECT UPON THE TREES.—The tunnels of the adults and the larval-mines kill the inner bark, and if the greater part of the trunk is infested the tree usually dies in one year. The foliage of infested trees usually remains green until late fall or spring, fading during fall and spring to yellow and finally to red by mid-summer. If only a portion of the bark is affected at first, the remaining bark is usually attacked in the following summer, or during the same season, by later-appearing beetles.

The infested trees are to be distinguished by the gum-tubes, the red boring dust extruded from the tunnels and, later, by the fading foliage. The foliage frequently remains nearly normal in appearance until spring; but many trees fade more or less during the fall so that they may be picked out as unthrifty. In selecting infested trees for cutting, gum-tubes and boring-dust on the bark must be largely depended upon. It not infrequently happens that trees are attacked only in the upper and middle portions. The gum-tubes are usually distinguished quite readily, but when high up the trunk they are easily overlooked. The selection of the trees will be made most easily in the early fall, while the gum is fresh and light in colour.

THE CONDITIONS AT SUGAR LAKE (VERNON DISTRICT).—An outbreak of this species in the Sugar Lake and Mable Lake region has been in existence for about eight years, and a body of fine white pine timber has been killed by it. Much of

this killed timber has since been injured by the tunnels of the larger wood-borers of the families *Cerambycidae* and *Buprestidae*. The thin sap-wood of the mountain pine renders it more resistant to causes of deterioration than the bull pine, and the beetle-killed trees often retain much of their value for several years.

CONTROL MEASURES.

The Mountain Pine Bark beetle is controlled by the measures already recommended for the Western Pine Bark-beetle. It is not necessary, however, to burn the bark from the logs, for the grubs, larvæ and adults are mostly in the inner bark, and are exposed when the latter is removed. The simple separation of the bark from the wood is effective, therefore, in killing a sufficient number of the brood. The control work should aim at destroying over three-fourths of the hibernating broods, and should be completed during the late fall, winter and early spring months. There is apparently no considerable movement of the beetles into green timber until early in July, but all control work should be completed if possible by the first of June.

If water is available, the infested logs may be floated; or the logs may be sawn and the slabs burned before or during spring; or the bark may be removed from the infested portion of the trunks of the felled or standing trees during the specified time.

Logging operations, which include the burning of tops, the burning or barking of cull-logs, the barking of stumps, and proper treatment of infested logs to destroy broods contained in the bark, will go far towards protecting surrounding timber.

INJURIES TO LODGEPOLE OR BLACK PINE.

The black pine, *Pinus murrayana*, occurs throughout the Interior of British Columbia. It is considered by Sargent a variety of the scrub pine, *Pinus contorta*, which is found along the coast and on Vancouver island.

It is subject to attack in British Columbia by two injurious species of Bark-beetles: *Dendroctonus monticolæ* and *Dendroctonus murrayanæ*; and by numbers of species of secondary importance.

Reports were received of considerable dying timber in parts of the Kootenays but these districts could not be visited this summer. The most important injury observed was by the Mountain Pine Bark-beetle about Sugar Lake. This beetle was there killing black pine quite as readily as the white pine. Outbreaks can be controlled by the measures already recommended.

INJURIES TO THE DOUGLAS FIR.

The Douglas fir, *Pseudotsuga mucronata*, extends over a very wide area in the southern half of British Columbia, from the eastern foot-hills of the Rockies to the coast and Vancouver Island, with a very irregular northern and northwestern limit. Throughout the area covered by the survey there were no very extensive insect injuries found. The Douglas Fir Bark-beetle, *Dendroctonus pseudotsugæ* Hopk., is perhaps its most serious enemy, and a number of other species are important secondary enemies.

THE DOUGLAS FIR BARK-BEETLE (*Dendroctonus pseudotsugæ* Hopk.)

The Douglas Fir Bark-beetle was found killing timber in small amount in several places, notably in Creighton valley, (Vernon district), at Cowichan Lake and at Campbell River near Seymour Narrows. The number of trees killed was not large in any instance found; but such incipient outbreaks should be kept under observation, so that proper control measures may be applied if they should become necessary.



Fig. 13.—Inner face of bark from a beetle-killed Bull Pine, showing Egg-tunnels and larval-mines of The Western White Pine Bark-beetle.—1. Egg-tunnel of The Western White Pine Bark-beetle.—2. Larval mines of the same.—3. 3a., Egg-tunnel of *Ips integer* Eichh.

This species is extremely abundant in Douglas fir slash throughout the parts visited, and probably occurs throughout the range of its food-plant. Its normal habit is to prefer dying bark, and to breed in the bark of trunks and larger branches of injured and dying trees, and in stumps and slash from cuttings. Not rarely it spreads to healthy timber and may become a more or less serious enemy. It also breeds in British Columbia in the western larch.

The adult is stout, reddish brown to nearly black, and 4 to 7 mm. in length. The pronotum is broader than long, with the sides rounded and strongly narrowed in front, irregularly punctured and hairy above. The elytra have long hairs nearly to the base, with impressed striæ of punctures and roughened interspaces. It is readily distinguished from all other described species in British Columbia by the straight parallel sides of its epistomal process, and, practically, by its occurrence in Douglas fir and western larch.



Fig. 14.—The Douglas Fir Bark-beetle.
(*Dendroctonus pseudotsugae* Hopk.)
Greatly enlarged. (Original).

LIFE-HISTORY AND HABITS.—The adults emerge from the old bark during the spring and early summer and attack dying or healthy bark in pairs. They enter usually through the thinner places, or bark fissures, and excavate elongate, rather straight tunnels between the bark and wood surface, upward from the entrance hole. The female deposits eggs singly in shallow niches cut in groups alternately on the sides of the egg-tunnel and covers all with a layer of boring-dust which later largely fills the egg-tunnels. The larvæ cut their galleries through the inner bark, away from the egg-tunnel, leaving the wide, long and often rather straight larval galleries packed with concentric layers of reddish boring-dust. The larvæ enlarge the ends of the galleries to form pupal cells, either exposed in the inner bark or in the middle layers, and there pupate. They emerge through round holes cut through the outer bark during late summer, or hibernate beneath the bark, either in the pupal cells or congregated in cavities caused by the destruction of the inner bark.

Both egg-tunnels and larval mines are usually distinctly engraved on the wood surface. They hibernate beneath the bark as young adults, larvæ, and parent adults.

The chief emergence of the over-wintered adults, and attack upon fresh bark, takes place during May, June and early July. Fresh tunnels were started this season until the end of July, and probably later. By the end of July the tunnels which were started earliest contained larvæ of various sizes, pupæ and young adults. By the end of the season the tunnels which were started in May and early June had the young mostly transformed to adults; in the tunnels started last many of the young over-wintered as larvæ, and will complete their transformations in the spring. It is notable that in the southern part of the Interior a moderate number of young adults appear late in the season and start new tunnels, which contain small larvæ during winter. There is thus one brood each season, with possibly a partial second brood.



Fig. 15—The Douglas Fir Bark-beetle. Larval-mines and pupal cells on the inner surface of Douglas fir bark. (Original).

The abundant reddish boring-dust ejected from the entrance tunnels, and lodged in the bark fissures, distinguishes the infested trunks. During the late fall and spring the foliage of infested trees fades from green to yellow and finally to reddish before summer. When only a portion of the tree is attacked during the first summer the remaining portion may be infested the following season. In such cases the foliage may be in part quite red before the broods have emerged; though, as a rule, by the time the foliage becomes red and dry, few living beetles will be left in the bark.



Fig. 16.—Egg-tunnels and larval mines of The Douglas Fir Bark-beetle on the inner face of Douglas fir bark. The boring dust has been removed. (Original).

CONTROL MEASURES.

This species prefers dying bark, and is everywhere found in slash and stumps from cuttings. As long as cutting continues in a district, the slash and logs usually supply abundant breeding places, and the subsequent treatment of the logs removes many of the beetles. When the beetles become very numerous, however, they may spread from the slash to surrounding green timber, and this is to be feared if the cutting suddenly ceases. The beetles and their larvæ winter in the bark of the slash and logs, and regular winter slash-burning is therefore an efficient method of control. Such work should be completed between early October and the first of March. When it is required to control this beetle in seasons during which little or no cutting occurs, over three-fourths of the infested



Fig. 17—The Sitka Spruce Bark-beetle. (*Dendroctonus obsesus* Munn.) Greatly enlarged. (Original).

trees may be barked during winter; or the infested logs may be floated, or sawn and the slabs burned before the middle of March. The unbarked portions of the trunk and the slash should be burned during winter.

INJURIES TO THE SITKA SPRUCE.

The Sitka spruce occurs in British Columbia throughout the Coast region and on Vancouver island. Its most injurious insect enemies are apparently the Sitka Spruce Bark-beetle, and the Western Spruce Gall Louse. The former was found this summer killing large timber, and is certainly an enemy which is apt to be very destructive. The Gall Louse is widespread and abundant, but probably not of much importance in the forest; in parks and where sources are isolated, or in isolated groups, much serious injury is done by it.

THE SITKA SPRUCE BARK-BEEBLE (*Dendroctonus obsesus* Munn).

This species is represented in our collections from Alaska along the coast and islands south to the United States boundary. It probably occurs throughout the Sitka spruce area and we have not yet obtained it from any other tree. It evidently prefers diseased and dying bark of stumps, logs, slash, and injured trees;



Fig. 18—Inner face of bark from the trunk of a Sitka Spruce killed by the Sitka Spruce Bark-beetle. Portions of two Egg-tunnels are shown, and the effect of the larvae in almost completely destroying the inner bark. Menzies' Bay, Vanc. Isl.
(Original)

but it was found this summer attacking apparently sound timber, and proving a destructive enemy. The outbreaks located were not large, but proved that this species may become a very serious enemy to the Coast spruce. Reports were received of extensive bark-beetle injury to spruce farther up the coast and on Queen Charlotte islands. It is possible that this beetle is the primary cause of the injury, but it was impossible to make a personal investigation this season.

The adult beetle is black, stout, from seven to nine thirty-seconds of an inch in length, distinctly hairy, with long hairs extending nearly to the base of the wing-covers; the pronotum wider than long, with the sides strongly narrowed in front; the wing-covers with impressed stripes of rather small punctures, and the interspaces of the dorsal portion rough.

The larvæ are stout whitish grubs, about as long as the adults, with powerful jaws, and are found working in the inner bark of the Sitka spruce.

Habits.—The pairs of beetles enter the bark during spring and summer and excavate elongate, rather straight tunnels upwards from the entrance hole between the bark and wood. The eggs are laid along the sides of the tunnel in irregular rows or groups of varying numbers. The tunnel side is grooved for their reception, and they are usually enclosed by a continuous layer of boring-dust. The rows of eggs are frequently more or less distinctly alternately arranged. The eggs are frequently scattered rather sparsely along the tunnel side at first, and later, more eggs may be laid along the same portion of the tunnel, between those first deposited. In a specimen before me the egg-tunnel is about 4.5 mm. wide, with the egg-groove 1 mm. deep. There are tunnels of larvæ two-thirds grown arising from one portion, and along the same side, between the origins of these tunnels, are numerous eggs, singly and in groups. The larvæ when hatched bore through the inner bark away from the egg-tunnel. Their mines are separate and distinct for a half inch or less, and then interlace irregularly so that the inner bark is often entirely reduced to powder. After the larvæ are two-thirds grown their mines tend to become distinct, and separate tunnels are excavated up or down the trunk. The pupal period is passed in the enlarged ends of the larval mines, either in the inner bark or in the middle layers.

When standing trees are attacked, the first broods apparently enter the thinner bark of the middle trunk, and those appearing later extend the infestation to the base of the tree and even upon the larger roots.

A few cocoons of a hymenopterous parasite were found in the ends of larval tunnels.

Seasonal History.—The early history of the species was not completely studied; but, in Oregon, Dr. Hopkins finds that the adults become active in April, emerge from the bark and attack fresh trees during May and June, and probably later. The principal period of larval development, in Oregon, is during June, July and August. The larvæ transform to pupæ from the last of July onwards, but mainly during August and September. The pupæ transform to adults from mid-August to the end of the season. Eggs and young larvæ were common in September, and may have represented a second brood, or may have been from a second batch of eggs laid by the parent adults.

The above history appears to hold for the southern half of British Columbia, except that a larger percentage of the beetles emerge and start their tunnels in fresh bark during August. By the middle of September, in the latitude of Vancouver, some tunnels contained only young adults, some only pupæ and large larvæ, and many contained only small larvæ and eggs, or eggs alone. It is apparent that tunnels are started by over-wintered young adults during early summer and throughout August. The majority of the tunnels started in September were cut by black, fully-matured adults, without doubt the parent adults of the early broods. In tunnels started during August and September, egg-laying continues until October. We obtained no evidence this season of any considerable partial second brood. In the older tunnels the broods transform to adults quite completely before winter. The winter is passed as young adults, larvæ and old parent adults.

CONTROL MEASURES.

Serious outbreaks by this beetle may evidently be controlled by the destruction of the broods during the winter months, by any of the methods already recommended. If water is available, the infested logs should be cut and floated between November and the last of March. The infested logs may be cut during the fall and winter, sawn during the winter and the slabs burned before April. The infested logs may be barked between November and the middle of March and the logs left for later sawing. The removal of the bark from the lower and middle trunk of over three-fourths of the infested trees in a district should suffice to bring this insect under control. It is not necessary to burn the bark.

It is probable that where cutting is carried on during winter, spring or early summer, the stumps, logs and slash will attract the beetles and protect the green timber. Slash-burning between the first of October and the first of March, should prove an efficient control.

Trap trees might be used with advantage in control of outbreaks in valuable holdings, at a distance from cuttings. A few trees to the acre cut in the infested area during late winter or early spring should attract sufficient beetles to protect the surrounding timber. These trees must be treated during the following fall and winter so as to destroy the broods contained in the bark.

AMBROSIA BEETLES.

These insects, also known as Timber-beetles, or Pin-hole Borers, are small elongate wood-boring beetles, which excavate round black tunnels, the diameter of a pencil lead, for several inches into the wood of dying trees, logs or stumps.

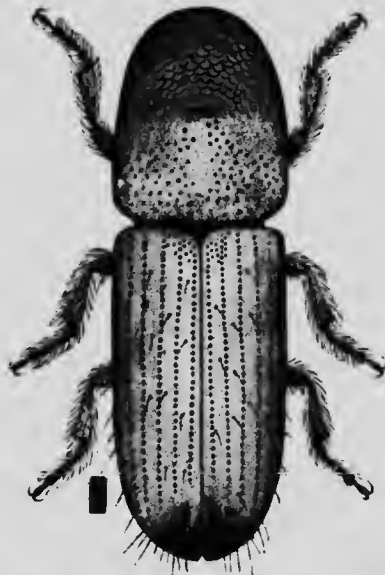


Fig. 19—*Gnathotrichus retusus* Lec.; The Douglas Fir Ambrosia-beetle. Greatly enlarged.
(Original).

The species found in British Columbia confine their work to the outer seven or ten inches of the wood, but frequently ruin that portion of the logs for all valuable purposes.

Those to be mentioned here are species of *Gnathotrichus* in pine, spruce, Douglas fir, balsam, and hemlock of the Coast and Interior, and an undescribed species of *Platypus* in spruce, Douglas fir, balsam and hemlock of the Coast and Island regions. The Western Spruce Timber-beetle is abundant in conifers; and other Ambrosia-beetles occur, but have not been found entering deep enough into valuable timber to cause serious loss.

The two most abundant Western Timber-beetles in conifers are *Gnathotrichus retusus* Lec. and *Gnathotrichus sulcatus* Lec. They are extremely abundant in Douglas fir, western hemlock, balsam, pines, and probably occur in all conifers throughout the province. They enter stumps, logs and injured and dying trees. I have rarely found them entering in great numbers the trunks of hemlocks with green foliage and apparently otherwise healthy; but this is certainly not their normal habit.

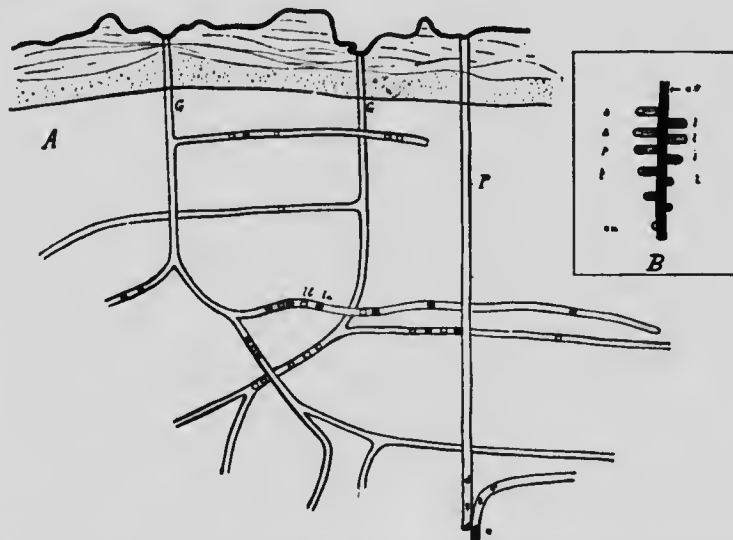


Fig. 20—A. Tunnels of *Gnathotrichus sulcatus* Lec. (G) and *Platypus* sp. (P) in Western Hemlock; la., larval cradles pointing up; lb., do. pointing down; e., eggs in ends of *Platypus* tunnels.
B. Sideview of portion of *G. sulcatus* tunnel: e.t., egg-tunnel; e.n., egg-niche; l., larva in cradle; p., pupa; a., young adult.

The adults are elongate dark-brown beetles, one-eighth of an inch in length, almost perfectly cylindric and smooth. The front of the pronotum is roughened with scale-like asperities, and the elytra are sparsely hairy behind.

The adult beetles excavate cylindric tunnels, about the diameter of a small pencil lead, from four to about six inches into the wood. The entrance tunnel, entering usually in the depth of a bark-fissure, passes directly through the bark and into the wood for from one to two inches; there branching takes place in a somewhat irregular fashion, though all parts of the set of tunnels extend in the same horizontal plane. Usually one long side-tunnel is cut shortly within the bark, parallel to the wood surface. The meal-like boring-dust and excrement are extruded through the entrance hole. Along the inner tunnels above and below, the females cut cup-like niches and deposit an elongate egg in each. The larva which hatches from the egg lengthens the niche in which it finds itself into a short tunnel, or larval-cradle, slightly more than its own length when full-grown, and transforms therein to the pupal stage, with its head towards the egg-tunnel. The pupa transforms to the adult in the cradle. The chief food of the larvæ, and an important food of the adults, is a peculiar fungus

called Ambrosia, which grows in a dense glistening layer upon the walls of the tunnels and cradles. It penetrates the cut wood-cells and grows for a considerable distance along the vessels; but is entirely saprophytic in its relations to the wood. The walls of the tunnels are stained black for a millimeter or more in thickness. These small, black, round, branching tunnels in the wood are characteristic of the Timber-beetles or Ambrosia-beetles.

The winter is passed by parent adults in the tunnels, young adults in the tunnels and cradles, and pupæ and larvæ of various sizes in the cradles. Apparently work is continued in these tunnels in the spring; and new tunnels are started by the young adults. A second brood appears and starts fresh tunnels early in August.

The Pacific Coast Timber-beetle, an undescribed species of the genus *Platypus*, is abundant on the coast and inland in the same trees with *G. sulcatus*,



Fig. 21.—The Pacific Coast Timber-beetle; *Platypus undes. sp.*; female; greatly enlarged. (Original).

and *G. retusus*. Its habits are quite similar to those of *Gnathotrichus*, except that the eggs are deposited free in the tunnels, and not in special niches. The tunnels are slightly but distinctly larger than those of *Gnathotrichus*, and penetrate the trunk for from six to ten inches, giving off lateral branches. The entrance-tunnel often enters four or six inches before any branching occurs. There is probably one brood in British Columbia. Tunnels which were started in August and September contain parent adults and eggs during winter; and are completed in the following season.

Its boring-dust, seen in white piles in the crevices below the entrance-holes, is in the form of minute splinters of wood, and quite easily distinguished from the meal-like boring-dust of *Gnathotrichus*.

The adult beetle is about five millimetres (one-fifth of an inch) in length, dark brown in colour, flattened, elongate, with the wing-covers strongly ribbed, and, in the male, produced on each side behind.

ECONOMIC IMPORTANCE OF THE AMBROSIA-BEETLES.—A considerable amount of injury is caused by these "pin-hole" borers, and they are likely to become more numerous in the future, as cutting becomes more extensive. They breed in all dying trunks, and recently cut logs and stumps; never in dead and dry wood, and seldom, perhaps never, in perfectly healthy trees. The Pacific Coast Timber-beetle is the most injurious, since its tunnels penetrate several inches deeper into the wood. Such injury is chiefly to logs which remain out of the water during summer. The timber-beetles are particularly injurious in the west to fire-injured timber, and about recent burns the little piles of white boring dust, extruded from their tunnels, are spotted over even the thoroughly blackened bases. The inner bark and wood of these trees are of course still full of sap, and entrance is made through cracks in the burned surface of the bark.

CONTROL MEASURES.

These insects enter dying trunks and logs in which the inner bark and sap-wood are green and full of fermenting sap, or even barked logs and sawn lumber, if the surface is moist; but never through a dry, sapless wood surface. They start their tunnels during the spring and summer months, so that logs cut between April and September are often attacked shortly after being felled. The late fall and winter cut usually remains sappy until spring and is then readily attacked. Logs cut in the early fall are not entered that season, and if piled loosely in the open often dry sufficiently to be protected from attack the following spring. Logs placed in water are safe from further serious injury. There is little injury when the summer cut is placed in water as rapidly as produced and the winter cut floated before the middle of April. Lumber from summer sawing of green logs is partially protected by piling loosely so that the surface dries rapidly.

THE LARGER WOOD-BORERS.

In localities where logs are, for any reason, left out of water in the limits for two or more seasons, serious damage often results from the work of large wood-boring larvæ of the families *Cerambycidae* and *Buprestidae*. As these are to be dealt with in a later publication, only a brief reference to the injury is included here. The adults are medium to large beetles; the *Cerambycidae*, Round-headed Borers, or Long-horned Beetles, with long antennæ or feelers; the *Buprestidae* often with metallic colouration and therefore known as The Metallic Wood-borers, and also as Flat-headed Borers.

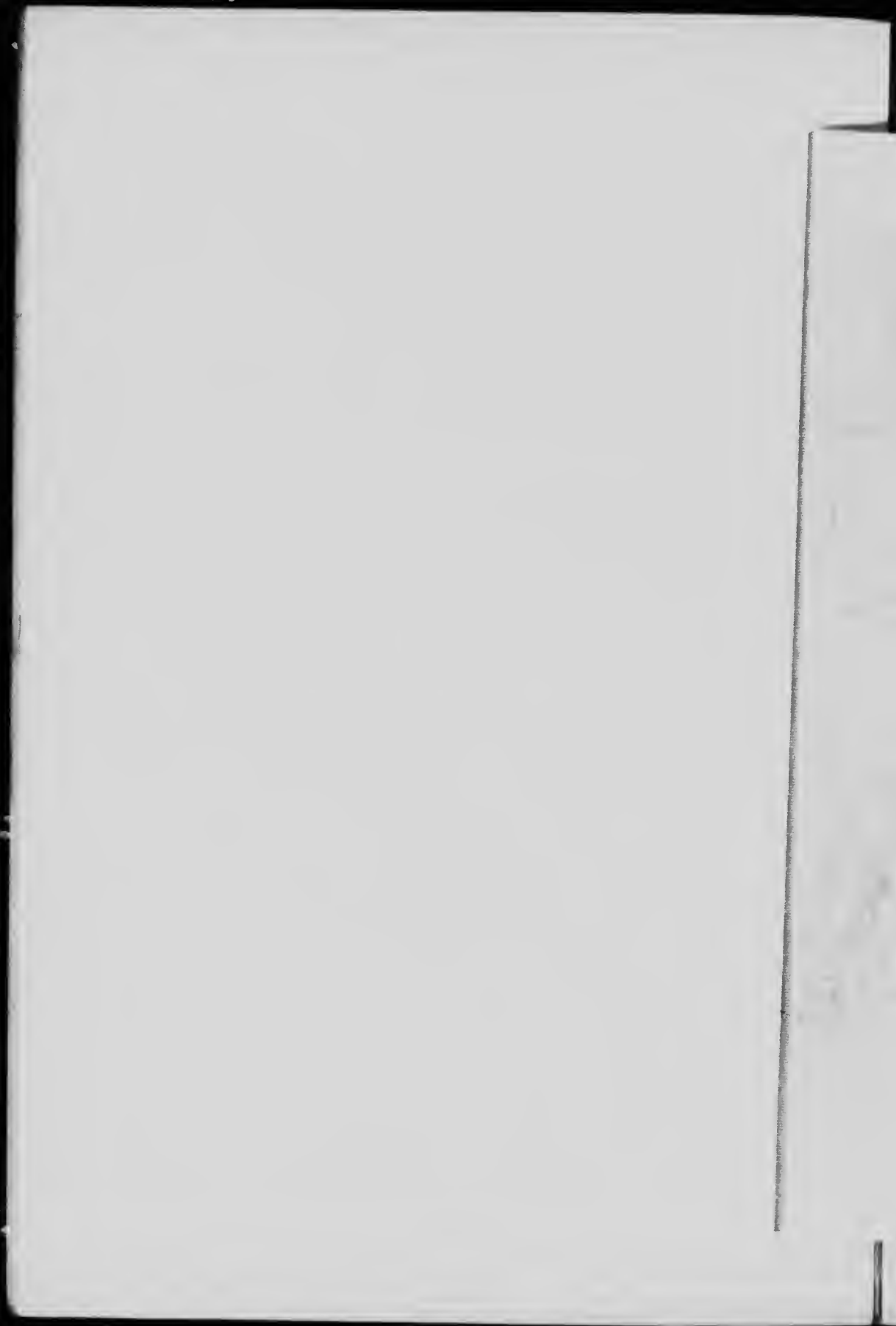
The adults pair during summer, and the females insert their eggs in slits in the bark cut with the jaws or mandibles, or place them in bark crevices. The mating adults are often seen in great numbers on logs and slash or fire-injured timber, crawling upon the bark and flying readily when disturbed. The grubs feed for a few weeks upon the inner bark, and later many species enter the wood beneath, where they live for one or two years, or in some cases longer. Some species bore only in the outer part of the sap-wood; other more injurious species drive their tunnels throughout the sap-wood deep into the heart-wood. Their large tunnels, one-half inch in diameter or smaller, destroy the wood for all valuable purposes.

CONTROL MEASURES.

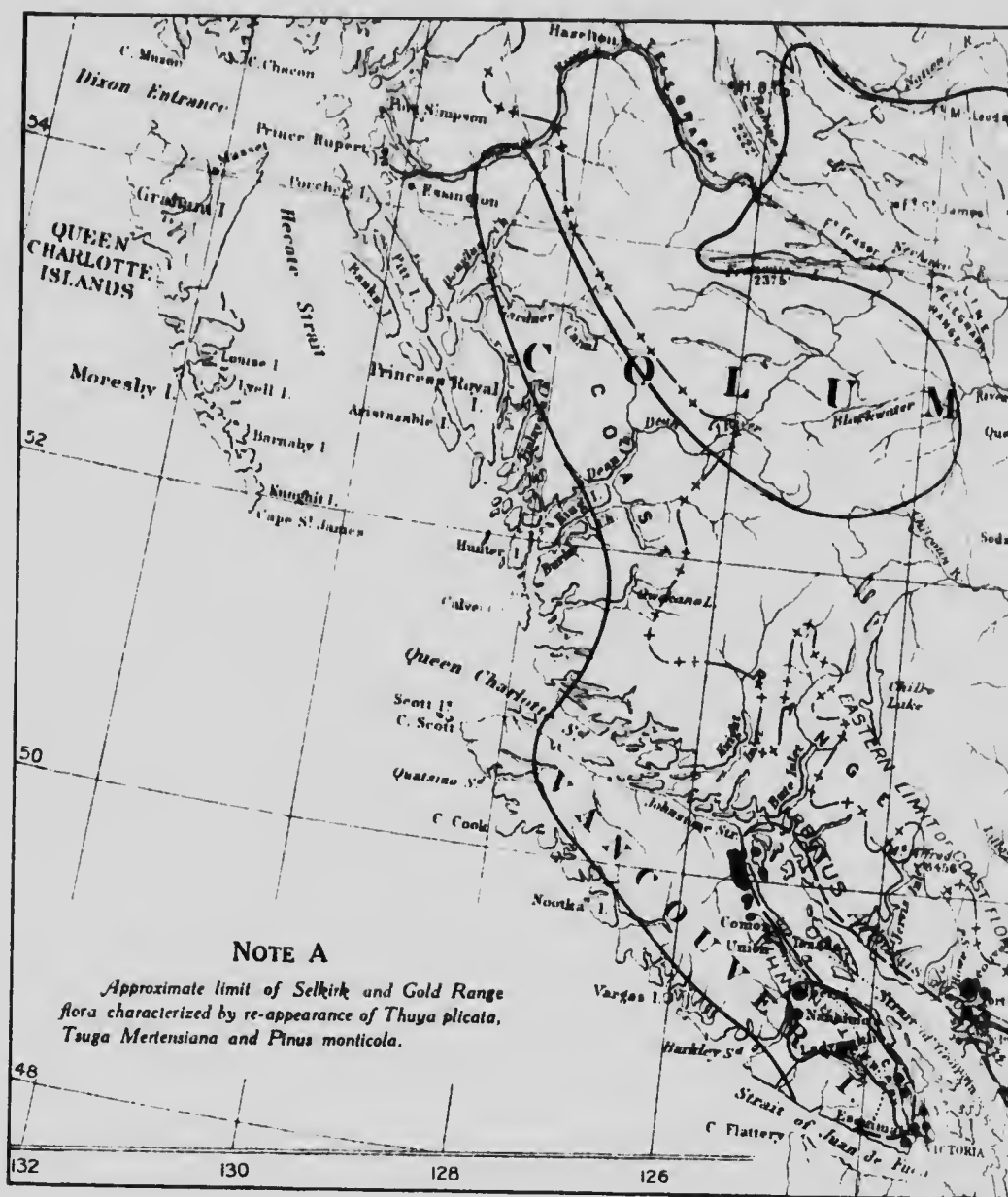
Logs which are sawn the first winter after cutting are usually but little injured; most of the tunnels come away with the slabs. The serious loss is to logs and fire-injured timber left out of water for several years. Logs placed in water within a month from cutting will be mostly free from injury. Logs barked within three weeks from cutting will be entirely free from injury. The beetles do not deposit eggs upon bare wood, and the young grubs apparently require the softer inner bark for their first food. Logs which are loosely piled in the open shortly after cutting escape serious injury if the bark dries rapidly. Covering the logs thickly with brush affords some measure of protection.



Fig. 22.—Inner surface of bark of Sitka Spruce, Agassiz, B.C. Egg-tunnels and larval-mines of *Ips* (larger) and *Polygraphus* (smaller), cocoons of parasites are shown in the ends of the mines. (Original).







NOTE A

Approximate limit of Selkirk and Gold Range
flora characterized by re-appearance of *Thuja plicata*,
Tsuga Mertensiana and *Pinus monticola*.

