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Biology and Control of the Douglas-Fir Beetle *in the Interior of British Columbia*

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BIOLOGY AND CONTROL OF THE DOUGLAS-FIR BEETLE IN THE INTERIOR OF BRITISH COLUMBIA

by

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INTRODUCTION

The Douglas-fir beetle, Dendroctonus pseudotsugae Hopk., has long been recognized as an insidious, if unspectacular, pest of Douglas fir, Pseudotsuga menziesii (Mirb.) Franco., in the interior of British Columbia. Although no appraisal of the losses from the insect has been made in British Columbia, it is certain that they are appreciable, particularly in the Kamloops and southern Prince George forest districts. In some localized areas annual loss has exceeded annual growth. Although primarily associated with logging operations, the insect occurs in stands of mature and overmature Douglas fir throughout its range in the Interior. The beetle also infests western larch, Larix occidentalis Nutt., although its attacks on this species are usually confined to weakened trees.

APPEARANCE OF AN OUTBREAK

Normally the Douglas-fir beetle prefers to attack logs, windfalls, slash, and injured or weakened trees. Frequently, however, it becomes aggressive and infests trees singly, or, more usually, in groups of a few to a hundred trees. Reddish boring dust in the bark crevices at the point of each attack is the first evidence of infestation (Fig. 1). As many as eleven thousand beetles may attack a tree from ground level to a height of about 60 feet. Infested trees die rapidly. The foliage of trees infested in the spring turns red in August of the same year and the trees appear as "red-tops" for about a year when most of the needles will have dropped. Both the commencement of discoloration and the persistence of the foliage vary considerably depending on rainfall and other site conditions. Characteristically, small groups of trees are infested. Generally, such groups are killed by the attacks of one season, the beetle population then migrating to infest other groups of trees some distance away.

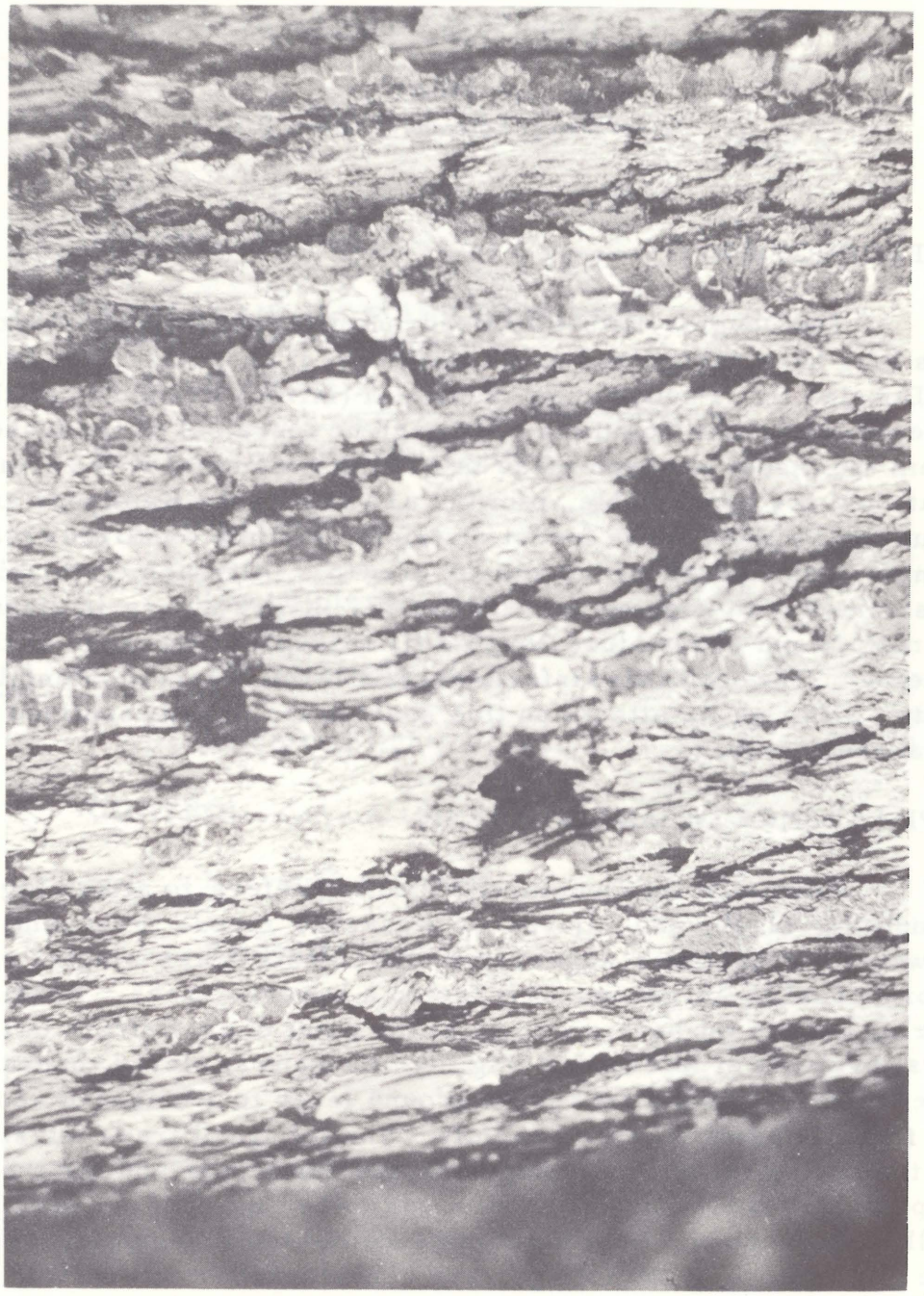

Fig. 1. Boring dust at entrance holes of Douglas-fir beetles infesting a log.

DESCRIPTION OF THE INSECT

The adult beetles are cylindrical, about 3/16 inch in length with a hard, brown to black integument (Fig. 2 A and B). The eggs are elliptical, pearly white, and about 1/20 inch in length (Fig. 2 E). The larvae are whitish, legless grubs with a light brown head (Fig. 2 C). Typically, the larvae show a tendency to curl. When fully grown they are about 1/4 inch long. Pupae are creamy white at first, becoming light brown as they transform into beetles (Fig. 2 D).

BEETLE WORK AND HABITS

Upon emerging from the trees or logs in which they have developed the beetles fly to fresh host material. Male and female beetles work in pairs in excavating the egg gallery after the female has bored an entrance hole from the outside of the bark to the cambium. Entrance holes of many beetles of the genus Dendroctonus are marked by pitch tubes but in the case of the Douglas-fir beetle the hole is usually free of pitch and is packed with boring dust. Pitch is found only in those entrance holes from which the beetles have been "pitched-out".

The egg gallery constructed by the adult beetle is of the simple-vertical type extending longitudinally up the tree without forking and parallel with the grain (Fig. 3). Galleries range in length up to 27 inches, the most common length being between 8 and 10 inches. The galleries, which are about 1/4 inch wide, are excavated in the cambial surface of the inner bark and are readily visible when the bark is peeled from the tree. In thin bark the sapwood is sometimes etched by the beetles as they construct the galleries. Typically, like the entrance holes, the galleries are packed with frass for the first part of their length.

About 50 eggs are laid in elongate groups of a few to about 30 on alternate sides of the egg gallery. Eggs are usually laid individually in niches cut in the sides of the gallery and packed with frass (Fig. 2 E). Upon hatching the larvae mine more or less at right angles to the gallery. As the mines are extended they become wider and tend to diverge, each group of larval mines appearing fan-shaped (Fig. 3). Length of the mines varies up to 3 1/2 inches. The pupal cavities, which are excavated at the ends of the larval mines, are exposed on the inner surface of thin bark or may be concealed within the bark if it is thick.

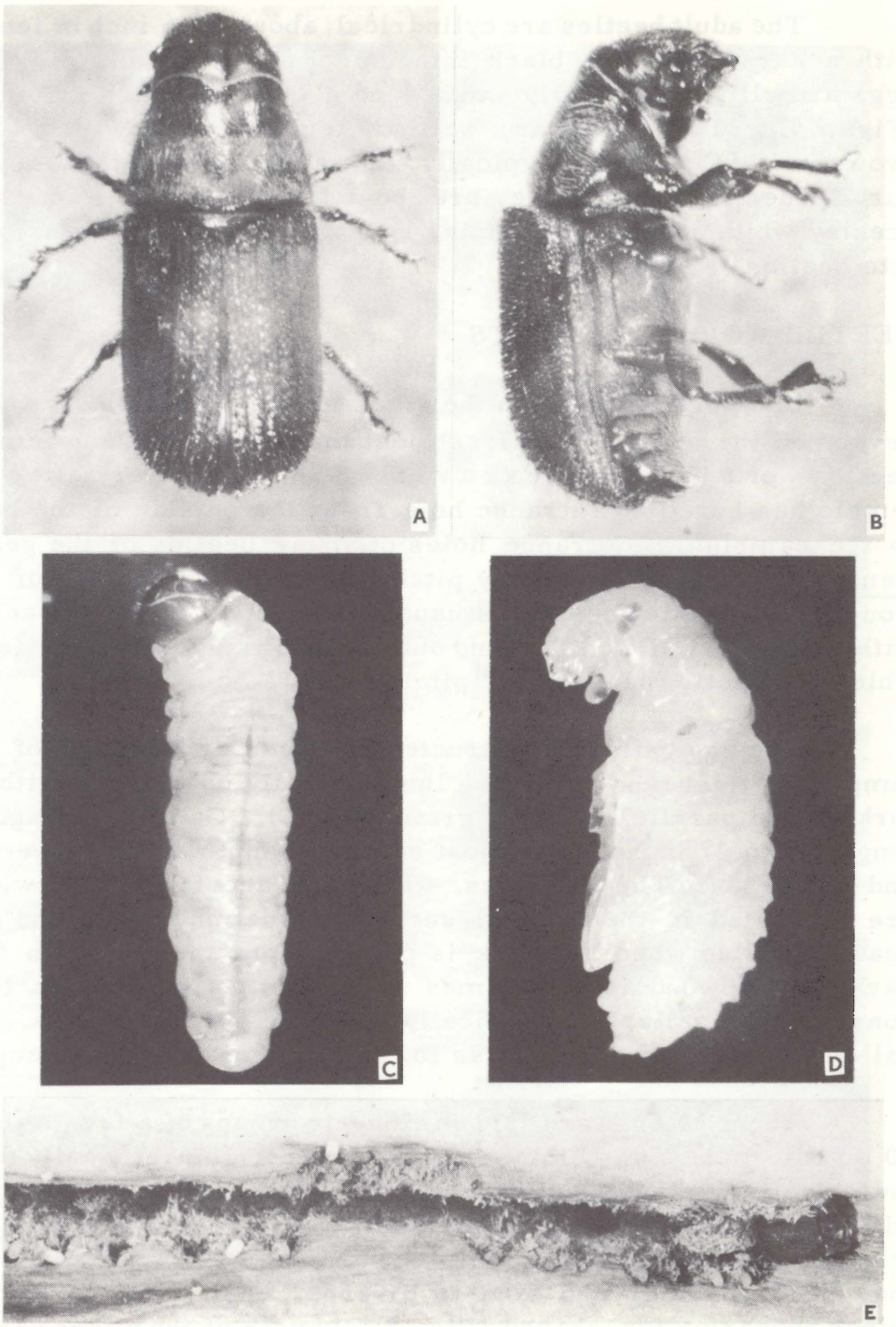

Fig. 2. Developmental stages of the Douglas-fir beetle: A and B, adult, x 11; C, larva, x 11; D, pupa, x 11; E, eggs in niches grouped on alternate sides of egg gallery, x 2.

Fig. 3. Egg gallery and larval mines of the Douglas-fir beetle with larvae in place. Note the grouping of larval mines on alternate sides of the egg gallery and the frass packed in the gallery, slightly less than natural size.

Transformation from mature larvae to pupae and then to adult beetles takes place in the pupal cavities. The virgin adults enlarge the cavities as they feed. Before emerging about eight months later to infest other host material, they often congregate in communal feeding chambers within the bark.

Infested trees die primarily from mechanical girdling caused by the beetles as they construct egg galleries and larval mines. Although rarely apparent to the naked eye a blue-staining fungus, introduced into the tree by attacking beetles, assists in killing the tree by blocking the conducting tissues of the xylem.

The presence of the Douglas-fir beetle can be confirmed readily by removing a section of bark and noting the characteristic pattern produced on the cambial surface by the gallery and mines on nearly all dead and dying Douglas firs.

LIFE-HISTORY

The Douglas-fir beetle has a one-year life-cycle with two broods per generation. Although there is considerable overlapping in the emergence and attack periods of the two broods, there are definite spring and summer flights producing one brood each (Fig. 4).

Overwintering Stage

The overwintering stage most frequently found is that of the virgin or callow adult. Larvae are less commonly found but pupae and eggs are never found. Parent adults may be observed overwintering in galleries of the summer brood. The term "overwintering stage" refers to the period from September to April, when the beetles are relatively inactive. Overwintering adults take part in the spring flight while overwintering larvae mature in time for the summer flight. Although beetles emerge to infest fresh host material from May to August, the main emergence takes place in the spring.

Spring Flight

The first attacks are made between late April or early May to mid-June by virgin beetles emerging from host material infested in the previous spring to start their first brood and by the parent adults of the previous year's summer brood. The progeny

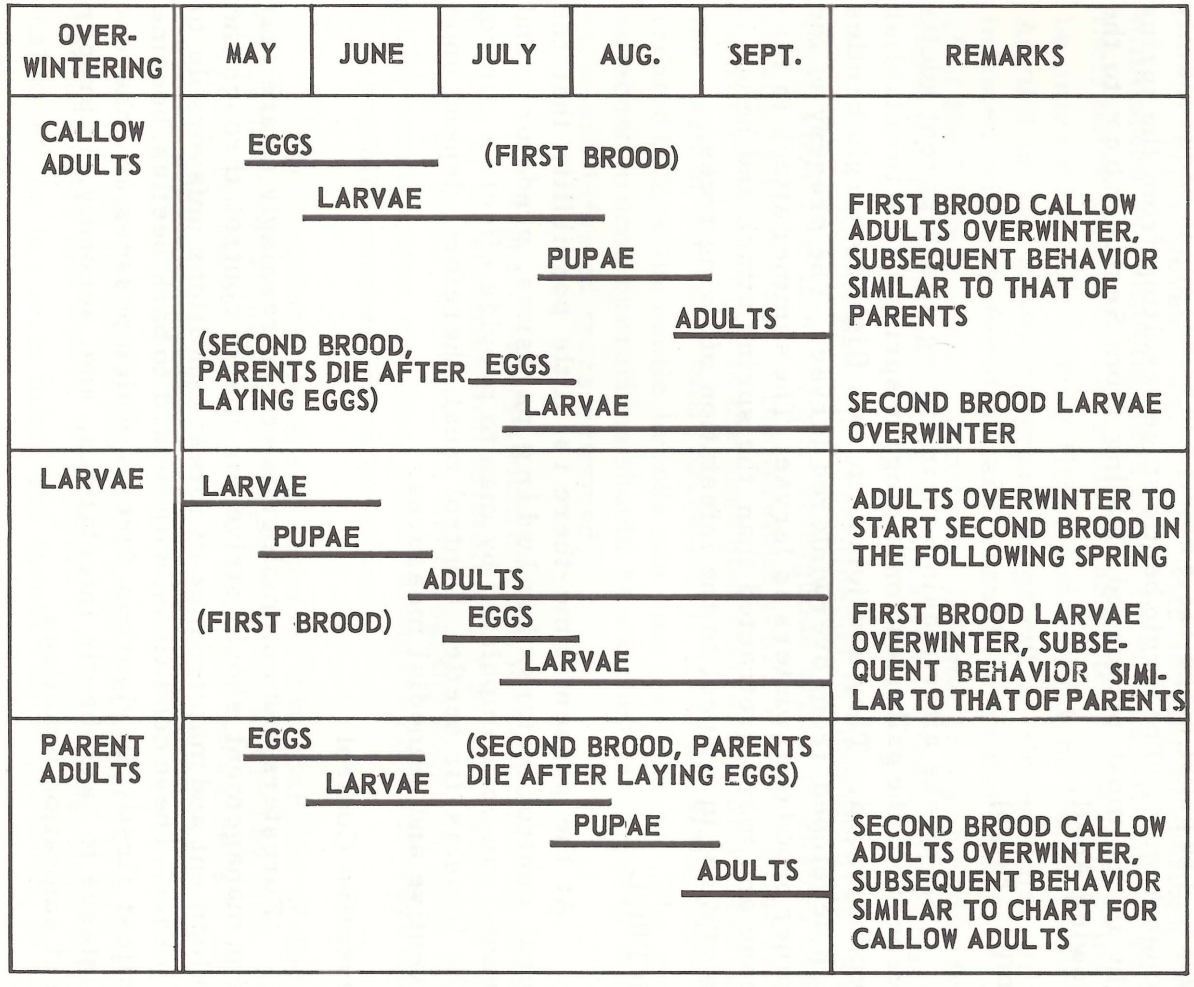

Figure 4. Brood Development and Life Cycle of the Douglas-fir Beetle.

of this attack is referred to as the spring brood. By the latter part of May eggs can be found in the galleries. The eggs hatch in from 15 to 20 days. Larvae, which require about 60 days to become fully grown, may be found from mid-June until mid-August. The pupal stage lasts about one week; pupae occur mainly through August. The virgin beetle stage resulting from the spring flight is the most prolonged, lasting from September to the following April.

Summer Flight

Six weeks after making their spring attack parent adults emerge from the galleries containing the spring brood to establish a second brood. They are joined in this flight by virgin beetles which developed from overwintered larvae. The progeny of the summer brood overwinters as larvae. The summer attack is less intense and more protracted than the spring attack and hence is less critical in respect to the infestation of living trees.

CONTROL

At the present time there is little possibility that the natural control factors, including parasites, predators, and disease, can be manipulated by man to provide effective control of the Douglas-fir beetle. Control must, therefore, depend upon preventive and remedial measures.

Preventive Control

Foresters and entomologists are increasingly aware that forest management should strive for insect control through the development and maintenance of forest conditions unfavorable to the insect. These conditions, with regard to bark beetles, become manifest firstly in vigorous forests which possess an inherent resistance to bark-beetle infestations, and, secondly, in proper forest sanitation practices.

By harvesting on a selective and critical basis the forest can be made relatively resistant to bark-beetle infestations. Trees that are more than 150 years old, particularly those that are slow growing, appear more susceptible to attack than younger, vigorous trees. Over-mature, decadent stands often suffer considerable annual depletion and timber owners should always be prepared to give such stands priority in the cutting program.

The following recommendations for the control and prevention of Douglas-fir beetle infestations should be followed as closely and as fully as the economics of the area permit:

(1) Outbreaks associated with logging operations can be minimized by removing logs from the woods within one year of their being infested. Logs cut in the winter and early spring will be infested by the spring flight and should be removed before April 1 of the following year. Logs cut in the summer will be infested within a few days and should be removed before June 15 of the following year. Similarly, infested trees should be felled and removed from the woods within a year of their being attacked.

(2) Logging should be continuous in time and area. Fresh slash should be laid down on contiguous areas to absorb beetles emerging from slash of the previous year. Where logging is discontinued in time (as in the case of a shut-down) or in area (as in the case of portable mill operations), infested slash should be treated before the beetle broods can emerge from it. The stands adjacent to such operations should be watched for signs of infestation and infested trees removed.

(3) Right-of-ways should be cut wherever possible towards the end of the summer immediately prior to use. When cut in the spring or early summer, or when logging does not soon follow their construction, marginal stands along the right-of-ways should be carefully watched for infestation.

(4) Residual trees and those on the margins of logging operations and right-of-ways should not be injured by fire, skidding, or bulldozers. Injured trees threaten the success of control work by providing favorable breeding habitats for the beetle.

These sanitation practices offer the best way of minimizing beetle losses and where it is possible to plan operations with the habits of the beetle in mind, the forest can be protected in large degree from outbreaks.

Remedial Control

As in the section on preventive control, the following suggestions should be followed as closely and as fully as economics permit. The value of the timber being infested or threatened must be such as to warrant the cost of the control treatment.

(1) Probably the least expensive method of treating infested material to kill bark-beetle broods is to pile and burn it. As long as the treatment is applied within the year of the material being infested it is effective in any season. The fire hazard will obviously be the factor determining the time of burning.

(2) Beetle broods can be destroyed by peeling the bark to expose the insects. This method may have the associated disadvantage of increasing the fire hazard. When used in conjunction with the burning method it does, however, have the advantage of requiring a less intense burn than when the infested material is not peeled.

(3) Oil solutions and water emulsions of various fumigants have been used for the control of certain bark-beetles in the United States with considerable success. Pilot tests made in British Columbia of formulations developed in the United States have shown that they are effective in destroying broods of the Douglas-fir beetle.

The insecticides are applied from tank-type pressure sprayers equipped with a valve by which the rate of application is regulated. The nozzle should deliver a fine fan-shaped spray. Insecticide should be applied in the summer since ethylene dibromide freezes at about 49°F. Some proprietary products with an ethylene dibromide base contain substances to lower the freezing point of the formulation.

Ethylene dibromide.....15 pounds
Emulsifier (a blend of 3 parts by weight of alkylated aryl polyether alcohol and 5 parts of modified phthalic glycerol alkyd resin) 2 1/2 pounds
Fuel oil to make 4 Imperial gallons.

Add 16 gallons of water to this concentration.

The ethylene dibromide, emulsifier, and fuel oil should be thoroughly mixed first. The water is then added and the batch thoroughly agitated to make a homogeneous mixture. If the mixture is allowed to stand the emulsion will break down and reagitation will be required. Formulations should be used the same day as mixed if at all possible.

Although ethylene dibromide is one of the less disagreeable insecticides used to kill bark-beetle broods, it is sufficiently toxic to warrant considerable care in its use. Pure lanolin should be applied to hands and face, and goggles and rubber gloves should be worn while mixing since ethylene dibromide will blister the skin.

Further information on the biology and control of the Douglas-fir beetle can be obtained from the

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