INSECTS CAUSING SEED LOSSES IN DOUGLAS FIR ON VANCOUVER ISLAND IN 1957[1]

A. F. HEDLIN

Forest Biology Laboratory, Victoria, B.C.

Previous work on cone and seed insects on Vancouver Island has indicated that insect-caused seed losses in Douglas fir are important (Graham and Prebble, 1941; Radcliffe, 1952). However, these studies were interrupted before a conclusion was reached.

The present study was started in 1957. The object is to determine first what insects are present and their relative importance in causing seed losses in Douglas fir. There are a number of insect species involved and it is hoped to identify at least those of economic importance. The life histories and seed-destroying capabilities will be studied and eventually experiments in chemical and cultural controls will be carried out. Thus it is hoped that it will be possible to reduce insect-caused seed losses within restricted areas, such as seed orchards.

To study cone production and seed losses on an area-basis one plot was measured out at each of four different elevations in the Cowichan River area of Vancouver Island. In each plot, potential cone-bearing Douglas-fir trees were tagged. These trees will be examined each year for cone and seed production and for records of insect losses at the different elevations. Plot elevations ranged from 400 to 1625 feet.

Biological studies were carried out by examining cones for insects and damage at regular intervals from time of pollination until cone maturity. In this way complete series of immature forms were obtained and their damage noted. In early spring, eggs were obtained and later observations yielded larvae of the different instars through to the pupal stage. Four hundred and ninety cones were dissected scale by scale.

Results

The insects of importance can be conveniently divided into three groups: seed chalcids, cone moths, and cone gall midges.

Megastigmus spermotrophus Watchl family Chalcididae

The biology of the seed chalcid *Megastigmus spermotrophus* is well known (Hussey, 1955), so little time was spent on it. The egg is laid within the young seed in the spring. After hatching, the larva feeds on the developing seed and by the time it is fully grown has devoured the inside of the seed. It remains in the seed over winter, pupates and emerges the following spring. Each insect destroys one seed.

Barbara colfaxiana (Kearf.) family Olethreutidae and other cone moths

The cone moths have received much more publicity than other Douglas-fir cone insects with the possible exception of *M. spermotrophus*. The reason for this is probably that they are larger and their feeding activities are more conspicuous than the other important species. *Barbara colfaxiana* is the species to which almost all the blame is attached. According to Heinrich (1923) there are three different forms or varieties causing damage to cones of Douglas fir and several others which attack cones of other conifers. In this study, larvae of other lepidopterous forms were obtained also, including *Dioryctria* sp. and several smaller unidentified forms.

1. Contribution No. 458, Forest Biology Division, Science Service, Department of Agriculture, Ottawa, Canada.

1. Personal communication: F. P. Keen, California Forest and Range Exp't. Stn., Lafayette, Calif., Jan. 1958.

2. Personal communication: N. E. Johnson, Weyerhaeuser Timber Co., Forestry Research Center, Centralia, Wash., Jan. 1958.

The adult *Barbara colfaxiana* emerges in March or April and lays its eggs, usually singly, on the exposed portions of the cone bracts. When the larva hatches it begins to feed on the bract tissue and migrates into the cone where it feeds mostly on scale tissue for some time. The late-instar larva feeds on scales and seeds without showing any particular preference for either. In late summer it bores a tunnel to the surface of the cone and at the same time discharges frass, which adheres to the surface of the cone in pitch. The insect then forms a tough cocoon near the axis of the cone in which it pupates. It remains there over winter.

Damage resulting from the feeding by this insect can be divided into two categories, direct and indirect. Direct damage to seeds is simply the result of feeding on the seed. This is easy to assess. Indirect damage is the effect which injury to conductive tissues may have on developing seeds. The larva wanders around in the cone and obviously the damage to surrounding tissue will affect neighbouring seeds. The extent of this type of damage is more difficult to assess. Radcliffe (1952) found a significant difference in seed-viability between seeds from infested and uninfested cones. When only one larva is present a cone may develop quite normally, but when several are present the apical half of the cone is often killed before maturity. In 1957, 23 per cent of the cones in plots were infested with *B. colfaxiana* and the average direct damage was 3.6 ovules and 1.9 scales per cone. The average damage to ovules in one severely infested tree was 9.6 per cone.

TABLE I.—Percentage Douglas-fir cones infested with cone moths and gall midges.

Location	Elevation	No. of trees Total	Produced cones 1957	Percentage cones infested Cone moths	Gall midges
Plot 1	1625	33	7	50	32
Plot 2	1300	42	11	8	11
Plot 3	925	41	5	0	62
Plot 4	400	60	4	20	90

The Cone Gall Midges, Family Cecidomyiidae

The third group comprising the gall midges of the family Cecidomyiidae has received little attention, but some of its members are very destructive. Graham and Prebble (1941) recognized their potential as seed-destroyers but little mention has been made of them since. Some of the species occurring in Douglas-fir cones have been described by Foote (1956) but there is still uncertainty as to identification of some species. Keen[1] states "there are at least four species of gall midges (Itonididae) found in Douglas-fir cones and possibly more." The one which causes most damage lays its eggs in clusters near the base of the scales of the young cone. When the eggs hatch, the young larvae enter the soft scale tissue and form a polythalamous gall which usually destroys the seed. When few larvae establish themselves, the seed may form but becomes fused with the scale, and is not released from the cone. In the fall the larvae leave the cone to enter the duff, and emerge the following spring. Under natural conditions pupation probably does not occur until spring.

Gall midges infested 33 per cent of the cones in the plots and caused an average of loss 4.4 seeds per cone. The maximum seed-loss recorded in one cone was 32. Infestation of cones ranged from 11 to 90 per cent in different plots. Johnson[2] reported these insects to be serious in the State of Washington also.

Discussion and Summary

This study is aimed at separating the different species and their damage, working out their life histories, and determining a means of control for the important species in seed orchards. It is difficult to draw definite conclusions following only one year's work. However, it is apparent that a number of insect species are involved and that some of these are potentially capable of destroying appreciable amounts of Douglas-fir seed.

In 1957, seed chalcids, cone moths, and cone gall midges were present in appreciable numbers with the latter being the most important single group.

References

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Two remarkable Moth Chrysalises

Towards the end of May 1925, I received from the government fumigation station in Vancouver, four sapling Chinese elms with curious hard lumps projecting from the stems. The lumps were smooth, oval, nearly ½ inch long by 5/16 inch wide, striped with six alternate brown and white longitudinal bars and were stuck tightly to the stems. I had an idea that they were of lepidopterous origin so kept them in the laboratory.

On June 20 when working at a table I heard a curious little "plop!" and immediately something flashed to the window which fortunately was closed, and banged up against a pane. It was a stout-bodied brownish-orange-yellow moth with a wing spread of about 1⅛ inches. Closely watching the other lumps on the stems, I was fortunate enough to see the emergence of another moth; suddenly the rounded top of the chrysalis, like an operculum, flew off with a click and in one fluid movement, without the pause for wing expansion and drying common to most moths, this one emerged from the chrysalis and flew straight towards the light, to hit the window with a thud.

Having no references to Chinese insects, I consulted Maxwell Lefroy's "Indian Insects" and found an illustration and brief description of a very similar moth; it belongs to the Limacodidae, closely related to the Eucleidae or flannel moths which have caterpillars with extremely irritating spines.

In the Blackmore-Wynne collection of Lepidoptera at the University, are specimens of only one species of Limacodidae in this Province, *Tortricidia testacea crypta* Packard, from Saanichton and Enderby, with no notes about its chrysalis.

The emergence of these moths from their hard chrysalises is so remarkably swift as to raise the question "Why?". Every other moth that I have ever heard of or seen takes some little time for the expansion and drying of its wings and the large silk worm moths take several hours. Against what enemies or danger is this moth so protected that it emerges from its chrysalis like a jack-in-the-box?

The second remarkable chrysalis was brought to my attention by Mr. F. Jackson, 440 E. 35th Avenue, Vancouver, who rang me up in June 1957 to ask "What insect is made of gold?" As usual in such cases, I said that I did not know but to send in specimens. In a few days he sent some withered leaves tied into clumps with scanty silk and showing in spots, touches of gold. On tearing open the leaves I was amazed to find small obtected pupae of pure, polished gold, the most beautiful things imaginable. For once a citizen was correct, they *were* of gold. From July 2 to July 5, four moths emerged from these pupae leaving behind them delicate empty cases with only the faintest tinge of gold. The moths are geometrids *Sicya macularia crocearia* Packard and from the Blackmore-Wynne collection I find that they are quite commonly distributed at the coast and at Enderby where Mr. Wynne lived, and in the southern interior. Larvae of the form *macularia* are recorded by Llewellyn Jones as feeding upon *Acer, Betula, Vaccinium, Spirea, Pinus contorta, P. monticola* and *Tsuga,* a very wide range of food plants. It would be interesting to know if all the pupae from larvae that feed on such diverse hosts have this polished gold reflection.