

numerous in the sections from the lower bole in the lindane treatment. Possibly control may have been more effective against the larvae in the thinner-barked upper sections.

This trial indicates that more experimental work should be done with lindane, preferably under varied environmental conditions. Air temperature at the time of spraying was 70° F; temperature rose to the high 70's daily for the following week, during which time there was no rain-

fall. Possibly an oil carrier might have been desirable had inclement weather followed treatment or if treatment had been carried out in the winter.

Summary

A one per cent emulsion of lindane applied on 24 May, 1964 controlled *Dendroctonus ponderosae* Hopk. in a freshly-felled *Pinus monticola* Dougl. tree at Trinity Valley in the interior of British Columbia.

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RELEASES OF CINNABAR MOTH, *Hypocrita jacobaeae* (L.), (LEPIDOPTERA: ARCTIIDAE) ON TANSY RAGWORT IN BRITISH COLUMBIA¹

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Introduction

Tansy ragwort, *Senecio jacobaea* L., a noxious weed native to Eurasia, has been introduced into New Zealand (Cameron, 1935) Tasmania, Australia, South Africa, and North and South America (Harper and Wood, 1957). In Canada it is established in Nova Scotia and has been in British Columbia at least since 1950 (Harris, 1964, Hughes, 1951). It is well established in pastures in the lower Fraser Valley near Abbotsford and on Vancouver Island near Nanaimo. Regular spraying with herbicides or cutting before flowering is needed to keep it in check.

In British Columbia only three insects have been found feeding on tansy ragwort during four years: caterpillars of *Phragmatobia fuliginosa* L.; *Aphis lugentis* Williams; and the dipterous leaf miner *Phytomyza atricornis* Meigen. Only a few of the caterpillars have been found and the aphids appear to have little effect on the plant. The leaf miner becomes effective only in the laboratory. In Washington, Oregon and California, 15 endemic insects were reared to maturity on tansy ragwort but many of these were of minor importance and some were rare (Frick, 1964). None of the endemic insects appears to be effective in impeding the growth and spread of this weed.

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The cinnabar moth, *Hypocrita jacobaeae* (L.), is one of the primary natural controls of the weed. It was introduced into New Zealand from England (Cameron, 1935) following host-specificity studies. The first successful releases in North America were made in California in 1959 (Frick and Holloway, 1964) after further host - specificity studies (Parker, 1960). In Canada releases were made in Nova Scotia in 1961 and a year later in British Columbia (Harris, 1964). The cinnabar moths were brought into Canada from Switzerland and were bred at the Entomology Research Institute for Biological Control, Belleville, Ontario until they were free of parasites and disease. Further host-specificity tests were made at this time (Bucher and Harris, 1961).

Releases at Abbotsford

In summer 1962, 856 first- and second-instar larvae were released by transferring them with a camel's hair brush onto ragwort plants in small fenced areas in a pasture near Abbotsford. Fifteen larvae were also placed in each of five lumite field cages (Nicholls, 1960) over tansy ragwort. Healthy mature larvae were observed in the cages as late as July 27, 1962 but no pupae were found and no adults emerged in the cages in 1963. So far as could be determined none emerged in the field. Sixty mature larvae had been collected in the field and were kept in an outdoor insectary over winter. No parasites emerged from the mature larvae or the pupae and all but a few survived the winter.

In 1963, 5000 larvae, one-half of which were reared at the Vancouver Station and the other half at Belleville, were released in the same area. The larvae again did well, both in cages and in the open, but pupae could not be found. No disease was observed in the field and none of 100 mature larvae collected from the field was parasitized.

In 1963, 2nd- and 3rd-instar larvae were transferred to marked plants in two locations. In the first, two hours

after releasing 230 larvae on 23 plants, 168 were counted; nine days later there were still 162. In the second location, two hours after releasing 250 larvae on 25 plants, 162 were counted but nine days later only 85 remained. The missing 77 larvae could have moved to the ground to pupate, since the surviving larvae were mature. The greatest loss usually occurred within 2 hours after transfer of the young larvae to the plant.

It was evident by this time that something other than weather, disease or parasitism was responsible for the failure of this insect to become established. Predation by small mammals seemed to be a possible reason. There was little cover such as stones or wood and the silt loam soil was too packed for the larvae to burrow into it, hence they probably would pupate on the surface where mice and shrews could readily find them. Sixty mouse traps, baited with raisins and walnuts or bacon, were set out in late August and early September in the release area. In nearly one month of trapping the catch was 2 mice, 1 shrew, and a sparrow. This very low population was unlikely to have caused the rapid and complete disappearance of the entire cinnabar moth colony. Moreover, mice or shrews were clearly not the reason for the simultaneous absence of pupae in the cages.

In 1964 50 larvae were found in the release area and one moth was seen by a resident about 0.8 km ($\frac{1}{2}$ -mile) south of the release area. No further releases were made at Abbotsford and no larvae or moths were observed in 1965. It is very doubtful that the cinnabar moth has become established in the Abbotsford area.

Releases at Nanaimo

In 1964 the release site was a 35-acre, newly-cleared pasture near Nanaimo. The land was rough, the soil was light, and there was cover and debris under which the larvae could pupate. Between June 29 and July 11, 2800 2nd- and 3rd-instar

larvae were released. The larvae showed no signs of disease or parasitism in the field nor was there any parasitism in 300 pupae obtained from mature larvae collected from the release area.

In 1965 about 200 larvae from the overwintering population were observed in this pasture. No moths were seen but larvae in all instars were found in 15 different locations. In one instance, 1st-instar larvae were present and in another only heavy and characteristic feeding damage was observed indicating that the period of emergence was about 1 month extending from late May to late June. A further 6200 2nd-, 3rd-, and 4th-instar larvae were released at the Nanaimo site in 1965.

Relation of Establishment to Carabidae

We reasoned that the cinnabar moth must have been eradicated at

Abbotsford during the period when the mature larvae were wandering in search of a place to pupate or else during the pupal stage. It was evident that mice were not responsible and no moles were active near the release site. In 1964, a single ground beetle, *Pterostichus melanarius* Ill., which came into the laboratory on a tansy ragwort plant from Abbotsford, was seen to destroy eight pupae. These and other ground beetles were readily found in the release area at Abbotsford. To sample and compare the populations of carabids, 30 pitfall traps were set out at the release sites at Abbotsford and Nanaimo at 10-meter (33 feet) intervals. The traps were new preserving cans 3.5 cm in diameter by 11.5 cm deep (3¼ x 4½ inches) placed in the soil with the opening at ground level. Counts were made on three consecutive days. The species and numbers caught are shown in Table 1.

TABLE 1.—Ground beetles collected by pitfall traps at cinnabar moth release sites in British Columbia, 1965

	Abbotsford		Nanaimo
	July 17-19	Aug. 11-13	July 22-24
<i>Agonum mulleri</i> Hbst.	—	—	1
<i>Amara obesa</i> Say	—	—	1
<i>Amara</i> sp.	—	—	1
<i>Anisodactylus</i> sp.	2	—	—
<i>Calathus fuscipes</i> Goeze	25	101	—
<i>Calosoma tepidum</i> LeC.	—	2	2
<i>Carabus granulatus</i> L.	15	6	3
<i>Carabus nemoralis</i> Müll.	8	1	1
<i>Harpalus affinis</i> Schrk.	2	—	52
<i>Pterostichus melanarius</i> Ill.	80	177	7
Total	132	287	68

In laboratory studies larvae of the cinnabar moth were fed to those species of ground beetles that occurred in large numbers. *P. melanarius* and *Calanthus fuscipes* were extremely predacious and were far more abundant in Abbotsford than Nanaimo. *Harpalus affinis* were fairly abundant in Nanaimo but showed no interest in cinnabar moth larvae. Six larvae of the cinnabar moth were placed on tansy ragwort in each of two cages. In one cage two *C. fuscipes* were included and in the other, two *P. melanarius*. All the larvae were

destroyed except one which pupated between the stems of the tansy ragwort plant about 10 cm (4 inches) above the soil surface.

C. fuscipes was twice seen in the branching upper part of the plant in the laboratory but this was never observed in the field. Both of these species could destroy newly-formed pupae and sometimes more mature pupae. Usually they were unable to break through into old pupae. Holes were often seen in the soil at the base of ragwort plants at Abbotsford and as many as five ground beetles

were found in these burrows. Since the larvae of cinnabar moth wander considerably when mature and looking for a site to pupate they undoubtedly fall prey to ground beetles; but when these holes are located right at the base of the plant the possibility of their being caught is very much greater.

The ground beetles had voracious appetites, feeding until their abdomens were distended far beyond their elytra. They ate everything put in their cages except a woolly-bear caterpillar (probably *Phragmatobia fuliginosa*) and a few hard-shelled pupae including some of *H. jacobaeae*. Prey fed to them included the larvae and sometimes the pupae of the following: the variegated cutworm, *Peridroma margaritosa* (Haw.); the alfalfa looper, *Autographa californica* (Speyer); the imported cabbage worm, *Pieris rapae* (L.); the onion maggot, *Hylemya antiqua* (Meig.); the wireworm, *Ctenicera lobata* (Esch.); the leatherjacket, *Tipula paludosa* Mg.; the

larvae and adults of the black vine weevil, *Brachyrhinus sulcatus* (F.); the confused flour beetle, *Tribolium confusum* Duval; a mature larva of a large June beetle; and earthworms. They were also cannibalistic, and would eat meat or fish scraps. *Carabus granulatus* and *C. nemoralis* were also extremely predacious but were in small numbers.

The ground beetle population was very probably responsible for the failure of *H. jacobaeae* to become established in the Abbotsford area. If other sites near Abbotsford have a lower population of carabids, it may be possible for the cinnabar moth to become established. Once established nearby it may provide control at the original site by annual migration of adults.

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A Second British Columbia Record of
Silpha surinamensis F. (Coleoptera:
Silphidae)

On May 23, 1962, at Vernon, one specimen of *Silpha surinamensis* F. was taken in a black light trap between 2100 and 2300 hours P.S.T. The only previous British Columbia record of this species was from east of the Rocky Mountains in the northeast

section of the Province near Pouce Coupe (Hatch 1957).

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