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PAGE

THE DISTRIBUTION OF OVERWINTERING TRYPODENDRON (COLEOPTERA, SCOLYTIDAE) AROUND A SINGLE TREE IN RELATION TO FOREST LITTER VARIABILITY[1]

J. A. Chapman[2]

Introduction

The occurrence of overwintering *Trypodendron lineatum* (Oliv.) in forest litter was first reported and studied by Hadorn (1933). Later investigations on the hibernating sites of this ambrosia beetle were made by Kinghorn and Chapman (1959). One of their findings was that the beetles tended to concentrate around the bases of trees.

Examinations of litter in British Columbia have shown that there is often considerable difference in numbers of beetles from similar or adjacent samples. An example of this is given by Chapman (1959). There are many factors which may contribute to forest litter variability; for example, amount of rotten wood or moss, relative contribution from various tree species, moisture, and nature of ground cover. The purpose of the present study was to secure information, within a small sample area, on obvious differences in ground cover and nature of litter in relation to numbers of overwintering beetles.

Method

It was believed that the information desired could best be secured by sampling in such small units that the approximate location of individuals could be determined, in relation to litter variability. Accordingly, in 1959, near Parksville, B.C., some time was spent sampling the litter surrounding a single tree within a stand of timber. The seasonal activity of *Trypodendron* had been studied earlier in adjacent logging settings (Chapman and Dyer, 1960) and the location of a fairly large population of overwintering beetles was known from studies by E. D. A. Dyer and J. M. Kinghorn of this Laboratory. The work was done in November and December, after the beetles were all in their overwintering quarters. The area to be sampled was marked out in 6 by 6 inch squares and, including some smaller units next to the tree, 287 samples were taken. In each square the litter and organic material which could easily be removed by hand from above the mineral soil was taken. Previous work (Kinghorn and Chapman, l.c.) had shown that most if not all of the overwintering population is located above the mineral soil. The portion of the surface covered by leaves of salal (*Gaultheria Shallon* Pursh), the common under-growth plant of the coast forest, was noted, and the amount of moss estimated for each sample. Other obvious features of the litter, as presence of bark flakes in large amounts, or surface roots or fallen branches were also noted and the volume of each sample was measured after examining it for beetles.

Immediately upon collection the samples were placed in individual plastic bags and kept at outdoor temperatures in a shaded location until they were examined, within two months. This was done by spreading the litter thinly on a warm surface under a light (Hadorn's method) and watching it for a period of time judged entirely sufficient to activate all beetles. With this method they are seen easily when they begin to crawl about and at this stage of their life they seldom fly from the warmed

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[2] Forest Biology Laboratory, Victoria.

litter. The litter was redistributed on the warm surface at intervals during the examination period, to increase search effectiveness. Twelve of the samples which had been stored longest and from which a total of 37 beetles had been taken using the above procedure, were next examined by a wet method which reveals dead insects also (Kinghorn and Dyer, 1960). Only three more beetles were found, giving a recovery of 92 per cent for the warm pan method. This agrees well with previous tests of beetle recovery (Kinghorn and Chapman, l.c.) and is good evidence that few had died in the interval between collection and examination of litter, or were missed by the warm pan method.

Results

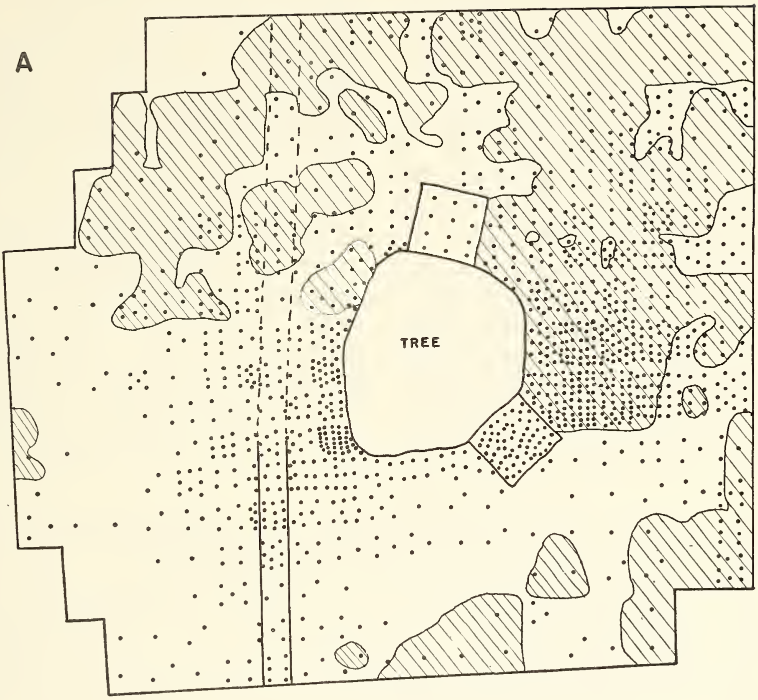
The data from this study are best given as a beetle distribution map of the area sampled (Figure 1). In (A) each beetle is represented by a dot. Within any given sample unit the dots have been arranged uniformly. The two squares adjacent to the tree represent 12 x 12 inch samples taken previous to this study. It is obvious that the positions of the beetles are only approximately shown. While most of them are closer, the maximum distance they could be recorded from their true position is 8½ inches (the length of a diagonal of a 6 by 6 inch square). The portion of ground surface covered by salal leaves is shown by the diagonal lines. No distinction was made between low, dense cover and higher, more diffuse cover. The position of a small dead tree which lay across the sample area is also shown, the interrupted lines indicating contact with earth or litter, the solid-lined portion being 2 to 4 inches above the surface.

In (B) the relative abundance of surface moss is indicated by from 2 to 49 dots per sample unit, corresponding to a range of trace amount to 2/3 of the litter sample volume, in 8 steps. The relative volume of litter per sample is also indicated; the range 25-35 cubic inches, to 100-150 cubic inches per sample being shown by use of 0 to 8 horizontal lines per sample square, with five categories. No obvious relationships between numbers of beetles and presence of dead salal leaves, small twigs, shallow roots or other miscellaneous features of the litter were noted.

Discussion

Certain inferences or tentative conclusions may be based on this study. First, there appears to be no direct relationship between moss or litter volume and numbers of beetles. Secondly, although the beetles concentrate next to trees, as earlier reported by Kinghorn and Chapman, a considerable proportion occur over a foot away. Thirdly, two features of the data suggest that surface cover is a significant factor in determining the final position of overwintering beetles: 1) the apparent effect of that part of the small fallen tree lying above the surface in concentrating beetles beneath and close to it (note Fig. 1-A), and 2) the quite marked association between high density of beetles and salal cover on the southeast side of the tree. It is possible that a concentration of large trees 15-20 feet to the southeast resulted in a shading effect which contributed somewhat to the heavier population on that side of the tree. It appears, however, that the primary factor was the salal cover, which in this section of the sample area formed a dense well defined zone, contrasting with an adjacent open space. It should be said that the area of felled logs from which, presumably, most of the beetles came, lies to the north through about 200 feet of timber. Finally, it can be noted that the distribution of

A



B

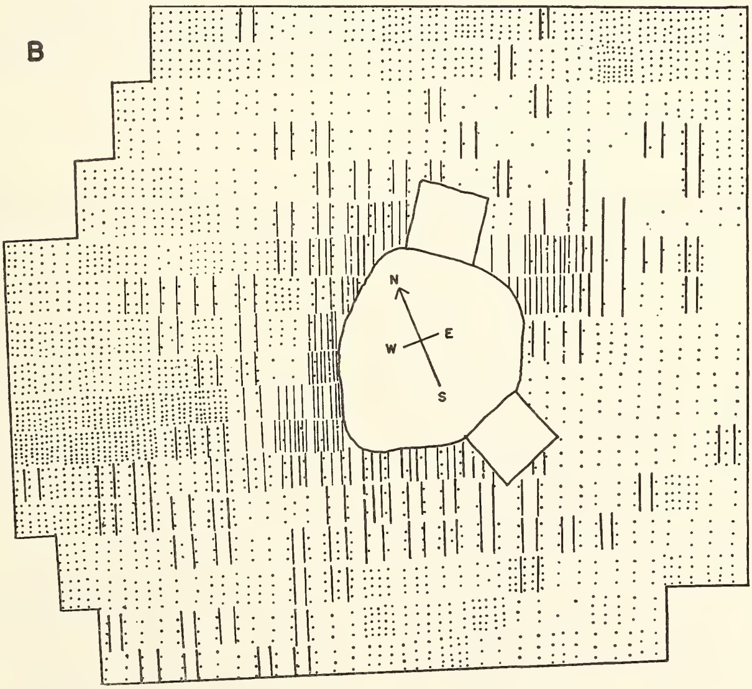


Fig. 1.—(A) Distribution of beetles (dots) around a tree in relation to salal (**Gaultheria**) undergrowth. (B) Relative amounts of moss (dots) and litter in the same area (see text).

beetles, while not random, is certainly variable enough so that a single sample anywhere around the tree would give only a rough idea of the actual population there.

Kinghorn and Dyer (1960) reported considerable numbers of *T. lineatum* overwintering in tree bark. Beetles were found not only in thick, heavily fissured bark, but also in niches bored into the relatively thin, smooth bark of smaller trees. This, together with earlier findings concerning location of overwintering beetles, suggests that it is the physical nature of a location in offering small, protected crevices within a certain general setting which influences a beetle to select its specific hibernating quarters. If this is so, then one would not expect differences in litter composition or appearance, even at the surface, to have much influence apart from the fact that most litter offers, at almost any point, relatively dark, moist, easily entered hiding places in abundance. The results of the present study are in agreement with this view and also indicate that it is factors other than those associated with obvious variations in litter itself which are of primary importance in determining location of overwintering beetles.

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ADDITIONS TO THE CHECK LIST OF MACROLEPIDOPTERA OF BRITISH COLUMBIA[1]

DAVID A. ARNOTT

While investigating the cutworm species present in southern British Columbia the author used light traps at two localities to supplement data from field surveys. A trap was operated at Kamloops for 5 esasons from 1955 to 1959 and at Summerland for one season, 1956. Among the macrolepidoptera captured were thirty-two species not recorded for the Province by Llewellyn-Jones (1951), including *Laphygma exigua* Hbn., the beet armyworm, not previously known to occur in Canada. A single new record was obtained from Summerland, that of a geometrid, *Cheteoscelis bistriaria* Pack. Thirty species were recorded only at Kamloops. Adults of *L. exigua* were recorded at Kamlops in 1956 and 1958 and an adult recorded from southern Vancouver Island in 1958. The larvae of this species were also found during 1958 infesting crops of table beets and tomato at Ladner and tomato at Pavilion.

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The arrangement and numbering of species, locality and flight period, conforms with Llewellyn-Jones' list, which mainly follows that of McDunnough (1938) in his "Check List of Lepidoptera of Canada and the United States, Part I".

Family ARCTIIDAE

Subfamily ARCTIINAE

Apantesis Wlk.

1033 virgo L.
1. Kamloops.
2. July, August.

Family NOCTUIDAE

Subfamily NOCTUINAE

Euxoa Hbn.

1236 dargo Stkr. *rumatana* Sm.
1. Kamloops.
2. July, August, September.

1247 olivalis Grt. *mcdunnoughi* Cook.
1. Kamloops.
2. June, July, August, September.

near 1250 maimes Sm.
1. Kamloops.
2. August.

near 1371 servita Sm.
1. Kamloops.
2 July.

Agrotis Ochs.

1425 venerabilis Wlk. Dusky cutworm.
1. Kamloops.
2. August, September.

Amathes Hbn.

1518 substrigata Sm.
1. Kamloops.
2. August.

Anomogyna Staud.

1558 imperita Hbn.
a discitincta Wlk. *arufa* Sm.
1. Kamloops.
2. August.

Subfamily HADENINAE

Trichoclea Grt.

1652 fuscolutea Sm.
1. Kamloops.
2. May.

Ceramica Gn.

1951 picta Harr. *exusta* Gn. *contraria* Wlk. Zebra caterpillar.
1. Kamloops.
2. July.

Subfamily CUCULLIINAE

Lathosea Grt.

2021 pulla Grt. *pullata* Grt.
1. Kamloops.
2. April.

Cucullia Schrank.

2038 intermedia Speyer.
a cinderella Sm.
1. Kamloops.
2. May, July, August, September.

Oncocnemis Led.

2090 augustus Harv.
1. Kamloops.
2. September.

2127 riparia Morr.
a aqualis Grt.
1. Kamloops.
2. July.

Homohadena Grt.

2150 stabilis Sm.
1. Kamloops.
2. July, August.

Brachylomia Hamp.

2209 discinigra Wlk.
1. Kamloops.
2. April, September.

Hillia Grt.

2211 iris Zett. *crasis* H.-S. *semisigna* Wlk. *erdmanni* Moesch. *senescens* Grt.
1. Kamloops.
2 September.

Fishia Grt.

2279 discors Grt. *vinela* Sm.
1. Kamloops.
2. October.

Anathix Franc.

2319 aggressa Sm.
1. Kamloops.
2. August.

Subfamily AMPHIPYRINAE

Archanara Wlk.

2440 subflava Grt.
1. Kamloops.
2. July, August.

Hypocoena Hamp.

2451 basistriga McD.
1. Kamloops.
2. August.

Amphipoea

2459 americana Speyer.
a pacifica Sm.
1. Kamloops.
2. July, August.

Achytonix McD.

near 2558 praeacuta Sm.
1. Kamloops.
2. August.

Platyperigea Sm.

2654 camina Sm.
1. Kamloops.
2. August.

Caradrina

near 2660 morpheus Hufn.
1. Kamloops.
2. June, July.

Laphygma Gn.

2683 exigua Hbn. *flavimaculata* Harv. Beet armyworm.
1. Vancouver Is., Ladner, Pavilion, Kamloops.
2. July, August, September, October. A migrant from the south.

Subfamily HELIOTHIINAE

Schinia Hbn.

2982 walsinghami Hy. Edw.
1. Kamloops.
2. August.

Subfamily PLUSIINAE

Chrysaspidia

3273 putnami Grt.
1. Kamloops.
2. August.

Subfamily CATOCALINAE

3346 unijuga Wlk. *lucilla* Worth.
1. Kamloops.
2. September.

3352 faustina Stkr.
1. Kamloops.
2. September, October.

Family GEOMETRIDAE

Subfamily GEOMETRINAE

Cheteoscelis Prout.

4079 bistriaria Pack. *udinaria* Stkr.
1. Summerland.
2. June.

Subfamily ENNOMINAE

Pero H.-S.

5072 honestarius Wlk. *stygiarius* Wlk. *dyari* C. & S.
1 Kamloops.
2. May.

ACKNOWLEDGMENT

The author is indebted to Dr. D. F. Hardwick, Entomology Research Institute, Canada Department of Agriculture, Ottawa, for identification of specimens and encouragement in publishing the appended list.

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AN INCIDENT OF DESTRUCTION OF HONEYBEE COLONIES IN THE INTERIOR OF B.C. BY AN ANT, PROBABLY FORMICA INTEGRA NYLANDER

In a letter received on June 3, 1959, from Mr. J. C. Keswick of Osoyoos, B.C., he advises that a few of his honeybee colonies were moved from Osoyoos up into the Anarchist Mountain area as a safeguard against destruction by Sevin. Four days after moving, Mr. Keswick checked his colonies at which time a great deal of ant activity was noticed. Upon checking the first colony in line it was found to be empty; the only trace of bees being a little capped brood and about a quarter of an inch of wings on the bottom board of the hive. The second hive examined was found to be in the same condition and the third one was just being invaded.

According to Mr. Keswick it was an amazing thing to observe the ants attacking honeybees. Generally at least three ants would attack a bee, snip her in two at the join of the abdomen and thorax, snip off the wings and head, and carry the dissected bee to their nest.

It would appear that as soon as the honeybee colony had been destroyed the ants then polished off any stores of honey, pollen or brood. The hive next in line had not been touched, neither were the remainder of the colonies.

Mr. Keswick carefully checked the area and at about forty feet from the colony a large nest of ants was discovered. This was destroyed after dark and specimens of the ants were sent to the author who in turn had them mailed to G. L. Ayre of Research Branch, Summerland, where they were identified as probably being *Formica integra* Nylander. This species is common in the Okanagan and because of its predacious habits is generally considered to be beneficial. It is very indiscriminate in its choice of food and will take anything handy.

—*J. Corner, Provincial Apiarist, Vernon, B.C.*

AN EXPERIMENT IN CONTROLLING DDT-RESISTANT CODLING MOTH, CARPOCAPSA POMONELLA L.[1]

J. Marshall and K. Williams[2]

The presence in British Columbia of a race of the codling moth, *Carpocapsa pomonella* L., resistant to DDT was demonstrated in a laboratory experiment in 1958 by Marshall (1). The same year, in an attempt to save the crop in the orchard that was most heavily attacked by the DDT-resistant insect, second brood spraying was carried out with a new insecticide that had given good results in 1957 against what had been considered a normal codling moth population. The new insecticide was the carbamate Sevin (N-methyl-1-naphthyl carbamate).[3]

The results of this late spraying were encouraging enough to justify a careful orchard assessment of Sevin in 1959. To broaden the experiment a second new insecticide, having a molecule structurally quite different from either DDT or Sevin, was also examined. It was the organo-phosphate Ethion (O, O, O′, O′-tetraethyl, S, S′-methylene bisphosphorodithioate)[4].

Experimental

An orchard in the Glenmore district near Kelowna was used for both the 1958 and 1959 experiments. In 1958 one acre was sprayed twice, and in 1959 seven acres were sprayed five times.

The trees were mature McIntosh and Delicious with a diameter of 20 to 30 feet, and an average height of about 18 feet. One series of seven plots was in a block of McIntosh trees, and a second series of seven plots, sprayed with the same materials and the same equipment, in a block partly of McIntosh and partly of Delicious trees.

The two experimental chemicals were applied to separate half-acre plots, each containing 20 to 30 trees, with three different orchard concentrate sprayers. Of these a 1955 model Turbo-Mist[5] and a 1959 model Swanson[6] were independently powered with gasoline engines. The third machine was a compact, experimental power-take-off unit designed and built at the Summerland Research Station. Designated Okanagan Experimental Sprayer Mark II, it is the subject of a separate article by McMechan and Williams (2). DDT was applied to only one plot (duplicated) with the Turbo-Mist machine.

In the course of the season three cover sprays were applied against the first brood codling moth, and two against the second brood. The first application was made a week after petal-fall.

DDT and Sevin were used as 50 per cent wettable powders, and Ethion as a 25 per cent wettable powder. The dosage in all plots was 50 imperial gallons of spray concentrate per acre.

Fruits were analyzed for spray deposits immediately following the last cover spray, and again, at harvest 34 days later. Ten apples were sampled from each of six trees per plot.

At harvest the numbers of worm-infested and "stung" fruits were noted in 500 fruits sampled from each of five 25-bushel bins from the centre trees of each plot.

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[1] Contribution No. 46 from the Regional Research Station, Canada Department of Agriculture, Summerland, British Columbia.

[2] Entomologist and Chemist respectively.

[3] Union Carbide Corp., White Plains, New York, U.S.A.

[4] Niagara Chemical Div. Food Machinery Corp., Middleport, New York, U.S.A.

[5] Okanagan Turbo Sprayers Ltd., Penticton, British Columbia.

[6] Swanson Sprayers, Okanagan Centre, British Columbia.

Results

Bearing in mind the percentage of active ingredient in each of the three insecticides, and the quantities applied per acre, the chemical determinations listed in Table 1 show that the three different sprayers applied roughly similar amounts of insecticides to the tops, and to the bottoms, of the trees. In each case about one-fourth as much insecticide was deposited on the fruits in the tops of the trees 12 to 15 feet above ground as on the fruits in the bottoms of the trees.

TABLE I—Average Spray Deposits from Duplicate Plots Following Last Cover Spray

Plot	Machine	Material	Amount per acre, lb.	Parts per million Top of tree	Parts per million Bottom of tree
1	Turbo-mist	DDT 50%	12	1.9	9.2
2	Turbo-mist	Sevin 50%	6	1.0	4.1
3	Expt. Mark II	Sevin 50%	6	0.8	3.5
4	Swanson	Sevin 50%	6	1.3	4.0
5	Turbo-mist	Ethion 25%	12	1.4	5.1
6	Expt. Mark II	Ethion 25%	12	0.8	4.4
7	Swanson	Ethion 25%	12	1.3	4.3

Table 2 giving the spray deposits immediately following the last spray application, and the residue that was present 34 days later, suggests that Sevin is less persistent, and Ethion more persistent, than DDT. (In a short article there is only room to tabulate averages; but the averages do sum up what was suggested by the unabridged results.)

TABLE II—Average Spray Deposits, Bottoms of Trees, Immediately Following Last Spray Application and at Harvest, 34 Days Later

Plot	Machine	Material	Amount per acre, lb.	Parts per million Last spray	Parts per million Harvest
1	Turbo-mist	DDT 50%	12	9.2	3.3
4	Swanson	Sevin 50%	6	4.0	0.8
7	Swanson	Ethion 25%	12	4.3	2.2

The next table shows that many more fruits were injured by the codling moth in the plots sprayed with DDT than in the plots sprayed with the two experimental compounds. But the difference was, in fact, far greater than the figures suggest. That was because, first, the amount of active ingredient applied per acre was twice as great in the DDT plots as in the Sevin or Ethion plots. Second, as the outcome of codling moth infestation, at least half of the fruits had fallen from the DDT-treated trees before harvest; these were not assessed for codling moth injury. Virtually none of the dropped fruits in the other plots showed codling moth injury.

This experiment demonstrated in the field what had been suggested in the laboratory, and what had been the experience of the owner of the property; in this orchard the codling moth can no longer be controlled with DDT.

TABLE III—Codling Moth Infestation in Harvested Fruit (5,000 Fruits Each Plot Including Duplicates)

Plot	Machine	Material	Amount per acre, lb.	Apple variety	Fruits % stung	Fruits % wormy
1	Turbo-mist	DDT 50%	12	McIntosh	3.2	14.1
1A				McIntosh	4.8	39.0
1A				Delicious	7.2	41.2
2	Turbo-mist	Sevin 50%	6	McIntosh	1.8	0.6
2A				McIntosh	3.4	2.0
2A				Delicious	1.6	2.3
3	Expt. Mark II	Sevin 50%	6	McIntosh	2.1	0.4
3A				McIntosh	2.5	0.4
3A				Delicious	1.2	0.5
4	Swanson	Sevin 50%	6	McIntosh	1.8	0.9
4A				McIntosh	1.0	0.1
4A				Delicious	1.3	0.5
5	Turbo-Mist	Ethion 25%	12	McIntosh	3.3	2.2
5A				McIntosh	0.6	0.1
5A				Delicious	1.7	0.9
6	Expt. Mark II	Ethion 25%	12	McIntosh	7.4	4.3
6A				McIntosh	2.0	0.6
6A				Delicious	1.7	1.1
7	Swanson	Ethion 25%	12	McIntosh	6.6	3.8
7A				McIntosh	1.7	0.3
7A				Delicious	2.0	1.3

What then of the experimental chemicals? Of the two, Sevin, as applied with the Turbo-mist sprayer in plot 2, undoubtedly was subjected to heavier codling moth attack than Ethion because, in both of the experimental blocks, plot 2 immediately adjoined the DDT plot. So plot 2, doubtless, was heavily invaded by second generation moths that had developed due to the failure of DDT. That is probably the explanation for the slightly heavier infestation in plot 2 than in the other plots, (3 and 4), that were sprayed with Sevin. The over-all performance of Sevin, in this orchard experiment, shows that this material was evidently about as effective against DDT-resistant codling moths as was DDT against non-resistant codling moths when the later insecticide was introduced into British Columbia 15 years ago.

To judge from the records of infestation alone, Ethion, although apparently less effective against DDT-resistant codling moth than Sevin, is nevertheless a promising material. There is, however, another consideration; about a month before harvest some defoliation occurred on Delicious trees that had been sprayed with Ethion. On the other hand, Sevin gave no evidence of phytotoxicity in this orchard, but experience elsewhere indicates that Sevin may have a thinning effect if applied to fruitlets shortly after petal fall.

The experimental effects of Sevin and Ethion on orchard pests other than the codling moth may be summarized in a few words. Five applications of Sevin gave adequate control of the green aphid, *Aphis pomi* DeG., but resulted in a heavy infestation of the mite, *Tetranychus mcdanieli* McG. Ethion, on the other hand, gave good control of the mite, but not of the aphid.

Summary

1. Against a codling moth population highly resistant to DDT, the carbamate Sevin and the organo-phosphate Ethion gave good control.

2. Sevin gave adequate control of the green aphid, *Aphis pomi* DeG., but resulted in a heavy infestation of the mite, *Tetranychus mcdanieli* McG. Ethion had the opposite effect.

3. On apples, Sevin left a less persistent deposit than DDT, and Ethion a more persistent deposit.

4. Ethion caused some defoliation of Delicious apple trees a month before harvest. Sevin caused no phytotoxic effects either on McIntosh or on Delicious.

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A BREEDING PLACE OF XESTOBIUM ABIETIS FISHER (Coleoptera: Anobiidae)

In his check-list of the Coleoptera of North America, Charles Leng records only 2 species of the anobiid genus *Xestobium*, *X. rufovillosum* (DeG.) the notorious deathwatch beetle of Europe which Leng records from New England, Illinois and Indiana, and *X. affine* Lec. from Vancouver and California.

In mid-February, 1960, Professor K. Graham gave me 2 chunks of very punky wood taken from a rotten top branch of a broad-leafed maple *Acer macrophyllum* Pursh. at Langley Prairie in the lower Fraser Valley and a couple of beetle grubs which he had dug out of the wood. I dug out another grub and put the wood into a plastic bag. In a few days time 2 beetles emerged which keyed out to genus *Xestobium* but were definitely not *rufovillosum* of which I have several specimens sent to me for reference from the government laboratory at Princes Risborough, England. My specimens have exactly the same type of markings consisting of scattered patches of pale golden-yellow recumbent hairs on a black background, but are only 4/5 the length and 1/3 the breadth, of *rufovillosum*.

I sent the specimens to Mr. Gordon Stace Smith of Creston who replied: "I have spent a lot of time with your *Xestobium;* it was your host record that puzzled me. I collected a type series of 4 specimens, extracting them from pupal cells in a dry tree of *Abies grandis* Lindl, the white fir. No other specimen is known until yours so it must be regarded as very rare. Fisher who described the species retained 2 and I have 2 paratypes".

The wood from which my beetles emerged and (August, 1960) are still emerging is so rotten that one can easily stick a finger into it; it is white with the dry rot fungus *Poria* which Dr. R. J. Bandoni of the Department of Botany at the University tells me is either *Poria ferrea* or *P. ferruginosa,* both of which cause white rot. Emergence records of the 10 specimens that I retained are Feb. 26, 2; March 1, 2; March 5, 2; March 26, 3; August 4, 1.

I kept some of the beetles alive in a glass jar for 2 weeks where they did not seem to feed on anything, not even on the brown mycelium of the *Poria* but they periodically drank water sprayed into the jar. Some mated and went through the motions of laying eggs in bits of fungus-covered wood so I hope to raise another generation. On bright days they were very active but on dull overcast days they were quiescent, hiding under trash.

Note

On 26 August I received this note from Mr. W. J. Brown, coleopterist of the Science Service "*Xestobium abietis* Fisher. The habitat seems wrong but I can make it nothing else Our specimens are from long-dead standing fir."

—*G. J. Spencer, University of British Columbia, Vancouver.*

ON THE NESTS AND POPULATIONS OF SOME VESPID WASPS

G. J. SPENCER[1]

The year 1957 was a year of wasp abundance in the lower Fraser Valley as was 1943 in the interior of the Province.

I had occasion to remove a number of nests of *Vespula* (*Dolichovespula*) *arenaria* (Fabricius) and one each of *V. vulgaris* (L) and *V. pensylvanica* (Saus.) in West Point Grey district of Vancouver and kept counts of the populations in each nest. The procedure in taking the nests was to wait until at least 10:30 at night when all activity had ceased around the nests and to set up a powerful spotlight at a distance on a stand so as to illuminate the area, then to squirt the jet of a 5% D.D.T. aerosol bomb into the entrance of the nest while holding underneath a sack stretched open on a round frame of heavy wire. The wasps poured out into the sack; when no more came out the nest was cut from its supports, dropped into the sack and examined next morning when practically all wasps were dead. Later, I used a small compression sprayer filled, at the suggestion of Professor K. Graham, with carbon tetrachloride which was much faster than the D.D.T. aerosol bomb since it immobilized the wasps instantly; however those that had not received a good shot of it tended to recover and had to be re-treated. Since all the nests contained combs with capped pupal cells, they were caged until emergence had ceased, then counts were made of each caste and the nests were set aside for the emergence of parasites and scavenger moths, which may occur as much as 10 months later.

TABLE of Populations of Wasps Nests

Nest No.	Drones	Queens	Workers	Total	Parasites	Caterpillars
D. arenaria						
1	470	77	695	1242	150	1
2	132	160	612	904	0	2
3	1	42	241	284	3	0
4	159	6	146	311	12	0
5	0	1	53	54	3	0
V. vulgaris						
6	32	43	2230	2305	0	0
V. pensylvanica						
7	126	33	224	383	0	0

Notes on These Nests

The parasites mentioned in the table are *Sphecophaga burra* (Cresson), Ichneumonidae (3) and the caterpillars are those of the moth *Vitula serratilineela* Ragenot, Pyralidae, as determined by comparing their adults with those in the Blackmore-Wynne collection at the University; this identity has not been checked by an authority.

Nest 1 taken 28 June 1957 from under the eaves on the south east corner of a garage, consisted of 6 combs inside 4 outer paper walls. The number of drones in this nest is surprising, being nearly 38% of the total population and 6 times the number of queens.

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Nest 2 taken 5 July from under the steps on the south east corner of a back verandah, consisted of 7 combs and 4 outer paper walls. Samples of these wasps were weighed directly after being killed to give the relative weights of each caste; 99 drones weighed 17 grams = 0.1717 grams each; 135 queens weighed 40.4 grams = 0.2886 grams each and 612 workers weighed 70.8 grams = 0.1157 grams each.

Nest 3 taken 24 July was scraped off a window pane facing south in a cottage on the first slope of Mount Seymour; it consisted of 4 combs and a new and completely empty one the size of a silver dollar, under no fewer than 11 outer walls reducing to 6 at the entrance and was obviously a new nest. Of the 42 queens, 13 were race *fernaldi* and of the 241 workers, 3 were *fernaldi*. The race *fernaldi* (Lewis) according to Bequaert (1), is only a xanthic form of *arenaria* characterized by 2 large round yellow spots on the propodeum which are not found in normal *arenaria*.

Nest 4 was brought in by a sanitary inspector on July 29 and consisted of 7 large combs; he had removed it from a laurel hedge after drenching it with gallons of insecticide, thus reducing it to a soggy mess. From the size of the combs, this must have been a very large nest with a large population of wasps of which only a few (311) reached me. Since drones usually hang around a nest, their number, 159, was probably normal but most of the workers were missing. Of the drones, 42 were race *fernaldi;* of the 6 queens, 4 were *fernaldi* and of the 146 workers, 46 were *fernaldi*. According to Buckell and Spencer (3) drones are not usually of the race *fernaldi* so this number 42, is of note. No nests have yet been taken where all wasps were of race *fernaldi*.

Nest 5, given me by Dr. K. Graham, was taken by him on 6 August at Langley Prairie and consisted of only 2 combs of which the larger was $2\frac{3}{4}$ x $2\frac{1}{2}$ ins. across. The nest had obviously been recently started because the queen only was of normal size, the 53 workers were very small.

Nest 6, Vespula vulgaris (Linn.) was taken 23 August from under the roots of a clump of iris in a rock garden facing north. The entrance was about one inch across and the combs when excavated from between the plant roots and stones were found to be of very irregular shapes and sizes and to occupy a hole roughly 12 ins. x 10 ins. There were no outer walls. The labour involved in excavating such a large hole must have been colossal. One queen out of the 43 taken was immense and was probably the founder of the nest; the others were apparently the season's brood. Amongst the normal - sized workers, were over 80 only one third the size of the others, being about 1 centimetre long; Mr. C. D. F. Miller, hymenopterist of the Research Branch, Ottawa, informs me that such dwarfs sometimes occur in wasps' nests and are apparently only xanthic forms of normal specimens; the reason for their occurrence is unknown.

Nest 7. On 19 October 1958 I was asked to remove a wasps nest from a compost heap in a friend's garden. The heap consisted of regularly-cut slabs of turf built up like bricks in a wall with spaces between the sods. Taking this apart sod by sod, I found a number of little combs lying between the slabs with a dozen or so wasps around each comb, none of which contained brood or even eggs: each group had to be poisoned separately and the wasps collected. Well down inside the pile was the main comb with a large number of *Vespula* *pensylvanica* (H. de Saussure) wasps around it. As with Nest 6 of *V. vulgaris* in the ground, there were no parasitized cells or scavenger caterpillars in the combs: apparently subterranean nests escape these intruders. It seems strange that workers should make isolated groups of cells away from the main colony; apparently the urge of the workers to build cells was stronger than that of the queens to lay eggs in them.

On 17 January 1958 a citizen in the Dunbar district of Vancouver telephoned to say that he had a wasp's nest in the corner of a back verandah roof, that measured 3 feet across: in spite of my doubting it, he stuck to his story. So I went over and after an arduous journey through my lady's dresses in a clothes closet, up a ladder and through a small trap-door in the roof, across the whole house length of rafters travelled the last part of the way on my stomach, I reached the corner where the sloping roof of the house met that of the verandah. Across the right angle of the corner was a nest 3 feet across and 18 ins. high, even as the owner had stated. From what I could reach of the nest I scooped out a few handsful of comb and later recovered from it 2 dead workers and one male of *Vespula pensylvanica* (H. de Saussure), one *Ptinus fur* Linn. the white-marked spider beetle, one *Ptinus ocellus* Brown (*tectus* Boield) the Australian spider beetle, several exuviae of *Anthrenus verbasci* (Linn.) the varied carpet beetle and one scavenger moth caterpillar. The owner said that the nest had been inhabited for 2 years in succession and feared that it would be re-occupied the coming season. I urged its total removal and the blocking-up of the entrance holes since the dermestid beetles that it haboured could very well invade the house.

Further note on the scavenger moth Vitula serratilineela Rag.

In August, 1959, I was given two nests of *D. arenaria* and one of the white faced hornet *Vespula maculata* (Linn.) with a few dead wasps in each and evidences of caterpillar silk between the tiers of comb of *arenaria* but not of *maculata*. They were maintained in a carton with a loose cover and from the end of February, 1960, to the end of June, moths flew out of the carton and around the room where the better specimens were collected and pinned. By August every comb was plastered with silk webbing and the frass of caterpillars, and the frass of wasp larvae which is compacted at the base of every cell, was completely consumed; dried bodies of wasp larvae and pupae, were not eaten. This would indicate that the larvae of this moth are true scavengers and not predators of early stages of wasps. Further proof of the scavenging behaviour of these larvae was obtained when fifteen moths picked up dead from the window sill were placed in a covered Syracuse watch glass for relaxing later on. Some weeks afterwards when I examined the dish, I found that the bodies of all the moths had been eaten and a full-grown caterpillar was moving amongst the loose wings; this pupated and a moth eventually emerged. Apparently a moth had laid an egg on the body of one of those lying dead on the window sill and the resulting caterpillar found enough food in 15 moth bodies, to complete its development.

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A WHOLE-BARK METHOD OF REARING DRYOCOETES CONFUSUS SW.

A. C. MOLNAR[2] AND C. B. COTTRELL[3]

Introduction

During studies on the relation of a fungus, *Ceratocystis* sp., to the western balsam bark beetle, *Dryocoetes confusus* Sw., it was found necessary to rear the insect in the laboratory. Lacking proven methods, a search was made among those used for other cambium-feeding insects, to find one which would be suitable for *Dryocoetes* or which would at least serve as a starting point for developing a satisfactory method. With a few modifications, a whole-bark rearing method used by Finnegan (1) to rear the pine weevil, *Pissodes approximatus* Hopk., was found very satisfactory. All stages of *Dryocoetes confusus,* from egg to adult developed well in alpine fir, *Abies lasiocarpa* (Hook.) Nutt., whole bark and were readily observed during their development.

Method

Finnegan placed newly hatched larvae in small grooves in the cambial surface of freshly cut Scots pine, *Pinus sylvestris* L. bark discs. The discs were then pressed tightly, cambial surface down, in the bottom of petri dishes by filling them with moist sand and applying pressure on the cover with rubber bands. He indicated the importance of using sterilized glassware and sand and keeping to a minimum the exposure of the cambial surface of the inner bark to the air during preparation.

Finnegan's method as used for *Pissodes approximatus* was moderately satisfactory for *Dryocoetes confusus* but a number of changes effected a marked improvement, particularly where the insects were reared throughout their life stages in a single rearing chamber. The changes made were largely in connection with improving the maintenance of suitable moisture conditions and with getting rid of the objectionable feature of sand sifting out of the chambers during handling. The sand was replaced by vermiculite, for vermiculite dried less quickly and more evenly. It also had a slight tendency to sift out but this was overcome by placing two slightly oversized pieces of filter paper in the chamber, one next to the bark and one next to the lid, to enclose the vermiculite. The filter paper provided the additional advantage of assuring an even distribution of water, which was added after about five weeks in long term observation chambers.

The procedures used for the preparation of materials and setting up rearing chambers for *D. confusus* were as follows:

1. Preparation of bark discs

Discs were generally cut from fresh alpine fir logs with non-corky bark, but equally satisfactory results were obtained using logs several weeks old when the ends were sealed with wax at the time of cutting and the logs were kept in a cool place. Immediately before cutting the discs the logs were scrubbed with 70 per cent methyl alcohol and the thin outer bark was sliced off with a clasp knife or draw knife. Discs of the right size to fit the 100 mm. dishes used were readily obtained by cutting around a template with a sharp-pointed, sturdy knife and slicing through between the inner bark and cambium. To maintain the bark as aseptic as possible until being used in the rearing chambers, the discs were stacked in sterilized, metal petri dish holders alternately

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with fresh filter paper. It was found desirable to use the bark within a few hours after cutting, although overnight storage in a refrigerator did not appear to be detrimental. Complete asepsis is not possible, of course, for even if the bark were rendered aseptic, beetles or larve gathered in the field would introduce their naturally associated flora and fauna. These were in fact found to develop in the rearing chambers but very rarely inhibited the development of the insects.

2. The moistening medium

The moistening medium was prepared in advance by dry-sterilizing fine-grained vermiculite at 95° C for 48 hours. To this was added sterile water at the rate of one volume of water to four volumes of vermiculite. Two gms. of sodium benzoate were added to 1,000 mls. of the sterile water to inhibit bacterial activity.

3. Setting up rearing chambers

The procedure for setting up the rearing chambers was essentially that used by Finnegan except that some of the materials were different as indicated. A number of features were particularly critical to the success of the rearings and should be emphasized:

a) The nature and size of the bark niches in which the insects were started was important for eggs and larvae. A size just large enough to hold the larvae, preferable triangular in shape, appeared to be the best. A small triangular niche cut with a scalpel provided the necessary purchase for the larva to start feeding. Adults were less critical in this regard and a round hole to simulate a nuptial chamber, cut with a cork borer, served well.

b) After placing the insects in the niches care was necessary to make sure the inner bark was tightly pressed against the bottom of the dish by inverting the dish over it and holding it firmly until the first filter paper, vermiculite, second filter paper, lid, and rubber band were added. Space between the bottom of the dish and bark permitted insects to escape into these spaces where they were often unable to start feeding again.

c) It was necessary to avoid adding water to the extent that free moisture formed in the bottom of the dish, which tended to hold the insect immobile and often drowned it.

d) The rearing chambers were kept in a dark cupboard at room temperature.

Efficacy of Method

The primary purpose of the rearings of *Dryocoetes confusus* was to produce adults free from contamination by the apparently pathogenic fungus under study. Since the egg stage was the only one amenable to sterilization, it was necessary to rear the insect throughout its life stages. The results of rearings, however, suggested the suitability of the method for rearing studies beyond the scope of the present investigation. It appears suitable to life history studies and other laboratory investigations involving detailed observations on active living insects of this and probably other bark and cambial feeding species. Some of the results of rearings, especially survival figures, are summarized below to permit the reader to evaluate the method in terms of his own requirements.

Survival

Field collections of *Dryocoetes* for rearing purposes were confined to larvae and adults but transfers to fresh rearing chambers were carried out at the egg and pupal stages as well. The survival figures for rearings and transfers are summarized in Table 1. The relatively poor survival obtained with field-collected larvae

TABLE 1—Survivors from Rearing Studies of **Dryocoetes confusus** Sw. in Whole Bark-Petrie-Dish Rearing Chambers.

Time from start (weeks)	A Field larva (Oct. 1958 collection)	B Transferred larvae off-spring of "A"	C Transferred pupae off-spring of "A"	D Field adults (May 1959 collection)
	Number living			
0	289	71	21	55
2	129	57	—	44
4	119	55	16	44
8	102	—	—	—
16	73	—	—	—
Final disposition	Transferred for rearing studies	All survivors adults; discarded	All survivors adults; discarded	Rearing study; eggs transferred as needed, rest discarded

was not considered a reflection on the rearing method, for the larvae were sent by mail from Vernon to Victoria and nearly a week elapsed before they were placed in rearing chambers. In addition, they were first started with sand as the moistening medium, then changed to vermiculite when it was found that the sand would prove troublesome. It can be seen that 55 per cent of the mortality occurred in the first two weeks of rearings. In the other columns of this table it can be seen that relatively little difficulty was experienced in transferring laboratory-reared larvae and pupae and field-collected adults.

All eggs used in the egg-transfer studies came from breeding experiments using the wholebark rearing chambers described. Transfers to fresh rearing chambers were carried out using two methods of egg sterilization.

In the first method of egg sterilization, eggs were freed from boring dust and washed for 30 seconds with a 1:1000 solution of Hg Cl, followed by a sterile water wash for 60 seconds. The eggs were then placed in the described niches in fresh bark. In the second method eggs were washed with 95 per cent ethonal with a brush on sterile agar plates and moved to a clean part of the agar. A day later the eggs were transferred to bark niches with a sterilized needle.

There did not appear to be a significant difference in survival between the various methods and control used except for the poor results obtained in the second Hg Cl treatment (Table 2), but the writers favoured the

TABLE 2—Survivors of **Dryocoetes confusus** Egg Transfers

Time from transfer (weeks)	Eggs from adults reared from larvae (Table 1"A")		Eggs from field adults mated in whole bark chambers		Eggs from field adults mated in whole bark chambers	
	sterilized Hg Cl	not sterilized	sterilized Hg Cl	not sterilized	sterilized ethanol	sterilized ethanol, inoculated with **Ceratocystis**
	Number living					
0	6*	15*	15*	15*	15*	25*
1	4	13	3	11	10	17
2	3	13	1	10	10	17
3	3	13	1	10	10	17
4	—	—	—	—	10	17
5	—	—	—	—	9	15
Final disposition	Broken up for isolation experiments. Larva only.		Broken up for isolation experiments. Larva only.		Broken up for isolation experiments; 3 adults remainder larvae	

* Healthy appearing eggs but some may not have been viable.

ethonal method because it involved less handling of the eggs and afforded less opportunity for over-exposure of the eggs to the sterilizing agent. It should be pointed out that the chambers with sterilized eggs did not remain entirely free from micro-organisms but they were free from the pathogenic *Ceratocystis* under study. To obtain aseptic chambers a suitable method of sterilizing bark will have to be developed which does not change its essential properties. Steam sterilization, a method recommended by Holst (2), rendered alpine fir bark somewhat plastic and unacceptable to both larvae and adults of *Dryocoetes.*

Development of *Dryocoetes confusus* in rearing chambers

Detailed observations and measurements on the insect's development were not included in the scope of these experiments and, since relatively little is known of its development in nature, little can be said concerning the effects of artificial rearing on development. A number of observations, however may be worth recording here.

1) The life cycle of *D. confusus* was carried to completion and viable eggs were produced by females reared in the chambers.
2) It was evident that the life cycle can be greatly accelerated through artificial rearings by reducing the normal periods of inactivity induced by unfavourable weather conditions. The progeny of the first set of larvae collected in the fall of 1958 attained maturity by the following May, a full year before this would have occurred under field conditions.
3) Survivors of larvae collected in the field in October attained adulthood at nearly a 1:1 male-female ratio, while 250 adults collected the following spring in the same area at Bolean Lake were in the ratio of 1:12 males to females.
4) Adults reared from larvae in the chambers started oviposition 6-7 days after mating on fresh bark, while field-collected adults started oviposition within 3 days of being placed on fresh bark in the chambers. The field collections were made as much as 2 months before normal oviposition when the insects were still frozen in the host trees. Thus, a much wider time scope is available for laboratory work with eggs than would be possible with those collected in the field; in addition field-collected eggs pose difficult handling problems and require time-consuming observations to collect the right stage.
5) Apparently mating in the spring is not required for females collected in the field. Females collected from frozen trees in the spring and placed unmated in rearing chambers produced viable eggs in abundance.

Conclusion

Finnegan's method for rearing weevils in whole-bark rearing chambers, with minor modifications, met the requirements for the laboratory rearing of *Dryocoetes confusus.* The results of experiments indicate the suitability of the method for detailed observations on all phases of the insect's development from egg to adult. The adaptability of the method to other bark and cambial feeding insects is suggested by its success with two widely separated species.

The advantages of the method are the simplicity of the set-up and procedures, readily available materials, the lack of a troublesome moisture problem, and the ease of observing development at any time (Figs. 1, 2, and 3). While 100 mm. petri dishes were used in these studies, larger sizes are available if desired.

The possibilities of adapting this rearing method to standard insectary procedure for rearing larvae of unknown bark and cambial feeding insects sent in through the Forest Biology Survey are worth investigating. Materials and procedures could be readily set up. The main problem would stem from the unavailability of bark of the right species; but this difficulty could be overcome by one or both of two ways. Logs with waxed ends could be kept in cool storage for considerable periods without the bark losing its desirable qualities, or the collector could air-mail a section of wood and bark with his collection of unknown larvae.

Acknowledgements

The authors wish to take this opportunity to thank Dr. D. A. Ross, Officer-in-Charge, Forest Biology Sub-laboratory, Vernon, British Columbia, for helpful suggestions and assistance during the course of these studies.

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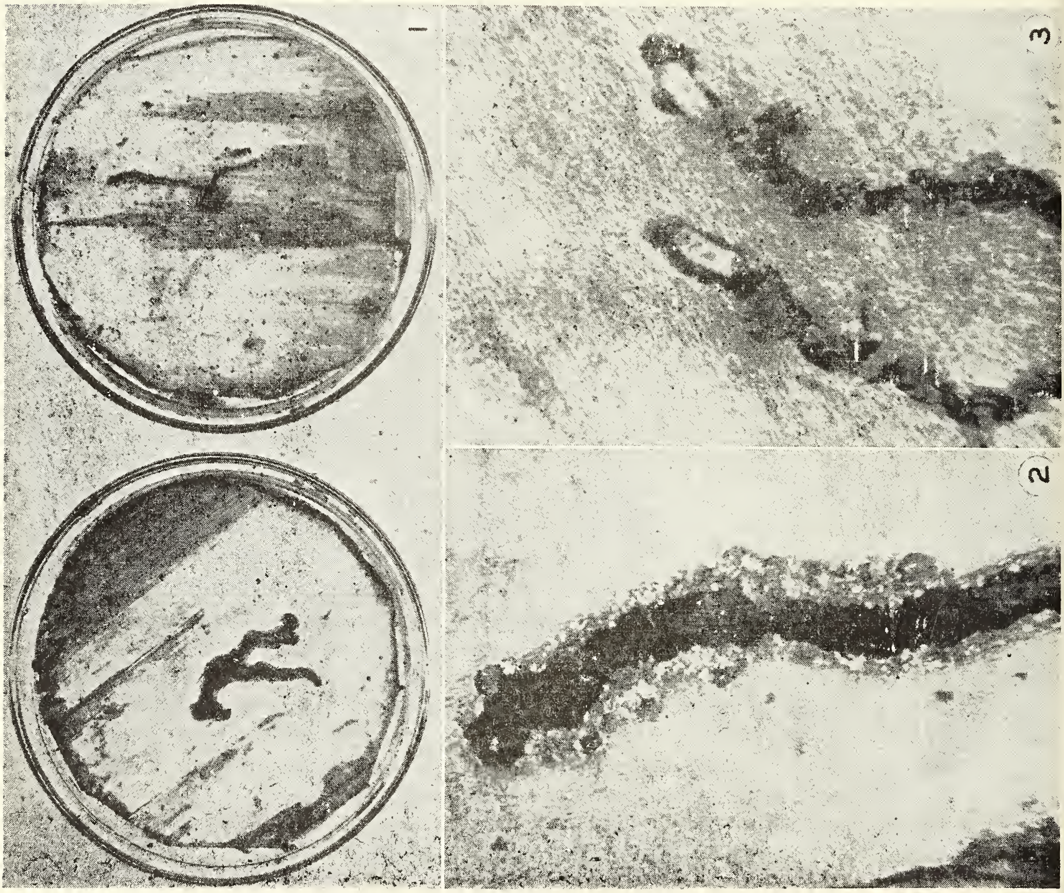

Fig. 1.—Underside of whole-bark rearing chambers showing **Dryocoetes confusus** feeding galleries on the left and egg galleries on the right. 0.6 X.

Fig. 2.—Egg gallery in whole-bark rearing chamber showing deposited eggs and female **Dryocoetes** in process of extending gallery. Approximately 8 X.

Fig. 3.—Newly hatched larvae of **D. confusus** in whole-bark rearing chamber. Approximately 8 X.

OBSERVATIONS IN THE INTERIOR OF BRITISH COLUMBIA DURING 1959 OF THE EFFECT ON HONEYBEES OF ORCHARD SPRAYING WITH SEVIN

J. C. Arrand[1] and J. Corner[2]

In 1959 in the Interior of British Columbia a new insecticide, Sevin, 1-naphthyl *N*-methylcarbamate, was recommended for the control of several orchard pests. During the early part of the season reports were received from throughout the Okanagan and Kootenay Valley that where Sevin was used honeybees were being killed. Observations by the authors, particularly in the Oyama and Salmon Arm districts, substantiated these reports and confirmed the work of Anderson and Atkins (1959) that Sevin is highly toxic to honeybees. Sevin applied as a pink spray killed a considerable number of foraging honeybees from colonies located within about one mile of the treated orchards. The mortality of bees, as observed at the hive entrances, was extremely heavy for about three days after spraying. Dead bees continued to appear, although in greatly reduced numbers, for a further three to four days. There was no evidence of brood poisoning although, due to a depletion in the numbers of workers, there was some larval mortality from chilling.

In many cases the wet weather during the spring of 1959 caused a delay in applying the "pink spray" until the late pink or early bloom stage. Lime sulphur which has been reported (Eckert, 1949) to have some repellent action and is usually applied in the pink spray was not applied with Sevin because the two materials are not compatible. These factors may have contributed to the high honeybee mortality. It is interesting to note that according to Carl Johansen (1960) a new bee repellent, R 874 (hydroxyethyl octyl sulfide), shows promise and may be effective in safeguarding bees against hazardous insecticides.

There appeared to be little ill effect on honeybees where Sevin was used as a cover spray for codling moth control.

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DICTYONOTA FULIGINOSA COSTA (HEMIPTERA: TINGIDAE) IN THE NEARCTIC

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During 1959 samples of populations of Mirid Heteroptera on broom (*Sarothamnus scoparius*) were taken on the campus at the University of British Columbia. In July and August specimens of a Tingid, *Dictyonota fuliginosa* Costa, were also beaten from this plant; determination of the Tingid has been verified by Prof. C. J. Drake of the United States National Museum. This capture appears to be the first record of this insect in the Americas, although the related *D. tricornis* (Schrank) occurs in eastern Canada and the eastern United States. *D. fuliginosus* is a common insect on broom in Europe and since this plant has been introduced into British Columbia, it seems probable that this insect has also been introduced. Broom was abundant at Beacon Hill, Victoria in 1911 (J. Davidson via G. J. Spencer, *pers. comm.*), and was probably introduced by the early English settlers between 1890 and 1900. Broom is now widely scattered in the lower Fraser Valley and on Vancouver Island; it also occurs in the lower Interior of the Province, but in the latter seems to bear little insect life.

The broom Mirid collected in this study was the introduced *Melanotrichus virescens* (D. & S.) and this was found to be very abundant, yet it has not previously been taken on the mainland. Downes (1957) records taking *M. virescens*[2] on Vancouver Island and I have seen specimens from Victoria, Nanaimo and Cowichan. Thus, although *D. fuliginosa* has not previously been recorded from the area in question, it is probably not a recent introduction.

In the Heteroptera in Canada and the United States, at least 90 species appear to be Holarctic, or at least, are recorded from the Palaearctic and the Nearctic regions. A number of these appear to have been introduced into one of the areas. Species almost certainly introduced into the Nearctic and occuring in British Columbia include: *Megalonotus chiragra* (F.), *Nabis major* Costa, *Heterotoma meriopterum* Scop., *Campyloneura virgula* Fieb., *Dicyphus pallidicornis* (Fieb.), and *Blepharidopterus angulatus* (Fall.). These introduced insects may have come in on plants, for example *Dicyphus pallidicornis* on foxglove (*Digitalis*) (Downes, 1957) or they may have come in by other means as in ballast, suggested for *Megalonotus chiragra* by Slater & Sweet (1958). However, these are the few exceptions and most of the other 'Holarctic' species need critical examination, since most if not all of the non-arctic species, with a wide distribution would appear to be endemic rather than introduced. A critical examination of a few of these has shown that the Old and New World representatives are not conspecific.

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[2] **M. virescens** (D. & S.) = **M. concolor** of Downes.

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CONTROL OF THREE SPECIES OF LEAFHOPPERS, ON RUBUS IN BRITISH COLUMBIA[1]

J. RAINE[2] AND N. V. TONKS[3]

Ribautiana tenerrima (H.-S.) and *Edwardsiana rosae* (L.), both of Typhlocybinae, and *Macropsis fuscula* (Zett.), of Macropsinae, frequently damage various species of *Rubus* on Vancouver Island and in the lower Fraser Valley.

Ribautiana tenerrima, and *E. rosae,* have similar life cycles and habits (Raine, 1960; Childs, 1918). There are two generations each year; nymphs emerge during May and again in August, and adults appear during June and September. Both species overwinter as eggs. Feeding by nymphs and adults on the undersides of the leaves causes a characteristic whitish stippling, impairs leaf function, and reduces plant vigour.

Macropsis fuscula, a European species, has only one generation each year. Nymphs emerge from overwintered eggs in late May, and adults appear during July (Tonks, 1960). In the Netherlands this species is reported as a vector of the virus disease known as rubus stunt (de Fluiter, 1953). The nymphs feed mostly on the undersides of the calyces of flower buds and fruit. Damage to the berries is not readily visible, but studies during 1959 showed a 20 per cent reduction in yield from heavily infested plots compared with clean plots. Fruit quality may be reduced by the growth of a sooty-mould fungus in honeydew excreted by the leafhoppers, and nymphs included with the fruit during picking become a contamination problem.

This paper presents results obtained with several materials for control of the three species of leafhoppers. The work was conducted on Vancouver Island, and in the lower Fraser Valley, from 1955 to 1959.

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Materials and Methods

The following chemicals were used in the experiments:

DDT, 25 per cent liquid; Chipman Chemical Company, Toronto, Ont.

Derris, 2.5 per cent liquid and 1 per cent dust of rotenone; Chipman Chemical Company, Toronto, Ont.

Diazinon, 25 per cent liquid and 5 per cent dust of *O, O*-diethyl *O*-(2-isopropyl-6-methyl-4-pyrimidinyl) phosphorothioate; Geigy Agricultural Chemicals, Yonkers, N.Y.

Dimethoate, 46 per cent liquid of *S*-methylcarbamoylmethyl *O, O*-dimethyl phosphorodithioate; American Cyanamid Company, Stamford, Conn.

Di-Syston, 5 per cent granules of *O, O*-Diethyl *S*-2-(ethylthio) ethyl phosphorodithioate; Chemagro Corporation, Kansas City, Mo.

Endrin, 18 per cent liquid of endrin; Velsicol Corporation, Chicago, Ill.

Ethion EC 4, liquid containing four pounds of *O, O, O′, O′*-tetraethyl *S* S′-methylene bisphosphorodithioate per U.S. gallon; Niagara Chemical Division, Food Machinery and Chemical Corporation, Middleport, N.Y.

Guthion, 18.4 per cent liquid of *O, O*-dimethyl *S*-4-oxo-1, 2, 3-benzotriazin-3 (4*H*)-ylmethyl phosphorodithioate; Chemagro Corporation, Kansas City, Mo.

Heptachlor, 25 per cent liquid of heptachlor; Velsicol Corporation, Chicago, Ill.

Malathion, 57 per cent liquid and 4 per cent dust of malathion, American Cyanamid Company, Stamford, Conn.

Methoxychlor, 25 per cent liquid of 1, 1, 1-trichloro-2, 2-bis (*p*-methoxyphenyl) ethane; Geigy Agricultural Chemicals, Yonkers, N.Y.

Phorate, 48.5 per cent liquid of *O, O*-diethyl *O* (and *S*)-2-(ethylthio) ethyl phosphorothioates; Chemagro Corporation, Kansas City, Mo.

Phosdrin, 48.5 per cent water-soluble liquid of 2-methoxycarbonyl-1-methyl vinyl dimethyl phosphate; Shell Oil Company of Canada, Toronto, Ont.

Rogor, 40 per cent liquid of S-methylcarbamoylmethyl *O, O*-dimethyl phosphorodithioate; Fisons Pest Control Limited, Cambridge, Eng.

Sevin, 50 per cent wettable powder and 13 per cent emulsion of 1-naphtyl *N*-methylcarbamate; Union Carbide Chemicals Company, New York, N.Y.

Systox, 26 per cent liquid of a mixture of *O, O*-diethyl *S*-(and *O*) (2-ethylthio) ethyl phosphorothioates; Chemagro Corporation, Kansas City. Mo.

Thiodan, 24 per cent liquid of 6, 7, 8, 9, 10, 10-hexachloro-1, 5, 5a, 6, 9, 9a-hexahydro-6, 9-methano-2, 4, 3-benzodioxathiepin 3-oxide; Niagara Chemical Division, Food Machinery and Chemical Corporation, Middleport, N.Y.

Trithion, 43.7 per cent liquid of *O*, *O*-diethyl *S*-*p*-chlorophenylthiomethyl phosphorodithioate; Stauffer Chemical Company, Mountain View, Calif.

The experiments were conducted on loganberry because this crop was most heavily infested with the three species of leafhoppers.

Plots varied in size from year to year, but consisted of not less than four plants per plot, with three replicates. Buffer rows, or portable barriers, were used between plots to prevent spray drift.

Sprays and dusts were applied to the foliage in mid-May to control emerging nymphs. Sprays were applied to the canes in March to kill overwintering eggs. Systemics were applied as drenches to the crowns in April or painted on the canes in May to control emerging nymphs. Di-Syston granules were sprinkled on the soil around the base of the plants in April to control emerging nymphs.

The sprays were applied with a portable "Bean" sprayer operated at 100 lb. pressure. About 200 gal. per acre were required for foliage sprays, and 100 gal. when canes only were sprayed. The dusts were applied with a backpack puff duster at about 50 lb. per acre. The drenches were applied with the same "Bean" portable sprayer fitted with a 3-foot spray wand having a quick shut-off valve and a solid-cone nozzle. (Tee Jet TG3, John Brooks and Co., Ltd., Montreal, Que.). With the machine operating at 100 lb. pressure, one pint of drench was applied to each plant when the nozzle was held for 10 seconds about 15 in. above the crown. The DiSyston granules were used at one pound toxicant per acre.

Counts of Typhlocybinae nymphs were made in May, and late July, on the leaves of 10 to 25 fruiting spurs per plot, collected at random on one side of the row along the top wire. Populations of *M. fuscula* were assessed in late June or early July by counting the nymphs on 200 to 500 berries per plot from both sides of the row. Samples of loganberries treated with Rogor either as a drench, or as a foliage spray were frozen and shipped by air to Fisons Pest Control Ltd., England, for analysis of residues.

Results and Discussion

A summary of the materials used as foliar sprays and the results obtained appears in Table I. Survival is expressed as the mean number of *M. fuscula* nymphs per 100 berries, and the mean number of Typhlocybinae nymphs per 10 fruiting spurs. Where possible, data on the control of both generations of Typhlocybinae were evaluated, since reinfestation may occur from adjacent infested plantings.

Control of Typhlocybinae—One foliage spray of DDT, Thiodan, Trithion or Systox in mid-May controlled first-generation nymphs, and reduced re-infestation by the second generation in August. Diazinon, methoxychlor, Sevin, Guthion, Phosdrin, endrin, phorate, derris, Dimethoate, and Rogor controlled the first generation but did not prevent extensive reinfestation by the second generation. Heptachlor was ineffective.

The mean number of first generation Typhlocybinae nymphs per 10 fruiting spurs, following treatment with foliage dusts in mid-May were as follows:

Malathion	0
Diazinon	2
DDT	5
Derris	28
Check	180

DDT or Trithion spray applied to the canes in mid-March effectively controlled nymphs emerging in May. The action was probably residual rather than ovicidal.

TABLE 1—Mean number of nymphs of **Macropsis fuscula** per 100 berries, and of Typhlocybinae per 10 fruiting spurs, following treatment with foliage sprays in mid-May, 1955-59.

Insecticide	Pints per 100 gal.	Toxicant lb. per 100 gal.	**Macropsis**	Typhlocybinae 1st generation	Typhlocybinae 2nd generation
DDT	3	0.94	25	0	20
Derris (Cube)	4	—	6	6	—
Diazinon	2	0.63	0	0	59
Dimethoate	1	0.62	—	0	63
Endrin	1	0.25	—	0	183
Ethion	¾	0.46	0	—	—
Guthion	1	0.23	0	0	67
Heptachlor	2	0.62	—	203	192
Malathion	2	0.63	0	0	122
Methoxychlor	4	1.25	0	0	126
Phorate	¼	0.16	—	0	77
Phosdrin	½	0.13	—	0	72
Rogor	1	0.50	—	0	60
Sevin WP	2½	1.25	0	—	—
Sevin	8	1.25	—	0	52
Systox	¾	0.23	—	0	18
Thiodan	1	0.31	7	5	20
Trithion	½	0.31	0	0	19
Check	—	—	28	160	102

Results obtained with systemics showed that Dimethoate at one pint per 100 gal. applied as a drench to the crowns in early April controlled first generation nymphs, but did not prevent reinfestation by the second generation. Similar applications of Rogor at one-half pint, and Systox at one pint, per 100 gal., were not effective. Dimethoate at a dilution of 1:10 painted in a one-inch band on the canes of potted plants gave excellent control of nymphs within five days, and at dilutions of 1:100 and 1:800 significantly reduced infestations within 12 days. Granular Di-Syston was ineffective as a soil treatment.

Control of Macropsis fuscula—In the Netherlands, good control of *M. fuscula* is obtained with dormant sprays of tar oil or DNC to kill the eggs in the canes, or by spring applications of Parathion, malathion, Diazinon, or Systox to kill the nymphs (de Fluiter, 1958).

In British Columbia, a dormant spray of tar oil applied to loganberry in mid-March reduced *M. fuscula* infestations in June by 95 per cent; lime sulphur plus dormant oil was about 75 per cent effective. Control with water-soluble dinitrocresol was unsatisfactory. Probably because of better coverage, dormant sprays were more effective when applied after the canes were up on wires than when the canes were trailing on the ground. Dormant sprays have not been generally recommended for leafhopper control in British Columbia, because most growers leave the loganberry canes on the ground throughout the dormant period, and because it is difficult to operate heavy equipment on the land during the winter.

Foliage sprays of malathion, Guthion, Ethion, or Sevin applied once, in mid-May, gave excellent control. Thiodan and derris reduced infestations considerably but were less effective than the other materials. Fall sprays of methoxychlor, malathion, Diazinon, or Trithion applied to assess their potential ovicidal action caused no reduction during the following spring.

Dimethoate at one pint per 100 gal. applied as a drench to the crowns in early April significantly reduced the number of nymphs emerging in late May. Rogor at one-half pint, and Systox at one pint, per 100 gal., were not effective. Granular Di-Syston was ineffective as a soil treatment.

Phytotoxicity—Ferbam, at three lb. per 100 gal. added to emulsible concentrate sprays of malathion, Diazinon, Trithion, methoxychlor, Guthion, and wettable powder sprays of Sevin, caused no deleterious effects on loganberry, nor did Captan, at three lb., added to malathion and Diazinon. Endrin 18 per cent emulsible concentrate at one pint per 100 gal. caused some injury to loganberry foliage. In previous experiments on phytotoxicity of spray materials, DDT and methoxychlor emulsible concentrates at four pints per 100 gal. caused some yellow spotting on raspberry; malathion 50 per cent emulsible concentrate, at two pints, occasionally caused a slight leaf burn on raspberry, particularly on young growth.

Residues — Residues of Rogor in loganberries at harvest were below 0.1 ppm, which is the limit if sensitivity of the clorimetric method for determining phosphorus. Samples for analysis were taken from Rogor treatments applied either as foliage sprays in mid-May at one pint per 100 gal., or as soil drenches in April, at one pint per crown, at a dilution of one-half pint per 100 gal. Dietary toxicity studies conducted by Fisons, including daily oral ingestion trials with humans, have shown that up to 2 ppm of Rogor may be regarded as innocuous in most human foods.

Summary

The bramble leafhopper, *Ribautiana tenerrima* (H.-S.), the rose leafhopper, *Edwardsiana rosae* (L.), (both Typhlocybinae), and *Macropsis fuscula* (Zett.), frequently damage *Rubus* species in British Columbia. One application of Trithion in mid-May controlled all three species, including second-generation nymphs of Typhlocybinae. Malathion, Diazinon, Sevin, methoxychlor, and Guthion applied in mid-May controlled *M. fuscula,* and first - generation nymphs of Typhlocybinae, but did not reduce infestations of the second generation. DDT controlled both generations of Typhlocybinae, but was ineffective on *M. fuscula.* Phorate, endrin, Phosdrin, and Systox, in trials conducted on Typhlocybinae, controlled the first generation; Systox reduced infestations by the first and second generation. Dimethoate applied as a drench to the crowns in April controlled nymphs of both Typhlocybinae and *M. fuscula* and also gave control of Typhlocybinae nymphs when applied as a foliage spray in mid-May. Residues of Rogor at harvest were at a safe level below 0.1 ppm. No deleterious effects were observed from the addition of Ferbam or Captan to foliage sprays on loganberry.

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NOTES ON THE LIFE HISTORIES OF TWO BUTTERFLIES AND ONE MOTH FROM VANCOUVER ISLAND

GEORGE A. HARDY[1]

Colias occidentalis Scud.

A specimen taken at Royal Oak on June 4, 1958, laid about 50 ova by June 12. They were placed on the upper side of the leaves of *Lathyrus nuttallii* Wats. over which the butterfly was confined.

Ovum

Size 1.5 mm. by 0.5 mm., fusiform, truncate at the base at the point of attachment, shiny, with about 14 ribs, whitish at first, becoming rosy-red with an ivory-white tip. Hatched June 11.

Larva—1st Instar

Length 2 mm. Head black, dull with short, sparse, white-knobbed hairs. Body fuscous green, covered with glandular-tipped hairs, A.8 and A.9 bearing a few long, backwardly directed, white hairs. The chorion was partly, or entirely, consumed by the larva.

2nd Instar

June 17. Length 5 mm. Head grey-green, body green matching the leaves. Both head, and body, with a hoary look due to a covering of close-set, glandular-tipped hairs, each arising from a small, black tubercle.

3rd Instar

June 23. Length 7 mm. Appearance similar to second instar larva. From this date until April, 1959, the caterpillars remained quiescent in the fold of a shrivelled leaf.

4th Instar

April 18, 1959. Length 10 mm. The larva showed signs of life on April 3. Head pale green, thickly dotted with short, black, non-glandular hairs arising from black bases. Body dark, velvety green, closely dotted with white, black-centred spots, each bearing a short, white, non-glandular seta. Segments with six transverse wrinkles.

5th Instar

April 25. Length 18 mm. Appearance as before, but with white hairs thickly distributed on the sides of the body but not on the dorsum. Spiracular line thin but conspicuously white, the white ring round the black dots replaced with green.

April 29. Length 25 mm. Appearance as before, with a faint pink suffusion along the spiracular line, underside glaucous - green minutely black-dotted.

When disturbed the larvae raised the thoracic segments in a sphinx-like attitude. Just before pupation they were 30 mm. long. Pupated May 4. Thirty-six hours elapsed between the first attachment by the last segment to a silken mat, and pupation with the head up and a girdle round the thorax.

Pupa

Size 23 mm. by 6 mm. The head was produced into a projecting beak, and there was a decided hump on the dorsum of thorax. Smooth, emerald green at first, becoming darker and assuming a yellowish colour towards maturity. The beak was dark green above and yellow below. The wing-cases showed faint dark lines of the venation beneath. The three abdominal segments beyond the tip of the wing-cases each had two small black dots. Spiracular line distinctly yellowish.

Imago

Emerged May 21, 1959, after 17 days' pupation.

The continuation of aestivation without a break into hibernation, both covering nearly ten months, is noteworthy. It would be of interest to know if this is the rule throughout the insect's wide range.

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Coenonympha inornata insulana McD.

This butterfly has a long period of flight on Vancouver Island, from May to October, with a marked gap in July, suggesting the occurrence of two broods per season. With the idea of clearing up this point, the life history was investigated during 2 years. Ova were obtained from specimens taken at Royal Oak on May 26, 1958.

Ovum

Size 1 mm. by 0.9 mm. Barrel-shaped, having a slight hollow in the upper end, with a distinct boss or umbo in the centre of the depression. Smooth, shiny, faintly ribbed and cross-ribbed, white, lightly flecked and streaked with brown to form an irregular band round the middle of the egg.

Larva—1st Instar

June 7. Length 2 mm. Head pale dull flesh coloured. Body tapering from head and of the same colour, with darker dorsal and subdorsals, and two fleshy anal processes directed backwards in line with the body.

2nd Instar

June 18. Length 4 mm. Appearance as before, with the addition of numerous small, white, mushroom-like protruberances covering both head and body, and seven dark green lines on dorsum, one dorsal and three on each side of it.

3rd Instar

June 25. Length 8 mm. Appearance as before.

4th Instar

July 3. Length 15 mm. Appearance as before.

5th Instar

July 12. Length 20 mm. Head grass-green, thickly covered with white mushroom-like protruberances. Body grass-green, with the mushroom-like bodies giving a glaucous bloom. The dorsal line and the three lines on each side of it dark green, spiracular line yellow, highlighting the lateral fold, spiracles evident as very small black dots, anal processes tinged with pink.

The larva was well camouflaged. As it rested along the edge of a blade of grass the tapering body merged into the blade and the large head simulated a tear or break in the edge. Various grasses are the food of this species. The succulence of the grass evidently affects the rate of metamorphosis.

July 16. Length 22 mm. at maturity. The larva suspended itself by the cremaster from a grass stem, and pupated on July 21.

Pupa

Size 10 mm. by 3 mm. Rather short and broad, smooth, grass-green, with a fuscous line on the costal and hind margins of the wing-cases, and two short fuscous lines on the underside of the last abdominal segment, converging to form a V at the base of the cremaster.

By August 1 the wing-cases had turned a light brownish colour, while the green of the rest of the body assumed a dull, muddy look, an indication that the imago was about to emerge. It died before doing so. Some larvae of the same age group grew very slowly. One of these was only 10 mm. long on October 9 and showed signs of hibernating for the winter.

In 1959 three imagos of a second brood were obtained; two were from ova laid on June 13. They emerged on August 24. One was from an ovum laid on July 2. It emerged on September 15. In 1953 an ovum laid on September 4 hatched on September 20; another laid on September 14 hatched on October 15. One of these larvae hibernated, and resumed feeding in April 1954.

From the foregoing it would appear that *insulana* is at least partially two-brooded. There is disparity in growth of the same age group, and the winter is passed by larvae of various ages and sizes. The largest of these give rise to the spring adults, the smaller ones to the late summer contingent. The latter are augmented by individuals of the second brood. *C. inornata insulana* would seem to be midway between the single-brooded *C. kodiak* of northern regions and *C. californica* in the south where two broods is the rule.

Orthosia transparens Grt.

A specimen taken at Royal Oak, on April 22, 1959, laid about 215 ova, singly, or in irregular groups, on the sides of the container.

Ovum

Size .75mm. by .5 mm. A depressed sphere with about 40 vertical ribs whose sides have a bright sheen, varying in intensity with the incidence of the light, a small light brown dot in the micropylar area, and a fine broken ring of the same colour on the shoulder of the egg. Hatched on May 1.

Larva—1st Instar

Length 2.5 mm. Head light brown, sparsely but strongly dotted with black. Body whitish, transparent, with prominent, black, seta-bearing tubercles. The larva consumed part of the chorion, then fed on *Arbutus menziesii* Pursh penetrating into the leaf-bases of the expanding buds.

2nd Instar

May 8. Length 8 mm. Head semi-translucent suffused with white, and dotted with black. Body olive or bluish-green, thin, milky-white dorsal and subdorsal lines, tubercles prominent, black-ringed with white bases, each bearing a stiff hair, spiracular line a vague whitish band, underside concolorous with the upper.

3rd Instar

May 12. Length 15 mm. Appearance as before.

4th Instar

May 16. Length 20 mm. Head near white, blending into a pinkish purple on the vertex, finely reticulated and spotted with brown. Body pinkish brown, thin white dorsal and subdorsal lines, spiracular line light grey centred with an irregular, pale, rust-coloured suffusion, underside a sordid flesh colour, the whole body finely spotted with black.

5th Instar

May 20. Length 28 mm. Appearance similar to 4th instar larva. Body a general sienna brown matching the twigs of the arbutus, tubercles black, edged with white. The larvae fed at night, hiding by day among the debris at the bottom of the container.

6th Instar

May 27. Length 40 mm. Head pale sienna brown, dorsal and subdorsal lines indicated by very thin whitish lines, spiracular line inconspicuous, body finely speckled with white and fuscous dots.

May 31. Length 45 mm. The larva by now full grown, general colour a drab flesh, faintly tinged with reddish-purple, without noticeable markings except suffused dark dorsal and subdorsal lines.

During the period between May 31 and June 14 the larvae became restless and moved continually feeding lightly now and then, but obviously having an urge to travel before pupation. Some larvae had made pupal cells by June 6, in which they lay quiescent without pupating until a week later.

Pupa

Size 15 mm. by 5 mm. Smooth, shiny, the wing cases finely etched with minute, close-set lines. Abdominal segments finely punctate on the anterior margins, light mahogany brown. Cremaster consisting of two very thin, nearly straight spines with four short hairs with knobbed tips at the base, all set upon a shiny boss party sunk into the tip of the last segment.

In 1958 the preferred food plant was unknown until too late; one or two larvae were reared to the 5th instar on Garry oak, which was evidently not relished. By the time arbutus was provided the survivors were too weak to complete their metamorphoses.

SEASONAL FLIGHT ACTIVITY OF THE AMBROSIA BEETLE, TRYPODENDRON LINEATUM (OLIV.), FOR 1959, NEAR PARKSVILLE, B.C.[1]

J. A. CHAPMAN[2] AND E. D. A. DYER[2]

Introduction

Hadorn (1933) reviewed earlier work on the flight periods of *Trypodendron lineatum* (Oliv.) and contributed further information on this subject. Prebble and Graham (1957) outlined the biology of this and other ambrosia beetles found on the west coast of Canada. More recently, the seasonal flight activity of *T. lineatum* in the Lake Cowichan, B.C. area has been the subject of special investigation (Chapman and Kinghorn, 1958; see also Kinghorn and Chapman, 1959). In 1959 some further data were secured on this phase of the beetles' activity, to assist in carrying out and interpreting chemical control and various biological studies. It seems worth while to place this information on record.

Methods and Results

Through the co-operation of the Pest Control Committee of the B.C. Loggers' Association, two areas (logging settings) of approximately 20 acres each, on which all trees had been felled and cut into logs, were made available for an experiment on protection of logs from ambrosia beetle attack by helicopter - applied spray. One area was sprayed and the other, near-by, left untreated to serve as the control. The latter was also used for studies on seasonal development and biology of *T. lineatum*.

The experimental settings were situated on land owned by the MacMillan, Bloedel and Powell River Company, some seven miles south of Parksville, B.C., at an altitude of about 1,200 feet. The trees on both settings had been cut in December 1958 and were, presumably, suitable for *Trypodendron* attack in the spring of 1959. Much of the land surrounding these two settings and the intervening block of timber was clear, having been logged in previous years. In this area the land slopes rather gently to the north and there are no marked topographical features.

The several methods used to secure information on relative numbers of beetles in flight during the season will be described briefly. The information secured by each method is presented in Figure 1, together with weather data taken from the Department of Transport weather station at Cassidy (Nanaimo Airport), about 20 miles from the test area and near sea level.

Glass barrier flight traps, used in earlier studies (Chapman and Kinghorn, l.c.), were placed over felled logs at widely spaced positions, eight in the sprayed and eight in the control area. Collections were made from them throughout the season at intervals of one to seven days (C). The numbers of beetles in all records are averages, representing the number collected divided by the days since the previous collection. About the time beetles began to emerge from some of the logs after brood-rearing activity or development, two other sets of traps were placed in the control setting; four next to logs known to be attacked by the earliest beetle flights (F), and eight intended to reveal any movement of beetles into a block of timber between the spray and control settings (five outside and three within the timber)—(E).

Thirty-two collecting pans (Chapman and Kinghorn, l.c.) were placed

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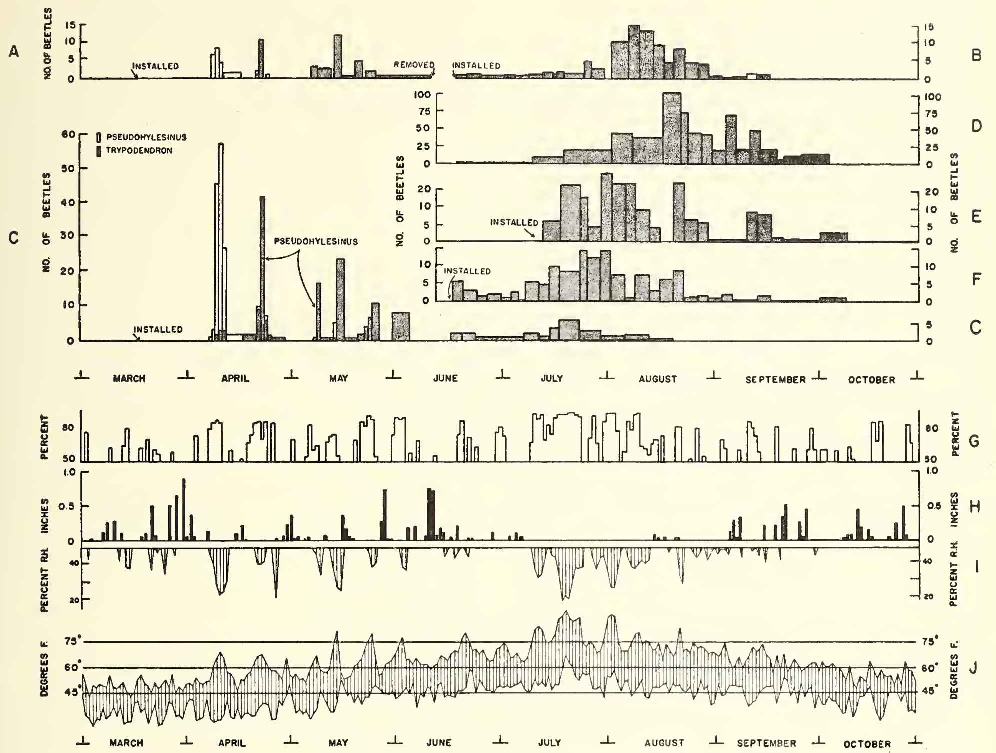

Fig. 1.—Numbers of **Trypodendron** taken in relation to weather and time of season. (A) and (B) from collecting pans under logs; (C), (E) and (F) from glass barrier traps; (D) from retaining cages on established galleries; (G) sunlight over 50 per cent of that possible; (H) precipitation in inches; (I) minimum relative humidity when below 50 per cent; (J) maximum and minimum temperatures (see text; all weather data based on daily values). In (C) the lesser catches of **Pseudohylesinus** relative to **Trypodendron** on some days are indicated by arrows.

under selected logs in the two settings, 16 in each, to cover the attack flight period (A); then, when beetles began to leave logs, they were removed and 16 placed under control setting logs known to be well attacked (B). The latter pans were located close to (F) traps. Between May 6 and June 10, 138 galleries in various parts of the control setting were fitted with cloth-covered aluminum rings, to retain beetles after they emerged, and the numbers leaving the galleries counted at intervals (D). Finally, it should be noted that opportunities for visual observations of beetle flight activity throughout the season were numerous.

Discussion

Although the data in Figure 1 are largely self-explanatory in indicating beetle flight activity in relation to weather and season, a few comments will be made to provide a background for better intepretation or to emphasize certain features. When comparisons are made or implied they refer to the previous Cowichan Lake area work and the conclusions based upon it.

The sunlight record (G) shows only the duration of sunlight over 50 per cent of that theoretically possible for each day at that latitude. It is felt that this shows more clearly than would the total hours of sunlight per day, the occurrence of sunny intervals during the season. This record, together with those of the daily maximum and minimum temperatures (J), precipitation (H), and minimum relative humidity on days when this fell below 50 per cent (I), shows fairly well the nature of the weather at various times during the season.

The numbers of beetles active about these logging settings and the resulting attack densities were relatively low compared with those encountered in previous studies. Moreover, the first beetles did not appear in the area during the first warm period with maximum daily temperatures substantially exceeding 60° F., as expected. Maximum air temperatures at the work area during the April 7-11 period did not differ by more than three degrees F. from those at the weather station. The slow appearance of the first beetles, therefore, cannot be attributed to a considerably lower temperature at the work area than at Cassidy. Also, beetle attacks continued over a relatively long time. It was obvious, from field observations, that many logs not attacked by beetles of the first flight were selected for attack during later flights. Peaks of attack and emergence activity, therefore, were not the same throughout the settings. It seems quite possible that the initial delay of attack, its long duration relative to earlier findings, and the small numbers of beetles involved, can all be explained by assuming that there was no large near source of beetles and that those reaching the area had come from distant and scattered sources. The logging history within a radius of about five miles of the area supports the suggestion that near-by forests harboured relatively few beetles.

It is of interest that *Pseudohylesinus* spp. again served as an indicator for *Trypodendron* by appearing shortly before, as well as during, its early flights. Also, the glass barrier traps and the pans under logs gave, in spite of the small numbers of beetles, substantially the same picture of times of attack (A and C).

There is general agreement between the various measures of beetle flight from logs after brood - rearing or development. The main feature of this movement to be noted is its long duration. One factor which probably contributed to differences in the pattern of emergence shown in Figure 1 is the previously mentioned variability in the times at which logs were attacked in different parts of the setting. Without doubt the duration of gallery construction and egg-laying activity differed in the various logs, also. The data represented at (B) and (F) were based largely on logs attacked by the earliest flights. Many of these logs had unusually long galleries and young beetles were still being produced relatively late in the season. The data in (C) represent pooled catches throughout both spray and control settings, but none of these traps were near logs which were attacked and they cannot be considered to represent the emergence period well. Item (E) represents beetles emerging near those traps of this group which were in the open and, in addition, movement of beetles from a large part of the control setting towards and into the block of timber between the settings. The data in (D) represent a composite picture based on galleries from several locations and logs attacked at different times.

The difference between (F) trap data and (B) pan data, which were taken in the same location, may perhaps be explained as follows. The traps were set up just above or to one side of the logs and, undoubtedly, took, for the most part, beetles leaving the upper surface of the logs. The pans, on the other hand, were placed beneath the logs and were much more likely to take beetles emerging from the more shaded, cooler under-portions where development would be slower.

Acknowledgments

We would like to thank M. Jackson and G. Richardson for help in carrying out this study, and the Pest Control Committee of the B.C. Loggers' Association and the MacMillan, Bloedel and Powell River Company for their co-operation in making the settings available for these investigations.

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A Note on **Eulonchus tristis** Lw. (Diptera: Cyrtidae)

Eulonchus tristis Lw. is fairly common in the southern Kootenay region of British Columbia; Mr. H. R. Foxlee has collected many specimens in the vicinity of Robson and I have taken a few at Remac, Ainsworth, and Champion lakes. The adults frequent flowers, particularly those of queenscup, **Clintonia uniflora** Kunth.

Eulonchus tristis is a strong flier, and is capable of some unusual aerobatics. On June 13, 1959, near Remac, four of these flies, clinging together in a tight ball and producing a loud discordant buzz, flew past me and were gaining altitude and avoiding various obstacles before being netted. There were three males and one female.

The ability of insects in several orders to fly while copulating is so well developed that it scarcely merits attention; but this instance of four individuals combining to form a single airborne unit is, I think, remarkable.

—*J. Grant, Forest Biology Laboratory, Vernon, B.C.*

THE CORIXIDAE (HEMIPTERA-HETEROPTERA) OF BRITISH COLUMBIA

I. LANSBURY[1]

Introduction

Prior to this list nineteen species were recorded from British Columbia; twenty five are recorded here and three new species are described. Some of the records are from Hungerford (1948) and Lansbury (1955). The remainder are from material in the collections of the Department of Zoology at the University of British Columbia, Vancouver. Full descriptions of the species listed, excluding the new ones, can be found in Hungerford (1. c.).

List of Captors

A.B.A.	A. B. Acton
L.D.A.	L. D. Anderson
K.F.A.	K. F. Auden
W.B.	W. Bennedict
J.C.B.	J. C. Bradley
O.B.	Owen Bryant
E.R.B.	E. R. Buckell
D.C.B.	D. C. Buckland
B.C.	Bueno Coll
G.C.C.	G. C. Carl
N.C.	N. Carter
W.D.	W. Downes
J.F.	J. Fraser
A.N.G.	A. N. Gartrell
J. H.	J. Hart
J.K.J.	J. K. Jacob
H.B.L.	H. B. Leech
C.C.L.	C. C. Loan
V.Z.L.	V. Z. Lucas
J.A.M.	J. A. Munro
P.	Parshley
J.H.P.	J. H. Pepper
W.H.P.	W. H. Preece
G.G.E.S.	G. G. E. Scudder
G.S.S.	G. Stace Smith
G.J.S.	G. J. Spencer
A.T.	A. Thrupp
U.C.	Uhler Coll
P.N.V.	P. N. Vroom
J.B.W.	J. B. Wallis
J.W.	J. Waterfield
N.S.W.	N. S. Wright

Species Recorded

Cymatia americana (Hussey)

Kamloops (G.J.S.); Brent Lake, Summerland (A.N.G.); Fort St. John (A.B.A.); Nulki Lake near Vanderhoof (J.A.M.). This species has also been collected in the North West Territory, Manitoba, Alberta, Saskatchewan and Alaska. Apparently not very common although widespread.

Dasycorixa hybrida (Hungerford)

Vernon (P.) (Hungerford, 1.c.).

Corisella decolor (Uhler)

Osoyoos (H.B.L.); Hope (L.D.A.). British Columbia forms the extreme northern limit of this species; it occurs abundantly in California, Utah, Nevada and Oregon.

Callicorixa audeni (Hungerford)

Kamloops (G.J.S.); Fraser Lake (G. J. S.); Chilcotin (G.J.S.); Nicola (G.J.S.); Australian (N.S.W.); Midday Valley, Merritt (K.F.A.); Oliver (W. D.); Williams Lake District (G.G.E.S.); Alkali Lake South of Clinton (G.G.E.S.); Soda Creek, to light (G.J.S.); Nulki Lake near Vanderhoof (J. A. M.); Downie Creek, Selkirk Mountains (J.C.B.); Prairie Hills (J.C.B.); Paxton Valley (A.T.); Keremeos (C.C.L.); Westbank (A.N.G.); Jesmond (J. K. J.); Nr. Clinton (A.B.A.); Fort St. John (A.B.A.); 45 miles N. of Atlin (A.B.A.); Revelstoke.

Callicorixa alaskensis (Hungerford)

Seymour Mountain 4,000 feet, Vancouver (H. B. L.); Masset, Q.C.I. (A.B.A.); 20 miles south of Port Clements, Q.C.I. (A.B.A.); Tlell, Q.C.I. (A.B.A.); Fort St. John (A.B.A.); Atlin (A.B.A.). Hungerford (1.c.) also lists B.C. but no locality is given. This species is most common in Alaska.

Callicorixa vulnerata (Uhler)

Saanich (W.D.); Milner (G.J.S.); Pond, Univ. B.C. (G.J.S.); Mission (W.D.); Point Grey (J.H.); Malahat (W.D.); Metchosin (W.D.); Bear Foot Mts. (B.C.); Peachland (A.N.G.); Penticton (A.N.G.); Port Clements, Q.C.I. (A.B.A.); Tlell, Q.C.I. (A.B.A.); Masset, Q.C.I. (A.B.A.); 20 miles south of Port Clements, Q.C.I. (A.B.A.). Recorded from scattered localities in the Western United States.

[1] Hope Department of Entomology, University Museum, Oxford.

Cenocorixa bifida (Hungerford)

Kamloops (G.J.S.); Chilcotin (G.J.S.); Nicola (G.J.S.); Malahat (W.D.); Vernon (E.R.B., W.D.); 6 miles South of Clinton (G.G.E.S.); 149 mile lake, Cariboo (G.G.E.S.); Soda Creek, to light (G.J.S.); Milner (G.J.S.); Westwick Lake, Cariboo (G.G.E.S.); Riske Creek, North Range (G.G.E.S.); Boitano Lake, Cariboo (G.G.E.S.); Peachland (J.B.W.); Nulki Lake (J.A.M.); Westbank (A.N.G.); Summerland, Fish Lake (A.N.G.); Oliver (A.N.G.); Hope Mt., 4,500 feet (A.N.G.); Jesmond (J.K.J.); Minnie Lake (N.C.); Nicola (P.N.V.). This is an extremely common species over the Plateau region, most common in Montana in the United States.

Cenocorixa utahensis (Hungerford)

Vernon (W. D.); Windermere (O.B.); Copper Ht. (G.J.S.); Brent Lake, Summerland (A.N.G.); Penticton (A.N.G.). British Columbia seems to be the northern limit of this Corixid.

Cenocorixa andersoni Hungerford

Victoria (K.F.A.); Goldstream (K.F.A.). Not hitherto recorded from Canada; known only from Oregon and Washington where it is not very common.

Cenocorixa expleta (Uhler)

Kamloops (G.J.S.); 6 miles South of Clinton (G.G.E.S.); Riske Creek, North Range (G.G.E.S.). Not previously recorded from British Columbia; found most commonly in North Dakota and also known from Manitoba and Saskatchewan.

Hesperocorixa laevigata (Uhler)

Kamloops (G.J.S.); Vernon (W.D.); Pond, Univ. B.C. (V.Z.L.); Osoyoos (H.B.L.); Vancouver (H.B.L., G.J.S.); Nicola (G.J.S.); Metchosin (W.D.); Midday Valley, Merritt (K.F.A.); Mission (W.D.); Oliver (W.D.); Point Grey (J.H.); Alkali Lake South of Clinton (G. G. E. S.); Riske Creek, North Range (G. G. E. S.); Cariboo (G.G.E.S.); Peachland (J.B.W., A.N.G., H.B.L.); Chilliwack; Cranbrook (J.H.P.); Sahacks Lake (U.C.); Victoria, Swan Lake (A.B.A.). Apparently an abundant species in the lower part of the province. Found over most of the United States, but not very common along the Eastern seaboard; it has been recorded from Mexico.

Hesperocorixa vulgaris (Hungerford)

Oliver (W.D.); Williams Lake district (G.G.E.S.); Cranbrook (O.B.); Sooke (K.F.A.); Clinton district, Beaverdam Lake (H.B.L.). Seemingly on the edge of its distribution, this Corixid is found principally in Michigan and Minnesota and there are records for most of the United States.

Hesperocorixa michiganensis (Hungerford)

Saanich (W.D.); Chilcotin, Riske Creek (G.G.E.S.). Found in scattered localities across Canada, but not along the Eastern seaboard.

Hesperocorixa atopodonta (Hungerford)

Saanich (W.D.); Riske Creek, North Range (G.G.E.S.). A new record for British Columbia, this species is found most commonly in Michigan, Minnesota and Wisconsin.

Arctocorisa convexa (Fieber)

Revelstoke (Walley, 1936). Known in B.C. only from this locality. Found principally so far in Labrador.

Arctocorisa sutilis (Uhler)

Kamloops (G.J.S.); 45 miles N. of Atlin (A.B.A.). Not previously recorded from British Columbia. This *Arctocorisa* has a wide distribution extending from Alaska to Colorado.

Sigara (Arctosigara) decoratella (Hungerford)

Kamloops (G.J.S.); Lac la Jeune (A. C. T.); Smithers; Chilcotin (G.J.S.); Oliver (P.N.V.); Shafer Lake (J.A.M.); Nicola Lake (E.R.B.). Not a common species; the main centre of distribution is Michigan and Minnesota.

Sigara (Arctosigara) penniensis (Hungerford)

Prince Rupert (N.C.).

Sigara (*Vermicorixa*) *bicoloripennis* (Walley)

Chilcotin (G.J.S.); Cariboo, Westwick Lake (G.G.E.S.); Brent Lake, Summerland (A.N.G.). Found mainly in Manitoba, Michigan and Minnesota.

Sigara (*Vermicorixa*) *washingtonensis* Hungerford

Windermere (O.B.); Adams Lake (K.F.A.); Vernon (L.D.A., W.D.); Oliver (L.D.A.); Quesnel Lake (W.B.); Needles (H.B.L.); Mill Creek, Kelowna (A.N.G.). A fairly common species in British Columbia, although this province appears to be the northern limit.

Sigara (*Vermicorixa*) *grosslineata* Hungerford

Quesnel (G. J. S.); Burns Lake (G.J.S.). Not previously recorded from British Columbia. Recorded principally from Manitoba in Canada and over the greater part of the United States, but with few records for the seaboard areas.

Sigara (*Vermicorixa*) *solensis* (Hungerford)

Quesnel (G.J.S.); Shuswap (G.J.S.); Nulki Lake (J.A.M.); 16 Mile Lake (J.A.M.); Seymour Lake (J.A.M.). Not very common; has a discontinuous distribution over Canada and the United States.

Sigara (*Vermicorixa*) *omani* (Hungerford)

Metchosin (W.D.); Malahat (W.D.); Stanley Park (G.J.S.); Prince Rupert (N.C.); Saanich (W.D.); Chilliwack; Port Clements, Q.C.I. (A.B.A.). A common species. Distribution in the United States is confined to the western seaboard of Washington, California and Oregon.

Sigara (*Phaeosigara*) *dolabra* Hungerford & Sailer

Lagoon (G.C.C.). A new record for British Columbia. This is an exceedingly rare species. The distribution elsewhere is Minnesota, Michigan, Rhode Island and Newfoundland.

Sigara (*Vermicorixa*) *mulletensis* (Hungerford)

Chief Lake (J.A.M.). Found principally in Michigan and Minnesota.

Cenocorixa hungerfordi n. sp. Fig. 1

Size: length 7.7 mm. to 8 mm.; width of head across eyes 2 mm. to 2.1 mm.

Colour: general facies light; pronotum crossed by 8 to 10 dark lines narrower than the pale interlineations, the median dark lines being broken in the centre of pronotum; claval pattern broken, vermiculate dark splotches with colour etched away from inner angle; corial pattern vermiculated dark splotches arranged in three indistinct longitudinal series; membrane and corium distinctly separated by pale smoky line; embolium, head and limbs pale, venter pale to black.

Structural characteristics: Head half as long as pronotal disk, interocular distance greater than the width of an eye (about 25%); vertex of male as seen from above produced slightly medianly beyond margins of eyes; facial hairs few, male fovea broad attaining margins of eyes; fovea well defined but not deep, overhung medianly by projection of vertex; pronotal disk with median carina visible on anterior fifth, moderately rastrate; hemelytra rugulose with few pale hairs; pruinose area of embolar groove posterior of nodal furrow subequal in length to that of claval suture; lateral lobe of prothorax elongate, slightly pointed distally; mesoepimeron narrow, osteole near tip; metaxyphus slightly longer than broad, pointed apically.

Front leg of female of typical shape, with about 19 hairs on lower palmar row.

Front leg of male: Pala slightly longer than broad at widest point; peg row broken, 12 pegs in basal portion, 3 large pegs separated from each other and those of the basal and

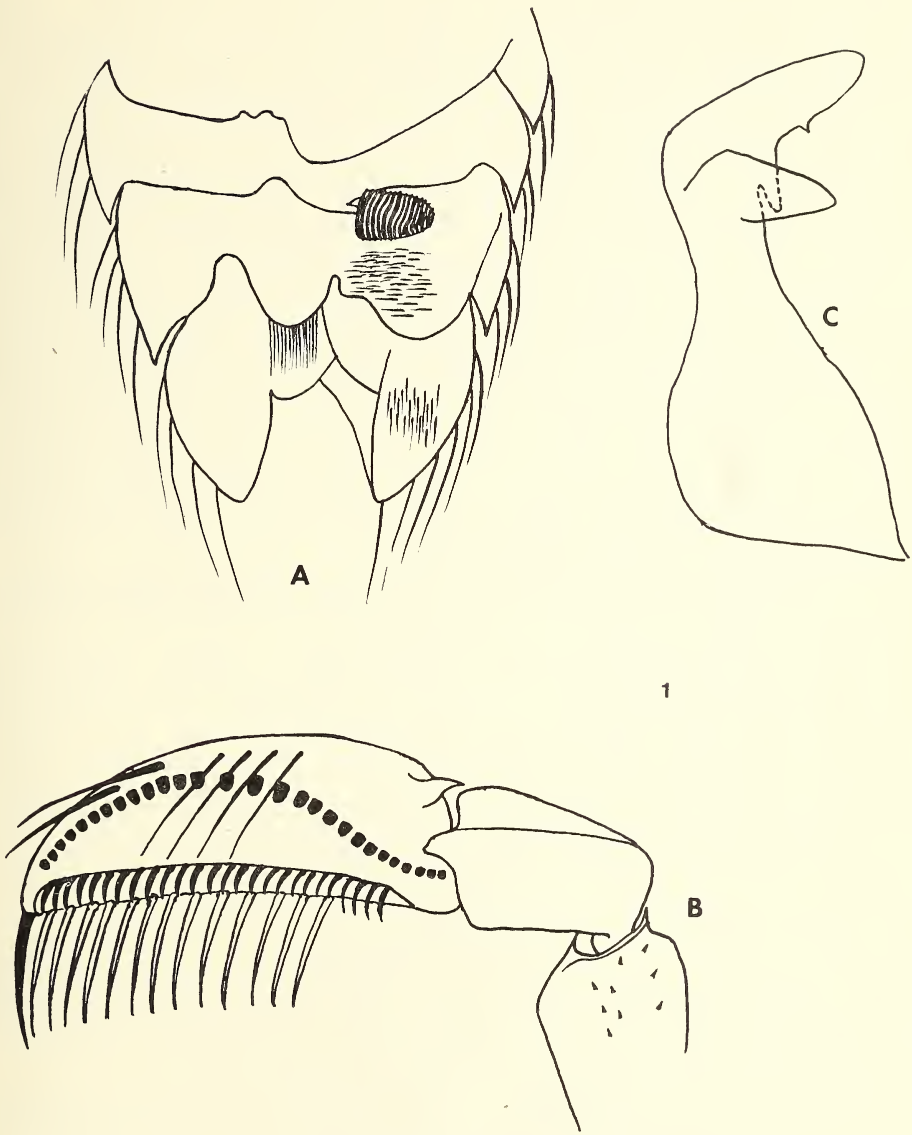

Fig. 1.—**Cenocorixa hungerfordi.** A Dorsal view of male abdomen. B Front leg of male. C Right clasper of male.

distal portion by 1½ to 2 times their own width; 12 pegs in distal portion. There are also 4 long hairs on upper part of median area of pala reaching lower palmar fringe of hairs. Pala without basal carina; tibia half as long as pala, with pronounced dorsal carina and no pad; femur fairly slender, widest just beyond median line distally, inner margin slightly curved with about 15 rows of stridulatory pegs on inner surface near base; middle and hind legs slender; middle femur spinose; hind femur with four teeth distally on inner margin of femur. Comparative measurements of segments, middle leg — femur, tibia, tarsus, claw: 100, 56, 37.5, 46.6; hind leg—femur, tibia, tarsus I, tarsus II: 100, 105, 126.1, 63.

Male asymmetry dextral, strigil large of about 13 irregular combs. Right clasper of male genital capsule bifurcate at tip, curved, distal tip with small pointed notch.

This species is very similar to *C. bifida,* from which it differs by the right genital clasper and strigil.

Described from four males and eight females; holotype, allotype and paratypes in the collection of the University of British Columbia. Dedicated to Prof. H. B. Hungerford the eminent Hemipterist.

Type series as follow: 4 ♂♂ 8 ♀♀ Kamloops, 29 July 1945, G. J. Spencer.

Cenocorixa columbiensis n. sp. Fig. 2

Size: length 6.9 mm. to 7.1 mm.; width of head across eyes 2 mm.

Colour: general facies dark; pronotum crossed by 9 to 11 dark bands, rarely 8, about the same width as the pale interlineations, dark bands broken medianly; claval pattern, apical portion more or less regularly transverse, basal portion more irregular; corial pattern vermiculate dark figures with somewhat vague longitudinal series; membrane and corium clearly separated by a pale line; embolium pale to smoky; rear and fore legs suffused with reddish brown, limbs a little paler; venter pale at margins, dark to smoky over remainder.

Structural characteristics: Head about half as long as pronotum; interocular space slightly wider than width of an eye; vertex of male produced a little beyond margins of eye as seen from above; facial hairs few; male fovea shallow almost attaining eyes laterally; pronotal disk with median carina visible on anterior third; pronotum and hemelytra rastrate, the latter with numerous pale hairs; pruinose area of the embolar groove posterior of the nodal furrow plainly longer than the claval suture; lateral lobes of prothorax about as long as basal width; mesoepimeron narrow with osteole near tip; metaxyphus longer than broad with apex pointed.

Front leg of female: long and slender with 20 hairs on lower palmar row of pala.

Front leg of male: moderately broad, very similar to *C. andersoni* with about 29/30 pegs in a single curved row; pala without basal carina; tibia with pronounced dorsal carina and about half as long as pala; femur with a patch of 12 rows of stridulatory pegs on the inner surface; middle and hind legs slender. Comparative measurements of segments: middle leg—femur, tibia, tarsus, claw: 100, 58.3, 38.9, 46.3; hind leg—femur, tibia, tarsus I, tarsus II: 100, 116.6, 118.1, 60.6.

Male asymmetry dextral, strigil large of 12 regular combs; rear margin of the seventh abdominal segment of the male with three lobes; right clasper of male not bifurcate at tip; seventh ventral abdominal segment of female broadly incised at tip.

This species can be separated from the remainder of the genus by the male genitalia, the number of dark lines on the pronotum and the fact that the hind tibia and tarsus I are

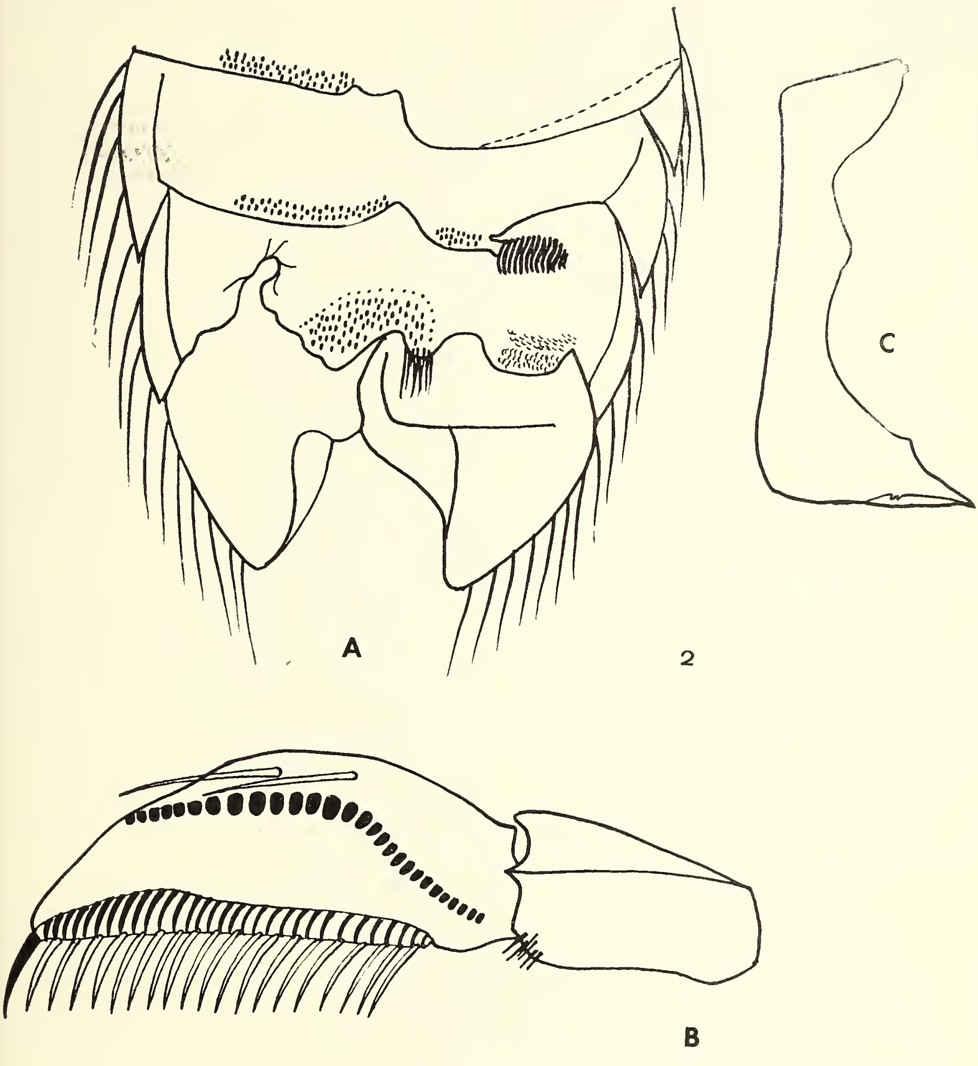

Fig. 2.—**Cenocorixa columbiensis.** A Dorsal view of male abdomen. B Front leg of male. C Right clasper of male.

almost the same length whereas in *C. andersoni* tarsus I is considerably longer than the tibia.

Described from eight males and twelve females. Holotype, allotype, and paratypes in the collection of the University of British Columbia.

Type series as follows: 6 ♂♂ 6 ♀♀, Pond, Univ. Brit. Col., 12 October 1928 (G. J. Spencer); 3 ♀♀, *id.,* 11 October 1928 (V. Z. Lucas); 1 ♂ 1 ♀, *id.,* 12 October 1928 (J. Waterfield); 1 ♀, Metchosin, 30 August 1919 (W. Downes); 1 ♂, Vancouver, 27 March 1929, 1 ♀, *id.,* 10 October 1925 (P. N. Vroom).

Cenocorixa downesi n. sp. Fig. 3

Size: length 7.5 mm.; width of head across eyes 2.5 mm.

Colour: general facies light brown; pronotum crossed by 7 dark lines about half as wide as pale interlineations, median ones forked in the centre; claval pattern irregularly transverse, the dark pigment being etched away at the apical end; corial pattern with a longitudinal stripe along the outer margin and two incipient stripes along the median and inner margins; membrane separated from the corium by a distinct smoky line; membrane with an indistinct vermiculate pattern; embolium pale, venter dark except at margins, limbs pale.

Structural characteristics: head half as long as pronotum, interocular space slightly wider than the width of an eye; vertex of male slightly produced beyond margins of eye as seen from above; facial hairs very few, male fovea shallow almost attaining lateral margins of eye; pronotal carina visible only on anterior fifth; pronotum and hemelytra moderately rastrate, hemelytra with numerous pale long hairs; pruinose area of the embolar groove posterior of the nodal furrow 25 per cent longer than that of the claval suture; lateral lobe of the prothorax one third longer than broad at widest point, tip truncated; mesoepimeron narrow with osteole near tip; metaxyphus longer than broad, apex pointed.

Front leg of male: pala twice as broad as long, widest at median line; 32 pegs in a curved continuous line; tibia two thirds as long as pala, with a pronounced dorsal carina; femora nearly twice as long as tibia, with a patch of about 12 rows of stridulatory pegs on the inner surface and an irregular row of small spines from the stridular patch to the apex of the femora; middle and hind legs more robust than other species in the genus. Comparative measurements of segments, middle leg: femora, tibia, tarsus, claw: 100, 60.9, 38.7, 36; hind leg: femora, tibia, tarsus I, tarsus II: 100, 100, 127.6, 54.6.

Male asymmetry dextral, strigil large of 15 regular combs; rear margin of the seventh abdominal segment rather similar to that of *C. andersoni*, differing in that just sinistral of the median lobe there is a small projection basally. On the dextral side is a dense patch of hairs produced inwardly. Right clasper of the male not bifurcate at the tip.

This species can be separated from the others of the genus by the shape of the right genital clasper and the configuration of the seventh abdominal segment, and also by the fact that the hind tibia and femora are the same length.

Known only by the male type from Stanley Park collected by T.T.W.M., 8 October 1925. Type in the collection of the University of British Columbia. Dedicated in honour of W. Downes who in his life time did so much to advance our knowledge of the Hemiptera of British Columbia.

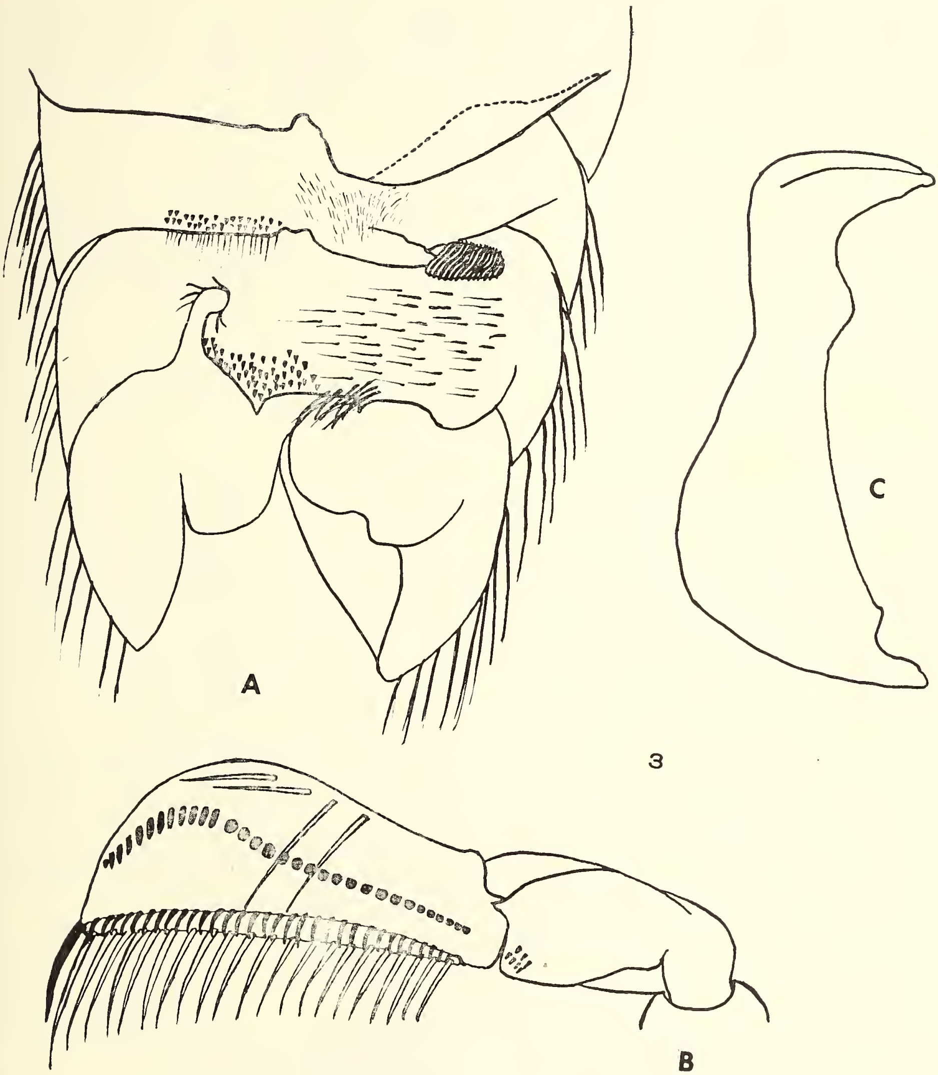

Fig. 3.—**Cenocorixa downesi.** A Dorsal view of male abdomen. B Front leg of male. C Right clasper of male.

TABLE I—Distribution of Corixid species in the Pacific northwest and Alberta exclusive of new species.

	Alaska	B.C.	Alta.	Wash.
Cymatia americana	X	X	X	
Trichocorixa naias (Kirk.)			X	
Corisella decolor		X		
C. inscripta (Uhler)				X
C. audeni	X	X	X	X
Callicorixa alaskensis	X	X	X	X
C. vulnerata	X	X		X
C. producta norvikensis Hung.	X			
Cenocorixa bifida		X	X	
C. dakotensis (Hung.)			X	
C. utahensis		X	X	
C. andersoni		X		X
C. wileyae Hung.				X
C. expleta		X		
Hesperocorixa laevigata		X	X	X
H. vulgaris		X	X	X
H. michiganensis		X		
H. atopodonta		X		X
H. obliqua (Hung.)	X			
Arctocorisa convexa		X	X	
A. sutilis	X	X	X	
A. chanceae Hung.	X			
Dasycorixa hybrida		X	X	
Sigara conocephala (Hung.)			X	
S. decoratella	X	X	X	
S. penniensis		X		
S. bicoloripennis		X		
S. alternata (Say)			X	X
S. washingtonensis		X	X	X
S. solensis		X		
S. mathesoni Hung.			X	
S. omani		X		
S. mulletensis		X		
S. grosslineata		X		
S. dolabra		X		

Distribution

The distributions of 35 species in the Pacific northwest and Alberta are summarised in Table I.

Of the species recorded only *Corisella audeni* and *Callicorixa alaskensis* are common to all four areas. The large number of species recorded from British Columbia must in part be due to the fact that there is a wide variety of habitats and climates enabling such genera as *Corisella, Arctocorisa* and *Dasycorixa* to occur although none of these genera are very abundant. It must, however, be borne in mind that great areas of this province have never been collected.

The known Corixids of British Columbia can be divided into four categories according to their distribution in America north of Mexico.

I. Species principally confined to the western seaboard. At this stage it is not possible to state definitely that British Columbia forms the northern limit of distribution for group A; however, the range of group B is known to extend into Alaska:

Group A	Group B
C. decolor	**A. sutilis**
C. utahensis	**C. audeni**
C. bifida	**C. vulnerata**
C. andersoni	
S. washingtonensis	
S. omani	

II. Species with a predominantly trans-Canadian distribution:

A. convexa **C. americana**

III. Species distributed across Canada, and north central plains of the United States:

C. alaskensis	**S. decoratella**
H. vulgaris	**S. penniensis**
H. michiganensis	**S. bicoloripennis**
H. atopodonta	**S. solensis**
	S. mulletensis

IV. Species recorded from most of Canada and found in most of the United States:

H. laevigata **S. grosslineata**

The remaining three species, *D. hybrida, S. dolabra* and *C. expleta,* are difficult to comment upon regarding their distribution because of the lack of data.

Acknowledgements

I wish to acknowledge the assistance of Prof. H. B. Hungerford of the University of Kansas for help in the determination of certain species of **Cenocorixa** and **Sigara dolabra.** I also wish to thank Dr. G. G. E. Scudder, of the Department of Zoology at the University of British Columbia, for allowing me to examine the University collections and for reading and criticising these notes.

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THE BLACK WIDOW SPIDER, LATRODECTES MACTANS FABR., IN VANCOUVER

Spiders of many shapes and sizes are sent in to the Department of Zoology throughout the year by fearful citizens with enquiries as to their propensity for killing human beings: I have always told them that no deadly poisonous spider occurs in Vancouver or in the wet coastal region.

In the mid 1950s a dead specimen in very poor condition was sent in which resembled a Black Widow except that the abdomen was conspicuously marked with pale bands, very much like those of a typical male *L. mactans,* in contrast to all those females I have seen in the dry belt, those from Davis, California and those from Victoria, whose abdomens were totally black.

In December, 1959 when checking the low crawl space under a small house in east Vancouver for termite damage, I found 2 sprawling webs of coarse silk and 2 mature female spiders which were undoubtedly *mactans,* with pale linear markings on the dorsum of the abdomen: they ran into holes from which I failed to retrieve them.

In January, 1960 I was assessing termite damage in the basement of a large house on Granville Street south and found a female *mactans* with pale markings in a typical coarse web, between the edge of a carpet and the wall, just under the edge of a Hollywood bed on which 3 small children and a dog were accustomed to play; nearby was a male in its much smaller web; both were in a position where they could easily have been squashed by a child. Both were captured and brought to the laboratory; the female soon ate the male and in time became coal black except for one small pale spot on the dorsum of the abdomen.

Hitherto I have always given the distribution of the Black Widow in British Columbia as the dry belt of the Interior and the drier sections of Vancouver Island from Victoria to Nanaimo, and on the dry Gulf Islands; this distribution will have to be revised to include at least Vancouver in the lower mainland. If it increases in Vancouver it will constitute a definite hazard and the public will have to be alerted to watch out for it.

—*G. J. Spencer, University of British Columbia, Vancouver.*

EFFECT OF SPEED OF TRAVEL ON THE PERFORMANCE OF CONCENTRATE ORCHARD SPRAYERS[1]

A. D. MCMECHAN,[2] J. M. MCARTHUR[3] AND K. WILLIAMS[3]

Introduction

For several years the official recommendation for British Columbia fruit growers has been to operate concentrate sprayers at a speed of one mile per hour in mature plantings with rows 30 feet apart (3). This recommendation was necessary because, when travelling at a faster speed, many of the sprayers did not give good spray coverage in the tree tops. During the last few years most of the concentrate orchard sprayers manufactured in British Columbia have been improved to the point where it should be feasible to operate them at higher speeds. In experiments carried out by Messrs. D. B. Waddell and J. M. McArthur at the Summerland Research Station (unpublished work) it was determined that an efficient concentrate sprayer gave as good deposits at two miles per hour as at one mile per hour, in pre-bloom sprays in large apple trees. In the work reported here, two makes of sprayers were operated at one, and two, miles per hour, for applying summer sprays, and a comparison was made of the spray deposits in the trees at the two speeds.

Methods

Two concenctrate sprayers in common use in British Columbia orchards were used for the experiment. Sprayer A was a single-side sprayer that delivered 7000 cubic feet of air per minute at an average velocity of 115 miles per hour; Sprayer B was a double-side sprayer that delivered 10,300 cubic feet of air per minute per side at an average velocity of 87 miles per hour.

The experiment was carried out in three parts. In May, and August, of 1956 Sprayer A was used to apply DDT to replicated plots of mature McIntosh apple trees in three orchards, at speeds of one, and two miles per hour. The plots that were sprayed at one mile per hour received 72 gallons of spray mixture per acre, and those sprayed at two miles per hour, 36 gallons per acre. The per-acre dosage of DDT was the same for all plots. The sprays were applied at a pump pressure of 300 pounds per square inch.

The second part of the experiment was carried out in July 1957, when Sprayer A was used to apply DDT in two orchards of mature McIntosh apple trees at speeds of one, and two, miles per hour. Fifty gallons of spray mixture per acre were applied on all plots at a pump pressure of 75 pounds per square inch.

The third part of the experiment was carried out in the fall of 1957 when both sprayers were used to apply a post-harvest spray of methoxychlor to replicated plots of mature McIntosh apple trees. The sprayers were operated at one, and two, miles per hour with pump pressures of 75, and 300, pounds per square inch. All plots received 50 gallons of spray mixture per acre.

In all the orchards used in the experiments, the trees ranged in height from 18 to 22 feet, and in diameter from 25 to 30 feet. The trees were 30 feet apart in the rows, and the rows were 30 feet apart.

Leaf samples were taken for insecticide deposit analysis after each spray. Fifty leaves were taken from the top, and 50 leaves from the bottom, of each of five trees per plot. Tree-top samples were taken 15 feet above ground level, and tree-bottom

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samples 6 feet above ground level. Sampling technique and sample treatment were the same as reported by Waddell and McArthur (5). DDT was determined by a modified Schechter-Haller procedure (2); methoxychlor was determined by a modified Fairing-Warrington method (1).

Results and Discussion

The results in Tables 1 and 2 show that, in a majority of the plots, the tree-top deposits on leaves were slightly higher at two miles per hour. It is likely, therefore, that, with the sprayers used, pests in the tree tops can be controlled as well at two miles per hour as at one mile per hour.

TABLE 1—DDT Deposits on Leaves (mmg./sq. cm.) with Sprayer A Operated at Two Speeds. Spray Applied at 300 p.s.i. (Average of 10 Determinations.)

		Tree tops		Tree bottoms	
Date	Orchard	1 m.p.h.*	2 m.p.h.**	1 m.p.h.	2 m.p.h.
May,	1	2.5	3.4	8.1	12.0
1956	2	4.6	4.7	9.1	14.2
	3	5.1	3.3	9.4	6.8
	Average	4.1	3.8	8.9	11.0
August,	1	4.1	6.0	6.9	9.4
1956	2	5.6	6.1	9.4	12.1
	3	4.7	4.0	7.3	8.5
	Average	4.8	5.4	7.9	10.0

* Spray applied at 72 gallons per acre.
** Spray applied at 36 gallons per acre.

In general, the tree-bottom deposits were higher at two miles per hour. In concentrate spraying, more spray chemical is usually deposited in the lower parts of the trees than is required for pest control. Evidently this tendency is accentuated when the sprayer speed is increased.

In this experiment the amount of pesticide applied per acre was the same at both speeds. In the sprays applied in May and August, 1956, this was accomplished by using the same nozzle orifices at both speeds, and doubling the concentration of pesticide in the spray liquid applied at two miles per hour. Theoretically, at the two-mile-per-hour rate, there would be only half as many spray drops per unit area of sprayed surface, and each drop would contain twice as much pesticide. This type of distribution of spray chemical is probably satisfactory for the control of mobile pests but may be inadequate for the control of diseases such as apple scab (4). In the remainder of the experiment suitable nozzles were used to apply the same amount of spray liquid per acre at both speeds. It is interesting to note that the relationship between amounts of insecticide deposited at the two speeds was independent of the volume of spray liquid applied per acre and of the pump pressure.

Growers having sprayers with air-stream characteristics similar to those of the sprayers used in the experiment can save considerable time, without sacrificing effectiveness of the spray, by spraying throughout the season at a speed of two miles per hour; growers having less efficient equipment should continue to spray at the previously recommended rate of one mile per hour.

TABLE 2—Insecticide Deposits on Leaves (mmg./sq. cm.) with Two Sprayers Operated at Two Speeds. Spray Applied at 50 Gallons per Acre. (Average of 10 Determinations.)

			Pump pressure	Tree tops		Tree bottoms	
Sprayer	Date	Orchard	p.s.i.	1 m.p.h.	2 m.p.h.	1 m.p.h.	2 m.p.h.
A	July,	1	75	2.8	2.9	6.3	6.8
	1957	2	75	4.0	3.2	5.5	7.2
		Average		3.4	3.1	5.9	7.0
A	September,	4	300	2.8	3.6	2.9	4.5
	1957		75	3.3	3.8	3.9	4.4
B	September,	4	300	2.9	2.2	4.3	6.7
	1957		75	2.2	2.6	4.0	9.3

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TWO RECORDS OF IXODES SIGNATUS BIRULA AND ONE OF IXODES URIAE WHITE, MARINE BIRD TICKS

The first Canadian record of *Ixodes signatus* Birula was by Eric Hearle[2] in 1938 from 2 females and 22 nymphs which I had taken from a cormorant at Tofino, Vancouver Island, in 1926. Other records from Cormorant as given by Gregson[1] are 4 nymphs and I larva from Gull Island, 1 female larva from Cowichan Bay and 3 females from Langara Island. Gregson gives also one unusual record of 3 females and 1 nymph from a rosy finch from the Pribilof Islands.

To these records I can now add 2 others, of collections given me by students at the University who have given me ectoparasites from birds and mammals at odd times.

The first collection was made by Rudolf Drent and G. F. van Tets from *Phalacrocorax pelagicus* Pallas, the pelagic cormorant, found dead on 6 May 1959 on Mandarte Island, B.C. and consists of 1 adult engorged female, 3 adult males, 17 male nymphs and 54 female nymphs and 317 seeds or larvae of both sexes, giving the remarkable total of 392 ticks off one bird. The second collection was made by Rudolf Drent from another pelagic cormorant found dead on 2 June 1959 on Mandarte Island and consists of 2 engorged females, 2 partly engorged females, 1 flat female, 1 small and 1 very small female nymphs and 1 female seed or larva, a total of 8 females and no males.

The third record is of *Ixodes uriae* White, the hairy tick, collected by F. H. Fay from the head of *Uria lonvia* s.s. *arra* the Thick-billed Murre, in June 1954 at Gambell, St. Lawrence, Alaska, and consists of 1 engorged female adult and 11 engorged female nymphs of several sizes. The proportion of females to males in these collections, is interesting; in 2 collections there were no males at all; in the large collection the proportion was roughly 3 females to 1 male; in all collections, 1 or at most 2 engorged females seemed to be responsible for the entire infestations. The 3 collections totalled 412 specimens of what are normally, relatively rare ticks. All the material is in the entomological museum at the University.

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—*G. J. Spencer, University of British Columbia, Vancouver.*

A BRIEF HISTORY OF THE TUBER FLEA BEETLE, EPITRIX TUBERIS GENT., IN BRITISH COLUMBIA[1]

H. G. Fulton[2] and F. L. Banham[3]

The tuber flea beetle was first noted in British Columbia in 1940. Damaged potato tubers from Rosedale and Lulu Island on the lower mainland were received by the Entomology Laboratory at Agassiz for diagnosis. These tubers were found to have pimpling injuries in the skin leading to brown worm-tracks immediately below. Similar damage was reported by Cowan (1) in 1927 and described by Webster and Baker (5) in 1929 in Washington. They attributed the injury to feeding by larvae of the eastern potato flea beetle, *Epitrix cucumeris* Harris.

In 1941, flea beetles were collected from areas where the damaged tubers had been grown. Two species were present; one, the western potato flea beetle, *Epitrix subcrinita* (Lec.), was a minor pest of potatoes that had been present for more than 20 years. This species damaged foliage by feeding but was not known to damage tubers. Later observations (4) indicated that larval damage could occur to tubers when large numbers were present. The second species was readily distinguished from *E. subcrinita,* and was assumed to be *E. cucumeris* until specimens sent to the Systematics Unit in Ottawa, were shown to be undescribed. Finally, in 1944, the insect was described by L. G. Gentner (2).

The first published record of this insect was made in Colorado in 1904 (2) where it caused heavy loss. The insect was first recorded in Oregon, Washington, and Nebraska before 1928.

From 1941 to 1943, *E. tuberis* spread throughout the lower Fraser Valley. Heavy damage occurred at Agassiz, Chilliwack, Langley, and Sumas but the damage diminished towards the coast. The Delta region remained virtually free until 1948.

In the southern interior heavy infestations were general in 1951 and 1952. At several places in the Lillooet district in the upper Fraser Valley and at Kamloops, heavy adult populations severely damaged the foliage of tomato, bean, beet, rhubarb and potato plantings.

In 1953, *E. tuberis* was taken at Gilpin 7 miles east of Grand Forks. New locality records were also made at Fauquier and Burton on the Arrow Lakes about 70 miles north of Grand Forks. Both localities were completely isolated from previously known infestations.

By 1958, *E. tuberis* had appeared 90 miles east of Grand Forks at Wynndel on Kootenay Lake.

Except where references are given the data in this paper were taken from the records of the Chilliwack Sub-station (formerly the Agassiz Entomology Laboratory), the Kamloops Entomology Laboratory, and the Provincial Entomologist, Mr. C. L. Neilson, to whom grateful acknowledgement is made. We also wish to thank Dr. H. R. MacCarthy, Head, Entomology Section, Research Branch, Vancouver, who suggested this topic and for his assistance in the preparation of this paper.

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Fig. 1.—Distribution of **Epitrix tuberis** Gent. in British Columbia.

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A FURTHER RECORD OF GRYLLOBLATTA CAMPODEIFORMIS CAMPODEIFORMIS WALKER, IN THE INTERIOR OF B.C.

A further record for the distribution of *Grylloblatta campodeiformis campodeiformis* Walker, is established with the discovery of this insect in the Monashee Mountains east of Lumby, B.C. Two specimens, one male and one female nymph, were found on September 13, 1956, at a road crossing over Tepee Creek approximately two miles north-west of Lightning Peak in the Monashee Mountains. The identification of these specimens was verified by Professor Emeritus G. F. Spencer of the University of British Columbia.

It is interesting to note that along with both of these insects was captured a large Carabidae — *Pemphus angusticollis* verified by Gordon Stace Smith of Creston, B.C.

The specimens were taken from a deep crack in a soft granite boulder on the bank of the creek. The outer slab of the rock was removed and the insects were found among the moss which was growing inside of the rock fissure. It was a bright day and temperature was estimated to be 65°F. although evening temperatures were below freezing. Altitude was estimated at 6,300 feet.

These specimens and the one captured by J. D. Gregson (1938) at Kamloops, B.C. have coal black eyes which is in contrast to the non-pigmented eyes of two adult specimens taken at Jasper (1930) and which are held by Professor G. J. Spencer.

Seven specimens, one adult and six nymphs, were taken by D. K. Campbell and J. Grant and are assumed to be of the same variety, although identification was not confirmed. These specimens were found beneath the rocks, at the foot of a stable talus slope, located on the north-east side of the Monashee highway approximately 32 miles east of Lumby at an elevation of about 3,800 feet. The date of capture was November 11, 1952. At the time of capture the insects were active although air temperature hovered about the freezing point with intermittent snow flurries. The temperature within the rock slide was below freezing. The pigmentation in the eyes of these specimens was not observed.

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SCOLYTID NOTES[1]

J. M. KINGHORN[2]

A. Hosts of *Anisandrus pyri* (Peck) —This ambrosia beetle is a common pest of many species of deciduous trees including most of the common fruit trees. In addition, Essig (1926) lists hemlock, cedar, and pine as hosts. Chamberlin (1939, 1958) states that these coniferous hosts were undoubtedly listed in error.

In a Douglas fir log at Cowichan Lake, B. C., two ambrosia beetle galleries were found which were of the diameter of *A. pyri*. The remains of an insect in one of the galleries was positively identified as a female of the species. In addition, the tunnels were occluded with a fungus. Upon minute examination, the spores of the fungus closely resembled those of the fungal symbiont of *Xyleborus dispar* described by Schneider-Orelli (1913). *X. dispar* is a European species closely related to, and probably synonymous with *A. pyri*.

Although evidence of brood development was not found, the fact that attack did occur in Douglas fir indicates that Essig's coniferous host records should be considered valid.

B. Pupation of *Orthotomicus vicinus* (Lec).—This species is doubtfully distinct from *O. caelatus* (Eichh.) according to Swaine (1918). Near Nanoose Bay, B. C., a white pine log was infested by the insect. The larvae typically destroy most of the inner bark. Pupae and young adults were found during August in the outer bark and in the sapwood. The sapwood pupal cells were of particular interest because this habit is infrequent among bark beetles. The larvae bored radially into the sapwood to a depth equivalent to about their body length, then turned and cut a pupal niche lying parallel with the grain of wood. White frass plugged the entrance. Upon emerging, the teneral adults bored through the frass plugs and directly through the outer bark. The L-shaped pupal cells are like minature replicas of those mined by the cerambycid, *Tetropium velutinum* Lec.

C. Excessive Brood Mortality of *Dendroctonus monticolae* Hopk. — High natural brood mortality of the mountain pine beetle is not uncommon. However, during the course of chemical control studies at Windermere, B. C., from 1951 to 1953, exceptionally high brood mortality during the late larval and pupal stages was often encountered. In June and July, large, apparently healthy larvae were found, but emergence in August was negligible. It was noted that in such trees much fungus mycelium was growing around the galleries in the inner bark. Dead larvae and pupae were often surrounded or completely covered with white mycelium.

An example can be cited from among ten lodgepole pine trees used for checks in a chemical control experiment. The trees were examined for attack and survival in August, 1953. All were infested to about the same degree, and whereas survival in nine of the trees averaged 17.8 ± 8.7 $(\bar{X} + t_{.05}S\bar{X})$ insects per square foot, only an average of 1.4 beetles per square foot survived in the tenth tree. Heavy mycelium was present around the insect galleries in all parts of the infested bole. Blue stain invariably associated with the species was in the sapwood along with an incipient decay. Field culturing facilities necessary for determining the identity of the mycelial mass were not available at the time. Cultures inoculated from the wood in the laboratory later re-

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vealed that the decay fungus was *Peniophora gigantea* (Fr.) Massee. That wood decaying fungus might be implicated in the death of bark beetle broods is worth noting. Heretofore, certain mould fungi *(Erotium, Penicillium* and *Aspergillus)* are reported to have destroyed broods of *Ips* spp. (Trimble, 1924), but the possibility that decay fungi might have a smothering effect on broods has apparently received no attention in North America.

Fungi, other than the commensal bluestains, are so frequently observed proliferating in and around bark beetle brood galleries, that one is led to suspect that they are responsible for much undetermined bark beetle mortality. There is a need for carefully isolating and identifying fungi where they appear to be deleterious to broods, and to determine the conditions necessary for them to become operative.

D. *Trypodendron lineatum* (Oliv.) Attacks in Living Trees.—This ambrosia beetle usually confines its attacks to recently dead trees, windfalls or logs. During the last five years, at least two cases of the beetles attacking living trees have been observed.

The first instance was where one end of a log highly attractive to beetles had been tied to a healthy hemlock. Attacks on the log were very heavy. In autumn, when the bark of the living tree was wet with rain, small pitch exudations could be seen on the outer bark. When the bark was removed, it was found that beetles had attempted to gain entry to the sapwood, but had only succeeded in penetrating to the cambium.

The other case occurred in a mature forest next to a logging setting where susceptible logs had been left during the spring attack period. In August, a standing, but suppressed hemlock was noted at the edge of the forest with many small pitch exudations on the lower five feet of its bole. *Trypodendron* had succeeded in penetrating into the wood to a depth of at least one-half inch, but no brood developed. The tree added its annual ring of xylem and succeeded in covering over all the entrance holes. Only dimples on the surface of the sapwood revealed where the beetles had entered.

In both of these cases, it appears that the beetles had been confused by the presence of highly attractive wood nearby. The resinosis is evidence that the species is not capable of coping with living trees. Even in recently cut logs and in windthrown trees, it has occasionally been observed that resin flow has thwarted successful attack. Although tropical ambrosia beetles attack, and sometimes kill healthy trees, there is little likelihood of our conifers succumbing to attacks by indigenous ambrosia beetles.

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DIMETHOATE, A SYSTEMIC OF LOW MAMMALIAN TOXICITY, AS AN ORCHARD INSECTICIDE IN BRITISH COLUMBIA[1]

D. P. PIELOU AND R. S. DOWNING[2]

Introduction

Until quite recently systemic insecticides have been of high, or moderately high, mammalian toxicity. Now systemics of low mammalian toxicity have been developed. Among these is dimethoate[3] (marketed in Europe as Rogor[4]), formerly known by the code numbers E. I. 12880 and NC 262 in Canada. The active ingredient is described chemically as *O,O*-Dimethyl *S*-(*N*-methylcarbamoylmethyl) phosphorodithioate, according to the nomenclature adopted by Martin (8). Discovery of the properties of the chemical appears to have been simultaneous and independent in the U. S. A. and in Europe. The available commercial products appear to be very similar (1, 5) in characteristics; however, formulation, and the actual industrial procedure of synthesis, may be different for the different products, and may lead to small differences in performance. Cyanamid dimethoate has been available as a 50 per cent wettable powder, and as an emulsifiable concentrate (46 per cent "solubilized liquid concentrate" containing four pounds active ingredient per U. S. gallon); Rogor as an emulsifiable concentrate containing 320 grams active ingredient per litre.

The acute oral toxicity (LD 50) of this compound to male rats is in the range 200 to 300 milligrams per kilogram of body weight. The corresponding range for dermal toxicity is 750 to 1,150 milligrams per kilogram (1, 5). The toxicity of the older systemic, demeton (*O,O*-Diethyl *O*-2 (ethylthio) ethyl phosphorodithioate) is approximately 60 times greater orally, and 10 times greater dermally, than that of dimethoate (6). The new material is comparable with DDT in so far as hazards to the operator are concerned. It is, for an insecticide, of unusually low toxicity to fish (5). In Canada, dimethoate has been registered for use on a number of nonbearing crops; and on bearing apples and pears, where a torenance of 2.0 parts per million has been established.

In our work at Summerland dimethoate has been tried aganst apple aphid, pear psylla and tetranychid mites; pests that have been difficult to control in recent years.

Control of Pear Psylla

The pear psylla, *Psylla pyricola* Foerst., after a quiescent period of many years (10) has once again come into prominence as a serious fruit pest in the Okanagan Valley. Resistance to malathion [*S*-(1,2-Dicarbethoxyethyl)-*O,O*-dimethyl phosphorodithioate] the recommended control material until 1958 (2), appears widespread (4). Difficulties, or failures in control, have been reported with other organo-phosphorus insecticides, and even with rotenone, once a widely recommended material.

In 1958 D. J. Marshall conducted some experiments in which he used dimethoate in two orchards. Dr. Marshall has allowed mention of his unpublished findings. In the orchards concerned, malathion, applied at 12 pounds of 25 per cent wettable powder per 100 gallons[5], did not give satisfactory control. However, the two dimethoate liquid formulations (NC

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[2] Entomologists.
[3] Common name; originally coined by American Cyanamid Company, Stamford, Connecticut, U.S.A.
[4] Trademark of Montecatini, Rome, Italy. Distributed in Canada by Fisons (Canada) Limited, Toronto, Ont.
[5] Gallons are Imperial gallons except where otherwise indicated.

262 and 12880), applied at the rate of 32 ounces per 100 gallons, gave such promising results that it was decided, in 1959, to continue the work using lower rates of application.

The first trial in 1959 was carried out in an orchard of Bartlett pears on June 17. The trees were sprayed with a high-pressure (425 pounds per square inch), high-volume, gun sprayer. There were seven to ten trees per plot and two plots per treatment. Approximately seven gallons of dimethoate 46 per cent emulsion, diluted one pint per 100 gallon, were applied per tree. As a comparison, malathion was applied in similar amounts at a dilution of 1.5 pounds of 25 per cent wettable powder per 100 gallons. After the application, examinations of the leaves were made at intervals. Fifty leaves (10 from each of five central trees) were picked per plot and examined in the laboratory by stereomicroscope. Results are shown in Table 1.

TABLE 1—Effectiveness of dimethoate emulsion against pear psylla*

Treatment	Number of nymphs per 50 leaves				
Insecticide per 100 gal.	June 24	July 7	July 21	July 30	Aug. 10
Dimethoate, 1 pt.	33	10	22	32	110
Malathion, 1½ lb.	44	118	resprayed		
Check — no treatment	108	836**	9	5	61

* Treatment date, June 17.
** Sprayed with dimethoate, July 8.

Table 1 shows that dimethoate gave commercial control (an average of less than one nymph per leaf) for 43 days. Malathion gave commercial control for only seven days. The malathion plots were resprayed, with another experimental insecticide, when the average number of nymphs rose above two per leaf; the results of this spraying are not relevant to this investigation. On the check plots, after 20 days, the average number of nymphs per leaf was over 80 times that of the dimethoate plots and approximately 8 times that of the malathion plots. The latter fact indicates that although control with malathion was poor, total malathion-resistance had not been reached in this orchard. The check plots were subsequently sprayed with dimethoate and the results from this application confirmed the effectiveness of the material.

A second trial was carried out in an orchard of Bartlett, Bosc and Flemish pears on August 5. These applications were made with a concentrate air-blast sprayer of the turbine axial-flow type. One gallon of 46 per cent emulsifiable dimethoate in 50 gallons of water was applied per acre; nozzle pressure was 300 pounds per square inch and the rate of travel 1.5 miles per hour, a recommended speed for the 20 x 20-foot planting. Evaluation of effectiveness was made as in the previous experiment; the results are shown in Table 2.

TABLE 2—Effectiveness of concentrate spraying against pear psylla*

Treatment	Number of nymphs per 50 leaves		
Insecticide per acre	Aug. 12	Aug. 21	Aug. 31
Dimethoate, 46%, 1 gal. in 50 gal. water	0	0	6
Check — no treatment	92	132	172

* Treatment date, Aug. 5.

It cannot be assumed, though it is probable, that the superior results obtained, compared with the previous experiment, were the result of concentrate spraying because of the differences in plant and insect development at the two dates; and because the temperature, at the time of application, was 10 °F. higher in the latter case. In this experiment some foliage injury was observed on the Bartlett variety but not on the other two varieties; about one-fifth of the foliage area was affected.

Since experience in British Columbia (9) is that wettable powders, in concentrate spraying, are less phytotoxic than emulsions, a third experiment was carried out in a Bartlett orchard. This trial was conducted later in the season, on October 2, when infestation was very high. Application was made with the air-blast concentrate sprayer as in the second trial; and conditions were approximately the same. Dimethoate 50 per cent wettable powder was applied at rates of 8 and 12 pounds per acre, the checks received no treatment. There were seven to ten trees per plot and two treatments per plot. Because insect numbers were high, evaluation was made using the "mite-brushing" technique (7), which proved to be applicable to psyllids. In view of the stage of the season, a single evaluation of results on Octaber 9 was judged sufficient. At that date nymph counts averaged zero per 50 leaves at the 12 pound rate of application and two per 50 leaves at the 8 pound rate. On the check plots the average was 532 per 50 leaves. No foliar damage was observed. In other work (4) on pear psylla, dimethoate proved at least the equal of any other new material being tested.

Control of the European Red Mite

Resistance to various organo-phosphorus materials is common throughout the Okanagan Valley (3) in the European red mite, *Panonychus ulmi* (Koch). Though dimethoate is such a compound it was nevertheless deemed advisable to check its efficiency against this pest. Experiments were carried out in an orchard of semi-dwarf Red Delicious apples. Mites were sampled by the brush method (7) and, before spray application, averaged 12.3 mites per leaf in the orchard. Applications of insecticide were made on June 26 by high-pressure (420 p.s.i.) gun sprayer; approximately four gallons of spray fluid were used on each tree. There were three trees per plot and three replications per treatment. Results are shown in Table 3.

TABLE 3—Dimethoate and malathion against resistant European red mite*

Treatment	Average number mites per leaf	
Dilute application	July 3	July 9
Dimethoate, 0.05% active	5.7	27.0
Malathion, 0.05% active	11.0	30.3
Check — no treatment	24.3	41.6

* Treatment date, June 26.

Control of Reinfestation by Apple Aphid

Although both dimethoate, and malathion, treatments showed a significant reduction of mites after seven days, as compared with the check, the reduction was quite insufficient to constitute commercial control. Moreover, after 13 days, populations were not significantly lower than on the check plots. It was concluded that resistance to organo-phosphorus materials will preclude recommendation of dimethoate as a miticide in the Okanagan Valley. Experiments with mites were, therefore, terminated at this point.

By Spray Application

The current problem in the control of apple aphid, *Aphis pomi* DeG., is not so much that of the immediate effectiveness of freshly deposited insecticides on the insects, but of the effectiveness of residual deposits in the prevention of reinfestation from outside sources (13). It is a common occurrence, when sprays are applied against this sphid, for an efficient aphicide to give complete kill (11, 12) but for reinfestation to occur as the result of recolonization, by winged forms, from neighboring trees or orchards. A true persistent effect of an aphicide can be demonstrated only if invaders are given the opportunity of recolonizing aphid-free, but sprayed, trees; there is then no question that newly observed aphids originated from outside sources and are not the survivors, or offspring of survivors of indifferent spraying.

The experiments were carried out in 1958 in an orchard of dwarf (Malling *IX* rootstack) apple trees, approximately seven feet high, planted five feet apart, and in rows ten feet from each other. Two rows, of varieties Golden Delicious and McIntosh, were kept free of aphids, up to the time of the experiment, by repeated spraying with nicotine. Alternate rows were left untreated, as a source of infestation; and a high population of aphids developed on these. Plots of trees in the *aphid-free* rows (three trees per plot, two plot replications for each variety) were sprayed on July 7 with dimethoate emulsifiable concentrate, one pint per 100 gallons. Subsequently observations were made on the five subterminal leaves (omitting the terminal "bud") of tagged twigs. Five twigs were tagged per tree. Aphids were counted on both dorsal and ventral leaf surfaces, and the leaves left undisturbed till the next count. Tests showed that there was no error in counting up to 40 aphids per leaf, an error of + 3 up to 70 per leaf and an error of + 6 up to 100 per leaf. In numbers above 100 per leaf, aphids were estimated by counting the numbers in one part of the leaf and then judging what fraction this was of the whole population on the leaf. Counts on all trees, on all plots, were made 3, 7, 14, 17, 22, 25 and 31 days after application. Though there were generally more aphids on the more distal leaves of the group of five, figures were pooled to give a mean value per leaf. Comparison is made with the results for Sevin (*N*-Methyl-l-naphthyl carbamate), an efficient residual aphicide of the non-systemic type (13), applied at the rate of one pound 50 per cent wettable powder per 100 gallons. The results obtained are shown in Table 4.

TABLE 4—Recolonization of aphid-free apple leaves; means aphids per leaf

Treatment and variety	Days after application 0	3	7	14	17	22	25	31
Dimethoate Golden D.	0.00	0.10	0.10	0.50	0.40	0.56	0.46	1.90
McIntosh	0.00	0.08	0.30	0.00	0.00	0.00	0.14	0.71
Sevin Golden D.	0.00	0.10	0.34	1.10	0.91	4.41	16.40	15.20
McIntosh	0.00	0.06	1.44	0.71	1.20	2.66	13.80	18.90
No treatment Golden D.	0.00	16.40	39.30	115.00	106.00	118.00	350.00	220.00
McIntosh	0.00	13.90	31.00	28.00	49.10	38.10	160.00	80.80

This table shows that Sevin gave a highly significant reduction over the check after 31 days. However, good commercial control (indicated on the basis of field experience as a mean of one aphid per leaf) was evident for only 17 days. Dimethoate was significantly better than Sevin from the seventh day onward, and good commercial control was evident up to 31 days. In these experiments dimethoate therefore performed almost twice as well as Sevin. The method of evaluation ignored the cluster of aphids in the terminal "bud" of the twig as these are not easy to count in the field. In a further evaluation, six such buds per tree were removed, from each tree in each plot, 33 days after application. They were placed in alcohol and the aphids counted later. The results of these counts, in aphids per bud, were as follows: checks, 151; Sevin, 29.9; dimethoate, 5.7. These figures confirm the superiority of dimethoate.

By Trunk Applications

Some years ago a limited experiment suggested that demeton might give effective aphid control when painted on the trunks of young trees early in the season (4). The possibility of such effective systemic action with dimethoate was therefore investigated. In the dwarf orchard described above, a row of 30 Red Delicious apple trees was selected. These trees had a trunk diameter of approximately 1½ inches. Individual trees were treated in randomized plots in three ways as described below.

(a) An average of 1.3 millitres of the emulsifiable concentrate was painted on the basal part of the stem of each tree with an artists' No. 10 brush. The trunks were painted all round, over a length of about six inches, approximately nine inches above the ground.

(b) First-aid medical "bandaids" were taken, and 0.3 millitres of concentrate applied to the pad of the bandaid. Four such bandaids were then arranged around the trunk of the tree approximately nine inches above the ground but below the first branch. Each tree therefore received 1.2 millitres of concentrate. The bandaids were completely covered with polythene film and the film secured to the trunk. The hypothesis behind the use of the bandaids was that a small, but continuous, supply of systemic would be available to the tree for a long period; and that, unlike the brush applications, the chemical would not tend to evaporate, or be washed away, by sprinkler irrigation water.

(c) Checks; these trees received no treatment.

The trunk applications were made on May 1. Aphid counts, on the five subterminal leaves of tagged twigs, were made directly in the field, as in the previous experiments, on June 3, July 4 and August 6. Results are shown in Table 5.

TABLE 5—Effectiveness of trunk application of dimethoate, applied May 1

Treatment	Mean number aphids per leaf		
	June 3	July 4	Aug. 6
In bandaids, 1.2 ml. per tree	0.31	0.92	1.91
By paint brush, 1.3 ml. per tree	0.69	1.21	154.00
Check — no treatment	10.33	45.70	170.50

It will be seen that bandaid applications gave commercial control for between two and three months; application by paint brush for between one and two months. However, if this procedure is adopted by growers for use on small trees or nursery stock, two applications by paint brush rather than one by bandaid, may be more economical of time and labour.

Some bark damage was evident in trees that received either form of trunk application. However, these trees did not seem to suffer any lasting effects, and two years later were not obviously different in any way from the check trees.

Summary

Dimethoate is a systemic insecticide of low mammalian toxicity and of great promise against fruit pests in the Okanagan Valley. Effective rates of spray application have been: one pint of emulsifiable concentrate per

100 gallons in dilute application; eight pounds of 50 per cent wettable powder per acre in air-blast application. Against the pear psylla, *Psylla pyricola* Foerst, dimethoate gave better, and more lasting, control than malathion. Against a strain of the European red mite, resistant to organophosphates, it did not provide commercial control, although it performed significantly better than malathion. In the persistence of its residual effects dimethoate was outstanding in preventing reinfestation of apple by apple aphid, *Aphis pomi* DeG. Here, under circumstances of severe reinfestation, commercial control by spray application was evident for four weeks; control was about twice as good as with Sevin, a relatively persistent non-systemic insecticide. Excellent control of aphids on young trees was obtained by painting small amounts of undiluted liquid concentrate, or by applying the concentrate in bandaids, to the lower parts of the trunks in May. In the former case effective control was apparent for one to two months; in the latter for two to three months. Trunk applications gave rise to a limited amount of bark injury that, however, did not prove to be permanent.

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NOTE ON PREDATION BY CALOSOMA FRIGIDUM KBY. ON OPEROPHTERA BRUCEATA HLST.

On June 2, 1959, eight miles west of Chetwynd (Little Prairie), B.C., a carabid, *Calosoma frigidum* Kby., was found preying upon the larvae of Bruce spanworm, *Operophtera bruceata* Hlst. Eighteen beetles were counted on the trunk and branches of ten trembling aspen trees. To gain its prey a carabid would start at the axis on the upper surface of a curled leaf, and using its mandibles, puncture the curled leaf tissue, driving the larva before it. When both beetle and larva reached the open end of the habitaculum the beetle would drop to the under side and seize the larva as it wriggled out. Neither rain nor wind seemed to deter the beetles' activity.

—*T. A. D. Woods, Forest Biology Laboratory, Vernon, B.C.*

CHEMICAL CONTROL OF LOOPERS IN STANLEY PARK, VANCOUVER[1]

G. T. SILVER[2]

Introduction

Stanley Park has long been recognized by the Forest Insect Survey as a good collecting area for loopers, primarily the western hemlock looper, *Lambdina fiscellaria lugubrosa* (Hlst.). A heavy outbreak of this species occurred between 1911 and 1913, but by 1914 the population was greatly reduced by the action of a tachinid fly (Whitford and Craig, 1918). Many western hemlock, *Tsuga heterophylla* (Raf.) Sarg., were killed outright. Another outbreak caused moderate defoliation in 1929, and the Park was dusted in 1930 to prevent further damage (Hopping, 1934).

No further outbreaks of the hemlock looper were recorded until 1958. In July, 1958, large numbers of hemlock loopers were present, but in association with a much larger number of green-striped forest looper, *Melanolophia imitata* Wlk. By July 15 the combined population has caused light to heavy defoliation on coniferous understory trees and light defoliation to many mature overstory hemlock. Six hundred acres were sprayed by aircraft on July 26 with 10 per cent DDT to protect the trees from further damage. No appraisal was made of insect mortality but about 30 minutes after spraying the roads and paths were littered with dead and dying larvae. Samples taken on the understory trees two days after spraying indicated a relatively large number of larvae had survived the treatment, apparently protected by the thick mid-story of vine maple which exists in some sections of the heavily wooded areas.

By mid-July, 1959, the numbers of western hemlock looper and the green-striped forest looper were large enough on some trees that if allowed to complete their feeding it was feared that top-kill could occur on some of the mature and over-mature western hemlock. In contrast to 1958 the hemlock looper was the more numerous species. About 550 acres were sprayed between 7:17 a.m. and 7:43 a.m., July 25, by a Grumman Avenger aircraft from Skyway Air Services Ltd. at Langley. The insecticide was DDT in fuel oil, without emulsifier, and applied at the rate of one gallon per acre.

Methods

Because of Park restrictions it was impossible to cut branch samples so larval mortality was calculated by a series of prepared tests. Larvae of both species were obtained by beating trees. Small hemlock branches were tied to a lath cross-piece suspended about a foot above a 40-inch square of factory cotton stretched on a frame. Tanglefoot was placed around the edge of the frame and the ends of the cross-piece to prevent larvae from escaping. The trays for the two species were set up in pairs in a large clearing with three replications about 200 feet apart at right angles to the line of flight. Larvae were placed on the foliage on the evening of July 24, and checked again early the next morning. The trays were checked four times after spraying on July 25, and once again early on July 26. All living larvae were then taken to the laboratory and reared for 11 days on foliage collected adjacent to each tray.

Spray deposit cards were set out on each tray prior to spraying, and samples of the insecticide were obtained.

Results

The insecticide samples were analysed by the Chemical Control Sec-

[1] Contribution No. 598, Forest Biology Division, Research Branch, Department of Agriculture, Ottawa, Canada.
[2] Forest Biology Laboratory, Victoria, B.C.

tion, Forest Biology Division, and contained 7.54 per cent DDT by weight. The amount of DDT recovered from the spray deposit cards was small, ranging from 0.06 to 0.10 pounds per acre.

Considering the low DDT deposits hemlock looper larval mortality was remarkably heavy. In the three replications 0.06, 0.09, and 0.10 pounds of DDT per acre were recovered, and the corresponding larval mortality three days after spraying was 97.4, 90.4, and 96.8 per cent respectively. The combined mortality from the three replications is shown in Table 1. Mortality was 91.2 per cent after 24 hours, and increased slowly to 96.8 per cent on the ninth day. Of the seven survivors after 12 days four were pupae.

TABLE 1—Hemlock looper larval mortality resulting from an average deposit of 0.083 lb./acre DDT. Stanley Park, 1959. Figures are uncorrected for natural mortality.

Date	Days after spray	No. larvae Dead	Living	Per cent mortality
July 26	1	197	19	91.2
July 27	2	199	17	92.1
July 28	3	204	12	94.4
July 30	5	206	10	95.4
July 31	6	207	9	95.8
August 3	9	209	7	96.8
August 6	12	209	7	96.8

Larval mortality of the green-striped forest looper was less than the hemlock looper. DDT recoverey in the three tests was 0.06, 0.09, and 0.10 pounds per acre, and larval mortality after three days was 75.8, 90.4, and 86.5 per cent respectively. Mortality in the first replication increased slowly, but reached 86.7 per cent on the twelfth day compared with 86.5 per cent for the test which received 0.09 pounds of DDT per acre. The data for the three replications were grouped (Table 2). Total mortality barely reached 90 per cent, considerably less than for hemlock looper. Twelve of the 27 survivors were pupae.

TABLE 2—Green-striped forest looper larval mortality resulting from an average deposit of 0.083 lb./acre DDT. Stanley Park, 1959. Figures are uncorrected for natural mortality.

Date	Days after spray	No. larvae Dead	Living	Per cent mortality
July 26	1	225	46	83.0
July 27	2	232	39	85.6
July 28	3	233	38	86.0
July 30	5	235	34[1]	87.4
August 3	9	237	32	88.1
August 4	10	238	31	88.5
August 6	12	240	27[2]	89.9

[1] 2 larvae missing.
[2] 2 larvae died of parasites.

As material was not available to allow for check experiments the mortality percentages are not corrected for natural mortality.

On July 25, about 20 per cent of the hemlock loopers were in the fourth instar and about 80 per cent in the fifth or ultimate instar. Most of the fourth-instar larvae died within 24 hours. The first green-striped forest looper larvae to drop and die were the smallest. Dead larvae the first day were 23.5 per cent fourth, 52.5 per cent fifth, and 24.0 per cent sixth or ultimate instar. By the second day all fourth-instar larvae were dead, and after the fifth day only last-instar larvae were alive. Based on these records it appears that the best time to spray for both species is no later than when the majority of the larvae reach the fourth instar. In this particular instance treatment one week or 10 days earlier would have resulted in heavier mortality in a shorter time.

The hemlock looper appears to be the more susceptible of the two species of DDT. This difference may be associated with behaviour. When the hemlock looper larvae were set out for the tests in the evening they were extremly active, dropping from the foliage and trying to escape over the tanglefoot. This activity continued after spraying, thus exposing the larvae to more DDT as they moved over the foliage and across the trays. The green-striped forest looper larvae were more docile, tending to settle down on the foliage and remain stationary. Some larvae moved under the foliage and remained there, thus not being directly exposed to the insecticide.

As no further defoliation was observed after July 25, and no top-kill occurred, the control operation was considered a success.

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LIOCORIS SPP. COLLECTED ON ALFALFA IN CENTRAL AND NORTHERN BRITISH COLUMBIA

J. C. ARRAND[1]

During the summers of 1957-58 collections were made in alfalfa fields from Grand Forks through the Interior to as far north as Fort St. John, in the Peace River district. Identifications were made according to Kelton (1955):

Fort St. John, Taylor, Two Rivers—*Liocoris lineolaris, L. rufidorsus, L. borealis, L. unctuosis, L. elisus, L. nigrosignatus, L. solidaginis.*

Vanderhoof—*L. unctuosis, L. borealis, L. columbiensis.*

Smithers—*L. unctuosis.*

Vernon, Otter Lake, The Coldstream Valley—*L. lineolaris, L. rufidorsus, L. borealis, L. unctuosis, L. elisus, L. nigrosignatus.*

Grand Forks—*L. lineolaris, L. rufidorsus, L. borealis, L. unctuosis, L. nigrosignatus.*

Liocoris unctuosis, L. borealis, and *L. lineolaris* appear to be the most important species economically. One or more of these species generally made up the bulk of the "Lygus bug" population, although the relative abundance varied considerably.

It is interesting to note that in Kelton's (1955) distribution maps of *Liocoris* spp. in the prairies provinces, *L. nigrosignatus* is limited to the southern part of Alberta. Kelton does not record *L. elisus* from the northern areas of the prairies provinces, although he had examined specimens from the Yukon. *L. nigrosignatus* and *L. elisus* were commonly collected on alfalfa in the Peace River district.

Kelton, L. A., 1955. Species of **Lygus, Liocoris,** and their allies in the Prairie Provinces of Canada (Hemiptera: Miridae). Canadian Ent. 87: 531-556.

In Memoriam

WILLIAM DOWNES - 1874-1959

William Downes was born in Combe Raleigh, South Devon, England on October 13, 1874. His father, the Reverend W. Downes was an ardent botanist and an authority on the geology of the West of England. From him, and two elder brothers, Mr. Downes learned the elements of botany, geology, and entomology. All three men were keen entomologists with good collections.

He started school at Newton College in South Devon but on the death of his father, the family moved to Bristol where William went to Bristol Grammar School. Here there was ample opportunity for the study of natural science. Since there were no organized athletics nor even a proper playing field, he spent his free afternoons in the country searching for specimens. Besides entomology he studied the fresh water molluscs and acquired a considerable collection of them.

On leaving school Mr. Downes accepted an offer from his eldest brother to join him in New Zealand where he was established in sheep farming. After a year on his brother's place he worked for the Kiaora Sheep Farming Co. for two years, and subsequently purchased a property of his own. This was all bush land that had to be cleared and sown to grass, work that he let by contract. After six more years, he had cleared two-thirds of the land and established a flock of 1200 sheep. In 1901 he sold this farm and returned to England for nine months. Then he decided to visit Canada and spent one winter in Alberta. After having experienced the balmy New Zealand climate the Alberta winter gave him a poor opinion of the prairies and he left for British Columbia.

In May 1902 Mr. Downes purchased the J. Johns ranch near Armstrong, B.C., and for 14 years engaged in mixed farming. Because of ill-health, in the winter of 1915, he rented the ranch and moved to the coast. By the beginning of 1917 his health was greatly improved and he was employed to study the biology of the pear thrips by Dr. A. E. Cameron and Mr. R. C. Treherne, entomologists of the Canada Department of Agriculture, after they left the field station at Royal Oak near Victoria. The work was accomplished to the satisfaction of Dr. G. Hewitt, Dominion Entomologist and Mr. Downes was placed in charge of a new laboratory at Victoria in 1919 which position he held until his retirement in 1946. During this period he studied many insect pests of farm, garden, greenhouse, orchard, and dwelling. Some of his outstanding contributions were in the developing of control measures for root weevils, narcissus bulb fly, European earwig, cherry fruit-worm, pea leaf weevil, and apple sawfly.

His entomological zeal did not diminish after he retired for he continued to work on his insect collection, attend entomology meetings and publish papers. He received world recognition as a specialist in Hemiptera and had one of the finest collections of this order in North America. He donated the collection to the University of British Columbia two years before he died. In 1956 he enjoyed attending the Tenth International Congress of Entomology at Montreal where he saw many friends and coworkers in his field.

He was the author of many scientific papers and articles in systematic and applied entomology, 25 of them in our Proceedings. He was a rare, valuable combination of systematist and very practical economic entomologist. During his last 25 years he altered little in appearance or in keen mental alertness. His eyesight was failing somewhat but he still passed the annual driving test, and drove his car. He took good care of his health, believed in keeping busy at an unhurried pace and found time for his favorite diversions—snoozing after lunch, playing the stock market, salmon fishing, and gardening.

He was a member of the Entomological Societies of America, and Canada, and of the Professional Institute of the Public Service of Canada. His keen interest in our Society was reflected by his election to every office, and service on the executive continuously from 1918 until his retirement. On retirement he was elected Honorary Life Member of the Society.

He is survived by his wife, the former Miriam Palmer at Victoria, and one daughter, Dorothy Halley at Texada Island, B.C.

—HARRY ANDISON.

INSTRUCTIONS TO CONTRIBUTORS

EDITORIAL COMMITTEE

Every journal should occasionally review its editorial policy and directions to contributors. The last time this was done for the *Proceedings* was about 1946, under the editorship of Hugh B. Leech. A clear understanding by authors of the requirements and a measure of uniformity help to shorten the time lag between the annual meeting and the publication date. Uniformity of presentation need not make for dullness, but it does make for efficiency, in that readers and abstractors can quickly find salient points. The presentation need not be without humor or individuality of expression, but it must be as simple and brief as possible and above all, clear.

Papers published in the *Proceedings* have not necessarily been delivered at the annual meeting, and papers delivered are not always published in the *Proceedings*. It is preferable, but not mandatory, that authors be members of the Society and contributions from amateurs are as welcome as those from professionals. Papers on almost any aspect of entomology are acceptable at the discretion of the Editorial Board, so long as they have some bearing on insects or pests of this Province.

Authors should understand that manuscripts will be scrutinized by the Editorial Board, and in certain cases may be submitted to outside reviewers at the Board's discretion; in these cases the author is given an opportunity to revise his paper in accordance with the reviewers' comments.

The maximum space allowed to one author per issue is 10 printed pages, i.e. about 25 pages of MS typed double spaced on 8½x11-inch paper. The cost of printing pages in excess of 10 must be borne by the author or his sponsoring institution, at a current rate of $10 per page. The price is subject to change.

Adherence to the following suggestions for preparing manuscripts will help to keep down costs by simplifying typesetting, and will minimize editorial revision.

Typing.—Use a fresh ribbon on one side of 8½x11-inch white bond. Submit the original and one clear carbon; retain a copy against possible loss. Double - space everything including quotations. Keep all margins at least 1-inch wide.

Title.—The shorter and more specific the better. Type in capitals. Identify organisms properly with author, taxonomic Order, and Family. Use a footnote to give a contribution number.

Author(s).—Give the initials and names only. Omit *By*. Centre and type in lower case. Use a footnote to give the location where the work was done or the sponsoring institution. The author's rank is not necessary, but if some details are desirable give these in a footnote.

Abstract or Summary.—Place at the end of the paper. Do not combine discussion and summary, and avoid numbered facts. The author is at an advantage if his summary can be used unchanged by abstracting organizations.

Footnotes.—Avoid them in the text wherever possible. Place a footnote between ruled lines immediately below the line of type in which the reference occurs. Use superscript numbers which run consecutively.

References.—Always put these at the end where they are easily found, not in brackets or footnotes. Arrange them alphabetically and number them. In the text make references consistently by number or by name and year. The preferred system of presentation is, in order: author's surname, and initials, year, title, name of publication, volume number in Arabic numerals, and pages. Junior author's initials precede the surname. The Chemical Abstracts system of abbreviations is to be used for journal names. A convenient list of several hundred Chem. Abstr. abbreviations, including Proc. Entomol. Soc. Brit. Columbia, is to be found in Can. J. Agr. Sci. 36: 513-519, 1956. Keep capitals to a minimum in titles of papers, but titles of books should be capitalized.

Tables.—These should be kept to a minimum and made as simple as possible. With its caption, a table should be self explanatory. It should not reproduce information given in the text or illustrations, but each table should be referred to in the text, e.g. Table 3. Number them in arabic numerals. The word TABLE should be capitalized in the caption. Do not use vertical lines. Small text tables, to fit in a single column without a caption, can often substitute for formal numbered tables. For taxonomic keys do not use progressive indentation.

Illustrations. — Line drawings are much cheaper to print and reproduce better than photographs. They should be on good quality white paper or light blue graph paper, and the author should bear in mind the probable reduction in choosing the thickness of lines; about 50 per cent is a good figure to bear in mind. This point is more critical in taxonomic illustration than it is in graphs. In a graph, the line of a curve must be heavier than the lines of the axes. Avoid more than 2 or 3 curves on a single graph. Photographs must be glossy prints with good contrast. Write clearly the author, title of paper, and Fig. number on the back of all illustrative material. Type the legends double-spaced on a separate sheet, each prefaced by its appropriate Fig. number. Legends must not be a part of the text. Indicate where the illustrations are to go in the paper.

Underlining.—Only words to appear in italics should be underlined.

Chemicals. — Describe clearly and specifically materials under discussion and identify them chemically. Give the source of supply in such a way that the work may be repeated. Put this information in a footnote so as not to break the continuity, unless there is a long list when it may form part of the text. In reporting dosages the concentration of active ingredient should be given. Common insecticides should be identified and then referred to in accordance with the published lists of the Committee on Insecticide Terminology of the Entomological Society of America.

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Proofs. — Galley proofs will normally be sent to authors, who should initial each sheet to indicate that it was read and approved. Use standard proofreaders marks in correcting, but do not hesitate to supplement them by writing clearly in the margins using a ball point pen. The aim is not uniformity of marks but absolute clarity for the typesetter.

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Abbreviations.—There are no hard and fast rules, but most situations will be covered by the following: Use periods for abbreviations. Do not add *s* for plurals. Per cent should be written in the text, and the sign, %, used in tables. Numbers should preferably appear as numerals, including 1 to 10. A good list of acceptable abbreviations is found on the 2nd page of any of Vol. 50 (1960), of Phytopathology.

THE BROWN DOG-TICK, RHIPICEPHALUS SANGUINEUS (LATR.) IN VANCOUVER

In summer, 1958 a veterinary surgeon in Vancouver sent me 3 ticks which he had removed from a Boxer dog whose past history he did not know. I sent the ticks to Mr. J. D. Gregson at Kamloops, the Canadian authority on ticks, who identified them as *Rhipicephalus sanguineus* Latr., the brown dog tick and warned me about its capacity for carrying disease. This was apparently the first western Canadian record of this species.

The last week in October 1959, another veterinary surgeon brought me some nymphal ticks and one engorged female which he had removed from a miniature poodle; I identified them as the brown dog tick and promptly got in touch with the owner of the poodle, to get its history. She told me that she had obtained a first poodle from California in early spring 1959 but the animal was not healthy and died in 3 or 4 months. She therefore imported another dog from the same stock in June and when this one also showed signs of sickness by October, she took it to the veterinarian since, as she said, she was tired of picking ticks off a sick dog. She told me that from the animal itself, from its padded sleeping basket, from the walls of the closet where the animal slept and from the wall-to-wall carpet in the bedroom, she had picked up and washed down the toilet at least one hundred ticks, many of them engorged females: even halving this number, gives a heavy infestation. I searched the penthouse where the people lived and obtained 1 engorged female, 16 male and 33 female nymphs averaging 3 to 3.3 mm. in length, a total of 50 ticks.

Of this tick, Gregson[1] says, ". . . this cosmopolitan species . . is potentially dangerous. Although normally a parasite of dogs, it may bite man and because of his close association with dogs there are frequent opportunities for the transmission of disease to him. In the Old World it is the vector of boutonneuse fever amongst dogs and man. It also transmits canine piroplasmosis which is not only present in Europe, Asia and Africa but has also been found in the southern United States, Panama and Brazil (Cooley, 1946a). This tick is moreover, suspected of being able to transmit Rocky Mountain spotted fever and is considered to be an important vector of this disease in Mexico (Varela and Ortiz, 1949). Miller (1947) cites it as being capable of transmitting at least 11 diseases of man and animals."

I felt certain that the poodle that died and the one I investigated, suffered from canine piroplasmosis, so the owner's husband who is a medical doctor, treated the poodle himself accorded to standard methods recommended for this disease, and the animal recovered completely. They then telephoned my findings to the kennels in California where these poodles were bred and the breeders reported later that they had searched the premises and had found ticks swarming over the entire house and kennels and their dogs to be very sick. They therefore had the place fumigated and all the dogs inoculated for piroplasmosis and latest reports showed all animals to have recovered.

Warning notices about this tick are being sent to all veterinary surgeons in the Vancouver area.

[1] Gregson, John D., 1956. The Ixodoidea of Canada. Pub. 930, Science Service, Entomology Division, Canada Dept. of Agr., Ottawa.

—*G. J. Spencer, University of British Columbia, Vancouver.*

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1. Gregson, John D. 1956. The Ixodoidea of Canada. Pub. 930, Science Service, Entomology Division, Canada Dept. of Agr., Ottawa.

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A METHOD FOR TESTING LOW-VOLUME ORCHARD SPRAYERS[1]

J. M. McArthur[2] and D. B. Waddell[3]

Introduction

A low-volume sprayer using a 110-125 mile per hour airstream to carry the pesticide was developed at this laboratory for the control of orchard pests (2). This sprayer greatly reduced spraying time and labour. After the practicability of the sprayer had been demonstrated, a number of commercial versions appeared. Some of these were very good but others were inadequate. This resulted in a demand for sprayer assessments to ensure that the orchardist could get satisfactory equipment. The object was then to develop a sprayer testing procedure for two purposes: determining the effect of sprayer modifications designed to improve spray distribution and assessing commercial sprayers.

To test sprayers in the field, many acres of orchard and large amounts of time, manpower, and materials are required. It was obvious that the demand could not be met with field tests. On the other hand, although much development work had been done in the laboratory, the amount of information that would be obtained this way was limited and far short of that required. The solution appeared to be a method intermediate between those of the field and the laboratory.

Frame for Sampling Spray Deposits

It was decided that the most practical approach was full scale tests, *i.e.*, to measure deposits at distances normally encountered in orchards. Therefore, it was desirable to have a convenient method of obtaining spray deposits at heights up to 25 feet and horizontal distances up to 15 feet. To achieve this, a wooden frame was built upon which could be placed various sampling devices (Figure 1). The frame was 30 feet in height and width. On the back of the frame were 3 plank walks, 6, 14, and 22 feet above the ground. A ramp led from the ground to the three walks.

At heights of 5, 10, 15, 20, and 25 feet, lengths of angle iron were bolted to each end of the frame and extended 18 inches out from the front. A 7-inch length of strap iron was bolted to the end of each angle iron so that it would be at 90° to a line from the midpoint of the sprayer vent (Figure 2). Two galvanized wires, 1/16 inch in diameter, were fastened to the strap iron by heavy springs. The wires were 3 inches apart and sheet aluminum spacers were fastened to them midway between the sampling points to maintain the 3-inch spacing along the 30-foot length. Each sampling position was marked by a short length of string tied to the lower wire (Figure 3). There were 6 sampling positions, 5 feet apart, the end positions being 2.5 feet from the angle-iron brackets.

Sampling Surfaces

Microscope slides, 1 by 3 inches, were used to collect spray deposit samples. To increase the spray holding capacity of the slides, they were put in a silicone preparation[4] for about 3 minutes and then placed on a rack to drain and dry.

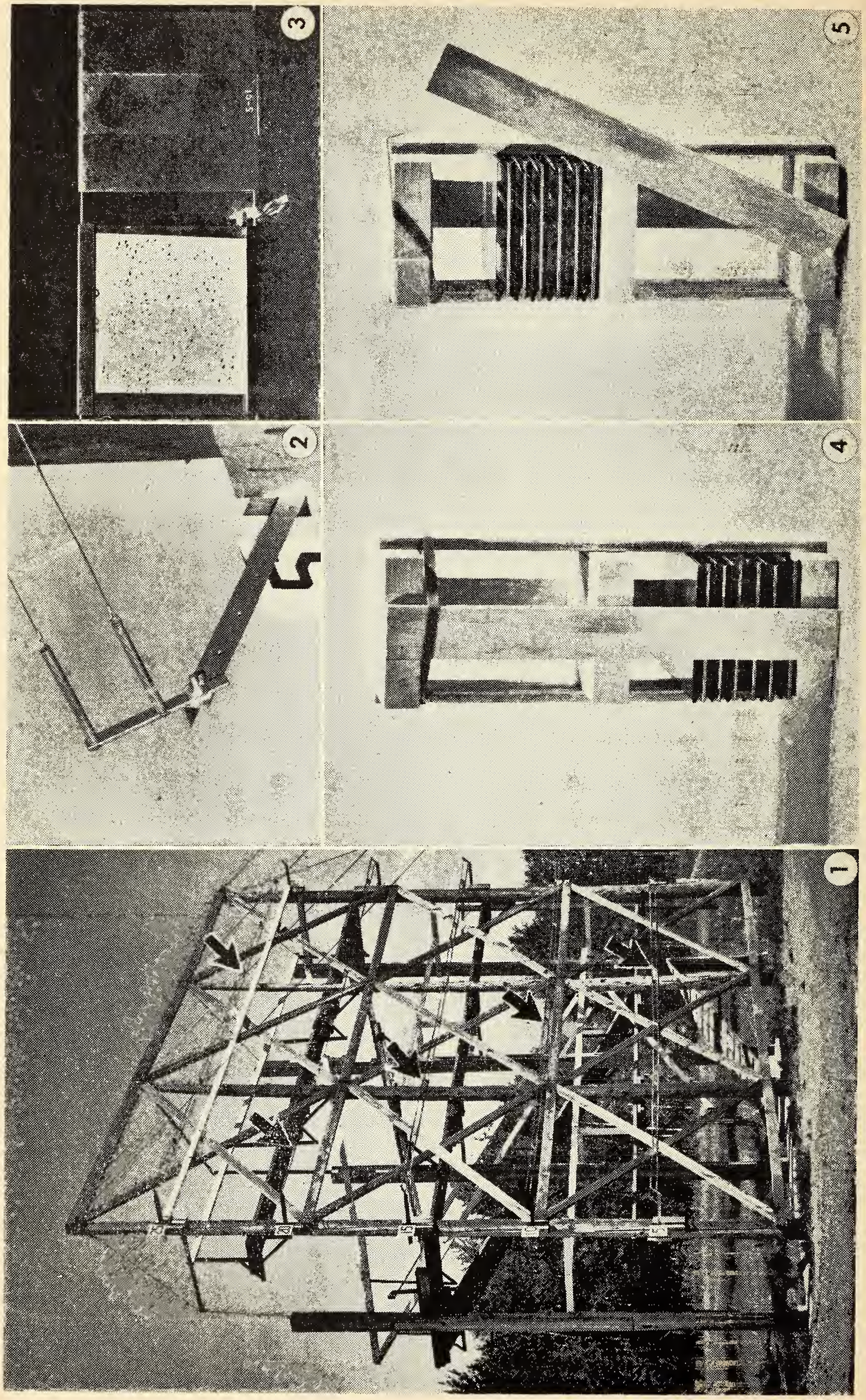
The slides were held on the wires on the spray frame by clips made as follows. A piece of 3- by 3.5-inch tinplate was turned over on two edges to form a clip 3 by 3 inches. The sili-

[1] Contribution No. 16, Research Station, Research Branch, Canada Department of Agriculture, Summerland, British Columbia.

[2] Chemist.

[3] Entomologist; now with Canada Department of Agriculture, Research Branch, Ottawa.

[4] Xpandoseal with Silicone, Xpandoseal Corporation, 43-15-36th Street, Long Island City 1, N.Y.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cone-treated slide was fastened to the clip with rubber cement. Two spots of cement were placed on the clip and on the back of the slide and allowed to stand a few minutes until tacky; and then the slide was placed on the clip so that the spots on the clip and slide were in contact (Figure 3).

Waxed cards were also used to collect samples. These were made from 5- by 3-inch plain index cards that had been immersed for a few minutes in a solution of 15 gm. of paraffin wax in a litre of petroleum ether. When dry, the cards were cut into 2 pieces, 2.5 by 3 inches. These fit between the folded edges of the metal clips (Figure 3). A small amount of rubber cement was placed on the centre of the clip to hold the waxed card securely. When the cement was tacky the card was slipped into the clip and pressed firmly against the cement.

For convenience in handling, the cards and slides were carried in 2-compartment boxes (Figures 4 and 5). The unsprayed cards and slides were placed in the lower compartment, the sprayed in the upper. The turned edges of the clips allowed the sprayed cards and slides to be stacked without smearing the deposits. For each sampling height, one box with 6 cards and 6 slides was required, *i.e.*, 5 boxes, 30 cards and 30 slides for each test.

At each sampling position, the card was placed on the wires before the slide; otherwise the slide would drop off. Those at 5 feet from the ground were put into position from the ground; those at 10 feet from the 6-foot walk; those at 15 and 20 feet from the 14-foot walk; and those at 25 feet from the 22-foot walk. The slide was removed before the card.

Test Solution

A solution of rhodamine B[5] dye in water was used as the spray liquid. For most sprayer tests, 30 gallons of spray was sufficient. The dye solution was prepared by dissolving 90 gm. of rhodamine B in approximately 250 ml. of methanol. This was then added to 30 gallons of water in the sprayer tank and mixed.

Wind Velocity and Direction

The sprayer testing was done outdoors when the wind velocity was less than 2 miles per hour. Wind direction and velocity were measured during a test because variations affected spray deposits. These measurements were made 12.5 feet above the ground on a small platform 30 feet in front of the spray frame.

Wind direction was determined by means of a simple aluminum wind vane mounted on a wooden dial marked in 10-degree divisions. The dial was set up so that the 0-180 line was parallel to the spray frame. Thus wind direction was recorded in relation to the frame.

Wind velocity was measured by means of an anemometer[6] and a velometer[7]. These were mounted so that they could be pointed in the direction from which the wind was blowing. The anemometer was started at the beginning of the test run and stopped

[5] Rhodamine B-500, Canadian Industries (1954) Limited, 355 Burrard Street, Vancouver 1, B.C., Canada.

[6] Taylor Instrument Companies, Rochester, N.Y.

[7] Illinois Testing Laboratories, Inc., Chicago, Ill.

Fig. 1.—Frame for collecting spray samples. On the back are the ramp and walks with white guard rails. Brackets carrying wires for holding sampling surfaces (arrows) are arranged at 5-foot intervals above the ground.

Fig. 2.—Bracket with spring-loaded galvanized wires on which spray targets are placed. One of the spacers to keep the wires 3 inches apart is shown at top centre.

Fig. 3.—Sprayed waxed card and microscope slide in place. The two darker areas on the slide are cement. The string on the lower wire marks the sampling position.

Figs. 4 and 5.—Two-compartment box containing stacked cards and slides for one sampling height, before and after a test, respectively.

at the end. The air movement was recorded in feet but, as the run was timed, the velocity could be calculated. The operator noted the variation in air movement shown by the velometer. If a wind gust occurred during the spraying period, it was noted and also the position of the sprayer in relation to the frame. As the spraying time in a test run was approximately 30 seconds, gusts occurred in few runs.

Spraying Procedure

The course the tractor was to follow when pulling the sprayer past the frame was marked on the ground with heavy white cord. The course varied depending upon the information wanted. For example, if the effect of a sprayer modification on deposit at one distance was wanted, the course was parallel to the frame. However, if information was wanted on deposits at various distances, as for sprayer assessment, the course was at an angle to the frame. In this case the course was marked so that in the test the mid-point of the sprayer vent passed 15 feet horizontally from the first sampling positions and 5 feet from the last. The tractor and sprayer were driven over the course and the throttle setting for the desired speed was determined. The speed was usually 1 mile per hour but speeds up to 4 miles per hour have been used.

The cards and slides were placed on the frame. When the sprayer was in position, the wind observer ready and air conditions satisfactory, the sprayer was drawn along the marked course. When the sprayer vent passed a point 10 feet before coming into the path of the spray frame, the person in charge gave a signal and started a stopwatch. At the signal, the sprayer operator turned on the spray and the wind observer started the anemometer. Similarly, the spray and instruments were stopped when the sprayer was 10 feet past the frame. The duration of the test, pump pressure, and velocity and direction of air movement and other pertinent items were recorded.

Slide and Card Treatment

As soon as spraying was complete, the targets were removed and stored in the carriers (Figure 4) until dry. Then the slides and cards were removed from their metal clips with a thin-bladed spatula. The cement was removed from the backs of the slides by rubbing with the fingers or a cloth. The slides were stored in microscope slide boxes. A 1- by 2-inch piece of each card was glued on a 12- by 15-inch sheet of black photograph-album paper in the same relative position as on the spray frame (Figure 6) and filed.

To determine the spray deposit, the dye was washed off the slides with water. This was done by placing the slide in a 8-ounce bottle, 2 by 2 by 5¼ inches, and adding 15 ml. of water. The tightly capped bottle was then placed on its side in an oscillating shaker and gently shaken for 5 minutes. The solution was decanted and the absorption measured in a spectrophotometer at 555 millimicrons or in a colorimeter with a green filter transmitting in the 500 to 570 millimicron range. A sample of spray solution taken from the sprayer tank was diluted to 100 times its volume and the absorption measured. The deposit on the slide was calculated as microlitres of spray per square centimeter.

Discussion

Frame for Sampling Spray Deposits

Originally it was planned to erect a structure that would have a resistance to a spray stream somewhat similar to that of a mature apple tree. For this purpose the frame was covered with lath snowfencing. However, the resistance was very high; there were practically no deposits on surfaces behind the fencing. Other materials such as netting with various materials fastened to it were considered. Finally, it was decided to use the simple frame instead of a more elaborate structure.

Placement of Sampling Surfaces

The next step was to determine where the spray sampling surfaces should be placed on the frame. By means of an anemometer and small wind vanes the behaviour of airstreams around the frame was examined. In the areas between the structural members of the frame there was considerable air disturbance, but none 12 inches or more in front of the frame. Therefore the sampling surfaces were placed 18 inches in front of the frame. The thin wires used for carrying the surfaces created a negligible amount of disturbance in the airstream and the amount of sag was slight.

When the sampling surfaces were placed vertically, a considerable quantity of spray deposit was blown off by the airstream. Also, because the angle of the sampling surface to the spray stream varied with the position on the frame, it was necessary to calculate the deposits on the basis of a common angle. The deposits on cards could not be corrected and were of little or no value under these conditions, but by tilting the sampling surfaces so that each was at right angles to the spray stream this problem was overcome.

Test Solution and Sampling Surfaces

The information wanted for each sampling point on the frame was the quantity and type of spray deposit. As it was desirable to determine a large number of deposits quickly, a water-soluble dye was used and the amount determined colorimetrically. Rhodamine B was used because its high absorption at a wavelength of 555 millimicrons permits small deposits to be determined. Most materials absorb the dye and are unsuitable for sampling surfaces. However, the recovery of measured amounts of dye from glass was excellent, and microscope slides were used. The slides were treated with a silicone preparation to make the surface hydrophobic. This increased the water-holding capacity. Silicone preparations for treating laboratory glassware are not suitable because they give a very smooth surface from which much of the spray deposit is blown off by the sprayer airstream. Paraffin wax and petroleum oil were also tried but were less convenient and the surface was easily damaged. The silicone preparation finally used produced a satisfactory surface and the slides could be used several times before requiring retreatment.

Cleared photographic film was also tried and is satisfactory for determining small spray deposits. The gelatin layer absorbs the dye as a solution and in this form the amount present can be determined directly by measuring the light absorption in a photoelectric colorimeter. Because the dye solution is not continuous in the gelatin, a colorimeter should be used that measures absorption over an appreciable area of the film. The Klett-Summerson photoelectric colorimeter[8] was found satisfactory. Two sizes of film have been used, 1 by 3 inches and 1¾ by 3 inches. With the smaller size 2 absorption measurements were made, 1 on each end; with the larger, 4 measurements were made, 1 in each quarter. The mean value was used for calculating the spray deposit. The absorption could be measured almost immediately after spraying without processing. However, there is a disadvantage in using film. Because the hydrophilic gelatin surface has a low spray-holding capacity its use is limited to small spray deposits. Dye deposits on other transparent materials, such as glass and

[8] Klett Manufacturing Co., New York, N.Y., U.S.A.

plastics, cannot be measured in this way because the spray solution dries and the dye separates as a solid. For this method the dye must be in solution in a transparent medium.

The amount of material per unit area is not the only factor in assessing spray deposits. The fraction of the sprayed surface covered is of equal, if not greater, importance. Of a number of materials tried for surfaces to assess coverage, plain index cards impregnated with paraffin wax were the most satisfactory. The treatment described gave the cards a smooth, hydrophobic surface upon which droplets of rhodamine B solution left sharp, circular stains. An attempt to measure the spray coverage on the cards by reflectance was not successful. Visual estimation of coverage has been found satisfactory for practical purposes. The majority of sprayers tested by this method delivered spray at approximately 2 gallons per minute and travelled between 1 and 2 miles per hour. Under these conditions there is considerable coalescence of droplets on the waxed cards and they could not be used for determining droplet sizes. However, when the spray deposit was light, drop spectra could be determined from the ratio of stain to droplet diameter. Coalescence of drops on the cards could be detected visually with some experience. Very large spray drops could be detected also as they tended to fall out of the airstream and struck the targets at an acute angle making a distinctive elliptical stain.

Both the waxed cards and the microscopic slides had to be cemented to the metal clips. Although the folded edges of the metal clips held the dry cards snugly, sprayed cards bulged and fell out unless cemented to the clips. As the cards and slides are removed from the clips after the spraying, the cement must hold the targets firmly during the test but give a bond that can be readily broken. Rubber cement for paper is suitable if the surfaces are placed together when the cement is tacky but not dry. This cement has a further advantage in that, when dry it can be readily removed from the surfaces by gentle rubbing. The sampling surfaces may be damaged if touched by the fingers and drop stains are obscured. When the waxed card was pressed onto the cement, it was protected with a piece of card. When a slide was cemented to a clip, the cement had to be applied to both surfaces to obtain a satisfactory bond. Also, the slide had to be bonded at 2 points (Figure 3) or the blast of the airstream occasionally spun the slide or blew it off. Before the deposit on the slide was determined the cement had to be removed because it absorbed the dye.

Assessing Deposits

The number of microscope slides used for measuring deposits depended upon the volume of spray. For sprayers applying 50 to 100 gallons per acre, 1 slide was used at each sampling position at heights of 5, 10, 15 and 20 feet and 2 slides at 25 feet. Where smaller quantities of spray were applied more slides were used.

Preliminary experiments were made concerning the course of the spraying run. In each experiment 4 runs were made. In 2 runs the course was 15 feet horizontally from the first sampling positions and 5 feet from the last. In the other 2, the course was 5 feet from the first sampling positions and 15 feet from the last. The means of the 4 runs for 3 experiments were given by Cox (1, pp. 26-33). The data indicated that greater precision would be obtained with 3 runs along the course starting at 15 feet from the sampling positions and ending at 5 feet than with the 4 runs used in the experiments.

Equal amounts of deposit at all sampling positions might be considered ideal. However, this is not the case. The spray frame is 2-dimensional whereas a tree is 3-dimensional. Horticultural practices affect distribution of the deposits in the tree. In British Columbia, apple trees are usually planted 30 feet apart. They are heavily pruned, and open in the centres. Mature trees almost touch their neighbors and are approximately 20 feet high. Under these conditions the sprayer vent passes under the outer edge of the tree. Since the work was directed toward obtaining efficient pest control in British Columbia orchards some of the conclusions may not apply in other areas.

The deposits on the sampling surfaces give information on the distribution of the spray in the airstream. An even distribution of spray in the airstream is not ideal. The airstream expands as it travels out from the sprayer vent so that the shape in vertical section is approximately that of a right-angled fan. The shape of the tree above the trunk is roughly cylindrical and a plane vertical section through the tree is approximately a rectangle. The vertical columns of targets then correspond to vertical lines through the rectangles. These points should be kept in mind when one scrutinizes data obtained on the spray sampling frame.

If the deposits on the sampling surfaces at the 25-foot height were small the top deposits in trees were small. These deposits could be increased by increasing the amount of spray in the upper half of the airstream. However, the amount of spray in the top portion of the airstream should not be high because this portion travels almost vertically and has a comparatively small part of the tree to spray. If the surfaces at the 5-foot level 5 feet from the sprayer were sprayed to the point of runoff then the spray deposit on the parts of the tree nearest the sprayer were high. If the surfaces near this position were also flooded, then a larger portion of the tree was heavily sprayed. In a well-adjusted sprayer the greatest deposit for any level fell approximately on a diagonal line from the nearest position on the 5-foot level to the farthest position on the 25-foot level. The portion of the spray stream sampled on this diagonal was the portion that sprayed from the lower outside of the tree to the top centre. This part of the stream had to carry the greater portion of the spray because it sprayed a greater portion of the tree. Orchard tests showed that the sprayers that gave good spray distribution in trees also gave nearly uniform spray deposits on the frame at distances of 11 to 13 feet.

In Figure 6 are shown waxed-cards sprayed by a sprayer as received from the manufacturer and after modifications had been made to give a better deposit distribution. The spray output in the 2 tests was the same, 2.24 imperial gallons per minute. The larger stains on the more heavily sprayed cards are formed by coalescence of drops on the cards. In the right-hand group, there has been little or no coalescence of drops on the left-hand 25-foot level card. On the next 2 cards to the right some coalescence has taken place. The larger stains surrounded by comparatively clear areas, on these 2 cards, are distinctive of coalesced drops. There has been coalescence of drops on all cards in this set with the exception of the 1 on the upper left. The spray did not contain any coarse drops. These would be detected as large oval stains present in greater concentration on the lower cards than on the upper.

Figure 7 shows the deposits obtained on the spray sampling frame and on the foliage of mature apple trees. The sprayer used applies 70 imperial gallons per acre and has given good control of insect pests in British Columbia. It is evident that there are

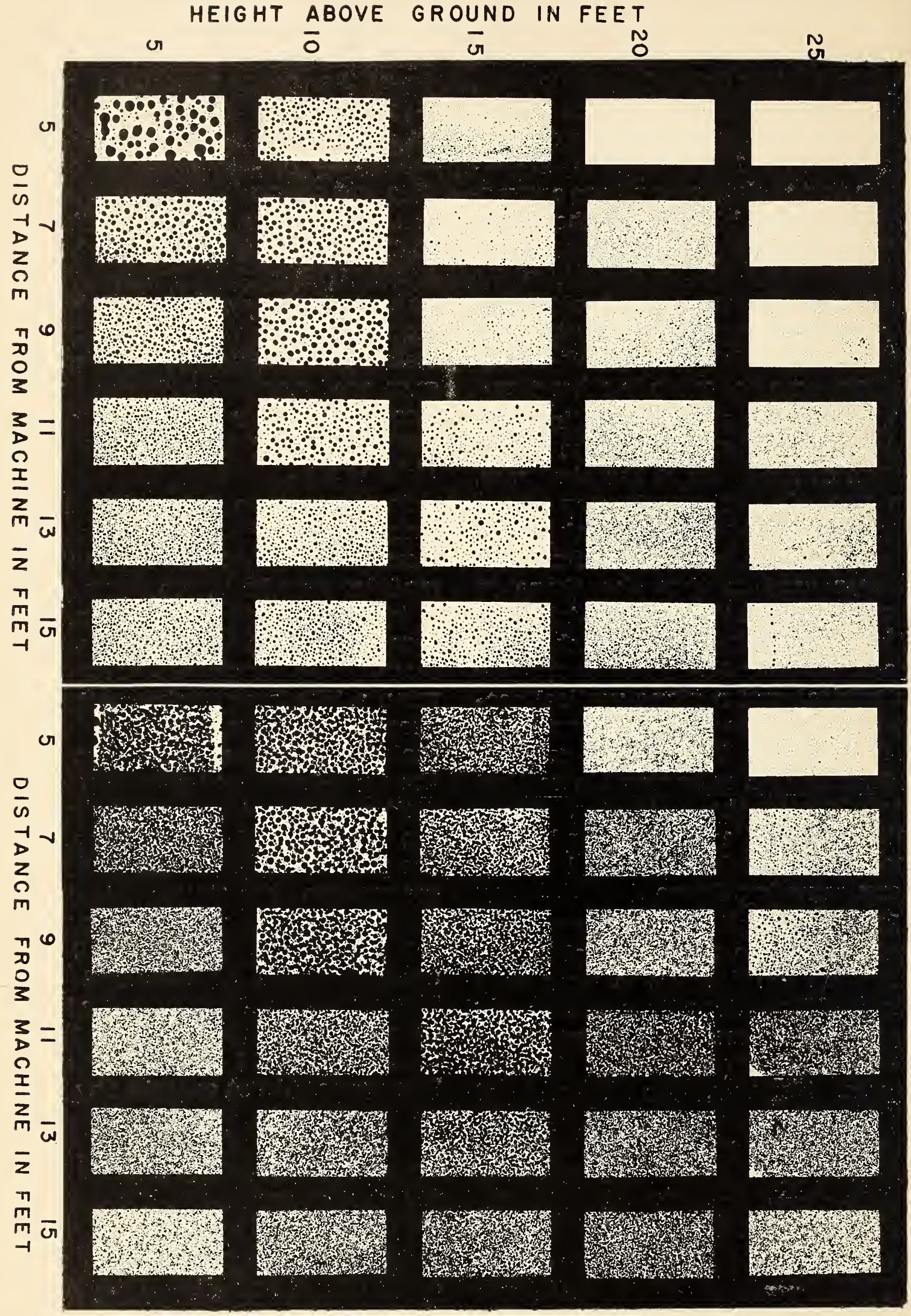

Fig. 6.—Mounted sprayed wax-card targets mounted for reference. Upper a poor spray distribution; lower, good.

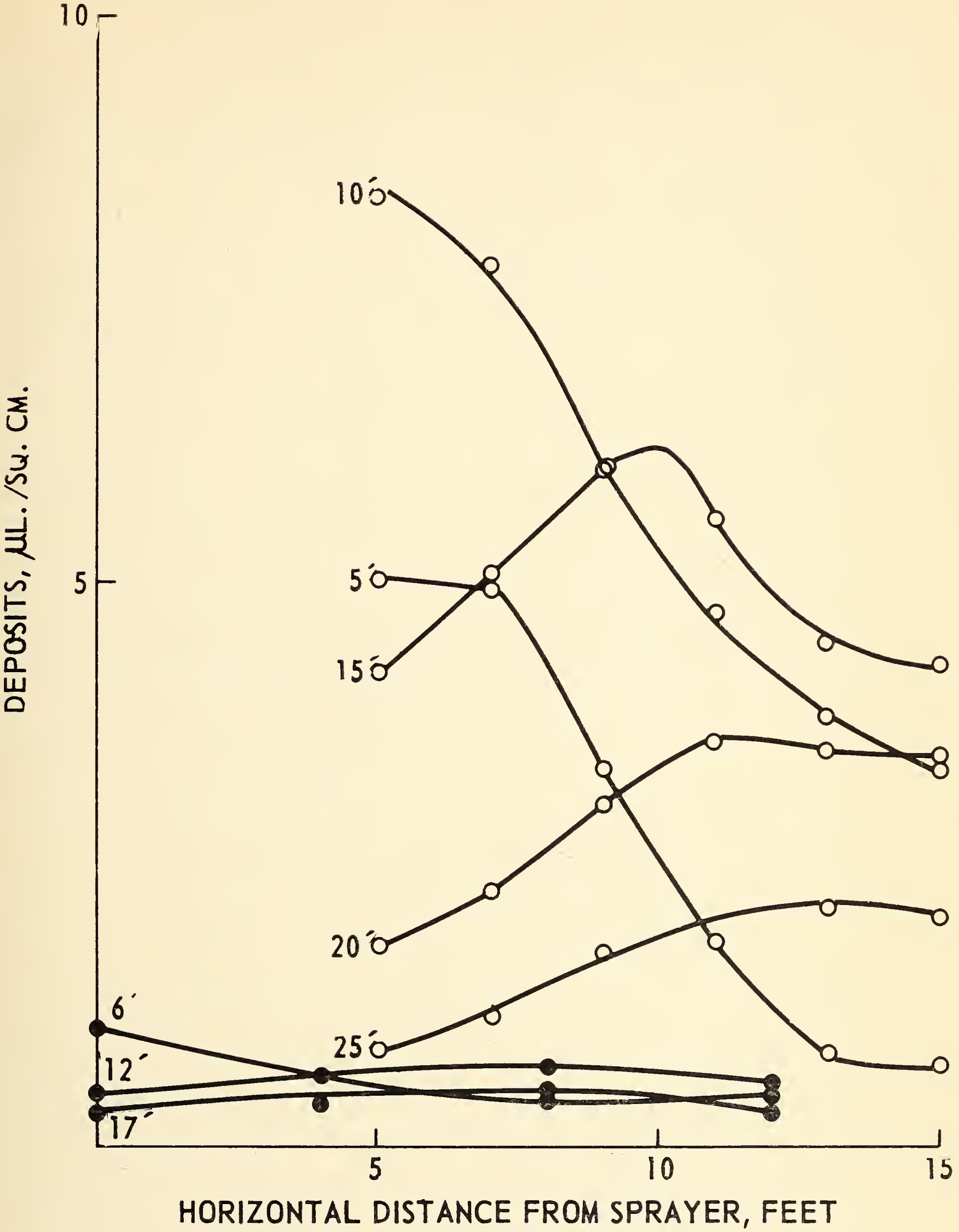

Fig. 7.—Spray deposits, 5 upper curves on spray sampling frame at 5-, 10-, 15-, 20-, and 25-foot heights; 3 lower curves on mature apple trees at 6-, 12-, and 17-foot heights.

large differences between the frame and tree deposits. Nevertheless, when the correlation between frame and tree deposits is known, the efficacy of a sprayer in the orchard can be predicted from the frame data with considerable accuracy.

Abstract

A method is described for full-scale testing of orchard sprayers with outputs up to 100 gallons per acre. Performance is assessed from deposits obtained on waxed cards and treated microscope slides.

Acknowledgment

The authors thank the staffs of the Chemistry and Entomology sections, Summerland, B.C., for suggestions and assistance in carrying out tests, G. F. Lewis and G. D. Halverson for constructing the spray frame and S. R. Cannings for taking the photographs.

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A Note on Catching Insects at a Small Pool

In 1960 I was very successful in collecting insects when I sat over a small pool on several occasions during the very hot summer. I had caught several good species at the same place in previous years. It was much the same as sitting over a water hole in Africa, but with an insect net instead of a rifle, and in the heat of the afternoon instead of just before sundown. I found that insects of certain families seem to need a drink in the hottest part of the afternoon on the really hot days. The hotter it is the more anxious for a drink and the less alert they are.

I had lunch about noon and rested until 1:30, then started out for the pool, which is a little less than two miles from home, a good half of the walk up a side-hill that faces south. It was generally between 90° and 95° F. on the north wall of my house when I left home so it must have been well over 100° F. going up the hill. I told some friends about it and one remarked I should have my head examined, for I was over 76 at the time.

I wanted to catch species of the Stratiomyid genus **Euparyphus,** but I found that several species of Therevidae came for a drink just as readily as the Stratiomyids, although Therevidae are reported to be dry area flies. I also caught some Tabanids. The flies took little notice of me. Apparently all they worried about was to get to the water for a drink. The bottom of the creek was covered with rocks of different sizes and when I put my net over a fly it would just walk or fly through one of the openings caused by the net being held up by rocks. I was very discouraged at catching so few in proportion to the number I had the net over and should have bagged had the surface been more nearly level.

On the way home I remembered making a very small net years ago to catch flies around the house. That evening I made one with a rim 5 inches in diameter. The frame was of baling wire; the handle was the two strands of wire twisted tightly together. The handle was only 10 inches long so you can tell how "tame" the flies were. The small net did not get so wet as the large one. The Stratiomyids in particular liked to go directly to the edge of the pool, or to climb down the perpendicular face of a small rock standing a little out in the water. It was funny to see them walk down this perpendicular rock; they waddled, or perhaps backpeddled, down it. I missed quite a few with the small net, but it was much better than a large one. I could just clap it over some of the rocks and the trapped fly had to climb into the net. I caught several horse flies but had to use the large net for these as they were very alert. I caught two **Tabanus rhombicus** O.S. males and one **Tabanus agrotus** O.S. male, besides **Euparyphus crotchi** O.S., **E. crucigerus** Coq., **E. major** Hine, and **E. latelimbatus** Cn. and several **Scoliopelta luteipes** Will., all more or less flying together. There were ten or a dozen species of Therevidae, four of which were not in the C.N.C. I did not catch a great number but most were very good finds. I shall be watching that place next year.

—*H. R. Foxlee, Robson, B.C.*

NOTES ON THE CHEMICAL CONTROL OF ECTROPIS CREPUSCULARIA SCHIFF, AT KITIMAT, B.C.[1]

G. T. SILVER[2]

The saddle-backed looper, *Ectropis crepuscularia* Schiff., has not been regarded as a serious defoliator of hemlock stands in coastal British Columbia, and there is only one record of damage in the Interior. Populations started building up in 1951 in the hemlock-cedar stands of the North Thompson River Valley, and in 1953 nearly all the ground cover plants in the Thunder River area were completely defoliated. The population declined in 1954 with no apparent damage to overstory trees.

The saddle - backed looper then remained at a low level in British Columbia until 1958 when larvae became common in Forest Insect Survey collections. The population build-up continued in 1959, but there was no indication of an impending outbreak. A heavy moth flight was reported at Kitimat in May, 1960, and by the end of July hemlock stands at Kitimat were severely defoliated.

Only the general life history of this species is known. The moths emerge in early or mid-May, mate, and lay eggs. The larvae apparently feed on the understory and ground - cover plants before moving to the larger trees. In August the larvae drop to the ground and pupate in the duff beneath the trees, where they overwinter.

The full-grown larvae are about 1¼ inches long. The head is brownish, often mottled. The body is dark grey to brown, sometimes reddish in colour. The first three instars have a distinct inverted V marking on the dorsal side of the 2nd abdominal segment, but this marking becomes indistinct and is often missing in the last instar. The light grey moth has a wingspan of about 1¾ inches. The general mottled and indistinct markings of this species makes identification difficult. The wings appear to have scalloped edges and many fine transverse lines, often poorly defined.

The number of larval instars has not been definitely established. About 1,400 larval head capsules collected in the fall of 1960 were measured and plotted. When these data were combined with rearings conducted during the winter there appeared to be five instars. However, three of 16 larvae reared individually through to maturity had six instars. More work will be required to resolve the number of instars; the discrepancy could be a sex difference or a result of forced rearing.

Extent and Intensity

Heavy defoliation extended from about two miles south of the Smelter site to about three miles north of Kitimat Station, and from the Kitimat River westward up the mountain slopes to about 1,500 feet. All merchantable timber in the Anderson and Moore Creek valleys was also heavily defoliated. The total area was 10,500 acres, and was remarkably well defined. There was no gradual decrease in defoliation or number of larvae towards the edge of the infestation but rather an abrupt line, in places only ¼ mile wide, separating infested and non-infested stands. The area of heavy population coincided remarkably well with the extent of the "fume" cloud from the smelter. The reason for this is not understood yet.

With few exceptions the undergrowth, including devil's club, elder-

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[2] Forest Entomology and Pathology Laboratory, Victoria, B.C.

berry, and other deciduous bushes was defoliated. Most of the coniferous reproduction, regardless of species, was completely stripped. Defoliation was heaviest on the southern slope of Sand Hill, and the northern slopes of Anderson and Moore Creek valleys, all southern exposures. This species feeds from the forest floor up, and feeding was stratified to the extent that when defoliation was heavy in the upper third of the crown of intermediate trees feeding was also heavy on the lower and mid-crowns of co-dominant and dominant trees. This pattern is illustrated in Table 1 which summarizes data from one of six plots examined in the infestation area.

TABLE 1—Ocular estimate of defoliation caused by saddle-backed looper in Fume Plot 2. Anderson Creek, Kitimat, B.C. September, 1960.

Tree species	Crown class	No. trees	Average defoliation by crown levels (%) Top ⅓	mid ⅓	lower ⅓	Total	No. trees 100% defoliated	No. Trees 70-99% defoliated
Hemlock	Dom	4	38	46	73	51	0	1
	CoD.	3	39	52	77	52	0	1
	Int.	5	81	81	81	81	3	1
	Sup.	4	100	100	100	100	4	0
Balsam	Dom.	1	50	80	100	80	0	1
	CoD.	7	14	31	47	29	0	0
	Int.	5	81	92	92	91	2	2
	Sup.	10	100	100	100	100	11	0
Cedar	Dom.	1	0	0	10	3	0	0
	CoD.	3	0	2	13	4	0	0
	Int.	2	8	35	55	30	0	0
	Sup.	1	30	30	10	30	0	0

Chemical Control

In an effort to prevent further defoliation to the stands bordering the highway and facing the townsite it was decided on July 29 to spray. Approximately 1,800 acres were sprayed on August 1 by a Grumman Avenger aircraft from Skyway Air Services, Langley. Dosage was ½ lb. of DDT per U.S. gallon of fuel oil, applied at the rate of one gallon per acre. Lack of time did not permit the organization of a proper appraisal, but 32 one-tree sample stations were established in the spray area, and 10 check trees were established outside the spray area. All samples were from reproduction trees or the lower crown level of larger trees which could be reached with clippers from the ground. Two 18-inch branch samples were taken from each tree at each sample date, measured, and the larvae counted. Population was expressed as number of larvae per 10 square feet of foliage surface. Spray deposit cards were set out at each station, and were analysed by the Chemical Control Section, Forest Entomology and Pathology Branch, Ottawa.

The amount of DDT recovered was considered adequate at only two stations where the deposit was 0.28 and 0.29 gpa (Table 2.). The average survival at these stations after 24 hours was 21.4 per cent, but increased to 65.5 per cent 48 hours after spraying. No larvae were found after seven days, but overwintering pupae averaged three per square foot of duff, indicating that some larvae survived. The percentages of larval survival for the other stations are shown in Table 2. In many cases more larvae were found 48 hours after spraying than before spraying. It was impossible to obtain larvae at some stations after seven days because the trees were completely defoliated, and the larvae had left the trees.

TABLE 2—Percentage survival of saddle-backed looper larvae and estimated DDT spray deposit. Kitimat, B.C. 1960.

Number of stations	Deposit gpa	Percentage survival 24 hrs.	48 hrs.	7-10 days	No. pupae per sq. ft. of duff
2	0.28	21.4	65.5	0	3.0
8	0.03-0.09	84.5	47.0	74.2	15.2
22	less 0.01	83.6	93.7	—	6.7
10	check	95.2	95.0	38.5	12.1

From the standpoint of larval mortality the operation does not appear to have been very successful. However, during a survey by helicopter in October it was observed that the trees within the spray area appeared to be in better condition than the unsprayed stands, so that the operation is believed to have saved a considerable amount of foliage.

Several possible explanations for the high larval survival are: the advanced stage of the larvae at the time of spraying, insufficient dosage of DDT, and the insects' habit of feeding from the ground cover up.

On July 31, 76.4 per cent of the larvae were in the ultimate instar, and 22.7 per cent in the penultimate instar. There was some indication that the younger instars were more susceptible to DDT as the percentage of larvae in the last instar increased at the spray stations whereas the distribution of larval instars did not alter greatly in the check stations.

The recovery of DDT at the 32 stations indicated that coverage was neither heavy nor uniform. Only two stations recorded a deposit heavy enough to be effective, 0.28 and 0.29 gpa. Eight stations received from 0.03 to 0.09 gpa, and the remaining 22 stations received less than 0.01 gpa. Some of the reason for the low DDT recovery could be that as *Ectropis* feeds from the ground cover up most of the upper crown levels were not defoliated, and a large portion of the spray would be caught and held in the tree crowns. Nevertheless the amount of spray deposited after allowing for foliage screening was still very small. It could be significant that the two stations receiving the heaviest dosage were on the edge of stands. The feeding habits of the larvae thus offer them a certain amount of protection, and this presents a difficult problem of obtaining spray penetration through a dense, undefoliated forest canopy to where the larvae are feeding. This problem is even greater if spraying is conducted during the early instars when larvae are still on the understory plants and not on the overstory trees as was the case during 1960 at Kitimat.

An hour after spraying was completed thousands of larvae were observed dropping by silk threads from the trees. By afternoon the larvae were crawling up the trees again and few dead larvae were observed. Larvae continued to drop the day after spraying; two days after spraying larval drop was still quite heavy but many of the larvae were free-falling, i.e., not on silk threads. Larvae on the ground were sluggish and many appeared unable to crawl back up the trees.

The assumption is that as larvae continued feeding after the initial knockdown and returned up the trees they were exposed to more DDT in the upper crown levels and gradually accumulated a lethal or sub-lethal dose of insecticide causing them to drop again to the ground and understory. This would also explain the large numbers of larvae counted on the lower crown levels on the second day after spraying.

The high survival of the looper is clearly shown by the large number of pupae per square foot of duff found in October, 1960 (Table 2). Pupal samples within the infestation area averaged 7.8 per square foot of duff. There was no significant difference in the number of pupae inside and outside the area sprayed in 1960. Barring any unforeseen mortality a heavy population is expected in 1961.

The author wishes to acknowledge the assistance given by the District of Kitimat and the Aluminum Co. of Canada during this work.

MYZOCALLIS WALSHII MONELL (HOMOPTERA: APHIDIDAE) ON RED OAK AND A METHOD OF CONTROL[1]

PETER ZUK

Introduction

The aphid *Myzocallis walshii* Monell is a major nuisance on the red oak, *Quercus borealis* Michx. f. (*Q. rubra* auth.), a boulevard tree in Vancouver.

The aphids excrete large amounts of honeydew which falls as droplets over the leaves and eventually on sidewalks, lawns, and cars parked beneath the trees. Another objectionable feature is the sooty mould that grows on the honeydew. Repeated sprayings are necessary to alleviate the nuisance.

During the 1930's the red oak was commonly planted as a boulevard tree in Vancouver. In recent years, the Parks Board, who are responsible for planting and maintaining these trees, have planted smaller flowering species in preference to the larger oaks, maples, horse-chestnuts, catalpas and birches. Another reason for this change was that the red oak in particular supported a dense population of the aphids.

This paper deals with investigations on the life-history and control of this aphid in Vancouver.

Biology

M. walshii has been recorded on the leaves of various oaks (*Quercus alba, Q. bicolor, Q. imbricaria, Q. palustris, Q. rubra, Q. velutina*) (2), and hickories (*Carya* spp.) (1). It has no alternate host.

During the two years of this study, apterous viviparae appeared in the first week in June, when honeydew was found on the leaves on the high branches. A few alate viviparae were found on the lower leaves about the middle of June. The numbers of aphids increased slowly until the second or third week in July after which there was a rapid increase. In 1960, the peak was reached in the first week of September. The previous year there were two peaks: in the middle of July and at the end of August. At the peak of the infestation average counts in untreated trees ran as high as 54 alatae, 107 apterae, and 343 nymphs per leaf. At this time, the honeydew could actually be seen as it fell.

In late September and early October eggs were laid upon the bark of the larger limbs, and on the trunk in the vicinity of the first crotch, in which area the bark was rough, but not so rough as on the trunk below. Distally the limb bark was smooth. After the apterous oviparae had mated with alate males they moved from the undersides of the leaves to the crotch area where they deposited eggs in the cracks of the bark. In 1961, the eggs hatched in the middle of May.

CONTROL EXPERIMENTS

Materials and Methods

The experiment was conducted on mature red oak trees in plantings of

[1] Contribution No. 28, Research Station, Research Branch, Canada Department of Agriculture, 6660 N.W. Marine Drive, Vancouver, B.C.

16 trees per city block. Di-Syston[2] was applied in the third week of May by two methods: the granules were (a) poured into 24 holes in the soil each 4 inches deep, spaced around the periphery of the tree, and the holes plugged with soil; (b) the granules were buried at a depth of 4 inches in a trench next to and surrounding the trunk of the tree. The material was used at three dosages: 5 oz., 10 oz., or 15 oz. per tree. The treatments were set out in random arrangement and replicated four times. The trees in Block I were treated in 1959 and again in 1960 by method (a). Trees in Block II were treated in 1960 at the three dosages. Of these four trees receiving each dosage, two were treated by method (a) and the other two by method (b).

Counts of adult aphids on ten leaves per tree were made at weekly intervals, commencing in the first week in June. In the experiment on Block I, aphid counts from two trees were very low, perhaps because these two trees had been treated with Di-Syston in 1958. Missing data therefore were calculated for these two trees according to the method of Yates (in Snedecor (3)) for inclusion in an analysis of variance.

The circumference of the trees was measured three feet above soil level.

Results and Discussion

Since spray drift and spray residues might be hazardous to children and pets, to birds and their nestlings, and to predatory and parasitic insects, a systemic insecticide that can be applied to the soil and absorbed by the tree has obvious advantages. Such a preparation, Di-Syston, was obtained in granular form and was applied through the soil with a minimum of labor.

The average number of adult aphids on 10 leaves per tree per season for the two methods of application was:

Method of application	Oz. of 5% Di-Syston per tree 5	10	15
(a) in soil in holes spaced around periphery of tree	2262	1976	1389
(b) in soil buried in a trench surrounding the trunk	1927	1895	910

There were no significant differences between the two methods of applying the insecticide. Since method (a) involves a considerably higher labor cost than method (b), the latter is preferred.

The average number of adult aphids on 10 leaves per tree per season was:

Area treated	Year treated	Untreated	Oz. of 5% Di-Syston per tree 5	10	15	% control determined by Abbott's formula at 15 oz.
Block I	1959	1220	843	989	719	41
	1960	3552	2335	2067	1502	58
Block II	1960	4634	2095	1936	1150	75

Any two means not underscored by the same line are significantly different at the 5 per cent level.

Although the lower rates of application did not reduce the numbers of aphids significantly in the experiment on Block I in either 1959 or 1960, the highest rate of 15 oz. per

[2] Chemagro Corp., Kansas City, Missouri. 0,0-Diethyl S-2-(ethylthio) ethyl phosphorodithioate.

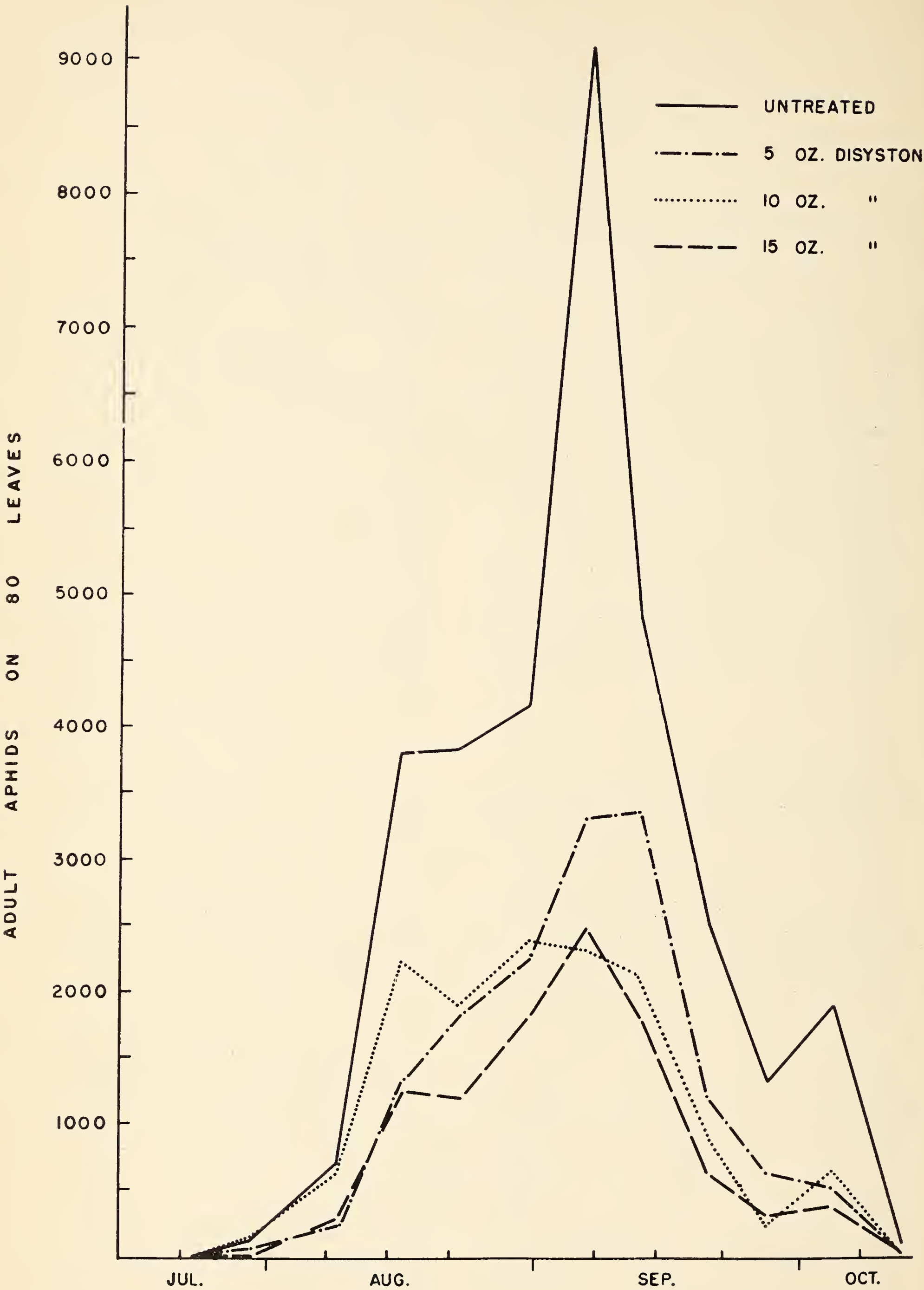

Fig. 1.—Number of adult aphids on ten leaves per tree in Blocks I and II at Vancouver, B.C., 1960.

tree did reduce the numbers significantly below that of the checks. In Block II there was no significant difference between the three levels of application but all significantly reduced the numbers below that on the untreated trees.

Adult aphids on ten leaves per tree in Blocks I and II in 1960, are shown graphically in figure 1. In late July, two months after the insecticide was applied, the populations rose sharply, but the increase in the untreated trees was much more rapid than in the treated trees.

Although the tree trunks ranged from 25 to 41 inches in circumference, the degree of aphid control was not influenced by tree size. However, trees over 40 inches in circumference should probably receive not less than 24 oz. of 5 per cent Di-Syston.

Two trees in Block I, the aphid counts from which were excluded from the experiment, had been treated for three consecutive years with 24 ounces of Di-Syston. They were virtually free from aphids. Indeed they were the only trees under which cars could be parked with impunity.

Summary

Myzocallis walshii Monell is a major nuisance on the red oak, *Quercus borealis* Michx. f. (*Q. rubra* auth.), a boulevard tree of many streets in Vancouver, British Columbia.

The aphid has no alternate host. The males are winged. Mating takes place on the leaves, after which the apterous oviparae move to the vicinity of the main crotch to lay their eggs in crevices of the rough bark. In 1961, the eggs hatched in the middle of May.

A five per cent granular formulation of Di-Syston appreciably reduced the numbers of aphids when applied in the soil around the trees at the rate of 15 oz. per tree.

Acknowledgements

I am indebted to Dr. W. R. Richards, Entomology Research Institute, Research Branch, Canada Department of Agriculture, Ottawa, for identification of the aphid, and to my colleagues Dr. H. R. MacCarthy, Mr. A. R. Forbes, and Mr. M. D. Noble for assistance during the course of this work.

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Heliothis phloxiphaga G. & R. (Lepidoptera: Phalaenidae) on Vancouver Island

In the past twelve years I have met with this species only once, in 1957, when it was frequently to be seen on the open grassy slopes of the hillsides near Victoria and Goldstream.

It was observed in two periods, May 4 to 7, and again from July 5 to August 4. In the first period it was fairly common, feeding on the flowers either of sea blush, **Valerianella congesta,** or of several species of **Trifolium.** More commonly, it was aroused to flight on my close approach, and remaining just out of reach of the net, would fly swiftly and erratically for a short distance and then dive suddenly into the herbage, repeating the process if again disturbed.

In the second period it was not so often seen but several were taken at light. Most of the individuals were obviously second brood, judging from the fresh condition of their wings.

Jones records the species from Victoria, Mill Bay, and Duncan on Vancouver Island so there is evidently a resident nucleus which gives rise to noticeable numbers in an exceptionally favourable season.

H. phloxiphaga is closely related to **H. obsoleta,** a pest associated with the cotton crop of the southern states. I have no information concerning its economic status in British Columbia.

—*George A. Hardy, Provincial Museum (Rtd.), Victoria, B.C.*

COMPARISON OF SPRAY DEPOSITS FROM CONCENTRATE AND SEMI-CONCENTRATE ORCHARD SPRAYING[1]

K. WILLIAMS AND A. D. MCMECHAN[2]

Introduction

Although concentrate spray machines are widely used in the Okanagan Valley of British Columbia, some growers use semi-concentrate spray machines. Marshall (2) has defined a concentrate sprayer as one that causes no drip from mature trees sprayed with up to 75 Imperial gallons of spray liquid per acre, and a semi-concentrate sprayer as one that applies 150 to 300 gallons per acre. The experiment reported here was undertaken to compare spray deposits on foliage when sprays were applied at rates of 50, 100 and 250 gallons per acre, with the same amount of spray chemical per acre in each case.

Methods

Two orchard sprayers in common use in the Okanagan Valley were used for the experiment. Sprayer A was a double side sprayer that delivered to each side an airstream with an average velocity, at the vent, of 87 miles per hour, and a volume of 10,300 cubic feet per minute. Sprayer B was a double side sprayer that delivered to each side an airstream with an average velocity, at the vent, of 105 miles per hour and a volume of 7,700 cubic feet per minute. The speed of travel for all spray applications was one mile per hour.

The experiment was conducted in an orchard of mature McIntosh apple trees in which the rows were 30 feet apart and the trees 30 feet apart in the rows. Trees ranged in height from 18 to 22 feet, and in diameter from 25 to 30 feet. In 1959, each sprayer was used to apply Sevin, 50 per cent wettable powder, at the rate of 4 pounds per acre in all treatments. Each treatment consisted of two replicates and there were three treatments per sprayer: 50, 100 and 250 gallons of spray liquid applied per acre. The experiment was repeated in 1960.

Sampling technique and sample treatment were as reported by McMechan et al. (1). Sevin was determined by a colorimetric method (3).

Results and Discussion

The results (Table 1) show that when the same amount of spray chemical was applied per acre the spray deposits on the leaves were not increased by increasing the volume of spray liquid. With both sprayers the 50-gallon-per-acre rate gave equal or slightly higher deposits than the 100- and 250-gallon-per-acre rates.

During the last several years sprays applied at the rate of 50 gallons of spray liquid per acre have given excellent pest control both in experimental plots and grower-sprayed orchards. In limited experiments Fisher and McMechan (unpublished results) have found that chemical thinning of apples was as good with 50 as with 100 or 250 gallons of spray liquid per acre. From the results obtained it appears that there is no advantage in using more than 50 gallons of spray liquid per acre because time is wasted in filling the sprayer when higher volumes are used.

The amount of spray chemical applied per acre should be the same for sprayers applying from 50 to 250 gallons of spray liquid per acre. When applying more than 250 gallons of spray liquid per acre the amount of spray chemical applied per acre may have to be increased because of in-

[1] Contribution No. 72 from the Regional Research Station, Canada Department of Agriculture, Summerland, British Columbia.

[2] Chemist and Agricultural Engineer respectively.

TABLE 1—Mean Spray Deposits of Sevin (mmg./cm.2) on Apple Foliage from Two Sprayers Applying Three Volumes of Spray Liquid per Acre (Sevin, 50 per cent Wettable Powder, Applied at Rate of 4 Pounds per Acre in All Plots).

			Tree-top deposit			Tree-bottom deposit		
			Gallons of Spray liquid per acre			Gallons of Spray liquid per acre		
Sprayer	Year	Replicate	50	100	250	50	100	250
	1959	1	1.2	0.9	0.6	3.2	2.7	1.9
A		2	1.5	1.1	1.0	3.3	3.2	2.1
	1960	1	1.0	1.3	1.1	3.3	3.5	2.4
		2	1.2	0.9	1.1	3.5	2.8	2.5
	Average		1.2	1.1	1.0	3.3	3.1	2.2
	1959	1	1.5	1.6	1.2	2.5	3.3	2.4
B		2	1.6	1.0	1.4	3.0	2.7	2.7
	1960	1	1.4	0.8	1.0	2.8	2.9	2.9
		2	1.2	1.3	1.2	3.7	3.3	3.0
	Average		1.4	1.2	1.2	3.0	3.1	2.8

creased "run-off" of spray liquid from the fruit and foliage.

Summary

When the same amount of pesticide was applied per acre, spray deposits on foliage were equal for two sprayers applying concentrate sprays of 50 gallons of spray liquid per acre and semi-concentrate sprays of 250 gallons per acre.

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Dock sawfly larvae boring holes in cedar siding.

On October 27, 1959, at the request of a pest control operator, I visited a house in Burnaby to investigate a complaint of insects boring into cedar siding. The house was six months old, in a new subdivision on a northern slope with bush only a block away. No landscaping had been done.

Thirteen sawfly larvae were collected on the outside north wall and on a cement walk next to the house. The larvae had moved from the soil, across the walk and up the cement house foundation to the painted cedar siding in order to pupate within holes on the wood. The lower edge of the siding was 18 inches above the concrete walk. By the time the owner enlisted the services of the pest control operator, they had already made many holes in the lowest 18 inches of wood.

The larvae were placed in a jar containing a large cork into which they immediately started to bore. The jar was left in an outdoor screened insectary for the winter. Adult sawflies emerged at the end of May and were identified as **Ametastegia glabrata** (Fallen) by Dr. H. E. Milliron, Entomology Research Institute, Ottawa.

A. glabrata, which feeds on docks (**Rumex** spp.) and **Polygonum** spp., normally hibernates in the stems of these plants. Occasionally it causes considerable damage in the fall by boring into apples in orchards that are not clean cultivated. It may also hibernate in the dead portions of spur growths that have been cut back the previous season.

Becker and Sweetman recorded leaf-feeding sawfly larvae **Macremphytus tarsatus** (Say) in large numbers crawling about dooryards and on buildings in Massachusetts. The larvae bored into wooden structures to make pupal cells, completely embedding themselves in decayed or naturally soft wood.

Reference

Becker, W. B. and H. L. Sweetman. 1946. Leaf-feeding sawfly larvae burrowing in structural wood. J. Econ. Ent. 39: 408.

—*Peter Zuk, Research Station, Vancouver, B.C.*

EXPERIMENTS IN BRITISH COLUMBIA WITH ACRICID, A NEW DINITRO MITICIDE[1]

R. S. DOWNING[2]

The control of phytophagous mites, especially the European red mite, *Panonychus ulmi* Koch, and the McDaniel spider mite, *Tetranychus mcdanieli* McG., is becoming an increasingly important and difficult problem, mainly because of the mites' ability to develop resistance to most acaricides in a relatively short time. In some areas of British Columbia, the European red mite has developed strains resistant to malathion, parathion, and other organic phosphates; to the sulpho-esters fenson, ovex, and Tedion; and in some instances to the chlorinated hydrocarbon Kelthane. The McDaniel spider mite poses a perplexing problem because malathion, parathion, and other phosphates, and in many cases, Kelthane, have been ineffective against it. There are few effective and safe miticides available, consequently, the search for new miticides of different molecular structure has special significance in the research work at Summerland and elsewhere.

Dinitrophenol derivatives have been used extensively for mite control in various areas of the world, especially in British Columbia (5) and, to the author's knowledge, these compounds have yet to induce resistance in insects or mites. Twelve to fifteen years ago dinitro-*o*-cyclohexylphenol (DNOCHP) was used quite extensively in British Columbia but was dropped in favor of newer and less phytotoxic miticides. The fungicide - acaricide Karathane (dinitro capryl phenyl crotonate) is fairly effective against mites (1) but because of its relatively high cost has had very limited use strictly as a miticide. A new dinitro compound, closely related to Karathane, became available for experimental purposes in 1959. This compound, described chemically as 1,1-dimethyl acrylic acid ester of 4,6-dinitro-2-*sec*. butylphenol and given the trade name Acricid, was developed by Farbwerke Hoechst A.G. in Germany. Emmel and Czech (2) state that the mammalian toxicity of Acricid is average, the acute LD50 to rats being 165 mg. per kg. When fed to rats at 200 p.p.m. for 90 days, it caused no harmful effects.

This is a report of laboratory and orchard experiments with Acricid in British Columbia.

Methods

Laboratory Experiments

Stringless green pod beans were grown in four-inch pots, three plants per pot, and only the two primary leaves were allowed to develop. The plants were infested with the McDaniel spider mite, *Tetranychus mcdanieli* McG., or the two-spotted spider mite, *Tetranychus telarius* (L.), by placing on the plants pieces of infested leaves from a stock culture of the mites. The infested plants were placed in a 70°F. greenhouse for four to five days. Then they were sprayed with a compressed air paint gun sprayer until thoroughly wetted. Living and dead mites were counted with a stereomicroscope at intervals after spraying.

Orchard Experiments

Sprays were applied either by a high-volume hand-gun sprayer, or by a concentrate sprayer. The former was operated at 425 p.s.i. and the trees were sprayed until dripping. The latter was a 1955 model "Turbo-Mist" concentrate machine. It applied 50 gallons of spray mixture per acre.

Estimates of mite populations were

[1] Contribution No. 76 from the Regional Research Station, Canada Department of Agriculture, Summerland, British Columbia.

[2] Entomologist.

made by taking a 20-leaf sample from one quadrant of each of five trees per plot. The leaves were processed by the method of Henderson and McBurnie (3) as modified by Morgan *et al.* (4).

Results and Discussion

Laboratory Experiments

On June 4, 1959 Acricid was compared with DNOCHP (DN Dry Mix No. 1, Dow Chemical Company, Midland, Michigan) against the McDaniel spider mite. Three pots of bean plants were used per treatment; mite counts were made four, eight, and twelve days after spraying. Both preparations, at 0.0125, 0.025 or at 0.050 per cent concentration of active ingredient, caused 100 per cent mortality of mites but the Acricid seemed to be somewhat more rapid in its effect.

Lower concentrations were compared against the active stages of the McDaniel spider mite and the results are summarized in Table 1. Acricid at 0.0125 and 0.0062 and DNOCHP at 0.0125 per cent concentration were equal in effectiveness but the two lowest concentrations of DNOCHP gave practically no control of the mite.

TABLE 1.—Average Per Cent Mortality of the McDaniel Spider Mite at Various Periods after Spraying

Miticide	Per cent active ingredient	Average per cent mortality Days after spraying 3	7	12	16
Acricid	0.0125	88	64	78	53
Acricid	0.0062	52	75	73	48
Acricid	0.0031	62	40	29	31
DNOCHP	0.0125	73	70	74	33
DNOCHP	0.0062	38	42	32	30
DNOCHP	0.0031	36	33	28	25
Check—no treatment		12	21	11	16
S.S.R. @ 5% level		31.66	20.80	26.06	16.28
@ 1% level		43.38	28.50	35.71	22.31

Because of their close chemical relationship, Acricid was compared with Karathane (Rohm & Haas Company, Philadelphia, Pa.) in January 1961 against the two-spotted spider mite on bean plants. Table 2 shows that Acricid is considerably more effective than Karathane against the two-spotted spider mite.

TABLE 2.—Average Per Cent Mortality of the Two-Spotted Spider Mite at Various Periods after Spraying

Miticide	Per cent active ingredient	Average per cent mortality Days after spraying 4	9	14
Acricid	0.0125	100	100	100
Acricid	0.0062	100	100	98
Acricid	0.0031	82	100	100
Karathane	0.0125	31	74	82
Karathane	0.0062	22	50	82
Karathane	0.0031	17	8	27
Check—no treatment		16	33	15
S.S.R @ 5% level		21.27	11.93	9.75
@ 1% level		29.15	16.34	13.36

Orchard Experiments

In the first orchard experiment with Acricid, its toxicity to Anjou pear, a variety very sensitive to spray injury, was compared with that of DNOCHP. Acricid 25 per cent wettable powder was applied at two, four, and eight pounds per 100 gallons, and DNOCHP, 40 per cent wettable powder at one, two, and four pounds in the summer with a bucket-pump sprayer. Injury (yellow mottling and browning of the leaves) was evident with DNOCHP even at one pound concentration. On the other hand, Acricid at two pounds caused no injury. At four pounds it produced some yellow mottling and slight necrosis of the foliage. At eight pounds mottling was similar but the necrotic spotting was more obvious.

In the summer of 1959 two orchard experiments were carried out against the European red mite. The first was on mite-infested prune trees to which the spray chemicals were applied by hand-gun sprayer. Acricid, 25 per cent, one pound per 100 gallons gave good control; but one-half pound per 100 gallons was unsatisfactory (Table 3). DNOCHP appeared to be somewhat more effective.

TABLE 3.—Average Numbers of the European Red Mite per Leaf After Spraying Prune Trees by Hand-Gun Sprayer on August 17, 1959

		Average number mites per leaf		
	Amount	Before spraying	After spraying	
Miticide	per 100 gal.	Aug. 17	Aug. 24	Sept. 1
Acricid (25% w.p.)	1 lb.	31.5	0.2	0.2
Acricid (25% w.p.)	8 oz.	40.7	10.7	4.3
DNOCHP (40% w.p.)	5 oz.	34.9	0.3	0.3
Check—no treatment	—	54.1	28.0	0.6

For the second comparison, the two preparations were applied by concentrate sprayer to Newtown apple trees infested with the European red mite. One week after spraying, Acricid applied at eight pounds per acre had reduced the mites from 11.5 to 0.7 per leaf. DNOCHP at three pounds per acre had reduced them from 16.0 to 2.0 per leaf. DNOCHP caused slight injury to Newtown apple foliage.

In 1960 Acricid was applied against the European red mite infesting Jonathan apple trees in the pink bud stage. It was compared with Karathane, 25 per cent wettable powder, and fenson (50 per cent *p*-chlorophenyl benzene sulphonate, Murphy Chemical Company, Wheathampstead, England), a currently recommended "pink-bud" miticide. The preparations were applied with a concentrate sprayer. Seventy-nine days later the average numbers of mites per leaf were:

Miticide	Pounds per acre	Average numbers mites per leaf
Fenson 50%	4	0.1
Acricid 25%	8	1.5
Karathane 25%	6	16.4
Check—no treatment		10.5

Acricid was compared with Kelthane [18.5 per cent bis (*p*-chlorophenyl) trichloroethanol, Rohm & Haas Company, Philadelphia, Pa.] in June 1960 against the European red mite on seedling apple trees. The results of these hand-gun applications are given in Table 4. Acricid at three-quarters or one pound per 100 gallons gave good control as did Kelthane.

TABLE 4.—Average Numbers of the European Red Mite per Leaf after Spraying Apple Trees by Hand-Gun Sprayer on June 28, 1960

Miticide	Amount per 100 gal.	Average number mites per leaf* Before spraying June 27	After spraying July 5	July 12	July 20	July 26
Acricid (25% w.p.)	0.75 lb.	7.4	0.7	0.3	0.4	0.6
Kelthane (18.5% w.p.)	2.00 lb.	4.4	0.0	1.3	0.3	0.2
Check—no treatment		17.6	38.8	34.0**	0.2	2.8

* Based on 50 leaves per plot

** Sprayed with Acricid (25% w.p.) 1 lb. per 100 gal. on July 13, 1960

Kelthane and Acricid were compared again against the European red mite in July, application being by concentrate sprayer to Delicious, Winesap, Jonathan, Newtown, and Stayman apple trees. As indicated in Table 5 both miticides controlled the mite well. Neither preparation caused any foliage or fruit injury.

TABLE 5.—Average Numbers of the European Red Mite per Leaf after Spraying Apple Trees by Concentrate Sprayer on July 26, 1960

Miticide	Amount per acre	Average number mites per leaf Before spraying July 25	After spraying Aug. 2	Aug. 9	Aug. 16	Aug. 29
Acricid (25% w.p.)	8 lb.	17.2	0.6	5.2	1.7	2.3
Kelthane (18.5% w.p.)	10 lb.	13.3	0.4	4.6	1.8	0.6
Check—no treatment	—	6.6	3.9	9.8	11.0	3.8

Summary

Acricid, a new dinitro miticide of moderate toxicity to mammals, was less toxic to pear and apple trees than the older and more hazardous dinitro miticide, DNOCHP. In laboratory experiments against the McDaniel spider mite, Acricid was somewhat more effective than DNOCHP. Against the two-spotted spider mite, it was more effective than a third dinitro preparation, Karathane. In field experiments against the European red mite, Acricid was effective at one pound per 100 gallons in high-volume application and at eight pounds per acre in concentrate spraying, but was not quite as effective as DNOCHP.

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SOME HETEROPTERA NEW TO BRITISH COLUMBIA

G. G. E. SCUDDER[1]

During the course of the past three years, collecting in British Columbia and examination of existing collections have produced a number of Heteroptera not recorded from the Province. Whilst a revised annotated check-list of Heteroptera for British Columbia is in preparation, it is evident that it will be some time before this is complete; it seems worthwhile to record now some of the more interesting new records.

Family PENTATOMIDAE

Sciocoris microphthalmus Flor. Bouchie Lake, near Quesnel, 31. vii. 1959 (G. G. E. Scudder); Wycliffe, 8. vi. 1961 (G. G. E. S.); Cranbrook, 8. vi. 1961 (G. G. E. S.); Sullivan River, Big Bend Highway, 10. vi. 1961 (G. G. E. S.)—abundant on flower heads of Yellow Dryas (*Dryas. drummondii* Rich.); Westwick Lake, Cariboo, 23. vi. 1961 (G. G. E. S.).

Family LYGAEIDAE

Arphnus coriacipennis (Stal.). Vancouver, 21. ix. 1921 (W. Downes); Penticton, 22. ix. 1921 (W. D.); near Olalla, 6. viii. 1959 (G. G. E. S.); Vaseux Lake, 4. vi. 1961 (G. G. E. S.). Ashlock (1961) has recently synonymised *A. tristis* Van Duzee and *A. profectus* Van Duzee under *A. coriacipennis*. He indicates that there appear to be three colour forms of *coriacipennis,* ones with head and pronotum black *(=A. tristis),* ones with head and thorax brownish *(=A. coriacipennis s. str.)* and ones which are quite pale *(=A. profectus)*. At the moment it is not possible to state what causes these colour variations. The specimens from Vancouver, Vaseux Lake and near Olalla are dark forms and those from Penticton are pale. Ashlock records *A. coriacipennis* from California, Oregon, Washington, Nevada, Utah and New Mexico: Utah specimens have been taken on *Juncus balticus*.

Kolenetrus plenus (Distant). Westwick Lake, Cariboo, 1. viii. 1959 (G. G. E. S.), a single brachypterous male. This species was originally described from Guatemala and Bueno (1946) records it from Massachusetts, Connecticut, New York and Arizona: Moore (1950) records it from Quebec. The Westwick Lake specimen was taken by searching among *Juncus* tufts at the edge of the lake. When first captured, I mistook the specimen for an *Acompus,* not only due to its appearance, but also because this is a frequent habitat for *Acompus* in Britain. However, dissection revealed that spiracles on abdominal segments II, III and IV were dorsal indicating that the specimen belonged to the Myodochini; further study indicated that it belongs to the genus *Kolenetrus*. It seems to be conspecific with *K. plenus* (Dist.); this latter species has the fore femora markedly incrassate and with two spines.

Since I at first thought the specimen to be an *Acompus,* I considered that others also might have made the same mistake and that perhaps the record of *Acompus* from British Columbia might really refer to *Kolenetrus*. Barber (1918) recorded *Acompus rufipes* (Wolff) from British Columbia. His record was based on two specimens in the United States National Museum. These were from the collection of P. R. Uhler and one had the data 'Victoria' and the other 'N.R.R.', which Barber (loc. cit.) considered to refer to Northern Pacific or Canadian Pacific of British Columbia.

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Through the kindness of Dr. D. M. Weisman and Dr. Gates Clarke of the United States National Museum, I have been able to borrow and examine the specimen from 'Victoria' mentioned by Barber: Dr. Weisman *(in litt.)* informs me that he is unable to trace the other specimen in the Museum collections.

Examination of the 'Victoria' specimen, a female, shows that this is not *Acompus rufipes* and belongs neither to the genus *Acompus* Fieber nor to the genus *Kolenetrus* Barber. It is in fact a representative of a new Australian genus of which I have seen a number of specimens from New South Wales. Thus I think it is safe to conclude that the 'Victoria' specimen is from Victoria, Australia and not from British Columbia, Canada. *Acompus rufipes* is therefore here removed from the list of Heteroptera from B.C.

Ligyrocoris latimarginatus Barber. Goldstream, 15. ix. 1927 (W. D.). A Pacific coast species recorded from California, Oregon and Washington.

Megalonotus chiragra (Fab.). I have already noted (Scudder, 1960) that this species occurs in British Columbia, but have given no details. Specimens examined are as follows: Duncan, 1. x. 1932 (W. D.); Wellington, 14. iv. 1949 (R. Guppy); Salt Spring Is., 25. vi. 1949 (G. J. Spencer) —on strawberries; University Campus, Vancouver, 14. viii. 1958, 22. ix. 1958, 18. iv. 1959 (G. G. E. S.); Vernon, 5. viii. 1959 (G. G. E. S.); Cultus Lake, 9. v. 1959 (G. G. E. S.); White Rock, 7. iii. 1960 (G. G. E. S.); West Vancouver, 18. v. 1961 (G. J. S.); Creston, 7. vi. 1961 (G. G. E. S.); Sicamous, 11. vi. 1961 (G. G. E. S.); Pavilion, 30. vi. 1961 (G. G. E. S.); Essondale, 25. v. 1961, 1. vi. 1961 (W. Lazorko). I have also seen specimens in the Canadian National Collection from Victoria (G. S. Walley), Mission City (W. R. M. Mason) and Oliver (J. R. McGillis), and specimens are at hand from Seattle, Wash. In Vancouver and on the University Campus, *M. chiragra* in 1959 was very abundant on boulevards. It is possible that this species was introduced into the area in ballast (see Lindroth, 1957: Scudder, 1958): I was in error (Scudder, 1960) in stating that Slater & Sweet (1958) suggested that this was the mode of introduction of *M. chiragra* in the Eastern United States.

Most of the British Columbia material seems to be referable to *M. chiragra sabulicola* (Thoms.) and further to the nominate form of this with both the second and the third antennal segments usually pale in the basal half; for other notes on this complex see Bueno (1946). We may note here that there does not appear to be a significant difference in the dimensions of the scutellum in the various Nearctic and Palaearctic populations, when the difference in wing development and consequent thoracic changes, are taken into account. Measurements made are listed, the ratio scutellum length/scutellum width being given with the standard error of the mean: *chiragra chiragra* from Southern England ♂ 1.28 ± 2.49, ♀ 1.27 ± 2.65; *chiragra sabulicola* from Jersey, Channel Islands ♂ 1.29 ± 3.23, ♀ 1.40 (only 1 specimen studied); *chiragra* from Vancouver, B.C. ♂ 1.28 ± 3.46, ♀ 1.32 ± 1.72.

Stygnocoris pedestris (Fallen). Malahat, 20. ix. 1950 (W. D.); Cultus Lake, 2. ix. 1959 (G. G. E. S.); Lions Bay, Squamish Road, 16. x. 1960 (G. J. S.). This species was first recorded in North America by Barber (1918) from specimens taken in Nova Scotia and New York. It is recorded from Quebec by Moore (1950).

Family TINGIDAE

Gargaphia opacula Uhler. Dog Lake (Skaha Lake), 29. viii. 1946 (W. D.); Vaseux Lake, 4. vi. 1961 (G. G. E. S.); 8 mi. N. of Oliver, 18. v. 1958 (H. & A. Howden) (Can. Nat. Coll.). Also taken by the late W. Downes on *Purshia tridentata* D.C. at Oroville, Wash., 1. vii. 1927.

Teleonemia nigrina Champ. Agassiz, 16. vii. 1933, 23. vii 1933 (W.D.). According to notes left by the late W. Downes, these specimens were taken on *Penstemon menziesii* Hook at 1,000 ft. and on *P. ruficola* and *P. diffusus* Dougl. in rock gardens.

Melanorhopala clavata Stal. Boitano Lake, Cariboo, 30. vii. 1959 (G. G. E. S.); Westwick Lake, Cariboo, 23. vi. 1961 (G. G. E. S.).

Dictyla labeculata (Uhler). Cache Creek, 18. vi. 1959 (G. G. E. S.). This species, formerly listed in the literature as *Monanthia labeculata* Uhler, now must be placed in the genus *Dictyla* Stal. since it has been shown that *Monanthia* Le Peletier is a synonym of *Copium* Thunberg (see Drake & Ruhoff, 1960).

Family REDUVIIDAE

Reduvius personatus (L.). Creston, vii. 1949; Oliver, 26. v. 1945 (D. Blair); Oliver, 9. vii. 1961 (A. T. S. Wilkinson); Vaseux Lake, 12. vi. 1961 (P. Zuk); Vancouver, 19. x. 1960 (P. Z.)—the latter taken as fourth and fifth instar larvae and reared. These insects were fairly abundant in a dockside warehouse in Vancouver.

Family CIMICIDAE

Hesperocimex coloradensis List. (det. R. L. Usinger). Summerland, 16. vii. 1949 (G. B. Rich)—from nest of Red-shafted Flicker *(Colaptes cafer* (Gmelin)*)*. Lattin & Schuh (1959) recorded this rare species from Oregon and note that previous records are from Colorado, Nebraska, California and Mexico. The Oregon material was taken from an abandoned woodpecker nest and the species is usually associated with the Purple Martin *(Progne subis* (L.)*)*. I wish to thank Prof. G. J. Spencer for allowing me to include this record.

Family NABIDAE

Stalia major (Costa). University of B.C. campus, Vancouver, 20. x. 1949 (Orchard); Brighouse, 15. x. 1944 (I. Kosin). Possibly introduced in ballast.

Family MIRIDAE

Pronotocrepis clavicornis Kngt. Rock Creek, 30. v. 1958 (Forest Insect Survey, Vernon)—on *Ribes* sp. Described originally from specimens taken at Ft. Garland, Colorado.

Dichrooscytus suspectus Reuter. Elko, Twin Lakes, viii (F. I. S. V.); Soda Creek, vii (H. R. MacCarthy); Otterhead River, viii (F. I. S.:V); Vanderhoof, vii (F. I. S.:V) — on *Picea;* Topley, vii (F. I. S.:V)—on White Spruce *(Picea glauca)*.

Deraeocapsus fraternus (Van Duzee). Revelstoke, 17. vii. 1925 (A. A. Dennys); 4 miles N. of Moyie, 28. viii. 1942 (F. Hesketh); Garibaldi, 13. vii. 1951 (W. Cottle); Salmo, vi (F. I. S.:V); Christina Lake, vi (F. I. S.:V). The species was described from the Sierra Nevada, near Lake Tahoe, California.

Orectoderus obliquus Uhler. Jesmond, Williams Lake, Canim Lake: specimens in Canadian National Collection, Ottawa.

Family SALDIDAE

Lampracanthia crassicornis (Uhler). Colpitt Lake, Cariboo, 17. vi. 1959 (G. G. E. S.); Westwick Lake, Cariboo, 1. viii. 1959 (G. G. E. S.); Boitano Lake, Cariboo, 17. vi. 1961 (G.G.E.S.).

Micracanthia ripula Drake. Kamloops (G. J. S.); Marble Canyon, Lillooet, v. (J. McDunnough) (Can. Nat. Coll.).

Family HYDROMETRIDAE

Hydrometra martini Kirk. Lytton, 24. vii. 1931, 26. vii. 1931 (G. J. S.).

Family VELIIDAE

Microvelia buenoi Drake. Elk Lake, Saanich Distr., 9. iv. 1926 (W. D.);

Duncan, 4. ix. 1926 (W. D.); Chilcotin, 26. v. 1959 (G. G. E. S.); Oliver, 5. vi. 1961 (G. G. E. S.); Westwick Lake, Cariboo, 14. vi. 1961 G. G. E. S.); 149 mile Lake, Cariboo, 22. vi. 1961 (G. G. E. S.); Williams Lake District, 24. vi. 1961 (G. G. E. S.); found in ponds and sloughs often in association with Duckweed *(Lemna)*.

Microvelia pulchella Westw. Oliver, 6. ix. 1957 (W. D.); Vaseux Lake, 13. viii. 1957 (W. D.); in sheltered waters at edge of lake, behind bulrushes.

Family HEBRIDAE

Merragata hebroides White. Oliver, 15. viii. 1957 (W. D.).

Family CORIXIDAE

Dasycorixa rawsoni Hungerford. (det. I. Lansbury). McIntyre Lake, Chilcotin, 20. x. 1960 (G. G. E. S.)—taken in association with the corixids *Cenocorixa bifida* (Hungerford) and *Hesperocorixa laevigata* (Uhler), the notonectids *Notonecta kirbyi* Hungerford and *N. undulata* (Say) and the dytiscids *Dytiscus ooligbuki* Kby. and *D. cordieri* Aube. *D. rawsoni* was not recorded from the Province by Lansbury (1960) and previously has been recorded only from Southern Saskatchewan (Hungerford, 1948).

Acknowledgements

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ANNOTATED LIST OF FOREST INSECTS OF BRITISH COLUMBIA PART X—NOTODONTIDAE[1]

D. A. ROSS[2] AND D. EVANS[3]

The larvae of this family feed exclusively on broad-leaved hosts, chiefly of Salicaceae and Betulaceae. Several species are commonly found on members of Rosaceae as well. *Datana ministra* and *Schizura concinna* occasionally have been sufficiently numerous to cause noteworthy defoliation.

Notodontid larvae are quite similar to the cutworms, Noctuidae, but usually have more elongate heads. The majority are strikingly marked; most species have prominences. Setae on the upper body are primary, excepting *Datana* and *Ichthyura* which have a light clothing of fine secondary hairs. There are ventral prolegs on A3-6; and the anal prolegs are more or less reduced or modified. The anal prolegs may be held up at rest, and are not used by *Schizura* or *Cerura* for locomotion. The eversible gland on the prothoracic venter is branched on some species. Most notodontids overwinter as larvae in cocoons.

Ichthyura apicalis Walker. *Populus tremuloides* (1). Mile 50 Big Bend Highway. LARVA: head brown, excepting unpigmented configuration about the frons; no swellings apparent; pronotal shield with pair of brown patches; body drab cream-brown; faint dorsal lines. Head and body moderately clothed with fine short white hairs.

Ichthyura strigosa Grote. *Populus tremuloides* (1). Wasa. LARVA: unknown to writers.

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Ichthyura albosigma Fitch. *Populus tremuloides* (4), *Salix* sp. (1), *Alnus* sp. (1). Squilax, Kersley, Marguerite, Prince George, and southern V.I. One from Mile 49 Dawson Rd., Y.T. LARVA: young instars prominently humped, pale green with fine red lines and abdominal segments 1, 3, and 8 also red. Late instars stippled mauve-grey and brown, with indistinct brown lines pale edged; large black spiracles; shallow yellow tubercles, long silvery setae; the head large and mottled.

Ichthyura brucei Hy. Ed. *Populus tremuloides, Salix* sp. (1). Central Interior. LARVA: head black, excepting unpigmented inverted Y above and bordering frons; small transverse swellings on dorsum of A1 and 8, lateral portions of prothoracic shield, small supraspiracular patches, and spiracles, black. Head and body lightly clothed with fine, moderately long, white hairs.

Datana ministra Dru. Yellow-necked caterpillar. *Betula* spp., *Amelanchier* sp., *Crataegus* spp., *Prunus* sp. (1), *Salix* sp. (1). Central portion Southern Interior. LARVA: 1¾ inches; head and body black (body reddish-brown in earlier instars); prothoracic shield yellowish-brown; yellow subdorsal, supraspiracular, subspiracular, subventral and ventral lines; body sparsely clothed with long grey hairs.

Odontosia elegans Stkr. *Populus tremuloides,* Southern Interior, and Cuisson Creek. LARVA: 1¾ inches; head and thorax reddish to yellowish brown, glossy; dorsum of body mottled brown, venter of abdomen cream;

brown prothoracic shield; brown shallow transverse ridges on A2 and A8; brown blotch about spiracles down to prolegs on A3-6.

Notodonta simplaria Graef. *Salix* sp. (3), *Populus tremuloides* (1). Golden, Ochiltree, Lardo, and Burns Lake. LARVA: 1½ inches; head tapered to vertex, stippled with black; body purplish, mottled; pale diagonal lines; conical humps on A2, 3 and 8; faint pale subspiracular stripe running down to tip of ventral proleg on A6. Black above bases of thoracic legs; black double dorsal stripe on thorax and on humps of A2 and 3.

Pheosia rimosa Pack. *Salix* spp., *Populus tremuloides, P. trichocarpa, Betula* sp. Interior B.C. LARVA: about 2 inches; green or yellowish-brown, glossy; horn on A8; black transverse band on T2 and A8, may be broken on the former segment; thoracic legs red; spiracles black, pale-ringed.

Pheosia portlandia Hy. Ed. Vancouver Island. LARVA: unknown to writers.

Nadata gibbosa A. & S. *Betula* spp., *Salix* spp., *Alnus* spp., *Quercus garryana, Populus trichocarpa* (1), *Acer circinatum* (1), *Prunus* sp., *Rosa* spp. General throughout B.C. LARVA: 1¾ inches; head and body pale bluish-green, covered with a bloom; body flecked with yellow laterally; subdorsal stripe, base of prolegs and posterior margin of suranal plate, pale yellow; no protuberances; setae minute; spiracles small, reddish-brown.

Dicentria pallida Stkr. Vancouver Island. Hosts and larvae unknown to writers.

Schizura semirufescens Wlk. *Alnus* spp., *Salix* spp., *Betula papyrifera* (3), *Quercus garryana* (1), *Acer circinatum* (1), *Amelanchier* sp. (1). Southern B.C. and V.I. LARVA: 1½ inches; cream and brown head and body; abdomen may be tinged with green; brown M on head, X between arms; hump at posterior margin of metathorax; elongate forked protuberance on A1 bent forward; forked hump on A5 and 8. White V on A6 and 7.

Schizura ipomoeae Doubleday. *Betula papyrifera, Alnus* spp. (3), *Salix* sp., *Amelanchier* sp. (1). Southeastern B.C. (Jones, 1951, also records it from southern V.I.). LARVA: 1½ inches; brown and green with markings on dorsum of abdomen; a pair of black longitudinal lines on each side of the front of the head, with a reddish-brown X between; thorax green, speckled with brown; broken, reddish-brown dorsal stripe with white edge, split on thorax and diverging on T1; pleura on T1 partly brown; white dorsal patches on A1-4, shield-shaped on A2 and 3 and white broad-based V on A6-7; elongate short-forked tubercle on A1; smaller paired tubercles on A5 and 8. The setae on this species are more prominent than on the other three species.

Schizura concinna S. and A. Red-humped caterpillar. *Salix* spp., *Betula* spp., *Prunus* spp., *Populus tremuloides, P. trichocarpa, Alnus* spp., *Acer glabrum* and miscellaneous other broad-leaved hosts. Southeastern B.C. Occasionally known to completely denude single trees or clumps of trees. LARVA: 1½ inches; head and transverse swelling on A1, a dull red; body glossy, dull yellow streaked with black or reddish-brown; subdorsal, supra- and subspiracular stripes white, edged with black; tubercles black, those on dorsum elongated, the longest on A1.

Cerura occidentalis Lintner. *Populus trichocarpa, Salix* spp. Kelowna, Houston, Vernon, Prince George, B.C., and Carmacks, Y.T. LARVA: body 1½ inches + ¼ inch stemapods; head brown, dark brown bar from ocelli to vertex; body green; dorsal stripe brown-edged with cream, stripe broad at front of T1, tapered to posterior margin of T2, the "abdominal saddle" broadest on A4 where it encompasses the spiracles; brown subventral patches on prolegs of abdominal segments; pair of vestigal subdorsal warts on T1; small slightly bilobed swelling on T2.

Cerura scolopendrina Boisduval. *Salix* spp., *Populus tremuloides*. Southern B.C. and V.I. and two records from Skeena River Valley. LARVA: 1½ inches + 1/3 inch stemapods; head brown, darkest near vertices; body yellow-green; dorsal "stripe" purplish-brown, broad at front of T1, tapered to the posterior margin of T2, slightly interrupted at leading edge of T3. The "abdominal saddle" broadest on A4 where it extends down behind the spiracles; a pair of small subdorsal warts on T1; swelling if present on T2, not bilobed.

Schizura unicornis A. & S. *Alnus* spp., *Betula* spp., *Salix* spp., *Malus* spp., *Prunus* spp. (3), *Amelanchier* sp. (1), *Populus tremuloides*. Southern B.C. and V.I. LARVA: similar to *ipomoeae*. Head light brown with darker brown longitudinal stripes from ocelli to vertices; thorax green, pleura of prothorax partly brown, not joined to dorsal stripe; abdomen light brown and olive green; brown dorsal stripe on thorax, split on prothorax but not diverging; whitish triangular, and truncated triangle-like markings on dorsum of A1-3; narrow-based white dorsal V on A6 and 7; prominent forked tubercle on A1; paired swelling on A5 with vestiges of tubercles; pair of prominent tubercles on prominent swelling on A8.

Gluphisia septentrionis Wlk. *Populus tremuloides, P. trichocarpa*. Vernon, Squilax, 70 Mile House, 83 Mile House, Place Lake, Exchamsiks. LARVA: Head yellow-green with or without black stripe on either side of front; body yellow-green; yellow subdorsal stripe; reddish broken patches on dorsum of thoracic and abdominal segments — excepting A1 and sometimes A2.

The California Tortoise-Shell, **Nymphalis Californica** Bdv., on Vancouver Island

After an apparent absence of eight years this butterfly has again been seen in southern Vancouver Island. It was first noticed on September 8, 1960, and was last seen on October 18. The butterflies frequented highways, sheltered valleys, and slopes, usually flying back and forth, settling occasionally on roads, fences or bushes. While not observed to visit flowers, they sought damp places and over-ripe fruit such as blackberries and apples. A slight tendency to drift eastward was at times indicated but not so noticeably as in 1952.

At least some individuals hibernate here, for one was seen on the warm southern slope of Mount Douglas on January 26, 1961.

Following the immigration of 1952, this butterfly was frequently seen up to April 23, 1953, after which it disappeared. Whether the same pattern will eventuate in 1961 remains to be seen.

—*George A. Hardy, Provincial Museum (Rtd.), Victoria, B.C.*

ADDITIONS TO THE LIST OF CICADELLIDAE (HOMOPTERA) OF BRITISH COLUMBIA, WITH ONE GENUS AND FOUR SPECIES NEW TO CANADA

G. G. E. SCUDDER[1]

In his excellent monograph on the Cicadellidae of Canada and Alaska, Beirne (1956) gives the general distribution of the various species including those known to occur in British Columbia. Too little collecting has been done to allow the exact distribution of the British Columbia species to be plotted so an annotated check-list for the family is premature.

However, it seems worthwhile to record the occurrence in the Province of eleven species not previously noted from British Columbia: four of these and one of the genera are not recorded in Canada by Beirne (*loc. cit.*).

Macropsis occidentalis (Van Duzee). Royal Oak, 7. viii. 1919 (W. Downes); Saanich District, 7. vii. 1919 (W.D.): new to Canada. Recorded from California and Nevada by Breakey (1932) and DeLong & Knull (1945). This is a pale yellow-green to brown species with a black spot on the epimera. Breakey (loc. cit.) who revised the Nearctic *Macropsis*, notes that Van Duzee reports this species from *Salix* sp. In Beirne (1956) it would run to the *virescens* and *viridis* couplets. Breakey notes that *occidentalis* is similar to *M. viridis* (Fitch) from which it differs by having the rugae and punctures more coarse, the epimera with a black spot and the length 5mm. or less. *M. occidentalis* has the pronotum parabolically right-angled anteriorly, but lacks the black spot at the base of the hind tibiae, typical of *M. virescens* (Gmel.).

Thatuna gilletti Oman. Erie, 6. vi. 1961 (G. G. E. S.): new to Canada. Originally described from Moscow, Idaho and hitherto known only from that state and Washington. The genus has not been reported in Canada, and thus does not appear in Beirne (1956). It belongs to the tribe Errhomenellini of which to date only *Errhomus montanus* (Baker) is recorded in Canada from the southern part of British Columbia. *Errhomus* Oman can be separated from *Thatuna* Oman by the fact that the former lacks the numerous fine striae on the crown. In *Thatuna*, the head is short and broad and narrower than the pronotum, and the posterior margin of the pronotum is incised. A full description of the genus and species is to be found in Oman (1938).

Colladonus incertus (Gillette & Baker). Royal Oak, 30. viii. 1949 (W.D.); Saanich, 16. viii. 1952 (W.D.); Duncan, 22. ix. 1925 (W.D.): new to Canada. DeLong & Knull (1945) record this species from the following states—Colo., D.C., Fla., Mass., N.J., N.Y., N.C., N.D., Ohio and Tenn. Nielson (1957) has recently revised the genus *Colladonus* and notes that at the time of writing only female specimens of *C. incertus* were known. He remarks that it is at present placed in *Colladonus*, but states that this is presumably because the female has a spatulate process on the seventh sternum. He considered that since males were unknown, *incertus* should be treated as a species *incertae sedis*. All the British Columbia specimens examined are female. In Beirne (1956) *incertus* keys down with *C. flavocapitatus* (Van Duzee). Nielson (1957) states that *incertus* is similar to *C. waldanus* Ball which Beirne includes under *flavocapitatus*. From the latter *incertus* can be distinguished by having the hemielytra with the clavus brown and the corium with an oblique

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brown dash. Although these markings are distinct, they do not fuse to produce a *montanus*-like pattern. One should also note here that *C. egenus* Ball must be added to the British Columbia and Canada list. Nielson (1957) reports this from Utah northwestwardly to British Columbia, the type locality being Chilliwack, B.C. Recently I have come across a specimen of *C. egenus* with the data Penticton, 22. ix. 1919 (W.D.). This specimen, a male, was easily recognised by the unique falcate, serrate pygofer spine and the long bifurcate processes which are more than one-half as long as the aedeagel shaft. Other British Columbia species of *Colladonus* not considered in Beirne (1956) will be found in the paper by Nielson.

Paraphlepsius eburneolus (Osborn & Lathrop). Penticton, 16. viii. 1920 (W.D.). In Canada, previously recorded only in southern Saskatchewan and Manitoba.

Texananus extremus (Ball). Goldstream, 28. iv. 1926. (W.D.): new to Canada. Crowder (1952) reports this species from Utah, Arizona, Oregon, California and Colorado. The genitalic characters are distinctive in the male. *T. extremus* has the process of the connective as a single shaft (distinguishing it from *T. oregonus* [Ball]) and has the aedeagal shaft very short, the apical half not strongly tapering to apex, the inner margin of plate at apex constricted. In comparison, *T. decorus* (Osb. & Ball), *T. marmor* (Sand & DeL.), *T. arctostaphylae* (Ball) and *T. proximus* Crowder have the aedeagal shaft tapering strongly to apex and sickle-shaped, and the inner margin of plate less constricted. *T. extremus* also characteristically has the ventral shaft of the connective tapering to apex from its base in lateral view. This smallish pale species is also here recorded from Idaho. In the Downes collection, now at the University of British Columbia, are specimens taken by the late W. Downes at Boise, Idaho on 25 July, 1923: they were determined by P. W. Oman.

T. decorus (Osborn & Ball). Midday Valley, Merritt, 5. viii. 1925, 25. viii. 1925, 11. ix. 1925 (Wm. Mathers). In Canada, previously recorded only from southern Ontario.

Fieberiella florii (Stal). Penticton, 11. viii. 1957 (W.D.) — on Virginia Creeper. Beirne (1956) notes that this species occurs in southern Ontario and suggests that it was introduced from Europe, since this is a European species. A similar introduction in British Columbia is probable.

Driotura gammaroides (Van Duzee). Riske Creek, Chilcotin, 26. v. 1959, 30. v. 1959 (G.G.E.S.); 149 Mile Lake, Cariboo, 29. v. 1959 (G.G.E.S.): recorded as widely distributed and locally common in the grassland regions of Alberta, Saskatchewan and Manitoba. Dr. J. P. Kramer *(in litt.)* states that in the United States this species extends as far west as Montana.

Athysanella acuticauda Baker. Riske Creek, Chilcotin, 26. v. 1959 (G.G.E.S); Westwick Lake, Cariboo, 14. vi. 1961; (G.G.E.S.); Pavilion, 30. vi. 1961; (G.G.E.S.); Wardner, 7. vi. 1961 (G.G.E.S.); 149 Mile Lake, Cariboo, 15. v. 1959, 22. vi. 1961 (G.G.E.S.): common on open range land. Beirne notes that in Canada it is widely distributed and locally abundant in the grassland regions of Alberta, Saskatchewan and Manitoba, being also found in southern Quebec.

A. robusta (Osborn). Fort St. John, Peace River, 11. vi. 1959 (G.G.E.S.): taken only on dry grassland slopes of the Peace River canyon. In Canada recorded as widely distributed and locally common in the grassland regions of Alberta, Saskatchewan and Manitoba.

A. occidentalis Baker. Hedley, 4. vi. 1961 (G.G.E.S.): recorded from the grassland regions of Alberta and Saskatchewan.

Acknowledgements

The research for this paper was done whilst in receipt of a grant from the National Research Council of Canada. I am indebted to Dr. J. P. Kramer of the United States National Museum for kindly checking and determining the species listed. Material is in the collections at the University of British Columbia.

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BOOK NOTICE

The Cicindelidae of Canada, by J. B. Wallis. University of Toronto Press, Front Campus, University of Toronto, Toronto 5; 100 pages, 6 x 9 inches, 4 colour plates, halftones, maps, $5.00.

The bright colours and fascinating ways of this small but important group of insects attract immediate attention. Cicindelidae, or tiger beetles, are frequently encountered, but they are difficult to capture, since they are alert and elusive, and still more difficult to identify. This intensive study of the distinguishing characteristics, geographical distribution and variation, and habits and habitats of tiger beetles in Canada—the culmination of the author's main interest for many years—will provide a much-needed reference work. Studies of insect families are scarce, and professional and amateur entomologists alike will find this book a most useful aid in their investigations and a stimulus to further research.

J. B. Wallis, one of Canada's most distinguished amateur entomologists, is an honorary member of the Entomological Society of Manitoba and was one of the founders of the Natural History Society of Manitoba, which awarded him its medal for outstanding work in entomology.

The note above was received from the University of Toronto Press in September. We are pleased to draw the attention of our members to this important new Canadian work.

THE IDENTITY OF THE BLACK-WIDOW SPIDER IN BRITISH COLUMBIA

G. J. Spencer[1]

The genus *Latrodectus* Walckenaer comprises the "Black-Widow" spiders of the United States, though each part of the world where these spiders occur has its own name for them. An abstract of a paper by Levi (1959) as it pertains to the black-widows of this Province, is presented here.

These poisonous spiders are notoriously difficult taxonomically and considerable confusion has arisen from physiological observations on specimens of uncertain determination. All widespread species show variation, and representatives of this genus from neighboring colonies may differ greatly in color or structure. Since the female genitalia and the palpi of the male are required for identification, it is necessary to have large collections of both sexes, especially since the shape of the palpus may be considerably changed after use in transmitting sperm to the female. Immatures cannot be identified with certainty. Fortunately Levi had enormous collections to work over, from large areas of all the continents.

The extreme variation in these spiders is shown by the fact that at least 43 species have been named in the genus; Levi reduces them to six. To illustrate one of the most remarkable characteristics of the genus *Latrodectus,* I shall touch on the very wide and discontinuous occurrence of the six species.

Latrodectus geometricus C. L. Koch is a cosmotropical species reported from the southern United States, especially Florida; the West Indies; Colombia in South America; Saudi Arabia; Kenya, Zanzibar, Madagascar and Capetown; some of the East Indian Islands; Australia; and Spain.

Latrodectus mactans (Fabricius), *The* Black-Widow Spider, is practically world-wide, being reported from the warm areas of all the continents; it has at least 46 synonyms and 5 subspecies and the name *mactans* has been attached to a range of other species. It occurs in warmer parts of the United States but northward only as far as Oregon. It does not occur in Canada and has not been reported in Japan or most of China.

The Canadian species is *Latrodectus curacaviensis* (Müller) 1776, which was described from a female from Curacao in the Lesser Antilles. It has at least 16 synonyms, and in Canada has been called *mactans*. Levi describes its distribution as "the Americas from southern Canada to Patagonia including Galapagos Islands but apparently is absent in Mexico, Central America and Greater Antilles, and is more common in the temperate regions of north and south America. The greater number of *curacaviensis* specimens from northern, compared to southern United States, may be due to the comparative rarity of black-widows *(mactans)* in the northern states. The extreme commonness of *L. mactans* in the southern states probably discourages collectors from picking up black-widows." It occurs in 30 States of the Union, from those just south of the 49th parallel to Florida and New Mexico. In Canada, it has been collected in Ontario from Bruce Co., Dyer Bay; Lambton Co., near Oaksdale; Norfolk Co., Delhi; in Alberta from Medicine Hat; in British Columbia from Kamloops — many collections; Cascade, Wellington, Vernon, Vancouver by Nathan Banks; Summerland and Victoria—many collections. To these can be added the Gulf Islands and Lillooet, where a

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citizen reported it to me in January, 1961 as "occurring in thousands." I have found it on the Douglas Lake Ranch, in the Nicola area, and in Vancouver.

The dorsal abdominal patterns vary considerably, from coal black near the Pacific coast, to nearly white or very pale, with 6 black bars, in the Argentine. The largest males occur in Florida and the largest females in the Pacific States; the smallest males and females are in the Argentine.

Levi gives the habitat of *L. curacaviensis* as trees and shrubs in Florida, where *L. mactans* lives on the ground. In the northern States *curacaviensis* is found in fields and woods underneath logs and stones, usually away from human habitations. In the Nicola area I found its webs abundant in dark areas of horse stables, and in the Kamloops area at 3000 ft. (which seems to be locally its altitudinal limit), in little-used cabins, high on the walls. In Vancouver, I found it in the crawl space under a small house and in a basement at ground level.

The next 3 species are rare. *Latrodectus pallidus* O. P. Cambridge, from the Plains of Jordan in Palestine, differs from *mactans* only in habits and physiology, in its food, the location of its webs, the time of oviposition, the thermal death point and the degree of toxicity of its venom; morphologically, it is similar to *mactans*.

Latrodectus hystrix Simon is found only in Aden and the Yemen, and *Latrodectus dahli* Levi, n. sp., in Bushire, Iran.

This record of *Latrodectus* Walckenaer corrects my note on "The Black Widow Spider, *Latrodectes mactans* Fabr., in Vancouver" in Vol. 57 of our Proceedings, where the spelling was unfortunately taken from a volume on Medical Entomology, and now establishes our local spider as *Latrodectus curacaviensis* (Müller).

Acknowledgment

I am greatly indebted to Professor J. Adams for calling my attention to the article by Herbert W. Levi and for lending me his copy of the Journal in which it appeared.

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EDITOR'S NOTE

Readers and contributors will notice that the papers in this issue are in a new arrangement. This was suggested and discussed at the executive meeting of 9 March, 1961. Papers listed under Taxonomic and General have been scrutinized by one or usually more members of the Editorial Board; those listed under Economic have been subjected not only to scrutiny by three or more members of the Editorial Board, but also in some cases to competent outside referees in appropriate fields. The Board hopes that this policy will enhance the presentation and assure the quality of those important contributions, without narrowing the scope of the Proceedings by excluding papers of general interest.

Contributors will be interested in the following quotations from the minutes of the executive meeting of 9 March, 1961:

"The cost of reprints to authors unsupported by an Institution was discussed. 'Unsupported' authors were defined as those whose reprints are not paid for by the Institute concerned. Such authors if ordering 100 reprints or more, would in future receive 50 of these free and the rest to be charged at the regular price. Such unsupported authors would also in future be allowed two plate blocks free. Any other concessions were left in the hands of the Secretary to decide as best seems fit under the circumstances."

"The format of a reprint order was discussed and the free page allowance to each author per Proceedings was increased from 10 to 12."

DISTRIBUTION OF TRIRHABDA PILOSA BLAKE (COLEOPTERA: CHRYSOMELIDAE), ATTACKING BIG SAGEBRUSH IN THE INTERIOR OF BRITISH COLUMBIA[1]

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Introduction

In 1960 and 1961, distribution surveys were made of *Trirhabda pilosa* Blake, unofficially named the sagebrush beetle, in British Columbia. Interest in this insect centers on its apparent ability to control big sagebrush, *Artemisia tridentata* Nutt. From 1954 to 1961, larvae and adults of this species have attacked the foliage of big sagebrush plants on more than 3500 acres of rangeland in the Kamloops area. About fifty per cent of the plants attacked have been killed.

Big sagebrush normally inhabits overgrazed or otherwise impoverished volcanic soils in the lower and middle grass zones (i.e. 1000-2000 and 2000-3000 foot elevations, respectively) on much of the rangeland in south-central British Columbia. It is considered to be native in the former zone and an invading weed in the latter. In most locations its elimination or retardation would result in improved stands of native grasses.

In July, 1954, Mr. Wm. L. Pringle, Agronomist of the Canada Range Experimental Farm at Kamloops, observed a two-acre stand of big sagebrush which had been severely defoliated. This was near the Lac le Jeune road, about six miles southwest of Kamloops (3). Close examination showed numerous small metallic blue beetle larvae feeding on the leaves of the sagebrush. Adults collected from this site were identified as *Trirhabda pilosa* Blake by Mr. W. J. Brown, Entomology Division, Canada Department of Agriculture, Ottawa (1). This identification was confirmed by Mrs. Blake, who described and named *T. pilosa* in 1931, from specimens taken in California, Nevada and Wyoming (2). She listed *Artemisia tridentata* Nutt. as the host. In British Columbia, an authoritative identification of *T. pilosa* was uncertain for a time, because three other species of *Trirhabda* also have been taken. Specimens of *T. attenuata* (Say) and *T. flavolimbata* Mann. have been collected from the Kamloops area and *T. canadensis* (Kby.) from the Vernon area. The first is very similar to *T. pilosa*.

Careful checking of the Canadian National Collection by Mr. W. J. Brown showed that specimens of *T. pilosa* had been taken in this province at Seton Lake, Nicola, Summerland, and Kamloops. The earliest record was a single specimen taken in the Kamloops area in 1890. Although these records indicate that the insect has been taken from widely separated locations, no early reports have been found which record defoliation of sagebrush similar to that noted by Pringle.

Methods and Results

In 1960 and 1961 surveys were made

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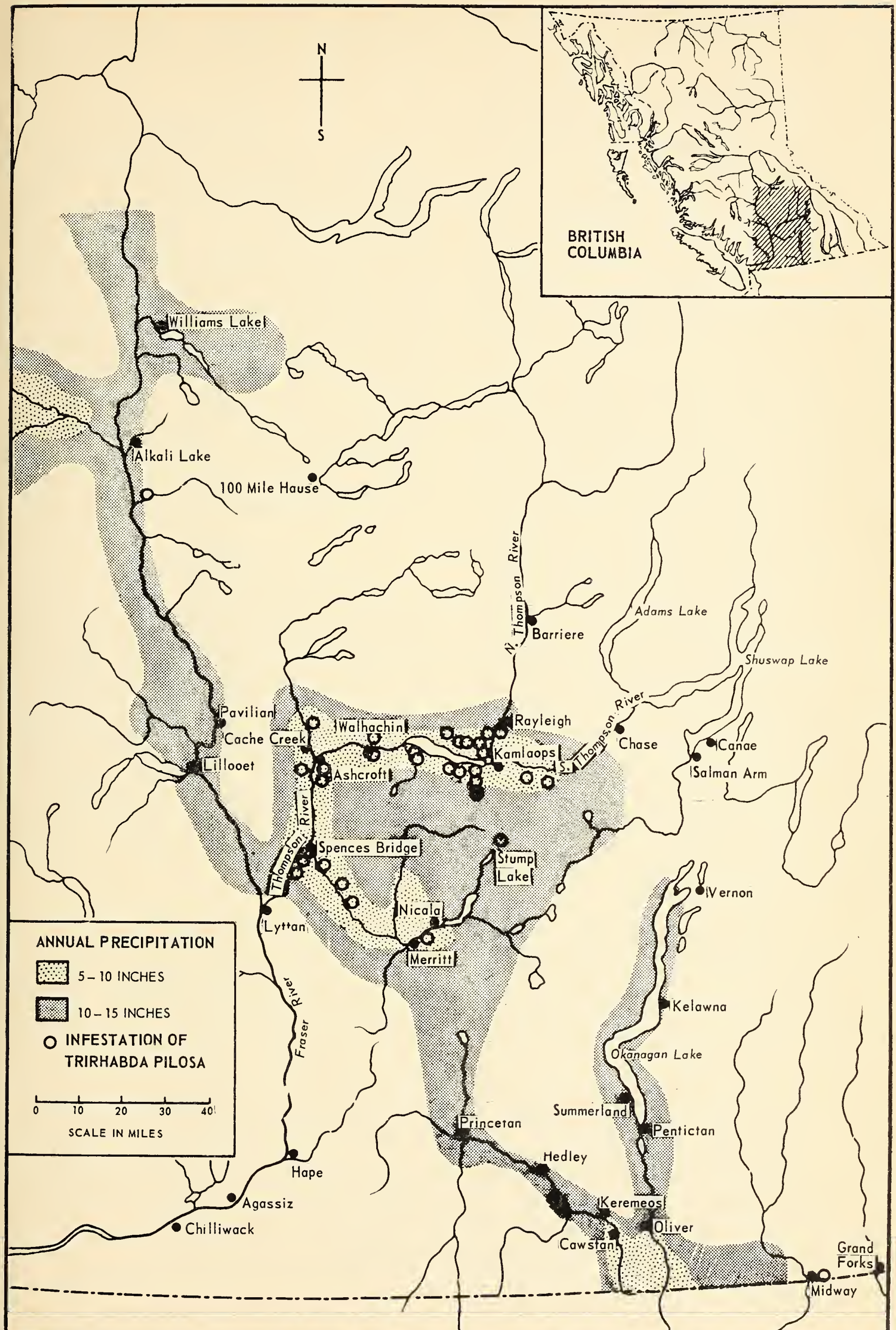

Fig. 1—Distribution of **Trirhabda pilosa** Blake in south-central British Columbia.

of *T. pilosa* in stands of big sagebrush and of areas which previously had been attacked. Active infestations were assessed by recording the numbers of larvae and adults per plant in the following categories:

Very light	—1 to 5
Light	—6 to 15
Moderate	—16 to 50
Heavy	—51 and over

Previously attacked stands of sagebrush were assessed on the basis of apparent damage caused by the insect.

T. pilosa appears to be fairly generally distributed in stands of big sagebrush in British Columbia. (Fig. 1). In most areas infestations of *T. pilosa* were recorded as light or very light and were restricted to fewer than ten sagebrush plants at any one location. The resulting larval and adult feeding on the sagebrush foliage appears to be causing so little damage as to be negligible. Single moderate infestations of one-quarter and two acres, respectively, were recorded at Merritt and Keremeos. Three light, one moderate, and four heavy infestations from four to 300 acres were recorded at Kamloops. There, three previously attacked stands of sagebrush ranging from 80 to 1500 acres were recorded as heavy. The heavy infestations indicate that stunting and death of big sagebrush will continue at Kamloops.

Discussion

To date, the sudden increase of *T. pilosa* has not been satisfactorily explained. It has been postulated that a new physiological strain may have developed, or that a hybrid may have developed from a crossing of two *Trirhabda* species present in the area. A single factor such as greater longevity of the adults and therefore greater fecundity, or particularly favourable environmental or host plant conditions, might explain the heavy feeding damage which has resulted in killing some big sagebrush.

Summary

T. pilosa Blake appears to be generally distributed in stands of big sagebrush, *Artemisia tridentata* Nutt., in south-central British Columbia. In most areas foliage feeding by light infestations of this insect has caused little or no apparent damage. However, in the Kamloops area, feeding by heavy infestations has killed or severely retarded the growth of big sagebrush on more than 3500 acres of rangeland.

Acknowledgement

The author acknowledges with thanks the assistance of W. A. Low, Student Assistant, who helped with the 1960 survey; and Wm. L. Pringle, Agronomist, Range Experimental Farm, Kamloops, who located and provided information regarding certain **T. pilosa** sites, and identified plants. The guidance and editorial assistance of Dr. R. H. Handford, Officer-in-Charge of this laboratory, are also gratefully acknowledged.

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HISTORY OF MOSQUITO CONTROL IN BRITISH COLUMBIA

C. L. Neilson[1] and L. C. Curtis[2]

As early as 1856, J. K. Lord (7) collected mosquitoes in the Lower Fraser Valley of British Columbia and made pungent remarks on their abundance and habits. His determinations, however, were generally faulty. The first careful study of mosquitoes in the province was by H. G. Dyar (1) who visited the Kootenay district and Vancouver Island in 1903. In 1919 he made a journey through the northern part of the province, and collected from Prince George to Atlin (2). From 1899 to 1919 Fletcher, Trehearne and Hewitt made collections, all of which appear to have been submitted to Dyar for determination and publication.

In 1919 Hearle began a study of mosquitoes in the Fraser Valley in response to a request from the municipalities of the lower mainland for a mosquito control programme. In 1920 he published a preliminary report of his findings (4). This work concluded with a full report published by the National Research Council (5) and a published list of the mosquitoes of British Columbia (6). Within two years of the establishment by Hearle of the Livestock Insect Laboratory at Kamloops in 1928, mosquito control programmes were started at Kamloops and Kelowna. Interest in controlling mosquitoes grew over the next 15 to 20 years until by 1948 Gregson (3) reported that twenty-four communities were practising mosquito control. Since 1948 L. C. Curtis has continued mosquito investigations at Kamloops and has acted as a technical adviser. Since 1953 C. L. Neilson has collaborated with Curtis as technical adviser and encouraged Provincial Government participation.

The number of projects varies somewhat from year to year. This is largely because adequate control has not always been achieved on account of lack of funds or loss of key personnel in the district. At present there are twenty-five cities, towns, or districts actively engaged in mosquito control.

The largest control district in the province is that of the Fraser Valley Mosquito Control Board, which consists of the Municipal Districts of Richmond, Burnaby, Maple Ridge, Pitt Meadows, Coquitlam, Surrey, Langley, Matsqui, Mission, Kent, and Chilliwack, together with the City of Mission and the Village of Harrison Hot Springs. The annual expenditure is about $25,000.

In the Interior, the cities of Revelstoke, Kamloops, and Kelowna spend approximately $3,000 annually, while the Penticton budget is near $1,800. All have been engaged in mosquito control for about thirty years. Other cities doing control work include Kitimat, Prince George, Quesnel, and Grand Forks. Of the smaller centres, Merritt, Clinton, and Salmon Arm are active.

Other mosquito control work is carried out by the following organizations: Barriere and Louis Creek Mosquito Control Association, Little Fort Mosquito Control Board, Central North Thompson Board of Trade (Birch Island - Clearwater), Lower North Thompson Mosquito Control Committee, Sicamous Mosquito Control Committee, Solsqua Farmers' Institute, Malakwa Farmers' Institute, Arrowhead Chamber of Commerce, Wasa Mosquito Control Committee, Christina Lake Community Club, and Falkland-Westwold Board of Trade.

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It is expected that new control organizations will operate at Spences Bridge and in the Invermere district.

Areas that conduct sporadic control include Argenta, Golden, Norgate Park in North Vancouver near the First Narrows Bridge, Oliver, and Savona.

Control measures now consist mainly of larviciding with 1 per cent DDT in oil at 2-3 gallons per acre or with DDT in gelatine capsules ("Tossits")[3] or treatment of breeding areas before hatching with five per cent granular aldrin or heptachlor at 1-2 pounds per acre.

Larviciding by the use of aircraft is carried on as a regular practice in the Fraser Valley, and at Kitimat, Kamloops, the North Thompson Valley, and a few smaller areas as the occasion demands, and as money is available. Engine-equipped ground sprayers for both larviciding and adulticiding are used at Penticton, Kelowna, Kamloops, Revelstoke, Kitimat, Louis Creek-Barriere, Clinton, Sicamous, and Grand Forks. Similar equipment was used by the Fraser Valley Mosquito Control Board in 1961. Other ground work is largely done by knapsack sprayer, granular insecticides, or "Tossits." However, insecticide-treated sawdust is still used, and a few aerosol generators are operated from the exhaust of jeeps, trucks or tractors.

[3] Wyco Inc., West Palm Beach, Fla., U.S.A.

Financing of the various control operations has been largely by city grants, or in smaller communities by fund-raising activities and gifts. The Fraser Valley Control Board operates on funds contributed by the various bodies on a population basis, and the Federal and Provincial governments make annual contributions. The Provincial Department of Agriculture has for the last two years made very small annual grants to ten of the widely scattered rural districts in order to encourage their efforts. The grants afford the Provincial Entomologist an excellent opportunity to work with the communities to improve their techniques.

In conclusion, it is our belief that the time has come for Provincial legislation under which control areas may operate, raise funds in an orderly manner, finance the purchase of heavy equipment, and provide continuity of employment for skilled workers. It would give workers the right to entry upon lands for the abatement of mosquito nuisance, and protect individual workers from damage claims. At the same time, it would give affected property owners and ratepayers a voice in the direction of operations.

A further desirable development would be an association of mosquito control workers to provide means for administrators and operators to discuss the many mutual problems that may arise in this difficult field.

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NOTES ON THE LIFE HISTORIES OF FOUR MOTHS FROM SOUTHERN VANCOUVER ISLAND (LEPIDOPTERA: PHALAENIDAE AND GEOMETRIDAE)

George A. Hardy[1]

Orthosia pulchella algula Sm.

This species has an expanse of 35 mm., the primaries of uniform fuscous brown with a faint purplish reflection, the secondaries a dark smoky brown. Compared with some members of the genus it is somewhat scarce in my experience; I have taken only two specimens in more than ten years of study. The caterpillar very closely resembles that of *O. transparens* Grt. A specimen captured at light, at Royal Oak, on March 27, 1959 had laid 135 ova by March 30, in a close-set, single-layered batch on the side of the container.

Ovum

Size 1.0 mm. by 0.75 mm., a slightly depressed hemisphere with about 40 vertical ribs, the edges of which are closely indented, giving a bead-like appearance; pale cream, gradually becoming darker as development proceeds, with an orange dot on the micropylar area and an orange ring about midway. On a few ova the orange was replaced by dark purple. Hatched April 22.

Larva—1st Instar

Length 2 mm. Head pale brown. Body sordid white, translucent, with short, scattered hairs. They did not eat the chorion. They nibbled reluctantly at willow leaves, but not until most of the larvae had died was it found that *Arbutus menziesii* is one of the preferred food plants.

2nd Instar

May 8. Length 6 mm. Body pale chocolate-brown, with thin white dorsal and subdorsal lines, tubercles black and conspicuous.

3rd Instar

May 15. Length 12 mm. Appearance similar to first instar.

4th Instar

May 25. Length 18 mm. Head small in proportion, reddish-white thickly covered with white dots having black centres. Body red-purplish-brown, finely vermiculated with white; dorsal line indicated as a white dash on the centre of each segment; one or two very fine whitish lines just above the spiracular line, which is hardly discernible as a pale band; the tubercles black, white bordered.

May 31. Length 20 mm. Head whitish, tinged with purple, the vertex and sides brown, the latter mottled with lighter brown. Body smooth, dark purplish-brown, finely irrorated with a lighter shade; dorsal line white, and broken; subdorsal lines very faint, whitish; the tubercles black, white on the outer sides; underside, legs and claspers concolourus with upper side. They fed well on arbutus. When disturbed they snapped the head and forebody vigorously back and forth, and emitted an oral fluid when irritated. Noticeably geotropic.

5th Instar

June 6. Length 25 mm. Head as described. Body thickly flecked with fuscous and luteus dots on a background of flesh-colour; cervical plate dark brown, centred with a white continuation of the dorsal line; dorsal line white and broken; spiracular line dark grey, inconspicuous; legs pale brown; underside and claspers flesh colour. Full-grown by June 10.

June 17. Larvae burrowed into the earth in the jar, where they spun strong cocoons.

Pupa

Size 18 mm. by 6 mm. Smooth, shiny, dark brown. Cremaster two fairly stout spines, with slightly curved tips and 2 or 3 minute curl-

[1] Provincial Museum, Victoria, B.C. (Rtd.)

tipped hairs at the base, set upon the smooth tip of the last segment.

Imago

Emerged March 25, 1960.

Pleroma obliquata Sm.

Four species of the genus *Pleroma* are listed by Jones (1951) for British Columbia, three of which have been recorded from Vancouver Island. All seem to have a western American distribution.

They are medium sized moths with densely hairy bodies, a wing expanse averaging 35 mm., and are coloured in various shades of ash-grey, often in striking contrast. They come readily to light, but hide by day where their colour and markings render them almost indistinguishable from their surroundings.

A female *P. obliquata,* taken on April 4, 1959, had laid 25 ova by April 10.

Ovum

Size 1.0 mm. by 0.75 mm., obconical, strongly ribbed and cross-ribbed, cream at first, turning darker in a day or two, with a purplish-lead tinge, heavily streaked, and blotched with dark brown, chiefly between the ribs of which there are about 40. Became a dark plumbeous colour at maturity. The eggs hatched on April 27.

Larva—1st Instar

Length 2 mm. Head light brown, shiny. Body, a dark grey with short scattered hairs. Rested with thoracic segments raised sphinx-like. It fed on wax-berry, *Symphoricarpos racemosus.*

2nd Instar

May 2. Length 5 mm. Similar in appearance to first instar but darker in colour.

3rd Instar

May 6. Length 7 mm. Head dark, piceous brown. Body slender, humped on A. 8, greenish-grey with a broad whitish dorsal line, narrower subdorsal lines and supra - spiracular lines, a broad spiracular line, the cervical plate dark brown. Hump on A. 8 brown, legs brown, spiracles black; tubercles black, each bearing a short black seta.

4th Instar

May 10. Length 10 mm. Head light orange-brown. Body dark olive, lighter on the sides, with a broad white dorsal line ending on A. 7, narrow subdorsal and supraspiracular lines, A. 8 and 9, with a transverse white dash. Spiracular line broader than the subdorsals but not so wide as the dorsal line; underside darker than dorsal side.

5th Instar

May 20. Length 20 mm. Head honey-brown with suffused dark vertical patches on each side, shiny and with a few long thin hairs. Body with a dark chocolate band on dorsum containing a broad white dorsal line; dorsal line edged with black and threaded along the centre with a thin, interrupted, greenish line; sides dark cinnamon with several very thin whitish lines; orange spiracular line only evident on A. 7, 8, and 9; spiracles white, ringed with black; hump on A. 8 dark chocolate with a transverse white bar. Underside greyish with many longitudinal, rather faint, darker lines.

6th Instar

May 27. Length 30 mm. Head grey with a broad, dark brown, vertical bar on each side. Body brownish to reddish grey, with a broad fuscous band on the dorsum containing the white dorsal line with an orange, or rust-coloured, suffusion; sides light grey, spiracular line not well marked except on A. 7 to 9, where it showed as a dark band containing the white spiracle. A. 8 humped, with a dark patch on dorsum edged behind with a transverse white line.

By June 2 the larva was full-grown. The body tapered towards the head, which was held straight out and looked like a part of the body, since the subdorsal lines continued along the side of the face. The dark dorsal band, containing the dorsal line, was constricted between segments, giving a wavy appearance to the band as a whole.

June 10. In the moss at the bottom of the container the caterpillar had constructed a tough, papery cocoon in which fragments of debris were incorporated.

Pupa

Size 15 mm. by 5 mm. Cylindrical, smooth, dull, and piceous. Abdominal segments with small, raised, irregular striae on the anterior margins; cremaster two very short, stout, divergent horns on a slightly rugose, conical base at the end of the last segment.

Imago

Two adults emerged on February 22, 1960, and five more on the next day.

Behrensia conchiformis Grt.

This distinctive moth has an expanse of 30 mm. The primaries are light grey with a dark central band containing a conspicuous white spot; the secondaries are light grey with a wide fuscous margin. It is usually taken at light during April and early in May.

A batch of ova was obtained on May 3, 1960, scattered singly on the sides and bottom of the container.

Ovum

Size 1.0 mm. by 0.75 mm. A truncate cone, with about 24 vertical ribs that produce iridescence according to the incidence of the light; white, gradually developing minute dark dots, chiefly on the upper part, some of which tend to form an indistinct ring round the upper third. Hatched on May 12.

Larva—1st Instar

Length 3 mm. Head opaque, white. Body opaque, dull white. They consumed the chorion, and were very active, looping like geometrid larvae. After trying several plants *Symphoricarpos racemosus* was accepted.

2nd Instar

May 19. Length 5 mm. Head as described, with small black dots bearing setae. Body bluish-green from the food ingested; subdorsal and supraspiracular lines indicated by faint dark lines; spiracular line bluish-white, bordered by thin dark lines; A. 8 slightly humped. Rested with the head extended in line with the body on the edge of a leaf or along a stem, where they were difficult to detect at a glance.

3rd Instar

May 26. Length 15 mm. Head pale bluish-white, streaked with light brown, with sparse, coarse hairs. Body slender, with a slight hump on A. 8, pale bluish-white; dorsal line faint, double, milky-white; the sides lighter than the dorsum, with 3 thin pale brown lines; spiracular line white; underside sordid white with a light brown spot on the centre of each segment; legs and claspers colourless, outer side of claspers with several black dots.

May 29. Length 18 mm. Head pale whitish-brown speckled and streaked with light brown. Body grey-green, faintly marked with a double, milky-white dorsal line; below this on each side, four very thin whitish lines; underside pale grey-green streaked with beige; tubercles very small black dots, each bearing a seta.

4th Instar

June 1. Length 22 mm. Head beige, dappled with light brown. Body greyish, with ochre tinge on dorsum; darker on sides; dorsal line a faint, creamy double line coalescing on A. 7 and 8, the latter slightly humped with fleshy processes on each side, each bearing a seta at the tip; three or four thin,light lines above the spiracular line which was indicated by a thin line on which were the small, white, black-rimmed spiracles; three or four thin, light lines below the spiracular line; underside paler than dorsal side; claspers with black dots on the outer sides.

June 4. Length 30 mm. When at rest they lay straight along stems which they superficially resembled, resulting in perfect camouflage.

June 10. Length 45 mm. The larvae full-grown. Head greyish, resulting from light brown freckles on a beige base. Body light brown with a faint tinge of ochre; sides lighter; dorsal line milk-white with a suffused brownish thread down the centre, more decided on A. 8 and 9, where it continued between the two short, seta-bearing papillae; spiracular line similar to the dorsal line, edged above with black on which were the spiracles; underside pale with several fine lines.

June 18. Pupated in cocoons spun on the leaf surface. Comminuted fragments of leaves were incorporated in the cocoon, which blended into the background as a result.

Pupa

Size 15 mm. by 4 mm. Cylindrical, tapering off for the last two or three segments; semi-glossy; the wing-cases minutely wrinkled; anterior part of the segments closely and coarsely punctate; dark brown, with a fuscous shade on the wing-cases. Cremaster two very minute, widely spaced divergent projections on an elongate, rugose, conical base.

Stamnodes blackmorei Sweet.

This small geometer has an expanse of 21 to 27 mm., and is of somewhat subdued colouration. It is pale cream with a satiny lustre, the primaries with some light brownish patches, chiefly along the costa and tips. In females these patches extend over the wing, with a noticeable U-shaped one on the middle third. The secondaries are devoid of markings on the upper surface but below have two brownish spots, one on the inner margin, the other near the anal angle.

My attention was drawn to the early stages when several larvae were found feeding on waterleaf, *Hydrophyllum tenuipes,* at Goldstream, in May, 1958.

In July, 1958, ova were obtained from several specimens but none hatched. On April 28, 1960, larvae in nearly all stages of development were taken by sweeping the food plant. From these the following sequence was worked out.

Ovum

Size 0.75 mm. by 0.50 mm. An obtuse oval, smooth, with very obscure microscopic reticulations; chalky-white to pale cream. They were laid loosely, or so weakly attached to a leaf as to be easily shaken off. Three batches consisted respectively of about 30, 20, and 27 ova. They were laid from July 3 to 5. A few ova were obtained on August 6, 1960.

Larva—1st Instar

Length 2 mm. Head green. Body semi-translucent, green, without markings.

2nd Instar

Length 5 to 10 mm. Head smooth, shiny, whitish-green, semi-translucent. Body pale green, subdorsal lines, supra-spiracular and spiracular lines thin and yellow, with several fine, broken lines between; a decided fuscous bar along the dorsum of A. 8 and 9.

3rd Instar

Length 18 mm. Head pale green. Body apple green, subdorsal, supra-spiracular and spiracular lines indicated by irregular rows of whitish dots; A. 8 and 9 with a strongly marked fuscous bar along the dorsum; inter-segmental rings yellow; spiracles black; tubercles minute, black on white bases, seta-bearing; underside pale green; body noticeably constricted between the segments.

4th Instar

Length 22 mm. Head pale brownish-green, dotted with black in four indistinct, vertical lines. Body green;

dorsum of segments with sagittate fuscous marks pointing forward, accentuated on A. 7 to 9; subdorsal lines thin, yellowish; spiracular area whitish with margins blending into the ground colour; spiracles black.

Some larvae had the sagittate markings widened to extend over most of the dorsum, with the ground colour sometimes very dark brown; the underside chocolate brown.

When at rest they lay curled up on the underside of the leaf, dropping to the ground if disturbed, or occasionally, when only slightly alarmed, raising the fore part of the body sphinx-like.

May 5. Pupated in a slight cocoon at the bottom of the container.

Pupa

Size 8 mm. by 3 mm. Smooth; the abdominal segments strongly punctate; green at first gradually changing to brown; the cremaster two divergent, stout, very short spines at the tip of a flat projection on the dorsal side of the last segment.

Imago

Two emerged on June 1, one on June 6, and one on June 9, 1960.

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A RECORD OF SLUGS IN VANCOUVER GARDENS

G. J. Spencer[1]

At the end of August 1959 we moved to another house in West Point Grey and before long it was evident that slugs were common in the garden. In the 18 years that we lived in the previous house, I had found and slain 6 slugs only so I asked the previous owners of the new house if they had been troubled by slugs and was told that they had seen less than a dozen. With a flashlight I collected and killed an uncounted number in the autumn of 1959, and throughout the season 1960 I estimated that I took between one and two thousand without seeming to reduce the population.

As soon as the creatures emerged from hibernation in March, 1961, I kept track of the numbers taken and from their first appearance to 29 July, I obtained 3158 slugs and 49 snails, collected as follows: March, 73 slugs and 8 snails; April, 558 and 12; May, 1271 and 15; June, 654 and 10; July, 602 and 4. By the middle of June the small native species of slugs began to appear, so for 2 weeks in June and 4 weeks in July, they were counted separately. They totalled 357 large and 681 small; of this number of the small species, 320 were taken on July 5 after 24 hours of pouring rain.

These slugs and snails were very kindly identified for me by Mr. R. J. Drake, Malacologist and Archaeologist with the Canadian National Museum who is currently working out from this University.

They fall into two groups: those that have come in from Europe and are rapidly reaching outbreak proportions, and our native species. Of the former, *Arion ater* (Linne) is by far the most common of the large, 3-inch slugs occurring locally and is in two forms: uniformly shiny black, and dark or light brown. They are the earliest to emerge from hibernation and feed on the new shoots of a number of garden plants, largely iris and daisies. An even larger slug occurring in much smaller numbers is *Limax maximus* Linne which is thin and long, reaching 5 inches when fully expanded. It is conspicuously spotted around the head end, with 3

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rows of black spots down the body. It occurs in one corner of our garden only, near the compost heap. This species has long been in western North America but originally came from Europe. The third immigrant is the snail, *Cepaea nemoralis* (Linne) which has a wide range of color patterns from uniformly yellow or yellow and brown, to having three wide or narrow conspicuous black lines following the spiral. This snail climbs high up on vegetation at night and hides on the ground by day.

The second group, of native species occurring locally, includes the largest of all, *Ariolimax columbianus* Gould. This reaches a length of over 6 inches and is brown or green with large or small irregular black blotches on the back, sometimes so close together as to make the slug look black. It is the chief slug of Stanley Park woods, to be found anywhere along the walks or paths. It occurs mostly in gardens that have recently been dug out of the bush and has not turned up so far in my garden.

Another native species is the little pale brown, grey, or dirty white *Derocerus reticulatus* (Müller) which is 1 to 1½ in. long, fully expanded. This slug does not show up until June but probably starts earlier in the season and is overlooked on account of its size. It seems to be largely a grass feeder but climbs iris, gladiolus and montbretia leaves and rasps off the upper epidermis. It occurs rarely on fine warm nights but swarms out during and after rain.

The size of this population in one garden is remarkable. Our lot is the average for this street, being 60 x 120 ft. from sidewalk to rear lane. In front, the property has a lawn on each side of the concrete approach and a flower bed against the house. At the back, 18 feet is taken up with a concrete drive to the garage under the house and the rest consists of lawn with a flower bed 4 ft. wide on three sides. At irregular intervals I patrolled the territory with a flashlight, following the same course every time and counting only the specimens that occurred on my property. Last summer I must have killed well over 1000 slugs and yet the count is over 3000 this year up to the end of July. The previous owners were apparently unaware of this infestation and it is remarkable that there was any garden left at all. Some of the slugs undoubtedly moved from the garden next door where the vegetation is rather rank.

The Control of Snails and Slugs

Snails at the present are scarce and occur singly; they are readily crushed under foot.

Slugs are favoured by rank growth either in garden beds or in brush alongside; therefore clean cultivation keeps down their numbers.

Salt sprinkled over a slug's body produces a tremendous outpouring of slime and kills it fairly rapidly. If insufficient salt is used, the slime keeps off the salt and the slug moves away.

Fifty or so slugs in a basin, shaken up with an ounce of gasoline, die almost immediately; even the fumes of gasoline in an enclosed space, will kill them.

The standard commercial bait of metaldehyde and calcium arsenate, in pellet form, is extremely effective; poisoned slugs seldom move more than one foot from the bait.

I have found that a pound of fish cat food mixed with an ounce of calcium arsenate or white arsenic, is very attractive to slugs. The mixture should be rubbed on the sides and bottoms of empty cans and the tops squeezed nearly flat so that cats and dogs cannot get at the bait but slugs can creep in between the edges. This costs 10c per tin for cat food and a variable amount for the arsenic and is the cheapest bait that I have evolved so far.

THE GROWING PROBLEM OF POLLINATION IN BRITISH COLUMBIA FROM THE POINT OF VIEW OF EXTENSION ENTOMOLOGY

J. C. Arrand[1] and J. Corner[2]

Extension work in the field of pollination, even with the large amount of research information available (Bohart [1960], Free [1960], Todd & McGregor [1960]), is difficult. The effects of adequate pollination are only realized when yields over a period of several years are considered. The results of a single field demonstration may be obscured by uncontrollable factors, such as weather, the general physiological condition of the plant, competing bloom, or the population level of wild pollinators. As a result, an important extension tool is often rendered ineffective. Furthermore, because of the complexity of the problem, many growers develop the attitude that with or without pollinators successful yields are largely a matter of chance. For example, the yields of legume seed in the Peace River district of Northern British Columbia fluctuate considerably from year to year. The yields of crops that are adequately pollinated tend to be higher than the district average. However, the fact that the variability is general suggests to many growers that the success or failure of the enterprise lies outside their control.

In some areas a reasonable wild or honey bee population exists and the growers obtain fair or good yields of self sterile crops without any special effort. Under these conditions it is difficult for the individual to accept his responsibility for preserving the pollinators. It is even more difficult for him to realize that an increase in the number of pollinators could result in increased yields, better quality and more even ripening.

[1] A/Provincial Entomologist, Vernon, B.C.
[2] Provincial Apiarist, Vernon, B.C.

The fruit- or seed-grower and the beekeeper often fail to understand each others' problems. The beekeeper in the Okanagan may feel that the orchardist is spraying dangerous insecticides unnecessarily and indiscriminately. The seed grower in the Peace River district may feel that the beekeeper is getting something for nothing and should pay for putting bees near the field. Bringing these two groups to a common point of understanding is a major part of the extension program in pollination.

A discussion of the program in British Columbia including what has been done, future plans and where research can help, is best considered under the main crops involved.

LEGUMES

Several methods have been used to give growers the facts on legume pollination. For the past three or four years considerable information has been included in the annual short courses in beekeeping in the Peace River district, and meetings for beekeepers and seed growers have been held. Several formal addresses have been presented to the British Columbia Seed Growers Association and to the British Columbia Honey Producers Association. An exhibit on pollination was prepared and exhibited at fall fairs. Two pamphlets, "Insects and Legume Seed Production" and "Clover Seed Growers, Why Gamble? Use Bees", have been written and distributed. A successful demonstration, described in this paper, of planned pollination of alsike clover has been conducted.

Alfalfa

In Canada the economic production of alfalfa seed depends on the population level of certain species of wild bees. Honey bees are able to obtain nectar by going into the side of the flower and consequently they "trip" only a small percentage of the flowers visited. They obtain pollen from other sources. Extension efforts to conserve wild bee nesting sites have been almost helpless against the economic facts which demand that the grower clear and break more and more land so that cash crops can be planted. The result has been that alfalfa seed production in the Peace River district has followed the familiar trend described by Stephen (1955). As the acreage increases the yields drop, growers are forced to turn to other crops, and alfalfa becomes confined to the hinterlands.

Future extension programs will probably depend on one or more of the following developments:

A. Establishing areas for alfalfa seed production where the wild bee population can be conserved.

B. Developing practical methods of semi-domesticating wild bees.

C. Finding ways of forcing honey bees to pollinate alfalfa under our conditions.

In the meantime extension efforts will have only a very limited effect.

Alsike and Sweet Clover

Alsike and sweet clover are readily pollinated by honey bees and are good nectar sources. Consequently more extension progress has been made in the pollination of these crops than in the pollination of other legumes. An increasing number of seed growers in the Peace River District are realizing the value of honey bees on alsike or sweet clover and are urging beekeepers to put colonies near their fields. They are not yet, however, willing to pay for the bees either in cash or on a share crop basis. The beekeeper is therefore necessarily concerned only with honey production, consequently he tends to use insufficient colonies for good pollination. Furthermore, he brings the colonies in before the fields are in bloom and does not space them — factors which greatly influence their effectiveness. It is important that the alsike or sweet clover seed grower and the beekeeper fully appreciate each other's position.

As a part of the extension effort a demonstration of alsike pollination was conducted in the Peace River district of Northern British Columbia:

On July 18, 1960, at Mile 24 Alaska Highway, forty colonies of honey bees were set out in 65 acres of alsike isolated by about 3 miles from other legumes. This acreage consisted of three adjacent fields of 20, 30, and 15 acres respectively. The colonies were spaced evenly around the centre 30 acre field.

By early September the seed had ripened evenly on all three fields. An average of 450 lb. of clean seed per acre was harvested as compared to an estimated district average of 250 lb. per acre. The most impressive feature was the appearance and quality of the seed.

It is interesting to note that the honey yield was 160 lb. per colony. The district average was 150 lb.

Red Clover

Red clover pollination presents several special problems. Although certain species of bumble bees are ideal pollinators, they are seldom present in large enough numbers except in newly settled areas. It has been pointed out elsewhere in this paper that attempts to conserve wild bee populations have generally proved futile. Honey bees are good pollinators of red clover if they are used in large enough numbers and if competing bloom is kept to a minimum (Bohart 1960). Unfortunately, beekeepers avoid putting colonies on red clover because it is an unreliable nectar source. The use of honey bees on red clover has to be consciously and specifically for pollination. Consequently, widespread acceptance of planned pollination on red clover will probably come only after it is an accepted practice on sweet or alsike clover.

FRUIT TREES

There is a large amount of research information on tree fruit pollination (Free 1960). However, the fact that little of the research has been conducted in British Columbia is a serious handicap to the extension worker.

Where the need for increased pollination is obvious, as with plantings of Red Delicious apples, cherries, and pears, certain fundamentals can be applied. For example, it is well known that honey bee colonies should be brought in after and not before the beginning of bloom. Several other questions are, however, impossible to answer. What is the value of hand collected pollen? Are beehive inserts more effective than hand applicators? How should honey bee colonies be spaced in the orchard? What are the effects of prevailing winds in pollination? In many cases the information from different areas on these questions is not in agreement.

The importance of pollination is sometimes unclear. McIntosh apples, for example, generally have an over-set of fruit. With this variety, however, would there be an improvement in quality and evenness of ripening if the king blossoms were set up quickly, even though thinning sprays were used subsequently?

There is also a lack of basic information on such questions as the foraging area of worker honey bees under various conditions. It is evident that only limited extension work is possible until an increased amount of research is conducted under local conditions and until more basic information becomes available.

THE PROBLEM OF INSECTICIDES

The widespread use of insecticides has no doubt been a factor in pollination in the Okanagan Valley fruit growing area. The chemical poisoning of honey bees except from the arsenicals has probably not been great, but in recent years some losses have occurred (Arrand & Corner, 1959). Partly because of a fear of insecticides, some beekeepers are moving their colonies to other areas. This along with the probability that wild pollinator populations have been reduced has increased the importance of planned pollination in this area.

During the past few years in British Columbia, beekeepers have been informed, by various methods, of the toxicities of new orchard chemicals and of possible ways of avoiding bee poisoning. Abstracts of pertinent papers have been mimeographed and distributed and the problem has been discussed fully at several beekeepers meetings. However, there has been little attempt made to bring the problem to the attention of fruit growers other than the warnings in the spray calendars.

Research can aid by giving more attention to the bee toxicity aspect of new chemicals that are being tested. The subject appears to be of increasing interest to researchers in other areas (Johansen [1960]; Anderson and Atkins [1959]).

BLUEBERRIES

Research information from other areas indicates that there is considerable variability in the self-fruitfulness of high bush blueberry varieties. However, the stigma of the flower on all varieties protrudes considerably beyond the anthers and regardless of the degree of self-fertility, bees are important in transferring pollen (Merrill, 1936). In addition, there is fairly general agreement that cross-pollination increases the size of berries and the earliness of ripening.

Once again extension is handicapped by a lack of information under local conditions and with local varieties. Many growers in the blueberry growing areas feel that their crops are not being adequately pollinated and are asking for information.

MISCELLANEOUS

In British Columbia the pollination of cranberries, greenhouse cucumbers, melons and holly has had little attention by research or extension workers.

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MUSINGS OF A RESEARCH OFFICER, AGRICULTURE (ENTOMOLOGY)

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Entomological research in Canada grew from virtually nothing in 1918 to a well organized profession 40 years later. There were at first more positions to be filled than trained entomologists to fill them, and so men with some background in zoology, and even amateur insect collectors, were pressed into service. It was not by chance that a number of those entomological pioneers were born in England, or were sons of English parents. The English, generally speaking, have a more lively interest in insects and other aspects of nature study than Canadians. Since the beginnings of entomology in this country at least nine of our universities have instituted Departments of Entomology, or courses in Entomology. The colorful day of the amateur entomologist turned professional is over.

Since many of the early problems in entomology had to be solved quickly and with no nonsense, the pioneers of the science tended, on the whole, to emphasize the practical viewpoint; and they did well with it. Then, as the more straightforward problems were cleared up, attention had to be paid to less obvious issues. There arose a growing band of bright and shining young college graduates complete with Ph.D. degrees and a tendency to regard their predecessors as well intentioned but really somewhat ignorant chaps. One scintillating mind has summed it up in a word—"nozzle-heads", he calls the pioneer entomologists and those of his contemporaries who work in applied research.

Entomology in much of the western world has been going through a sort of scientific adolescence, a period when on the slightest pretext, the amateur statistician churns his experimental results in an electrical calculator until finally they butter into some sort of statistical odds. There is an urge to substitute statistical formulae for common sense. Even simple bits of research may emerge so gaudily bedecked in statistical finery that only a knowing few would ever guess their true stature. Perhaps the entomologists, and other biologists, have been moved to strive for profundity in the belief that if the layman can comprehend it can't be science. Public awe of the mysteries of atomic science may have played a part here too.

Happily there are signs that Judgment, queen of human attributes, may be coming back into her own. What, in the argot, might be called the beatnik period of agricultural science seems to be on the wane. Of late more papers have been appearing in which the author, defying fashion, has been content to state in plain English the conditions of the experiment and the results. Readers have been given credit for sufficient intelligence to assess the results without recourse to mechanical predigestion.

Numbers of our agricultural scientists come from the towns and cities, and have never known the vicissitudes of farming. Although they might protest the point they have the townsman's outlook on farming, a profession that can be carried on successfully by an intelligent man with but little formal schooling. More by their actions perhaps, than by their words, they emphasize that they are scientists first, agriculturists second, and farmers not at all. Since the promotions of scientific workers in farming are not authorized by the farmers themselves it is not surprising that the agricultural scientist can drift away almost completely from the realities of life on the farm yet do better financially than if he had busied himself with the farmer's worries. Those of us who may be a trifle cynical have often noticed a tendency to identify intelligence with the business suit or, more particularly, with the white laboratory coat. But, in fact, the agricultural scientist has good reason to respect the ability and intelligence that are required for successful farming. Likely as not numbers of the so-called dirt farmers for whom, in the long run, he is working are at least his intellectual equals if not his superiors.

In the administrative circles of agricultural science there is an understandable proneness to equate a research worker's ability with the number and apparent profundity of his publications. The trouble is that to award a quid of salary for a quo of productive effort is to some degree a subjective matter as well as an objective one, and the administrator may be hard put to assess either aspect accurately. One of the crying needs in agricultural research, as indeed in many another field of human endeavour, is a better method of estimating the value of an individual's work to his fellow-man—some reliable means of stripping off the showier trappings of erudition and exposing what's underneath. This hardly seems to be the sort of job that the computer people will ever be able to solve; but maybe it is just as well that intrinsic human worth is not susceptible to mathematical analysis. In any case granting that every research worker should have to produce evidence that justifies his salary, today's pressure to publish can hardly be considered a boon to science. Certainly the literature of agricultural science, including entomology, is coming to wear pretty baggy britches. Its bulk seems to be greater than the substance warrants.

These remarks can be summarized in a few words. They urge less humbug in agricultural research, and more understanding of the farmer's problems. They urge less concern with the pay cheque, and more concern with a good day's work.

BOOK REVIEW

All things come to those who wait including, nowadays, almost every worthwhile book in a paper backed edition. 'The Forest and the Sea' started life in a hard cover; now it appears, well printed, at sixty cents as a Mentor Book (New York: New American Library, 1961, 216 pp.).

The importance and pleasure of this textbook of ecology are in no way diminished because most of the ideas, examples, and conclusions are not original, although it is fair to say that the best writing is in the author's references to his own experience in Albania, Colombia, central America, the south Pacific, and the West Indies. In a useful summary by chapters, nearly 70 sources are given, of which Bates remarks wryly that he has ". . . tried to observe the faint boundary between research and plagiarism . . ."

In fact much of the material is thoroughly familiar or even elementary, and for this the author rightly makes no apology. Essentially he has written an introduction to ecology, and it is the distillation of ideas with examples that is important. The book represents the content of an undergraduate general education course, "Zoology in Human Affairs," at the University of Michigan where Bates is a professor. Often one is aware of the author speaking, generally in the first person, as a wise, experienced biologist, giving his personal views to second-year students. The writing is discursive, eminently readable and never pedantic. In passing he raps the knuckles of professional ecologists for their addiction to coining words.

The title is from an interesting if not very useful analogy developed at some length, between the various layers of the forest and the sea, from the treetops or surface, to the floor or benthos. But the forest discussed, despite a conifer on the jacket, refers to mature, equatorial rain forest, such as most of us will never see.

The author refers to insects with authority, having worked for 25 years on malarial and yellow fever mosquitoes. Using an example of *Anopheles* in Albania, he presents a good discussion of speciation. From a single species, according to conventional taxonomy, no less than 7 non-interbreeding populations were sorted out, separable only by spots on their eggs and different tastes in hosts.

Bates makes a good case for more emphasis on what he calls 'skin-out' biology, the study of organisms as such, rather than 'skin-in' biology, the study of organs, cells and processes. The last few chapters deal with the evolutionary background and ecology of man, and the book ends with a plea for more intelligent conservation and better understanding of biology as a whole.

'The Forest and the Sea' should be required reading for ecology students, recommended reading for students of ecology.

—*H. R. MacCarthy.*

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Insects

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ECONOMIC — PAGE

GENERAL

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ECONOMIC PAGE

GENERAL

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CHEMICAL CONTROL OF THE ASPEN LEAF MINER, PHYLLOCNISTIS POPULIELLA CHAM. (LEPIDOPTERA: GRACILLARIIDAE)

S. F. Condrashoff[1] and J. C. Arrand[2]

In British Columbia and the Yukon Territory the aspen leaf miner, *Phyllocnistis populiella* Cham. recently has occurred in great numbers throughout the range of trembling aspen, *Populus tremuloides Michx.*

The labyrinthine mines made by the larvae cause the leaves to take on a silvery appearance. Every year inquiries are received from property owners who are concerned about the unsightly effects on aspen trees used as ornamentals or for shade. The control tests described here were aimed at providing home owners with a method of protection. The long-term effect of the leaf miners on trees has not been assessed, although unpublished reports from Idaho and Wyoming attribute deaths of aspen trees to heavy infestations over several years.

In spring, when the aspen buds open, the moths deposit eggs on both upper and lower leaf surfaces. Oviposition continues until leaves reach approximately two - thirds full size. The developing larvae mine the upper and lower epidermis, and after attaining full size in 4 or 5 weeks, they spin cocoons. Ninety per cent of the mining occurs in the third or final mining instar which lasts 4 or 5 days. The fourth instar does not mine. The pupal stage lasts about 2 weeks. New adults are frequently seen in June, July, and August, resting on trees and shrubs; soon afterwards they disappear to hibernate. There is one generation per year.

Trunk applications of a systemic poison were tested first. The possibility that the newly-hatched larvae might be easily killed with minute quantities of material, and the ease of applying insecticide to the trunk suggested that such a method might be ideal for home owners, who ordinarily lack adequate spray equipment. When it became evident that the trunk applications were not effective foliage sprays were tried.

Procedure and Results

1. Trunk Applications

On April 12, 1961, as buds were opening at 1700 feet elevation at Larkin, B.C., Rogor[3] emulsion (containing 30 per cent active ingredient[4] or three lb. per Imperial gallon) was brushed on to 10 aspen trees 4-10 inches d.b.h. picked at random. A total of 3.5 oz. of this material was used on the 10 trees. Ten untreated trees were marked for a check.

Two weeks later, in the same area, a felt band soaked with one oz. of Rogor was wound on the trunk of three trees. In addition, one-quarter-inch holes were drilled to a depth of about 2 inches in the trunk of 3 trees and one ounce of Rogor emulsion injected with a syringe. Assessments were based on examinations of 200-1000 aspen leaves from each treatment.

Results are shown in Table 1. The only method that showed promise of control was injection of the material into drilled holes. The kill achieved by this method was much higher than indicated under "third instar mines" in Table 1. Since many larvae were already in the third instar at the time of treatment, the proportion surviving to cocoon gives a truer picture of the kill, which was over 80 per cent. Injected trees sustained

[1] Forest Entomology Laboratory, Vernon, B.C.

[2] Assistant Provincial Entomologist, Vernon, B.C.

[3] Also known as Dimethoate.

[4] Methyl dimethyldithiophosphorylacetamide.

TABLE 1.—Effect of Rogor emulsion on **Phyllocnistis populiella** Cham. in trembling aspen at 1700 ft. elevation, Larkin, B.C. Material applied to trunks by various methods, April, 1961.

Treatment	Percentage leaf surfaces affected: All mines	3rd instar mines	Cocoons
Painted in 6-in. band	80	68	21
Banded with treated felt	70	70	29
Injected into ¼ in. holes	74	38	3
Untreated	63	62	20

some injury from the insecticide, resulting in blanching of the leaves. Lower dosages applied just before bud-burst should be tested.

TABLE 2.—Effect on 150 leaves (300 surfaces) of Thiodan and Rogor sprays on **Phyllocnistis populiella** Cham., in trembling aspen at 3000 ft. elevation, Vernon, B.C. Three 4-foot trees sprayed with 2 oz. of each material in 1 gal. water. 24 May, 1961.

Treatment	Infestation after 33 days: Surfaces infested at spraying	Surfaces with signs of survival to 3rd instar or beyond	Cocoons
Thiodan	264	52	7
Rogor	268	31	6
Untreated	284	243	163

2. Spray Applications

When trunk applications failed, spray tests were conducted at a higher elevation, where tree and insect development was less advanced. On May 24, 6 four-foot high infested saplings at 3000 feet elevation near Vernon, were sprayed to the point of dripping with a compressed-air hand sprayer. Three of the trees were treated with 2 oz. of Thiodan, and 3 with 2 oz. of Rogor, in one gallon of water.

As shown in Table 2, both materials gave excellent control. By June 26, 33 days after treatment, treated trees were markedly greener and had grown considerably taller than untreated trees, which suggests that the leaf miners may reduce growth significantly.

The control obtained is not surprising. Reports from other areas show that closely related species are easily controlled with a number of materials. Ayoub (1960) reported that *Phyllocnistis citrella* is readily controlled on citrus trees in Saudi Arabia with sprays containing any one of the following materials: parathion, malathion, heptachlor, dieldrin, DDT, or "Gamma Isomer." In Italy, De Bellis (1960) reported that good control of *Phyllocnistis suffusella* was obtained on poplars by spraying infested leaves with parathion, malathion, Diazinon, demeton, Rogor , or a mixture of parathion and DDT.

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INSECTICIDES FOR CONTROL OF BRASSICA PESTS IN BRITISH COLUMBIA[1]

H. R. MacCarthy

Introduction

The purpose of this 4-year investigation was to find a calendar recommendation for control of cole crop pests, better suited to local conditions than the existing one. An earlier paper dealt with the first season's work in 1958, when the pests were exceptionally abundant (Forbes and MacCarthy, 1959). During the next 3 years the populations at Vancouver were much lower, so that single treatments only were necessary, making it possible to study the rates of reinfestation.

Most of the insecticides were organophosphates with systemic effects. This paper reports the effectiveness of the materials, and the persistence of the best of these against the 4 common pests: the cabbage aphid, *Brevicoryne brassicae* (L.); the green peach aphid, *Myzus persicae* (Sulz.); the diamondback moth, *Plutella maculipennis* (Curt.); and the imported cabbageworm, *Pieris rapae* (L.). The last was in small numbers.

Materials and Methods

The insecticides were:

DDT; 50 per cent wettable powder.

Derris; 7.94 per cent emulsible concentrate, formulated for this experiment by P. C. Oloffs, courtesy of Laters of Canada, 330 Lysander Lane, Richmond, B.C.

Diazinon, *O, O*-diethyl *O*-(2-isopropyl-4-methyl - 6 - pyrimidinyl) phosphorothioate; 25 per cent emulsible concentrate; Fisons (Canada) Ltd., Toronto, Ont.

Dimethoate (Rogor), *O, O*-dimethyl *S*-(N-methylcarbamoylmethyl) phosphorodithioate; 46 per cent soluble concentrate; American Cyanamid Co., Stamford, Conn.

Di-Syston, *O, O*-diethyl *S*-2(ethylthio) ethyl phosphorodithioate; 5 per cent granules; Chemagro Corp., San Mateo, Calif.

Ekatin-M, *O, O*-dimethyl *S*-(morpholino-carbamionyl-methyl) dithiophosphate; emulsible concentrate containing 2.1 lb. active material per Imp. gallon; Sandoz Ltd., Basle, Switzerland.

Larvatrol "75 W", wettable powder containing 75 billion spores per gm. of *Bacillus thuringiensis* Berliner; Nutrilite Products, Inc., Buena Park, Calif.

Malathion; 57 per cent emulsible concentrate; American Cyanamid Co., Stamford, Conn.

Perthane, di(*p*-ethylphenyl) dichloroethane; emulsible concentrate containing 4 lb. of active material per U.S. gallon or 50 per cent wettable powder; Rohm & Haas Co., Philadelphia 5, Pa.

Phosdrin, dimethyl carbomethoxypropenyl phosphate; water soluble liquid containing 12.3 lb. Phosdrin per Imp. gallon; Shell Oil Co. of Canada, Toronto, Ont.

Phosphamidon, dimethyl 2-chloro-2-diethylcarbamoyl-1-methyl vinyl phosphate; "4 spray" containing 4 lb. of active material per Imp. gallon; Ortho Agricultural Chemicals Ltd., New Westminster, B.C.

Sevin, methylnaphthyl carbamate; 50 per cent wettable powder; Union Carbide Chemicals Co., New York, N.Y.

Thiodan, hexachloro - hexahydromethano-2, 4, 3-benzo-dioxathiepin oxide; emulsible concentrate containing 2 lb. of active material per Imp. gallon; Niagara Brand Chemicals, Burlington, Ont.

[1] Contribution No. 35. Research Station, Research Branch, Canada Department of Agriculture, 6660 N.W. Marine Drive, Vancouver 8, B.C.

The surfactant Triton B 1956 (Rohm and Haas Co., Philadelphia 5, Pa.) was added to all sprays at 4 ounces per 100 gallons. Di-Syston granules were applied at the base of the plants in 1959 and 1960; in 1961 they were mixed with the seed just before sowing. In that year the 3 brassica crops were not transplanted, but were grown directly from seed.

Brussels sprouts was the chief test crop, being used in all years. The methods of culture and appraisal of results have been published (Forbes and MacCarthy, 1959). In 1961 the size of the plots was tripled to include equal numbers of rows of broccoli and rutabagas, in order to gauge the effect of treatment on other brassica crops. In each year a randomized block design was used in 4 replicates. To determine any toxic effect of seed furrow treatment with Di-Syston by the end of the 1961 season (7 Nov.), 10 plants were taken at random and weighed, from each of the 4 replicates of the untreated, Di-Syston, and dimethoate plots. Above ground weights were recorded for Brussels sprouts and broccoli, both of which were not harvested; the weight of the entire plant was recorded for rutabagas.

Records made later than 6 weeks after spraying are not used here (with an exception noted), because after this time apparent control may result from inability of the pests to re-colonize, rather than from residual toxicity.

Results with the best materials are presented by plotting the cumulative totals (Fig. 1). This method permits easy comparison between the rates of increase in treated and untreated plots.

Bioassays were made in 1959 using discs 9 cm. in diameter, cut from middle leaves of plants in each of the control and Di-Syston plots. The leaf discs were placed in petri dishes and ten adult aphids from greenhouse colonies were put into each dish. The survivors were counted after 3 days.

Results and Discussion

The populations levels of the 4 pests varied from year to year as shown by the totals in the untreated plots in 6 weekly counts on an upper, middle, and a lower leaf of 5 Brussels sprouts plants in 4 replications, i.e. on 60 leaves per week:

	1959	1960	1961
Cabbage aphids, colonies	115	83	495
Green peach aphids, adults	591	123	155
Diamondback moth larvae	142	41	53
Imported cabbageworms	27	11	4

In 1959 green peach aphids were sufficiently abundant by 28 July to warrant spraying, but cabbage aphids did not appear until a month later. Hence in Fig. 1 (upper left) the points on the graph represent counts made from 31 to 66 days following spraying.

Tables 1, 2, and 3 show the treatments, rates and percentage control achieved, calculated by Abbott's formula. The materials are discussed here, in alphabetical order:

Since the local populations of diamondback moth and imported cabbageworm were known to be susceptible, DDT was included (Table 1) as a standard against which other larvacides could be measured.

Derris is recommended on provincial spray calendars for use against caterpillars near harvest. It reduced the numbers to about one-half of those in the control plots for 3 weeks following application. Disadvantages to its use are the high cost and the difficulty of obtaining fresh concentrate.

Diazinon gave fairly good results against aphids and caterpillars (Fig. 1), and retained its effectiveness for 2 weeks. It now appears on both the

TABLE 1.—Percentage control of brassica pests from single applications* of insecticides to Brussels sprouts, based on 6 weekly counts, 31 July-9 Sept., 1959, at Vancouver, B.C.

Treatment	Active material per acre, lb.	Cabbage aphids**	Green Peach aphids	Caterpillars
Diazinon 25% EC with Perthane 50% WP	0.5 / 1	24	71	71
Dimethoate 46% SC	1	47	86	49
Di-Syston 5 G with DDT 50% WP	1 / 1	83	41	83
Di-Syston 5 G with Perthane 50% WP	2 / 1	90	8	53
Malathion 57% EC	1.25	0	13	60
Phosdrin WS	.45	36	46	46
Phosphamidon 4	0.5	24	54	31
Thiodan 2 EC	0.75	0	34	75

* Di-Syston was applied to the soil at the base of the plants when they were 8 in. high, 3 and 4 July. Other materials applied 28 July.

** Cabbage aphids were absent until one month after application of the sprays. These data are based on the 6 counts 28 Aug.-9 Oct.

commercial and garden growers' calendars.

Dimethoate (Rogor) gave good control of all pests (Fig. 1), especially green peach aphids. Against caterpillars it had little effect after about 2 weeks. This material will be held in reserve for future recommendation.

TABLE 2.—Percentage control of brassica pests from single applications* of insecticides to Brussels sprouts, based on 6 weekly counts, 29 Aug.-7 Oct., 1960, at Vancouver, B.C.

Treatment	Active material per acre, lb.	Cabbage aphids	Green Peach aphids	Caterpillars
Dimethoate 46% SC	1	76	87	52
Di-Syston 5 G with Larvatrol 75 W	1 / 2	90	46	21
Di-Syston 5 G with derris 7.94% EC	1 / 1 pint	86	37	29
Di-Syston 5 G with Perthane 45 EC	1 / 1	90	57	85
Di-Syston 5 G with Sevin 50 W	1 / 1	83	63	71
Ekatin - M 20 EC	1	24	28	4
Malathion 57% EC with Perthane 45 EC	1.25 / 1	57	0	81
Phosdrin WS	0.5	66	18	42

* Di-Syston was applied to the soil at the base of the plants when they were 8 in. high 20 July. Other materials applied 25 Aug., 1960.

Di-Syston alone had no effect on caterpillars (Forbes and MacCarthy, 1959). Against cabbage aphids it gave superior control, and was effective for a shorter time against green peach aphids. There was a marked reduction in the numbers of aphids even when it had been applied with the seed 100 days earlier; in Brussels sprouts it reduced the numbers of cabbage aphid colonies by 74 per cent and of adult green peach aphids by 58 per cent. However, furrow application reduced the emergence of seedlings: in Brussels sprouts by 68 per cent, in broccoli by 46 per cent, and in rutabagas by 62 per cent. Some of the young plants were stunted but they had outgrown this when they were weighed on 7 November. Di-Syston appeared on the commercial growers' spray calendar for 1962-63 with the recommendation that the granules be applied at transplanting or as a side dressing.

Ekatin-M used at the rate recommended by the manufacturer gave poor results and was used in 1960 only.

Larvatrol "75 W" appeared to have little persistence but this may have resulted in part from rain that fell on the 2nd, 3rd, and 4th days following the treatment in 1960.

Malathion proved in 3 seasons of trial to be ineffective against aphids, but useful against caterpillars. It has been retained in the home gardeners' calendar because of its low mammalian toxicity but dropped from the commercial growers' calendar.

Perthane was tested 5 times in the 3 years, in combination with Di-Syston, malathion, or Diazinon (Fig. 1), giving good to excellent control of caterpillars. It was included in the commercial growers' calendar on the basis of its performance and very low mammalian toxicity.

Phosdrin is recommended as a late-season and pre-harvest spray. It must be reapplied frequently in seasons of heavy infestation, since pests appear to recover rapidly. The short residual effect is clear (Fig. 1).

Phosphamidon is a promising systemic with useful characteristics. It had good contact action against the 4 pests, with some systemic effect for 2 weeks. This agrees with the manufacturers' residue studies.

Sevin was shown in earlier studies to be ineffective against aphids, but against caterpillars it was effective and persistent (Fig. 1).

Thiodan appeared to be ineffective against cabbage aphids, but it reduced the numbers of caterpillars for 3 weeks after application.

The persistence of Di-Syston was investigated in 1959. Brussels sprouts, treated at 2 and 1 lb. toxicant per acre were harvested 101 and 102 days after treatment and sent to the Chemagro Corporation, Kansas City, Mo., for analysis. No detectible residues were found.

Table 4 shows the results of a bioassay of plants treated with Di-Syston. There was a significant reduction of cabbage aphids 126 days after treatment, but not later. Green peach aphids were not affected at 126 days and were not tested again.

In 1961 the materials judged most effective during the previous 3 seasons were tested on Brussels sprouts, broccoli, and rutabagas. All the treatments (Table 3) reduced ($P = .01$) the number of cabbage aphids for at least 6 weeks. Considering green peach aphids, the numbers were reduced to a highly significant degree by dimethoate for 6 weeks, by diazinon and by Phosdrin for 4 weeks after spraying, and by Di-Syston for 17 weeks or 119 days after the granules were applied. All the treatments

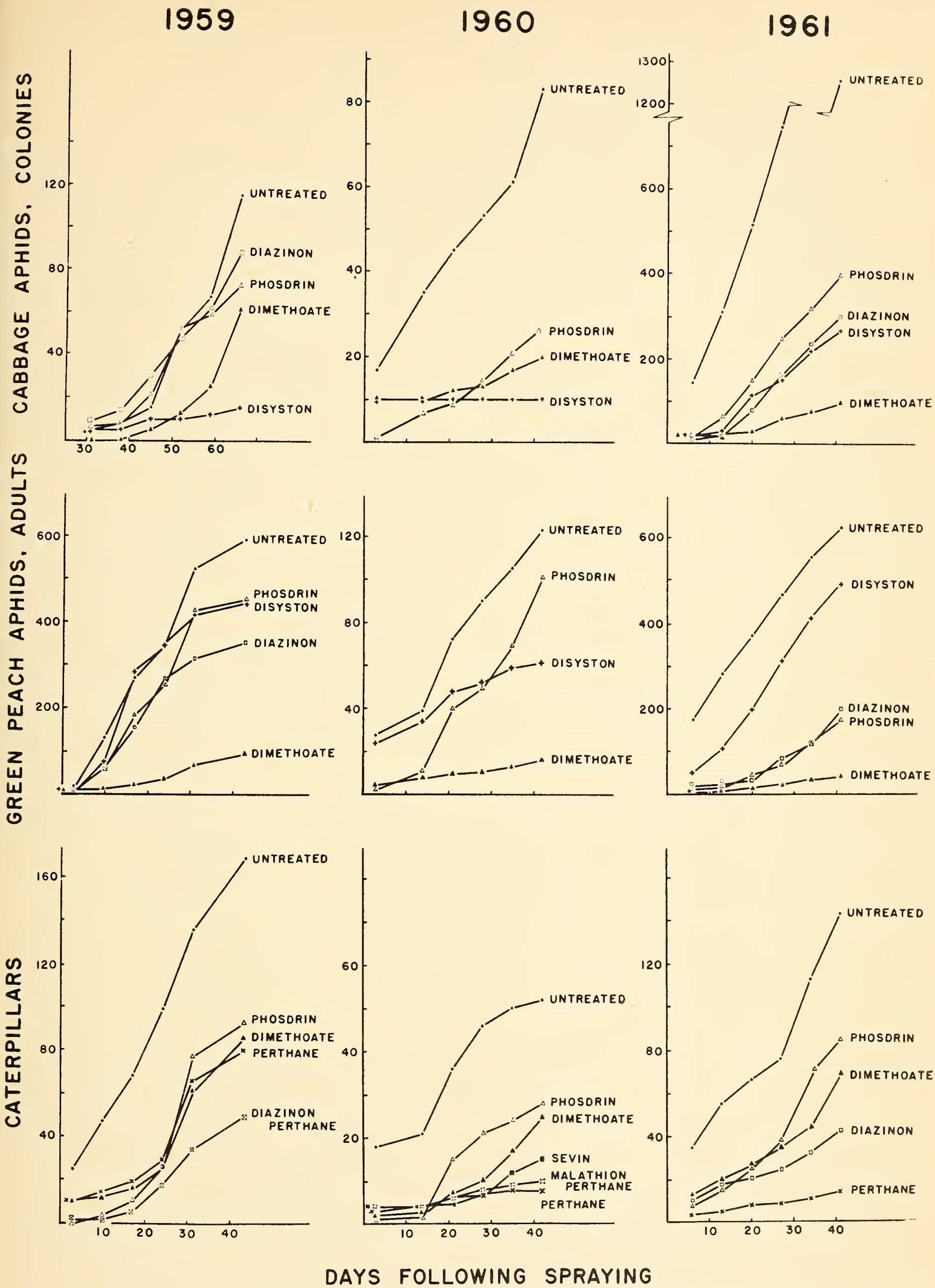

Fig. 1—Cumulative total numbers of brassica pests showing the comparative rates of reinfestation for 6 weeks following application of sprays.

TABLE 3.—Percentage control of brassica pests from single applications* of insecticides to Brussels sprouts, broccoli, and rutabagas, based on 6 weekly counts, 5 Sept.-10 Oct., 1961, at Vancouver, B.C.

Treatment	Active material per acre, lb.	Cabbage aphids	Green Peach aphids	Caterpillars
Diazinon 25% EC	1	80	79	70
Dimethoate 46% SC	1	94	96	44
Di-Syston 5 G with Perthane 45 EC	1 } 1 }	82	49	90
Phosdrin WS	0.5	73	82	35

* Di-Syston was applied with the seed 17 May. Other materials applied 30 August.

significantly reduced the numbers of caterpillars for 2 weeks, with further highly significant reductions during the 5th week with Diazinon, dimethoate and Perthane.

In the check plots there were fewer cabbage aphids (P = .001) in broccoli than in Brussels sprouts or rutabagas, but fewer green peach aphids (P = .10) in Brussels sprouts. The caterpillars were uniformly distributed.

Summary

Thirteen insecticides were tested during 1959, 1960, and 1961 for control of low to medium populations of cabbage aphids (*Brevicoryne brassicae* (L.)), green peach aphids (*Myzus persicae* (Sulz.)), diamondback moth larvae (*Plutella maculipennis* (Curt.)), and imported cabbageworms (*Pieris rapae* (L.)). The results are based on weekly appraisals, following single applications of the insecticides to Brussels sprouts. Alone or in combinations the spray materials were: DDT, derris, diazinon, dimethoate, Ekatin-M, Larvatrol, malathion, Perthane, Phosdrin, Phosphamidon, Sevin and Thiodan. Di-Syston granules were applied in the soil or with the seed. The best all-around control was achieved with Dimethoate, Diazinon, Di-Syston plus Perthane, and Phosdrin. Di-Syston was found to kill cabbage aphids up to 126 days, although it could not be detected by chemical means 102 days after application. Applied in the seed furrow it reduced emergence by up to 68 per cent, and caused stunting.

TABLE 4.—Surviving aphids out of 40 caged for 3 days on 9 cm. discs cut from middle leaves of Brussels sprouts plants, treated with Di-Syston, 1959, Vancouver, B.C.

Active material per acre, lb.	Days following treatment: Cabbage aphids			Green peach aphids
	126	137	144	126
2	3	6	26	35
1	19	10	22	25
Control	30	9	16	36

Acknowledgments

Grateful acknowledgment is made for assistance in the field from my colleagues, A. R. Forbes, A. T. S. Wilkinson, and D. G. Finlayson. Technical help was given by M. D. Noble, J. Hill, A. Clancy, and N. J. Filmer.

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INDICATIONS OF RESISTANCE TO DDT BY THE IMPORTED CABBAGEWORM IN THE OKANAGAN VALLEY[1]

R. H. HANDFORD AND IMANTS BERGIS[2]

Reports of dissatisfaction with DDT as used against the imported cabbageworm, *Pieris rapae* (L.), in the Okanagan Valley in 1960, suggested that experimental tests were advisable. Accordingly, an experiment was set up in June, 1961, in a field of Pennstate Ballhead cabbages on the farm of S. and J. Low near Kelowna, B.C. There were five treatments arranged in four randomized blocks. Each plot measured 16.5 ft. x 16.5 ft. and contained 80 to 100 plants.

The cabbage plants were set out on June 25 and the plots were staked on June 27. The insecticide for each plot was measured separately into two quarts of water and applied with a knapsack sprayer. Spraying was done on June 28, July 7, 18, 28, August 9 and 21. Dibrom was substituted for DDT on August 21 to avoid illegal residues at harvest. Otherwise the treatments on each date were as follows:

1. DDT, 50% wettable powder, 4 lb. per acre.
2. Thuricide, 30 billion viable spores per gram, 1 lb. per acre.
3. Phosdrin E.C., 1.54 lb. actual per 20 fl. oz., 8 fl. oz. per acre.
4. Dibrom E.C., 9.6 lb. actual per U.S. gal., 16 fl. oz. per acre.
5. Untreated check.

The effectiveness of the treatment was determined by counting the larvae on 12 plants selected at random in each plot on July 6, 11, 27, August 9 and 21, before treatment in each instance. The diameter of the cabbage heads was measured at the end of the experiment.

The total number of larvae on 48 plants per treatment, counted on the five dates indicated, was divided by the number of replicates (four) to give the following means:

Phosdrin	7.8
Thuricide	11.3
Dibrom	13.8
DDT	27.0
Check	51.3

Difference necessary for significance at the 5% point was 3.95.

Difference necessary for significance at the 1% point was 5.54.

The difference in amount of damage to the leaves and heads was considerably greater than indicated by the differences in numbers of caterpillars. Mortality in plots treated with Phosdrin and Dibrom was very high immediately following treatment, and the worms found in these and the Thuricide plots just before treatment were very small as compared to those in the check plots and in those treated with DDT.

The average sizes in inches of heads in plots receiving the different treatments were as follows:

Dibrom	5.36
Phosdrin	5.30
Thuricide	5.02
DDT	4.69
Check	4.41

Difference necessary for significance at the 5% point was 0.22.

Difference necessary for significance at the 1% point was 0.31.

Again, as in the comparison of the number of larvae, the differences in damage, and probably in marketable heads, was much greater than the differences in size, but in the same direction.

[1] Contribution from the Entomology Laboratory, Canada Department of Agriculture, Research Branch, Kamloops, B.C.

[2] Officer in Charge and Greenhouseman, respectively.

It was obvious, from both criteria, that DDT, although used at double the strength recommended in previous control charts, did not give satisfactory control.

Although no counts were made of aphid populations, it was observed that they were numerous enough to cause considerable injury to plants in the check plots and to those treated with Thuricide. They increased less rapidly on plants receiving DDT, and were not observed on those treated with Dibrom or Phosdrin. This may have accounted in part, at least, for the larger heads produced in the plots treated with Dibrom or Phosdrin.

We should like to express our thanks to Mr. E. M. King, Horticulturist (Vegetables), B.C. Department of Agriculture, Kelowna, for indicating the need for the experiment and for arranging for a suitable experimental site.

EFFECT OF TWO SPRAY PROGRAMS ON LEAFHOPPERS IN CHERRY ORCHARDS IN THE KOOTENAY VALLEY OF BRITISH COLUMBIA[1]

W. H. A. WILDE[2]

Introduction

The purpose of this paper is to present results of an experiment to assess the value of dieldrin ground sprays as compared to DDT and Sulphenone tree sprays for control of leafhoppers in sweet cherry orchards. Assessments of spray programs were made by comparing the numbers of leafhoppers caught on sticky boards in the tree canopies (2). Spraying tree canopies with DDT and Sulphenone was a procedure used by some Kootenay Valley growers for controlling leafhoppers and mites. Dieldrin was selected for use as a ground spray because of its reported residual action against earwigs, spittle bugs, and thrips, pests prevalent in Kootenay Valley cherry orchard cover crops, and because it was considered possible that such an insecticide would provide economic control against leafhopper populations. Most of the leafhoppers recorded in this test work are known to spend part of their life-cycle in cover crops.

Materials and Methods

Three plots were used, each consisting of a block of 24 sweet cherry trees, almost all of the Lambert variety, 10 to 16 years old. Each plot was bordered by a buffer row of trees on all sides. The two treated plots were in one orchard and the check plot was in another. The two orchards immediately adjoined each other and were separated by a fence somewhat overgrown with native shrubs including *Symphoricarpus* sp., *Ribes* sp., *Crataegus* sp., and *Rosa* sp. The check plot, which simulated conditions in many Kootenay Valley cherry orchards, was not irrigated, mowed, pruned, or sprayed for eight years, including the year of the experiment; the ground cover was tall couch grass. The check trees were vigorous but growth was not so succulent as that in the treated plots.

The sprays were applied by a high volume sprayer. Fogging in the tree canopy applications held spray runoff to a minimum. The ground sprays of 20 per cent emulsible dieldrin[3] at the rate of 0.75 gallon per 100 gallons of water were applied on May 15 and August 12. The tree spray was 50 per cent DDT wettable powder at 3 pounds per 100 gallons with 40 per cent Sulphenone wettable powder at 2.5 pounds per 100 gallons applied on May 15 and August 12. A single spray

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[3] Hexachloro-epoxy-octahydro-dimethanonaphthalene, Shell Oil Company of Canada, Limited.

of 40 per cent nicotine sulfate at 1 pint per 100 gallons of water, a standard black cherry aphid control spray used by Kootenay cherry growers, was applied to tree canopies of both sprayed plots on June 27.

The leafhoppers were sampled by hanging plywood sticky boards, measuring 6 x 12 inches, in the cherry trees. Each board was sprayed on one side with "Deadline" tanglefoot, a material which remained sticky in any weather (2) and was capable of holding large insects. The boards were hung at random with wire hooks up to a height that could be reached conveniently from the ground, on trees of which the numbers were randomized each week. The boards were also numbered; odd-numbered boards were painted yellow, even ones white. Yellow or white board colors were used to determine if variations existed in leafhopper color preferences (3). Ten boards were hung for one week at a time in each of the three plots. The boards were changed each Tuesday or Wednesday for 20 weeks from May 7 to September 18, 1957.

With large numbers of insects in fairly homogenous groups it was possible to determinue the value of ground- versus tree-sprays, and population changes in the spray plots with those in the check plot.

Mean monthly temperatures at Creston (elevation 1,990 feet) were somewhat below average during 1957, except in April (+2°F.), May (+6°F.) and September (+4°F.). Precipitation was about ½ inch below normal for

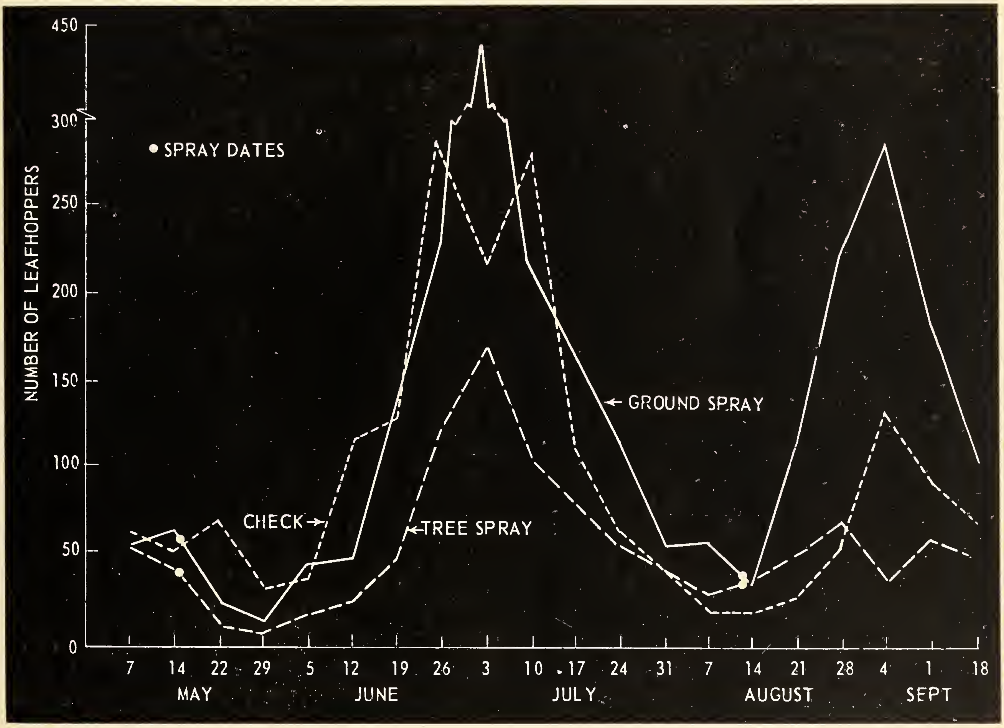

Fig. 1.—Leafhopper populations in tree spray, ground spray, and check plots in sweet cherry orchards, Creston, B.C., May to September 1957.

every month except May (— .26 inch) and June (— .03 inch). There was good snow cover in the previous winter. Killing frost in 1957 occurred September 16.

Results

The reduction of leafhopper populations by tree canopy sprays as compared to ground sprays is shown in Figure 1.

Although mesophyll - feeding leafhoppers of the genus *Edwardsiana* are unlikely to transmit little cherry virus, they were included in total leafhopper counts because they could be identified on sight, and because their high numbers showed the effects of the sprays. The residue of the foliage spray of August 12 appeared to hold down their numbers. Ground spraying had no deleterious effect on this predominantly tree- and shrub-living group. The first generation bred mostly on native shrubs growing along the fence referred to, but from early June the succeeding and overlapping generations bred on the cherry trees.

Macrosteles and *Psammotettix* were genera collected regularly. Week by week comparisons among counts of adult *Macrosteles fascifrons* show that numbers in the ground spray plot were greater than in the others. There appeared to be no migratory flights of *Macrosteles*. When the pooled numbers were plotted against time, the curve was bimodal with peaks about July 3 and September 4, suggesting two generations.

The pooled numbers of other species of leafhoppers were reduced by both programs. These species are likely to include vectors of little cherry virus.

Leafhoppers were more attracted to yellow colored sticky boards than they were to white colored sticky boards (3).

Summary

Two sprays of dieldrin, applied to ground cover only, had little effect on the numbers of leafhoppers in sweet cherry trees. By comparison, DDT-Sulphenone sprays, applied to tree canopies, gave economic control. The effects of the spray programs were assessed by comparing leafhopper counts on 10 sticky boards per plot with counts from 10 boards in the adjacent check plot. Ground sprays were tested against conventional tree canopy sprays because many leafhopper genera found in cherry orchards spend a portion of their life-cycle in orchard cover crop.

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Phyciodes mylitta Edw. on Vancouver Island

Available records make no mention of this butterfly as occurring on Vancouver Island, although records are frequent enough on the mainland of British Columbia.

I first ran across it in September, 1961, when two males were taken in separate localities in the general area of Coldstream. As **P. mylitta** is known to be double brooded and to feed on thistle in the caterpillar stage, I searched in the spring of 1962 for individuals of the first brood. After investigating many possible habitats I was at last rewarded by finding a small population of both sexes in the same district, thus establishing its existence on Vancouver Island.

It would interest me to know if anyone else has come across it. Why it has been overlooked for so long is a mystery for it is not particularly shy or retiring. It could be a recent introduction either by natural or artificial means, or with its very early and late appearance in the year and restricted habitat it could simply have eluded observation.

—*George A. Hardy, Provincial Museum (Rtd.), Victoria, B.C.*

INCIDENCE OF LEAFHOPPERS INHABITING SWEET CHERRY ORCHARDS IN THE KOOTENAY VALLEY OF BRITISH COLUMBIA[1]

W. H. A. Wilde[2]

Introduction

This report on the composition of leafhopper populations in two cherry orchards in the Kootenay Valley, British Columbia, is a part of the long-term search for vectors of little cherry virus of sweet cherry, *Prunus avium* L. At least three species of leafhoppers of the subfamily Deltocephalinae, included in this study, have transmitted little cherry virus experimentally from Lambert to Star or Sam varieties of sweet cherry under field and laboratory conditions (10).

The value of leafhopper surveys in an area where plant virus problems exist and the importance of determining if known leafhopper vectors are present in that area is discussed by Turner (8).

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Methods and Materials

The method of sampling leafhopper populations, arrangement of plots, and leafhopper nomenclature used in this investigation are described in a previous paper (11) by the author.

Results

The following table lists identities (1) and totals of leafhoppers trapped on sticky boards (2) during a period of 20 weeks in 1957 in test plots in sweet cherry orchards of the Kootenay Valley, B.C.

Discussion

The most numerous leafhopper was *Edwardsiana rosae* (L.); 4,393 adults were trapped out of a total of 5,849 adult leafhoppers. *E. rosae* is a meso-

TABLE 1.—Species and Numbers of Leafhoppers Trapped on Sticky Boards in Sweet Cherry Orchards, Kootenay Valley, B.C., May 1 to September 18, 1957.

Species	Total
Edwardsiana rosae (L.)	4,393
Neokolla hieroglyphica (Say)	265
Psammotettix lividellus (Zett.) = *affinis* Gill. & Bak.	262
Macrosteles fascifrons (Stal)	182
Dicraneura absenta DeL. & Cald.	168
Erythroneura spp. (*aspera* B. & G. and *plena* Beam.)	110
Empoa gillettei Van. D.	65*
Osbornellus borealis DeL. & M.	60
Scaphytopius acutus (Say)	57
Empoasca maligna (Walsh)	44
Idiocerus populi L.	24
Stenocoelidia lineata (Bak.)	23*
Euscelidius schenki (Kirsch.)	22
Aphrodes sp.	22
Colladonus geminatus (Van D. & *C. montanus* Van D.)	17
Sorhoanus orientalis (DeL. & Dav.)	14
Chlorotettix unicolor (Fitch)	7*
Exitianus exitiosus (Uhl.)	5
Macropsis ferruginoides group	4*
Gyponana angulata (Spang.)	2
Oncopsis sp.	2
Balclutha punctata (Thumb.)	1

* Species not recorded previously from Kootenay Valley cherry orchards.

phyll feeder and therefore is unlikely to be a virus vector. The first generation bred mostly on native shrubs, but succeeding and overlapping generations bred on the cherry trees.

Neokolla hieroglyphica (Say) is a vector of alfalfa dwarf virus. After the second week of June the numbers dropped sharply, then tapered off. Only a single specimen was trapped after July 17. It has a wide range of woody and herbaceous hosts.

Psammotettix lividellus (Zett.), a grass-living species, was noted as a migratory flight during mid-May. *P. lividellus* has been responsible for one experimental transmission of little cherry (10).

Species of *Macrosteles* are likely to include virus vectors. Most of those taken were *M. fascifrons* (Stal), a species long known to transmit aster yellows and more recently found by the author (10) to transmit little cherry virus.

Dicraneura (probably *absenta* DeL. & Cald.) was almost as numerous as *M. fascifrons*. This is a common grass-living form and, in the Kootenays, is often found in association with *M. fascifrons* and *P. lividellus*.

Erythroneura spp. (probably *aspera* B. & G. and *plena* Beam.) were numerous during the week of May 1 to 7. These progeny of the overwintered adults became well dispersed, since *Erythroneura* were trapped only occasionally after May 29. The host range is wide.

Both *Empoa gillettei* Van D. and *Osbornellus borealis* DeL. & M. have been caught on a wide range of hosts, but there is little specific information on their feeding preferences. *O. borealis* was collected only after the end of July, a pattern of distribution observed also in the Cariboo (4) and in Utah (3). Known hosts include alfalfa and potatoes.

Scaphytopius acutus is a vector of peach and cherry western X, and of alfalfa witches'-broom viruses. The host range of *S. acutus* includes grasses, legumes, potatoes, weeds, and woody brush plants. A few were trapped early in May, none in June, and then increasingly from early July. A similar pattern was obtained in the Cariboo (4).

The species of *Empoasca* trapped was probably *maligna* (Walsh). The genus includes three vectors of cranberry false blossom virus.

Euscelidius and seven species of *Colladonus* (5) are known vectors of aster yellows. Two species of *Colladonus, C. geminatus* and *C. montanus,* have transmitted Western X-disease of peach.

Chlorotettix unicolor (Fitch), never plentiful in Kootenay Valley cherry orchards, was first collected by the author in 1955. Since that time this species has shown a small increase in numbers in sweet cherry orchards of that area. *C. unicolor* is a vector of aster yellows.

Species of *Macropsis* have transmitted peach yellows and little peach viruses and a raspberry virus.

Species of *Empoa, Stenocoelidia, Chlorotettix,* and *Macropsis* are new records for sweet cherry orchards of the Kootenay Valley; they are not represented in Waddell's list (9).

The number of leafhoppers recorded in this study were much higher than those reported recently from Delaware (6, 7) in peach and apple orchards subjected to seven sprays.

Summary

The incidence of leafhoppers in sweet cherry orchards near Creston in the Kootenay Valley of British Columbia was recorded for 20 weeks in 1957. *E. rosae* was the most common leafhopper: 4,393 were trapped out of a total of 5,849. Next in order of

abundance were *N. hieroglyphica* and *P. lividellus* whose numbers were 265 and 262 respectively. Six leafhopper species found in trace numbers were *C. unicolor, E. exitiosus, Macropsis* sp., *G. angulata, Oncopsis* sp. and *B. punctata*. Of the 22 species recorded, *N. hieroglyphica, P. lividellus, M. fascifrons, C. geminatus, C. montanus, S. acutus, E. maligna, E. schenki, C. unicolor* and *M. ferruginoides* group are either known plant virus vectors or are closely related to species known to be vectors of plant viruses.

Acknowledgments

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Occurrence of Anoplonyx spp. in the Larch Forests of British Columbia and Yukon Territory

T. A. D. Woods[1]

Four species of the larch sawfly genus **Anoplonyx** occur in British Columbia, two of which extend into Yukon Territory. **Occidens** Ross and **laricivorus** Roh. and Midd. are found on western larch, **Larix occidentalis** Nutt., in southeastern British Columbia. **Canadensis** Harr. and **luteipes** (Cress.) occur on eastern larch. **L. laricina** (Du Roi) K. Koch, in central and northern British Columbia and southeastern Yukon Territory.

A. occidens has been collected throughout its host's range from June 8 to August 6. In southeastern British Columbia **A. laricivorus** larvae have been collected between June 13 and September 5.

A. canadensis larvae have been collected between August 2 and 31. In 1960, five larvae of **A. luteipes** were taken on July 23, at Mile 579 Alaska Highway, 40 miles east of Lower Post. Some **luteipes** larvae were collected on July 20, 1961 at Mile 658, 25 miles west of Watson Lake, Y.T. Previously, this species was known to occur only east of the Rocky Mountains (Wong, 1955). The collection dates represent the times that specimens were found and do not necessarily establish the complete larval feeding period.

The above information is based on data obtained from the records of the Forest Insect Survey at Vernon, B.C.

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THE PATTERN AND PERSISTENCE OF DEPOSITS OF SEVIN, WITH AND WITHOUT SURFACTANTS, ON THE FOLIAGE OF FRUIT TREES I. APPLICATION BY CONCENTRATE SPRAYER[1]

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Introduction

Most work involving the chemical anaylsis of insecticide deposits on foliage has been done with bulk samples of leaves. However, many analytical methods are now sufficiently sensitive that the small deposit on even one side of a single leaf may be determined. Determination of the residues on single leaves permits a more precise assessment of the distribution of deposit throughout a tree and allows one to obtain a more detailed picture of the deposit decline. The entomological importance of these matters in insect control is obvious. Difficulties in achieving effective control of certain insects and mites, in recent years, make such studies desirable. The understanding of certain aspects of insecticide resistance may be improved. The relative merits of 'heavy' and 'light' spraying (assumed to be equivalent to intense and moderate selection) have been argued in connection with the development of resistant strains. However, these arguments need modification if it is proven that there is a variegated pattern of deposit.

Methods

The insecticide used was Sevin[3] (1-methyl-*N*-naphthyl carbamate) 50 per cent wettable powder. The surface active spreader - sticker was Plyac[4] (polyethylene 629 emulsifiers and dispersants; estimated actual polyethylene, 25 per cent). Application was by concentrate air-blast sprayer[5] at a rate equivalent to eight pounds of formulated Sevin, in 50 Imperial gallons of water per acre. Where Plyac was used it was added at the rate of one Imperial gallon per acre. Rate of travel was 90 feet per minute (approximately one mile per hour); pump pressure was 300 pounds per square inch. There was no drip from the leaves at this rate of application. Marshall (2) has stressed that the absence of drip characterizes efficient concentrate spraying.

Cherry trees were used, variety Van, approximately 20 feet in maximum height. Leaf samples were taken at heights of 6, 10 and 14 feet. At each height there was one sampling point in each of the north, south, east and west quadrants of the tree. Each point was identified by a tag and leaves were collected within + or − 2 feet horizontally and + or − 1 foot vertically of the tag. On each sampling date leaves were picked at each point.

Leaves were carried from the orchard to the laboratory by their stems; they were handled with great care so as not to brush off any of the deposit. Insecticide deposits were removed from the leaves with the apparatus shown in Figure 1. The procedure is as follows. An individual leaf is placed on top of a screw-cap jar, S, the lip of which has been

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[4] Allied Chemical Corporation, General Chemicals Division, New York 6, N.Y.

[5] Okanagan Turbo Sprayers Ltd., Penticton, British Columbia.

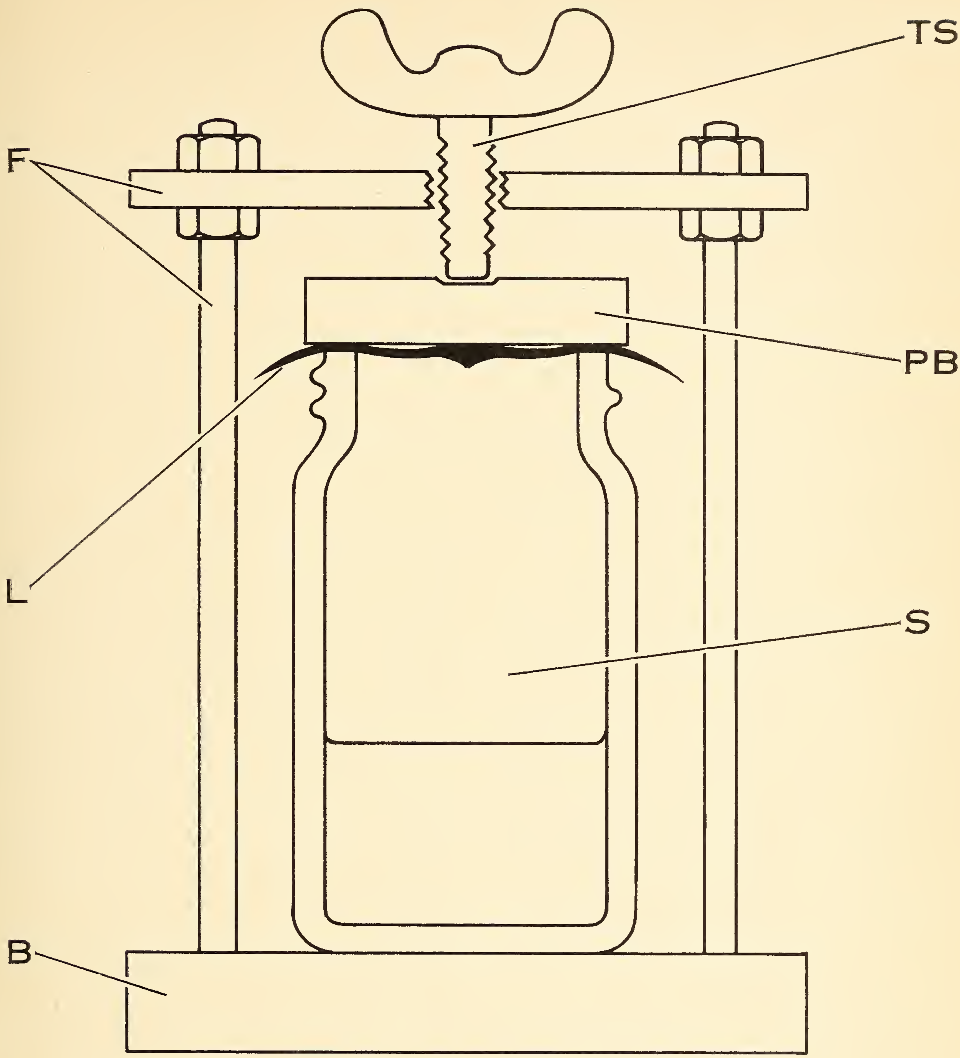

Fig. 1—Device for the removal of Sevin deposits from leaves. TS, thumbscrew; F, frame; PB, pressure block; B, base; S, solvent vessel; L, leaf.

ground flat. This vessel contains 15 ml. of chloroform. The leaf is pressed in solvent-tight juxtaposition with the vessel by the pressure of the thumbscrew, TS, against the pressure block, PB. The thumbscrew is held by the rigid frame, F, attached to the base, B. The entire unit is placed on its side and agitated briskly for one minute. Experiment shows (5) that this action removes the entire surface deposit of Sevin from the leaf; and (using test leaves bearing a deposit on one side only) that there is no translocation by the chloroform from one leaf surface to another in this period. The extract is analyzed by the colorimetric method of Miskus, Gordon and George (3). Since the circular area from which the insecticide is removed is known exactly, the residue can be expressed in micrograms per sq. cm. On individual leaves, deposits as low as 0.4 micrograms per sq. cm. can be accurately determined and traces as low as 0.07 micrograms per sq. cm. can be detected. Of the leaves picked at each sampling point, on each occasion, half wwere analyzed for deposit on their upper surfaces, the others on their lower surfaces. It is not possible to measure deposits on the two surfaces of the same leaf with the apparatus described. However, more recently we have devised a method in which this is possible (5). It was not, however, used in this study.

Chemical analyses were made on leaves on all trees immediately after the spray had dried and 1, 4, 8, 11, 16, 22 and 32 days later.

During the period of the experiments the mean maximum temperature was 75.8° F., and the mean minimum, 50.6° F. There was no measurable rainfall in this period. Irrigation of the orchard was by low level sprinklers. None of the sprinkler water reached the lowest sampling level.

Results

Examination of the original data immediately suggested that there were no differences between the north, south, east and west sampling points. A preliminary analysis of variance confirmed this and the data were therefore pooled to form categories of leaf surface, surfactant treatment, height, and leaf replication. A detailed analysis of variance was then done on this basis. A summary of the results for days 0, 1 and 4 is shown in Table I. Subsequent to day 4, there were too many zero values in the chemical analysis data to allow further convincing analysis of variance. Examination of Table I shows that the conspicuous differences arise from the presence or absence of Plyac or between the two leaf surfaces. It will be noted that there are significant first-order interactions, but as these are different interactions on each of the three days, and are not repeated, it is doubtful if they have any biological meaning. Table II shows the mean values for deposits on leaves categorized into: (a) upper and lower surfaces; (b) presence and absence of Plyac treatment. The ratio of deposits between lower and upper surfaces, and between Plyac-treatment and non-treatment are also shown.

The data plotted in Figs. 2 and 3 also emphasize the trends seen in Table II and continue them beyond the point at which full analysis of variance was possible. In Fig. 2 the decline of deposits (upper and lower surfaces combined) has been compared for treatment with, and without, Plyac. To eliminate the factor of difference in initial deposits, and to give a truer picture of the rate of decline, the curves have been plotted as percentages of the initial deposits. In Fig. 3 are shown the differences in decline rate of Sevin deposits on the upper and lower surfaces of Plyac-free leaves. Again a percentage plotting is used to eliminate the effect of initial differences in deposit on the two surfaces. Curves similar to Fig. 3, but slightly shifted to the right, are produced if the data for Plyac-treated leaves are plotted in the same way.

It was noticed that the standard wettable powder produced a deposit, on both upper and lower surfaces, that was very easily removed by gentle pressure with an artist's watercolor brush. The addition of the Plyac, however, produced a deposit that was very much more difficult to remove by this method.

TABLE I

Analysis of Variance for Deposits of Sevin on Cherry Foliage. S.S., sums of squares; M.S., mean square; d.f., degrees of freedom; F., ratio.

		Day 0			Day 1			Day 4		
Source of variation	d.f.	S.S.	M.S.	F.	S.S.	M.S.	F.	S.S.	M.S.	F.
Between surfaces, S.	1	36.76612	36.76612	14.387**	119.70667	119.70667	42.388**	73.72768	73.72768	27.170**
Between heights, H	2	15.07491	7.53745	2.949	12.31916	6.15958	2.181	10.16200	5.08100	1.872
Between treatments, T	1	10.67333	10.67333	4.177*	30.24015	30.24015	10.708**	14.16039	14.16039	5.218*
S X H	2	7.33140	3.66570	1.434	1.65306	0.82653	0.293	22.67398	11.33699	4.178*
S X T	1	0.83068	0.83068	0.325	17.08594	17.08594	6.050*	0.01789	0.01789	0.007
H X T	2	16.92917	8.46459	3.312*	7.46943	3.73472	1.322	6.00507	3.00254	1.106
S X H X T	4	1.35723	0.33931	0.133	13.62158	3.40540	1.206	8.56048	2.14012	0.789
Between replicates	82	209.55563	2.5556		231.57611	2.82410		222.51008	2.71354	
	95	298.51847			433.67210			357.81757		

TABLE II

The Influence of Surface, and Presence of Plyac, on the Mean Deposits of Sevin on Cherry Foliage.

Time	Surface	Mean deposits of Sevin, micrograms per sq. cm. With Plyac	Without Plyac	Ratio: with without
Day 0	Lower surface, L	3.31	2.46	**1.35**
	Upper surface, U	1.89	1.41	**1.34**
	Ratio: L/U	**1.75**	**1.74**	
Day 1	Lower surface, L	3.28	2.43	**1.35**
	Upper surface, U	1.85	0.95	**1.97**
	Ratio: L/U	**1.77**	**2.59**	
Day 4	Lower surface, L	3.23	2.33	**1.39**
	Upper surface, U	1.45	0.71	**2.04**
	Ratio; L/U	**2.23**	**3.28**	

Discussion

The work described in this paper shows that variations in deposit between leaf surfaces, on cherry trees up to a height of 14 feet at least, are essentially random except in one important respect. Initial deposits of Sevin are about 75 per cent higher on the lower surface than on the upper. Even in the absence of rain, as in this work, there is a marked tendency for this relative difference to increase, until the residual deposits have fallen to a low value. The half-life of the initial deposit is approximately two and a half days longer on the lower surface than on the upper (Fig. 3). In the presence of rain, or of high sprinkler water falling on the foliage, this divergence is likely to be further increased. Under such conditions deposits of wettable powder are rapidly

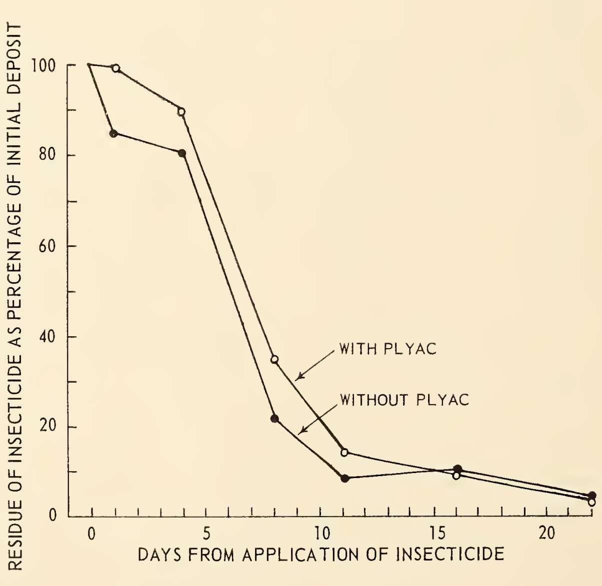

Fig. 2—The influence of Plyac on the rate of decline of Sevin deposits on cherry foliage in the absence of rain. The decline is plotted on a percentage basis as the presence of Plyac induced a substantially larger initial deposit on the foliage.

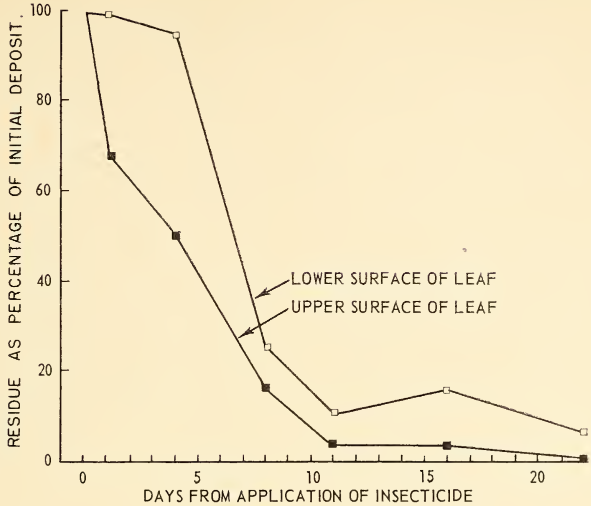

Fig. 3—Differences in the rate of decline of Sevin deposits on the upper and lower surfaces of cherry foliage in the absence of rain. The decline is plotted on a percentage basis as the initial deposits were approximately 75 per cent higher on the lower surfaces than on the upper.

reduced on apple leaves (6). More recently it has been shown that most of this loss, in dwarf apple trees subject to overhead sprinkling, is from the upper surface of the leaves (4). In fact when bulk samples of foliage reveal an appreciable deposit the whole of the insecticide may be concentrated on the lower leaf surfaces. The implications for the control of insects or mites that prefer one side of a leaf are obvious.

The addition of Plyac to the Sevin results in an increase of about 35 per cent in the initial deposits for a fixed output rate of the machine. The reasons for this are not certain. However, observations made with a laboratory atomizer sprayer (4) suggest that this may be as much the result of reduced rebound loss (caused by a decrease in surface tension and consequent loss of structural strength and elasticity of the drops), as of the adhesive qualities of the Plyac. It is also noteworthy that the addition of this surfactant, though it causes an increase in initial deposits, does not alter the initial partition ratio of the total deposit between lower and upper leaf surfaces. This strongly suggests that it is some inherent characteristic of the leaf, and not formulation, that induces the higher deposits on the lower surfaces.

Plyac is stated (1) to have some waterproofing or "rain resistant" qualities. This point was not examined in this work since no rain fell during the experiment; and irrigation was by low level sprinklers. Nevertheless, the Plyac treatment resulted in a somewhat slower decline of deposits even after making allowance for the greater initial deposits. It appears likely that this is the result of a lessening of loss caused by leaf-to-leaf abrasion. The influence of Plyac in improving resistance to loss by gentle brushing has been noted. However, experiments on isolated leaves in a wind tunnel (4) show that wind itself does not cause appreciable loss of deposit. But wind-induced rubbing of leaf against leaf must cause considerable loss. The matter would bear detailed investigation particularly if a quantitative method of measuring the abrasive forces could be devised. More effective substances than Plyac, or a different rate or formulation, could conceivably produce a greater effect on persistence. Some preliminary experiments (4) suggest that certain acrylic polymers, at suitable rates, have an enormous influence on the abrasion resistance of insecticide deposits but, also, that resistance to abrasion loss is not necessarily identical with resistance to rain loss.

Summary

An analysis of the inter-leaf pattern of Sevin deposited on cherry foliage, by concentrate air-blast sprayer has been made. There were no differences in mean deposit up to a height of 14 feet; nor were there any differences associated with leaves collected from different quadrants of the trees. Initially, deposits were approximately 75 per cent higher on the lower sides of the leaves than on the upper. Subsequent erosion of the deposits was faster on the upper surfaces so that the disparity was emphasized with time. There was no rain during the experiment; if there had been, there is evidence that this disparity would have been enhanced. The addition of an amount of Plyac, equal in its content of active ingredient to that of the Sevin, resulted in initial deposits approximately one-third higher than in its absence. The rate of decline of deposits was also somewhat slower when Plyac was present. In the absence of rain, loss of deposit by leaf-to-leaf abrasion is thought to be an important factor in the disappearance of a pesticide from foliage.

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Pleroma obliquata Sm. and P. conserta Grt. from ova laid by obliquata (Lepidoptera: Phalaenidae)

The progeny of a batch of ova laid by **P. obliquata** in April, 1960, consisted not only of the expected **obliquata** but also of 2 specimens of **P. conserta** in March 1961.

Many of the pupae remaining were alive, so they were kept over in a flower pot in an open shed. During March and April, 1962, there emerged 12 **conserta** and 4 **obliquata.**

Close examination of a series of these two species indicates that **conserta** is a melanic form of **obliquata.** One or two individuals showed a gradation between the two. **P. obliquata** is uniformly grey with dark a.m. and p.m. lines; **P. conserta** has primaries of solid black except for the grey outer margin and a contrasting white costal area on which an extension of the otherwise concealed a.m. and p.m. lines are plainly evident. It may be that a prolonged pupal period results in a larger proportion of **conserta.**

The foregoing suggests that **conserta** and **obliquata** are forms of one species. Since **conserta** was described by Grote in 1881 and **obliquata** by Smith in 1891, **obliquata** is a form of **conserta.**

—*George A. Hardy, Provincial Museum (Rtd.), Victoria, B.C.*

THE PATTERN AND PERSISTENCE OF DEPOSITS OF SEVIN, WITH AND WITHOUT SURFACTANTS, ON THE FOLIAGE OF FRUIT TREES II. APPLICATION BY HIGH VOLUME SPRAYER[1]

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Introduction

In a previous paper (5) an account was given of the distribution and decline of deposits of Sevin (1-naphthyl *N*-methylcarbamate), using a method of extraction applicable to the deposit on one side of a single leaf. The influence of Plyac (active ingredient, polyethylene 629) on these deposits was also investigated. Those investigations were made using the 'concentrate' air-blast method of spraying. In concentrate spraying the wet deposit on foliage consists of a dense pattern of drops. These drops have coalesced from the smaller drops in the air that have fallen on the leaves. By correct manipulation of the sprayer, these drops do not coalesce to the point where irregular patches of fluid occur, i.e., to the point of 'incipient run-off' (3). In high volume spraying, on the other hand, the foliage is deliberately drenched with large quantities of fluid, much of which ultimately falls to the ground. The film of water retained produces an insecticide deposit, which on drying, is different in many ways from that produced by concentrate spraying. In this paper an account is given of some characteristics of the deposits from high volume application. Points of comparison and contrast are made with the findings in the previous paper (5) in which concentrate spraying was used.

Methods

The methods, trees, and sampling arrangements were as previously described (5) except in a few important respects.

The sprayer used was a truck-mounted, gun-type machine. It was operated at a pump pressure of 400 pounds per square inch. The cherry trees were sprayed very thoroughly, approximately 20 Imperial[3] gallons being used per tree. Sevin, 50 per cent wettable powder, was applied at a rate of one pound per 100 gallons, and, Plyac, when included, at one pint per 100 gallons. This is one-sixteenth the concentration used in the concentrate application (5). Leaf samples were taken immediately after the deposits were dry, and six days later.

In place of the device previously used (5) a new piece of apparatus was constructed that allowed the simultaneous, but separate, removal of the deposits from the two faces of the same leaf. This apparatus is described elsewhere (6). Since both faces of each leaf were analyzed for insecticide it was possible to test for correlation between deposit size for the two surfaces. This was not possible in the former study.

Chemical analysis of the extracts was made according to the method of Miskus, Gordon and George (4).

Results

The mean values of deposits grouped according to sampling time, leaf surface, and treatment are shown in Table I. Ratios, showing the relation

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3 Imperial measure used throughout.

TABLE 1.—The Influence of Surface, and Presence of Plyac, on the Mean Deposits of Sevin Produced on Cherry Foliage by High Volume Spraying.

Time	Surface	Mean deposit of Sevin, micrograms per sq. cm. With Plyac	Without Plyac	Ratio: with/without
	Lower, L	1.76	3.12	**0.56***
Day 0	Upper, U	1.39	2.43	**0.57***
	Ratio: L/U	**1.27***	**1.28***	
	Lower, L	0.78	1.64	**0.48***
Day 6	Upper, U	0.49	0.87	**0.56***
	Ratio: L/U	**1.59***	**1.89***	

* All ratios significantly different from the null hypothesis value of 1.0.

between deposit size on the two leaf surfaces and between treatments, are also included in the table. It will be seen that, as in concentrate spraying (5) deposits are heavier on the lower surfaces of leaves. A conspicuous effect, but in the reverse direction to that observed with concentrate spraying, is also obvious as a result of Plyac treatment.

To see whether the values for deposit size on the lower leaf surfaces ranged independently of those on the upper surfaces, coefficients of correlation were calculated. For deposits sampled on the day of spray application, the coefficient of correlation between the lower and upper deposits was 0.3695 when Sevin plus Plyac was used; where Sevin was used alone it was 0.3797. Examination of Table VI in Fisher and Yates Statistical Tables (1) shows that these values are highly significant ($P = 0.01$). At the sampling on the sixth day the values of the coefficient were, respectively, 0.3057 and −0.1382. The former value is significant ($P = 0.05$) but the latter is not. It would appear, therefore, that initially there is a slight tendency for a heavy deposit on one surface to be associated with a heavy deposit on the other, and vice versa; but this relation tends to disappear or be reduced with time.

TABLE 2.—Sevin Deposits on Cherry Foliage. Samples Taken Immediately the Spray Had Dried. Means and Variances for Two Methods of Application, Presence Absence of Plyac, and for Upper and Lower Leaf Surfaces.

Type of spraying	Plyac	Leaf surface	Sevin deposit, Micrograms per sq. cm. Mean	Variance
Concentrate air-blast	Present	Lower	3.309	1.922
		Upper	1.885	1.227
	Absent	Lower	2.456	1.662
		Upper	1.405	0.953
			general mean, concentrate: 2.264	
High volume, hydraulic	Present	Lower	1.761	0.245[2]
		Upper	1.387	0.306[2]
	Absent	Lower	3.119	0.519[1]
		Upper	2.427	0.501[1]
			general mean, high volume: 2.178	

[1] Significantly lower than corresponding variance for concentrate application.
[2] Significantly lower than when Plyac absent in high volume application.

There was much less variation in deposit from leaf to leaf than was observed with concentrate application. The variances, for both leaf surfaces, and both treatments, are shown, together with the values for the mean, in Table 2. Also included in this table are some relevant figures from the previous study on concentrate application (5) together with values for the variance which were not previously published. The general mean for high-volume spraying was 2.178 micrograms per square centimeter; that for the concentrate application of the previous study was 2.264 micrograms. The closeness of mean deposit in the two series of experiments emphasizes the validity of comparison of various criteria for the two methods of application.

Discussion

The results summarized in Table 1 show that, as with concentrate spraying (5), significantly more Sevin is deposited on the lower surfaces of the leaves. With time this ratio increases as a result of a more rapid loss from the upper surfaces. Also, as in the previous work (5), the addition of Plyac does not alter the ratio of the initial deposits between lower and upper surfaces. Unlike the results previously obtained with concentrate spraying, however, there is no evidence that Plyac reduces the rate of decline of deposits.

However, the most noteworthy point of this investigation is that the addition of Plyac, instead of producing an increase in deposit of Sevin, as with concentrate spraying (5), reduced the initial deposits by nearly half. This reversal of effect, which holds for apple as well as cherry, has been referred to in a preliminary account (7). Plyac is generally described as a sticker-spreader (2). However, these results, in combination with those of the previous paper (5) suggest that the spreading properties are predominant in high volume spraying whereas the sticking properties are predominant in concentrate application. The abundance of water used in high volume application, and the ready wetting properties of the surfactant, ensure not only the production of a thin film of fluid on the leaves, but facilitate, all too well, run-off of the surplus fluid. On the contrary, with efficient concentrate application, no run - off occurs (3). Run-off is particularly wasteful with concentrated spray fluids. The Plyac additive cannot, under these conditions, promote film-formation nor enhance the efficiency of run-off. The increased deposits obtained in this form of spraying have been attributed to reduced loss from rebounding spray drops, and improved adhesion of the discrete clusters of particles of Sevin (5).

In Table 2 another important effect of the addition of Plyac in high volume spraying is apparent. There is much less variability in magnitude of deposits, between leaves when this material is present. The variance, for either upper or lower surfaces, was reduced to approximately one half by the addition of Plyac. On the other hand, the addition of Plyac did not produce any significant difference in variance in concentrate spraying. In the light of the comments in the previous paragraph this is what one might expect. Spreading properties, such as those shown by Plyac in high-volume spraying, tend to promote uniformity. But there is no reason why the sticking qualities, more apparent in concentrate spraying, should promote a more uniform deposit.

Another point, apparent in Table 2, is that even in the absence of Plyac, leaf-to-leaf variance is two or three times greater in concentrate than in high-volume spraying. This virtue of reduced variance, however, is bought at the price of a greatly increased amount of insecticide per acre for in high-volume spraying a large proportion of the spray fluid runs off the foliage and is lost on the ground. The proportion lost varies with the stage of foliar growth of the trees. However, in general, high-volume spraying uses twice as much insecticide per acre, and about 20 times as much water, to do the same job of insect control (3).

The low value of correlation between fresh deposits on the two surfaces shows there is a tendency for a heavy deposit on one surface to be associated with a heavy deposit on the other. The relation is not very marked, however, and it tends to disappear with time presumably as a result of the equalizing effects of weathering and loss processes.

Summary

A study of the inter-leaf pattern of deposits of Sevin on cherry foliage has been made using high-volume methods of spray application. The results are contrasted with previous studies in which concentrate air-blast spraying was used. As in the latter case there were no significant differences in mean deposit up to a height of 14 feet; nor were there any differences associated with different quadrants of the trees. Initially, deposits were approximately 27 per cent higher on the lower than on the upper surfaces of the leaves. Subsequent erosion was more rapid on the upper surface so that this disparity increased with time. This relation was not, however, as marked as in concentrate application. The addition of one pint of Plyac to one pound of 50 per cent Sevin resulted in decreased initial deposits; the reverse of the relation with concentrate application. However, the addition of Plyac markedly reduced the leaf-to-leaf variance; in contrast to concentrate spraying, where Plyac made no change. The variance was always less in high volume than in concentrate spraying. There was only a slight tendency for a high deposit on a lower surface to be associated with a high deposit on an upper surface; and vice versa. This correlation was significant but low immediately after application; after six days it was reduced or absent.

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THE GREEN-STRIPED FOREST LOOPER ON VANCOUVER ISLAND[1]

G. T. Silver, D. G. Collis, N. E. Alexander, and S. J. Allen[2]

Introduction

The green-striped forest looper, *Melanolophia imitata* Wlk., was not regarded as a potentially dangerous forest insect until it caused heavy defoliation in 1960 on the west coast of Vancouver Island. As this is the first record of *M. imitata* causing serious damage to forested regions in British Columbia the results are worthy of a historical note.

The moths of this looper emerge in April or May, mate, and each female lays an average of 80 eggs. The sex ratio is approximately 1:1. The larvae feed from June to September. Western hemlock, *Tsuga heterophylla* (Raf.) Sarg., is the preferred host. Foliage of all ages is eaten but one-year-old needles are preferred. When feeding is completed the larvae drop to the ground and the insects overwinter as pupae in the duff.

Methods

Data on annual population fluctuations were obtained by analysing random 3-tree beating samples collected on the west coast of Vancouver Island. The extent and intensity of defoliation in 1960 was obtained by aerial surveys. Plots and sample points were established in localities selected to represent light, medium, and heavy defoliation, and records were obtained on defoliation and tree mortality.

The method adopted for pupal counts, based on preliminary sampling to obtain data on the distribution of pupae, was to take four one-foot-square duff samples from beneath each tree. These were taken along a straight line, two on the exposed side of the tree and two on the shaded side. Sample positions were against the base of the tree and midway between the base of the tree and the periphery of the crown. Three trees were sampled at each area. The average number of pupae in the 12 samples was considered representative of the pupal population in each area.

Results

Extent and Intensity

Survey records show that in 1951 larval populations of the green-striped forest looper increased along the west coast of Vancouver Island. The build-up reached its height in 1952 on the south side of Barkley Sound, but defoliation did not exceed 30 per cent and that only in one small area. The population decreased in 1953, and remained at a low level until 1957.

The population of the green-striped forest looper started to increase again in 1957 as shown by the occurrence of larvae in collections (Table 1). Both occurrence and number of larvae increased in 1958, and by 1959 high populations were present in the west coast drainages of Vancouver Island, two of which are shown in Table 1. The outbreak reached a peak in 1960, particularly in drainages 005 and 023. Survey activities on the west coast were seriously curtailed in 1960 due to boat troubles, so no collections were made in the infestation area during the larval period. Heavy defoliation was reported in early September, and aerial surveys later in September recorded defoliation ranging from light to heavy in 32 localities extending from Herbert Inlet to Nasparti Inlet. The total area of visible feeding was calculated at

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TABLE 1.—Summary of Green-striped Forest Looper Larvae Found in Beating Samples From Drainage Divisions on the West Coast of Vancouver Island.

Year	% samples including larvae		Av. no. larvae/ sample containing larvae	
	DD 005[1]	DD 023[2]	DD 005	DD 023
1956	0	0	—	—
1957	20	14	2	4
1958	47	82	2	14
1959	88	72	45	31
1960	85	0	59	—
1961	61	61	58	7

[1] Alberni Inlet to Escalante Pt.

[2] Escalante Pt. to south of Cape Cooke on Brooks Peninsula.

22,755 acres, of which 4,640 had sustained heavy, 13,120 acres medium, and 4,995 acres light defoliation. The defoliation limits established during the aerial survey were 0-25, 25-50, and over 50 per cent for light, medium, and heavy, respectively. The infested areas ranged from 30 to 6,340 acres.

Visual estimates of defoliation on plot trees, and pupal counts made in the same localities, are shown in Table 2. The average number of pupae in areas of medium and heavy defoliation was about the same. There was, however, no way of knowing what 2.0 pupae per square foot meant in terms of expected larval population or defoliation. Although chemical control was not recommended, the need for such action was considered a possibility in 1961.

Efforts were made in the spring of 1961 to appraise the anticipated outbreak. Of 75 pupae collected and caged for adult emergence, only four produced moths, twenty were parasitized, and the remainder died of other causes. The moth flight at the end of May was very light, and only a small number of eggs was found in limited sampling. At this point it was believed that the 1961 population would be too small to cause appreciable defoliation. The predicted drop in larval numbers was confirmed by the reduced numbers obtained in beating samples (Table 1), and by the relative number of larvae per sample collected from the same points in 1960 and 1961. Some of these were (1961 in brackets): White Pine Cove, 444 (11); Herbert Inlet, 262 (4); Beddingfield Bay, 460 (40); Millar Channel, 486 (120); and Tofino Inlet, 215 (28).

Natural Control

Parasites — The effect of parasites on the large population of 1960 is not fully known as no samples were

TABLE 2.—Defoliation and Numbers of Green-striped Forest Looper Pupae at Sample Plots. September, 1960.

Locality	Degree of defoliation represented[1]	Percentage defoliation (western hemlock)	Av. no. pupae per sq. ft. of duff
Ououkinsh Inlet	light	21	0.44
Port Eliza	medium	54	0.46
Millar Channel	”	32	2.02
Beddingfield Bay	”	40	1.92
Eelstow Passage	heavy	50	1.46
Villaverde Is.	”	91	2.06
Bligh Is.	”	81	0.50

[1] Defoliation limits determined by aerial survey.

obtained from most of the more heavily infested areas. Of 563 larvae collected up to early September and reared, only 28 or five per cent died of parasites. Of 133 larvae collected after mid-September, 70 per cent died of parasites, and of a total of 317 pupae collected, 104 or 32.8 per cent were parasitized.

The figure of 70 per cent larval parasitism may be unreliable. As these collections were made late in the season, many healthy larvae might have already dropped to the duff and pupated, leaving the retarded parasitized larvae on the trees. The figure of 32.8 per cent pupal parasitism appears to be more reasonable, and is supported by collections made in the spring in which 26.7 per cent of the pupae died of parasites.

Seven hymenopterous parasites were reared from the 1960 collections. *Dusona pilosa* (Walley) and *Astiphromma strenuum* Holmberg were the major larval parasites and were recovered only from larvae. Other species reared from larvae were *Euceros thoracicus* Cresson, *Meteorus* sp., and *Zele* sp. *Aoplus cestus* (Cresson) was the most numerous pupal parasite, followed by *Gravenhorstia alaskensis* Ashmead. Three *E. thoracicus* Cresson were also reared from pupae. It is not certain if the numbers of parasites recovered from rearings are related to their importance as control factors in the field population.

Disease—On May 5, 1960, while searching for pupae, small orange fruiting bodies about ½ inch long were observed protruding from the duff. In every case these grew out from a *Melanolophia* pupa. The fructifications were identified as the perfect state of *Cordyceps militaris* (Fr.) Link. The fruiting bodies were plentiful in early May but appeared only in shaded locations at the end of the month. Sampling was not intensive enough to determine the control exerted, but it is believed that *C. militaris* caused considerable pupal mortality, and was probably one of the factors involved in the population decrease in 1961.

Defoliation and Tree Mortality

Defoliation estimates, made by crown levels and crown classes, show that feeding was, without exception, heaviest in the upper crown levels of all classes of trees. Trees of all crown classes from suppressed to dominant were fed upon, but defoliation was heaviest in the intermediate trees.

Mortality, in the plots analysed, was restricted to trees which were 90 per cent or more defoliated. Most of the remaining trees in this defoliation class were top-killed; in some instances the upper 2/3 of the crown was dead in 1961. Although no mortality occurred among trees with less than 90 per cent total defoliation, top-kill occurred among those which were less than 50 per cent defoliated.

Aerial and ground surveys indicated that mortality occurred only in the stands which had been heavily defoliated in 1960. The heaviest damage occurred on Villaverde Island where loss was calculated at 7,300 cu. ft. per acre for the 260 acres. Average tree mortality for the remainder of the area was calculated at 116 cu. ft per acre. Total mortality, up to the fall of 1961, was estimated at 2,400,000 cu. ft. of western hemlock. This figure could be conservative as some trees which were heavily defoliated may die in the next one or two years.

Discussion

The rapidity with which the greenstriped forest looper population increased to tree-killing proportions and then collapsed, allowed little time to obtain specific data on sampling techniques. With the exception of the occurrence and average number of larvae per collection no data were obtained to show correlation between population levels and defoliation. Although pupal counts were made in the fall of 1960, there was no way of determining if the numbers found represented a potentially dangerous population. Because of the reduced population in the spring of 1961 it was not feasible to develop a method for sampling eggs.

A number of natural control factors contributed to the decrease of the population. Larval parasites, although not numerous enough to exert any great degree of control, were present in appreciable numbers. Pupal parasitism accounted for about 30 per cent mortality in the overwintering population, but does not account for the heavy pupal mortality and the resulting low moth emergence. *Cordyceps* is an unknown factor, but could have played a significant role in the collapse of the outbreak.

One of the aspects in the outbreak which is difficult at this time to explain is the severe tree mortality on Villaverde Island. Aerial surveys, supported by ground observations, indicate that tree mortality was relatively light on Bligh Island, although it is near Villaverde Island and also received heavy defoliation.

The nature of the recent infestation points out one of the great difficulties in dealing with looper outbreaks. The population started to increase throughout most of Vancouver Island (in fact throughout most regions of the Vancouver Forest District) in 1958, and reached a level in 1959 which must now be regarded as dangerously high. Populations remained high or increased in 1960 only in isolated localities along the west coast of Vancouver Island; elsewhere the number of larvae dropped. Defoliation heavy enough to be observed from the air occurred in 32 localities, totalling less than 23,000 acres, scattered along 80 lineal miles of inaccessible coast line. Of this area only 4,640 acres were heavily defoliated, and over three-quarters of the total tree mortality of 2,400,000 cu. ft. occurred on a few small islands of only 260 acres. If future outbreaks follow a similar pattern very comprehensive and detailed surveys would be required to detect and take action to prevent such heavy mortality from occurring again on other small islands or inlets along the coast.

Summary

The green-striped forest looper which started to increase in 1957 reached severe outbreak proportions in 1960 in a large number of small separate localities along the west coast of Vancouver Island. The population decreased to a low level in 1961. Tree mortality, up to the fall of 1961, was estimated at 2,400,000 cu, ft. of western hemlock.

This species must be added to the growing list of defoliators capable of causing damage to forests in British Columbia.

Note on the reference collection of inflated larvae at the Forest Entomology Laboratory, Vernon, B.C.

Over the past few years the reference collection of inflated larvae of lepidopterous and hymenopterous tree defoliators has been expanded greatly. The collection is chiefly used as a reference aid in identifying larvae taken in Survey collections or submitted by persons in forest industry and related fields.

Represented in the collection are:

	Lepidoptera	Hymenoptera
Families	34	6
Genera	209	20
Species	350	23

The collection contains most common and many uncommon defoliators found in the forests of interior British Columbia. The lepidopterous families are represented by a varied number of species; for example, the collection contains 130 species of Geometridae, 75 species of Noctuidae and 15 species of Notodontidae. The total number of inflated larvae is about 1,530.

This note is published to make local entomologists aware of the existence of the collection and to invite them to use it.

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POPLAR BORER, SAPERDA CALCARATA SAY, IN INTERIOR BRITISH COLUMBIA

C. B. Cottrell[1]

Introduction

The poplar borer, *Saperda calcarata* Say, has caused extensive damage in open-growing stands of trembling aspen, *Populus tremuloides* Michx., in the Thompson and Nicola valleys. Although aspen is not considered a commercially important tree in this area, groves or belts of aspen provide shelter from wind and shade for cattle, and reduce soil erosion.

Complete data on the life history of the poplar borer in British Columbia are lacking. According to L. O. T. Peterson (1945), in Saskatchewan adults of the poplar borer emerge during the last part of June and most of July, usually in the fourth year of development. Egg-laying has been observed from July 2 to August 13. The collection of the Forest Entomology Laboratory at Vernon contains adults taken in interior British Columbia from June 27 to August 26.

Damage

The poplar borer is frequently found damaging trees at elevations under 3000 feet in the Thompson Valley from Kamloops to Spences Bridge, and from there to Stump Lake in the Nicola Valley. Smaller infestations in trembling aspen have been observed at Victoria, Vernon, Clinton, Lac La Hache, 158 Mile House, Williams Lake, Vanderhoof and Prince George. Larvae tentatively identified as *S. calcarata* were taken from a black cottonwood (*P. trichocarpa* Torr. and Gray) near Cache Creek. This is the only indication that *S. calcarata* may attack black cottonwood in interior British Columbia. Attacks have been recorded on several other species of poplar in eastern Canada and in the United States.

In most infestations only a few aspen trees have been killed. Even five-inch d.b.h. trees with up to 120 entrance holes on the main stem continue to live. Usually, attacked trees become disfigured and stunted; large swellings are often found on the bole around entrance holes and sometimes large branches and the tops of trees die. Of 170 trees in one grove at Kamloops, 10 per cent were dead and of 266 trees in a grove at Knutsford eight per cent were dead apparently from poplar borer attack.

TABLE 1—Average Diameter of Healthy and Infested Trees in Five Trembling Aspen Plots Attacked by Poplar Borer in the Thompson and Nicola Valleys, 1961.

Location	No. trees examined	Percentage trees infested	Av. d.b.h. healthy trees	Range d.b.h. infested trees	Av. d.b.h. infested trees
Kamloops	170	65	6.8	3-15	7.7
Knutsford	266	47	5.2	3-11	5.6
Cache Creek	51	51	8.0	3-14	8.0
Quilchena	49	41	5.6	3-10	5.8
Merritt	67	61	5.9	4-10	6.7
Average d.b.h.			6.0		6.6

It was observed that trees on the perimeter of pure stands of aspen on rangeland were the most heavily attacked, especially those in the portion of the grove with a north and east exposure. Very few attacks have been

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TABLE 2—Location and Number of Attacks by the Poplar Borer on Trembling Aspen in Sample Plots in the Thompson and Nicola Valleys, 1961.

Location	No. attacked trees examined	Av. no. attacks per tree section: Clear bole, Lower	Clear bole, Upper	Crown, Lower	Crown, Upper	Av. no. attacks per infested tree
Kamloops	110	1.3	4.6	17.7	8.1	32
Knutsford	124	0.4	4.5	5.9	0.7	12
Cache Creek	26	0.6	2.2	2.7	0.4	6
Quilchena	20	0.6	1.3	1.4	0.3	4
Merritt	41	0.7	2.7	0.8	0.1	4

observed on aspens growing in coniferous forests.

Five plots were established in the Thompson and Nicola valleys to record the number and size of trees attacked (Table 1), and the number and location of attacks on individual trees (Table 2).

No aspen trees under three inches d.b.h. were attacked and a preference was shown for trees in the five to eight inch d.b.h. class. A few trees as large as 15 inches d.b.h. were attacked.

In four of the five plots, the highest number of attacks occurred in the lower crown where often large branches were attacked. The next highest number of attacks was found on the upper clear bole, except in the Kamloops plot. In general, most attacks were concentrated near or included the first three or four large branches of the lower crown.

Some poplar borer attacks have been found on apparently healthy aspen trees, but in most of the Thompson and Nicola Valley infestations the poplar borer is associated with a carpenter worm, believed to be *Prionoxystus robiniae* (Peck), and has attacked aspen trees weakened by other pests such as satin moth, *Stilpnotia salicis* (L.).

Reference

Peterson, L. O. T. 1945. Some aspects of poplar borer, **Saperda calcarata** Say, (Cerambycidae) infestations under parkbelt conditions. Contribution No. 2528. Division of Entomology, Department of Agriculture, Ottawa.

Additional Notes on Nymphalis californica Bdv.

This is a sequel to my contribution regarding this species up to January 1961 (Proc. Entom. Soc. Brit. Columbia 58: 32, 1961).

On March 13, 1961, two specimens were seen on a sheltered hillside at Royal Oak on Vancouver Island. From then on it was often seen up to May 18, after which it disappeared from my notice.

No migratory tendency was observed until about May 18 when a definite drift to the northeast against a light northeast wind was clearly marked. They were flying in ones and twos at widely spaced intervals. Occasionally one would alight on a lilac flower or, on higher ground, on manzanita, soon to resume their northeastward journey.

Dates and localities include: Mt. Finlayson, May 16; Little Saanich Mountain, May 17; and the Langford district May 18. A few stragglers were reported from the general area up to May 21.

In the past this butterfly has disappeared from Vancouver Island after each visit, but showed up again in numbers from September 11, 1961. Evidently it is going to duplicate last season's record.

I have no information as to where it spent the period between May 21 and September 11, 1961, or whether it spent the larval stage on any plant other than Ceanothus, which is absent in this district; or whether it migrated from the mainland as usually seems to be the case.

—*George A. Hardy, Provincial Museum (Rtd.), Victoria, B.C.*

NOTES ON THE LIFE HISTORIES OF ONE BUTTERFLY AND THREE MOTHS FROM VANCOUVER ISLAND (LEPIDOPTERA: LYCAENIDAE, PHALAENIDAE AND GEOMETRIDAE)

George A. Hardy[1]

Strymon sylvinus Bdv.

Five species of *Strymon* are recorded for British Columbia, but only 2 of these on Vancouver Island. They are all small butterflies with a wingspan averaging 25 mm. The wings of *S. sylvinus* are dark brown above with orange spots in the anal angle of the secondaries; below, they are characteristically brownish-ash dotted with black.

Two females taken in the Malahat district on August 5, 1960 were confined over twigs of *Salix mackenziana*. By August 7 several ova were laid in the axils of the leaf scars close against the stem, in a row of two to six. Here they remained for the following winter.

Ovum

Size 0.8 mm. by 0.5 mm., turban shaped, coarsely reticulate, adjoining angles projected into blunt hyaline spines; light fuscous brown with an olive tinge, becoming whitish towards maturity. Hatched April 2, 1961.

Larva—1st Instar

Length 1 mm. Head small, retracted into T. 1, dark brown. Body tapering from the head, pale brown, with 2 paler lines on the dorsum, and 4 rows of short, stiff, curved hairs directed forward on the T. segments, but backwards on the rest. It fed on the under side of the willow leaves, eating small holes in the epidermis.

2nd Instar

April 26. Length 3 mm. Head black. Body onisciform, pale green, with 4 whitish stripes along the dorsum, their margins blending into the ground colour; hairs short and distributed over the body.

[1] Provincial Museum, Victoria, B.C. (Rtd.)

3rd Instar

May 20. Length 11 mm. Head nearly quadrate, narrow above, dark brown. Body onisciform, tapering dorsally and laterally from the T. segments; pale green sides, having a dark green dorsal stripe with yellow margins, broad on the T. segments, tapering to a point on A. 8; 10 double, oblique, faint, whitish lines on each side; spiracular line yellow; underside dark green; short pubescence chiefly in 4 rows; small white mushroom-shaped bodies thickly sprinkled over the whole body.

May 25. Length 17 mm. Full grown. Turned to dark purplish just before pupation, which took place on the underside of a piece of bark. The larva spun a silken mat and put a strand of silk round the thorax. Pupated June 1.

Pupa

Size 12 mm. by 5 mm. Dull, with an irregular band of short brown setae along the juncture of the upper and lower surfaces, and a few thinly scattered hairs on the upper side of the A. segments. Dark mahogany brown. No cremaster noticeable.

Imago

Emerged June 20, 1961.

Euxoa vetusta Wlk.

A female taken at rest in Saanich, laid about 300 ova in a loose pile on the bottom of the box, by September 14, 1960.

Ovum

Size 0.75 mm. by 0.50 mm. Hemispheric, smooth, faintly close-ribbed and cross-ribbed; white, turning in a day or so to pale cream with a pink dot in the centre and a broken ring of the same colour round the shoulder. Hatched September 26.

Larva—1st Instar

Length 2.5 mm. Head smooth, dark brown. Body dull grey, soon showing signs of green from ingested food; cervical plate dark brown. Fed on *Plantago lanceolata, Trifolium alba,* and later *Hypochaeris radicata.* They showed a marked preference for the latter.

By October 2 they were sluggish, tending to congregate in a heap beneath the herbage. General colour brown with fine whitish broken subdorsal lines.

2nd Instar

October 12. Length 6 mm. Head medium brown. Body olive grey with a pair of dark marks like parentheses on the dorsum of each segment, and a dark fuscous line just above the black spiracles; tubercles shiny, black; the underside dark olive-green. They dropped from the leaves at the slightest disturbance, and fed at night.

3rd Instar

October 24. Length 8 mm. Appearance similar to the second instar. They grew slowly and showed some tendency to hibernate.

4th Instar

November 22. Length 14 mm. Head shiny, dark brown with darker patches on the sides. Body with a dark grey dorsal band edged with fuscous and a faint, double, fuscous doral line; the sides with a lightly banded effect of grey, beige, and fuscous; spiracular line light grey, the edges blending into the ground colour; tubercles shiny, black and conspicuous; underside, legs and claspers dull grey; cervical plate dark brown with 3 white longitudinal lines.

5th Instar

December 20. Length 35 mm. Head, pale brown with broad oblique dark brown bar on each side, the rest faintly reticulated with the same colour. Body ground colour pale clouded grey, with a faint double dorsal line, subdorsal lines thin, pale fuscous; spiracular line indicated by a suffused fuscous line along the row of black spiracles; tubercles shiny black, prominent, larger along the subdorsal lines; underside and claspers pale grey; the legs pale brown. The larvae were geotropic, and moved up to feed at night.

6th Instar

April 19, 1961. Length 35 mm. Head as described. Body integument grey, tough and leathery; the subdorsal lines faint, broken, and light grey; the sides with a wavy darker grey band just above the indistinctly light grey spiracular line; tubercles black and conspicuous. They pupated in earthen cavities beneath the moss about the end of May.

Pupa

Size 18 mm. by 5 mm. Smooth and shiny, the anterior border of the A. segments finely punctate; dark piceous brown; cremaster 2 short, straight, slightly divergent spines at the tip of the last segment.

Imago

Emerged from July 14 to July 20, 1961.

Remarks

The data above were obtained from 2 groups of larvae from the same batch of ova. On October 24, 1960, about half were put with earth, moss and a food supply into a 10-inch flower pot, which was placed outdoors under the eaves of the south wall of a house. The remainder were kept indoors. Those kept outdoors hibernated on cold days, feeding infrequently in mild weather; those kept indoors continued to feed and grow slowly. On January 21, 1961, the outdoor group averaged 10-15 mm., while the indoor group averaged 30-35 mm. in length. Under normal conditions the larvae go into hibernation after about the second moult, resuming activity in the following spring.

Most of the outdoor group successfully completed the metamorphosis, but the indoor group died before pupating, apparently from inability to feed rather than from disease.

Xylomiges simplex Wlk.

Eight of the 10 species of *Xylomiges* recorded in British Columbia are from Vancouver Island. They form a compact group in size, general appearance, and time of flight, which is usually early in the season.

X. simplex has a wing expanse averaging 40 mm. It is light ash grey marked with an intricate pattern of black bars, lines and dots. It is on the wing from March to May.

A female taken at Royal Oak on March 24, 1961 had laid 300 ova by March 27. They were in a single compact layer on the side of the container. In another case the ova were disposed in several groups, but always in a single layer.

Ovum

Size 0.9 mm. by 0.5 mm. A depressed hemisphere with about 50 close-set ribs; pale cream with a greenish tinge, turning pink by March 31, and lead grey by April 18. Hatched on April 21.

Larva—1st Instar

Length 2 mm. Head smooth, shiny, jet black. Body translucent, whitish soon becoming green with ingested food; cervical plate black; tubercles black and conspicuous. After trying many plants the larvae finally ate *Alnus rubra*. They concealed themselves in folded leaves or between 2 leaves held together by a few strands of silk.

2nd Instar

May 5. Length 6 mm. Head as described. Body fuscous green; cervical plate black with lines coinciding with the doral and subdorsal lines, which were thin and whitish; tubercles prominent, black-ringed with white at their bases; spiracular line thin and white, with black spiracles; underside fuscous; legs and claspers black.

3rd Instar

May 16. Length 15 mm. Head as described. Body dark fuscous olive-green; cervical plate as described; dorsal and subdorsal lines thin and milk-white; spiracular line broad, yellow, threaded with a suffused rusty tinge along the centre; tubercles black, each bearing a short white hair; underside dark olive green; legs and claspers black. Each larva rested in a half curled position between 2 leaves or in a fold of a single leaf.

4th Instar

May 23. Length 20 mm. Appearance as described. The body with a tinge of yellowish grey; spiracular line orange.

5th Instar

May 30. Length 30 mm. Head round, large in proportion to the body, smooth, shiny, reddish brown. Body suffused with light pink over a yellowish background; dorsal and subdorsal lines very indistinct, pale cream; spiracles black on a pale yellow spiracular line; tubercles hardly discernible; underside concolorous with the upper.

At this stage all the larvae died from some cause unknown. These notes were completed from mature larvae collected in the field in 1960.

Pupa

Size 16 mm. by 5 mm. Smooth, shiny and brown; anterior part of the A. segments finely and closely punctate; cremaster 2 very short, closely set setae with recurved tips and 4 smaller ones at their base, set upon the smooth rounded end of the last segment. The pupae were in cells among the debris at the bottom of the container.

Pero morrisonarius Hy. Edw.

Four species of the genus *Pero* are recorded for British Columbia. All are similar in shape and colour, the wings with mottled shades of brown or grey and a broad central band of darker brown.

From a specimen of *morrisonarius* taken at Royal Oak, ova were obtained on June 6 and 7, 1960. They were laid in small irregular clusters or singly, mostly on raised fibres of the wooden box, affixed by the small end which gave them stalked appearance.

Ovum

Size 1 mm. by 0.75 mm. Broadly oval, smooth, shiny, translucent; pale green becoming dark olive at maturity. Hatched on June 17.

Larva—1st Instar

Length 5 mm. Head light honey-brown. Body very slender; olive green with darker intersegmental rings. They were very active and readily suspended themselves by a thread at the least disturbance. After various trials they ate *Cornus occidentalis*. The food plants listed in the literature are all conifers.

2nd Instar

June 23. Length 10 mm. Head light brown dotted with dark brown on the sides. Body brownish-green; dorsal line faint, dark green, broader on the T. segments and on A. 7 to 9; subdorsal lines lighter green. They spent considerable time suspended by a thread from the cover of the container, especially prior to moulting.

3rd Instar

June 30. Length 18 mm. Head dark brown on the vertex and sides, with a white patch on the front. Body pale olive-brown with several fine, alternately dark and light lines along the dorsum; tubercles noticeably black, 2 on the dorsum of each segment; a short fuscous line on the dorum of the T. segments and segments A. 7 to 9; A. 6 with an arrow-shaped dark brown spot on the centre of the dorsum; underside pale brown with alternate light and dark dashes along the median line. Some larvae had an additional small dark brown spot on A. 7, while others had a larger area of dark brown on the sides of A. 6.

4th Instar

July 6. Length 25 mm. Head notched, dark brown above but whitish below. Body cylindrical, with a slight hump on A. 9, light olive-brown with several faint, thin, pale lines on the dorsum; A. 1 with 2 small irregular brown spots on the dorsum, A. 6 with 2 oblique dark brown dashes on the dorsum followed by a horseshoe spot of the same colour, A. 7 with 2 parallel brown dashes, A. 9 with a dark transverse bar, and a brown patch on each side of the T. segments; tubercles black and conspicuous. The intensity of these markings varied with individuals.

5th Instar

July 20. Length 45 mm. Appearance as described but the general colour more yellowish brown. In one or two specimens the body was uniformly pale brown lightly and evenly freckled with dark brown; underside of A. 3 with a pair of dark brown fleshy tubercles on each side.

Pupated in the moss at the bottom of the container on August 1.

Pupa

Size 14 mm. by 5 mm. Wing-cases dull, roughened by minute etchings and piceous brown, the rest of the pupa smooth, shiny, mahogany-brown; anterior part of the A. segments closely punctate; cremaster 2 parallel, closely set spines with the tips slightly excurved, and 1 or 2 very short, fine hairs with recurved tips, set on a smooth, shiny, sub-conical boss at the end of the last segment.

Imago

Emerged May 31, 1961. Other specimens continued to emerge up to June 18.

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Jones, J. R. J. L. 1951. An annotated check list of the Macrolepidoptera of British Columbia. Entomol. Soc. Brit. Columbia, Occasional Paper 1.

APHIDS OF STRAWBERRIES IN BRITISH COLUMBIA[1]

A. R. Forbes

Considerable interest is being taken in the aphids found on strawberries because of their importance in transmitting viruses. Since 1956 special attention has been given to collecting aphids from strawberries in British Columbia in connection with a major project on strawberry viruses. This paper reports data from the collections.

Methods

From 1956 to 1961, about 75 collections of aphids were made from strawberry fields on the lower mainland and Vancouver Island, which are major strawberry growing areas of British Columbia. Commercial varieties sampled included British Sovereign, Marshall, Siletz, and Puget Beauty. Several collections were also made from strawberries in greenhouses. Some rearing was done in the insectary at Vancouver.

The aphids were preserved in 80 per cent ethyl alcohol and mounted by the method of Hille Ris Lambers (Hille Ris Lambers, 1950; Spencer, 1959). Identifications were made by the author and by Dr. W. R. Richards, Taxonomy Section, Entomology Research Institute, Ottawa.

Only aphids that were actually reproducing on strawberries are discussed in this paper. The alate strays which were frequently found on the plants are not included.

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Species Found

Nine species of aphids were found colonizing on strawberry: *Pentatrichopus fragaefolii* (Cockerell), *Pentatrichopus thomasi* H.R.L., *Macrosiphum euphorbiae* (Thomas), *Myzus ascalonicus* Doncaster, *Aulacorthum solani* (Kalt.), *Fimbriaphis fimbriata* Richards, *Myzus ornatus* Laing, *Aphis forbesi* Weed, and *Acyrthosiphon malvae* subspec. *rogersii* (Theobald). These are listed in their approximate order of abundance.

Discussion

P. fragaefolii and *P. thomasi* are the commonest aphids on strawberry in the area, one or both being present in large numbers in every field examined. Until 1953 both were identified as *P. fragaefolii*. Hille Ris Lambers then recognized two morphotypes: one with 6 marginal capitate setae on abdominal tergites II-IV and one with the 6 marginal plus 6 submarginal setae. Cockerell's type lacked the submarginal setae and so the name *fragaefolii* applied to this species. Hille Ris Lambers named the other *thomasi* (Hille Ris Lambers, 1953 pp. 72-73). *P. thomasi* was identified from British Columbia in 1957 (Forbes, 1959).

The chaetotaxy on which this separation is based is subject to variation however and Hille Ris Lambers recognized this in his description when he said: "In exceptional specimens the inner pair of marginal hairs [submarginals] is absent on most of the mentioned segments [II-IV]." Figure 1 shows the occurrence of these submarginal setae on the 3 abdominal tergites II-IV on 677 adult apterae collected in British Columbia. The variation is considerable but nevertheless populations of the two species can be distinguished.

Intraclonal variation also occurs. Several clones were reared at Vancouver. Of 20 adult apterae examined from one clone, 2 had 5 submarginal setae on abdominal tergites II-IV and 18 had 6; of 15 examined from another clone 2 had 0, 2-1, 2-2, 3-3, 3-5, and 3-6; of 21 from still another clone 1 had 0, 1-2, 2-4, 6-5, and 11-6.

Schaefers (1960) studied the chaetotaxy of these aphids in California and found the same range. This marked variation leads to confusion in separating these species and even raises the question of their validity as species. Further biological study is needed.

As for hosts other than cultivated strawberry in British Columbia, *P. fragaefolii* has been collected from *Rosa* spp. and *P. thomasi* has been collected from *Potentilla anserina* L. and from *Fragaria glauca* (S. Wats.) Rydb.

Pentatrichopus minor (Forbes), which is common on strawberries in eastern Canada, and *Pentatrichopus jacobi* (H.R.L.), recorded on certain wild *Fragaria* species in the western United States (Schaefers, 1960), have not been collected here.

M. euphorbiae (= *solanifolii* Ashm.) occurred frequently on strawberries, usually on the petioles of young leaves or on the runners. In one field this species constituted about 40 per cent of the aphids of the sample but usually it accounted for less than 5 per cent. It was especially common on strawberry in May and it seems likely that it can hibernate on strawberry. This is a polyphagous species.

M. ascalonicus occurred each spring. Damage to strawberries by this polyphagous aphid was first recorded in the spring of 1955 (Andison, 1956). The aphids feed on the blossom trusses and young leaves distorting them and dwarfing the plants. When numerous these aphids cause severe damage from March to early May. It was a serious pest in 1955 and 1958.

When first found on strawberry this aphid was identified as *Myzus persicae* (Sulz.), which it resembles closely. In fact *M. ascalonicus* was collected by R. Glendenning from carrot at Chilliwack, B.C. in October, 1947 and he had tentatively labelled it as *M. persicae* (MacGillivray, 1954). This makes one wonder whether the published records of *M. persicae* on strawberry (e.g. Palmer, 1952) really refer to *M. ascalonicus*. Repeated attempts in the insectary at Vancouver failed to establish *M. persicae* on strawberry (H. R. MacCarthy, unpublished).

A. solani occurred fairly often, especially on strawberries in the greenhouse. Like *M. euphorbiae* it preferred new growth. It too is a polyphagous aphid.

F. fimbriata was described (Richards, 1959) from material collected by the author from Marshall strawberries on Lulu Island. They were first observed there in August, 1956, when a very heavy infestation was present. The species has since been collected from strawberry at Agassiz, Victoria, and Vancouver and from blueberry, *Vaccinium corymbosum* L., at Vancouver.

M. ornatus has been collected several times from strawberry in the greenhouse and in the field at Vancouver. In 1961 it became abundant in strawberry plots on the farm at the University of British Columbia and caused some deformity in the plants. This is another polyphagous species.

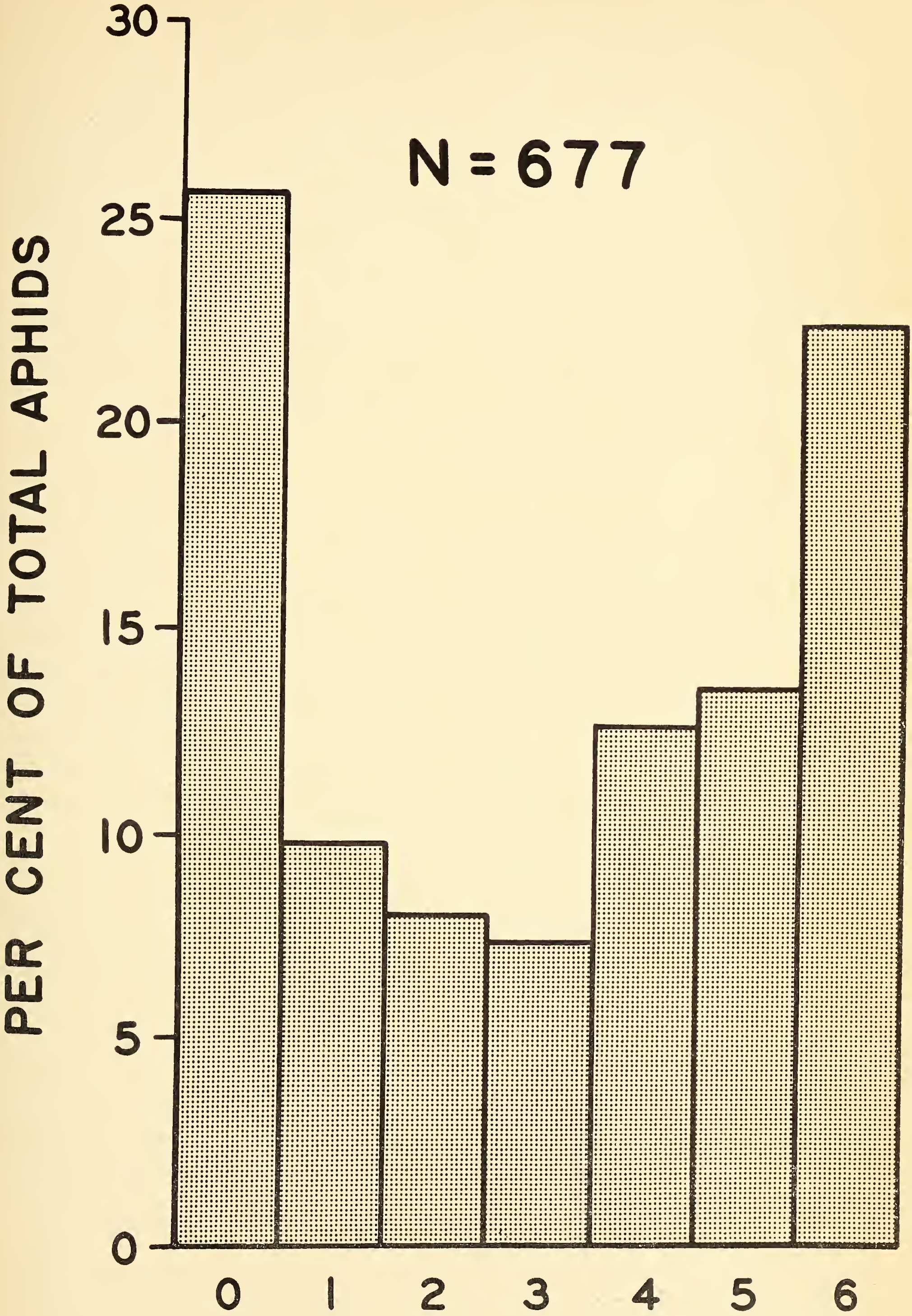

Fig. 1—Number of submarginal setae on abdominal tergites II-IV of **P. fragaefolii** and **P. thomasi** in British Columbia.

A. forbesi was collected in large numbers from the stems and crowns of British Sovereign strawberries in a garden at Vancouver in 1958 but has not been recorded elsewhere in the province. The only other Canadian records of this species according to Richards (1958) are from St. Catharines, Ontario. This species is apparently confined to strawberry.

A. malvae subspec. *rogersii* was collected in small numbers at Vancouver (April 24, 1959; May 5, 1959; May 18, 1960) and at Saanich (June 5, 1959). It is common on strawberry in England and the Netherlands (Hille Ris Lambers, 1947) but has not been recorded from North America before. This subspecies is apparently confined to strawberry.

Of the 8 aphids reported by Massee (1935) as having been recorded on strawberry, only 4 (*P. fragaefolii, A. malvae* subspec. *rogersii, M. euphorbiae,* and *A. forbesi*) are included in the present list. Three other species from Massee's list occur on other hosts in British Columbia but have not been taken on strawberry: *Macrosiphum rosae* (L.) is very common on species of *Rosa; Pentatrichopus potentillae* (Wlk.) has been collected from *Potentilla anserina* L.; and *Amphorophora rubi* (Kalt.) is common on species of *Rubus. Pentatrichopus brevipilosus* Baerg, the 8th aphid on Massee's list, is now thought to be *P. minor* (Schaefers, 1960).

Most of the species of the present list have also been identified from strawberries in the Netherlands (Klinkenberg, 1947). In addition she lists *Macrosiphum (Sitobion) fragariae* (Wlk.), which has been collected from *Rubus* spp. at Vancouver but has not been found on strawberry. Hille Ris Lambers (1939) states that it has as host plants *Rubus* spp. and Gramineae and more rarely *Rosa, Agrimonia,* and *Fragaria.*

Several of these aphids have been tested and found to be vectors of strawberry viruses (Mellor and Forbes, 1960).

Summary

Nine species of aphids were found colonizing on strawberry in British Columbia: *Pentatrichopus fragaefolii* (Cockerell), *Pentatrichopus thomasi* H.R.L., *Macrosiphum euphorbiae* (Thomas), *Myzus ascalonicus* Doncaster, *Aulacorthum solani* (Kalt.), *Fimbriaphis fimbriata* Richards, *Myzus ornatus* Laing, *Aphis forbesi* Weed, and *Acyrthosiphon malvae* subspec. *rogersii* (Theobald). These are listed in their approximate order of abundance.

F. fimbriata was described from strawberry in British Columbia in 1959. It also occurs on *Vaccinium. A. malvae* subspec. *rogersii* has not previously been recorded from North America.

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Resistance to insecticides in root maggots in British Columbia

Considerable experimentation by entomologists of the Victoria, Agassiz, Chilliwack, and Kamloops laboratories resulted in effective controls for onion maggots, **Hylemya antiqua** (Meig.), in onions; cabbage maggots, **Hylemya brassicae** (Bouche), in cole crops; and carrot maggots (carrot rust fly), **Psila rosae** (F.), in carrots, parsnips, and celery. Each control included one or more of the cyclodiene group of chlorinated hydrocarbons.

Until 1957, damage to onions was reduced below one per cent by using dieldrin applied to the seed. In 1957 damage at one location near Vancouver was above 75 per cent and great numbers of maggots were present. In 1958 damage was general wherever onions were grown commercially in B.C. Puparia sent to Oregon State University, Corvallis, for toxicological testing showed that maggots from Vancouver, Vernon, Kamloops and Kelowna were resistant to dieldrin and heptachlor but still susceptible to DDT and malathion.

In 1959 reports of poor control of cabbage maggots near Victoria on Vancouver Island indicated that resistance had developed. Puparia from the fields concerned and from fields near Vancouver were sent to the Entomological Laboratory, Chatham, Ont., for testing. The results showed that flies from the fields on Vancouver Island had a high degree of resistance to cyclodiene hydrocarbons but were still susceptible to the phosphate Diazinon. Flies from the lower mainland were still susceptible to both types.

In 1961 loss of the first planting of carrots at Colony Farm, Essondale, signalled resistance in carrot maggots. Puparia from this field were sent to Chatham for testing. The results showed a high degree of resistance to the cyclodiene insecticides but susceptibility to phosphates.

Resistant cabbage and carrot maggots occurred only in isolated pockets until the summer of 1962. Then resistant cabbage maggots were reported and later confirmed from Abbotsford and Cloverdale, the two principal cole crop areas of the lower mainland. Uncontrolled damage in 1962 to first planting carrots at Colebrook and to second planting carrots at Cloverdale with later confirmatory tests showed that resistant carrot maggots had become established in those areas.

An alarming feature was the very large numbers of each species at locations where resistance developed. We are now faced with the problem of reducing the population to acceptably low numbers using control practices that are not entirely satisfactory.

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THE TICK REFERENCE LIBRARY AT KAMLOOPS, BRITISH COLUMBIA, AND ITS APPLICATION TO TICK STUDIES IN CANADA

J. D. Gregson[1]

The tick reference library at Kamloops consists of about 5000 references on 5 x 8 cards, together with more than 1200 reprints. Because there is no comparable library elsewhere in Canada and because it may be of service to those engaged in related fields of study, particularly those of zoonosis, it is timely to draw attention to its main headings. Its role in aiding present studies on ticks is exemplified by references to current and future problems on these parasites.

The ticks of Canada received their first recognition through C. G. Hewitt, when, as the Dominion Entomologist at Ottawa, he published "A contribution to the knowledge of Canadian ticks" (Hewitt, 1915). He cited sixteen species and emphasized the importance of ticks as carriers of serious diseases to man and animals. Only seven of the names then listed remain unchanged in the present list of over thirty species recorded in Canada (Gregson, 1956). On the other hand, the cause of the disease, tick paralysis, which had been recognized then only for three years, is still little understood.

Projected research on ticks did not begin until 1928 when Eric Hearle, Officer-in-Charge of the newly-established Dominion Entomological Laboratory at Kamloops, commenced his studies on insects affecting livestock and man in British Columbia. Kamloops has since remained the center for tick studies and attention has accordingly been paid to the compilation of references pertinent to this work. At first these were mainly confined to North American publications on taxonomy, with little regard to tick-borne diseases south of the forty-ninth parallel. As knowledge of bird migrants and parasites increased and as world-travel became an everyday occurrence it became increasingly important to recognize species of ticks and diseases transmitted by them that were of potential importance to Canada. Similarly, as literature on ticks increased, it became desirable to refer to any fundamental research being done elsewhere on species similar to those in Canada. Thus the reference library now covers every aspect of tick research that has come to the writer's attention, including publications on tick-borne diseases, for these frequently contain information on the vectors and their hosts. Reprints have been secured wherever possible. However, complete works of foreign publications and their translations are often difficult to obtain. A third of the references to ticks and tick-borne diseases, for example, are in foreign languages; more than half of these are in Russian.

An arbitrary filing system was adopted to include the main sections on systematics, morphology, tick-borne diseases, and control. However, because many of the references referred to data on more than one of these subjects, priority was given to the first category. References to specific ticks are filed according to their respective genera; those containing several genera are filed under a "grouped" heading. For convenience Nearctic references are filed separately. When the emphasis is on morphology, disease, or control, they are filed under these headings or

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subheadings thereof. To date no attempt has been made to cross index the individual references for subject matter, or to make an author index of the whole series. Both are desirable.

1. Systematics

Over 1500 separate references are in this category. The vast amount of information in many of the foreign works, Russian in particular, can be extracted only as the publications are acquired and studied. Such papers on Old World species, their hosts and habits, have much to offer when compared with our own studies, for in Canada we are in a favourable position to appraise our north-western species in terms of Holarctic origins. Considered in this light, it is important to speculate on their capacity to transmit tick-borne diseases at present confined to Asia and Europe.

Looking southwards, an observant eye must be kept on all Nearctic records and descriptions of ticks, particularly those which may be transported on bird or bat migrants. Recent taxonomic studies of certain argasids in this group have cast doubt on the identity of at least one species that is presumed to have been brought in on a bird. Past records of ticks from caves, seashore retreats, beaver houses, burrows, and human dwellings, have shown that they may well extend their normal range in such protected conditions; the biology and epizootic significance of southern species cannot be ignored. Amongst species occurring in Canada are taxonomic problems of variation in size, host specificity, and distribution which can profitably be compared with similar findings in the U.S. and other parts of the world.

2. Morphology

This section contains over 600 references and is broken down to include anatomical observations, studies on behaviour and physiology, reproduction, and feeding. Histological and embryological studies go back little further than 1900. Since then there have been several major works on the feeding mechanisms of various members of the Ixodoidea, the last originating from this laboratory in 1960, but controversy and ignorance still exist over the exact function of certain structures of the sucking apparatus. Considerable study in Europe has also been made on the cuticle of ticks in relation to water balance; again, experience has shown that these researches could profitably be extended to cover local species.

References to the behaviour of ticks cover such challenging subjects as host specificity, dispause, photoperiodic rhythm in feeding, questing habits, attractants, and phenological correlations. Knowledge of any one of these topics can aid our search for better methods of tick control; taken together they represent the intricate relationships that exist between the tick, its environment, and its host.

Studies on parthenogenesis, fertility, the egg waxing organ, and other aspects of reproduction are of special significance to local population research. This becomes apparent when it is realized that the potentiality of tick population is measured largely in terms of the several thousand eggs that a female lays. Because mating causes an increase in the engorging rate of female *Dermacentor andersoni* Stiles, these studies are also of interest at Kamloops where attempts are being made to feed ticks by artificial means.

3. Tick-Borne Diseases

There are over 2000 references to tick-borne diseases, with emphasis on Texas fever, Rocky Mountain spotted fever, tularaemia, relapsing fever, tick paralysis, Q fever, and Colorado tick fever, all of which occur in North

America. Except for Texas fever, all have been recorded in Canada. Since British Columbia is unique in having a greater tick paralysis problem than anywhere else in the world, the 350 references to this disease are particularly complete. In addition, there are about one hundred references to kindred conditions of toxicity produced by tick bite.

The value of these references to disease will be not so much in their practical use as in providing data for a fundamental picture of tick-borne disease potentialities. In Canada, particularly in British Columbia, are heavy populations of ticks at the border of many urban areas. The fact that these ticks are largely free of virulent forms of disease should not be accepted as a fortuitous circumstance—rather, it should be studied as a phenomenum peculiar perhaps to our latitude, and correlated with records of the complex interrelations that exist between ticks, their hosts, and their geographic positions.

4. Control

Five hundred references to control show that ticks have been fought mainly by sprays and dips of arsenicals, and recently of chlorinated hydrocarbons. Resistance to chemicals has appeared in South Africa, Australia, Brazil, and the United States. To date none has occurred in Canada; the brown dog tick (*Rhipicephalus sanguineus* (Lat.)) will probably be the first to show resistance here. Russian references to the control of ticks on vegetation by smokes, dusts, and sprays, and to their elimination by manipulation of either their natural or domestic hosts are of importance, particularly in relation to tick-wild-life complexes in Canada. Although tick parasites have been studied and released on many occasions, there is a lack of information on other means of natural control, such as predation and tick diseases. Voles and ground beetles have been cited as devouring ticks, and there is one reference to a fungus attacking the genitalia of ticks. The causes of fluctuations in the population of ticks in British Columbia are largely unexplained. In North America the tick parasite, *Ixodiphagus texanus,* has been taken as far north as Idaho; in Africa the northward movement of similar parasites has been observed in a parasitized tick on a migrating bird. It has not been determined whether such parasites play a part in British Columbia.

Hewitt hoped that the meagreness of his records would stimulate others to add to the knowledge of a group which offered problems of unusual interest. Since his time there have been about ninety publications on ticks and tick-borne diseases in Canada; more than a third of which pertain to tick paralysis. Although much fundamental research remains to be done there is little doubt that his wish is being fulfilled.

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OVIPOSITION OF THE CABBAGE FLY, HYLEMYA BRASSICAE (BOUCHE) (DIPTERA: ANTHOMYIIDAE) IN COASTAL BRITISH COLUMBIA[1]

A. R. FORBES

The cabbage maggot, *Hylemya brassicae* (Bouche), is the most serious pest of cole crops in British Columbia (Forbes and Finlayson, 1957). Its biology was studied from 1947-1956 in connection with extensive field experiments which resulted in highly effective control measures with chlorinated hydrocarbon insecticides. By 1960 a strain of *H. brassicae* resistant to the chlorinated hydrocarbons was established on Vancouver Island. This paper records results of the 1947-1956 oviposition studies which may be useful in efforts to achieve control of this pest again.

Methods

Most of the observations were made on cabbages and rutabagas grown in loamy sand or clay loam on a single farm near Victoria. Egg counts were made in 1956 on cabbages grown in sandy loam at Vancouver.

The beginning of egg-laying each year was determined by searching for eggs in the soil around large numbers of seedlings in seedbeds and young transplants in the field as frequently as possible during April and early May.

The eggs around each of 10 plants were counted twice weekly during the oviposition period of the years 1952-1956. The same plants were used for each count, except that young cabbage plants were substituted as the older ones matured and were harvested. All the eggs found were removed with a moistened camel hair brush.

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Results and Discussion

At Victoria the flies began to emerge from the overwintered puparia during the first long warm period during April or May and began to lay eggs about a week thereafter. In the 9 years under study, the earliest and latest dates for the start of egg-laying were April 23 and May 8, respectively (Table 1.).

TABLE 1.—Beginning of egg-laying by the cabbage fly, **Hylemya brassicae** (Bouche), at Victoria, B.C., 1947-1956.

Year	Date
1947	April 23
1948	April 26
1949	April 25
1950	May 8
1951	May 3
1952	April 24
1953	April 24
1955	May 2
1956	May 2

Representative egg-count data are presented graphically (Fig. 1).

These data and others not reported show that eggs are laid throughout the growing season but that 3 periods of relatively heavier egg-laying occur. The times of this heavier egg-laying varied with the season but were generally in May, mid-June to mid-July, and mid-August to mid-September. Field observations and cage studies showed that these periods of heavier egg - laying followed closely the appearance of overwintered, first, and second generation flies and therefore represent the times of deposition of most of the first, second, and third generation eggs.

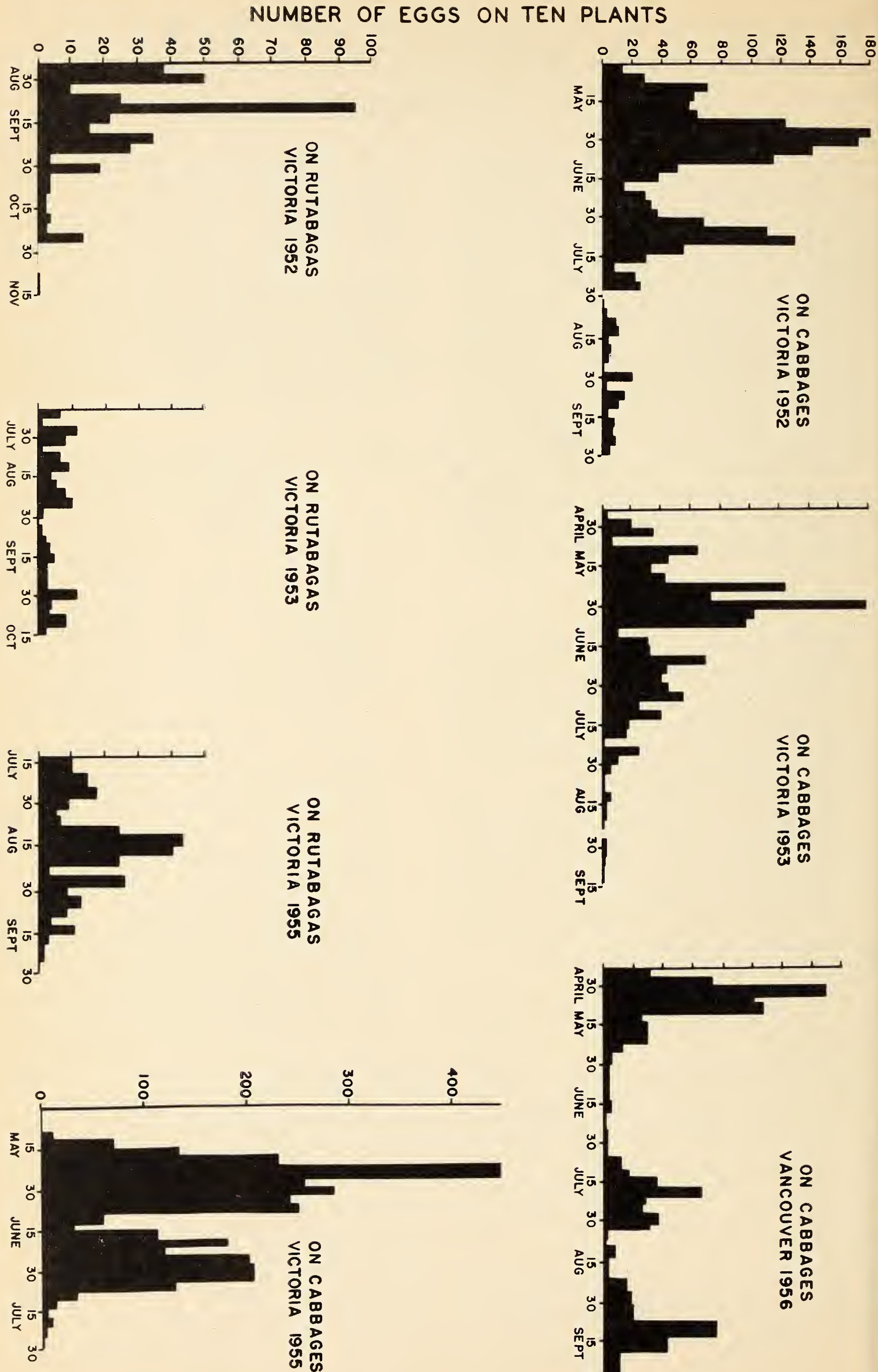

Fig. 1.—Oviposition by the cabbage fly, **Hylemya brassicae** (Bouche), in British Columbia.

Egg deposition in spring appears to be heavier than in summer (Fig. 1). This has also been noted by Gibson & Treherne (1916) in British Columbia, by Miles (1953) in England, and by de Wilde (1947) and Yaman (1960) in the Netherlands. Miles considers that this is not due to lack of adults but rather to the fact that the environment in summer provides little food to sustain the adults and as a result they do not survive to complete oviposition. De Wilde implicates parasites, predators, and weather conditions. In the localities of the present studies still another factor was involved: as the season advanced there was present a progressively greater acreage of cole crops over which the eggs were distributed and while the egg-laying of each generation may have been equal or even successively greater, the number of eggs to be found on a sample of 10 plants was smaller.

In coastal British Columbia early cabbages attract large numbers of first and some second generation eggs. Later cabbages attract some first and some third but mostly second generation eggs. Since rutabagas are not usually seeded until late June and are not favored for oviposition until mid-July, they receive mostly third generation eggs.

Summary

Oviposition studies in coastal British Columbia from 1947-1956 showed that the cabbage fly, *Hylemya brassicae* (Bouche), begins to lay eggs in late April or early May. Some eggs are laid throughout the growing season but periods of heavier oviposition occur in May, mid-June to mid-July, and mid-August to mid-September. These are the times of deposition of most of the first, second, and third generation eggs.

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Fig. 1.—Lead casts of galleries formed by wood-boring cerambycid larvae, **Monochamus** sp., displayed in a plastic cylinder. —Photo by J. C. Holms.

A METHOD OF DEMONSTRATING THE FORM OF LARVAL GALLERIES OF WOOD-BORING INSECTS[1]

N. J. GEISTLINGER AND D. W. TAYLOR[2]

A method of displaying the characteristics of the larval galleries of wood-boring insects was developed by using lead casts of the galleries. A dry section of log that had been infested with cerambycids was split longitudinally into several pieces to expose a larval gallery. Larval boring shreds were removed and the gallery was cleaned throughout its length. The pieces of log were then reassembled to form a mould held in place by wire or clamps.

The entrance hole of the cleaned gallery was sealed with adhesive tape, and molten lead was poured into the exit hole. After the lead in the gallery mould had hardened for three to five minutes, the wood was carefully chipped away. The cast was then separated from the wood and dressed with a coarse file, taking care not to alter its shape or the size of the entrance and exit holes.

A demonstration model was constructed by cementing the gallery casts, in natural positions, into a hollow, transparent plastic cylinder 20 inches long, and 6 inches in inside diameter with walls ⅛ inch thick. Holes of 3/16 inch diameter were made with an electric hand drill through the walls of the cylinder at the position of the entrance and exit hole for each cast. These holes were shaped with a small round file to receive each end of the lead cast. The casts were painted and then cemented into place with Lepage's Model "B" (No. 440) airplane cement.

The cylinder was set vertically in a heavy wooden base (Fig. 1). A thin circular sheet of plastic was cemented to the top of the cylinder to keep out dust.

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SOME TECHNIQUES IN INSECT PHOTOGRAPHY

D. H. Oldershaw[1]

Insects are very small compared to man. Since average cameras are built for panoramic and human photography, this means that to photograph small objects extra equipment is necessary such as extension tubes, telephoto lens or multi-lens built for microbe work. The camera should have a reflex system focusing through the lens to relieve the camera-man of parallax correction worries. A very firm support for the camera should be used such as a bench or tripod. For accurate light intensity reading an incident type light meter is preferable.

Reflectors should be made by the photographer of size and type to suit the occasion. Aluminum foil glued over a stiff backing which is then mounted in a stand, allows two-way movement. A smooth-surfaced aluminum foil reflector will give a hard, clear beam of light, but a slightly wrinkled aluminum surface will give a softer light. If a very soft effect is required, use a dull white reflector. Take care that there is not any light beamed directly into the camera lens from a reflector.

For shiny convex surfaces of dark color in the subject, which is very often encountered with insects, use a polar screen over the lens to cut out unwanted reflections. For extremely shiny subjects it may be necessary to use polar screens over the light beam and over the lens. The light source may vary from the sun to strobe or tungsten. In any case with a number of reflectors, not only is the light increased, but also the heat factor. This can be controlled by heat screens which are placed in the light beam, if the subject is susceptible to heat.

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The following examples will help to show how the equipment mentioned can be used:

Photographing Wasps Digging Burrows

Having observed a wasp at work, imagine a clock face lying on the ground, its figures facing up, with the wasp's position at the centre of the dial. Call this position X.

The sun's rays enter at 9 o'clock passing through X to 3 o'clock. One reflector placed at 3 o'clock reflects the sun's rays to X, a second reflector at 5 o'clock also reflects the sun's rays to X, while the camera is at 6 o'clock with its lens focused on X. Check the front of the lens to make sure that no light rays are directly beaming into it from the sun or reflectors. If light is entering directly into the lens, put on a lens hood over the lens mount. Check the exposure with a meter, and set the lens aperture and speed.

Photographing Into Cavities, Cocoons, etc.

A comb containing young honey bee larvae is held in its natural vertical position, at right angles and at eye level to the observer who faces the sun.

Make a variable parabolic reflector. Take a large piece of plywood coated with aluminum foil on one of its surfaces and cut a small hole in its centre. Two loops of cord positioned at either end of the board and tightened with a piece of wood twisted between the cords, produce the parabola. Place this reflector immediately in front of the observer. Focus the camera lens through the hole in the reflector. Use a lens hood to prevent stray direct light entering the lens.

Photographing Internal Structures of Insects

Visualize a clock face in its normal vertical position. At the dial centre (X) place a shallow transparent trough containing the organs in fluid. Direct a light beam from 4 o'clock to pass through X and illuminate the organs. The camera is positioned at 2 o'clock with its lens focused on X.

Improvised Controlled Artificial Lighting

Visualizing the clock face once more, direct a projector beam from 9 o'clock through X where the insect is stationed to 3 o'clock, where a flat or parabolic reflector is placed to re-direct the beam to X.

It is left to the artistic ability of the photographer or his desire to emphasize certain features as to how far from the subject the reflectors are placed in these examples.

Exposure Compensation

When the subject is closer to the camera than 10 times the focal length of the lens the exposure must be increased. For instance with a 4 inch lens any object less than 40 inches away requires additional exposure.

The corrected exposure is determined by the following method:

Multiply exposure time *as indicated by meter* by a *correction factor.*

The correction factor is $(M + 1)^2$ where $M =$ magnification or reduction. To calculate M, measure the object and its image in the viewing screen, and divide the value for the object into that for the image. Example: with insect size and image size the same, write $(1 + 1)^2 = 4$. With a meter reading of 1/100 sec. at F 11, we have $1/100 \times 4 = 1/25$ sec. at F 11.

Following are the comparative F stop settings for this exposure giving a varying depth of focal field:

1/400 at F 2.8, i.e. the shallowest field of focus, 1/50 at F 8.

1/200 at F 4, 1/25 at F 11.

1/100 at F 5.6, 1/10 at F 16, i.e. the deepest field of focus.

Reference

Exposure Meter Manual. Photo Research Corporation, Hollywood, U.S.A.

SCIENTIFIC NOTE

An instance of chemical attraction of the ambrosia beetle, **Trypodendron lineatum** (Oliv.), is of enough interest to record. During December, 1957, a batch of home-made beer was prepared, using malt extract, sugar, bakers yeast, hops and gelatin. It was capped and held for about three months. After use, a few bottles were put in a basement, these still containing small amounts of liquid and settled material, possibly including living as well as dead yeast cells.

The following May, after the spring flight of the ambrosia beetles, it was noted that there were several dozen **Trypodendron** in the bottles. They had apparently entered the basement and crawled through the necks of the bottles and had drowned in the liquid residue. Four or five bottles had attracted and trapped an estimated 80 - 100 beetles.

Youbou is the site of a large sawmill and log booms are common on Cowichan Lake, close to the town. Although beetles may have been attracted to the general area by the floating logs or freshly sawn lumber, they have not been known to enter houses in numbers. It is assumed, therefore, that a strong attractant was produced in the beer residue, leading beetles, presumably at the time of their spring attack flight, to enter the basement, find the bottles and crawl inside them.

No other insects were found with the beetles, which were readily recognized as **T. lineatum.** The British Columbia Forest Products Company has carried out control operations against this species in recent years, and the species is familiar.

This observation is being placed on record as a result of the interest of J. A. Chapman and J. M. Kinghorn, Forest Entomology and Pathology Laboratory, Canada Department of Forestry, Victoria, B.C.

—*W. E. Binion, B.C. Forest Products Co., Youbou, B.C.*

BOOK REVIEW

SILENT SPRING. Rachel Carson. 297 + 67 pages, Houghton Mifflin Co., Boston, 1962. $5.95. Reviewed by J. Marshall, Canada Agriculture, Research Station, Summerland, B.C.

In Silent Spring Miss Carson flays the misuse of pesticides; and in so doing she says much that badly needs saying. It is a grisly book; and like its more cheerful predecessor, The Sea Around Us, it is exceedingly well done.

To have dealt in a strictly factual way with pesticides, with equal prominence to their good features as well as their bad, would have given us a book for scientists. But a book for scientists was not what Miss Carson or her publishers had in mind. Silent Spring is aimed at the general public, so it emphasizes only one aspect of pest control, that is, the possibility of the wholesale poisoning of man, and other animals, through the thoughtless and indiscriminate use of physiologically potent pesticidal chemicals.

Miss Carson gives the public a very dim view of the applied entomologist. "The concepts and practices of applied entomology," she says, "for the most part date from the stone age of science. It is an alarming misfortune that so primitive a science has armed itself with the most modern and terrible weapons, and that in turning them against the insects it has also turned them against the earth." That is her parting blast.

Despite all the work that has gone into this book the author cannot have learned a great deal about applied entomology. Presumably she has not understood that applied entomology includes the application of the principles of biological control, a procedure to which she gives highest praise. To refer to applied entomology as a stone age science might presuppose an immensely erudite critic. Admitting her undoubted skill as a writer, Miss Carson has erected no notable landmarks in science. Her background in research hardly qualifies her to launch a sweeping indictment of a branch of science that is patently foreign to her.

But the end may justify the means. Certainly, if Silent Spring fails to arouse the public, and bring about a change of emphasis in pest control procedures, it will be no fault of Rachel Carson. If the book puts an end to massive, ill-conceived campaigns to wipe out insects over wide areas by the wholesale application of chemicals, or if it discourages the blind reliance on chemical control that is only too obvious in some parts of North America, it will serve well indeed.

Back of the current pesticide scare there are faddists. On the one hand are the food faddists who harbour the neurotic suspicion of insidious poisoning from almost any food that is not "naturally" grown. On the other hand are the eradication faddists who have an urge to rid the world, or bits of it, of any organism that might be labelled "pest." Despite public shock following the tragedy of thalidomide, if we had no faddists doubtless we would have no pesticide scare.

Silent Spring deplores the widespread and, in a sense, indiscriminate operations of the professional eradicator, as well it might. But it does not differentiate sufficiently between campaigns aimed at the eradication of an insect over a wide area, and the operations of a farmer or fruit grower aimed at the control of an insect on his own property. To eradicate an insect with pesticides is an exceedingly difficult, in fact almost impossible, job. But merely to control an insect over a modest area is usually a routine operation. In the first case the use of pesticides generally is prodigal, and failure is soon forgotten; those responsible are financially unaffected. In the second case the individual has to pay for the pesticides, and failure can mean serious financial loss.

Although Miss Carson is not opposed to the use of pesticides—"It is not my contention that chemical insecticides must never be used. I do contend that we have put poisonous and biologically potent chemicals into the hands of persons largely or wholly ignorant of their potential for harm"—she does not tell us how to reconcile the two statements. It is difficult to imagine how more than a handful of people could qualify as pesticide applicators if qualification meant adequate schooling in the intricacies of toxicology and biological control. As long as pesticides are used they will, in all likelihood, be used by people who know little or nothing of their side effects. The problem is to develop pesticides so specific that harmful effects will not overshadow beneficial effects. Substantial progress has already been made in that direction. That is contrary to Miss Carson's opinion that all pesticides should be called biocides.

An obvious reply to Silent Spring is that serious curtailment of pesticide usage would mean more human hunger. The author has foreseen the criticism. She maintains that the real food problem nowadays is, in fact over-production. It is costing the United States about one billion dollars a year to carry surplus food supplies. She does not mention that over two-thirds of the world's population is undernourished. Nor does she mention that the surplus would vanish overnight if pests and diseases were uncontrolled. Nor does she mention that the stock piled foods do not by any means cover the United States dietary.

Here is an example of a curious blind spot in Miss Carson's approach; the belief that there is something particularly stealthy and baleful about chemicals that are synthesized around carbon. She notes that in Nova Scotia, where pest control she believes, is on a highly enlightened plane, synthetic insecticides are avoided. The recommended ones are Ryania, nicotine sulphate and lead arsenate. On several occasions she refers approvingly to Ryania. Her assumption appears to be that because Ryania is derived from a plant it has special virtues as a pesticide, i.e., toxic to pests yet innocuous to plants, or to the higher animals. But experiments conducted in British Columbia apple orchards have shown Ryania to be highly phytotoxic. And if it had been given a fraction of the toxicological study that has been accorded DDT who knows what other doubtful qualities might have come to light.

As for nicotine sulphate, the fact that it too is derived from a plant makes it no less toxic to mammals. Of 61 currently listed insecticides nicotine sulphate is the seventh most lethal to humans, and its residue persists longer than is generally believed.

In one chapter of Silent Spring mention is made of the high mammalian toxicity of the arsenicals. But the third insecticide that apparently meets with the author's approval (perhaps because it does not have a bad record against birds) is the worst of the arsenicals. Lead arsenate, in fact, is perhaps the most sinister pesticide that has ever been in common use. During the 17 years since lead arsenate was banished from British Columbia orchards, spray poisoning of orchard workers has dropped from a commonplace to a rarity. And the wholesale poisoning of orchard soils has been halted. Yet the substitutes are synthetic organic compounds held in special horror by Silent Spring.

Since agriculture is strange territory for Miss Carson it is to be expected that she will lose her way from time to time in that most complex of sciences. Here is an example of a seemingly minor lapse that leads to a notable misconception. In Eastern apple growing districts where forested areas often adjoin orchards the codling moth may be greatly reduced during the winter by woodpeckers. Since in those areas the insect has but one generation a year, birds may thus play a measurable or even a decisive role in controlling it. Silent Spring implies that woodpeckers are effective agents of codling moth control everywhere. That may not be so. In the drier areas of Western North America the apple orchards are generally well removed from forested areas, and the codling moth may have three generations a year. Even in neglected orchards, near woodlands in which woodpeckers are active during the winter, there are always codling moth survivors. In two or three generations, over the course of four or five months, the progeny of those survivors increase to such numbers that the fruit is invariably a total loss.

Silent Spring has particularly bitter words for the chlorinated hydrocarbons. In one chapter Miss Carson has them leaching out the soil and contaminating underground water, with incalculable potential for harm. In another chapter she emphasizes that their prolonged persistence in the soil is a hazard to the complex web of life that maintains soil fertility. These are versatile compounds indeed.

Silent Spring contends that new chemicals introduced to combat the development of pesticide resistance will necessarily be more and more poisonous to higher animals. The reasoning is unclear. As time passes more and more of the new pesticides have low rather than high mammalian toxicity. An example is Sevin, a new compound used to combat certain insects that have become resistant to DDT. Sevin is even less toxic to the higher animals than DDT. Another example is the acaricide Tedion, of which 2 pounds is the estimated lethal dose for an adult human. Pity the adult human who, at one sitting, downs even one pound of ordinary table salt!

In her preoccupation with biological control Miss Carson overlooks the fact that the great majority of applied entomologists are far from wedded to the use of pesticides. (Admittedly there are exceptions.) Indeed, few applied entomologists would not cheerfully bury all pesticidal chemicals if that were feasible. Silent Spring conveys a different thought. Referring to biological control there is this: "It had its period of drought, when workers in applied entomology, dazzled by the spectacular new insecticides, of the 1940's, turned their backs on all biological methods and set foot on the treadmill of chemical control." Tut tut, Miss Carson!

Few entomologists would disagree with Silent Spring's approving quote from the Director of the Plant Protection Service of Holland. "Practical advice should be: 'Spray as little as you possibly can'." Although there have been some lapses, certainly that broadly summarizes Canadian policy. It is a far cry from the picture painted by Miss Carson.

If Silent Spring succeeds in bringing about a more rational use of pesticides it will do what it sets out to do, and will be for the general good. The danger is that it may do more than it sets out to do. If the book leads to unreasoning fear, and hence to unnecessarily restrictive pesticide legislation, the cost of food production will assuredly rise. Then the consumer will suffer; and the poorer the consumer the more the suffering.

Phaeoura mexicanaria (Grote) in British Columbia (Lepidoptera: Geometridae)

J. GRANT[1]

Rindge (1961) gives the range of the geometrid moth, **Phaeoura mexicanaria** (Grote), as the western United States. Although there are no published records for this species in British Columbia, larvae have been taken in Forest Insect Survey collections on a few occasions in the southern Interior: Kettle Valley, 28 August, 1953; Salmon Arm, 17 July, 1958; Grand Forks, 12 August, 1959; and Oliver, 24 August, 1961. Larvae were obtained by beating the branches of ponderosa pine trees over a sheet laid on the ground, and were fed ponderosa pine foliage in the insectary for periods up to 26 days before they pupated. The only members of the genus for which the food plants were previously known were two deciduous feeders: **P. quernaria** (J. E. Smith) on oak and cherry, and **P. cristifera** Hulst on willow.

The larva of **P. mexicanaria** resembles a rough twig of the host tree. A description of an ultimate-instar larva from Grand Forks follows: head 4.56 mm. wide, pale brown, notched, with brown patches suggesting a herring-bone pattern; body 44 mm. long, 6.4 mm. wide, pale brown, covered with fine brown granules; conspicuous tubercles bearing setae D-2 on abdominal segments 1 to 5 and setae D-1 on segment 8. Tubercles largest on A2, gradually diminishing in size to A5; those on A8 about equal in size to those on A3. An adult reared from this larva was identified by Dr. E. Munroe of the Entomology Research Institute, Ottawa, as **P. magnificans** Dyar; since reduced in Rindge's revision to synonymy with **mexicanaria.**

An adult male, also identified by Dr. Munroe, was collected at Rock Creek on 10 July, 1958. It was flying in a lighted garage about 10 p.m.

Acknowledgment

The writer is indebted to Dr. W. C. McGuffin, Forest Entomology and Pathology Laboratory, Canada Department of Forestry, Calgary, Alta., for the description of the larva.

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Rindge, F. H. 1961. A Revision of the Nacophorini (Lepidoptera, Geometridae). **Bull. Am. Mus. Nat. Hist.** 123: 91-153.

[1] Forest Entomology Laboratory, Vernon, B.C.

EDITOR'S NOTE

It may surprise contributors and readers to learn how widely the *Proceedings* are distributed. Here is a list of places outside British Columbia to which one or more copies are sent, either in exchange for publications or by subscription.

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BOOK REVIEW

A Handbook of Biological Illustration, by F. W. Zweifel. University of Chicago Press, 1961. Pp. 131. $1.95.

This paper-back fills a need. Here, in simple terms are clear instructions and up-to-date information "for the biologist who is not an artist and the artist who is not a biologist." The author is both. She holds a B.A. in zoology, and from the University of Arizona an M.A. in art. The book is an expansion of her thesis.

Although not exhaustive the coverage appears to be adequate, and the rather brief treatment is well planned, as the chapter headings show: Printing Processes, Size and Reduction of Illustrations for Publication, Materials, Drawing, Preparation of Graphs and Maps, Lettering, Illustrations from Photographs, Mounting and Handling Illustrations. The chapters on drawing and graphs take up more than half of the book.

One illustration is worth special mention. In describing the use of scratchboard (cardboard surfaced with chalk) the author shows 3 stages in drawing the ventral view of a bandicoot's skull. The finished product (p. 60) is a classic, having an almost three-dimensional quality.

The printing, paper, and of course the illustrations are of high quality, which may account for the rather high price. Fifteen different references are given at the ends of the chapters, but are not cited in the text. There are sub-headings within the chapters, and an index.

—*H. R. MacCarthy.*

BOOK REVIEW

Observations and Experiments in Natural History, by Alan Dale. New York. Doubleday - American Museum of Natural History, 1962. Pp. x and 148. $.95.

For anyone concerned with instructing young people in biology or research this attractive little book could be a good starting point. Its English author, who died in 1960 at 44, was a teacher who must have had a flair for generating curiosity and excitement. He was influential in revising the curriculum in High School biology in the U.K., and was the author of 3 textbooks and 'Patterns of Life' and 'Introduction to Social Biology.' The current edition of this book has been adapted for North American use from the 1960 original.

First of the 6 chapters is an introduction in which Dale illustrates research methods and pitfalls. Then follow observations and experiments on invertebrates, insects (45 pages), vertebrates, lower plants, and higher plants. There are simple experiments on snails (homing, use of oxygen), flukes, crustaceans, earthworms (light reactions, regeneration, burrows), spiders, hydra, centipedes, and millipedes.

In the insects there are experiments on pupation and hibernation, phototaxis and feeding, light-compass reactions, color and sex recognition by Lepidoptera, selection of food by caterpillars, pollination by various bees, olfaction in ants, and so on. The subjects are common, e.g.: beetles (water, click, burying, ground, and *Geotrupes*); water striders and water boatmen; lacewings, grasshoppers, gall makers, cabbage butterflies and aphids.

But there is more than just experiments and observations. On every page the author poses questions and leaves problems dangling, perhaps with a hint as to how answers might be found. He sees groups of 5 or 6 water striders in mid-winter. Are they feeding? On what? How long can they go without food? If males play no part in rearing larvae are over-wintering adults always female? Try with bumblebees, mosquitoes and earwigs. How fast do aphids reproduce? Which end of an aphid is born first? Do blowflies arrive at rotting meat in succession or at random? Dale thinks *Calliphora* come first and *Lucilia* a day or so later. The same fertility of ideas runs through the chapters on vertebrates and plants.

The style is easy and appropriate with no undue use of the first person. There are 28 sketches in the text and 8 original halftone plates illustrating 13 or 14 of the phenomena dealt with. In short, here is a book to stimulate the latent biologist in most young people.

—*H. R. MacCarthy.*

BOOK REVIEW

Insects, a Guide to Familiar American Insects. H. S. Zim and C. Cottam. New York, Simon & Schuster, 1956. Pp. 160. $1.00.

One of the avowed aims of our society is to encourage amateur entomology. Members who are asked to suggest a book for beginners need look no further than this really pocket-sized Golden Nature Guide. The authors are the ubiquitous Dr. H. S. Zim, Professor of Education at the University of Illinois, and Dr. Clarence Cottam, Director of the Welder Wildlife Foundation, Formerly Assistant Director of the U.S. Fish and Wildlife Service. The all-important illustrations are by James Gordon Irving. These are all in color, mostly showing food plants or other background. It is surprising that the book is not better known for this is the revised second edition; the first edition appeared in 1951.

To save space there is no table of contents, but there is an index. The book opens with directions and a short descriptive key to 15 orders with typical specimens illustrated. Then comes a 10-page outline, giving one or 2 paragraphs each on: what insects are; insect relatives; numbers; insects and man; insects in their place; control; family tree; structure; when and where to look; and how to set about collecting and studying. Later 2 pages of text describe and distinguish between butterflies and moths. These pages are enlivened by marginal and text pictures. Most of the 225 species on 135 pages have their ranges shown on small maps, covering North America from just south of the Mexican border to about 200 miles into Canada. Naturally, the species include some not found in Canada, nevertheless all the insects are common but showy or striking in some way. Scientific names of all the species illustrated, are given in a second index by page numbers. There is also an annotated list of 6 books to cover the next stage of study or inquiry. These are: *Comstock, J. H., An Introduction to Entomology; Jaques, H. E., How to know the Insects; Klots, A. B., A Field Guide to the Butterflies; Lutz, F. E., Field Book of Insects; Swain, R., The Insect Guide; and Urquhart, F. A., Introducing the Insect.*

In sum, this little book is a miracle of compression. For price, coverage, and sheer attractiveness it has no peer.

—*H. R. MacCarthy.*

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Insects

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WIREWORMS OF CULTIVATED LAND IN BRITISH COLUMBIA[1]

A. T. Wilkinson

The first published record of wireworm damage in British Columbia appears to be that of Anderson (1892) who reported great damage during 1891 at Salmon Arm and South Saanich by a "hard yellow worm, the larva of the skip jack beetle". Many reports of damage followed but identifications were largely by inference based on adults collected in the general area where wireworm damage occurred. The first authentic identification of pest species appears to be that of Glen *et al.* (1943). They listed *Limonius canus* LeC., *Ludius (=Ctenicera) aeripennis* Kby., *L. (=C.) glauca* Germ., and *L. (=C.) pruinina* Horn. as pests in the Okanagan Valley and *L. (=C.) aeripennis* and *L. canus* as pests of truck crops on the Pacific Coast. In the Peace River area they found *L. (=C.) a. destructor (=destructor)* Brown and *Cryptohypnus (=Hypolithus) nocturnus (=bicolor)* Esch. attacking grain and truck crops. From 1946 to 1958 annual surveys were made of many agricultural areas to identify the species found and to determine their importance as pests. The purpose of this paper is to bring together the information obtained in the surveys (Table 1), and to provide a workable key to the known local species.

Methods

The surveys were carried out mainly during the spring when the larvae could be found near the surface actively feeding on seeds or seedlings. Large numbers were collected wherever possible; some were preserved and some reared to obtain adults for positive identification. In some areas damage was assessed at harvest. Grower's inquiries on wireworms were followed up and assistance was obtained from Provincial District Agriculturists and Horticulturists in locating areas where wireworms were troublesome. Adults were collected by sweeping the grass and beating shrubs and trees around the fields. This was done to help determine the larvae found in the fields.

The illustrations were made with the aid of a squared reticule, but are not drawn to the same scale throughout. The adults were identified by E. C. Becker, Taxonomy Section, Entomology Research Institute, Ottawa, and by M. C. Lane[2], U.S.D.A., Walla Walla, Washington. Determinations of larvae were made or checked by M. C. Lane.

The key to the species was made using largely the methods and terminology of Glen *et al.* (1943) and Glen (1950). The lengths given for larvae are those of the last instar at full growth.

Results and Discussion

Twenty-seven species of wireworms in 9 genera have been identified from cultivated land. Other *Dalopius* species were found and are listed here but are not separable to species in the larval stage. It has not been pos-

[1] Contribution No. 57, Research Station, Research Branch, Canada Department of Agriculture, 6660 N.W. Marine Drive, Vancouver 8, B.C.

[2] Now retired at Tacoma, Washington.

sible to determine their separate importance as pests. The larvae of 9 species in other genera have been recognized only recently and described in this paper for the first time. Little is known about their habits or status, but none of these new species is thought to have caused appreciable damage in the past.

Genus AGRIOTES Eschscholtz

This is one of the most important genera. Six species are found in agricultural land: *Agriotes criddlei* Van D., *A. ferrugineipennis* (LeC.), *A. opaculus* (LeC.), and *A. sparsus* LeC. are native, but *A. lineatus* (L.) and *A. obscurus* (L.) were introduced from Europe around 1900. The 9th abdominal segments (Fig. 2, 36, 37, 39, 40) of *Agriotes* and *Dalopius* are conical and pointed, which separates them from the 7 other genera mentioned in this paper. In *Agriotes* the 9th abdominal segment lacks the two central dorsal setae (Fig. 37) which are present in the closely related *Dalopius* (Fig. 36). Becker (1956) included 10 species of *Agriotes* in his key to the larvae of nearctic species. The larva of *A. opaculus* was not included in Becker's key since it was recognized only in 1956.

Agriotes criddlei Van Dyke. The larva is small, about 10 mm. long. Like *Dalopius* it has a ring of setiferous tubercles (Fig. 36) on the apical third of the 9th abdominal segment which separates it from other *Agriotes* but has the blunt point typical of *Agriotes*. Glen (1944) described the larva in detail.

It has been found in three locations in upper parkland loam where wheat was grown. Once only was it found feeding on the seedlings. The damage caused was considered negligible.

Agriotes ferrugineipennis (LeConte). This larva is large, about 21 mm. long. It is readily distinguished from other *Agriotes* by the nipple-like, blunt tip of the 9th segment (Fig. 39) and a small, well defined eye spot at the base of each antenna.

Glen (1944) described this larva as *Agriotes* sp. It is found across southern British Columbia and is especially abundant in the lower Fraser Valley. It seems to have no preference for any particular type of soil but is usually found in wet areas and irrigated land. Often it is found in gardens where the soil is kept wet by sprinkling. It has not been found in large numbers nor has it been reported damaging crops.

Agriotes opaculus (LeConte). This larva is about 15 mm. long, and is generally lighter yellow than any other species. The setae are fine, light colored and very difficult to see, which gives the larva a naked look. There is no eye spot at the base of the antenna (Fig. 38).

Only one infestation has been found. *A. opaculus* and *C. aeripennis* were found together feeding on potato seed pieces near Quesnel. The land was silty-loam and had been in sod for the previous 4 years.

Agriotes sparsus LeConte. About 17 mm. long. It has two clear muscular impressions (Fig. 37) similar to those of *lineatus* and *obscurus* but is somewhat smaller and lacks eye spots (Fig. 38) at the base of the antenna. Becker (1956) has described this larva more fully.

The larvae of *sparsus* are found mostly in low, moist, silty-loam soils in the delta of the Fraser River. They have been found causing damage as far east as Cloverdale. This is one of the main pests attacking potatoes in the area. In one field near Ladner in 1955 where a population of nine *A. sparsus* larvae per sq. ft. was found, 65 per cent of the potatoes were graded as unmarketable for table use because of wireworm damage and the average damage in nine fields was 20 per cent. Damage usually occurs when potatoes are planted following sod and is more severe in the second year. Most of the damage is caused late in the season so that early potatoes are seldom damaged. There is one record of their attacking gladiolus corms on Lulu Island. *Ctenicera lobata* (Esch.) is often found in the same fields as *sparsus*.

Agriotes lineatus (Linnaeus) and *Agriotes obscurus* (Linnaeus). The larvae of these Old World species are extremely difficult to separate. They are discussed here together. Full grown larvae are 18-22 mm. long. Both have muscular impressions on the 9th abdominal segment (Fig. 37), and eye spots (Fig. 38) at the base of the antenna. Both have been described by Beling (1883), Eidt (1954), and Becker (1956). *A. lineatus* has also been described by Roberts (1928, p. 90) and *A. obscurus* by Ford (1917).

The distribution in British Columbia is limited to two areas each of about 1000 acres near the coast. The rate of spread is slow. Both species are found near Cobble Hill on southern Vancouver Island but *A. lineatus* is dominant (King, 1950). *A. obscurus* alone occurs near Agassiz in the lower Fraser valley (King, *et al.*, 1952). Potatoes, corn and rye planted following pasture have been very severely damaged (Wilkinson, 1957). Populations of more than 20 wireworms per square foot have been found in pastures, but less than half this number have caused severe reduction in stands of corn.

The soil at Agassiz is silty-loam and at Cobble Hill it is clay, but both species may occur in light sandy, gravelly and muck soils so long as the moisture remains high all year.

Genus CTENICERA Latreille

Eight species of this important genus have been found. They are, *Ctenicera aeripennis* (Kby.), *C. funerea* (Brown), *C. glauca* (Germ.), *C. morula* (LeC.) *C. pruinina* (Horn), and *C. semimetallica* (Walk.) in one group and *C. lobata* (Esch.) and *C. resplendens* (Esch.) in another. The first group has a large caudal notch (Fig. 1, 22, 25, 26, 28, 29, 30), and the presternum of the prothorax is divided into four sclerites (Fig. 16). The second group has a small caudal notch (Fig. 7, 8) and the presternum of the prothorax is undivided (Fig. 15). The larvae of *lobata* and *resplendens* resemble closely those of the genus *Limonius* included in this paper. The larvae of *funerea, semimetallica, morula, lobata,* and *resplendens* are described here for the first time.

Ctenicera aeripennis (Kirby) and *Ctenicera destructor* (Brown). Glen (1950) described *destructor* in detail and found it indistinguishable from *aeripennis* except by size. The larva of *aeripennis* attains 28 mm. but *destructor* rarely exceeds 22 mm. The most important character separating the *aeripennis-destructor* complex from other *Ctenicera* having a large caudal notch, is the lack of setae on the central dorsal area of the 9th abdominal segment (Fig. 29). *C. glauca* is also without setae in this area (Fig. 26) but can be recognized by the sharp horny protuberances on the lateral margins of the 9th segment (Fig. 26), and by relatively slender urogomphi (Fig. 27). In *aeripennis* and *destructor,* the protuberances are rounded and the urogomphi are short and thick (Fig. 29, 31).

C. aeripennis is by far the most widespread pest species in the province. Larvae have been found in all agricultural areas. It is found in light sandy loams in the valleys but is much more abundant in high parkland soils. It is not found in large numbers in irrigated land. Glen (1950) records both *aeripennis* and *destructor* in the Peace River area with *destructor* predominating in open grassland. Because they are indistinguishable and both occur in the same general area of the Peace River Block, the localities are listed in Table I for the *aeripennis-destructor* complex. The two species are not known to occur together elsewhere.

Ctenicera glauca (Germar). The largest specimen collected measured 17 mm. The species falls in with the *aeripennis* group but can easily be separated by projections on the lateral margins and the urogomphi (Fig. 26). Glen (1950) described this species in detail.

It has been found in three areas attacking wheat in parkland soil. It was found with *aeripennis* but was never numerous enough to cause serious damage. It was also found in muck soil in the Okanagan Valley near Vernon damaging cabbage transplants.

Ctenicera morula (LeConte). Length about 23 mm. *C. morula* resembles *aeripennis* in appearance and is found with *aeripennis* in the same habitat. It can be separated by the presence of 4 setae on the central dorsal area of the 9th abdominal segment (Fig. 30) which are lacking on *aeripennis* (Fig. 29). In lateral view the urogomphal prongs on *morula* and *funerea* are like grappling hooks (Fig. 32). These two species can be separated by the inner prongs; on *morula* the inner prongs angle inward from the base (Fig. 30), while on *funerea* they curve strongly inward (Fig. 25).

There is no record of crop damage by this species. It is usually found with *aeripennis* in well-drained light soils but is never the predominant species nor does it occur in numbers that would cause serious damage.

Ctenicera funerea (Brown). Length about 15 mm. *C. funerea* has a large caudal notch and urogomphal prongs like grappling hooks (Fig. 32). It can be further identified by the presence of several small setae in addition to the 4 larger setae in the central dorsal area of the 9th abdominal segment (Fig. 25).

There is no record of damage by this species. It has been found only twice: in well-drained, light, sandy-loam soil planted in wheat, and in an irrigated orchard.

Ctenicera pruinina (Horn). Length about 22 mm. It can be separated from other species in the group by having a large caudal notch, 4 or more setae on the central dorsal area and outer urogomphal prongs which are straight or bent slightly caudad at the tip (Fig. 33). The outer prongs of *funerea, morula, aeripennis* and *glauca* all have outer prongs that curve sharply caudad (Fig. 31, 32). Glen (1950) described this larva more fully.

This is a serious pest of grain crops in dry-farming areas of Washington, Idaho and Oregon (Lane, 1925, 1935) but there is no record of it as a pest in British Columbia. It has been found only in newly broken sagebrush land in the southern Okanagan Valley.

Ctenicera semimetallica (Walker). The largest specimen measured 23 mm. It is similar to *aeripennis* and *morula* but can be separated by the two setae on the central dorsal area of the 9th abdominal segment (Fig. 22).

Several specimens are usually found in large collections of *aeripennis* from parkland soils. There is no record of it causing damage.

Ctenicera lobata (Eschscholtz). Length about 15 mm. This species differs from previously mentioned *Ctenicera* in having a small caudal notch (Fig. 8) and an undivided presternum of the prothorax (Fig. 15). The color varies from light yellow to brown depending upon the soil in which it is found. In peat soil it is whitish yellow, but in silt loam it is much darker. It is very similar to several *Limonius* larvae described here but can readily be separated and recognized by the dark transverse striations on the dorsum of abdominal segments 1-8 (Fig. 9).

Agriotes sparsus is found with *C. lobata* in heavy silt loams but not in peat soil. It is mainly a pest of late potatoes in the Lower Fraser Valley but has attacked other vegetable crops and gladiolus corms. Damage is usually heaviest when potatoes are grown in the second year after sod.

Ctenicera resplendens (Eschscholtz). The largest larva measured 27 mm. Like *lobata* this species has a small caudal notch (Fig. 7) and an undivided presternum of the prothorax (Fig. 15). It can be separated from *lobata* by the blunt setiferous protuberances on the lateral margins of the 9th abdominal segment; these are more rounded and less prominent on *Limonius* larvae (Fig. 19) and *lobata* (Fig. 8). It has been found in land planted to wheat where *aeripennis* was causing damage. It is not considered a pest.

Genus LIMONIUS Eschscholtz

Five species of the genus *Limonius* were found in agricultural land: the Pacific Coast wireworm, *L. canus* LeC., the most important pest species; the western field wireworm, *L. infuscatus* Mots.; the sugar-beet wireworm, *L. californicus* Mann.; the Columbia Basin wireworm, *L. subauratus* LeC.; and *L. pectoralis* LeC.

Larvae of this group are recognized by the small caudal notch and small posterior aperture (Fig. 14, 19, 21) and by the undivided presternum of the prothorax (Fig. 15). Other genera having these characteristics can be separated from *Limonius* by transverse striations on the dorsum of the abdominal segments 1-8 (Fig. 9) *(Athous pallidipennis* and *C. lobata)* or by prominent blunt setiferous protuberances on the lateral margins of the 9th abdominal segment *(C. resplendens)* (Fig. 7). *L. canus, infuscatus, californicus* and *subauratus* were included in a key by Lanchester (1946) to six *Limonius* species. Lanchester's method of separation was followed closely.

Limonius canus LeConte. Length 18 mm. The anterolateral grooves of the 2nd, 3rd, and 4th abdominal tergites (Fig. 18) fade as they approach the median suture on *canus* and *subauratus* but remain strong (Fig. 17) on *infuscatus* and *californicus*. *Canus* can be separated from *subauratus* by the tergal plate which is longer than wide with angulate anterior corners in *canus* (Fig. 19) and as wide as long with rounded anterior corners in *subauratus,* (Fig. 21). Lanchester (1939) described the species in detail.

This wireworm has been a major pest of vegetables for many years. It is generally found in light, moist, sandy loam, and loam soils throughout southern B.C. and Vancouver Island and has become adapted to conditions in irrigated areas. Seedlings are severely damaged in the spring when the larvae feed near the surface after overwintering at depths of 2 or more feet. Root crops are damaged in late summer and fall.

Limonius infuscatus Motschulsky. This wireworm is similar to *canus* in size, color and habits but can readily be separated from the other 4 *Limonius* species by the outer urogomphi which curve anteriorly to form hooks (Fig. 13).

It is generally found with *canus* and is often the predominant species causing damage. It has not been found so far north as *canus*.

Limonius californicus (Mannerheim). In size and color the larvae are similar to those of *canus* and *infuscatus*. The anterolateral grooves remain strong as they approach the median suture as in *infuscatus* (Fig. 17) but the outer urogomphal prongs stand erect (Fig. 20).

This species was found in economic numbers only in the Kootenay Valley near the Montana border, where it was damaging potatoes. It has been found as far north as Kelowna in the Okanagan Valley but the infestations were light.

Limonius subauratus LeConte. The larvae are similar to other *Limonius* species in size and color. Like *canus* the anterolateral grooves fade out as they approach the median suture on abdominal segments 1-8 (Fig. 18), but unlike *canus* the tergal plate on the 9th abdominal segment is wider than long and the anterior corners are rounded (Fig. 21).

According to Lane *(in litt.)* and Lanchester (1946) this species is a pest and may often be found with other species of *Limonius* in the Pacific Northwest, but we have found a single specimen in 70 collections of *Limonius* larvae. The adults of this species have been collected in fields bordering sandy moist river banks but larvae have never been collected in cultivated land.

Limonius pectoralis LeConte. Length about 14 mm., colored light yellow. The larvae of *pectoralis* differ from other elaterid larvae in having two prominent conical protuberances on the dorsum of the 9th abdominal segment (Fig. 14). The outer prongs of the urogomphi are reduced to small pointed tubercles (Fig. 14). Previous descriptions were made by Glen *et al.* (1943) and Glen (1950). It was found once in wheat growing in loam near Prince George. The field was also heavily infested with *Ctenicera aeripennis* and *Dalopius* sp.

Genus HYPOLITHUS Eschscholtz

Only two species of this genus have been found in cultivated soil in the Province. They can be recognized by the presence of small, dorsoposteroepicranial setae and medial anterotergal setae on the anterior part of each body segment (Fig. 3) and by four setae on the central dorsal area of the 9th abdominal segment (Fig. 4). The larva of *Hypolithus impressicollis* (Mann.) is described here for the first time.

Hypolithus bicolor Eschscholtz. Length 11 mm. It is separated from *H. impressicollis* by the urogomphal prongs: the inner prongs on *bicolor* are larger than the outer prongs (Fig. 5) while on *impressicollis* the prongs are subequal in length (Fig. 6). Glen *et al.* (1943) described this larva more fully.

This species appears to have a wide range. It was found in well separated localities (Table 1), generally in loam soils. The population was usually low but on occasion moderate damage was caused.

Hypolithus impressicollis (Mannerheim). Length 12 mm. This species is readily separated from *bicolor* by the urogomphal prongs.

It has been found only in the delta of the Fraser River in low, poorly drained fields. Damage observed has been that caused to potato seed pieces in spring but not to the mature crop.

Genus MELANOTUS Eschscholtz

Melanotus oregonensis (LeConte). This species is the only representative of the genus found so far in the Province. The larva is described here for the first time. The largest larva collected was 23 mm. and was considerably darker than most wireworms. It is readily recognized by the 9th abdominal segment which is flattened and scalloped at the tip (Fig. 34, 35) and by striate impressions on the anterior dorsum of each abdominal segment (Fig. 35).

It is not considered a serious pest. It was found only once, when it was damaging newly-planted grape cuttings in light sandy soil in the Okanagan Valley.

Genus HEMICREPIDIUS Germar

Hemicrepidius oregonus (LeConte). Only one species of this genus has been found in cultivated land. The largest larva collected measured 21 mm. This wireworm has not been described previously. It has transverse striations on the dorsum of abdominal segments 1-8 (Fig. 9) and an undivided presternum of the prothorax like that of *C. lobata* (Fig. 15) but with a large caudal notch. It is also similar to *Athous* species but can be recognized by the absence of eye spots at the base of the antennae. It has been found only in the lower Fraser Valley in muck and peat soils. It has no record of damaging crops in this area.

Genus ATHOUS Eschscholtz

Athous pallidipennis Mannerheim. Length 21 mm. The caudal notch is small (Fig. 11) and the outer prongs are long, slender and curved anteriorly (Fig. 12). It has transverse striations (Fig. 9) like *C. lobata* and *H. oregonus* but can be separated by the sharp horny protuberances on the lateral margins (Fig. 11). Eyes are present. Glen (1950) described this larva more fully. It has been found twice in cultivated fields of muck soil but is not considered of economic importance.

Genus AEOLUS Eschscholtz

Aeolus mellillus (Say). The largest larva collected measured 14 mm. This small flat larva is easily recognized by the v-shaped caudal notch (Fig. 24) and the anal armature on the 10th abdominal segment (Fig. 23). A more detailed description is given by Comstock and Slingerland (1891). It was found once in light sandy soil planted to potatoes. It is not considered to be a pest species.

Genus DALOPIUS Eschscholtz

The genera *Dalopius* and *Agriotes* are closely related and in many ways are similar in habits and appearance. *Dalopius* larvae are separated from *Agriotes* by having central dorsal tergal setae on the 9th abdominal segment (Fig. 36). The 9th segment of *Dalopius* is pointed and bears three whorls of pre-apical setiferous tubercles (Fig. 36). The larvae are relatively slender and the largest measured 19 mm. The following 10 species, known to occur in British Columbia, cannot be recognized or separated in the larval stage: *D. asellus* Brown, *D. corvinus* Brown, *D. fucatus* Brown, *D. gartrelli* Brown, *D. insolens* Brown, *D. insulanus* Brown, *D. maritimus* Brown, *D. spretus* Brown, *D. suspectus* Brown and *D. tristis* Brown.

Dalopius larvae have been found in nearly every area but usually in such small numbers that they are not considered to be pests. Populations build up in sod but seldom seem to survive even light culivation. *D. asellus* Brown, which was identified by rearing larvae to adults, damaged potato seed pieces in the Cariboo. *Dalopius* larvae also caused considerable damage to a strawberry planting in the Kootenay Valley.

Key to wireworms of cultivated land in British Columbia

1. Ninth abdominal segment with median caudal notch (Fig. 1, 4) 2
   Ninth abdominal segment without median caudal notch (Fig. 2) 19
2. Head bearing dorsal posteroepicranial setae; thoracic segments and first 8 abdominal segments bearing medial anterotergal setae (Fig. 3) 3
   Without dorsal posteroepicranial setae and medial anterotergal setae 4
3. Inner prongs of urogomphi longer than outer prongs .... **Hypolithus bicolor**
   Urogomphal prongs subequal in length (Fig. 6) .... **Hypolithus impressicollis**
4. Caudal notch small with narrow posterior aperture (Fig. 7, 8, 11, 14, 19, 21) 5
   Caudal notch large with wide posterior aperture (Fig. 1, 22, 24, 25, 26, 28, 29, 30) 12
5. Dorsum of abdominal segments 1-8 with transverse striations (Fig. 9) 6
   Dorsum of abdominal segments without transverse striations (Fig. 17, 18) 7
6. Outer prongs of urogomphi, long, slender and curved anteriorly; ninth abdominal segment with sharp horny protuberances on lateral margins (Fig. 11, 12) .... **Athous pallidipennis**
   Outer prongs of urogomphi short and erect; ninth abdominal segment with small rounded protuberances (Fig. 8, 10) **Ctenicera lobata**
7. Dorsum of ninth abdominal segment with prominent, blunt setiferous protuberances on lateral margins (Fig. 7) .... **Ctenicera resplendens**
   Dorsum of ninth abdominal segment with rounded less prominent protuberances on lateral margins (Fig. 14, 19, 21) 8
8. Ninth abdominal segment with two conical protuberances on the central dorsal area (Fig. 14) **Limonius pectoralis**
   Ninth abdominal segment without protuberances on the central dorsal area 9
9. Inner ends of anterolateral grooves of second, third and fourth abdominal tergites remain strong as they approach the median suture (Fig. 17) 10
   Inner ends of anterolateral grooves of second, third and fourth abdominal tergites fade and end before reaching the median suture (Fig. 18) 11
10. Outer prongs of urogomphi curved anteriorly to form hooks (Fig. 13) .... **Limonius infuscatus**
    Outer prongs of urogomphi erect or inclined posteriorly (Fig. 20) .... **Limonius californicus**
11. Tergal plate of ninth abdominal segment elongate, with sides straight distinctly angulate (Fig. 19) .... **Limonius canus**
    Tergal plate of ninth abdominal segment round or oval with anterior angles rounded (Fig. 21) .... **Limonius subauratus**
12. Tenth abdominal segment with anal armature (Fig. 23); caudal notch V-shaped (Fig. 24) .... **Aeolus mellillus**
    Tenth abdominal segment without anal armature; caudal notch rounded (Fig. 22, 25, 26, 28, 29, 30) 13
13. Presternum of prothorax divided into 4 sclerites (Fig. 16) 14
    Presternum of prothorax undivided (Fig. 15) .... **Hemicrepidius oregonus**
14. Ninth abdominal segment with setae on the central dorsal area (Fig. 22, 25, 28, 30) 15
    Ninth abdominal segment without setae on the central dorsal area (Fig. 26, 29) 18
15. Ninth abdominal segment with 2 setae on the central dorsal area; caudal notch U-shaped (Fig. 22) .... **Ctenicera semimetallica**
    Ninth abdominal segment with 4 or more setae on the central dorsal area; caudal notch not U-shaped, inner prongs curved or angled inward (Fig. 25, 28, 30) 16
16. Outer prongs of urogomphi curved strongly caudad (Fig. 32) 17
    Outer prongs of urogomphi straight or bent slightly caudad at the tip (Fig. 33) .... **Ctenicera pruinina**
17. Inner prongs of urogomphi curved strongly inward; protuberances on lateral margins of ninth abdominal segments small (Fig. 25) .... **Ctenicera funerea**
    Inner prongs of urogomphi angled inward from base; lateral margins of 9th abdominal segment with prominent protuberances (Fig. 30) .... **Ctenicera morula**
18. Ninth abdominal segment with rounded protuberances on lateral margins (Fig. 29); urogomphi short and thick (Fig. 31) .... **Ctenicera aeripennis** **Ctenicera destructor**
    Ninth abdominal segment with sharp horny protuberances on lateral margins (Fig 26), urogomphi relatively slender (Fig. 27) .... **Ctenicera glauca**
19. Posterior of ninth abdominal segment flattened and scalloped (Fig. 34, 35) **Melanotus oregonensis**
    Posterior of ninth abdominal segment subconical (Fig. 2, 36, 37, 39, 40) 20
20. Central dorsotergal setae on ninth abdominal segment as figured (Fig. 36) .... **Dalopius spp.**
    Central dorsotergal setae not present (Fig. 37, 39, 40) 21

21. Ninth abdominal segment with two conspicuous muscular impressions (Fig. 37) 22
Ninth abdominal segment without muscular impressions (Fig. 39, 40) 23

22. Head with definite eye spot behind base of antenna (Fig. 38) .... **Agriotes obscurus** **Agriotes lineatus**
Head without eye spot behind base of antenna .... **Agriotes sparsus**

23. Ninth abdominal segment with setiferous tubercles (Fig. 36) .... **Agriotes criddlei**
Ninth abdominal segment without setiferous tubercles (Fig. 39) 24

24. Ninth abdominal segment nipple-like (Fig. 39) .... **Agriotes ferrugineipennis**
Ninth abdominal segment tapering gradually towards a blunt tip (Fig. 40) .... **Agriotes opaculus**

TABLE 1—Species of wireworms found in cultivated land with localities in British Columbia.

Species	Localities
Agriotes criddlei Van D.	Kettle Valley, Brigade Lake, Wycliffe.
A. ferrugineipennis LeC.	Creston, Grand Forks, Keremeos, Chilliwack, Coquitlam, Vancouver, Armstrong, Kelowna, Cloverdale.
A. lineatus (L.)	Cobble Hill.
A. obscurus (L.)	Cobble Hill, Agassiz.
A. opaculus (LeC.)	Quesnel.
A. sparsus LeC.	Ladner, Lulu Island, Cloverdale.
Athous pallidipennis Mann.	Cordova Bay, Lulu Island.
Ctenicera aeripennis (Kby.)—**C. destructor** (Brown)	Prince George, Vanderhoof, Wycliffe, Montney, Grand Haven, Bessborough, Smithers, Quesnel, Cranbrook, Creston, Brigade Lake, Cowichan, Courtenay, Burnaby, Cloverdale, Ladysmith, White Rock, Cordova Bay, Coquitlam, Victoria, Salmon Arm, Gundy, Dawson Creek.
C. funerea (Brown)	Wycliffe, Oliver.
C. glauca (Germ.)	Wycliffe, Quesnel, Kettle Valley, Vernon, Grand Forks.
C. lobata (Esch.)	Ladner, Lulu Island, Cobble Hill, Chilliwack.
C. morula (LeC.)	Prince George, Montney, Smithers, Terrace, Kettle Valley, Creston, Tete Jaune, Brigade Lake, Salmon Arm, Procter.
C. pruinina (Horn.)	Keremeos, Oliver.
C. resplendens (Esch.)	Boundary Creek, Prince George.
C. semimetallica (Walk.)	Quesnel, Kamloops, Kettle Valley.
Dalopius asellus Brown	Prince George.
Dalopius spp.	Smithers, Tete Jaune, Cobble Hill, Grand Forks, Lulu Island, Chilliwack, Metchosin, Vancouver, Oliver, Cowichan, Glen Lake, Prince George, Quesnel, Agassiz, Ladner, Armstrong, Echo Lake, Cranbrook, Balfour, Salmon Arm, Procter.
Aeolus mellillus (Say)	Grand Forks.
Hemicrepidius oregonus (LeC.)	Lulu Island, Cloverdale, Ladner.
Hypolithus bicolor Esch.	Quesnel, Smithers, Prince George, Agassiz, Armstrong, Salmon Arm, Kelowna, Brigade Lake.
H. impressicollis (Mann.)	Lulu Island, Cloverdale, Ladner.
Limonius californicus (Mann.)	Wycliffe, Newgate, Kelowna.
L. canus LeC.	Wycliffe, Duncan, Vernon, Kelowna, Grand Forks, Agassiz, Vedder Crossing, Abbotsford, Kamloops, Shoreacres Nelson, Cranbrook, China Creek, Langley, Summerland, Saanich, Oliver, Penticton, Armstrong, Salmon Arm, Lillooet.
L. infuscatus Mots.	Victoria, Vernon, Duncan, Kelowna, Grand Forks, Alberni, Keating, Cobble Hill, Oliver, Armstrong, Lavington.
L. pectoralis LeC.	Prince George.
L. subauratus LeC.	Cranbrook.
Melanotus oregonensis (LeC.)	Kelowna.

Conclusions

Since Lane (1952) has listed 150 elaterids from the Province, it is likely that species not listed here will turn up in cultivated land; it is less likely that they will be in economic numbers. The most serious pests in the southern Interior were *L. canus* and *L. infuscatus* in irrigated land, *C. aeripennis* in dry land, and *L. californicus* in both. In the southern coastal area the most serious pests were *C. lobata* and *A. sparsus*, with the two European wireworms posing a continuing threat. In the Peace River area *C. aeripennis* and *C. destructor* predominated, but in the Cariboo area *C. aeripennis* only.

There is evidence that in cultivated land the wireworm population is being depleted. Each year losses from wireworm damage are becoming less and enquiries on control fewer. Other workers have noticed the same trend (Lafrance, 1963). This may result from the extensive use of soil treatments not only against wireworms but also against other soil insects. The combination of the long life cycle and the wide use and persistence of modern insecticides in the soil has reduced wireworms from major to minor pests in British Columbia.

Summary

Spring surveys of the various agricultural areas in British Columbia produced 27 species in cultivated land. These are listed by localities, annotated, and distinguished briefly. An illustrated key is provided. The major damaging species were: *Ctenicera aeripennis* (Kby.), *C. lobata* (Esch.), *Limonius canus* (LeC.), *L. infuscatus* Mots., and *Agriotes sparsus* LeC. An assessment is made of the relative importance of each species.

Asknowledgment

Grateful acknowledgment is made to M. D. Noble, Technician, for assistance in the field; and to C. L. Neilson, Provincial Entomologist, for some collected material; and especially to M. C. Lane for instruction and identifications.

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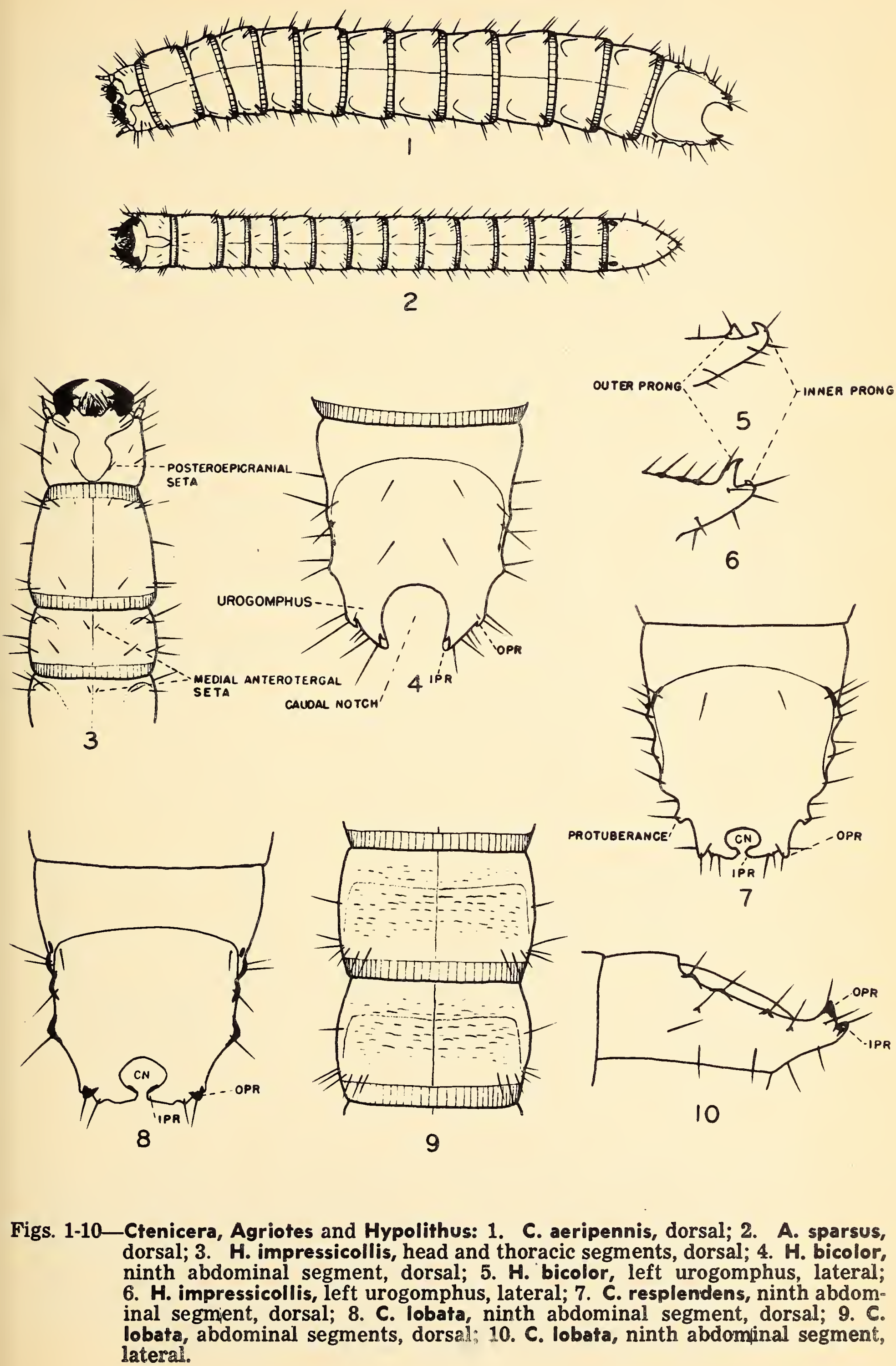
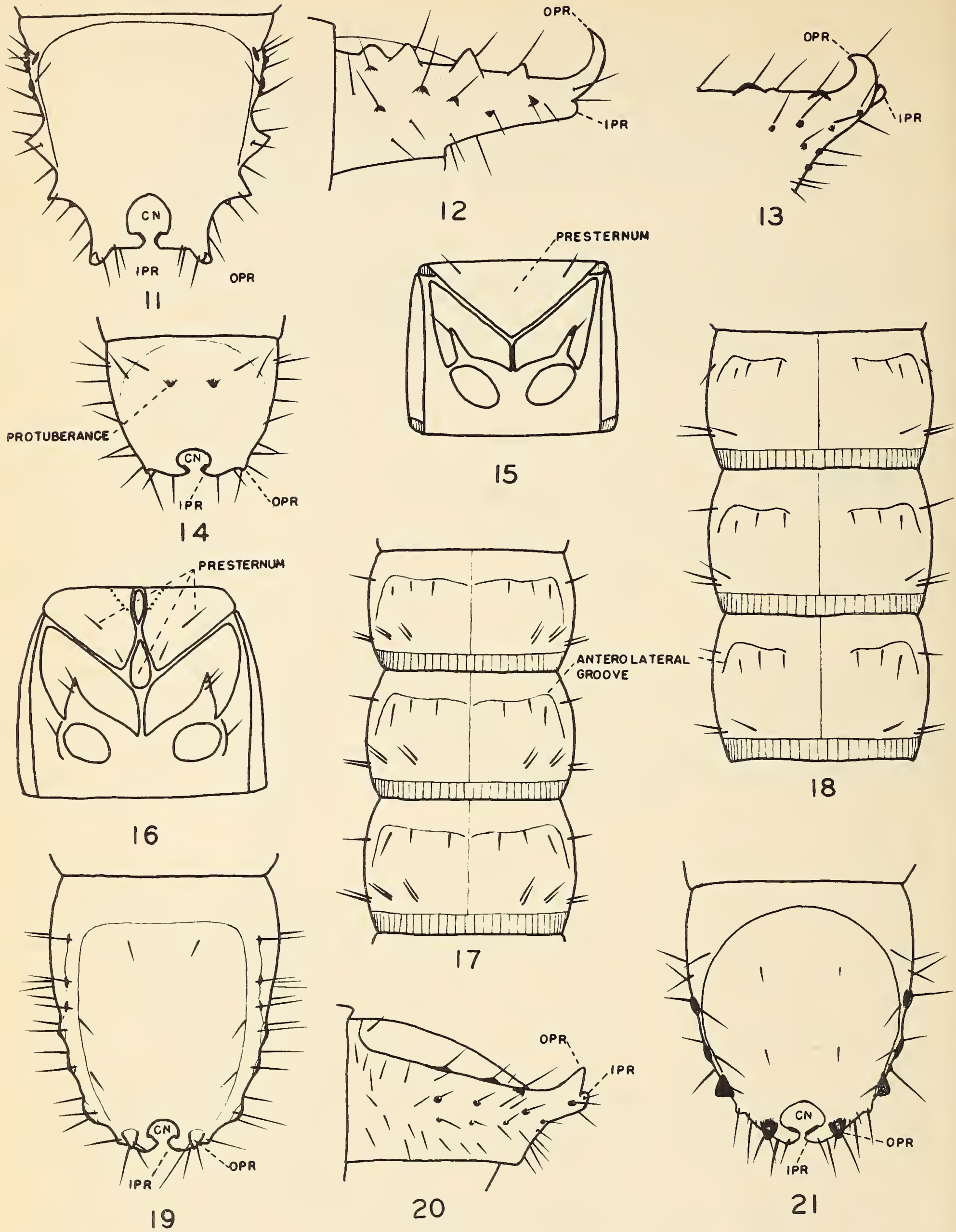
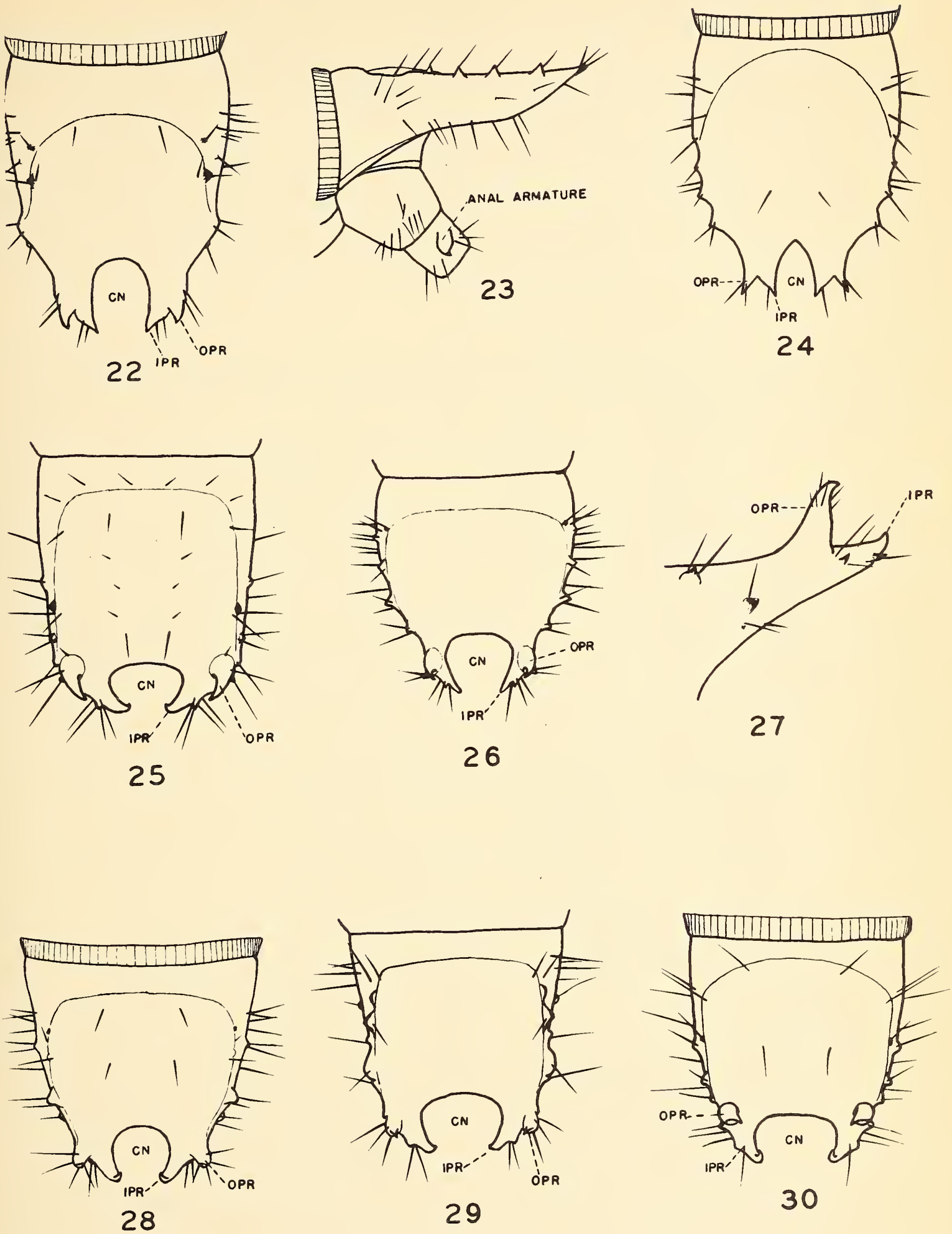


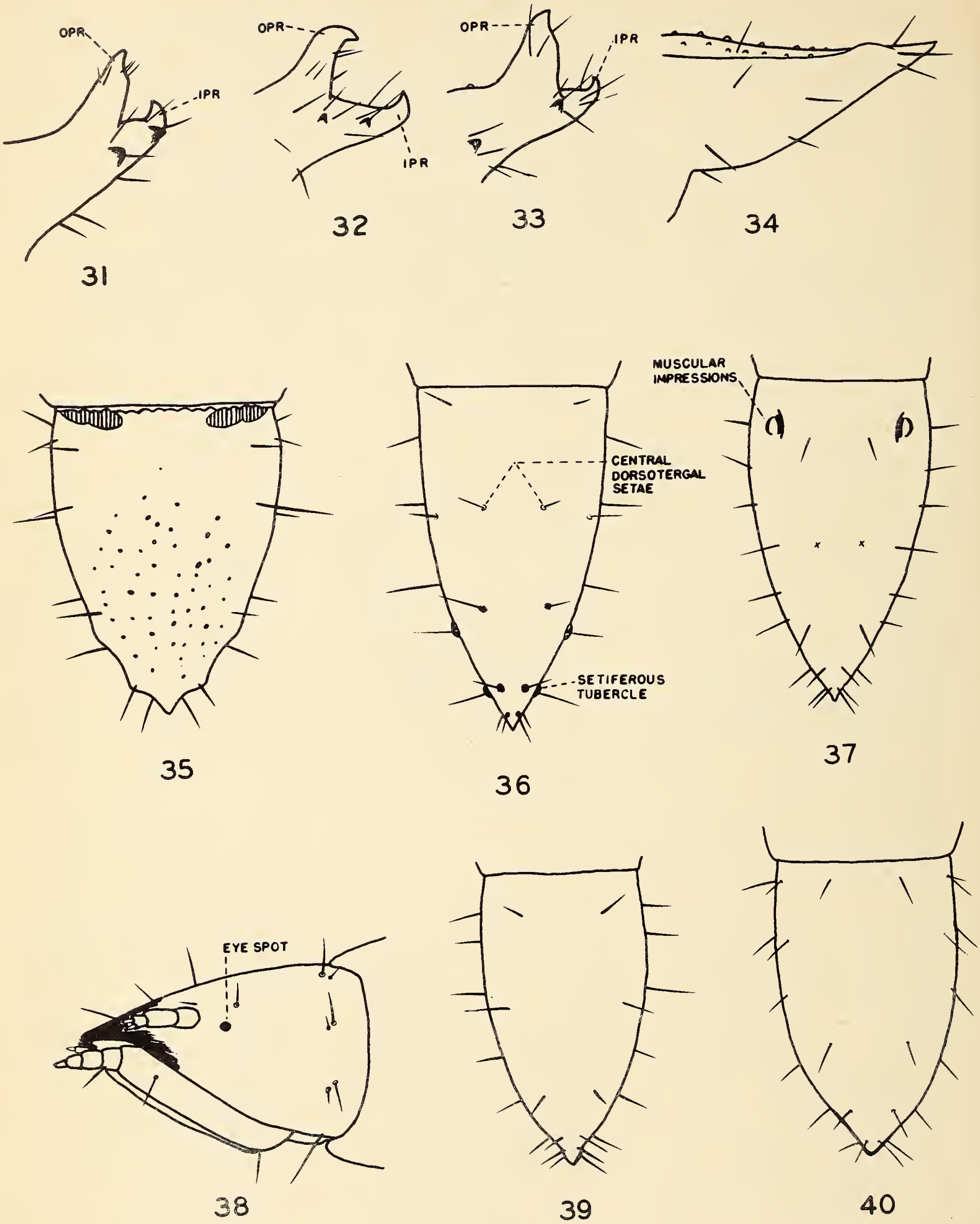
Figs. 1-10—**Ctenicera, Agriotes** and **Hypolithus:** 1. **C. aeripennis,** dorsal; 2. **A. sparsus,** dorsal; 3. **H. impressicollis,** head and thoracic segments, dorsal; 4. **H. bicolor,** ninth abdominal segment, dorsal; 5. **H. bicolor,** left urogomphus, lateral; 6. **H. impressicollis,** left urogomphus, lateral; 7. **C. resplendens,** ninth abdominal segment, dorsal; 8. **C. lobata,** ninth abdominal segment, dorsal; 9. **C. lobata,** abdominal segments, dorsal; 10. **C. lobata,** ninth abdominal segment, lateral.



Figs. 11-21—**Athous, Limonius, Hemicrepidius, Ctenicera:** 11. **A. pallidipennis,** ninth abdominal segment, dorsal; 12. **A. pallidipennis,** ninth abdominal segment, lateral; 13. **L. infuscatus,** left urogomphus, lateral; 14. **L. pectoralis,** ninth abdominal segment, dorsal; 15. **H. oregonus,** presternum of the prothorax; 16. **C. aeripennis,** presternum of the prothorax; 17. **L. infuscatus,** second, third and fourth abdominal segments, dorsal; 18. **L. canus,** second, third and fourth abdominal segments, dorsal; 19. **L. canus,** ninth abdominal segment, dorsal; 20. **L. californicus,** ninth abdominal segment, lateral; 21. **L. subauratus,** ninth abdominal segment dorsal.



Figs. 22-30—**Ctenicera, Aeolus:** 22. **C. semimetallica,** ninth abdominal segments, dorsal; 23. **Aeolus mellillus,** ninth and tenth abdominal segments, lateral; 24. **A. mellillus,** ninth abdominal segment, dorsal; 25. **C. funerea,** ninth abdominal segment, dorsal; 26. **C. glauca, ninth** abdominal segment, dorsal; 27. **C. glauca,** ninth abdominal segment, lateral; 28. **C. pruinina,** ninth abdominal segment dorsal; 29. **C. aeripennis,** ninth abdominal segment, dorsal; 30. **C. morula,** ninth abdominal segment, dorsal.



Figs. 31-40—**Ctenicera, Melanotus, Dalopius, Agriotes:** 31. **C. aeripennis,** left urogomphus, lateral; 32. **C. morula,** left urogomphus, lateral; 33. **C. pruinina,** left urogomphus, lateral; 34. **M. oregonensis,** ninth abdominal segment, lateral; 35. **M. oregonensis,** ninth abdominal segment, dorsal; 36. **D. asellus,** ninth abdominal segment, dorsal; 37. **A. sparsus,** ninth abdominal segment, dorsal; 38. **A. obscurus,** head, lateral; 39. **A. ferrugineipennis,** ninth abdominal segment, dorsal; 40. **A. opaculus,** ninth abdominal segment, dorsal.

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ANNOTATED LIST OF FOREST INSECTS OF BRITISH COLUMBIA PART XI *Papilio* spp. (PAPILIONIDAE)[1]

B. A. Sugden and D. A. Ross[2]

Six species of the genus *Papilio* commonly occur in British Columbia. The larvae of four species feed on the foliage of broad-leaved trees and shrubs but are not sufficiently numerous to be of economic importance.

Full-grown forest *Papilio* larvae are velvet green, about 1½ to 2 inches long, widest at the metathoracic segment and tapering gradually to the last abdominal segment. The head is tan to reddish brown. A dorsal Y-shaped, orange-coloured, eversible gland is present near the anterior margin of the prothorax; two "eye spots" appear on the dorsum of the third thoracic segment, and a transverse yellow band bordered posteriorly by a velvet black band occurs on the dorsum along the anterior margin of the first abdominal segment. *Papilio* spp. overwinter in sheltered sites as chrysalids usually supported in an upright position by a silken "harness". Hybrids may occur where the ranges of some species overlap.

[1] Contribution No. 989, Forest Entomology and Pathology Branch, Department of Forestry, Ottawa, Canada.

[2] Forest Entomology Laboratory, Vernon, B.C.

P. glaucus canadensis R. & J. — *Populus tremuloides* Michx., *Alnus* sp. (3 records), *Betula* sp. (3), *Populus trichocarpa* Torr. & Gray (1), *Salix* sp. (1). Throughout the interior of British Columbia, commonest in the central and northern Interior. LARVA: easily separated from other forest *Papilio* because each "eye spot" is composed of only one element. The "eye spot" is yellow, outlined in black and bisected by a black line; the blue centre spot is enclosed by a black line. The black transverse band, narrower than the anterior yellow band, does not extend to the spiracular line.

P. rutulus Luc.—*Populus* spp., *Salix* spp., *Betula* sp. (2), *Alnus* sp. (2). Central to southern Interior, southern coastal regions and Vancouver Island; common. LARVA: each "eye spot" composed of two elements, yellow, enclosed by a black line. The larger element, bisected by a black line, has a bluish centre spot; the line about the blue spot is wider than the line containing the element. The black transverse band, twice as wide as the anterior yellowish band, does not extend to the spiracular line.

P. eurymedon Luc. — *Ceanothus sanguineus* Pursh, *Betula* sp. (1), *Prunus* sp. (1). Central and southern Interior, southern coastal regions and Vancouver Island; common. LARVA: the markings on the larvae of this and the preceding species are similar, but the blue centre of the eye spot on *P. rutulus* measures about 1 mm. while that of *P. eurymedon* is approximately ½ mm.

P. multicaudatus Kby. — *Prunus* spp., *Salix* sp. (1), Southern interior of British Columbia; common. LARVA: each "eye spot" is composed of two elements that range from yellowish green to yellow, and are enclosed by very fine black lines. The larger element, bisected by a thin black line, has a centre spot of pale blue bordered by yellow which in turn is outlined in black. The black transverse band, three or four times wider than the anterior yellowish band, extends below the spiracular line. Many individuals have a narrow black line on the dorsum of the anterior margin on some of the abdominal segments.

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HOLOPLEURA MARGINATA Lec. reared from Douglas fir (Coleoptera:Cerambycidae)

On October 5, 1961, I noticed small piles of fresh boring dust beneath two Douglas fir branches lying on the ground in a dense stand near Okanagan Landing. Most of the bark of the branches was intact but the wood surface had been beautifully sculptured by wood-boring larvae, which subsequently had tunnnelled into the centre of the branch. One branch containing a cerambycid pupa was opened; the other was kept at room temperature and on January 20, 1962, an adult **Holopleura marginata** Lec. emerged through the same elliptical hole by which the larva had entered the wood. A living larva in a second gallery was preserved.

Adults have been collected on only three occasions in the Forest Insect Survey in Interior British Columbia: Arrowhead, (H. B. Leech, Proc. Ent. Soc. B.C. 42:18); Silverton, June 24, 1953; and Texas Creek, May 25, 1961. In all cases, specimens were obtained by beating the branches of Dougas fir trees.

—*J. Grant, Forest Entomology Laboratory, Vernon, B.C.*

Termites in the Queen Charlotte Islands

In September, 1962 I received five specimens of **Zootermopsis** termites from Mr. J. F. Munro of the British Columbia Forest Service which he had taken in Queen Charlotte City; this was the first record I had of these insects on the Queen Charlotte Islands.

In the autumn of 1962, I was given one worker termite by Mr. Bristol Foster, a graduate student, which he took at Rose Harbour, Q.C. Islands, on 16 August 1960.

These two records increase the known range of termites in this Province. Since the specimens were workers and so cannot be determined to species, one can only guess that the species is **Z. angusticollis** which I took in 1926 in large numbers at Tofino, on the west coast of Vancouver Island. This was an island distribution but not nearly so far north as the Queen Charlotte Islands.

—*G. J. Spencer, University of British Columbia, Vancouver 8, B.C.*

THE SPECIFICITY OF BINAPACRYL, A DINITRO MITICIDE, AGAINST THE EUROPEAN RED AND McDANIEL SPIDER MITES[1]

R. S. Downing and I. D. Jack[2]

The miticide, 2 - sec - butyl - 4,6 - dinitrophenyl 3-methyl-2-butenoate, generically known as binapacryl, has been under investigation at the Summerland Research Station since 1959. Laboratory and field experiments in 1959 and 1960, when the preparation was known by the trade name Acricid, have been reported by Downing (1). Field experiments during 1961 and 1962 are described in this paper.

Methods

Sprays were applied to dripping with a high-volume handgun sprayer or at 50 gallons per acre with a low-volume "concentrate" sprayer. The handgun sprayer was used to spray dwarf apple trees where the plot size was 10 to 12 trees. The concentrate sprayer was used against standard size apple trees of which there were 12 to 18 trees per plot.

As a rule, mite populations were estimated by taking a 20-leaf sample from one quadrant of each of 5 trees per plot. The leaves were processed by the method of Henderson and McBurnie (2) as modified by Morgan *et al.* (3).

In 1959 and 1960 the miticide was obtained from Farbewerke Hoechst, Frankfurt, Germany. In 1961 the Hoechst product, Acricid, was supplemented by a formulation from the United States, Niagara 9044, a 50 per cent wettable powder obtained from Niagara Chemical Division, Food Machinery Corporation, Middleport, New York. In 1962 Niagara 9044, given the brand name, Morocide, was formulated as 25 per cent or 50 per cent wettable powder.

Results and Discussion

In 1961 binapacryl (Niagara 9044) was applied at low volume to control the European red mite, *Panonychus ulmi* (Koch), and the McDaniel spider mite, *Tetranychus mcdanieli* McG. on mature Delicious, Winesap, Newtown, Jonathan and Stayman apple trees. The preparation gave excellent control of the McDaniel spider mite (Table 1) but was ineffective against the European red mite. The spray caused no foliage or fruit injury.

[1] Contribution No. 138 from the Regional Research Station, Canada Department of Agriculture, Summerland, British Columbia.

[2] Entomologist and Student Assistant respectively.

TABLE 1—Average Numbers of the European Red Mite and McDaniel Spider Mite per Leaf Before and After Spraying Apple Trees by Low-Volume Sprayer on June 27, 1961.

Miticide	Amount per acre	Before spraying	Days after spraying 9	15
European Red Mite				
Binapacryl[1] (50% w.p.)	4 lb.	18	27	25
Check — no treatment		12	36	35
McDaniel Spider Mite				
Binapacryl[1] (50% w.p.)	4 lb.	7	1	1
Check — no treatment		4	3	2

[1] As Niagara 9044

Table 2 summarizes results from high volume application of binapacryl against mites infesting dwarf apple trees. Mite counts were from samples of 10 leaves from each of 5 trees per plot and 2 plots per treatment. As in the previous experiment binapacryl gave poor control of the European red mite but excellent control of the McDaniel spider mite.

TABLE 2—Average Numbers of the European Red Mite and McDaniel Spider Mite per Leaf Before and After Spraying Apple Trees by High-Volume Sprayer on August 7, 1961.

Miticide	Amount per acre	Before spraying	Days after spraying 7	14	25
European Red Mite					
Binapacryl[1] (25% w.p.)	1.5 lb.	12	16	18	37
Check — no treatment		0.3	2	1	2
McDaniel Spider Mite					
Binapacryl[1] (25% w.p.)	1.5 lb.	10	0	0	1
Check — no treatment		0.4	3	11	26

[1] As Acricid

Later in the summer of 1961 binapacryl was compared with Tedion against the McDaniel spider mite. Applied at low volume, binapacryl 25 per cent wettable power at 8 or 12 pounds per acre gave excellent initial and residual control. Tedion, on the other hand, gave characteristically poor initial control but excellent residual control. A year later, however, leaf samples from these plots, that had not been sprayed in the meantime, gave surprising results. As shown in Table 3 there was an outstanding increase in numbers of the European red mite where binapacryl had been applied. There was no such effect from the use of Tedion.

TABLE 3—Average Numbers of the McDaniel Spider Mite and European Red Mite per Leaf After Spraying Apple Trees by Low-Volume Sprayer on June 13, 1961.

Miticide	Amount per acre	McDaniel Spider Mite Before spraying	Days after spraying 8	18	27	European Red Mite 1 year after spraying
Binapacryl[1] (25% w.p.)	8 lb.	70	0	0	0	66
Binapacryl[1] (25% w.p.)	12 lb.	73	0	0	0	13
Tedion (25% w.p.)	4 lb.	82	11	1	0	6
Check — no treatment		85	69	47[2]	8	0.2

[1] As Acricid

[2] Sprayed with Tedion (25% w.p.) 4 lb. per acre

Application of binapacryl was repeated in this orchard in 1962 in the same way as in 1961 except that the formulation of binapacryl was 25 per cent wettable powder instead of 50 per cent wettable powder. The dosage of active ingredient, however, was unchanged. Table 4 shows that binapacryl, 3 pounds of active ingredient per acre, in 2 applications gave good control of the European red mite, but a 2-pound dosage was inadequate. But even the lower dosage kept the McDaniel spider mite at an exceedingly low level for the season.

TABLE 4—Average Numbers of the European Red Mite and McDaniel Spider Mite per Leaf After Spraying Apple Trees by Low-Volume Sprayer on July 26, 1962.

Miticide	Amount per acre	Before spraying	Days after spraying 8	14	23	34
European Red Mite						
Binapacryl[1] (50% w.p.)	4 lb.	66	31	30[2]	5	6
Binapacryl[1] (50% w.p.)	6 lb.	13	2	2[2]	0	0
Check — no treatment		2	9	14	25	21
McDaniel Spider Mite						
Binapacryl[1] (50% w.p.)	4 lb.	1	0	0[2]	0	0
Binapacryl[1] (50% w.p.)	6 lb.	1	0	0[2]	0	0
Check — no treatment		2	10	16	20	62

[1] As Morocide
[2] Resprayed Aug. 13

Summary

Binapacryl is the generic name for the miticide that has been previously known by the trade designations: Acricid, Niagara 9044, and Morocide. During 1961 it gave excellent control of the McDaniel spider mite at a dosage of 2 pounds of active ingredient per acre in low-volume spraying and at 0.75 pound of active ingredient per 100 gallons in high volume spraying. Binapacryl was ineffective against the European red mite in 2 of the 3 orchards in which it was applied. In the third orchard the European red mite was not numerous in 1961; but in 1962 a surprisingly heavy European red mite infestation occurred in trees that had been sprayed with binapacryl the previous year. This infestation was not adequately controlled by 2 successive applications of binapacryl at 2 pounds of active ingredient per acre. Two applications at 3 pounds per acre did, however, prove effective.

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A Live Giant African Snail Intercepted in Vancouver, 1963

On January 16, 1963, one of us (R.J.D.) was telephoned by a housewife in North Vancouver about a large snail shell from Hawaii. I picked up the live snail and recognized it as the giant African snail, **Achatina fulica** Bowdich. The housewife was pleased to be rid of it.

The shell was collected near a beach at Honolulu by the man and his wife while they were on a Christmas vacation. They wanted the large attractive shell as a souvenir. The man put it in his pocket and it was carried thus in all innocence when they cleared through customs at Vancouver. At home the shell was placed on the moist soil of a large potted plant. Presently the family realized the shell was occupied since the snail began to extend and bury itself. They then called the University.

The snail was killed and deposited in the Zoological Museum of the University of British Columbia, (U.B.C.I.M 10743). The dimensions in cm. were as follows: length, 7.5; width, 4.0; aperture, 3.5x2.0; weight, 43.4 gm.; with about 7 whorls.

This is the second interception of the giant African snail at Vancouver (Zuk, P. Proc. Entomol. Soc. Brit. Columbia 46: 32, 1950).

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MOSQUITO PRODUCTION IN SEWAGE LAGOONS

L. C. CURTIS[1]

A fairly recent development in community sanitation is the rapidly expanding use of sewage lagoons, or stabilization ponds. Compared with the traditional mechanized sewage disposal plant they have the advantages of low first cost, depreciation, and maintenance. Unfortunately for those interested in mosquito control, some communities have responded to the low maintenance concept by providing none, with the result that the lagoons have provided ideal conditions for producing mosquitoes, principally *Culex tarsalis,* a potential disease vector.

A heavy population of *C. tarsalis* at Kamloops led to an investigation of four lagoons in the district which gave clear demonstrations of mosquito breeding at its worst, and the possibility of its suppression. These four pools are discussed in descending order of nuisance value.

Lagoon A, a pool about three acres in extent, was attached to a large private institution. Roughly rectangular, it had a peninsula extending a short distance from one end on which were the inlet works. The water had the appearance of pea soup due to algae, and the pool apparently performed its primary function excellently. It contained a number of large carp which no doubt played an important role in keeping the main body of water free of mosquito and other insect larvae. Unfortunately the banks were heavily overgrown with vegetation down to and beyond the waterline, giving place to a massive growth of cattails extending in places six feet from the shore. In this zone, sheltered from wave action and predation, *Culex* larvae proliferated excessively.

Lagoon B, a large pool of about twelve acres, served a suburban community. The banks were heavily covered with weeds and some willows, and there was a margin of a few inches of vegetation emerging from the water. This margin supported a moderate population of *Culex* larvae. At one end an overflow carried the effluent to a depressed area of several acres where it formed a swamp, heavily overgrown, which supported an exceedingly dense population of mosquitoes.

Lagoon C consisted of two sections of fifteen acres each, which at the time of inspection had been in use only for a few weeks. The banks were thickly overgrown with annual weeds, some of which had been inundated by the rising water. This had formed a narrow margin of protected water in which were a few mosquito larvae. It was obvious that this was a temporary condition, and the future state of the banks would depend upon the quality of maintenance. However, in this case there had been a long interval between the original excavation of the pools and the inauguration of the system, during which the beds had given rise to numerous tall terrestrial plants, even including willows, which protruded above the water. The annual plants would soon be gone, but the willows could thrive and form a mosquito harbour.

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Lagoon D was two small basins, totalling about three acres, attached to a large public institution. The pools had been in use for a number of years but produced no mosquitoes. The reason for this lay in their construction. The outline was rectangular, and the banks were lined with shale which gave footing to a scattered population of annual weeds, none of which extended below the water line. Accordingly wave action and native predators eliminated all larvae.

Chemical methods of larval control are uneconomic in sewage lagoons, as the normally residual larvicides degenerate rapidly in the highly polluted water, making repeated, heavy applications necessary. Fortunately, the environment may be so manipulated that the existing natural control factors become highly efficient.

The most effective deterrents to mosquito production in these pools are wave action and natural predators. Both are inhibited by the presence of emergent or floating vegetation. If the following points are observed in the construction and maintenance of sewage lagoons there is little likelihood that they will become sources of mosquitoes.

1. The area of the pools should be as large as possible, and the establishment of nearby windbreaks should be avoided, so that wave action may be encouraged.

2. The dykes should be wide enough on top to permit the passage of mowers and other maintenance machinery.

3. The banks should have a moderate slope, and if formed of soil, they should be planted to grass and kept mowed.

4. The water should be kept at sufficient depth to prevent the establishment of bottom-rooted vegetation.

5. There should be provision for a rapid draw-down of a foot or so, when this is compatible with the primary function of the pool, to destroy larvae by stranding.

6. Seepage or overflow should be carried away in deep, clear channels.

7. Emergent vegetation should be killed by herbicides or removed mechanically. Floating drift should be cleared away.

8. Coarse fish, such as carp, may be introduced as predators.

Abstract

Four sewage lagoons are described that illustrate in varying degree conditions that encourage mosquito production. Steps are outlined by which mosquito breeding in ponds can be prevented.

CONTROL OF PESTS IN INSECT AND HERBARIUM CABINETS

G. J. Spencer[1]

For some years I have worked on control of museum pests, chiefly *Anthrenus verbasci* (L.), the varied carpet beetle, which is also the most widespread household pest in Vancouver; *Attagenus piceus* Oliv., the black carpet beetle; *Perimegatoma (Megatoma) vespulae* Milliron, a parthenogenetic species which feeds indiscriminately upon herbarium specimens and dried insects; *Stegobium paniceum* (L.), the drug store beetle; and *Ptinus ocellus* Brown *(=tectus)*. We do not yet contend

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with *Anthrenus scrophulariae,* the buffalo carpet beetle, which is common as far west as Haney, or with *A. museorum,* the museum beetle, which is a pest in eastern North America. My experiments have employed sprays, baits, and fumigants.

Sprays

Before the university museum acquired steel cabinets, I sprayed 5 per cent chlordane once a year around the bases of our wooden cabinets. This was effective in keeping out *A. verbasci* and *A. piceus* but not *P. vespulae;* the adults of this species apparently fly indoors and must oviposit in cracks under the lids of wooden drawers. I have found dead adults on the glass tops of drawers.

Two per cent chlordane and 2 per cent heptachlor are effective applied with a 4-inch wide fine jet to susceptible places or painted on by hand with a 2-inch brush where spray vapour is undesirable. However, treating the edges and lids of drawers is a laborious process and is not very effective after three months.

Baits

Herbarium specimens are attacked by three species of beetles: *S. paniceum, P. ocellus* and *Perimegatoma vespulae*. Solutions of mercury bichloride have long been used against these pests in herbaria, but after about one year the mercury sublimes so that the flowers and buds are destroyed and sometimes the leaves.

Canned cat food, dried and pulverized is an excellent medium for rearing household insects. To prepare baits I used 4 per cent Paris green, i.e. ortho-arsenite of copper of about 53-63 per cent arsenious oxide content. This was thoroughly incorporated into 96 per cent wet cat food, which was then dried and pulverized, and put in containers in a deep enough layer that *A. verbasci* larvae could burrow under it. The culture was maintained at 70° F. The larvae readily ate the bait but did not become paralysed. In 24 hours, 8 per cent were dead; in 15 days, 23 per cent; in 3½ months, 88 per cent; and the last died in 4 months.

Fumigants

A block of histological embedding wax of 1½ cubic inches was kept on the surface of crude benzene hexachloride in a sealed jar for three weeks until it smelt fairly strongly. Two thin shavings of the wax were cut from the corners and placed in a tight, glass-topped tin box of 3 inches diameter with 25 *A. verbasci* larvae of various sizes taken at random. In 22 hours several were showing circus movements or ataxia which gradually spread until every one was affected and the larvae started to die off. After 17 weeks only one was alive but twitching. It was still in the same condition two weeks later. It appeared that 4 per cent of the larvae showed a degree of resistance to the vapour of benzene hexachloride given off from wax.

One half gram and one gram respectively of lindane (99 per cent gamma isomer) was thoroughly incorporated into 100 grams each of unpurified, natural, beekeepers wax, which was melted, stirred, poured into molds, cooled, and cut up into small pieces. The pieces were rolled by hand into half-inch diameter marbles. About one month after being made, the 'marbles' had a white bloom of lindane. They were transfixed with stout insect pins in the same way that moth balls are prepared for insect cabinets. Into the centre of two clean, empty insect drawers each of 538 cubic inch inside capacity, were stuck one marble each of 0.5 per cent and 1 per cent lindane with 50 *A. verbasci* larvae taken at random from a large culture. The drawers were checked daily.

In both drawers, the smallest larvae became paralysed in 24 hours. In 48 hours those nearest the wax marbles were on their backs, dead. Day by day paralysis affected the larvae; first they showed circus movements, then ataxia, and then they lay upside down apparently dead or occasionally twitching their legs. It became difficult to tell when larvae were really dead so that their reaction to light was used as an index. Ten inches from a 100 W globe the light was 180 foot candles; a beam concentrated through a 1½ inch reading glass at 10 inches was 600 f.c. and at 7 inches, 900 f.c. A severely paralyzed larva normally motionless on its back would slowly twitch its feet in 15 seconds at 600 f.c. and at 900 f.c. within 5 to 10 seconds. If no movement occurred at 900 f.c., the larva was declared dead. Within 30 days at 1 per cent lindane and 37 days at 0.5 per cent lindane, every larva was dead. In both drawers, two out of the 50 larvae survived nearly one week after the others died, again suggesting some resistance in 4 per cent of these insects.

One peculiar feature was the fact that about 25 per cent of the larvae pupated and produced beetles which seldom moved more than about an inch from the pupal case and invariably died upside down 24 hours after emergence.

A local collector complained about book lice infesting his cabinet of insects. I gave him lindane and wax which he made into marbles. He reported to me that 24 hours after these were pinned out every book louse was either paralysed or dead. This happened with fresh lindane marbles before the bloom appeared.

To test lindane vapour further, a 3-inch diameter petri dish, ½-inch deep, was carpeted with fine sand to give good footing, supplied with 7 dried grasshoppers and one bee and then stocked with 50 *A. verbasci* larvae. The petri dish was placed in the middle of an empty insect drawer into which had been dusted one gram of lindane of salt-shaker size. Within 19 hours some larvae had lost the ability to climb on to the food. In three days one was dead, several lay on their backs with legs twitching and the rest showed irregular and circus movements. In 31 days only 4 were alive. In 43 days only one showed any twitching under prolonged light of 600 f.c. and in 54 days this one was dead. Lindane vapour must take effect relatively fast because no larva attempted to chew the dead insects or to tunnel into them.

A test with the black carpet beetle and lindane showed that mature and nearly mature larvae of this species are more resistant than *A. verbasci* larvae. Into a cabinet drawer full of irregularly pinned-out large and small insects was dusted evenly one gram of coarse lindane crystals averaging 1mm x 0.5mm. Twenty-five mature and early mature *A. piceus* larvae were added. Within 24 hours they showed irregular back and forth, but not circus movements. In a few days some were dead or dying; after 12 days the remaining 19 were removed and placed in an empty petri dish in a clean untreated drawer to see if recovery occurred. Three survived after 28 days. These were transferred to a clean tin with normal food; 12 days later another one apparently recovered and was similarly transferred, with food. These recovered larvae were left undisturbed for 7 months and were then checked: the single one had died, and of the three larvae, one had transformed into a beetle which had died and the other two were paralysed, lying on their backs twitching when disturbed. Turned right side up, the larger one slowly burrowed into the food but the smaller seemed unable to burrow. It is likely that they had eaten some food during the 7 months.

Another 25 larvae from the same stock were put into the drawer with coarse lindane. The effect of the poison was more rapid than it had been on the first group. In 6 days most were dead or paralysed and 11 showed movement under 600 to 900 f.c.; one larva seemed stimulated and crawled slowly and incessantly; in 18 days this was the only survivor and it finally died on the 49th day.

These experiments show that 1 gram of lindane scattered on the floor of a drawer of insects will immobilise and eventually kill dermestid larvae and should prevent others from becoming established. One ounce of lindane will treat 28 drawers for a year.

BACKGROUND FOR INTEGRATED SPRAYING IN THE ORCHARDS OF BRITISH COLUMBIA

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The practical meaning of integrated spraying is the production of a maximum crop of high quality fruit with a minimum of pesticides. In controlling our orchard pests the idea is to work with Nature as closely as we can rather than to disregard her by relying blindly on preventive spraying and "shotgun" spray chemicals. The ultimate objective is to improve our competitive position, and stay in business.

In 1944 Country Life in British Columbia (28:6, 5) carried an unorthodox item on orchard pest control. Titled, "Is it advisable to spray for the three types of mites in B.C. orchards?", the article was a forerunner of a number of others, published elsewhere, that are helping to put orchard pest control on a logical basis. That early item drew attention to the importance of natural factors in controlling orchard pests. It pointed out that when a spray treatment kills beneficial species as well as pest species, it may, in the long run, do more harm than good. In local orchard circles the article aroused brief speculation. Then this entomological firecracker quietly fizzed out. Like the American Austin it was ahead of its time.

But, during the intervening years, things have been happening in the entomological world. In 1946 Pickett, Patterson, Stultz and Lord (Scientific Agriculture 26:11) published the first of a series of articles dealing with the influence of spray programs on the fauna of apple orchards in Nova Scotia. Their well documented work aroused considerable discussion. It stimulated inquiry in various other fruit growing areas; notably in Holland, Belgium, Great Britain and California. The outcome has been the firm realization that we cannot hope to subdue our orchard pests by any one method of control; and, in particular, that chemical control should be applied with caution. During the last 10 or 12 years this note of caution has been heavily underscored by the development of resistance to pesticides in a wide variety of noxious insects and mites.

For many years it had been known that insects might become resistant to such very different inorganic preparations as acid lead arsenate and lime sulphur. But only in the 'fifties, after the introduction of DDT and its many successors, did the full significance of resistance become clearly evident. The problem is widespread; all over the world pesticide-resistant insects, mites and ticks are evolving rapidly under the stimulus of chemical selection. Synthetic molecules of high initial effectiveness become useless one after another. The chemists are hard put to keep pace with the ceaseless change. Some entomologists claim that a pesticide used at low dosage may lead more quickly to the segregation of a resistant strain of pest than at high dosage. Other entomologists incline to the opposite view. We have to balance uncertainty there, against certainty otherwise, that the low dosage is preferable.

The man on the land may not realize that the way in which he uses a pesticide can have a bearing on its period of usefulness. Apart from being a waste of money the needlessly frequent use of a pesticide may be an open invitation to chemical selection. The more often a pest population is exposed to a pesticide the sooner will a resistant strain be segregated. And there is another matter to think about. Some pesticides are highly toxic to certain pests, but only moderately toxic to certain beneficial species. Heavily applied these compounds may be indiscriminately lethal. But, if used at a dosage just high enough to kill pests, they may spare the beneficial species.

The careful use of pesticides yields yet another, and very different dividend. The lower the dosage of pesticide the lower the spray residue on the fruit at harvest. The consumer is becoming increasingly uneasy about spray residues, and understandably so. There is no point in giving any justification for public concern. That brings us to a modern best-seller. Rachel Carson's book, Silent Spring (Houghton & Mifflin, Boston, 1962), is already one of the most quoted, and most editorialized books of our time. In lovely, flowing English it evokes a grisly spectre. With spine-chilling examples of death already done, it warns of the mass poisoning of our environment by sinister pesticides synthesized with diabolical skill in the laboratories of modern merchants of death. To millions unacquainted with the facts (most consumers) Silent Spring's impressively technical list of references, and its frequent dropping of names in science and medicine, greatly emphasize its credibility. And of special concern to fruit growers, spray residue, writ large throughout the book, becomes a term to rank with that modern abomination, atomic fallout.

Regardless of the fact that Silent Spring is woefully biased, and in fact misleading, our methods of pest control will assuredly be modified by spray residues, the needless destruction of beneficial, or aesthetically desirable organisms, and the development of pesticide resistance. That is why, as the author of the long-defunct Country Life article that suggested more thought and less spray, I think the time has come for action.

In 1961 we of the Summerland Research Station began a long-term experiment in a commercial orchard at Summerland. The purpose was primarily to demonstrate the influence of various dormant sprays on the abundance of pests, predators, and parasites. Following the application of the dormant sprays (one plot received no dormant spray) we applied foliage sprays only when pest-induced, commercial loss was clearly imminent, and used selective pesticides whenever possible. During the second year the per-acre outlay for pesticides in the owner-sprayed part of the orchard (sprayed "according to the book") was about 25 dollars more than the outlay in the experimental block. Yet the owner-sprayed trees were no healthier, and the crop returns no larger. And equally important, the owner, a very competent operator, had a more efficient sprayer than that employed in the experimental block.

This demonstration of savings in operational costs shows what can be done with integrated spraying. But it does not go far enough. The orchard in question is in a cool part of the Summerland district. Pest control there is considerably less difficult than in, for example, the hotter and drier Oliver-Osoyoos district. What we need now is an extension of this sort of thing into each major fruit producing area of the B.C. interior; and that is what we are planning.

Working together, the Horticultural Branch of the British Columbia Department of Agriculture, and the Summerland Research Station of the Canada Department of Agriculture are arranging comprehensive demonstrations. Adjoining blocks of mature pear trees and mature apple trees (except for a third of each treated with dormant oil, and a third treated with dormant lime sulphur), will be sprayed only when spraying is unquestionably necessary. That will hold whether against insects, mites, or fungus diseases. Preference will be given to selective pesticides. Indiscriminate compounds, such as DDT, will be avoided if at all possible. By doing all we can to ensure the survival of predatory and parasitic species, and by enlisting the aid of the weather whenever the weather can help us we shall aim for the maximum reduction of pests by natural control agencies, and hence the minimum application of chemical control measures. In the Okanagan Valley there will be demonstration blocks of from 3 to 5 acres each at Oliver, Summerland, Kelowna and Vernon. In the Similkameen Valley there will be a block at Keremeos.

We shall have to ensure that the spraying technique is adequate, and that the spray chemicals are deposited in the amounts intended. To that end foliage and fruits will be sampled from the tops and bottoms of the trees in each orchard. The samples will then be analyzed in the chemical laboratory.

Of the many interrelated forms of life that exist in British Columbia orchards, we know relatively little. Until fairly recently the resources of the Entomology Laboratory at Summerland had to be largely devoted to the "brushfire" type of research—the day-to-day job of keeping abreast of the codling moth and its associated problem makers, the orchard mites. With the codling moth problem contained for the moment, thanks to the two modern synthetic preparations Guthion and Sevin, we can now tackle the broader issues. Some of these issues are inherent in the proposed project on integrated pest control. As long as the project is in operation (at least 5 years) we shall assess the rise and fall of pest species, parasites, and predators. This ecological work is fundamental; without it we are, in a sense, without a compass. In making our pest control recommendations we shall eventually be on more solid ground.

Let us now consider where we stand with our present spray practice. Although perhaps unnoticed by many fruit growers, the use of pesticides in the British Columbia fruit industry has been progressively put on a more rational basis over the last 13 years. We took the first step in 1949 with the introduction of low-volume (concentrate) spraying, a technique in which our industry is a recognized leader. At once the growers were able to reduce quite substantially the per-acre quantities of pesticides. The next step was in 1960 when we further reduced the dosages of pesticides. After that date the recommended amounts presupposed good equipment, properly operated (minimum dosages), rather than as previously, poor equipment, poorly operated (maximum dosages). The latter procedure is still followed in many other fruit growing areas. And finally, by undertaking the demonstration of integrated spraying, we are preparing to take the third step. When we have shown the wisdom of spraying only when spraying is clearly necessary, instead of as a just-in-case preventive measure, we shall have reduced the use of pesticides to an absolute minimum; and that will be a good thing. But none of us, research people or fruit growers, can afford to forget that the very survival of the fruit industry still depends on pesticides.

The next job will be to develop radically new pest control techniques. The autocidal (sterile male) project for controlling the codling moth, that has been under way at the Summerland Research Station since 1956, represents such a technique. Although this new method of control looks more and more promising as the work goes on, it is still some years from practical application even if all continues to go well.

We plan to follow the demonstrations of integrated spraying with the preparation and distribution of a grower's manual to illustrate clearly the essentials of the procedure. The manual, a loose-leaf publication in full color, would be used in conjunction with the annually-revised spray recommendations. Primarily a pictorial representation of symptoms of pest infestation, and disease infection, rather than of the pests or disease organisms themselves, it would illustrate the stage of damage, or pest abundance, at which spraying becomes necessary. It would also carry illustrations of the most important agents of biological control.

Integrated control requires that pests be associated with the symptoms of their attack. For that reason certain pests such as the European red mite and the McDaniel mite, and their eggs, would likewise be illustrated. The manual would also carry full-color illustrations of symptoms of the various mineral deficiencies that may be found in British Columbia orchards. Sometimes such symptoms are confused with pest injury, or with disease symptoms.

No deciduous fruit industry has yet been provided with a manual of the type that we propose. The reasons, doubtless, are that the best of color reproduction, which is what we would need, is expensive; and it necessitates superior photography. But, if our demonstrations of integrated spraying should prove successful, preparation of the manual will be such an obvious step that the growers themselves will insist on it. That is why, in anticipation of success, the Research Station photographer will get on with the job this year.

AN OCCURENCE OF THE BULB AND POTATO APHID *Rhopalosiphoninus latysiphon* (Davidson) (HOMOPTERA: APHIDIDAE), ON POTATO IN BRITISH COLUMBIA[1]

A. R. FORBES

In mid-April 1963, we were called to examine sprouting potatoes which were very heavily infested with *Rhopalosiphoninus latysiphon* (Davidson) (Fig. 1). The tubers had been stored at a comparatively warm temperature since January in preparation for early planting. This is the first record of this aphid on potatoes in B.C., although Glendenning (1929) recorded it from cultivated violet at Agassiz.

R. latysiphon is easily recognizable by its cornicles (Fig. 2 and 3). It was described from California by Davidson (1912) who found it on *Vinca major* and *Convolvulus arvensis*. It was later recorded in California from *Chrysanthemum* sp. (Shasta daisy) and *Primula* sp. (Essig, 1917), in small numbers from potato (Swain, 1919), and from *Saxifraga* sp. (U.S. Department of Agriculture, 1960).

Hille Ris Lambers (1953) records it in Europe from the Netherlands, England, Germany, and Switzerland, giving *Bromus sterilis, Potentilla anserina, Tulipa,* and potato as host plants. He states that it lives on the subterranean parts of its hosts in the field, and on potato tubers and tulip bulbs in storage.

In England, Legowski and Gough (1953) studied infested potato fields and found that fairly heavy infestations caused loss of vigor, premature yellowing of leaves, and decreased yield. The aphids occurred only on the underground parts of the potato; up to 3,000 were counted on a single plant. Gair and Cummins (1960) estimated the yield loss on some main crop potato fields at 2-3 tons per acre. *Agropyron repens, Brassica sinapis, Solanum nigrum, Tussilago farfara,* and *Urtica urens,* growing near potatoes were recorded as new host plants (Legowski and Gough, 1953).

R. latysiphon has been reported as a vector of potato leaf roll virus (Kennedy, Day, and Eastop, 1962), so may be a threat by spreading disease. Disease transmission would be particularly serious in storage where the aphids crawl freely over the seed trays. In the infestation we examined the trays as well as the floor and walls of the building were literally crawling with aphids.

This aphid then is a serious potential pest of potato in B.C. Stored tubers should be watched carefully and any incipient infestations immediately eradicated. Because of the subterranean habits of the aphid, control in the field would be very difficult, but since most infestations seem to originate in storage (Hille Ris Lambers, 1953; Legowski and Gough, 1953), field infestations may not be a problem so long as clean tubers are planted.

[1] Contribution No. 59, Research Station, Research Branch, Canada Department of Agriculture, 6660 N. W. Marine Drive, Vancouver, B.C.

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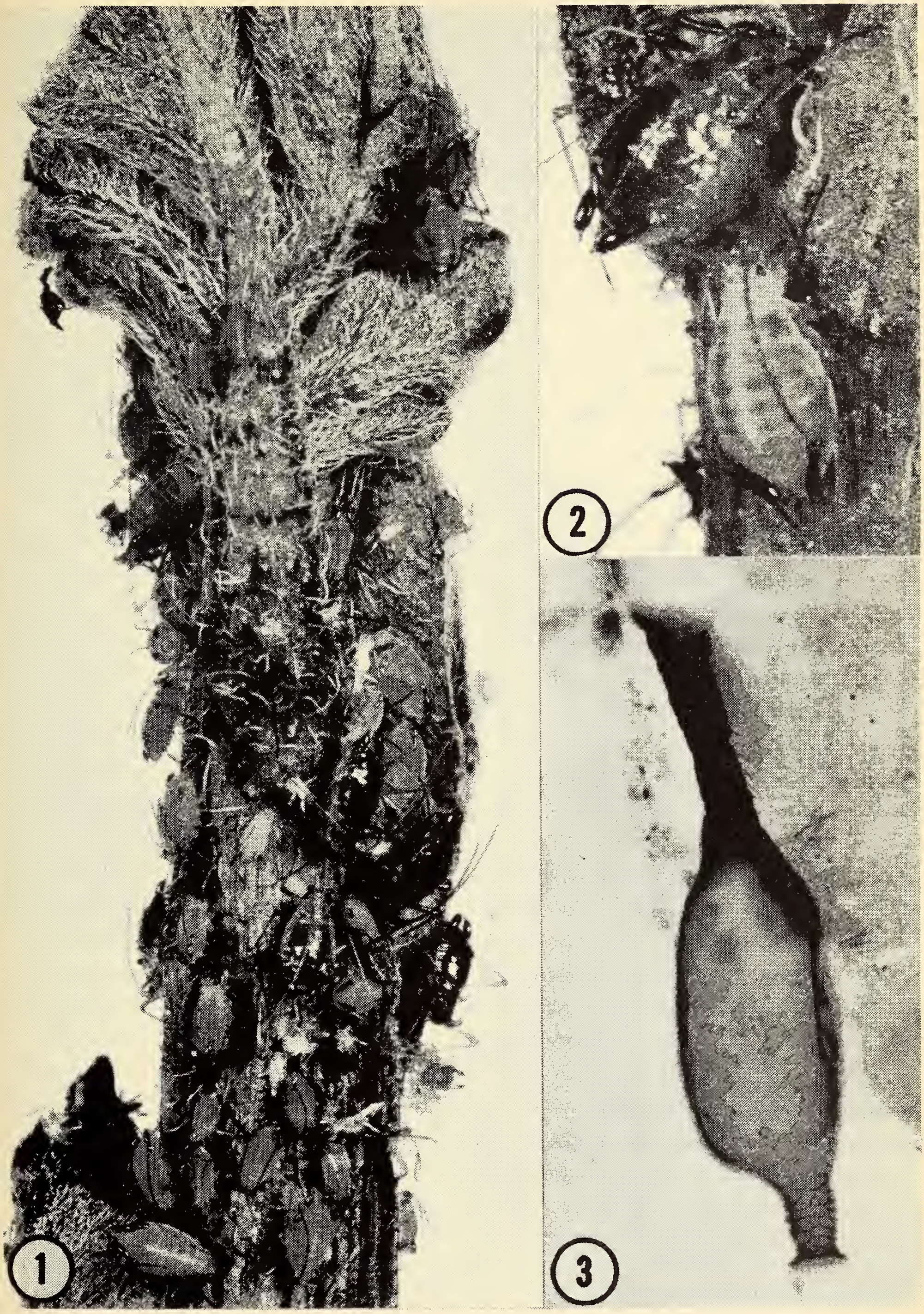

Fig. 1-3—**Rhopalosiphoninus latysiphon** (Davidson). 1, Colony on sprout of potato tuber. 2, Close-up of two aphids. 3, Photomicrograph of cornicle.

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PRELIMINARY INSECTICIDE TESTS AGAINST THE DOUGLAS-FIR NEEDLE MIDGES, *Contarinia* spp., LARKIN, B.C., 1962[1]

D. A. ROSS[2] AND J. ARRAND[3]

Introduction

Periodically, Douglas-fir trees in portions of the southern interior of British Columbia are severely infested with needle midges, *Contarinia* spp. Needles attacked by larvae of these tiny gall midges become distorted and discoloured, and dehisce. Even light infestations can degrade the market value of Christmas trees or mar the appearance of shade trees. Recently the Christmas tree industry, which in 1961 grossed approximately two million dollars in British Columbia, has become concerned over midge damage; also, home owners have requested advice on use of insecticides to protect Douglas-fir shade trees.

Life histories and bionomics of the Douglas-fir needle midges of British Columbia were investigated by S. F. Condrashoff (1962a, 1962b). The adults emerge from the ground in May as the Douglas-fir buds are opening, and eggs are deposited on the new needles. Shortly after hatching, the maggots enter the new needles and feed there until October, when they drop to overwinter in the ground. The life history studies indicated that insecticides directed at emerging adults or at newly hatched larvae should be most effective for control.

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Methods and Results

The test was carried out at Larkin, B.C. Five trees from five to seven feet high were used for each treatment and another five were left unsprayed as checks. Insecticides were applied with a hand sprayer until the run-off point was reached. Thiodan and DDT emulsions and a lindane suspension were the insecticides tested. One imperial gallon of water was added to each of the following quantities of commercial concentrates to obtain the finished formulations:

3 fl. oz. Thiodan emulsifiable concentrate containing 2 lb. technical Thiodan per imperial gallon

2 fl. oz. DDT emulsifiable concentrate containing 2.5 lb. technical DDT per imperial gallon

3 teaspoons of 25% lindane wettable powder

The concentrations of the finished sprays were: Thiodan—0.375%; DDT—0.312%; and lindane—0.12%.

The midges were first observed in flight on May 14, and the sprays were applied during the morning of May 16. At the time of spraying, most of the buds on the majority of test trees had opened; none on one of the check trees had opened. This variation is common in a natural stand of Douglas-fir.

Immediately after spraying, five open buds were picked at random from each check and each test tree. Three to eleven eggs were present on each bud, and two of the fifty buds contained larvae.

Late in the morning of May 17 the trees were examined for the presence of adults. Myriads were present about the four "check" trees with open buds, while none was seen among the foliage of the check tree with unopened buds. None to five adults were observed in flight among individual sprayed trees.

On May 21, five open buds from each treatment were examined. Table 1 shows the average number of eggs and larvae per bud.

TABLE 1—Average Number of **Contarinia** Eggs and Larvae per Bud on Five Opened Buds from each Treatment Five Days after Spraying.

Treatment (May 16, 1962)	Eggs	Larvae	
Check	18.0	5	
Lindane	5.5	4.0	most larvae dead
Thiodan	2.7	1.5	
DDT	1.5	0.2	

The results shown in Table 1 indicate that more eggs were deposited on the unsprayed trees than on the sprayed trees during the period May 17 to 21. Presumably adults were killed or repelled by the insecticides.

Final effectiveness of the sprays was assessed during the last week of August, 1962, when damaged needles were easily recognized. Percentage infestation was determined from ten terminal twigs picked at random at about breast height from each tree (Table 2).

TABLE 2—Percentage Infestation of Current Year's Douglas-fir Needles by **Contarinia** spp., Larkin, B.C., August, 1962.

Treatment (May 16, 1962)	Average	Range
Check	17.5	*10-28
Lindane	12.7	4-25
DDT	4.0	3-6
Thiodan	2.0	0.1-5

* Check tree with unopened buds at the time of spraying.

The control achieved with DDT or Thiodan as indicated in Table 2 would be adequate for the Christmas tree industry; the colour and growth of the current year's foliage was better than on the lindane-treated or the untreated trees. It should be noted that lindane was applied at about one third the rate of DDT and Thiodan which is in general line with usage of these chemicals against some pests of ornamentals. The check tree with the lowest infestation (10%) had no open buds at the time of treatment. This suggests that much of the adult flight was over by the time buds on this tree had opened.

Summary

At Larkin, B.C., in 1962, Thiodan and DDT applied with a hand sprayer at the time of bud opening gave satisfactory control of the Douglas-fir needle midges. At the concentration used, lindane did not give adequate protection. The concentrations of the finished sprays were Thiodan 0.375%; DDT 0.312%; and lindane 0.12%.

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Phidippus AND THE WASP

A. A. DENNYS

Walking along a dusty trail on a sparsely timbered hillside one hot afternoon in July, 1936, my attention was attracted by the quick movements of a dark, iridescent blue wasp with dusky brown wings. The wasp seemed to be searching as it ran and flew amongst the grass roots and lumps of soil. The lost prey, when it was regained, was a jumping spider, *Phidippus* sp., dark grey with red and white markings on its hairy body.

The spider was seemingly lifeless. It had been paralyzed by the wasp which had already excavated a cell in the earth nearby and was stocking it with several of the spiders. Having filled the cell the wasp would lay an egg beside the spiders and then fill the entrance. The paralyzed spiders would provide fresh food for the wasp larva. If the spiders were killed they would decompose and dry before the wasp egg could hatch.

I took the spider home and put it in a vial on a shelf. It was late September before I remembered it again. To my surprise it was not a shrivelled corpse, but looked as fresh as ever. On examining it with a magnifying glass I thought there was a slight trembling of the pedipalps. With a fine glass tube I placed a drop of water on its mouth. The mouth parts moved slightly and the bead of water gradually disappeared. I replaced the water several times with the same result. A few days later the process was repeated. This time the mouthparts moved visibly. Next I caught a fly, mashed it in a drop of water, and placed it upon the spider's mouth. For several days this feeding was repeated. Each time there was improvement, until the spider could actually sit with its legs in a natural position and move them slightly.

Two weeks after the first drink I held a whole fly, partly killed, against the spider's jaws, which opened far enough to clasp it. By early December it could move 6 legs. By Christmas it had begun to web the earth in the jar. In February, 1937, it could jump at a fly or a pencil waved nearby. During the next summer it moulted once, and in February, 1938, it was still living in the jar, apparently as healthy as ever.

It is difficult to appreciate the delicacy of the paralyzing operation. The spider must be stung exactly in the thoracic ganglion or the operation is a failure, in which case the spider either lives and kills the wasp larva, or dies and so starves the larva.

Editor's Note: The foregoing is a condensed and revised version of a manuscript found in 1963 among the papers of the late A. A. Dennys, Vernon, B.C. It is used here by permission of Mrs. Dennys. The wasp is not identified further than as a "Digger." Probably it was one of the Psammocharidae.

NOTES ON THE LIFE HISTORIES OF FOUR MOTHS AND ONE BUTTERFLY FROM VANCOUVER ISLAND (LEPIDOPTERA: PHALAENIDAE, LASIOCAMPIDAE AND LYCAENIDAE)

GEORGE A. HARDY[1]

Panthea portlandia Grt.

P. portlandia is one of the three species of the genus listed by Jones (1951) for British Columbia and the only one from Vancouver Island so far as I am aware. It is a fairly large moth with a wing expanse averaging 45 mm., conspicuously marked on the forewings with grey and black lines and bands. It is on the wing from April to August.

In confinement a female taken in Saanich laid 200 ova between August 10 and 12, 1962 in single mat-like layers in several groups.

Ovum

Size 1 mm. by 0.75 mm. A depressed sphere, smooth, shiny, with about 25 coarse ribs; bright yellow soon turning to dark brown and finally to lead grey at maturity. Hatched August 18.

Larva—1st Instar

Length 3 mm. Head smooth, shiny, jet black. Body light fuscous blending into pale lemon on the T. segments and on A. 6 to 8; tubercles prominent, shiny and black, bearing a short black hair; legs and claspers black. Fed on Douglas fir, eating the stomatic area on the underside of the needles.

2nd Instar

August 24. Length 8 mm. Head slightly notched, smooth, shiny, dark brown with a pale vertical line on each side connected below by a curved line of the same shade. Body pale orange brown, streaked with brown on the sides especially on the T. segments and the first few A. segments; a regular hyphenated white dorsal line; spiracular area indicated by a suffused greyish band; tubercles conspicuous bearing one or more black hairs, those on T. I larger than the others.

3rd Instar

August 30. Length 15 mm. Head shiny, light reddish with black hairs, a curved black line on each side of the front, the labium black. Body constricted between the segments, reddish purple, with a series of creamy elongated triangles along dorsum; spiracular band cream coloured and wavy; several very thin whitish lines between this and the dorsum; the lower side tubercles largest each with a spray of reddish hairs directed downward; a pair of short black tufts on T. I, A. I and A. 7; underside concolorous with the upper.

4th Instar

September 3. Length 20 mm. Head smooth, shiny, pale reddish with an intricate pattern of black scrolls and granulations. Body tapering slightly from the head backward; the ground colour black almost obscured above by a series of fine white lines and flecks, between the dorsal and spiracular lines; the dorsal line was a row of black-bordered white triangles except on A. 6-8 where they were replaced by a straight even stripe; the spiracular line wavy, interrupted, and creamy; the spiracles white; the tubercles large and spreading, bright rust-red bearing a tuft of short hairs; A. I and A. 8 with a pair of long black tufts on the dorsum; T. segments

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with some red and a whitish band on T. 2 and 3; the underside dusky. The larvae rested lying along twigs of the food plant where the pattern and colouration rendered them inconspicuous.

5th Instar

September 13. Length 40 mm. Head black to very dark brown, with the reddish markings much reduced. Body black with grey mottling, most evident on the T. segments; the dorsal line an interrupted chain of white bars, wider on the centre of the segments; spiracular stripe broad, wavy and white, constricted between the segments; spiracles white; tubercles large and red, bearing a few long red and black hairs, with more of the red ones on the lower sides; T. I with a pair of short black tufts; A. I with a pair of long black pencils; A. 8 with a pair of shorter pencils; the underside black with dull reddish bars and bands; claspers pale reddish.

There was some variation in colour and markings; one larva had white marbling and dapplings above and below, and orange claspers.

Pupation took place in a thin, tough, brown cocoon spun at the bottom of the cage among the debris, which was incorporated into it.

Pupa

Size 20 mm. by 8 mm. Rather stout; wing cases dull due to minute striations; A. segments smooth, shiny, strongly constricted between them; a dark reddish brown; cremaster consisting of many fine closely aggregated hairs of varying length with recurved tips; the longest in the centre, all set on a rugose prominence on the tip of the last segment.

Pupation occurred from mid-September to mid-October.

Ufeus electra Sm.

Of the four species of *Ufeus* listed by Jones for British Columbia, three are recorded from Vancouver Island. They are all uniformly dark brown with similar habits. They appear in the autumn, hibernate and reappear in the early spring. *U. electra* has an average wing expanse of 40 mm. and is usually taken at light.

A pair of this species was taken *in coitu* in a light trap on October 10, 1961. They were put in a cardboard carton provided with pieces of bark and moss where they successfully passed the winter. On March 7, 1962 the female commenced to oviposit in crevices of the bark. The male died a day or two later. Oviposition continued intermittently until April 14, resulting in about 200 ova. These hatched in ones and twos over a long period; those laid on March 7 hatched April 10, and the remainder hatched at gradually lessening intervals, as the temperature rose, running well into May.

Ovum

Size 1.00 mm. by 0.75 mm. A depressed hemisphere with about 40 fine ribs and cross ribs, the latter slightly indenting the vertical ones and giving them a beaded look; pale whitish green, turning in three days to pale brown with a reddish brown dot on the micropyle and a faint ring of the same colour around the shoulder; dark brown at maturity.

Larva—1st Instar

April 10. Length 3 mm. Head large in proportion, black, shiny, crevical plate the same. Body pale bluish fuscous, having a tinge of sienna brown on the sides; legs dark brown, claspers concolorous with the body and dotted with black on the sides. They crawled actively at first, finally concealing themselves under bark, between leaves or in loose material. They spun loose shelters in which to hide by day, feeding only at night. They preferred the leaves of *Populus trichocarpa* to any other plant provided.

2nd Instar

May 1. Length 8 mm. Head shiny, jet black, cervical plate the same. Body a dull glaucous green, with whitish dorsal and subdorsal lines; sides mottled with brown; spiracular line whitish; legs dark brown, claspers dull brown.

3rd Instar

May 9. Length 12 mm. Head jet black, not so shiny as before and with a few white hairs. Body, dorsum with a wide dark green band bordered by the bluish white subdorsal lines and centred by a similar dorsal line; sides dark brown; spiracular stripe bluish white; underside green; legs and claspers as described.

4th Instar

May 18. Length 15 mm. Head very dark olive green. Body light olive green with markings as described.

5th Instar

June 2. Length 20 mm. Head rather large in proportion, dark brown, mottled and reticulated with darker brown. Body as described, with sides dark fuscous brown; spiracular stripe having a central cinnamon line.

6th Instar

June 9. Length 25 mm. Head brown, heavily mottled and reticulated with fuscous brown, some of this colour concentrated to form a dark, suffused, oblique mark on each side. Body with a dark olive green band on the dorsum, centred with a wide blue-green dorsal stripe and bordered by the blue-white subdorsal lines; the sides darker tinged with brown; spiracular line a double wavy inconspicuous narrow band; spiracles white, thickly ringed with black and situated just above the line; underside pale grey; claspers grey with a black dot on the outer side.

The larvae continued to feed until July 11, 1962 when they measured 30 mm. in length.

At an early stage the larvae were divided into several lots and placed in a variety of containers; they appeared to feed well enough but in the last instar they languished and died from some unascertained cause.

Syngrapha celsa Hy. Edw.

Of the ten species of *Syngrapha* recorded by Jones in British Columbia six are known on Vancouver Island. Most of them are characterized by a silvery mark in the centre of the forewings. In *S. celsa* the forewings are blue-grey relieved by darker lines and marblings with the distinctive silver marks in the centre. The average wing expanse is 35 mm.

A specimen taken at the Forbidden Plateau Lodge on August 10, 1961 had laid 30 ova by August 15, scattered at random in the container.

Ovum

Size 0.95 mm. by 0.5 mm. nearly hemispherical, slightly depressed in the micropylar region, finely and closely ribbed, pale green, somewhat shiny due to reflected light from the ribs, soft and easily put out of shape, suggesting that under natural conditions it might be squeezed into a crevice in the bark.

Larva—1st Instar

August 20. Length 2 mm. Head very pale brown, almost white. Body white throughout, slightly translucent with a few scattered long white hairs. Food plants were Douglas fir and hemlock, preferably the former.

2nd Instar

September 1. Length 5 mm. Head smooth, pale brown. Body smooth, slightly humped on A. 8 and 9; green, with small black dots in place of the usual tubercles; lighter green along the spiracular area; the legs darker; the underside paler green. Fed on the soft stomatic zone on the underside of the needles; at rest they lay along the needles and were hardly noticeable.

3rd Instar

September 12. Length 10 mm. Head small, smooth, shiny, semi-translucent. Body green; a milky-white spiracular line; thin, whitish subdorsal lines with a dark green dorsal line, which increased the resemblance to the needles along which they rested with the head held in a straight line with the body.

From this date through the winter months the larvae became semi-quiescent, feeding very little and in partial hibernation, but not leaving the food plant.

On November 10 the brood was divided into two groups, one was caged in a sleeve on a fir branch, the other confined in a large glass jar with a muslin cover and placed in an open shed. Those in the sleeve cage died, but the other group overwintered in good condition.

4th Instar

March 18, 1962. Length 14 mm. Head quadrate, smooth, shiny, pale translucent green, faintly mottled with darker green on the sides; cervical plate similar without the mottling. Body with a glaucous green band along the dorsum containing the dark green dorsal line and the thin subdorsal lines; below this band a dark green area just above the broad glaucous green spiracular stripe; spiracles black along the upper edge of the spiracular stripe; tubercles indicated by black dots; underside dark green; legs dark brown; claspers green.

5th Instar

April 20. Length 18 mm. As described; growth was very slow.

6th Instar

May 27. Length 20 mm. Head as described. Body as described but the colour contrasts were more intense. Fed on the buds at the tip of the Douglas fir sprays and consumed the young needles.

June 13. Length 35 mm. Head smooth, shiny, pale translucent green. Body as described. Now full-grown.

June 22. Pupated in a dense but transparent cocoon spun among the needles at the base of the fir sprays.

Pupa

Size 20 mm. by 5 mm. Somewhat slender, smooth, shiny, black; legs and antennae faintly but distinctly outlined in pale ochre; the pleura between the A. segments 4-6 dull ochre on ventrum only, this colour extending in the form of a broad ochre saddle containing a central dark brown dot on to the underside of A. 5 and 6. Cremaster, two fine spines with recurved tips, on the end of the broad dorso-ventrally flattened rugose 'tongue' at the end of the last segment.

Imago

Emerged July 16, 1962.

Tolype dayi Blkmre.

Of the two species of *Tolype* recorded by Jones for British Columbia, *T. dayi* appears to be the only one found on Vancouver Island. It is ash grey with two darker cross bands, the veins noticeably white, and the white downy thorax with a dark central band. It is remarkably well camouflaged in all stages. The wing expanse is 30-35 mm.

A female taken at Royal Oak, September, 1961 had laid a number of ova by September 12. These were scattered on crumpled paper and in the crevices of bark in the container.

Ovum

Size 2 mm. by 1.5 mm. A slightly depressed sphere; the chorion very tough, dull, minutely and closely punctate; covered with many black and a few white scales from the tip of the moth's abdomen, which obscured the shape and size of the ovum. Hatched on June 14, 1962. The larva escaped through a round hole at one side of the egg which usually split into equal halves held together by a small section at the opposite side.

Larva—1st Instar

Length 5 mm. Head dark brown almost concealed by dense white hairs directed forward and curved downward from the T. segments. Body pale soon becoming black with a faint interrupted yellow dorsal line, most pronounced on A. 1-5; several thin whitish lines on the sides; tubercles prominent especially on the sides of T. 1., each bearing long black hairs on the dorsum and white, more abundant hairs on the sides. Ate the stomatic area on the undersides of Douglas-fir needles.

2nd Instar

June 22. Length 10 mm. Head dull, black. Body dark grey; a double thin, milky-white dorsal line; yellowish subdorsal lines with three fine whitish lines below these; tufts on the T. segments, the largest on T. 1 with forwardly directed white hairs; white hairs on the lower sides recurved downwards blending the body into the twig; dorsal tufts consisting of a few long black hairs; claspers yellowish with a large dot on the outer sides.

3rd Instar

June 30. Length 15 mm. Head as described. Body light grey, otherwise as described.

4th Instar

July 8. Length 20 mm. Appearance similar to the third instar; the general effect black with many fine grey lines; dorsum of T. 3 black with two yellow dots close together.

5th Instar

July 21. Length 40 mm. Head black with grey pubescence in several fine vertical lines. Body as described but with a more contrasting pattern of light and dark grey; dorsal band dark, alternately expanded and contracted on the A. segments.

6th Instar

August 1. Length 45 mm. Head as described. Body more brown than grey; the segments noticeably constricted where they joined one another; a wavy black line bordering the ash-grey spiracular area; the dorsal tubercles with short black hairs, the lower tubercles with long black and white, downward-curving sprays with scaly expansions along the lower part of the hairs which end in spatulate tips; spiracles grey, ringed with black, underside pink with a central band of orange that connects with the orange claspers; superimposed on this band is a transverse dark brown bar on the centre of each segment.

August 18. The larvae spun dense grey cocoons on the bark that blended in colour and texture into the substratum.

Pupa

Size 18 mm. by 7 mm. by 5 mm. Dorso-ventrally compressed; smooth, dull, piceous brown; no obvious cremaster.

Imago

Emerged through the thin end of the cocoon between September 2 and October 4.

Remarks

Each stage is characterised by camouflage; the disruptive pattern of the imago matches the light and dark shading of the bark on which it rests by day; the ovum is well disguised even when it is in full view; the larva, with its contrasting colours and hairiness is almost indistinguishable among the twigs; and the cocoon is also nearly invisible by its close resemblance to the substratum.

Plebeius aquilo megalo McD.

Nine species of the genus are recorded by Jones in British Columbia. Four are known from Vancouver Island. *P. aquilo* is an arctic species, the form *megalo* occurring on the Island. It has a wing expanse of 25 mm. Generally it is brownish blue with a black dot on each of the four wings.

A specimen observed on Mt. Becher, NW of Comox Lake on August 1, 1962, was seen to deposit an egg on a leaf of *Saxifraga bronchialis* near the tip of a shoot, another was found in a similar situation nearby.

Ovum

Size 0.9 mm. by 0.3 mm. Shaped like a flattened turban; the micropylar area deeply indented; closely pitted with round depressions, otherwise smooth, colour white. Hatched on August 13.

Larva—1st Instar

Length 1.5 mm. Head small, shiny, dark brown. Body rather short; white soon becoming honey-coloured then vinaceous with a fairly dense covering of very short hairs in four indistinct double rows.

2nd Instar

August 30. Length 3 mm. Head as described. Body slightly onisciform but the head not retracted; a rich vinaceous purple; faint, thin, pale subdorsal lines, with fuscous hairs in rows as described. The shed cuticle of the first stage was evident for a short time as a thin white tissue at the end of the body. They fed on the epidermis at the base of the upper surface of the leaves, where they also rested, protected by the overlapping leaves.

September 11. The larvae rested at the base of a leaf and ceased to feed, apparently having entered hibernation.

February 3, 1963. The larvae were in the same position as on Sept. 11. They were placed in a glass tube lightly covered with muslin and kept in an open shed. Both survived until late March, 1963, but did not feed on a garden specimen of *Saxifraga bronchialis*.

Attacks on Humans by IXODES ANGUSTUS Neumann, the Coast Squirrel Tick, and I. SORICIS Gregson, the Shrew Tick

In his publication on the ticks of Canada Gregson mentions (p. 38) two British Columbia and three United States records of **Ixodes angustus** Neumann, attacking humans. I now add three more records.

On September 17, 1958 a flat adult female was removed from a 9-year old girl at White Rock, B.C. The location of the attachment was not recorded.

On September 26, 1958, a flat adult female was removed from under the arm of a Vancouver woman who had been tramping through the bush at White Rock, five days before the tick was detected.

On October 23, 1963, an engorged female was removed by a doctor from the abdomen of a middle-aged woman in North Surrey. The doctor reported that the woman was house-bound with a sick husband and seldom went out, but that she had a cat which could have brought in a small mammal which harbored the tick. He was surprised at the point of attachment because the woman wore several layers of clothing, including what he called "corsets", so the tick must have attached at night when the woman had removed her garments.

The other unusual record is that of a flat adult female of the shrew tick, **Ixodes soricis** Gregson, which was removed from the outer upper arm of a 14-year-old girl from North Vancouver, on April 11, 1960. In this case also the tick may have come from a shrew brought into the house by a cat because children and shrews inhabit rather different strata on the earth's surface.

Gregson, John D. The Ixodoidea of Canada. Pub. 930, Science Service, Entomology Division, Can. Dept. of Agric. Jan., 1956.

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HETEROPTERA STRANDED AT HIGH ALTITUDES IN THE PACIFIC NORTHWEST

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The problem of dispersal is of particular interest to students of insect distribution and there has been a great deal of discussion on the main modes by which, for example, insects have colonized oceanic islands (see Zimmerman, 1948). It is now generally agreed that aerial dispersal, be it active flying or passive drift, has played a significant part in the colonization of new areas. The recent trapping research by the Hawaiian B. P. Bishop Museum indicates aerial dispersal of many groups of insects in remote areas (Gressitt, 1961; Gressitt & Nakata, 1958; Gressitt, Leech & O'Brien, 1960; Yoshimoto & Gressitt, 1959, 1960; Yoshimoto, Gressitt & Wolff, 1962; Gressitt, Coatsworth & Yoshimoto, 1962). Johnson (1953, 1954, 1962) demonstrated that the dispersal of aphids and many other insects was by passive drift, and captures of aphids on snow in Spitzbergen (Elton, 1925) shows that they can be carried long distances. Spread by active flight is well documented (Williams, 1958; Rainey, 1962) and reference to the spread of the spruce budworm, *Choristoneura fumiferana* (Clem.), shows the part played by prevailing winds in blowing pests in predictable directions (Henson, 1962).

Indeed, the evidence for aerial dispersal of insects and spiders is now so great that Bristowe (1958) was able to write, after mentioning additional records of spread to Krakatau and Jan Mayen, that 'we can now play havoc with much of the former evidence advanced in support of land-bridges which were sometimes imagined to explain the distribution of spiders and other invertebrates'.

In a study of insect (particularly Heteroptera) distribution in British Columbia, we are attempting to obtain information on dispersal. Most of this work is concerned with various trapping procedures, but it seemed possible that trapping records might be supplemented from various other sources. This paper is concerned with one such source, namely snowfield and glacier stranded insects.

Mani (1962) reviewed the occurrence of insects stranded on snowfields and glaciers and noted that these forms are distinct from the nival fauna and characteristically belong to the fauna of lower elevations. He noted that insects from low altitudes often get carried up by thermals and in the upper atmosphere and currents become chilled and are blown onto snowfields and glaciers where they become stranded. Here they form a source of food for the foraging nival fauna, but they also provide valuable records for students of insect distribution. The process of getting stranded on such areas might at first glance seem rather infrequent or unimportant and to provide little information, but familiarity with the records show this not to be the case. The famous grasshopper glacier in Montana (Gurney, 1953; Williams, 1958) demonstrates the possible magnitude of the process.

A number of records of insects stranded on snowfields include Heteroptera. Caudell (1903) found Pentatomids, Coreids, Lygaeids and one species belonging to each of the Aradidae and Miridae, on Pike's Peak snowfields in central Colorado. Van

Dyke (1919) reports Pentatomids, Coreids and Mirids on Mt. Rainier snowfields in west-central Washington, and Lygaeids, Coreids and Mirids on snow in the High Cascades and Sierra Nevada of eastern California. Howard (1918) records 'Coreid' bugs on snow at 13,000 ft on Sierra Blanca in south Colorado, but since these insects are said to have been bright green in color, they may have belonged to another family. I know of no published records of Heteroptera on snowfields in British Columbia, although other insects are recorded from such areas, for example in Currie (1904).

The records reported here are specimens collected by a group of energetic students who are mountaineers. The captures are detailed with remarks on each: the Garibaldi localities are around 5000-6500 ft. elevation.

Family Acanthosomidae

Elasmostethus cruciatus (Say). B.C.: Golden Ears, on snow at 4,500-5,800 ft., 19. v. 1963 (I. Stirling). WASH.: Mt. Sahale, Cascade Pass, 6,000 ft., on snow, 31. vii. 1960 (E. Adams). Widely distributed and taken from many conifers.

Family Pentatomidae

Banasa dimidiata (Say). B.C.: Garibaldi, on glacier, 15. ix. 1961 (J. B. Foster). WASH.: Mt. Sahale, Cascade Pass, 6,000 ft., on snow, 31. vii. 1960 (E. Adams). The above specimens are identical with material from Saanich District determined by H. M. Parshley as *dimidiata*. The species is fairly common and widely distributed in British Columbia.

B. sordida (Uhler). B.C.: Golden Ears, on snow at 5,500 ft., 12. vi. 1960 (E. Adams). In British Columbia this species to date has been taken on Vancouver Island and in the Lower Fraser Valley. It has been found on *Thuja* sp. in British Columbia.

Zicrona caerulea (L.). WASH.: Mt. Rainier, 5,300 ft., 3. vii. 1960 (E. Adams). A predaceous species also found in Europe, Asia, Dutch East Indies and the United States. Parshley (1923) reports that this species occurs occasionally on the summit of Mt. Washington in New Hampshire and notes that adventitious specimens have been taken in Connecticut in boxes of nursery stock imported from France. In British Columbia specimens have been studied from the Kootenays, Fraser Valley and southern Vancouver Island.

Family Coreidae

Theognis occidentalis (Heid.). B.C.: Garibaldi Neve, 7,000-7,500 ft., 25. ix. 1960 (J. B. Foster); Garibaldi, on snow, 15. ix. 1961 (J. B. Foster). WASH.: Mt. Sahale, Cascade Pass, 6,000 ft., abundant on snow, 31. vii. 1960 (E. Adams). Widely distributed in British Columbia.

Family Lygaeidae

Lygaeus kalmi kalmi(Stal.). WASH.: Mt. Sahale, Casade Pass, on snow at 6,000 ft., 31. vii. 1960 (E. Adams) — a teneral specimen. Common in warm interior districts of British Columbia, but scarce at the coast; occasionally taken on the south-eastern part of Vancouver Island.

Kleidocerys resedae (Panz.). B.C.: Golden Ears, very abundant on snow, 4,500-5,800 ft., 19. v. 1963 (I. Stirling). WASH.: Mt. Sahale, Cascade Pass, on snow at 6,000 ft., 31. vii. 1960 (E. Adams); Mt. Shuksan, on snow above 7,000 ft., 11. ix. 1960 (E. Adams). A widely distributed species reported from many hosts, but most probably overwintering ones: usually on *Alnus, Betula* or *Rhododendron*. This is a species taken by Caudell (1903) on snow on Pike's Peak, but recorded under a synonymic name, *Ischnorhynchus didymus* Zett.

Of the 30 odd families of Heteroptera represented in the Pacific Northwest, these records involve only four. Caudell (1903) found in Colorado that the most common families found on snow were also the Lygaeidae, Pentatomidae and Coreidae: only one species of Miridae was found and so far none of this family have been obtained in our collecting.

Leston (1957) has suggested that for the Heteroptera at least, each taxon differs in regard to its spread potential; it seems that taxa differ in their intrinsic ability to spread and colonize. Leston (loc. cit.), after studying the Heteroptera of four oceanic island groups, the Azores, Hawaii, Guam and Samoa, listed families with decreasing spread potential. The Miridae headed this list, closely followed by the Lygaeidae and Pentatomidae, but the Coreidae were near the bottom. Analysis of light trap captures showed much the same picture. It would appear that in the Pacific Northwest, the Miridae may not be such strong migrants as their representatives in other parts of the world. Further collecting may clarify this point.

Westdal *et al.* (1961) and Medler (1962) have shown that the six-spotted leafhopper *Macrosteles fascifrons* (Stal.) cannot overwinter in the North as adults, yet every year is carried into northern areas of its range by winds and here reaches pest proportions. Likewise, Robinson & Hsu (1963) note that some of the aphids on cereal grains and grasses in Manitoba cannot overwinter in this Province and hence appear to invade Canada each year from the south. The records of insects stranded on snow indicate a high spread potential, and point out a feature which may be important if they are pests and need control. *Theognis occidentalis* is a pest of coniferous seed in the West (Koerber, 1963) and *Banasa dimidiata* is a potential serious pest of blueberries and currants in New England (DeCoursey, 1963): the late W. Downes left notes indicating that *B. dimidiata* is sometimes numerous on raspberry fruit on Vancouver Island.

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The Eastern Larch Beetle, DENDROCTONUS SIMPLEX Lec. In British Columbia and Yukon Territory

The occurrence of the eastern larch beetle, **Dendroctonus simplex** Lec., in British Columbia was established June 1, 1960, when the writer collected adults and young larvae from a felled estern larch, **Larix laricina** (Du Roi) K. Koch, four miles west of Chetwynd on the Hart Highway. In mid-July 1960, adults and larvae were found in two flood-damaged trees 19 miles south of Fort Nelson. Dead parent adults, living pupae, and teneral adults were collected from these trees on August 18.

Further records were obtained by E. Pottinger on June 6, 1962, five miles east of Chetwynd. Adults were collected from two larch logs averaging 10 inches d.b.h. A month later an adjacent standing larch that had been heavily attacked in the spring was discovered. The foliage was beginning to fade and adults, large larvae, and teneral adults were found beneath the bark. On September 4, teneral adults were already taking on the dark colour of mature beetles.

The eastern larch beetle was found near Watson Lake, Yukon Territory in 1962 by J. V. C. Holms. Adults and larvae were recovered on July 19 from an 8-inch trap tree which had been felled on May 26. The attack had been much heavier on the stump than on the log.

Judging by the distribution of our records, it seems probable that the eastern larch beetle occurs throughout the range of its host in northeastern British Columbia and southeastern Yukon Territory.

Identification of the beetles collected has been verified by G. R. Hopping of the Calgary Forest Entomology and Pathology Laboratory.

—*T. A. D. Woods, Forest Entomology Laboratory, Vernon, B.C.*

KHAPRA BEETLE, *Trogoderma granarium,* Everts, INTERCEPTED AT VANCOUVER, B.C.

A. G. Rudd[1]

On 26 January, 1963, numerous Khapra beetle larvae were found during a routine examination of the holds of the M.S. Bengalen, Java Pacific Line, at Vancouver. Since the ship had unloaded at Los Angeles, San Francisco, Portland and Seattle, the U.S. Department of Agriculture was notified.

In No. 1 lower hold were some dried, larval skins of *Carpophilus humeralis* (Fab.). There were Khapra beetle larvae in moderate numbers in the No. 2 lower tween deck. In No. 4 lower hold were isolated infestations in fair numbers. No. 6 lower hold contained the heaviest infestation. Here bags of coconut were piled solidly, 8 feet high across the after end. This is a shallow hold, and the sides of the shaft are oil tanks. After the coconut was unloaded the tops of the tanks were found to be warm, and this circumstance may have helped in obtaining a good kill under the solid piles of bags. There was a great amount of extensively riddled wheat residue under the wooden ceiling in this hold.

Since the Khapra beetle was found in scattered sections of the ship, it was decided to fumigate the entire vessel as well as the cargo in holds 2 and 6. The rate was 10 lb. of methyl bromide per 1000 cu. ft. for 18 hr., hence 613,000 cu. ft. took 6,130 lb. gas. The fumigation was started at 9:30 p.m., 26 January, and the last hold was cleared at midnight, 27 January. The starting temperature was 34°F.; the opening temperature 40°F. A complete kill was achieved and the cargo was undamaged.

This vessel had been in Vancouver in January, 1962, when No. 6 hold was 'passed for loading.' It could not be 'cleared' because American wheat was loaded in the lower hold. It is possible that the Khapra beetle was present at that time.

The Bengalen trades from the Persian Gulf and India *via* Singapore, to the west coast of North America bringing such cargoes that infestations might be found at any time. It was with great difficulty that larvae were seen in the cargo discharged at Seattle, for Khapra beetle larvae hide so effectively that they are difficult to detect unless they are present in numbers. Cast skins are usually associated with and buried under debris, and the adults are not often seen.

[1] Plant Protection Officer

FURTHER RECORDS OF DELAYED EMERGENCE OF *Buprestis aurulenta* L. (COLEOPTERA: BUPRESTIDAE)

G. J. Spencer[1]

Within recent years there has been an increasing number of records of delayed emergence of *Buprestis aurulenta* L. from woodwork. In 1930 (2) I stated my belief that larvae of this beetle could develop from eggs laid in timber recently sawn from logs, without having to feed first on the cambium layer before entering sapwood and later heartwood. Dr. Gorton Linsley, University of California (1) questioned my view but I think

[1] University of British Columbia, Vancouver 8, B.C.

he inferred that I meant finished wood as in furniture, rather than rough sawn timber.

According to the authors in whose books the statement occurs, the span of life of an average buprestid is said to be 3 years, from the egg in a crevice of the bark, through the bark, cambium, and wood stages, to emergence. Only by controlled experiments upon caged trees could this statement be validated.

When lumber is purchased there is no way of telling its history of exposure to beetles; how long the larvae were inside the logs or how fast the wood has been drying out. This is borne out by the following emergence records taken from many on hand:

24 November, 1942; one adult and several larvae from a house in the 6000 block, Gladstone Street, Vancouver *one* year after it was built.

January, 1930; one adult from the woodwork of a corridor in the (then) Applied Science building of the University of British Columbia, *five* years after it was built.

8 June, 1954; one adult from a fir floor, 2500 block Trinity Street, Vancouver, *five* years after it was built.

June, 1953; one beetle from the badly damaged floor and subfloor of a house in North Vancouver, *eleven* years after it was built.

I have many records of beetles emerging from 14 to 33 years after houses were built, one more than 40 years after, and two more than 50 years after. The first of the 50-year records occurred in February and March, 1953. Beetles emerged in All Saints Church, Alberni after doing considerable damage to joists, timbers, flooring and other parts of the building. One beetle sent to me had been dug out of a pew. According to Mr. G. S. Wright, Chairman of the building committee, this Church was started in 1900 and completed in 1904. (*in litt.* 23 March, 1953).

The most recent record would seem to be the ultimate. In November, 1960, I received specimens from Port Washington, Pender Island, B.C. I identified these and gave the sender some details of their life history. His reply dated 22 November, 1960 states: ". . . this house which I am now tearing down was built in 1897 and the flat-headed wood borer I sent you was taken from a piece of fir flooring from the second story . . . the grub was taken from near the middle of the room away from any upright beams . . . I have seen the green beetle at different times in the house and am familiar with it having been a logger . . . my own observation is that the green beetle will not go from one board to another, while one board is absolutely chewed up the next one is untouched and I may add that there has been quite a number that I have examined."

These beetles emerged and a mature larva was found in a floor board sixty-three years after the house was built. *Either* the larva was over 63 years in developing in the extremely dry wood *or* the parent beetle had laid in prepared lumber. While the second alternative may sometimes (2) occur it is more likely that these larvae may, under adverse conditions, take almost incredibly long periods to develop.

In a much-perforated verandah post of a 32 year-old log house on Bowen Island I watched *B. aurulenta* adults running in and out of new and old emergence holes. One that I attempted to catch ran down a tunnel and did not reappear. These beetles may have been laying eggs in the tunnels. The longicorn, *Opsimus quadrilineatus,* which infests the same house, does so to my knowledge.

If newly emerged beetles lay eggs

in tunnels from which they have just emerged, the eggs should be mature in their ovaries and ready to be laid shortly after they emerge. To test this point, I asked the caretaker of the log house to drop newly emerged beetles into a bottle of preservative. I dissected nine of these and found that none had mature reproductive organs; in fact both ovaries and testes were so small as to be barely discernible. A specimen from West Vancouver which had just emerged from the railing of a small bridge had almost mature ova in well-developed ovarioles. It may have matured before it was caught. Only by dissecting newly-emerged beetles and by rearing others can we decide if this species can mate and lay eggs shortly after it has emerged. It seems reasonable that it should require a flight period and maturation in the sun before depositing fertile eggs.

As support for the view that maturation of larvae sometimes takes many years, I quote from a letter dated 22 August, 1955 from R. L. Furniss, Chief, Division of Forest Insect Research, U.S.D.A., Portland, Oregon:—"In 1939 I thought it would be a good idea to attempt to rear *Buprestis* from the egg to the adult stage because all of the records of prolonged development up to that time were of a circumstantial nature. That year and for several years subsequently we were able to get *B. aurulenta* and *B. langi* established in blocks of Douglas-fir. Periodically since then we have dissected the blocks, measured the larvae and re-established the survivors in other blocks of wood. Quite a number of them are still in rearing. Some have been in rearing for 16 years. The most advanced larvae are about ½ grown. Some of them have grown only 1 millimeter since they were introduced into the blocks 13 to 16 years ago. Consequently I expect that in another 15 or 20 years some of the adults will begin to emerge. Quite likely the more retarded individuals will vie with your 50-year old stock for longevity."

This experiment appears to support the view that the larval development of this beetle is sometimes remarkably protracted.

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Adult Insect Collection, Forest Entomology Laboratory, Vernon, B.C.

The writers have prepared this statement for the benefit of entomologists interested in obtaining information on host records, insect distribution, etc., in the interior of British Columbia and Yukon Territory.

The number of pinned adult specimens in the collection is estimated at over 25,000. Much of the material has been identified by specialists of the Entomology Research Institute, Ottawa. In all there are over 3,100 designated species distributed as follows in the major orders:

Order	No. of families	No. of species
Lepidoptera	43	724
Coleoptera	77	1,749
Hymenoptera	33	225
Diptera	33	227
Hemiptera	14	124
Homoptera	7	61

The collection is made up largely of insects that frequent forest trees and shrubs, although others such as Carabidae (245 species) are well represented. Most lepidopterous specimens were reared from immature stages taken during the course of the Forest Insect Survey; the majority of coleopterous specimens were collected as adults, a number by early entomologists such as Ralph Hopping.

Most of the Diptera and over two-thirds of the Hymenoptera are parasites reared at Vernon from host material collected for the Forest Insect Survey.

—*J. K. Harvey and D. A. Ross, Forest Entomology Laboratory, Vernon. B.C.*

HYPERPREDATORS OF THE PEAR PSYLLA, *Psylla pyricola* Foerster[1] (HOMOPTERA: CHERMIDAE)

W. H. A. WILDE[2]

Torre-Bueno (1950) defines a hyperparasite as "a form parasitic upon another parasite." Hence a hyperpredator may be defined as a predator that attacks another predator. This note concerns hyperpredators in relationship to the pear psylla, *Psylla pyricola* Foerster. Hyperpredators were observed in a bionomics study of the pear psylla started in the Kootenay Valley of British Columbia in 1960 and continued in the Okanagan Valley in 1961, 1962, and 1963.

In the Kootenay Valley larval and adult lacewings *(Chrysopa oculata* Say) were found entrapped in spider webs in the crotches of pear trees and spiders *(Philodromus* spp.) were seen with lacewing adults in their mandibles.

In the Okanagan Valley, hyperpredation was observed between anthocorid nymphs *(Anthocorus melanocerus* Reut.) and lacewing larvae. Success in this type of predation was reversible, and depended on the relative sizes of the predators. The larger predator always emerged victor, e.g., a fifth instar anthocorid nymph could overcome a first or second instar neuropteran larva (Fig. 1A) but a third instar neuropteran larva could easily overcome a second third or even a fifth instar anthocorid nymph (Fig. 1B). Spiders were also observed feeding on anthocorid nymphs and adults and on lacewing larvae and adults. As well, anthocorids and lacewings were observed entrapped in spider webs in tree canopies.

The role of ants (*Lasius sitkaensis* Pergande) in relation to the pear psylla is unclear. On two occasions ants were seen threatening and molesting lacewing larvae that were feeding on second, third, and fourth instar psyllid nymph. On three occasions ants were noted in close proximity to sluggish or semi-paralyzed lacewing larvae. Observations in July and August indicate that ants protect psyllid nymphs but in late September and October ants were observed carrying freshly killed psyllid nymphs along the limbs and down the trunks of pear trees.

Raphidians (*Agulla* sp.) were observed in six orchards and on test trees in the laboratory feeding on anthocorid nymphs and adults. This was the only predator observed in four years that caught flying pear psyllids.

Hyperpredators discussed here were identified by the Entomology Research Institute, Canada Department of Agriculture, Ottawa, Canada.

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[2] Entomologist.

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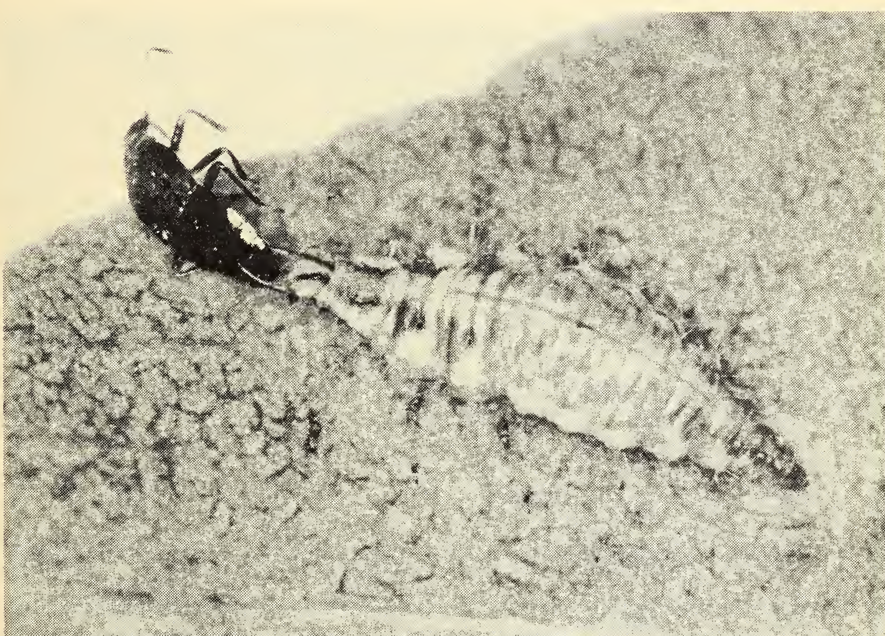

Figure 1A—Fifth instar anthocorid nymph feeding on a 1st instar lacewing larva. About 20X.

Figure 1B—Third instar lacewing larva feeding on a 5th instar anthocorid nymph. About 8X.

THE DECLINE OF THE PACIFIC TICK (*Ixodes pacificus* Cooley and Kohls) AT WEST VANCOUVER

J. D. GREGSON[1]

The Pacific tick, *Ixodes pacificus* Cooley and Kohls, is one of three ticks familiar to man in British Columbia (1). The adults are relatively small; the female is about one-eighth of an inch long, with black legs and head and a reddish-brown body. The male, which is usually found with the female, is about half as long and is entirely black. Both sexes "quest" on low vegetation along woodland paths and at rocky exposures along the coast of southern British Columbia (2). They are present throughout the year but are most numerous during the wet winter months and reach a peak of activity during warm spring days.

Man and domestic animals are frequently hosts for the adults. The males, which do not become distended, feed repeatedly for short periods only and leave multiple bites. The females remain attached at one site for a week or more, engorging slowly and turning dull blue-grey. During this period the flesh of the host may swell around the tick's mouthparts, giving rise to the fallacy that the tick burrows in. Because of its relatively long, barbed hypostome this tick is very difficult to remove and if it cannot be induced to release by irritating it with such fluids as kerosene, gasoline, or iodine, it usually has to be cut out. The bites may produce sudden and extensive swelling and cause ulcers that persist for many months (3).

Where the habitat of *I. pacificus* was close to urban areas, such as along the north shore of Burrard Inlet and English Bay, it was considered a pest of man and his pets for many years so that in 1940 this laboratory considered it advisable to conduct a survey. Return - stamped questionnaires were mailed in March to 210 persons residing at or between the communities of West Bay and Horseshoe Bay, their addresses hav-

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	1940	1950	1960
1. Are ticks a nuisance to you?			
Yes	63	31	8
No	37	69	90
2. Are ticks, in your opinion, becoming more numerous?			
Yes	65	10	4
No	8	48	79
3. Have you or your family had ticks attach to you?			
1-6 times?	43	30	30
Often	28	3	1
Never	28	37+	37+
4. Do you possess dogs or cats?			
Yes	84	67	57
5. Percentage of pets examined for ticks:			
Daily	60	36	10
Occasionally or weekly	20	38	25
Never	1	23	40+

ing been chosen randomly from a telephone directory. This survey was repeated in 1950 and 1960, with 700 and 260 questionnaires sent respectively. Many of the addresses in the last year were deliberately chosen from the earlier lists so that the information gained might be more relative. The returns were 38, 34, and 50 per cent of the mailings. The answers are given as percentages of the respective totals.

Of the residents replying in 1940, 44 per cent had lived at their address for more than ten years and were thus in a position to compare the relative abundance of ticks over the years. The comparable figures for 1950 and 1960 were 33 and 69 per cent. Eighteen 4-23 year residents replying in 1950 stated that the ticks had declined during the last 2-10 years. The same opinion was echoed in the 1960 returns, although by this time the pest had so declined that remarks on its absence were rather casual.

The period of tick activity was generally stated as being in the spring and to a lesser extent in the autumn. Some activity was noted during the summer but not during mid-winter.

Descriptions of the effects from the tick bites included: acute swelling of the arm; slow healing and painful festering sores with fever; large or hard and painful lumps; severe local inflammation; soreness for six months; fever; slight rash and headache.

Many ticks were removed with the aid of kerosene, iodine, turpentine, alcohol, hot needles, fire, and forceps. A surprising number were "unscrewed." One facetious resident removed his with a pick and shovel and another added that "a friend of ours had heard about the plague of ticks in West Vancouver, so she examined her dog and was horrified to find several ticks embedded in the animal's belly. She did not think it very odd that these lumps were arranged in two regular columns; it was only after she had inflicted considerable suffering on the dog that she ceased from trying to pry its nipples off!"

It would appear that the Pacific tick at West Vancouver reached a peak of activity about 1940 and subsequently declined to its present status as a pest of only minor concern. The reason for its decline is not known, but is probably related to the development of the district from brushland to a well maintained residential area.

During the last survey questionnaires were also sent to key personnel in other areas in the province suspected of harbouring *I. pacificus*. Returns have suggested its presence at Ganges, Nanaimo, Coquitlam, Agassiz, Wilson Creek, Sechelt, Pender Harbour, and Squamish, but not at Prince Rupert or Terrace. The most northerly record is from Ocean Falls (4).

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OBITUARY

F. C. WHITEHOUSE

Francis Cecil Whitehouse was born in Leamington Spa, Warwick, England, in 1879, was educated locally and left school at 16 to enter a bank. In 1905 he came to Canada and continued in banking until he retired in 1934 after 26 years as a branch manager in each of the western provinces. Always an ardent fisherman, he fished widely in the Atlantic and Pacific oceans. It was on his many fishing trips across Canada that he became interested in dragonflies, first in Alberta and then in British Columbia. His studies led to two publications "British Columbia Dragonflies (Odonata)", University Press, Notre Dame, Indiana, 1941, and "Catalogue of the Odonata of Canada, Newfoundland and Alaska", Royal Canadian Institute, 1948, the latter a very valuable comprehensive compilation from all publications on this Order. On a trip to Jamaica, he collected extensively and produced "A Guide to the Study of Dragonflies of Jamaica" which was published by the Institute of Jamaica in 1943; his specimens on this trip were identified by Professor E. M. Walker of the University of Toronto, the Canadian authority on Dragonflies with whom Whitehouse worked in close association. Walker named *Somatochlora whitehousei* after him.

When he ceased active field work, Whitehouse divided his Odonata collections between the Provincial Museum, Victoria, the City Museum in Vancouver and the University whose share consisted of two carefully spread and labelled specimens of each sex of 61 species of dragonflies and 18 species of damselflies, making 79 out of a total of 89 species recorded so far for the province. Most species of damselflies have 6 specimens each.

Whitehouse was a versatile author, for besides his publications on the Odonata, he wrote a novel, a book of poems, many essays on a diversity of subjects and two books on Sport Fishing in Canada. He was a sportsman to the end, being stricken in his 80th year while readying for a game of golf in Phoenix, Arizona, where he latterly spent the winters and where his funeral was held on December 5, 1959.

—G. J. SPENCER

The eversible glands of PAPILIO MULTICAUDATUS Kby.

Most lepidopterists are familiar with the eversible glands on the prothorax of larvae of the genus **Papilio.** When extended, these enhance the grotesque appearance of the larvae, and emit an odour. The following observation, made on September 3, 1961, indicates that these glands may have a more practical value than is commonly attributed to them. A larva of **multicaudatus** Kby. was observed resting on a silken hammock spun over the leaf of a hop tree, **Ptelea trifoliata** L., at the Forest Entomology Laboratory, Vernon. A braconid wasp 2.5 mm. in length was perching on the larva's dorsum. Attempting to see if the wasp was ovipositing, I carefully spread the foliage apart but the movement aroused both insects. The wasp flew about three inches to a nearby leaf and the larva reared up and extruded its thoracic glands. After a few moments the wasp flitted back to the larva and lit on the tip of one of the glands, where it was instantly enveloped in a clear, viscid fluid. Several minutes later when the larva retracted its glands, the dead wasp slid down the larva's side and onto the leaf in a globule of fluid.

Subsequently, larvae of **multicaudatus,** irritated by application of live ants held in forceps, lashed backward, alternately brushing each side of the body longitudinally with the extruded glands. Contact with the sticky secretion quickly immobilized small ants. It seems probable that parasites not sufficiently light of step would suffer the same fate.

—J. Grant, Forest Entomology Laboratory, Vernon, B.C.

OBITUARY

MRS. M. E. (HIPPESLEY) CLARK

Mrs. Clark was born Marianne E. Parker on April 2, 1880 in Leeds, Yorkshire, of Cornish parents, from whom she inherited an intense interest in Nature; her father was a keen conchologist and her mother a pencil sketcher who collected and studied mosses. A delicate child, Marianne was educated at home by her parents until the family moved to Manitoba in 1891. There she started a collection of local shells and of moths and butterflies of the Dauphin district.

The family next moved to Terrace, B.C., and engaged in ranching and lumbering. In November 1911 Marianne, now Mrs. Hippesley, lost her right arm completely in a gun accident and confined her collecting to beetles only. In between arduous duties of housekeeping, gardening and ranching she made some remarkable catches and all her material was identified by her close friend and helper Mr. C. A. Frost of Framingham, Mass., and to a lesser extent, by Mr. H. C. Fall. In 1922 she published a list of the beetles of Terrace, B.C. in Vol. 54, No. 3 of *The Canadian Entomologist* and in Vols. 44 and 45, 1948 and 1949 respectively, in the *Proceedings of the Entomological Society of British Columbia,* she published "An Annotated List of Coleoptera taken at or near Terrace, B.C. Parts I and II". (Professor M. Hatch has informed me by personal communication 19 July 1963, that "omitting incompletely named species, her three lists from Terrace number 659 species of beetles, by over 150 species the longest list of beetles ever recorded from any locality in the Pacific Northwest". (By contrast, the beetle collection of Mr. K. Auden made in the Midday Valley near Merritt, B.C. numbered 404 species: Auden donated it to the University of Illinois.) No one seems to know what has happened to the bulk of the specimens mentioned in these extensive lists. Some years ago Mrs. Clark sent to me a few small pinning boxes of beetles saying that she was distributing her collections between the University, the Vancouver City Museum and the Provincial Museum, Victoria; both these museums inform me that they never received any specimens from her.

There are large gaps in her personal history but about 1960 she came down to the Stave Falls district near Mission, B.C. on account of ill-health and died there on 26 September 1962; she is buried in Hatzic cemetery. There are no relatives surviving.

In her will, Mrs. Clark left to the University a home-made cabinet of insects and those of her books that the Mission High School and the Mission Public Library did not want. We obtained some useful old standard works on Entomology but of the insect collections the butterflies were destroyed by dermestids and what beetles remained were covered with dust and mould. When cleaned off, there remained nearly two store boxes of specimens, mostly labelled, of which twenty are new records for the Province; since these bear the identifications of Messrs. Frost and Fall, they are very valuable specimens.

Mrs. Clarke had astonishingly wide interests: besides insects, she collected shells, minerals and a large series of mosses, all, unfortunately without locality labels. Her choice of books showed profundity of learning.

She was in process of writing a Natural History for children when she died.

Note. The details for this life history were contained in a letter to Mr. H. B. Leech when he, as Secretary of our Society, wrote and asked her for a brief account of herself. The letter is in the files of our Society and was lent to me by our present Secretary, Mr. Peter Zuk.

—G. J. SPENCER

OBITUARY

EDWARD RONALD BUCKELL

Ronald Buckell, son of the late Dr. Edward and Mrs. Buckell, was born in Romsey, Hampshire on 8 April 1889 and was educated at Bedales school, Petersfield, and Caius College, Cambridge, where he obtained a B.A. degree. His family came to Canada in 1911 and settled at South Canoe on Shuswap Lake. Ronald arrived a year later and helped on his father's fruit farm until the outbreak of World War I when he enlisted on 21 September 1914 with the B.C. Horse, but transferred to the First Canadian Artillery Brigade at Valcartier. He was severely wounded on the Somme in 1916, sustaining a split left shoulder blade followed by ankylosis of the left shoulder from which he suffered great pain for several years. He returned from the war on 7 September 1917 and was offered a post with the Provincial Department of Agriculture working on the control of codling moth at Walhachin and later, on grasshopper control in the Chilcotin. After three years he transferred to the Dominion Entomological Branch with which he worked for the next 19 years in charge of the laboratory at Vernon and later at Kamloops until he retired in 1949. In 1936 he was sent as the Canadian delegate to an International Grasshopper Conference at Cairo, Egypt, where the control programme that he had initiated in the Dry Belt of B.C., was adopted by the Conference.

When he was at Vernon, he and his staff of Alec Dennys, A. D. Heriot and Peter Venables, discovered that perennial canker which was destroying the apple orchards in the Okanagan, was caused by wooly aphis and that control of the aphis also controlled the canker, thus saving the apple industry of the Province.

Ronald himself was inclined to systematics and he collected extensively and, over a period of years, published in the *Proceedings* of our Society, distribution records of the orthopteroid insects, some solitary wasps, the social wasps, bumble bees, dragonflies and sarcophagid flies, of British Columbia. His collections of all these groups are in the National Collection in Ottawa and the Laboratory at Kamloops. At the University in Vancouver are his synoptic collection of bumble bees and his large collection of dragonflies in alcohol which the National collection did not want.

Ronald was a man's man, passionately fond of the outdoors and adept at camping, hunting and fly-fishing. His love of nature began very early in life. When he was only eight years old he made detailed notes on each page of a large book on English birds, of the species he found and their nests. His completed collection of eggs was given to the British Museum when he moved to Canada. His eyesight was keen and his perception of objects was truly remarkable; when driving a car, his eyes ranged ceaselessly from side to side and he could spot the head only of a pheasant in a field of clover in flower at fifty yards and a deer in scrub or amongst trees, up to 200 yards away.

His eating habits were irregular and he never spared himself in the field; this strenuous life affected his heart and he retired from government life in 1949, to spend three months of each winter in Victoria playing eighteen holes of golf every day, and the summers at Salmon Arm or on Shuswap Lake at Celista. In November 1962 he wrote saying that he felt extremely fit but a month later he died suddenly from a heart attack within sight of his house as he was walking home from Salmon Arm—just as he always said he wanted to go. He was buried 21 December 1962 in a peaceful little cemetery in the woods below Mt. Ida, near Salmon Arm.

He is survived by one sister and two nieces to whom are willed his house just outside Salmon Arm and his hillside property at Celista; his books were donated to men friends and to the Library in Salmon Arm and his splendid collection of mounted game heads and skins, to a museum to be founded in Salmon Arm, together with two other collections.

—G. J. SPENCER

BOOK REVIEW

Wasp Farm. H. S. Evans, New York, Natural History Press, 1963. Pp viii and 178. $4.75.

If there were more books like this there would be more entomologists, for biology is contagious when it is presented by an enthusiast like Dr. Evans. Despite the title the book is entirely on wasps: spider, digger, mud, sand, and social wasps. The farm, an agriculturally unproductive 8 acres in upstate New York, was kept as a sort of insect refuge and is really only the point of departure.

Probably none of the information is appearing for the first time. It is compiled from the immense literature and largely from the experience of the author and his students, as presented in scientific journals and in publications such as Natural History and Nature Magazine. The level of writing falls somewhere between these types. It is lucid, factual, unsentimental, non-technical, graced with a deft use of words, and tailored for swift, effortless reading.

Dr. Evans (b. 1919) earned his Ph.D. in Insect Taxonomy at Cornell University, and is currently Associate Curator of Insects at the Museum of Comparative Zoology at Harvard University. He is thus a taxonomist *par excellence* and also a student of live insects. All taxonomists should follow suit.

He does not experiment with wasps, believing that experiments often merely pose situations which wasps never encounter in nature. ". . . the urgent need is to know precisely what wasps and other creatures do . . . until our understanding of animal behavior is on a very much higher plane than it is now . . ."

In discussing the *Ammophila,* wasps that use tools to close their nest holes, much of his own observation is used to give a reasonable slant to the much-discussed problem of instinct, intelligence, and behavior patterns. He puts the matter neatly in describing a spider-hunting *Priocnemis,* which emerges from pupation "ready to enact a script which is already largely codified in its nervous system". And again in outlining the vestigial instinctive behavior of *Microbembix,* which goes through the motion of stinging the dead, dried insect detritus with which it stocks its nest. This is a recent development from *Bembix*. In fact, the evolutionary history and arrangement of the groups are traced clearly for laymen, to whom the connection between evolution and taxonomy may well be new.

This is a tidy book. The loose ends are pulled together: nesting habits, types and numbers of prey, anatomy of the larvae, methods of stinging and carrying prey, are all discussed and arranged in tentative order of complexity, efficiency and development, and with no hint of anthropomorphism. Even the scanty fossil record is brought in and the author traces the relationships of wasps with other Hymenoptera and other orders.

Physically this is a neat little hard covered book, well presented and organized. The paper, type, and 16 text figures are good, as they should be at the price. There are 25 photographs by the author, with captions, but no reference to them in the text. At the end of each of the 15 chapters is a bibliography of significant papers and some general texts. At the ends of 12 chapters are listed the species described (50 in all), with Latin or Greek roots translated and the pronunciation indicated. Proper names are used throughout but not italicised. The book is a natural for the paperback trade.

—*H. R. MacCarthy*

BOOK REVIEW

The Insect Factor in Wood Decay, by Norman E. Hickin. London. Hutchinson & Co. Ltd. 1963. Pp. 336, illus., 2 colored plates. £2/10s.

The author regards conservation of building timber *in situ* as an important new technology that becomes more so as we use up forests and demand longer service from wood already in use. For pest control operators, inspectors, builders, lumberyard operators, and those in related work, he has produced a valuable reference book. It is clearly written and very well illustrated with numerous line drawings, some photographs and a spectacular colored fold-out plate of 9 longicorns. There is an adequate index. The high quality, paper, printing, and illustrations may account for the price.

There is one irritating feature: certain references, cited normally in the text by author and date, are omitted from the list at the end of each chapter. In a book so carefully written the omissions are probably deliberate, but they are not explained and they are disconcerting. In 33 pages of chapter III alone there are 9.

The book is written with special reference to Great Britain and the insects concerned are covered very thoroughly and mostly keyed. The coverage of *Anobium punctatum* de Geer and *Xestobium rufovillosum* de Geer is particularly detailed, since these anobiids are the most economically important insects in the field. The groups dealt with are: Anobiidae, Lyctidae, Bostrichidae, Buprestidae, Lymexilidae, Cossoninae, Cerambycidae, Scolytidae, the ambrosia beetles, termites, and wood-boring wasps and moths. Other chapters deal with the nature of wood, direct factors causing decay, the importance of the various wood-boring insects, and research on wood preservation.

—*Peter Zuk*

BOOK REVIEW

Research Problems in Biology: Investigations for Students. Series 1 and 2. American Institute of Biological Sciences. New York, Doubleday & Co., Inc., 1963. Pp xxxii and 232; xxviii and 240. 95c each.

Regular readers of *Science* and the *AIBS Bulletin* during the last 5 years have observed with interest as tangible results came out of the Biological Sciences Curriculum Study, whose activities and meetings have been regularly reported. These two paper backed books are the most recent results. The Study has been supported by the National Science Foundation.

The books have three identical sections. Dr. Bentley Glass, Chairman of the BSCS, and Dr. A. B. Grobman, Director, each contribute a single page, and Dr. P. F. Brandwein, Chairman of the Gifted Student Committee, contributes four. These are aimed at high school students. The tables of contents and lists of contents by subject categories, confirm that these books are indeed addressed to gifted students, preferably having gifted teachers. The scope of the books is shown by two tables adapted from the indexes. The first gives the numbers of experiments in each area of research:

	Series I	Series II
Animal Behavior	4	5
" Physiology	5	6
Ecology	4	6
Genetics	5	4
Growth, Form and Development	7	6
Microbiology	6	6
Plant Physiology	9	7

The second table gives the numbers of experiments in which various organisms are used:

	Series I	Series II
Protozoa	5	3
Euglena and **Tetrahymena**		1
Volvox		1
Hydra	1	
Worms	1	2
Insects		3
Ants	1	
Aphids	1	
Beetles		1
Damselfly		1
Fruit flies	2	1
Houseflies	1	
Tent caterpillars		1
Termites	2	
Spiders		1
Amphibians and Reptiles		1
Frogs	4	1
Salamanders		1
Fishes	2	
Birds	2	1
Birds' eggs		1
Bacteria and Virus	3	7
Fungi and Mold	3	1
Moss	1	
Pollen		1
Flowering Plants	8	11
Seeds and Seedlings	4	4

The authors originate as follows: State and other colleges and universities, 55; U.S. Government and State institutions, 7; industry, 5; private addresses, 5; high schools, 4; and research foundations and laboratories, 4. In outlining their experiments they follow no hard and fast format, but most of them use some of the following subheads: Background, Suggested Problem, Suggested Approach, Possible Pitfalls, Procedure, Precautions, Special Considerations, and References, general and specific. The latter are commendably up-to-date. The titles of the experiments invite comment, but space will not allow mention of more than a few examples in which insects are featured.

The experiment on aphids is by Gert B. Orlob, currently at South Dakota State College, entitled, Can

Aphids Find Their Host Plants. This is one of the simpler examples but is typical. A good background section of three paragraphs precedes a clear statement of the problem: Is there any food-finding mechanism operating in apterous aphids by which they become aware of the host plant before taste stimuli have been received? Then follow suggestions: use a host and a non-host plant, a paper or plastic dummy plant, sticks or wires, singly or in groups; release aphids into equidistant rings around the plant or object. Pre-experimental treatment can be varied, as by starvation. If a mechanism exists it should become apparent if 40-50 aphids are used singly. Use monophagous species at first. The tests must be run under uniform light intensity, the aphids must be of the same age, and so on. All quite obvious perhaps, but sound advice to a teenage learner. Orlob offers encouragement by pointing out that the only equipment needed is a 10X hand lens, and that aphids are not difficult to rear. The six references are well chosen.

The two examples using termites would need more patience. The Association of Subterranean Termites and Fungi: Mutual or Environmental, by A. E. Lund (Koppers Co., Verona, Penna.), involves petri dishes containing sterile nutrient agar, inoculated with wood destroying fungi, later to be occupied by termites, both in various combinations. A further study could be on the relationship between termites and fungi with the symbiotic protozoa in the termites' gut. There is a good deal of room for error and contamination here. The Problem of Castes and Caste Determination in Termites, by E. M. Miller (University of Miami, Coral Gables, Fla.), might take up to three years. Colonies should be established in jars with disproportionate numbers of soldiers, workers, nymphs or reproductives. Communication by Trail Laying in Ants, by E. O. Wilson (Harvard University), moves from setting up colonies and simple observations, through dissection of the abdominal glands producing pheromones, to imaginative behavioral studies with artificial trails.

A good contribution is Genetic Aspects of Competition Between Species, by A. C. Bartlett (U.S.D.A., State College, Mass.), who revives the classic problem of analyzing the factors that determine competitive ability in two species of *Tribolium*. A more original problem is to sort out the factors influencing the Rate of Heartbeat in Nymphs of Damselflies, by L. Bush (Drew University, Madison, N.J.). A genetic approach is advocated in the Population Dynamics of Tent Caterpillars, by W. R. Henson (Yale University). Using Wellington's classification of larvae he suggests establishing colonies comprising various proportions of each type of larvae, and mating adults of maximum and minimum vigor.

The important thing in these two books is the fresh approach to teaching high school biology, in which the student is given an investigative, experimental attitude and is expected to acquire background for himself from standard texts as a supplement and a means to an end. Lists of general references and periodicals are given for each area of research.

This reviewer's impression is that if more than a few per cent of high school students are capable of attempting these experiments and carrying them to successful conclusions, there must be less wrong with the education system than we had realized.

—*H. R. MacCarthy*

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Ent

PROCEEDINGS

of the

ENTOMOLOGICAL SOCIETY of BRITISH COLUMBIA

Vol. 61. **Issued December 1, 1964**

ECONOMIC — PAGE

GENERAL

PROCEEDINGS

of the

ENTOMOLOGICAL SOCIETY *of* BRITISH COLUMBIA

Vol. 61. **Issued December 1, 1964**

TABLE 1.—Chemical definitions of insecticides used for preventing root maggot damage.*

Aldrin	1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-1,4-endo-exo-5,8-dimethanonaphthalene
B.25141	0,0-diethyl 0-p-(methylsulfinyl)phenyl phosphorothioate
B.44646	4-dimethylamino-m-tolyl methylcarbamate
Calomel	mercurous chloride
Carbaryl	1-naphthyl methylcarbamate
Carbophenothion	S-[(p-chlorophenylthio)methyl] 0,0-diethyl phosphorodithioate
Diazinon	0,0-diethyl 0-(2-isopropyl-4-methyl-6-pyrimidinyl) phosporothioate
Di-Syston	0,0-diethyl S-[2-(ethylthio)ethyl] phosphorodithioate
E.I.43064**	2-(diethoxyphosphinothioylimino)-1,3-dithiolane
Endosulfan	6,7,8,9,10,10-hexachloro-1,5,5a,6,9,9a-hexahydro-6,= 9-methano-2,4,3-benzodioxathiepin 3-oxide
Ethion	0,0,0′,0′-tetraethyl S,S′-methylenebisphosphorodithioate
Fenthion	0,0-dimethyl 0-[4-(methylthio)-m-tolyl] phosphorothioate
Guthion	0,0-dimethyl S-(4-oxo-1,2,3-benzotriazin-3(4H)-ylmethyl) phosphorodithioate
Heptachlor	1,4,5,6,7,8,8-heptachloro-3a,4,7,7a-tetrahydro-4,7-methanoindene
Imidan	0,0-dimethyl S-phthalimidomethyl phosphorodithioate
Nemacide	0-(2,4-dichlorophenyl) 0,0-diethyl phosphorothioate
Phorate	0,0-diethyl S-(ethylthio)methylphosphorodithioate
Telodrin	1,3,4,5,6,7,8,8-octachloro-3a,4,7,7a-tetrahydro-4,7-methanophthalan
Tetradifon	4-chlorophenyl 2,4,5-trichlorophenyl sulfone
Trichlorfon	dimethyl (2,2,2-trichloro-1-hydroxyethyl)phosphonate
Zectran	4-dimethylamino-3,5-xylyl methylcarbamate
Zinophos	0,0-diethyl 0-2-pyrazinyl phosphorothioate

*A chemical name occupying two lines separated by an equal (=) sign is joined together without the equal sign if written on one line.

**Chemical name obtained from company brochure.

In 1961 the investigation was conducted at Prince George and Victoria, at Armstrong in sandy clay loam, and at Cloverdale in muck soil. The design was a split-plot randomized block consisting of 18 treatments and one untreated check, each replicated five times at each site. A plot consisted of four 20-foot rows. Two rows of each plot were treated by the band method, the other two were treated by applying the insecticide with the seed in the furrow. Seed was sown at 0.33 g per 20 row-feet.

In 1962 at Prince George and Victoria the experiment was a split-plot randomized block of six plots replicated five times. A plot consisted of eight 20-foot rows; two rows at each of the following rates: 0, 2.2, 3.3, and 4.4 oz of toxicant per 1,000 feet of row. This rate was equivalent to 2, 3, and 4 lb of toxicant per acre respectively based on 36-inch spacing between rows. Five of the six plots were treated with: diazinon, heptachlor, phorate, Nemacide, and Zinophos applied to the furrow with 0.4 g of seed. The sixth plot was used for screening eight candidate materials. One row in each replicate was treated with ethion, fenthion, Imidan, Guthion, B.25141, B.44646, and E.I.43064 applied in the furrow at 3.3 oz toxicant per 1,000 feet of row and calomel applied at 6.6 oz per 1,000 row-feet.

Furrow, band, and spray treatments were made as follows:

Furrow treatments: the insecticides were placed in the V-belt of the seeder with the seed and applied in the furrow as the seed was sown.

Band treatment: the insecticides were applied in 10-inch bands to the soil surface with a shaker or fertilizer cart, raked in to a depth of about one inch and the seed was sown down the centre of the bands.

Sub-furrow band treatment: the heptachlor granules were applied as a five-inch band, 1.5 inches below

TABLE 2.—Materials, methods, and rates of applications of various treatments against root maggots attacking rutabaga at several locations in British Columbia in 1960, 1961 and 1962.

Treatment		Method of application	Toxicant in ounces per 1,000 row-feet					
			1960	1961				1962
			All Sites	Pr. Geo.	Armstrong	Cloverdale	Victoria	Pr.Geo. & Victoria
Aldrin	5G	band	6.0	6.6	6.6	8.8	8.8	—
	5G	furrow	—	3.3	3.3	4.4	4.4	—
B.25141	10G	furrow	—	—	—	—	—	3.3
B.44646	10G	furrow	—	—	—	—	—	3.3
Calomel	4D	furrow	—	—	—	—	—	6.6
Carbaryl	10G	band	—	13.2	—	—	17.6	—
(Sevin)	10G	furrow	—	6.6	—	—	8.8	—
Carbophenothion	10G	band	6.0	6.6	6.6	8.8	8.8	—
(Trithion)	10G	furrow	3.0	3.3	3.3	4.4	4.4	—
	42%E	spray	4.0	—	—	—	—	—
Diazinon	10G	band	—	6.6	6.6	8.8	8.8	—
	10G	furrow	—	3.3	3.3	4.4	4.4	—
	5G	furrow	—	—	—	—	—	2.2, 3.3, 4.4
Di-Syston	5G	band	—	6.6	—	—	8.8	—
	5G	furrow	—	3.3	—	—	4.4	—
E.I.43064	10G	furrow	—	—	—	—	—	3.3
Endosulfan	4.6G	band	—	6.6	6.6	8.8	8.8	—
(Thiodan)	4.6G	furrow	—	3.3	3.3	4.4	4.4	—
Ethion	5G	band	6.0	6.6	6.6	8.8	8.8	—
	5G	furrow	3.0	3.3	3.3	4.4	4.4	3.3
	4E	spray	4.0	—	—	—	—	—
Fenthion	5G	band	—	6.6	—	—	8.8	—
(Baytex)	5G	furrow	—	3.3	—	—	4.4	3.3
Guthion	3D	band	—	6.6	6.6	8.8	8.8	—
	3D	furrow	—	3.3	3.3	4.4	4.4	—
	10G	furrow	—	—	—	—	—	3.3
Heptachlor	5G	band	—	—	—	—	—	6.6*
	5G	furrow	—	—	—	—	—	2.2, 3.3
Imidan	25WP	band	—	6.6	—	—	8.8	—
	25WP	furrow	—	3.3	—	—	4.4	—
	10G	furrow	—	—	—	—	—	3.3
Nemacide	5G	band	6.0	6.6	6.6	8.8	8.8	—
(V-C 13)	5G	furrow	3.0	3.3	3.3	4.4	4.4	2.2, 3.3, 4.4
	75%E	spray	4.0	—	—	—	—	—
Phorate	10G	band	—	6.6	6.6	8.8	8.8	—
(Thimet)	10G	furrow	—	3.3	3.3	4.4	4.4	2.2, 3.3, 4.4
Telodrin	5G	band	—	6.6	—	—	8.8	—
	5G	furrow	—	3.3	—	—	4.4	—
Tetradifon	25WP	band	—	6.6	—	—	8.8	—
(Tedion)	25WP	furrow	—	3.3	—	—	4.4	—
Trichlorfon	5G	band	—	6.6	—	—	8.8	—
(Dylox)	5G	furrow	—	3.3	—	—	4.4	—
Zectran	5D	band	—	6.6	—	—	8.8	—
	5D	furrow	—	3.3	—	—	4.4	—
Zinophos	10G	band	—	6.6	6.6	8.8	8.8	—
	10G	furrow	—	3.3	3.3	4.4	4.4	2.2, 3.3, 4.4
Untreated		—	—	—	—	—	—	—

*Applied in a sub-furrow band in ridged rows (See "Methods").

the seed trench in a ridged row. It was applied with a hand shaker, the soil was ridged over the band with a hoe, and the seed sown down the middle of the ridges with a V-belt seeder (Read, 1960).

Spray treatment: the insecticides were applied with a small portable sprayer at 13 gal per 1,000 row-feet immediately after thinning and again four weeks later.

Materials, rates, and methods of application for 1960, 1961, and 1962 are listed in Table 2.

The efficacy of the insecticides was assessed in several ways. Their

TABLE 3.—Average number of seedlings and percentage damage by root maggots after various treatments at several locations in British Columbia in 1960.

Insecticide	Method of application	Emergent seedlings per 20 row-feet				Average percentage damage			
		Pr. George	Kamloops	Kelowna	Victoria	Pr. George	Kamloops	Kelowna	Victoria
Aldrin	band	47	36	67	56	18.0	17.0	10.4	100
Carbophenothion	band	34	31	59	57	50.6	62.0	33.0	100
	furrow	48	37	59	57	40.0	36.8	24.0	100
	spray	30	31	59	60	60.0	50.8	27.2	100
Ethion	band	35	27	55	53	45.4	72.4	30.6	100
	furrow	46	30	59	49	33.2	44.8	28.2	100
	spray	31	28	61	55	61.0	69.2	31.4	100
Nemacide	band	48	27	62	53	46.6	53.0	31.8	100
	furrow	34	18	46	47	11.8	17.4	15.8	100
	spray	33	30	61	55	67.4	55.6	21.4	100
Untreated	—	39	36	60	56	52.8	68.0	29.0	100
Difference necessary for significance p=.05		10	N.S.D.	N.S.D.	N.S.D.	16.3	26.7	12.1	N.S.D.

effect on germination was measured by counting the number of seedlings which emerged in a given length of row. Their effect on plant growth was assessed by periodic examination of plants and comparing the growth and vigor of treated plants with those of untreated plants. Their effect in preventing damage was measured by examining and grading 25 roots from each plot and calculating the damage index (King and Forbes, 1954). The damage index is based on the severity of the damage to each root scored on an arbitrary grading as: clean, 0; light, 1; moderate, 2; and severe, 4. In this paper the damage index (maximum $25 \times 4 = 100$) is expressed as percentage damage.

Results

1960 Experiment (Table 3).—The number of emergent seedlings was reduced considerably in the mineral soil at Prince George and Kamloops, but not in organic soils at Victoria and Kelowna. At Victoria, band, furrow, and spray treatments of carbophenothion, ethion, and Nemacide did not protect rutabaga from a resistant strain of cabbage maggot. At the other locations, damage was significantly lowered when aldrin was applied as a band and Nemacide was applied with the seed in the furrow.

1961 Experiment (Table 4).—Furrow treatments with carbaryl, trichlorfon, and Zinophos caused a significant reduction in the number of emergent seedlings at all locations regardless of soil or the rate of application. Of the 9 insecticides tested, diazinon, phorate, and Zinophos applied in the furrow gave some protection against the resistant strain both at Victoria in peat soil and at Cloverdale in muck soil where a strain of maggots had also developed resistance to cyclodiene insecticides.

1962 Experiment (Table 5).—Extremely dry conditions at the Victoria site after planting reduced

TABLE 4.—Average number of seedlings and percentage damage by root maggots after various treatments at several locations in British Columbia in 1961.

Insecticide	Emergent seedlings per 20 row-feet								Average percentage damage							
	Pr. George		Armstrong		Cloverdale		Victoria		Pr. George		Armstrong*		Cloverdale		Victoria	
	Band	Furrow	Band	Furrow	Band	Furrow	Band	Furrow	Band	Furrow	Band	Furrow	Band	Furrow	Band	Furrow
Aldrin	42	49	35	36	71	78	79	80	24.0	6.0	1.2	1.0	76.8	49.6	100	100
Carbaryl	39	9	—	—	—	—	65	3	82.8	96.0	—	—	—	—	100	100
Carbophenothion	45	49	37	39	74	67	89	89	76.8	57.0	1.1	1.3	93.4	92.4	100	100
Diazinon	40	40	39	27	70	74	72	77	68.6	18.4	1.4	1.0	94.2	63.2	96.8	69.6
Di-Syston	38	36	—	—	—	—	97	79	74.8	51.4	—	—	—	—	100	99.0
Endosulfan	45	39	37	41	74	64	87	98	79.4	50.0	1.5	1.5	99.6	94.8	100	100
Ethion	48	49	39	37	82	78	79	77	80.6	70.2	1.1	1.1	91.0	94.8	100	100
Fenthion	43	51	—	—	—	—	75	83	91.4	50.8	—	—	—	—	100	100
Guthion	54	47	38	19	77	64	83	55	82.6	70.6	2.1	1.1	96.6	87.2	97.0	94.2
Imidan	37	45	—	—	—	—	79	80	81.6	77.8	—	—	—	—	100	100
Nemacide	33	30	36	2	74	44	88	34	67.8	22.4	2.0	2.3	97.0	81.4	99.2	100
Phorate	30	34	34	8	68	61	81	58	80.4	23.0	1.7	1.4	95.2	81.4	95.0	79.8
Telodrin	34	37	—	—	—	—	87	90	23.2	10.8	—	—	—	—	100	100
Tetradifon	40	34	—	—	—	—	88	91	71.2	65.2	—	—	—	—	100	100
Trichlorfon	50	5	—	—	—	—	61	4	79.0	94.2	—	—	—	—	100	83.0
Zectran	49	41	—	—	—	—	69	34	90.2	87.4	—	—	—	—	100	100
Zinophos	38	27	33	1	70	17	77	10	82.0	61.6	1.7	1.0	79.0	45.6	52.0	34.4
Untreated	42		40		67		76		88.4		2.2		92.2		100	
Difference nec. for signif. P=.05	N.S.D.	27	N.S.D.	7	N.S.D.	31	N.S.D.	14	21.5		0.9		12.8		17.0	

*Statistical analysis made with a $\sqrt{X+1}$ transformation.

germination to such a degree that the experimental area was disked. Seedling emergence per 20 row-feet at Prince George ranged from 10 seedlings with Zinophos to 99 when heptachlor was placed in a band below the furrow in ridged rows. As the rate of insecticide was increased the numbers of emergent seedlings decreased. With the exceptions of the ethion furrow and the heptachlor sub-furrow band treatments all other treatments grew significantly fewer plants than the untreated check. Damage by the turnip maggot ranged from 17.6% for the recommended furrow treatment with heptachlor to 91.8% for the furrow treatment with B.44646. The untreated plots had 85.7% damage. Several materials at various rates gave good protection. However, in general as the efficacy in protection increased the number of emergent seedlings decreased.

Discussion

The results summarized in Tables 3, 4, and 5 show that although furrow treatments afford greater protection from root maggot attack than band and spray applications, emergence of seedlings is reduced by the more effective insecticides. As in previous work (King *et al.*, 1955) it was noticed that reductions in the numbers of emergent seedlings resulted when the insecticides were applied in direct contact with the seed. This was more evident in the mineral soils than in the organic soils.

In 1961 when methods of application were compared at four locations with different soil types, there were no significant differences in the numbers of emergent seedlings when insecticides were applied by the band method. However, marked differences occurred when some of the insecticides were applied at half the rate in direct contact with the seed. The differences occurred at all sites with both organocarbamate and organophosphate insecticides. One plant survived in 20 feet of row when Zinophos was placed in the furrow but 33 plants when it was applied in a band. Reductions in stand of 75% were not uncommon. The organocarbamates, carbaryl and Zectran and the organophosphates, trichlorfon and Zinophos, caused the greatest reduction and to a lesser degree the phosphates Guthion, Nemacide, and phorate.

In 1962 when the effects were compared of several furrow dosages of promising insecticides, serious reductions were again recorded with Zinophos and less serious with diazinon, Nemacide, and phorate; as the rate of application increased the numbers of emergent seedlings decreased. Only furrow treatment with

TABLE 5.—Average number of seedlings and percentage damage by root maggots after various furrow treatments at Prince George, B.C., 1962.

Treatment		Percentage	Emergent	Treatment		Percentage	Emergent
Insecticide	Rate	damage	seedlings	Insecticide	Rate	damage	seedlings
Heptachlor	3.3	18	64	Zinophos	3.3	55	13
Heptachlor	2.2	21	68	Zinophos	2.2	61	20
B.25141	3.3	21	34	Heptachlor	6.6*	71	91
Phorate	4.4	30	34	Imidan	3.3	72	28
Nemacide	3.3	30	34	Fenthion	3.3	72	67
Phorate	3.3	31	40	Guthion	3.3	73	28
Diazinon	2.2	31	40	Ethion	3.3	73	73
Diazinon	4.4	34	26	Calomel	6.6	75	67
Nemacide	4.4	37	35	E.I.43064	3.3	83	44
Diazinon	3.3	39	35	B.44646	3.3	92	45
Nemacide	2.2	44	42	Untreated	—	86	81
Phorate	2.2	45	55	Difference necessary			
Zinophos	4.4	54	10	for signif. P=.05		16	12

*Applied in a sub-furrow band in ridged rows (See "Methods").

ethion had significantly similar numbers of seedlings when compared with those of the untreated checks.

The protection afforded by the insecticides in 1960 indicated that the furrow treatment was the best method for preventing damage so long as cyclodiene-resistant flies were not present. However, at Victoria a resistant strain had arisen, and 100% damage was recorded for all treatments regardless of method or material.

In 1961 the degree of protection varied considerably between locations. At Prince George, where one generation of susceptible maggots must be controlled, the damage was correspondingly lighter than it was at Victoria or Cloverdale where three generations of a resistant strain occur. At Armstrong, even though two generations and a partial third occur, the damage was so small that to compare the amounts statistically it was necessary to transform the data using $\sqrt{X+1}$. Of the 17 insecticides tested only diazinon, phorate, and Zinophos gave any protection at Victoria. Telodrin, an organochlorine closely allied to aldrin, was very effective at Prince George, but allowed 100% damage at Victoria.

Based on results from the work in 1960 and 1961, the experiment in 1962 was designed to test the effects of various rates of the promising insecticides at Prince George and Victoria. Unfortunately the germination at Victoria was so poor that the land was disked and results could be obtained only from Prince George. Of the insecticides tested only diazinon, heptachlor, B.25141, Nemacide, phorate, and Zinophos can be considered for further experiments. Heptachlor applied in a band below the seed furrow in ridged rows had little effect against the maggots.

Since none of the soil insecticides has sufficient residual toxicity to control resistant strains of maggots, especially in organic soils, they will have to be supplemented with sprays to prevent oviposition by adult flies. To ensure early protection low rates in the furrow or in bands should be applied at seeding in combination with foliar sprays beginning before the emergence of second generation flies.

Summary

Experiments against turnip maggots and resistant cabbage maggots were conducted at six sites with different soil types in 1960, 1961, and 1962 to determine the insecticides, methods, and rates of application for preventing maggot damage in rutabaga. Three methods were tested at various rates with several formulations. In 1960 at Victoria band, furrow, and spray treatments did not protect rutabaga from a resistant strain of cabbage maggots. At three other locations the damage was significantly less when aldrin was applied in a band at seeding or when Nemacide was placed in the furrow. In 1961 only diazinon, phorate, and Zinophos applied in the furrow gave any protection from resistant maggots, but phorate and especially Zinophos caused a marked reduction in the number of emergent seedlings. In 1962 the effect of rates of application on seedling emergence was demonstrated. The three phosphate materials mentioned caused extreme reductions in numbers even at 2.2 oz toxicant per 1,000 row-feet. Zinophos was especially harmful. Damage at Prince George by the susceptible turnip maggot, *Hylemya floralis* (Fall.), ranged from 17.6% with heptachlor to 91.8% with B.44646 and 85.7% in untreated plots. Where resistant strains of maggots are present furrow or band treatments at seeding must be supplemented with foliar sprays.

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Chrysophana placida infesting buildings in British Columbia (Coleoptera: Buprestidae)

In January, 1963, I received an enquiry from a lodge at McGillivray Falls, Anderson Lake, concerning beetles that were emerging from the walls of a fir log building. The accompanying specimens were **Chrysophana placida** Leconte, a beautiful golden green beetle with a purple stripe down each elytron and iridescent green on the underside. The females are one-half inch long, males slightly less. I had taken specimens at Salmon Arm, Kamloops, Chilcotin and Victoria, but knew nothing of their life history. In February owners of the lodge sent 36 more beetles with the information that three or four were emerging every day from the inside of the logs and actively running around. They came mainly from two logs on one side and from one log on the adjoining side of the room.

There is little published information on this species, but Doane, **et al.** suggest that there are evidences that they re-infest timber from which they have recently emerged. The lodge was 11 years old so the beetles had either been slowly developing during that time or the first ones that emerged had oviposited in the logs. To the owner's recollection it was the third year that the beetles had appeared. It is thus likely that with the slow drying of the logs, the larval development was correspondingly delayed. Emerging only on the inside of the logs, the larvae would appear to be attracted to heat before pupating.

This infestation almost parallels one that was reported in May, 1949, by a resident in Salmon Arm who claimed that "the beetles were working throughout the house . . . which is constructed of squared timbers with 1-inch strips nailed to the inside of same and then 2-ply of half-inch lumber with paper between; on top of that either gyproc or beaver board: the logs, lumber and the inside finish is being drilled throughout. The beetles are even boring through new gyproc." One living beetle was taken from an outside wall which had apparently been warmed by the sun.

According to Doane **et al.** the normal life history of this insect is several years so that 10 years would seem to be about the longest delay that can occur in the life of the larva before it pupates as opposed to the several-times-reported period of 50 years in the case of **Buprestis aurulenta.**

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—*G. J. Spencer, University of British Columbia, Vancouver 8, B.C.*

THE EFFECT OF DOSAGE OF ORGANOPHOSPHATE INSECTICIDES ON THE EMERGENCE OF RADISH SEEDLINGS AND ON DAMAGE BY CABBAGE MAGGOTS[1]

D. G. Finlayson and M. D. Noble

Introduction

With the development of a strain of cabbage maggot *(Hylemya brassicae* [Bouché]*)* resistant to the cyclodiene group of the organochlorine insecticides in the Pacific Northwest, it once again became virtually impossible to grow marketable root and stem brassicas on Vancouver Island and in the lower Fraser Valley. Work by Howitt and Cole (1962) and by Finlayson and Noble (1964) indicated that maggots attacking root crops might be controlled with several organophosphates. However, reduced numbers of emergent seedlings when granular formulations were applied in the furrow indicated that further work was needed. This paper reports on the effects of various rates of several organophosphate insecticides in three soil types on emergence of seedlings and prevention of damage in radish by resistant strains of cabbage maggots.

Materials and Methods

The insecticides were in granular formulations as follows:

Diazinon	0,0-diethyl 0-(2-isopropyl-4-methyl-6-pyrimidinyl) phosphorothioate; 5% on walnut shell; Fisons (Canada) Ltd., Toronto, Ont.
Guthion	0.0-dimethyl S-(4-oxo-1,2,3,benzotriazin-3(4H)-ylmethyl phosphorodithioate; 10%; Chemagro Corp., Kansas City, Mo.
Heptachlor	1,4,5,6,7,8,8-heptachloro-3a,4,7,7a-tetrahydro-4,7-methanoindene; 5%; Velsicol Chemical Corp., Chicago, Ill.
Nemacide (V-C 13) . .	0,0-diethyl 0-2,4-dichlorophenyl phosphorothioate; 5%; Pennsalt Chemicals Corp., Tacoma, Wash.
Zinophos	0,0-diethyl 0-2-pyrazinyl phosphorothioate; 10%; American Cyanamid Co., Princeton, N.J.

The Early Scarlet Globe variety of radish was used.

The investigation was conducted at three sites: at Essondale in muck soil; at Victoria in peat soil; and at the University Farm in Vancouver in sandy soil. The design, a split-plot latin square, consisted of five insecticides applied at four rates, 0, 7. 14, and 28 g of toxicant per 1,000 feet of row, replicated five times. A plot consisted of four 20-foot rows, each row treated at one of the above rates. The insecticides were applied with three grams of seed (approximately 300) sown with a V-belt seeder. The seedlings were counted about 15 days after planting. At harvest random samples of 50 radishes per sub-plot were collected, washed, and inspected for maggot tunnels. A radish was considered damaged if there was any blemish caused by maggots. Percentage damage was calculated in terms of the number of radishes damaged.

Results and Discussion

Counts of emergent seedlings and percentage damage by root maggots are given in Table 1. Only Zinophos caused an appreciable reduction in emergence and this was more evident in light sandy loam than in organic soils. There was no maggot damage in any treatment nor in the untreated checks at Vancouver and Essondale. At Victoria damage rang-

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TABLE 1.—Materials and rate of application, average number of seedlings, and percentage damage by root maggots in radish in British Columbia, 1962.

Granular insecticide	Toxicant in g per 1000 row-feet	Emergent seedlings per 20 row-feet			Percentage damage Victoria
		Essondale (muck)	Victoria (peat)	Vancouver (sandy)	
Diazinon 5%	0	245	250	229	79
	7	232	252	223	60
	14	248	257	222	24
	28	252	253	212	31
Guthion 10%	0	218	249	230	82
	7	211	245	223	56
	14	202	262	236	48
	28	233	237	220	36
Heptachlor 5%	0	225	248	225	92
	7	210	257	232	93
	14	218	260	232	93
	28	208	262	214	92
Nemacide 5%	0	211	246	239	96
	7	222	244	233	75
	14	223	234	220	69
	28	216	238	221	55
Zinophos 10%	0	249	257	227	87
	7	225	237	152	12
	14	218	230	119	9
	28	225	199	61	4
Difference necessary for significance, P=.05		N.S.D.	N.S.D.	14	13

ed from 4% in plots treated with 28 g of Zinophos to an average of 93% in treatments with heptachlor and 87% in untreated plots.

Howitt and Cole (1962) reported that cabbage maggots resistant to cyclodiene insecticides in Washington State appeared to be resistant also to organophosphates. Maggots of the strain at Victoria were susceptible however, especially to Zinophos. All treatments with organophosphate insecticides reduced the amount of damage. With the exception of a slight reversal at the 14 and 28 g rates with diazinon, the percentage damage decreased as the dosage increased.

Zinophos was the most effective insecticide. At 7 g per 1,000 row-feet only 12% damage was recorded, and this was very minor. Unfortunately, Zinophos caused some reduction in the numbers of emergent seedlings in the light soil. In peat and muck soils there was no appreciable reduction. At Victoria at the 28 g rate emergent seedlings were reduced 20%. The reduction was not significant. At Vancouver on the light soil even at 7 g per 1,000 feet of row approximately 30% fewer radishes emerged; at 14 g about 50%; and at 28 g the emergence was only 27% of the numbers recorded for the untreated plots.

Summary

At Vancouver, Victoria, and Essondale, furrow treatments with granular formulations of diazinon, Guthion, heptachlor, Nemacide, and Zinophos were applied at 0, 7, 14, and 28 g toxicant per 1,000 row-feet. No maggot damage was recorded at Vancouver and Essondale. At Victoria damage ranged from 4% in plots treated with Zinophos at 28 g to 93% for heptachlor treatments and 87% for untreated checks. Only Zinophos caused any appreciable reduction in the numbers of emergent seedlings. This was more evident in light sandy soil at Vancouver than in organic soils at Victoria and

Essondale. At Vancouver the average number of seedlings per 20 row-feet at 0, 7, 14, and 28 g of Zinophos was 227, 152, 118, and 61 respectively.

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EXPERIMENTS AGAINST CARROT RUST FLY *(Psila rosae* (F.)) RESISTANT TO CYCLODIENE ORGANOCHLORINE INSECTICIDES[1]

D. G. FINLAYSON, H. G. FULTON, AND M. D. NOBLE

In July, 1961 reports from the Provincial Government's Colony Farm at Essondale, near Vancouver, to the effect that aldrin was no longer protecting carrots from damage by carrot maggots *(Psila rosae* [F.]), led to an investigation to determine: if strains of flies resistant to cyclodiene insecticides were present, and if suitable control measures could be developed.

The first spring seeding of carrots at Essondale was destroyed because the damage was so severe. Although recommended chemicals had been applied it soon became evident that the second crop also was heavily infested. Random samples in mid-August showed that at least 50% of the carrots were damaged. Collections of pupae were made at this time by sifting the soil for three inches on each side of the row to a depth of about six inches. Forty-five feet of row yielded more than 750 puparia plus an additional 1,200 from the maggots in the infested carrots. Samples of these puparia were shipped to the Entomological Laboratory at Chatham, Ont., for screening against various insecticides. The results of these tests (Niemczyk and Harris, 1962) showed that the flies were highly resistant to aldrin but very susceptible to diazinon. The toxicity of malathion was about mid-way between the other two.

Based on results obtained during investigations to find effective insecticides against resistant strains of onion maggots (Finlayson, 1959 and Howitt, 1958); cabbage maggots (Finlayson and Noble, 1964a and b and Howitt and Cole, 1962); and carrot maggots (Howitt and Cole, 1959); experiments were designed to test the effective insecticides against the second generation of carrot rust fly at Essondale. This paper reports on the experiments in 1961, 1962, and 1963. A temporary method was developed for preventing damage and the effects are shown of several dosages of chemicals on seedling emergence in various soil types. In the lower Fraser Valley commercial carrots are usually grown in muck soil.

Materials and Methods

The pesticides used in the investigation are listed in Table 1 and are identified chemically in accordance with Billings (1963) and Kenaga

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TABLE 1.—Chemical definitions of pesticides applied against carrot maggots.

Aldrin	1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-1,4-endo-exo-5,8-dimethanonaphthalene
B.25141	0,0-diethyl 0-p-(methylsulfinyl) phenyl phosphorothioate
B.37289	0-ethyl 0-2,4,5,-trichlorophenyl ethylphosphonothioate
B.39007	0-isopropoxyphenyl methylcarbamate
Captan	N-(trichloromethylthio)-4-cyclohexene-1,2-dicarboximide
Carbophenothion (Trithion)	S-[(p-chlorophenylthio)methyl] 0,0-diethyl phosphorodithioate
Diazinon	0,0-diethyl 0-(2-isopropyl-4-methyl-6-pyrimidinyl) phosphorothioate
E.I.43064*	2-(diethoxyphosphinothioylimino)-1,3-dithiolane
Ethion	0,0,0′,0′-tetraethyl S,S′-methylenebisphosphoro dithioate
G.C.4072	2-chloro-1-(2,4-dichlorophenyl)vinyl diethyl phosphate
Guthion	0,0-dimethyl S-(4-oxo-1,2,3-benzotriazin-3(4H)-ylmethyl) phosphorodithioate
N.2790*	0-ethyl S-phenylethylphosphonodithioate
Nemacide (V-C 13)	0-(2,4-dichlorophenyl) 0,0-diethyl phosphorothioate
Zinophos	0,0-diethyl 0-2-pyrazinyl phosphorothioate

* Chemical name obtained from company brochure.

(1963). Formulations and rates of application are given in Table 2.

The carrot variety Scarlet Nantes Half-long was used, except at Essondale in 1963 when variety Gold Pak was grown. One g of seed (approximately 400), plus the insecticide, was sown in 20 ft of row with a V-belt seeder.

In 1961 the experiment was planted in mid-July on a plot immediately adjacent to the destroyed field of carrots. The design was a split-plot randomized block of 14 treatments,

TABLE 2.—Rate of furrow applications of insecticides against carrot maggot at several locations in British Columbia in 1961, 1962, and 1963.

Granular insecticide		Toxicant in grams per 1,000 row-feet			Granular insecticide		Toxicant in grams per 1,000 row-feet		
		1961	1962	1963			1961	1962	1963
Aldrin	5%	—	7	—	E.I.43064	10%	—	—	7
		14	14	—			—	—	14
		28	28	28			—	—	28
B.25141	10%	—	—	7	G.C.4072	10%	—	—	7
		—	—	14			—	—	14
		—	—	28			—	—	28
B.37289	10%	—	—	7	Guthion**	10%	—	7	—
		—	—	14			14	14	—
		—	—	28			28	28	—
B.39007	10%	—	—	7	N.2790	10%	—	—	7
		—	—	14			—	—	14
		—	—	28			—	—	28
Carbophenothion	10%	—	—	—	Nemacide	5%	—	7	—
		14	—	—			14	14	—
		28	—	—			28	28	—
Diazinon*	5%	—	7	7	Zinophos	10%	—	7	7
		14	14	14			14	14	14
		28	28	28			28	28	28
Ethion	5%	—	—	—					
		14	—	—					
		28	—	—	Untreated		—	—	—

* 10% granular was used in 1961.
** 3% dust was used in 1961.

comprising two rates with each of seven insecticides, and one untreated check, replicated five times. Each plot consisted of two 20-foot rows: one treated at 14 g of toxicant per 1,000 row-feet, the other at 28 g.

In 1962 the investigation was conducted at three sites: at Essondale in muck soil; at Victoria in peat soil; and at the University farm in Vancouver in sandy soil. The design was a split-plot latin square of five insecticides, applied at four rates, replicated five times. The insecticide granules were applied at 0, 7, 14, and 28 g of toxicant per 1,000 row-feet. Each plot contained four rows 20 feet long, one row at each rate.

In 1963 in muck soils at Essondale and Colebrook in the lower Fraser Valley, experiments compared eight granular insecticides applied to the furrow at 7, 14, and 28 g of toxicant per 1,000 row-feet with aldrin granules at 14 g and an untreated check. At each site were 25 furrow treatments, an untreated check and two captan seed treatments each replicated four times. Four captan plots received 14 g of diazinon to determine if captan would reduce the deleterious effects of diazinon on seedling emergence. For the captan seed treatment the carrot seed was dipped in 5% Methocel[2] sticker solution, and stirred with a glass rod in a beaker while captan was added at 1 oz per 2 lb of seed. Continuous stirring during the addition of the captan powder ensured a uniform coating on the seeds.

In 1961 efficacy of the treatments was measured by two appraisals of carrot samples for maggot damage; for the first, 50 carrots were pulled at random from each plot 100 days after seeding; for the second, the remaining carrots were pulled 30 days later.

In 1962 and 1963 emergent seedlings were counted 30 days after seeding and the foliage was examined periodically to determine any phytotoxic effects from the treatments. In addition two appraisals for damage were made. In 1962 they were made 100 days after seeding and at harvest 50 days later; in 1963 at 75 and 150 days after seeding.

Damage was assessed by washing the carrots thoroughly and examining them individually for signs of feeding on the main root. A single tunnel constituted a damaged carrot.

[2] Dow Chemical Co., Midland, Michigan.

TABLE 3.—Average percentage damage by carrot maggots after various treatments at Essondale, B.C., 1961.*

Treatment	Toxicant per 1,000 row-feet (g)	Damage after 100 days	Treatment	Toxicant per 1,000 row-feet (g)	Damage after 130 days
Diazinon	14	4	Zinophos	28	5
Diazinon	28	8	Diazinon	14	5
Zinophos	14	10	Zinophos	14	6
Zinophos	28	10	Diazinon	28	9
Guthion	28	35	Guthion	28	61
Nemacide	28	49	Nemacide	14	61
Guthion	14	52	Ethion	28	61
Ethion	14	54	Guthion	14	64
Ethion	28	64	Nemacide	28	67
Nemacide	14	67	Ethion	28	70
Carbophenothion	28	68	Carbophenothion	28	71
Carbophenothion	14	72	Carbophenothion	14	84
Aldrin	14	86	Aldrin	14	94
Aldrin	28	93	Aldrin	28	95
Untreated	—	94	Untreated	—	98

*Values within the same bracket are not significantly different (Duncan, 1955).

Results

1961 Experiment (Table 3).—Furrow applications with granular diazinon and Zinophos at 14 and 28 g per 1,000 row-feet significantly reduced the amount of damage caused by resistant carrot maggots. Damage was less than 10%, whereas in aldrin-treated and untreated plots it was more than 90%. No phytotoxic symptoms were seen nor was there any apparent reduction in the number of seedlings.

1962 Experiment (Table 4).—Maggot infestations were negligible at Vancouver and Victoria so that no damage was sustained even in the untreated plots. At Essondale the infestation was nearly as low. In September more than 100 days after seeding, no damage was evident. At harvest, 150 days after seeding, the damage was still very light. In the untreated plots it averaged 32.2% (range 6 to 50%). In the treated plots the damage was similar, indicating that the residual effective period of the organophosphates tested was shorter than that of the cyclodiene organochlorines. Granular formulations in general, regardless of soil type, caused a decrease in the number of emergent seedlings which became more significant as the rate of application increased. In the light soils Zinophos and diazinon caused greater decreases than Guthion and Nemacide. No other symptoms of phytotoxicity were seen.

1963 Experiment (Table 5).—There was no damage by first generation maggots at either site, nor at Essondale by the second generation. At Colebrook only B.25141 gave satisfactory protection from both generations of maggots, allowing 10, 29, and 44% damage for the three rates applied. Untreated and aldrin-treated plots had 77 and 76% damage respectively. The numbers of emergent seedlings were significantly reduced by several treatments: at Colebrook, B.39007 and Zinophos at the three rates, diazinon at 28 and 14, and E.I.43064 at 28 g; whereas at Essondale only B.25141 and diazinon at 28 g caused a reduction.

TABLE 4.—Average number of emergent seedlings and percentage damage by carrot maggots after various treatments in several soil types in British Columbia, 1962.

Treatment	Toxicant per 1,000 row-feet (g)	Emergent seedlings per 20 row-feet			Percentage damage at Essondale
		Essondale muck	Victoria peat	Vancouver sandy	
Aldrin	0	172	259	273	18
	7	147	275	237	38
	14	165	279	213	37
	28	172	285	222	38
Diazinon	0	153	274	271	30
	7	131	266	113	34
	14	102	235	83	28
	28	83	198	74	30
Guthion	0	167	302	249	26
	7	162	301	237	28
	14	167	284	219	28
	28	167	249	198	30
Nemacide	0	160	283	251	45
	7	156	279	235	34
	14	152	279	204	27
	28	140	262	193	29
Zinophos	0	165	254	257	42
	7	138	241	147	34
	14	127	241	134	41
	28	120	205	105	26
Difference necessary for significance P=.05		30	36	32	14

TABLE 5.—Average number of emergent seedlings and percentage damage by carrot maggots after various treatments at two sites in British Columbia, 1963.

Granular insecticides	Toxicant per 1,000 row-feet (g)	Emergent seedlings per 20 row-feet		Percentage damage (150 days)	
		Colebrook	Essondale	Colebrook	Essondale
B.25141	28	263	186	10	0
	14	302	214	29	0
	7	293	230	44	0
B.39007	28	82	208	73	0
	14	121	282	91	0
	7	146	277	83	0
Zinophos	28	196	200	49	0
	14	216	199	80	0
	7	241	196	77	0
Aldrin	28	337	231	76	0
G.C.4072	28	342	244	53	0
	14	348	286	64	0
	7	303	244	71	0
N.2790	28	266	221	24	0
	14	324	186	22	0
	7	319	219	31	0
B.37289	28	349	287	53	0
	14	370	313	64	0
	7	351	277	53	0
E.I.43064	28	246	217	61	0
	14	286	270	78	0
	7	346	208	75	0
Diazinon	28	144	144	67	0
	14	222	193	70	0
	7	282	204	73	0
Untreated	—	340	266	77	8
Captan	—	336	207	90	0
Cap.+diaz.	14	280	217	83	0
Difference necessary for significance P=.05		84	78	27	—

When the carrot seeds were coated with captan and sown with 14 g of diazinon there was little reduction.

Discussion

From experiments conducted in the lower Fraser Valley and at Armstrong from 1950 to 1954, recommendations were made for control of the carrot maggot in British Columbia (Fulton and Handford, 1955). These included several methods of application of aldrin, heptachlor, chlordane, and lindane, all of which gave outstanding results.

In the state of Washington (Howitt and Cole, 1959) and at Essondale, no indication of resistant carrot rust fly was observed during late carrot cropping of the previous year. The severe damage inflicted by carrot maggots in the first planting in 1961 and the large number of pupae collected exemplify the rapid rise in population when resistance develops. In 1961 the normal insecticidal application for crop protection was made to both early and late plantings, which probably contributed further to the selection for resistance.

From the experiments conducted in 1961 it appeared at first that both diazinon and Zinophos would protect carrots (Fig. 1) and would not reduce the number of seedlings. Since these tests confirmed work by Howitt and Cole (1959) methods and rates were determined for field applications. Although large numbers of pupae were present at Essondale in 1961, few flies were found and light damage only was recorded in the experimental plots in 1962 and again in 1963. These reductions were attributed in part to the control practices of the farm management. In both years the furrow treatment with diazinon was supplemented with sev-

Fig. 1. A.—Carrots, from aldrin-treated and untreated plots, damaged by resistant carrot maggots. B.—Carrots from diazinon- and Zinophos-treated plots.

eral total spray treatments which coincided with the emergence of flies so that the population was effectively reduced.

The experiments showed that the longevity of organophosphate insecticides was not enough to ensure undamaged carrots when these were subjected to attack by two generations of maggots. Indeed, only B.25141 appeared to have enough persistence in soil to afford protection to carrots sown in late spring and harvested in late fall, but at the rate necessary to prevent damage there was serious reduction in the numbers of emergent seedlings. Since the necessary period of protection extends from mid-May to late September an effective furrow dosage must be found which not only permits a normal stand of plants but also protects the young seedlings. A supplementary spray program must be initiated to reduce the numbers of adult flies and thus prevent oviposition.

Summary

Experiments were conducted in different soil types in 1961, 1962, and 1963, to determine the efficacy of organocarbamate, organochlorine, and organophosphate insecticides against carrot rust fy (*Psila rosae* [F.]) resistant to cyclodiene organochlorine insecticides. The granular insecticides were applied in the furrow at 7, 14, and 28 g per 1,000 row-feet. In 1961 diazinon and Zinophos allowed less than 10% damage by one generation of maggots; whereas the untreated and aldrin-treated plots had more than 90% carrots unmarketable. The treatments caused no apparent reduction in the numbers of emergent seedlings. In 1962 damage was recorded at harvest 150 days after seeding in the treated as well as the untreated plots indicating that the residual period of the organophosphates was not long enough to protect the carrots from attack by two generations of carrot maggot. The highest rate of application reduced the numbers of emergent seedlings. This was more evident in light mineral soil than in the organic soils. In 1963 no damage was inflicted by first generation maggots but only B.25141 was able to protect the crop from damage by second generation maggots. Several insecticides, B.39007, diazinon, Zinophos, and E.I.43064 causd significant reductions in numbers of emergent seedlings. A coating of captan on seeds sown with diazinon appeared to counteract the effect of diazinon on seedling emergence.

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FURTHER INSECTICIDE TESTS AGAINST THE DOUGLAS-FIR NEEDLE MIDGES, *Contarinia* SPP.[1]

D. A. ROSS[2], J. C. ARRAND[3], AND N. J. GEISTLINGER[2]

Introduction

In 1962, at Larkin, B.C., endosulfan (Thiodan) and DDT emulsible concentrates diluted to 0.3% and applied to run-off, when the buds had flushed, gave satisfactory control of *Contarinia* spp. (Ross and Arrand 1963).

In 1963, at Invermere, the effectiveness of lower concentrations of Thiodan and DDT wettable powders (WP), and Thiodan emulsible concentrate (E) was tested on single trees. Additional trials at Canal Flats to measure control in large blocks, and at Larkin to establish the optimum time for spraying, did not produce adequate data because of low numbers of *Contarinia* spp.

Methods and Results

At Invermere, 10 trees from 5 to 7 ft tall were used for each treatment and 10 were left unsprayed as checks. Insecticides were applied with a hand sprayer to run-off.

One Imperial gal of water was added to each of the following quantities of commercial concentrates to obtain the finished formulations:

1½ tablespoons Thiodan emulsible concentrate containing 2 lbs technical Thiodan per Imperial gal (0.1%); 1½ tablespoons of Thiodan 50% wettable powder (0.2%); 1½ tablespoons of DDT 50% wettable powder (0.2%).

Sprays were applied under warm (78 to 81° F.) calm conditions on May 22 and 23, when an average of 75% of the buds in the upper crown and 85% in the lower crown were open. At the time of spraying, midges were ovipositing on the buds.

Percentage infestation was determined in October from 10 terminal twigs picked at random at breast height from each tree (Table 1).

Wettable powders of Thiodan and DDT at 0.2% concentration, on the foliage of individual trees did not give adequate control, but an application of Thiodan emulsion at 0.1% concentration gave good control.

In October five twigs from each tree were examined for eggs of the spruce spider mite, *Oligonychus ununguis* (Jacot). Counts were limited to the basal inch of the underside of the terminal twig (Table 2).

There was no apparent difference between the check and the Thiodan treatments, but the DDT-treated samples had almost 100 times more

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TABLE 1—Percentage Infestation of Current Year's Douglas-Fir Needles by **Contarinia** spp. Invermere, B.C., October, 1963.

Treatment (May 22, 23) 1963	Concentration %	Average	Range
Check	—	28.6	16 - 40
Thiodan E	0.1	5.4	2.9 - 8.6
Thiodan WP	0.2	13.2	4.8 - 31.9
DDT WP	0.2	14.5	1.2 - 28.8

mite eggs than the check or Thiodan treatments.

Two plots of 0.7 and 1.5 acres, at Canal Flats and Edgewater respectively, were each sprayed using a gas-powered machine, with Thiodan wettable powder at the rate of 2 lb per 100 gal (0.1% concentration) per acre. The machine had a portable slip-on tank and an Echo low volume pump with a 2.25 hp motor. The gun was a trigger-controlled Spraymiser.

Good data were not obtained at Canal Flats, because fewer than 2% of the needles in the check plot were infested by *Contarinia* spp. At Edgewater foliage in the check plot was 62% infested, whereas foliage in the treated plot was only 2% infested.

Discussion

Control was unsatisfactory with 0.2% concentrations of wettable powders of Thiodan and DDT at Invermere, applied with a hand sprayer. Thiodan emulsion at 0.1% was superior to the wettable powder at 0.2%. It seems likely that the superior control can be explained by the attributes of an emulsion such as better adhesion qualities, possibly greater penetration, or even greater inherent toxicity. Wetting agents will be used with wettable powders in future trials to see if control can be increased with this formulation.

In the tests of 1962 there was some slight 'burning' of a fraction of one per cent of the new foliage where DDT emulsible concentrate was used. No burning was apparent in the 1963 trials.

Better control with Thiodan wettable powder was obtained at Edgewater than at Invermere. This may be because the ground and all vegetation at Edgewater was wetted with spray whereas at Invermere only the test trees were sprayed and there was little drift of poison onto the ground or vegetation about the trees.

These tests demonstrated the practicability of protecting commercially-grown Douglas-fir Christmas trees from injurious attack by *Contarinia* spp. with early season sprays of Thiodan.

The DDT-treated samples at Invermere, B.C., bore almost 100 times more mite eggs than did those from the check or Thiodan treatments. This confirms reports of infestations by spruce spider mite following treatment with DDT, the earliest by Hoffman and Merkel in 1948. It would obviously be unwise to recommend DDT because of the possibility of inducing an epidemic of this destructive mite.

The importance of determining the need for chemical control just

TABLE 2—Average number of Mite Eggs on Basal Lineal Inch of Terminal Douglas-Fir Twig, 5 Twigs From Each of 10 Trees. Invermere, B.C., October 30, 1963.

Treatment (May 1963)	Range between trees	Mean
Check	0 - 3.2	0.58
Thiodan E	0 - 0.4	0.11
Thiodan WP	0 - 1.0	0.18
DDT WP	12 - 109.0	52.00

before the emergence of midges from the ground in spring was demonstrated at Larkin and Canal Flats. There was moderate to severe foliage damage at these localities during 1962, but high mortality of midges occurred, resulting in a population collapse by the spring of 1963.

Summary

At Invermere, B.C. in 1963, 0.1% Thiodan E applied to individual trees with a hand sprayer at the time of bud opening gave satisfactory control of Douglas-fir needle midges. At the concentrations used, 0.2% Thiodan WP and 0.2% DDT WP, gave inadequate protection.

By October 1963, the number of mite eggs on the trees with the DDT treatment was approximately 100 times greater than the number on those with Thiodan treatments, and the check.

At Edgewater, Thiodan WP at 2 lb per 100 gal applied with a gas-powered sprayer gave excellent control of the Douglas-fir needle midges. Anyone using this control method should be cautioned that Thiodan is a chlorinated hydrocarbon and should not be used where cattle may graze within 30 days of treatment.

Acknowledgements

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STAPHYLINIDS DAMAGING BLOSSOMS

In the first week in May, 1964, W. D. Touzeau, Plant Protection Division, Vancouver, asked me to go with him to investigate a serious infestation of rove beetles on fruit tree blossoms. On May 8, we visited a West Vancouver home on Shamrock Place, south of the upper levels highway. The sloping backyard garden was planted in fruit trees and bushes. Blossoms of apple, pear, flowering cherry, red and black currant were swarming with beetles, as many as six per blossom. Nearby rock plants such as **Arabis albida, Aubretia deltoides,** and **Papaver nudicaule** were also attractive. Raspberry and strawberry blossoms had no beetles.

The beetles were head down in the corolla of the blossom, with their mouthparts at the base of the petals. They withdrew and dropped at the slightest disturbance. It was likely that they were feeding in the region of the nectaries. In the process, the stamens were injured and shortly turned brown. Fruit set was very light.

The beetles have appeared in this garden at the same time for four consecutive years. They are present in large numbers for about two weeks. The beetles were identified as **Pelecomalium testaceum** Mann. by W. J. Brown of the Entomology Research Institute, Ottawa.

Little appears to be known about the species which is apparently indigenous to the Pacific northwest, and is described as very common in British Columbia, Washington, Northern Idaho, and Oregon (Hatch, 1957). Mrs. Clark (1949) found a specimen on skunk cabbage at Terrace, B.C., and Casey (1893 in Hatch, 1957), states that the genus occurs on flowers.

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A PORTABLE, POWER-DRIVEN SIFTER FOR SOIL INSECT STUDIES[1]

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In root weevil studies it is necessary to sift the soil under many strawberry plants to obtain a valid measure of larval abundance. Because hand sifting is extremely laborious the sifter described here was built. As in most models the rocker principle was used. Lange *et al.* (1954) described a large self-propelled, power-driven sifter and reviewed the literature.

Dexion angle iron[2] was the principal material. It is easily cut with a special cutter or a hack-saw, and fastened together with bolts supplied. Sixty linear feet of angle iron was required. Exact measuremnts are not given here because the dimensions are not critical and a builder can estimate these or write to the author. (Figs. 1 and 2.)

The wheelbarrow-type frame on a 10-inch rubber-tired wheel allows the sifter to be moved by one man in the field and between rows. The four legs of the wheelbarrow project 1¼ inches below the lower side braces and sink into the soil to prevent the machine from creeping. Above the main frame the legs form the four corners of the rocker frame, from which the rocker bed is suspended. With the handles removed the machine is 74X24X30 inches and can be loaded into a sedan delivery vehicle.

The rocker bed has a rocker rod across each end between the overlapping angle irons at the corners (Fig. 2). Longer steel bolts 1¼ inches with lock washers are needed here. The front end of the rocker bed is reinforced with two extra cross pieces of angle iron to strengthen the rocker bracket, which is mounted in the center. This bracket is made from two pieces of angle iron with ⅝-inch holes drilled to receive the rocker pin. A cross-piece of angle iron bolted inside the bed at the back end keeps the screens from moving. The bed is suspended at each corner by an iron strap.

Plywood spacers placed on the rocker rods between the bed and the suspension straps and on the frame rods between the suspension straps and the rocker frame, allow ample clearance between the rocker bed and frame. The rocker rods are secured with washers and cotter pins placed immediately outside the suspension straps. The frame rods are inserted into holes drilled in the rocker frame and secured with washers and cotter pins placed immediately inside the suspension straps. Thus, the bed hangs freely in the angle iron framework and no special bearings are required.

The frames for the sieves are made of ⅝-inch, 5-ply plywood. The corners are reinforced with strips of plumber's medium - weight hanger iron. Wire screens of 14, 4, and 2 meshes per inch are fastened to the bottom of the frames with screws driven first through plywood strips. The middle screen has a plywood cleat at the center of each end and side to secure the three screens and facilitate lifting them off. The coarsest screen is placed on top.

The crank is driven by a shaft running through two grease-filled bearings mounted on the right side of the main frame and on the extension of the engine-mount frame just to the right of the center of the machine (Fig. 2). A collar is fastened on the outer end of the shaft and a 13-inch pulley carrying a V-belt is mounted between the

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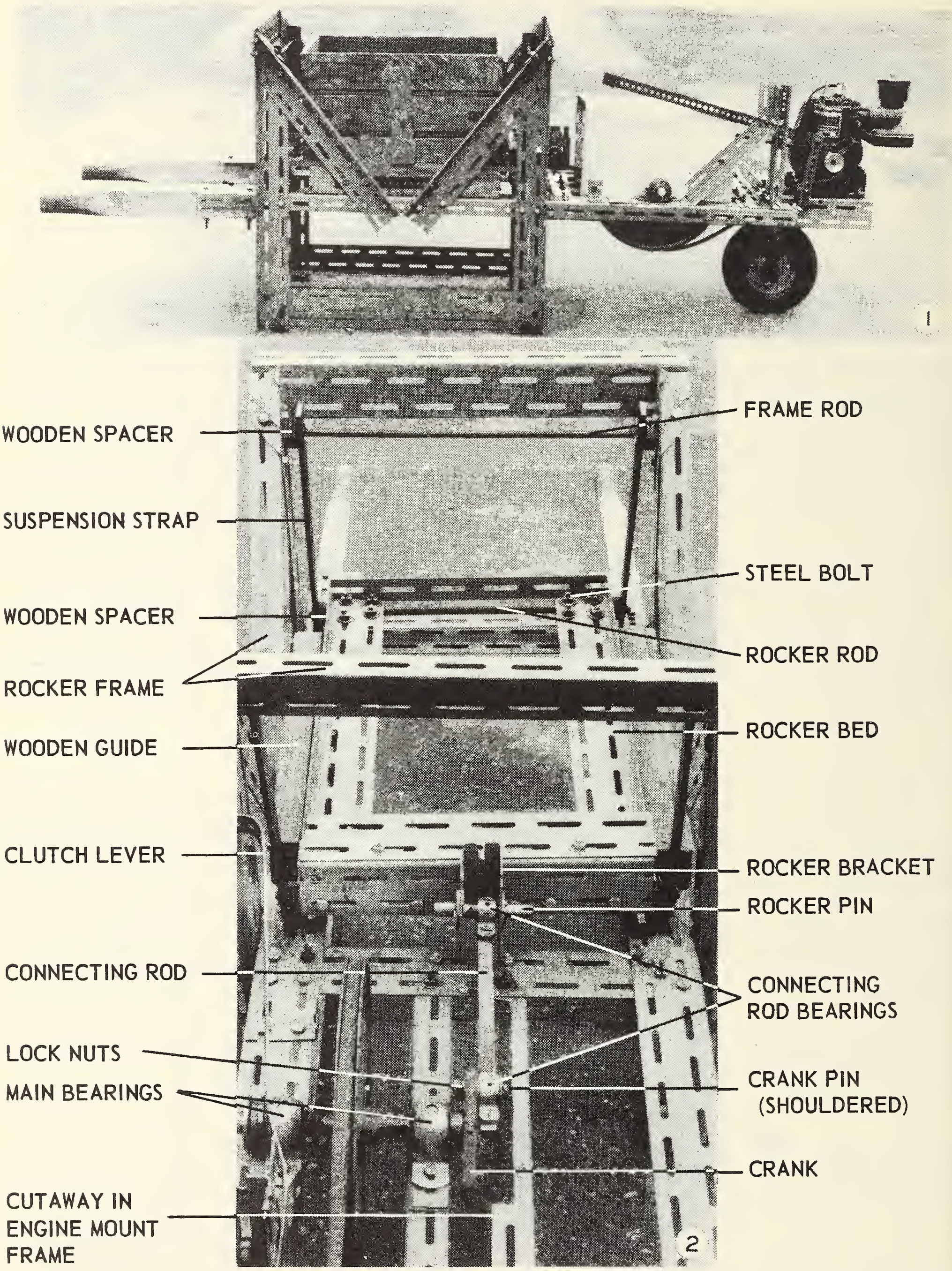
[1] Contribution No. 72, Research Station, Canada Department of Agriculture, 6660 N.W. Marine Drive, Vancouver 8, B.C.

[2] Available from FTS Ltd., 1240 Seymour St., Vancouver 2, B.C.



Figs. 1-2.—Portable power-driven soil sifter. 1, side view. 2, top view of crank and rocker assembly with hood and screens removed.

bearings. A steel spacer is placed on the shaft between the inside bearing and the crank. The crank of cold rolled steel is drilled at the center to fit the shaft snugly and at 1½ inches from center to fit the threaded end of the shouldered crank pin. The crank is rigidly fastened on the inside end of the shaft with a standard tapered pin. The crank pin is bolted to the crank with lock nuts. A washer and babbitt bearing are placed on the free end of the crank pin, secured with a washer and cotter pin and bolted to one end of the steel connecting rod. A babbitt bearing for the rocker pin is bolted to the other end of the connecting rod after marking the holes when the crank is vertical and the rocker bed at rest. The connecting rod and the crank are centered and aligned by adjusting the main bearings on the frame so that the rocker bed has a 3-inch stroke when the large pulley is rotated. Side sway is prevented by screwing wooden guides to the inside of the base of the rocker frame. These well-oiled guides are adjusted by placing washers between the guides and the frame.

The large pulley is aligned with the 2-inch drive pulley of a ¾ h.p., 4-cycle, air-cooled engine (Fig. 1), which is mounted so that the V-belt is slack. The belt tightener or clutch (Fig. 1), made from plumber's medium-weight hanger iron, allows the sifter to rock at any speed up to about 300 strokes per minutes. For safety a sheet metal hood is bolted to the frame to cover the crank and large pulley.

Some advantages of this machine over others are its lightness and portability, low cost (about $75.00, without engine and labour), ease of construction (about 12 hours for two men) and variable speed control. As with all machines that sift soil without using water, the condition of the soil is of utmost importance. The machine is most effective in fairly dry sandy upland soils and is not recommended for clays.

The machine can sift a soil sample 12 inches in diameter by 6 inches deep (678 cu. inches) in one filling. When the soil is not too wet, a sample can be sifted in a few seconds. Most of the operator's time is spent searching in the lower trays for larvae. These can best be found if the machine is operated at low speed so that the remaining soil is merely disturbed and the larvae exposed. In effect, the efficiency of the operation is dependent on the searching ability of the operator especially for small larvae.

This machine has been used for sifting soil under hundreds of strawberry plants and for preparing sifted soil for pot experiments. No repairs or changes have been necessary.

Acknowledgement

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A PRELIMINARY TEST WITH DDT FOR CONTROL OF THE WHEAT MIDGE *Sitodiplosis mosellana* (GEHIN)

D. A. ARNOTT[1] AND J. C. ARRAND[2]

In 1957 the wheat midge, *Sitodiplosis mosellana* (Gehin), caused severe damage to a crop of spring wheat near Kersley, British Columbia (Arrand, 1959). According to the farmer this field had been infested in 1956. The midge is now so well established in the area that spring wheat crops can no longer be grown profitably and farmers are concerned about loss of revenue from what has been a profitable cash crop. Previous recommendations for preventing damage, such as early seeding of quickly maturing varieties of wheat, plowing infested stubble fields before the midges emerge, locating new seedings as far as possible from infested stubble fields or growing fall wheat, are not applicable or not effective in the Kersley area.

In 1962 a preliminary test was carried out to determine whether treatment of spring wheat with DDT could provide practical control. Marquis wheat seeded during the third week of May was used. The treatment and a check were replicated four times using plots 6' x 40'. The treatment consisted of spraying the wheat with DDT 25% emulsion, at the rate of 1 lb. toxicant in 25 gal. water per acre. Treatment was applied on June 12 as the wheat began to head and when the first emergence of midges was noted from infested stubble fields.

The effect on midge infestation was determined by counting the eggs and larvae in six heads collected at random from each plot on July 26. The effect on yield of seed was determined by threshing, cleaning and weighing the seed from plants in two sample areas per plot, each one yard square, on September 4 when the crop approached maturity.

Counts of eggs and larvae showed that on July 26 infestation in the treated plots was 83.6 per cent less than that in untreated plots. (Table 1). Weights of clean seed showed that the yield of clean seed from treated plots was 78.6 per cent greater than that in the untreated (Table 2).

TABLE 1.—Numbers of midge eggs plus larvae in 6 wheat heads per replicate on July 26, after spraying with DDT on June 12, 1962, Kersley, B.C.

	Replicate						% Decrease
Treatment	1	2	3	4	Total	Average	with DDT
DDT	62	19	29	38	148	37.0	83.6
Check	180	185	184	353	902	225.5	

Although the DDT treatment gave fairly good control of midge infestation and a substantial increase in yield over that from the untreated wheat, the yields were only 11.1 bushels per acre in the treated and 6.2 bushels per acre in the untreated. The low yield from the treated wheat is attributed in part to phytotoxic effects of the spray. On July 26 foliage in the treated plots appeared reddish-brown as if burned compared with the fresh green colour in the untreated. On September 4 the average height of plants in the treated plots was 1.5 to 2.0 inches less than the average in the untreated.

Although results of this preliminary experiment have not provided a practical control for the wheat midge they indicate that further tests with insecticides are warranted.

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TABLE 2.—Weight in grams of clean wheat seed from one-yard square samples per replicate harvested on September 4, 1962, Kersley, B.C.

Treatment	Replicate				Total	Average per yd.[2]	% Increase over check
DDT							
Sample 1	54	54	62	87			
" 2	20	72	64	80	493	61.6	78.6
Check							
Sample 1	28	20	50	31			
" 2	44	27	42	34	276	34.6	

Acknowledgments

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INHERENT TOLERANCE IN LARVAE OF THE ROOT WEEVILS *Sciopithes obscurus* HORN AND *Nemocestes incomptus* (HORN) TO COMMON SOIL INSECTICIDES[1]

W. T. CRAM

The strawberry root weevil, *Brachyrhinus ovatus* (L.) and the black vine weevil, *B. sulcatus* (F.), are controlled in strawberry plantings by the soil insecticides heptachlor, aldrin, dieldrin, or chlordane (Eide, 1955; Cram and Andison, 1958). But the indigenous root weevils *Sciopithes obscurus* Horn and three species of the genus *Nemocestes,* which were previously not of economic importance, seriously damaged commercial strawberry plantings in 1954 in soil treated with heptachlor or aldrin at 5 lb, dieldrin at 3 lb, or chlordane at 10 lb of toxicant per 6-inch acre. *S. obscurus* adults were abundant in plantings in soil treated with heptachlor at 5 lb, and *N. incomptus* (Horn) in soil treated with aldrin at 5 lb. In a field treated with heptachlor, larvae of *S. obscurus* caused such extensive damage before the first picking season that the planting was ploughed under. Attacks by *N. incomptus, N.* prob. *montanus* Van Dyke and an unnamed species of *Nemocestes* were not so rapid, and severe damage did not usually occur until the second or third season.

This is a report of experiments in the greenhouse and field with soil insecticides for control of larvae of *S. obscurus,* and in the greenhouse alone for larvae of *N. incomptus.*

Methods

Greenhouse Tests—Coarse, sandy loam (pH 6.0, 10.1% organic matter) was passed through a 4-mesh screen, measured into a box of 0.5 cu ft, then spread 0.5 inch deep on paper. Each insecticide was applied evenly on the soil at a rate equivalent to broadcasting and mixing dust in the top 6 inches of soil in the field. The treated soil was mixed uniformly, then used to pot 9 runner strawberry plants, each in a 6-inch clay pot. When two insecticides were combined one was mixed with the soil first before the other was applied. The materials are detailed in Table 1.

Larvae were obtained from eggs laid by adults collected at night by

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TABLE 1—Larvae of **S. obscurus** and **N. incomptus** recovered 3 to 4 months after first instar larvae were placed on the soil of pots containing strawberry plants in soil treated with insecticide dusts.

Dusts	Toxicant per 6-inch acre, lb.	Larvae per plant[1] S. obscurus	N. incomptus
	1956—25 larvae per pot		
Aldrin 2½%	5	19.3 ab	17.0 a
"	10	17.3 ab	15.0 a
Dieldrin 2%	5	21.7 a	17.0 a
"	10	17.0 abc	18.7 a
Heptachlor 2½%	5	12.7 cd	14.7 a
"	10	11.7 cd	17.0 a
DDT 5%	5	18.3 ab	18.3 a
"	10	8.7 d	16.0 a
Untreated	—	19.0 ab	16.3 a
	1957—50 larvae per pot		
Diazinon 5%	5	20.3 a	not tested
Malathion 4%	5	16.7 ab	not tested
Toxaphene 5%	10	18.7 ab	26.7 a
Endrin 1%	1	16.7 ab	17.0 a
"	2	18.0 ab	29.0 a
Lindane 0.5%	0.5	14.3 ab	23.0 a
"	1	6.7 b	19.0 a
Untreated	—	12.3 ab	17.7 a
	1957—50 larvae per pot		
Lindane 0.5%	1	18.7 ab	
" +heptachlor 2½%	1, 5	12.0 b	
Lindane 0.5% +aldrin 2½%	1, 5	12.7 b	
Untreated	—	36.7 a	

[1] Means of 3 replicates. Values followed by the same letter are not significantly different at p=.05 (Duncan, 1955).

sweeping the tops of strawberry plants with a net. *S. obscurus* were collected in late June and July, and *N. incomptus* in October, March and April. Wide mouthed jars with screen lids, each containing 200 adults were kept in a rearing cabinet at 70° F and 75 to 85% relative humidity. The adults were fed fresh strawberry foliage twice weekly. Both species deposited their eggs in rows at the edges of the leaves, then folded the edges over and cemented them down. Eggs were laid in the same manner on tissue paper. They were trimmed from the foliage and paper twice weekly and kept in open jars in the cabinet where they hatched in 13 days. Newly emerged larvae cannot climb glass, so that fresh larvae could be obtained daily by merely covering the jars with 14x18-mesh screen, inverting the jars, and shaking them over paper. The unhatched eggs remained in the trimmings. Larvae were used in batches of 25 in 1956, and 50 in 1957. Unlike those of *B. sulcatus,* these larvae do not harm each other when confined in large numbers. The larvae were placed on the previously loosened soil in each of three pots per treatment.

In 1956, *S. obscurus* larvae were introduced 22 days and *N. incomptus* 49 days after the soil was treated. In 1957, *S. obscurus* larvae were introduced 64 days and *N. incomptus* 348 days after the soil was treated. In 1957 with insecticides in combination using *S. obscurus,* the larvae were introduced 15 days after the soil was treated. After 3 to 4 months, when the larvae were large enough to be found easily in the soil, the pots were emptied and the surviving larvae counted.

Field Test—In a planting of var. British Sovereign strawberry plants on the same soil used for the greenhouse pot tests, the soil was treated to test methods of applying insecticides for control of *Brachyrhinus* spp. The single-row plots, each 48 feet long, were 3 feet apart and replicated in 4 blocks. Before planting in April, 1956, dusts, sprays, or granules were applied to the soil, either alone in 10-inch bands, or combined with an application to the roots. These treatments are detailed in Table 2. The soil insecticides were mixed in the top 6 inches of soil with a 15-inch rotovator. From September 10 to 12, 1956, 50 newly-emerged *S. obscurus* larvae were placed on the soil around the crown of the first plant of each plot, and from September 26 to October 24, around the second plant of each plot. The larvae moved into the soil immediately. From May to July of the following year the plants were dug, and the soil was sifted in a 12-inch circle around the plant to a depth of 6 inches using a mechanical sifter (Cram, 1964). The larvae were counted. Earlier tests had shown that at this time of year nearly all the larvae are found in a sample of this size.

The insecticides were obtained as follows: aldrin, dieldrin, and endrin from Shell Chemical Co., Vancouver, B.C.; heptachlor from Velsicol Corp., Chicago, Ill.; toxaphene from Stauffer Chemical Co., Portland, Ore.; DDT from Buckerfield's Ltd., Vancouver, B.C.; lindane from Commercial Chemicals, Vancouver, B.C.; malathion from American Cyanamid, New York, N.Y.; and diazinon from Geigy Agricultural Chemicals, New York, N.Y.

Results and Discussion

Greenhouse Tests — None of the insecticides tested in 1956 gave adequate control (Table 1). The fewest larvae of *S. obscurus* were recovered from soil treated with DDT or heptachlor at 10 lb per acre, but the reduction was not adequate since 37 and 47%, respectively, survived. The toxicity to *B. sulcatus* of these materials was verified when larvae failed to survive in any of the treated soils, but in the untreated soil 29% survived. This is a high average survival rate for the species. An exception was DDT, which does not affect larvae of *B. sulcatus* even at 10 lb per 6-inch acre (unpublished data).

In 1957, none of the insecticides adequately reduced the survival of larvae below that of the untreated soil for either species (Table 1). With *S. obscurus*, lindane at 1 lb per acre was significantly better than diazinon at 5 pounds, but the reduction was inadequate. Larvae of *N. incomptus* were not affected by any of the treatments (Table 1), and with a single exception the lowest survival of larvae was in the untreated soil. Some biological control factor may have been more active here in untreated than in treated soil.

Earlier field observations indicated that strawberries on soil treated with lindane at 1 lb of toxicant per 6-inch acre were not attacked by *N. incomptus*. Since introduced larvae in pot tests were not affected it may be that the flightless adults are repelled from, or inhibited from ovipositing on, strawberries in soil treated with lindane. Aldrin or heptachlor at 5 lb combined with lindane at 1 lb per acre significantly reduced the numbers of *S. obscurus* larvae (Table 1), but still 34% survived.

Field Tests — Significantly fewer larvae of *S. obscurus* were recovered from the first plant of untreated rows than from many of the treated rows (Table 2). *S. obscurus* appeared to survive better in treated soil (33% average survival) than in untreated soil (13%). There were no significant differences between treatments of the second plant in each row, which was infested later. In 1957 a natural population of *B. sulcatus* infested the untreated but not the treated rows.

TABLE 2—Larvae of **S. obscurus** recovered in 1957, 8 months after 50 first instar larvae per plant were placed on the soil around strawberry plants in field plots treated with soil insecticides.

Soil[1] and/or root[2] treatments	Number of larvae[3] First plant	Number of larvae[3] Second plant
Heptachlor EC+root	25.0 a	15.8 a
" 2½% gran.	22.5 ab	13.8 a
Dieldrin EC	20.8 abc	14.2 a
" EC+root[4]	20.2 abcd	17.0 a
Heptachlor EC	19.8 abcd	14.2 a
Aldrin 2½% D+root	18.8 abcd	11.2 a
" 2½% D	16.8 abcd	22.5 a
Heptachlor 2½% G+root	16.5 abcd	8.5 a
Dieldrin 2% G	16.0 abcd	14.8 a
" 2% G+root	14.5 bcde	19.2 a
Heptachlor root only	14.5 bcde	11.5 a
" 2½% D	12.8 bcde	18.8 a
Aldrin root only	11.0 cde	10.2 a
Heptachlor 2½% D+root	10.8 de	16.0 a
Untreated	5.0 e	8.0 a

[1] Dusts, sprays, and granules were applied to the soil in a 10-inch band to rows 3 ft. apart at 1.4 lb toxicant per acre for all treatments except heptachlor granules at 2.1 lb and rotovated to a depth of 6 inches.

[2] Roots treated with 5 lb or appropriate dust per 10,000 plants.

[3] Means of 4 replicates. Means followed by the same letter are not significantly different at p=.05 (Duncan, 1955).

[4] Dieldrin 2% dust.

There were no apparent phytotoxic symptoms from the insecticides tested in the greenhouse or field. The plants infested with larvae of either *S. obscurus* or *N. incomptus* were severely damaged.

Summary

The root weevils *Sciopithes obscurus* Horn and *Nemocestes incomptus* (Horn) are indigenous to the Pacific Northwest. Both are serious pests of strawberries but cannot be controlled with organochlorine soil insecticides at ordinary dosages on southern Vancouver Island or in the lower Fraser Valley. In commercial fields, populations were not reduced by treatment with aldrin or heptachlor at 5 lb, dieldrin at 3 lb, or chlordane at 10 lb of toxicant per 6-inch acre. In potted soil treated with insecticide dusts and artificially infested, first instar larvae survived treatment with heptachlor, aldrin, dieldrin, or DDT each at 5 or 10 lb toxicant per 6-inch acre, toxaphene at 10 lb, endrin at 1 or 2 lb, or lindane at 0.5 or 1 lb. *S. obscurus* survived in soil treated with the organophosphates diazinon or malathion at 5 lb, but a combination of 1 lb of lindane with aldrin or heptachlor at 5 lb reduced the numbers of larvae by 66%.

When introduced into field plots, from 2 to 5 times more larvae of *S. obscurus* were recovered in the treated than in the control plots where the treatments were: 1.4 lb toxicant per 6-inch acre of aldrin or heptachlor dust, dieldrin or heptachlor spray, or dieldrin granules. These were applied either alone in a 10-inch band to rows 3 ft apart, or combined with 5 lb of appropriate dust per 10,000 plants. Heptachlor granules at 2.1 lb were ineffective.

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NOTES ON THE LIFE HISTORIES OF ONE BUTTERFLY AND THREE MOTHS FROM SOUTHERN VANCOUVER ISLAND (LEPIDOPTERA: NYMPHALIDAE AND PHALAENIDAE)

George A. Hardy[1]

Phyciodes mylitta Edw.

This species was first recorded from Vancouver Island at Goldstream in 1961 (Hardy, 1962). It has occurred since in the same general area, thus indicating a permanent addition to the fauna of Vancouver Island. *P. mylitta* is a small butterfly with a wing span of 30 to 33 mm for the female and 25 to 28 mm for the male. The upper surface of the wings has a yellow-fulvous base on which is imposed an intricate pattern of dark brown lines and dots, closer together and darker in the female than in the male.

Its flight is gliding with little vertical wing movement, though it can be swift and erratic, when the insect seems to vanish in mid-air. It haunts low sun-lit meadows and moist places with thistles, which are the food plants.

P. mylitta has a long period of flight; my earliest record is April 23, and the last September 18. It is most often seen in July and August. There are two generations. Larvae of the second brood appear in July, overwinter in the penultimate stage, and give rise to the first brood next April. In confinement there was an incipient third brood. A larva hatched on Angust 7, pupated on September 1 and emerged on September 22.

The eggs are laid near the tips of thistle leaves, *Carduus arvense,* on the upper or lower surface, in batches of 80 to 180, in a single or double layer. These notes start with ova laid on May 13, 1963.

Ovum

Size 0.50 mm by 0.50 mm. A smooth truncated cone with rounded sides, summit depressed, the upper part with 25 ribs, the lower third reticulate; the colour a pale pastel green, very inconspicuous, even in masses, on the surface of the leaf, changing through light to dark grey at maturity. Hatched May 25.

Larva—1st Instar

Length 1 mm. Head shiny, black with a few scattered short hairs. Body translucent, pale whitish, soon becoming a sordid grey, with minute black setae on the tubercles. Escaped through the top of the ovum, consumed the chorion, and fed gregariously on the epidermis of the underside of leaves.

2nd Instar

June 8. Length 3 mm. Head, as described. Body, with prominent hairy spines arising from the tubercles; colour black with a faint darker dorsal line.

3rd Instar

June 14. Length 7 mm. Head as described. Body black with a subdued greyish marbling on the lower sides.

4th Instar

June 20. Length 12 mm. Head as described. Body dull, black, faintly speckled with biege, with a dark dorsal line and white dots on the anterior base of spines along the subdorsal line; the spines on the spiracular band tinged with lemon yellow. The spiracular band consisting of two thin parallel lemon yellow lines, the spiracles black, ringed with bluish black; the under side pale grey. They readily dropped from the food-plant when disturbed, curling into a ring and remaining so for a time. At maturity they were 20 mm long. Just before pupation they suspended themselves from silken mats on the sides or top of the container, to remain for two or three days before pupating on June 29.

[1] Provincial Museum, Victoria, B.C. (Rtd.)

Pupa

Size 12 mm by 4 mm. Dull; the fore part abruptly square, A.3 to A.6 with conspicuous transverse ridges on the dorsal side, the antennal sheaths brown with a row of white dots indicating the segments; the wing-cases brown with two short rows of whitish dots near the hind margins. The ground colour of the pupa was biege thickly flecked and vermiculated with brown; cremaster a group of very fine setae with recurved tips on a short cylindrical base at the tip of the last segment.

Imago

Emerged July 15, 1963.

Remarks

Having failed hitherto to bring larvae through the winter, two larvae were placed in a jar indoors with a few leaves of the food plant on December 7, 1963. They fed sporadically but were less sluggish than those outside. One moulted on December 13, continued to feed and grew to a length of 20 mm. It pupated on January 5, 1964. The other moulted on January 5, pupating on January 26.

Normally the last moult would have taken place in the spring when the thistle was making new growth. In confinement only the two kept indoors ate *C. lanceolata,* which was the only thistle leaf available at this time of year. The summer brood completed the cycle in four instars, whereas the fall generation had five.

Xylomiges perlubens Sm.

Ten species of this genus are listed for British Columbia, of which seven are known to occur on Vancouver Island. It has a wing span of 38 to 40 mm. The primaries are patterned with contrasting browns and greys and the secondaries are white. It is attracted to artificial light from April to June.

Ova were laid on May 6 and 7, 1961, in a heap of several layers to the number of 400. Another lot was laid on April 30, 1962. These notes were made from observations on both groups.

Ovum

Size 0.95 mm to 0.50 mm. A flattened sphere, with about 40 fine ribs and cross-ribs; pale green at first, soon developing a thin ring of tiny brown dots on the upper part and a brown dot on the micropyle. At maturity the ovum was a dark lead grey. Hatched May 15.

Larva—1st Instar

Length 2 mm. Head pale honey colour with a few large black dots. Body translucent, whitish, coarsely hairy from prominent black tubercles. They were very active, moving fast in looper fashion, making use of a silk thread if dislodged. They fed on *Cornus occidentalis, Prunus demissa,* and were reared on *Amelanchier florida.*

2nd Instar

May 22. Length 6 mm. Head shiny, pale whitish brown dotted with black. Body dark olive green, the dorsal and subdorsal lines thin bluish white, the spiracular line broader and of the same colour; tubercles black, larger on A. 9; the underside concolorous with the upper; the legs pale brown and claspers semi-translucent.

3rd Instar

May 28. Length 10 mm. Head smooth, shiny, opaque, whitish, sparsely dotted with black. Body fuscous with an olive tinge; the dorsal and subdorsal lines milky-white; the spiracular band white threaded with rust brown; venter and sides of the claspers dotted with black.

4th Instar

June 12. Length 20 mm. Head whitish brown with sides reticulated with darker brown and a pair of short vertical bars on the vertex. Body as described, with the venter sordid grey-green, the legs and claspers semi-translucent, the claspers having three black dots on the outer side.

5th Instar

June 25. Length 25 mm. Head light brown with four large and many small black dots on the front, reticulate on the sides. Body brownish grey due to fine, close mottling of brown on a light grey background, the dorsal and subdorsal lines thin and whitish, cervical plate brown with three white lines as extensions of the dorsal and subdorsal lines. The spiracular band white threaded with rust brown and a short transverse brown bar on A.9. The spiracles black, tubercles small, black on the inner, white on the outer sides; venter, legs, and claspers sordid.

6th Instar

July 5. Length 30 mm. Appearance as described, the colour more concentrated into bands with the dorsum red-brown, the sides darker with a fuscous tinge, the dorsal line brown and broken; the spiracular band greyish threaded with sienna brown, the tubercles indicated by white dots. Individuals varied in shade and intensity of pattern. The length of full growth was 40 mm. When disturbed they would curl into a ring. Just before pupation they constructed hard - walled cocoons with earth and small stones incorporated outside but very smooth within. Pupated about the end of July.

Pupa

Size 16 mm by 5 mm. The wing cases smooth, shiny, fuscous, almost black. The A. segments finely punctate anteriorly, dark brown; cremaster two closely approximated short hairs with recurved tips having a few much smaller ones at the base, set directly on the rounded tip of the last segment.

Imago

Emerged April 14 to 29, 1963.

Pleroma cinerea Sm.

Four species of *Pleroma* are recorded for British Columbia, three of which occur on Vancouver Island (Jones, 1951). However, two of these have been shown to be forms of a single species (Hardy, 1962).

With an average wing expanse of 33 mm, the moth is light grey with an oblique dash of darker grey extending from the apex to near the inner margin. In Saanich it comes occasionally to light during September and October and may do so wherever the food plant, *Symphoricarpos racemosa,* grows.

A specimen caught on September 23,1962 laid about 30 ova scattered irregularly in a chip box.

Ovum

Size 1 mm by 0.90 mm. A depressed, rounded cone, flat at the base, with 30 coarse ribs, cream coloured, soon changing to a duller shade and irregularly marked with reddish lines and dots. These increased in intensity as development proceeded and the background took on a leaden hue towards maturity. Hatched February 16, 1963.

Larva—1st Instar

Length 4 mm. Head smooth, shiny, obscurely mottled light and dark brown. Body smooth, lead grey, with a few scattered hairs. They readily used suspensory threads when disturbed, and fed on newly opened buds of *Symphoricarpos racemosa.* By February 22 the length was 7 mm with a hump on A.8 and the colour was a very pale brown; the dorsal and subdorsal lines white; the hair-bearing tubercles black.

2nd Instar

February 25. Length 8 mm. Head ash grey, lightly dotted with black. Body slender with a slight hump on A.8 and a black band along the dorsum containing the white dorsal line which is interrupted on A.1 to A.3. The sides grey with a white line between the white spiracular line and the dorsal area and having a wider area of grey between A.1 and A.7; the venter dusky, legs and claspers dusky with a bluish tinge. They rested along the twig with the head stretched out in line with the body, when they were very inconspicuous; the head resembles an unopened bud of the food plant.

3rd Instar

March 2. Length 12 mm. Head quadrate, smooth, light grey, with a vertical suffused bar of light brown; this was darker above and in the centre, on each side of the front close to the sutures; the sutures indicated by dark lines; sides of the head dotted with black. Body tapering towards the head, with a decided hump on A.8; T. segments and A.8 and 9 dark velvet-brown connected by a broad dorsal band of the same colour; the sides of A.1 to A.7 light grey; a conspicuous white dorsal line interrupted on A.1 and 2, more evident on A.7 and 8; spiracular line white, more evident on T. segments and A.7 to A.9; venter dark brown; the claspers grey with a large round spot on the outer side.

4th Instar

March 9. Length 25 mm. Head as described. Body smooth; the laterally compressed hump on A.8 becoming more prominent as growth continued; colour and markings as described, but with many additional fine, suffused dark lines along the sides; the spiracular line white, very faint on A.3 to A.6; the spiracles small, white, ringed with black; venter pale with a dark central line.

5th Instar

March 15. Length 35 mm. Head as described. Body generally brown, lighter on the sides; the dorsal line white threaded with reddish on T. segments and A.7 and 8; the spiracular line cream; venter grey with a dark central line.

March 20. Length 40 mm. Colour in general lighter, with less contrast between the T. segments and A.7 and 8; the dorsum of A.1 to A.7 with a band of light grey-brown constricted between the segments. The larvae rested stretched out along the stem by day and fed by night. Length just before pupation 45 mm. They spun tough cocoons among the twigs, pupating about March 25.

Pupa

Size 16 mm by 4 mm. Smooth, dull, fuscous, with wing-cases minutely and closely vermiculated with impressed lines. A. segments fuscous with anterior margins encircled by a row of short longitudinal ridges; cremaster a rugose, truncate, dorsoventrally flattened process on the dorsal side of the last segment having 3 pairs of minute spines in series from base to summit.

Imago

2 emerged August 28, 1963. One on September 14.

Remarks

There is close resemblance between the larvae and pupae of *P. cinerea* and *P. conserta*. The pupae, with rows of short ridges, are characteristic. Most pupae of the family are punctate on the A. segments. It would be of interest to know if *P. bonuscula,* a mainland species, has the same larval and pupal resemblance.

Dryotype opina Grt.

This species seems to be the only North American member of the genus, and is recorded only from the western part of the continent. Originally it was dsecribed by Grote in 1878 from California under the generic name of *Valeria.*

The alar expanse is 33 to 35 mm. The primaries are dark fuscous-brown relieved by lighter lines and bands, with a small, conspicuous and characteristic vertical, slightly curved white reniform line; the secondaries are whitish shading to grey on the hind margins, and containing a dark dot in the centre, with a curved dark line parallel to the margin. It occurs frequently in light and sugar traps in the Royal Oak district in September.

A batch of about 60 ova were laid on September 21, 1956, and again in September, 1962; about 270 were laid September 29, 1963. They were deposited in clustered masses or scattered indiscriminately on the sides or bottom of the containers and in crevices. The ova were kept in an open shed. In each case the larvae emerged in late December or early January. They were overlooked at first and the 1962 batch were nearly missed also but one was reared to maturity in *Vicia* species. The 1963 batch were taken in time and two were brought to the pupal stage, feeding at first on *Vicia* and on a garden mint, *Mentha rotundifolia,* in the later stages.

The following notes are combined from the 1962 and 1963 groups, the dates referring to the last-named.

Ovum

Laid September 29. Size 0.75 mm by 0.50 mm. A squat connate sphere with about 24 coarse ribs connected by cross-ribs; cream coloured, soon becoming blotched and streaked with light red-brown, including a patch on the micropyle. By November 1 it was very dark fuscous with the black head showing through the top. Hatched December 24, 1963.

Larva—1st Instar

Length 2 mm. Head large, smooth, dark brown. Body, cervical plate similar, rest of body semi-translucent, pale brown or green with short, light brown hairs on prominent black tubercles.

2nd Instar

January 3, 1964. Length 5 mm. Head apple green. Body green; the dorsal and subdorsal lines thin, milk-white; the spiracular band broad and white, with an irregular fine white line between the dorsal, subdorsal and spiracular lines; tubercles small, black, white-ringed, each bearing a short hair.

3rd Instar

January 12. Length 12 mm. Head and cervical plate smooth, shiny, light green. Body green, darker above the spiracular line, minutely freckled with whitish dots, the dorsal and subdorsal lines doubled and dark green; spiracular line white, sharply dividing the dark green sides from the lighter apple green below; legs and claspers green; tubercles as described.

4th Instar

January 18. Length 18 mm. Head green with a brownish tinge. Body purple-brown above, thickly freckled with lighter specks, venter apple green; spiracles very small, black and ringed with white, otherwise as described. Some larvae remained green in later instars.

5th Instar

January 26. Length 25 mm. Head smooth, dull green faintly tinged with brown, having a few short hairs on front. Body, cervical plate greenish, the rest smooth and cylindrical; dorsum pale sienna brown due to minute white and brown freckles on a green base, the brown predominating; dorsal and subdorsal lines dark brown threaded with white; spiracular line thin and white; venter apple green thickly freckled with minute white dots, otherwise as described. Hid by day, fed by night.

6th Instar

January 30. Appearance as described, the upper side dark brown, sometimes with a greenish suffusion on the T. segments; the dorsal line solid dark brown; subdorsal lines very thin on the middle of the segments but thicker in the inter-segmental areas; the same feature was on a line bordering the dorsal side of the white spiracular line.

At maturity the length was 35 mm. Pupated on February 18, 1964, in a slight cocoon spun among the debris at the bottom of the jar.

Pupa

Size 15 mm by 5 mm. Smooth, shiny, dark brown, with wing-cases minutely vermiculated; the anterior borders of the A. segments finely and closely punctuate; cremaster two fine spines with slightly recurved tips set on a dorso-ventrally flattened rugose base at the tip of the last segment.

Imago

Emerged September.

Remarks

From the evidence it would appear that ova laid in September hatch in late December or early January; the larvae feed or become dormant according to the state of the weather. A larva taken at large in June pupated June 6 and emerged September 17.

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ANNOTATED LIST OF FOREST INSECTS OF BRITISH COLUMBIA PART XII, BOARMIINI AND MELANOLOPHIINI (GEOMETRIDAE)[1]

B. A. SUGDEN[2]

Larvae of these tribes are often twig-like, marked with shades of grey, red or brown with prominent tubercles or humps; some are green with no prominences. They are defoliators of coniferous trees and broad-leaved trees or shrubs. Infestations of two species have been recorded, however the other British Columbia members of these tribes have not been considered as economically important. Some species overwinter as naked pupae in the duff while others overwinter as small larvae.

Four species of *Stenoporpia,* occurring in British Columbia will be dealt with in a later paper.

Boarmiini

Hesperumia sulphuraria Pack. — *Salix* spp., *Prunus* spp., *Pseudotsuga menziesii* (Mirb.) Franco, *Betula papyrifera* Marsh. (4 records), *Alnus* sp. (1), *Populus trichocarpa* Torr. and Gray (1), *Larix occidentalis* Nutt. (1), *Tsuga heterophylla* (Raf.) Sarg. (1). Distributed generally throughout British Columbia south of latitude 54°. LARVA: 1⅜ inches; head, pale pinkish buff marked with brown or reddish-brown except along cleavage lines; body, yellowish-green, orange or brown; broad reddish-brown or dark brown subdorsal stripe, darkest on thoracic segments; reddish-brown or brown middorsal stripe finely outlined with yellow or pale buff, somewhat obscure on thoracic segments and occasionally on the abdominal segments of paler specimens; prominent subdorsal tubercles on second abdominal segment dark brown, particolored dark brown and yellow or dark brown and orange; spiracles outlined with black; pale yellow or buff ventral stripe.

Anavitrinella pampinaria Gn. — *P. menziesii, Salix* spp., *L. occidentalis* (4 records), *Picea glauca* (Moench) Voss (4), *Populus tremuloides* Michx. (3), *Pinus ponderosa* Laws. (2), *Thuja plicata* Donn (2). Throughout the Interior of British Columbia south of latitude 54°. LARVA: 1⅝ inches; head moderately bilobed, pale cream or buff marked with reddish-brown or dark brown; body, pale reddish-brown or pale grey with dark reddish-brown or dark brown and black markings; dark brown addorsal lines on thoracic segments and at the posterior margin of the first, second

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and third abdominal segments; prominent dark brown or black subdorsal tubercles on the second abdominal segment, and addorsal tubercles on the eighth abdominal segment; spiracles, pale yellow outlined with black; indistinct reddish-brown or pale grey ventral stripe.

Glena nigricaria B. & McD. — *P. ponderosa, P. menziesii, Pinus contorta* Dougl. Throughout the southern Interior south of 51° latitude; common. LARVA: 1¼ inches; head, medium green with dark reddish-brown blotches on sides, white markings above frons bordered on inside by reddish-brown; body medium green with white addorsal lines; reddish-brown subdorsal blotches on first thoracic segment; fine reddish-brown supra-spiracular lines, white subspiracular lines; reddish-brown blotches below the subspiracular line on thoracic and first abdominal segments; venter marked with series of small, reddish-brown dots.

Anacamptodes emasculata Dyar — *Alnus rubra* Bong., *Salix* spp., *Alnus tenuifolia* Nutt. (4 records), *Acer circinatum* Pursh (4), *Shepherdia canadensis* Nutt. (4) and occasionally on other broad-leaved trees and shrubs. South of 55° latitude in British Columbia; common. LARVA: 1⅛ inches; head, pale yellow or buff, heavily marked on the sides to the vertex with bright reddish-brown and a reddish-brown triangle on frons; body color variable, yellowish-green, yellow or orange, dorsum blotched with orange or reddish-brown and marked with a diamond pattern on abdominal segments two to five, dark brown lateral tubercles on second abdominal segment, dark brown to black addorsal tubercles on eighth abdominal segment; spiracles pale yellow outlined with pale orange; venter pale yellow or pale orange.

Aethalura anticaria Wlk. — *Betula* spp., *Alnus* spp., *Salix* sp. (1 record). Central to southern British Columbia, common in the Interior. LARVA: 1 inch; head, purplish-brown with pale buff markings, or pale green marked by light tan; two color phases, pale green or purplish-brown, narrow white addorsal and subdorsal lines; dark phase broadly banded with dark purplish-brown fading towards the venter; some green specimens marked by a broken subdorsal stripe of dark purplish-brown; venter immaculate on green phase, narrow pale buff central line on dark phase.

Ectropis crepuscularia Schiff. — *T. heterophylla, P. menziesii, T. plicata, P. glauca, Abies lasiocarpa* (Hook.) Nutt., *Picea engelmanni* Parry, *L. occidentalis, Picea mariana* (Mill.) BSP., *Picea sitchensis* (Bong.) Carr., *Salix* spp., *Alnus* spp., *P. tremuloides;* also feeds less frequently on other species of trees and shrubs. Common south of latitude 56°; infestations recorded in 1952 at Blue River and Kidd, and in 1960 near Kitimat. LARVA: 1⅜ inches; head, pale yellowish buff marked with dark brown or reddish-brown, black inverted "V" on frons; second thoracic segment swollen; body, pale yellowish-buff or buff; color of markings on dorsum variable, pale yellow or buff middorsal stripe outlined with indistinct brown lines and obscured by a diamond pattern on second to sixth abdominal segments; pale orange or dark brown inverted "V" on dorsum of second abdominal segment occasionally extending below spiracle on darker specimens; orange or brown supraspiracular stripes excepting first thoracic segment; two oval, dark brown subdorsal spots on second thoracic segment united on heavily marked individuals to form a dorsal band; dark reddish-brown or dark brown oblique blotch on abdominal segments two to five, caudad of spiracles, extending to venter; spiracles, pale yellow enclosed by a fine black line.

Melanolophiini

Melanolophia imitata Wlk.—*P. menziesii, T. heterophylla, P. sitchensis, P. engelmanni, P. glauca, T. plicata, Pinus monticola* Dougl., *Abies amabilis* (Dougl.) Forb., *Abies grandis* (Dougl.) Lindl., *A. lasiocarpa, L. occidentalis, Alnus* spp., *Salix* spp.; feeds less frequently on many other trees and shrubs. Central and southern British Columbia, Vancouver Island, and Queen Charlotte Islands; common. Infestations occurred in 1952 and 1960 on Vancouver Island, at Mile 7 north of Revelstoke and near Downie Creek in 1952 and on the Queen Charlotte Islands in 1963. LARVA: 1¾ inches; head, green; body, green, broad white addorsal and subspiracular stripes; spiracles, pale tan each enclosed by a fine brown line; narrow white ventral and subventral lines.

Protoboarmia porcelaria indicataria Wlk.—*P. menziesii, T. heterophylla, T. plicata, A. lasiocarpa, P. engelmanni, L. occidentalis, P. glauca, P. mariana, P. sitchensis, Juniperus scopulorum* Sarg., *P. ponderosa, Salix* spp.; feeds, less frequently, on the foliage of other trees and shrubs. Throughout British Columbia, Vancouver Island and Queen Charlotte Islands; common. LARVA: 1¼ inches; head, pinkish-buff, marked with dark brown; body, pale buff suffused with pinkish-buff on dorsum, dark brown "Y" shaped markings on dorsum of thoracic segments and a diamond pattern bordered by dark brown on dorsum of abdominal segments; prominent dark brown tubercles caudad of spiracles on each abdominal segment; spiracles, buff outlined with black in a pale buff patch, venter pale buff suffused with pinkish - brown, banded by dark brown between the third thoracic and first abdominal segments and first to fifth abdominal segments.

Neoalcis californiaria Pack. — *P. menziesii, T. heterophylla, T. plicata, A. grandis* and less frequently on other western conifers. South of 55° latitude on the Coast and Vancouver Island and rarely in the extreme southwestern Interior. LARVA: 1¼ inches; head, brown or pale reddish-brown marked with dark brown or reddish-brown, venter banded by dark brown or reddish-brown, frons with two small, irregular, dull white spots; body, pale buff or pinkish-buff; pale dorsal line bordered by thin dark brown or reddish-brown lines on thoracic segments, dark brown or reddish "V" markings on thoracic segments two and three; pale inverted "V" pattern separated by dark brown or reddish-brown bands on abdominal segments one to six; indistinct diamond pattern on abdominal segments seven and eight; prominent dark brown or reddish-brown dorsal tubercles on abdominal segments one to six, less prominent on segments seven and eight; subspiracular tubercles, particularly prominent on second abdominal segments; spiracular area blotched with dark brown and reddish-brown; venter with a diamond pattern on abdominal segments one to five.

Hypagyrtis nubecularia Gn. — *B. papyrifera, Salix* spp., *Prunus virginiana* L. (3 records), *Corylus* sp. (2), *P. tremuloides* (2), *Amelanchier* sp. (2). Central and southern Interior; uncommon. LARVA: 1¼ inches; head, pale brown marked with dark brown; body, reddish-brown; broken pale buff dorsal line on third thoracic and abdominal segments, indistinct on first two thoracic segments; two pale buff spots bordering dorsal line on abdominal segments one to six; indistinct diamond pattern bordered by dark brown on dorsum, pattern obscured on abdominal segments four and five by dark brown bands separated by a yellowish buff band extending to venter; small irregular yellowish buff patch above and caudad of spiracle on first abdominal segment; spiracles yellowish buff outlined in black; venter, pale buff marked with dark brown, venter of fourth abdominal segment broadly banded with dark brown.

Hypagyrtis piniata Pack.—*P. menziesii, T. heterophylla, L. occidentalis, P. contorta, P. engelmanni, T. plicata, A. lasiocarpa* (3 records), *P. ponderosa* (3). Central to southern Interior; common. LARVA: 1⅛ inches; head, bright reddish-brown with transverse dark brown bands; body light reddish-brown, pale yellow or buff, diamond pattern on dorsum except on first thoracic and ninth abdominal segments; dark brown "V" markings on dorsum extending diagonally to the venter; spiracles, pale reddish-brown outlined with black, located centrally in the dark brown diagonal band; venter marked by irregular bands of dark brown.

Eufidonia notataria Wlk. — *P. contorta, A. lasiocarpa* (1 record), *Larix laricina* (Du Roi) K. Koch (1). Central Interior; rare. LARVA: 1 inch; head, green with grey dots forming a herringbone pattern on vertex and sides; body, yellowish-green, fine grey green dorsal, addorsal and subdorsal lines; white spiracular stripe; thin red subspiracular line; spiracles pale yellow outlined with red; venter pale green with yellowish-green mid ventral line.

Eufidonia discospilata Wlk. — *Salix* spp.; *Alnus* sp. (1 record). Central Interior and central coastal regions; rare. LARVA: similar to *E. notataria.*

OCCURRENCE OF THE SMALL BLACK ROOT WEEVIL, *Trachyphloeus bifoveolatus* (BECK) (COLEOPTERA: CURCULIONIDAE), ON STRAWBERRY IN BRITISH COLUMBIA[1]

W. T. Cram

In mid-June 1964, a large adult population of a European root weevil, *Trachyphloeus bifoveolatus* (Beck)[2], was discovered[3] near Abbotsford in the Fraser Valley, feeding voraciously on the foliage of a newly set, 24-acre planting of strawberry (var. Northwest). This soil received a pre-planting treatment with insecticide at the recommended rate for the control of Brachyrhinus root weevils (Cram, 1962). The adults of *T. bifoveolatus* were found in groups of up to 50 on the surface of the dry, light soil, usually beneath leaves but sometimes fully exposed to the sun and drying wind. Some adults were feeding on the leaflets during the daytime which indicates that they can tolerate desiccating conditions. The foliage was so damaged that often only the mid-ribs of trifoliate leaves remained. Feeding notches were also noted in leaves of clovers, narrow leaf plantain and sheep sorrel or sour grass. Many adults were taken beneath these other plants. The evidence suggests that this introduced weevil has become established in old pastures and attacks strawberry when the pastures are broken up and planted. The field in question had been in oats for the two previous years and in pasture for many years before that. This occurrence is the first record of the species as a pest of strawberry in British Columbia.

Rosenstiel (1963) reported that in recent years this weevil, which he

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2 Determined by W. J. Brown, Entomology Research Institute, Ottawa.

3 Thanks to the vigilance of I. C. Carne, Horticulturist, British Columbia Department of Agriculture, Abbotsford, B.C.

calls the small black or grass weevil, has become increasingly abundant as a pest of strawberry and some nursery crops in the Willamette Valley and coastal counties of Oregon. In Canada, the species has been observed as numerous but not a pest in Nova Scotia, New Brunswick, Prince Edward Island and Ontario; a single specimen was taken in Fernie, British Columbia (Brown, 1940, 1950).

In the Fraser Valley, adults have been taken in abundance in recent years at windows in homes during the fall and spring. Their occurrence here is fortuitous, for like other root weevil adults they have the annoying habit of entering homes in late summer and fall.

The extent of damage to roots by the larvae is not known, but Rosenstiel (1963) considers that control is necessary and recommends a spray of Guthion in July. At Abbotsford, a satisfactory kill of adults was obtained using malathion with DDT applied in mid-June at field rates. In preliminary laboratory tests adults were readily killed with field rates of Guthion and malathion but not with diazinon or DDT.

The adults are not easy to find. They are only 3 mm long and usually are so coated with soil as to be virtually indistinguishable from small soil particles.

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THE CIGARETTE BEETLE IN VANCOUVER (Coleoptera: Anobiidae)

G. J. SPENCER[1]

In 1961, the dried, partly cleaned skeleton of a small monkey was sent from Malaya in a heavy plastic bag, to the university department of Zoology. More than six months later small beetles emerged from the hard, dried flesh on the bones. From the carcass I obtained a good series of *Lasioderma serricorne* (Fabr.) (Anobiidae) the cigarette beetle. This was the first time I had recorded the insect in the province.

In October, 1962 I received an enquiry and soon after some specimens of cigarette beetles from a medical doctor in New Westminster who reported "insects in numbers all over the house." The breeding place was in a 2 lb. bag of bran from which the infestation had spread to a contiguous bag of corn meal. Both materials had come from the food section of a large department store to whose manager I reported the seriousness of the situation; the man was furious, taking it to be a slight upon his department. I reported it to the owner of the store who appreciated the matter and apparently took steps to remedy it because there have been no further complaints.

The beetles are slightly larger and about one-and-a-half times as broad as the drug store beetle with the same cowl-shaped prothorax which nearly conceals the hypognathous head. The elytra are smooth and not grooved lengthwise as are those of the drug store beetle. When disturb-

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ed, the adults feign death but quickly become active and fly very readily.

I cultured them on various foods: pipe tobacco alone; powdered, peletted, small-animal food containing many ingredients reported to constitute a balanced ration; a mixture of pipe tobacco and pellet-powder; and a brand-name cat food, dried and powdered. Each culture formed a flourishing colony, the weakest being that on tobacco alone and the strongest, that on the mixture of tobacco and pellet powder.

The third record of this beetle occurred in February 1963 in the catch-basins of proprietary electric light traps which had electrocuted a considerable number of flies on whose dried bodies the beetles were developing. The traps had been installed around a paper mill where they functioned more to attract insects, especially moths, into the buildings, than to keep the buildings free from them.

The fourth record was in April, 1963, in the roots of *Adenophora verticillata* (Campanulaceae). The fleshy, white roots of this plant are used medicinally and in soups by Chinese, who import the material from Hong Kong; so this infestation may have come from the Orient. These adults were larger on the average than those from other sources. It is likely that the insects had spread to other commodities in the shop from which the roots came.

The fifth record came from a house in Abbotsford, in October, 1963. These specimens were the smallest of any and were reported to be emerging in numbers every day from one article of a two-piece chesterfield set which the owner had acquired two years before.

This beetle has been recorded breeding in tobacco, cigars, and cigarettes with a high sugar content, in furniture upholstered with flax, tow or straw, in seeds and other dried plant products and in black and red pepper (1). To these must be added my records of dried meat and insect bodies.

Metcalf *et al.* (1) recommend heat of 130° to 135°F for at least six hours to allow the heat to penetrate upholstering. In the cases recorded here I have recommended placing the breeding material overnight in deep-freeze compartments and for the upholstered chair, leaving it in a deep-freeze food locker for 24 hours.

It appears that the insect finds the climate of this part of the Province suitable for its development. I see no reason why it should not become another widespread household pest.

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NOTES ON DISTRIBUTION AND HOSTS OF THE WEEVILS *Pissodes schwarzi* HOPK. AND *Pissodes curriei* HOPK. IN BRITISH COLUMBIA AND YUKON TERRITORY[1]

R. O. WOOD[2]

Several species of the genus *Pissodes* are commonly found in British Columbia; interest in two of these, *Pissodes schwarzi* Hopk. and *P. curriei* Hopk., was heightened after new host records were established recently.

On August 19, 1960, nine teneral adults of *P. curriei* were obtained from pupal cells in the root collar of a two-inch dbh lodgepole pine, *Pinus contorta* Engelm., growing at 2,500 feet elevation 30 miles north of Grand Forks. This tree had sustained previous mechanical damage. Teneral adults of *P. schwarzi* were found in the root collars of blue spruce, *Picea pungens* Engelm., in 1960, at a nursery near Creston. The weevils apparently had caused some tree mortality. Identifications were obtained through Dr. S. G. Smith of the Cytology and Genetics Section, Forest Insect Laboratory, Sault Ste. Marie, Ontario.

In 1962, 59 dead or dying saplings of western white pine, *Pinus monticola* Dougl., (up to two inches basal diameter) were examined at elevations ranging from 1,500 to 3,800 feet at 13 locations in the Upper Arrow Lake and Columbia River watersheds. All these trees had been infected with blister rust or root rot; 18 contained weevil larvae, pupae, or teneral adults in or about the root collar. These were identified as *P. schwarzi* and *P. curriei*. In some instances, both species were inhabiting the same root collar.

To determine the distribution of the two species, the locations of Forest Insect and Disease Survey collections were mapped. Figure 1 shows that *P. curriei* occurs north to the Skeena River, and from Vancouver Island to the Alberta border; *P. schwarzi* has been recorded from the U.S. border to Mile 932, Alaska Highway, Yukon Territory, but not on the Coast. Adult weevils from random beating collections were identified by W. J. Brown, of the

TABLE 1—Perching records of **Pissodes curriei** and **P. schwarzi** from conifers in British Columbia and Yukon Territory.

Tree species	No. collections	
	P. curriei	**P. schwarzi**
Western white pine	26	19
Lodgepole pine	27	41
Ponderosa pine	6	7
Whitebark pine	0	1
Engelmann spruce	1	1
Black spruce	0	1
White spruce	0	2
Sitka spruce	1	0
Douglas fir	1	0
Western larch	1	1
Totals	63	73

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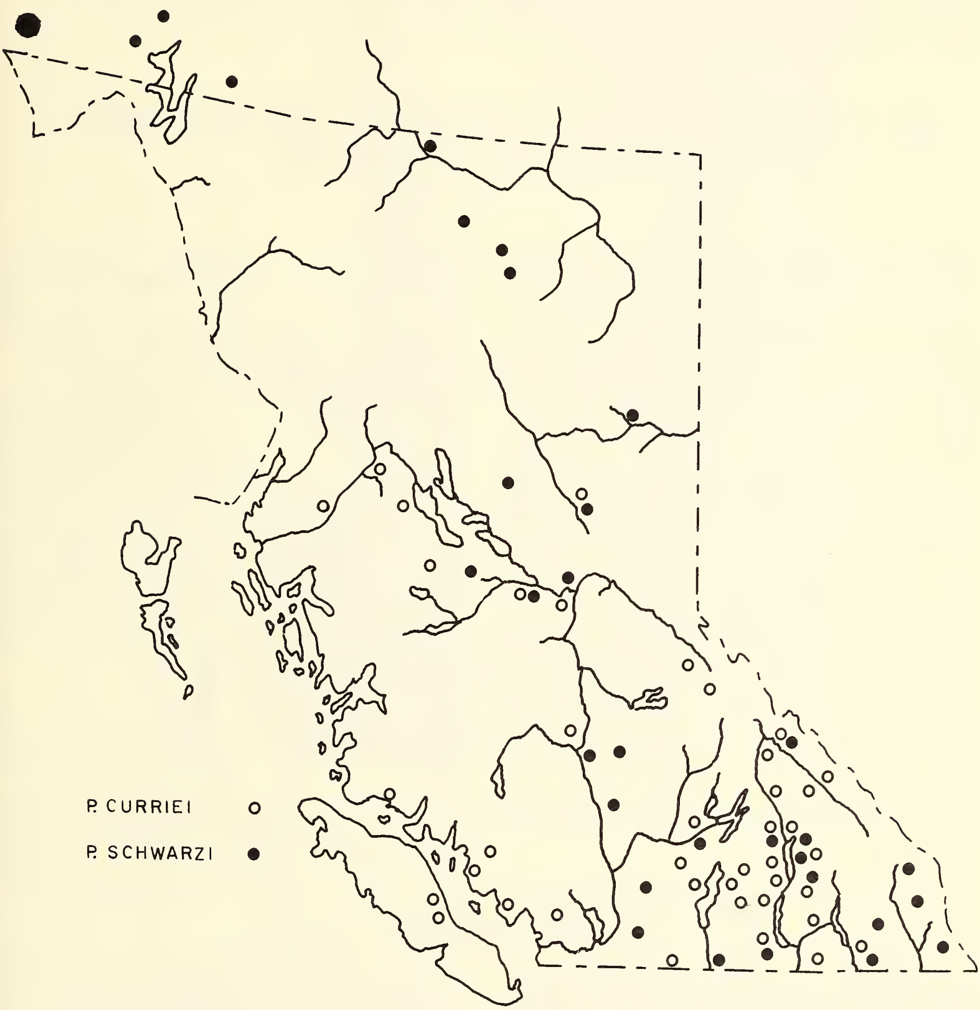


Fig. 1.—Location points of collections of **Pissodes** spp. in British Columbia and Yukon Territory.

Entomology Research Institute, Department of Agriculture, Ottawa. Perching records from these collections are shown in Table 1.

The presence of larvae and pupae of *P. schwarzi* and *P. curriei* in the root collars of western white and lodgepole pine, and teneral adults of *P. schwarzi* in the root collars of blue spruce establishes new host records for both species. The perching records indicate that the weevils are active over a large part of British Columbia and may have more hosts than has yet been determined.

Altica tombacina MANNERHEIM (COLEOPTERA: CHRYSOMELIDAE), A SERIOUS PEST OF FIREWEED

M. D. ATKINS[1]

Fireweed, *Epilobium angustifolium* L., provides the main honey crop for apiarists who move their bees from spring to summar foraging areas. This practice of migratory beekeeping is common among both large and small beekeepers on Vancouver Island. The colonies are overwintered in areas where the climate is moderate and where early blooming plants provide the necessary nectar and pollen for early and rapid buildup of the hives. Later, the bees are transported to logged areas where dandelion, *Taraxacum* sp., and fireweed, bloom in profusion throughout the summer and early fall. Profitable honey production depends largely upon the health of the fireweed and if conditions are suitable crops in excess of 200 pounds per hive are common.

In July, 1964, a local apiarist notified me of an area where the fireweed was suffering heavy damage as a result of a high population of small black larvae. These were identified as the immature stages of a flea beetle, *Altica tombacina* Mannerheim. Eggs and several larval instars were present on the plants at this time. Warm weather during the third week of July which would normally have resulted in an excellent honey flow, accelerated the development and feeding of the beetle larvae. Within a few days the fireweed was severely defoliated. Approximately two thirds of the plants over an area of about ten square miles were damaged, many to the extent illustrated in Figure 1.

All of the larvae brought into the laboratory in July pupated during the first week of August so the infestation was revisited on August 10. At that time the number of larvae feeding had declined noticeably, but was still from 70 to 200 per stalk. No other species of plant was heavily damaged, but evidence of light feeding and a few larvae were found on young roadside alders.

During the August 10 visit, an examination of representative hives among the 200 distributed throughout the infested area revealed that almost no excess nectar had been gathered and most of the foraging bees were visiting dandelion. Subnormal weather had also affected honey production, but sufficient suitable flight weather had occurred to produce some capped honey. An area of the size infested could normally support 1,000 colonies on a commercial basis. In 1964, the 200 hives present produced much less honey than could be expected. The loss of revenue to the beekeeper that could result from such an infestation is difficult to evaluate, but there is little doubt that as the competition for fireweed areas grows more acute, *Altica* could be an important factor in commercial honey production.

[1] Forest Entomology and Pathology Laboratory, Victoria, B.C.

Fig. 1.—A healthy stalk of fireweed and one damaged by larvae of the flea beetle **Altica tombacina** Mannerheim.

EDITOR'S NOTE

A newly set and bound second edition of the Style Manual for Biological Journals appeared in 1964, published by the American Institute of Biological Sciences. The 1960 edition ran through two printings. Since this society voted to adopt the AIBS Style Manual at the 63rd annual meeting at Kamloops, in March, 1964, it is fitting that the new edition be drawn to the attention of contributors.

In the new preface the committee points out that the most extensive changes are in the abbreviations of words used in literature citations. These are in line with the policy proposed by the American Standards Association. Their adoption represents another step forward and away from the maddening diversity of styles that formerly wasted the time of authors and editors.

Contributors with access to the Manual should by all means use it. For those to whom it is not available, the Manual is an unequivocal reference and arbiter for editors and reviewers.

GORDON STACE SMITH
(1886-1962) *
"An Insect-Chaser and a Sonnet-Weaver"

Gordon Stace Smith, coleopterist of Creston, British Columbia, was born in Beausejour, Manitoba, October 10, 1886, the eldest child of John Stace Smith (1862-1921) and Jean Horsburgh Grant (1861-1939). His family moved to Salmon Arm in 1890, where Gordon passed his boyhood and where he finished his formal education at the age of 14 in 1901. There followed twenty years of wandering at numerous occupations in many places — stone-quarryman, lumberman, hard rock miner, prospector, mining foreman — a rough, hard, and varied life that gave a wealth of experience but resulted in few worldly goods.

Gordon married Elizabeth Ann Martin (1876-1960) in April 1914 at Phoenix, B.C. His connection with Creston dated from 1921, but he was not continuously resident there until late 1944 or 1945. His interests were varied — literature, postage stamps, Indian artifacts, birds, butterflies— but his most creative work centered in writing verses and in collecting and studying beetles. His verses were collected in three choice volumes: *In the Kootenays and Other Verses* (London, 1930), *Poems and a Reverie* (Toronto, 1940), and *Far West and Book of Sonnets* (London, 1960).

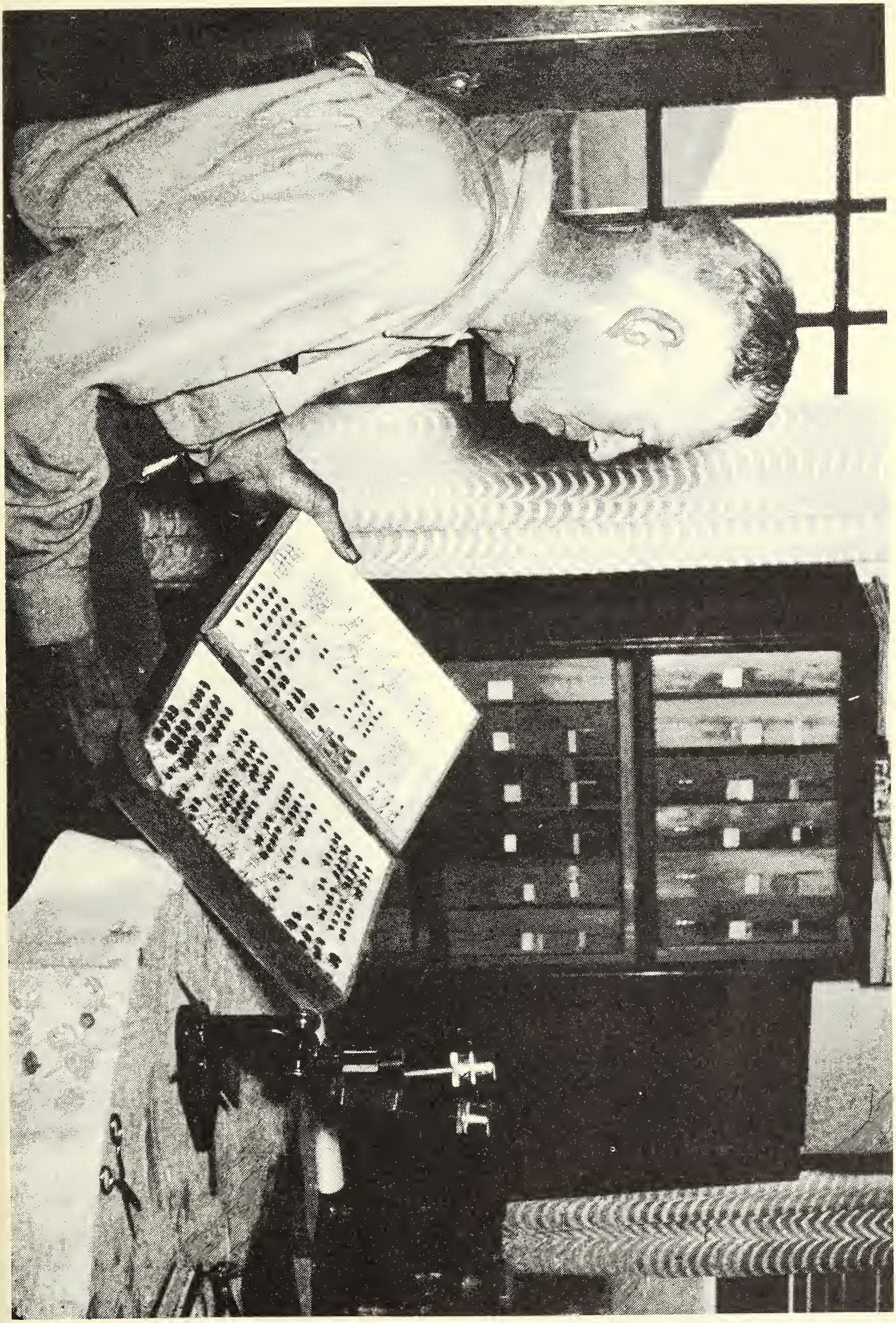
Gordon's interest in beetles dated from the early or middle 1920's. At first, his son tells me, he was compelled to keep his specimens in tobacco tins, cutting out discs of corrugated cardboard to press into the tins to receive the insect pins, and it was a great and happy event when he was able to buy regulation double insect boxes from London.

* For assistance in preparing this note I am indebted to Mr. Stace-Smith's son, Mr. J. Gordon Stace-Smith of Alberni, B.C. It is condensed from a longer manuscript that may be published elsewhere.

From 1927 to 1930 Stace Smith worked at Copper Mountain, B.C., in the eastern Cascade Mountains a little south of Princeton. The result of his collecting at Copper Mountain was Gordon's most important publication, a list of 323 species of beetles that appeared in two numbers of *Museum and Art Notes* (4, 1929: 69-74; 5, 1930: 22-25), published by the Art, Historical and Scientific Association of Vancouver, B.C. By nearly a hundred species this was the longest list of beetles from a single locality that had been published from the Pacific Northwest up to this time. Gordon's other publications consisted mostly of 17 notes in the Proceedings of the Entomological Society of British Columbia appearing between 1945 and 1957.

The years from 1934 to 1944 Stace Smith spent in mining at Duparquet, Quebec, between 48° and 49° north latitude, near Abitibi Lake and only a few miles from the Ontario line. He had by 1934 been pretty much committed to forming a specialized collection of British Columbia beetles. He applied himself vigorously, however, to the Abitibi fauna and eventually gathered a collection of over 16,000 specimens in 45 insect boxes, which he sold to the California Academy of Sciences about 1951.

Mr. Stace Smith organized his collections in the most approved manner, each specimen carefully mounted with full locality and frequently with host plant or other ecological data. Moreover each specimen that had been named by a correspondent bore the name of the identifier and the name or Leng Catalogue number of the beetle, and frequently the same specimen would come to carry several different names. He had a binocular microscope and studied his specimens closely, but most of his



identifications were based on a skillful comparison with specimens named for him by others. His library was insufficient to allow him to go very far on his own.

Gordon was a tireless collector, mostly on foot. He processed his specimens immediately upon returning from the field — mounting or papering or discarding, labeling and identifying and incorporating in his collection the same evening. When he found he had taken something new or rare, he would be back at the very same spot the next day and the day after that and so on, or at the same spot the following year, so that he was frequently able to build up extensive suites of specimens of rare species. Specimens taken in copulation were so marked and in a group like the flea beetles he did not collect specimens unless he could ascertain the host. His collection of British Columbia beetles came to number about 2,800 species in 145 insect boxes. He restricted his series of a species to 20 or 25 specimens, sufficient, however, to allow for specimens illustrating variation and distribution within the Province.

He corresponded widely. In his Copper Mountain list (1930) Ralph Hopping (1868-1941), W. J. Brown, G. A. Hardy, Alan S. Nicolay (d. 1950), and Karl E. Schedl helped with identifications. In 1934 the following additional coleopterists were assisting him: J. B. Wallis (1877-1962), Charles A. Ballon, Kenneth W. Cooper, Frank E. Blaisdell (1862-1946), R. E. Barrett, and John W. Angell (1885-1946). Among other correspondents may be mentioned C. A. Frost (1872-1962), Hugh B. Leech, George Ball, and Carl Lindroth.

The present writer visited Mr. Stace Smith 10 times between 1948 and 1960. His home was modest, even humble—a mile north of Creston overlooking the flood plain of the Kootenay River and the Nelson Range beyond. By the middle 1940's Gordon's collection of British Columbia beetles was the most important collection in the Province and it behooved anyone interested in beetles from this corner of the continent to see what it contained. Among coleopterists known to me to have visited Creston at this time were Hugh B. Leech, W. J. Brown, Mont A. Cazier, M. C. Lane, George Ball, Henry and Anne Howden, Jim Grant, and Carl Lindroth.

Desiring to keep his collection in the Province, early in 1960 Stace Smith sold his collection to the University of British Columbia in Vancouver for $6,000 and was in the process of transferring it at the time of his death. It was said to number 2,800 species in 1959 (Spencer, Proc. Ent. Soc. B.C. 56, 1959: 12). Especially noteworthy was his collection from the vicinity of Creston, which, if my memory serves me correctly, numbered 1,200 or 1,500 species; and it is hoped that the list of these species may be assembled and published.

Mrs. Stace Smith was laid low by paralysis in November 1957 and Gordon's life became troubled. She was taken by air to the home of a daughter in Penticton, B.C. in 1958, where she died March 19, 1960. Gordon continued on in Creston, but seems to have neglected himself. Returning to Creston from a visit on Vancouver Island with two daughters and a son in December 1961 and January 1962, he developed a cold. Entering the Creston Valley Hospital on February 10 in extreme cyanosis, he died on February 19 with a diagnosis of chronic myocarditis, arteriosclerosis, and chronic bronchitis. He was in his 76th year.

—MELVILLE H. HATCH

* For assistance in preparing this note I am indebted to Mr. Stace Smith's son, Mr. J. Gordon Stace Smith of Alberni, B.C. It is condensed from a longer manuscript that may be published elsewhere.

BOOK REVIEW

Insects in Colour, edited by N. D. Riley. Blandford Press Ltd., London. 1963. Pp. 116. 10s 6d or $2.25.

In reviewing this undeniably attractive little hard-backed book, comparison is inevitable with the paper-backed *'Insects'* in the Golden Nature Guide series. In my view *'Insects'* comes out best on the bases of background, coverage, organization and presentation of the subject, size and detail of the illustrations, format, and price.

'Insects in Colour' strikes me as an attempt to cash in on a book already produced for one smallish market by altering it for another. The results are probably better in other books of the same series, covering larger organisms such as: fungi, flowers, shrubs and trees, economic plants, indoor plants, dogs, roses, and wild animals. Here and there the book reveals its international origin. It was first published in Sweden, then in Denmark, then in England and printed in Holland. Although not unidiomatic the writing suffers from inconsistencies and neglect of critical proof reading. There is mention of Ternites and Sconeflies and errors such as accept for except, secret for secrete, and figurus for figures. In descriptions most of the insects are named normally, as aphid, fly, wasp or moth, but sometimes capitals creep in to give Click-beetle and Soldier-beetle, Caddis Fly, Water Boatman, Aphid or even *Aphis* used not in the generic sense. In host plants stinging nettles appear with and without capitals on the same page. There is hop, currant, willow; but Tussock Grass, Sorrel, Potato, Cabbage, and Giant Water Dock.

The scales of measurement are hybrid. Length, or 'length from head to tail' is in mm except for Lepidoptera, Diptera and some Hymenoptera, in which the expanse, or sometimes 'wingspread' or even 'wing spread' is in inches. Even the type face is sometimes non-uniform; The Clouded Border Brindle has an expanse of 1½ - 1 9/10 inches (*sic*) which is untidy and no clearer than 38-50 mm. It is necessary to turn from the picture to the description each time to find the size of an insect.

There are 64 full pages in color and these are very fine, covering 260 species. The printing is adequate and the quality of the colors particularly good. But up to 11 species are on a single page which means that the reduction is so great that detail is lost from wings, tarsi and antennae.

The English names of Lepidoptera are intriguing, perhaps because of the lack of uniformity. The article is placed before some names but not others, and the term moth or butterfly is often missing. Thus names such as Broom Moth, Winter Moth, or Codling Moth hardly rate a second look, but The Dunbar, The Feathered Gothic, The Shark, and The Claddagh certainly do. Then there is something called a Great Brocade (expanse 2½ inches), a Heart and Dart, and best of all, a Setaceous Hebrew Character.

A good deal of information is packed into the short and somewhat telegraphic descriptions of each species. Surprisingly, controls are given for two or three pest species but not for major ones.

The representation is good, even though large forms are emphasized, and includes: 84 Lepidoptera, 81 Coleoptera (13 longicorns), 31 Hymenoptera, 26 Diptera, 12 Hemiptera-Homoptera, 6 Orthoptera, and one or two each of 10 other Orders. This is said to be about 1.3% of the 20,000 known species in the U.K. Protective resemblance and mimicry are illustrated with five examples, and migrants and casual visitors with six. No less than 202 of the species were named by Linnaeus. A quarter of them are found only in southern England or are listed as rare in northern England and Scotland, which must limit the usefulness of the book as a reference.

The introduction, on p. 69, consists of four full pages of close and forbiddingly unbroken print, since the paragraphs are not indented. There is an index and a bibliography of 16 good English titles. It is hard to know for whom the book is intended, however. The dust jacket says it is a handy reference and a useful introduction, but it strikes me as too elementary for a reference and too pedantic for an introduction.

—H. R. MacCarthy

BOOK REVIEW

The Skippers of the Genus Hesperia in Western North America, With Special Reference to California (Lepidoptera: Hesperiidae) by C. Don MacNeill. University of California Press, Berkeley and Los Angeles, 1964. Pp. 221. $5.00.

This work, Volume 35 of the University of California publications in Entomology, presents a meticulous taxonomic treatment of the western members of North American *Hesperia* besides lucid discussions on some phases of their biology based on "—— intimate observation for a limited time upon a limited portion of the fauna." Although the book is chiefly of interest to certain specialists in taxonomy, ecologists and others concerned with biogeographic distribution (11 pp.) and behaviour of adult insects (18 pp.) will find good meat within the section on Biology.

The taxonomy is based on examination of more than 500 ova and 200 larvae and pupae of nine western and two eastern species. Over 7,500 adult specimens were studied representing all known North American species. Details and data on specimens, techniques and methods are fully documented. There are 9 range maps; 28 pages of good diagramatic drawings of larval setal patterns, pupae, antennae, and genitalia; a coloured frontispiece of adults of one species and three subspecies not previously illustrated; and 8 plates of photographs. All these are satisfactory but some of the black and white photographs do not measure up to the general high standard of the book. The writing is polished; the single error noted is that insidious old acquaintance 'data was' used once.

Proof reading was excellent although there are minor errors in the spelling of a couple of British Columbia place names. Faulty labels and failure to consult a gazetteer are sand traps for uncounted taxonomists.

At the end of the book are 258 references by 170 authors dating from 1793 to 1962. Greatly increasing the value of this list is a brief summary of each reference.

The only major disappointment is that there is no indication that material was submitted to a cytogeneticist for examination; apart from this single omission, the book is a model for emulation.

—D. A. Ross

BOOK REVIEW

Pocket Guide to Trees and Shrubs in British Columbia, by E. H. Garman. British Columbia Forest Service Publ. B. 28, 3rd. (revised) edition. Queen's Printer, Victoria, B.C. 1963. Pp. 137. $1.00.

Botany has its taxonomic quicksands, but botanists live in a more manageable world than entomologists, witness the short simple keys in this booklet. A stapled, single-folded paperback, 5x7½ inches, this updates an already useful publication, originally appearing in offset 30 years ago. The first printed edition by Dr. B. G. Griffith was dated 1937. Exhausted and revised in 1953 and 1963, it has reappeared printed in 1964. The work deserves to last and shows every sign of doing so.

The author sidesteps the problem of too-small and hence poorly printed range maps, by inserting a map of the province on the middle page carefully printed on glossy paper. It shows forest type boundaries overprinted with the broad groups of trees found. Latitude and longitude are shown, from which it is easy to locate obscure places, the coordinates for which are given in the text in brackets, where the figures are easily ignored in reading but are indispensable if needed. Also in the middle section are 12 glossy colored photographs on 6 pages, showing some needles, pollen flowers and cones, mature and immature.

The text is firmly tied to older and more ambitious works, with 44 references and a system of abbreviations that saves space in citing illustrations, e.g. NT 54 is p. 54 of Native Trees of Canada. The system is satisfactory but there should be a table of abbreviations; they are hard to identify from mention in one of the prefaces or buried in the text.

There is a good glossary and an index giving common and systematic names in 4 different type faces, a method simpler in use than it sounds. The keys are dichotomous, indented but not numbered. The descriptions are well planned and written. Some interesting historical notes are included, with individual records and locations of exceptionally old or tall or large trees. Heights of tall trees and their diameters are given in feet or inches. This choice probably bothered the author, for the measurements of smaller forms are given in meters and millimeters. Nevertheless it is a good and workable compromise.

Engelmann and white spruce are rescued from the splitters and regrouped by Prof. T. M. C. Taylor as subspecies of *P. glauca*. The longest key, to 34 different willows, is adapted from a key to northern species by Dr. H. M. Raup of Harvard. There are a few exotics. American and English elm are included because they have been widely planted notably on Vancouver Island and at Agassiz. The Himalayan blackberry, gorse, Scotch broom and rowan appear. A useful inclusion is a key for winter identification to genus of angiosperm trees.

This is a really pocket-sized guide book for the layman that is well-printed, authoritative and easily read. Since it also is sensibly priced it is a must for hikers, campers, assorted nature lovers and especially for ecologically-minded entomologists.

—*H. R. MacCarthy*

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EFFICACY OF SEVERAL ORGANOPHOSPHORUS COMPOUNDS AGAINST CYCLODIENE-RESISTANT ONION MAGGOTS[1]

D. G. FINLAYSON

Introduction

Investigations in 1955 and 1956 (Finlayson *et al.*, 1959) demonstrated that some degree of resistance had developed which allowed the onion maggot, *Hylemya antiqua* (Meig.), to inflict serious damage in Washington and Idaho. Crops in Oregon and British Columbia were not affected. By 1957, however, the condition had become general across the continent. Laboratory experiments showed that strains of the onion maggot resistant to cyclodiene organochlorine insecticides had developed independently in almost all areas of its economic distribution in North America (Elmosa *et al.*, 1959; McClanahan *et al.*, 1959; Howitt, 1958; and Crowell and Terriere, 1959).

Preliminary experiments in 1958 indicated that certain organophosphorus compounds would control resistant strains in British Columbia. However, some formulations of these insecticides caused severe phytotoxicity. The following experiment was designed to compare the effectiveness of the organophosphorus compounds, carbophenothion (Trithion), diazinon, and ethion, with that of endrin, the recommended insecticide (Finlayson *et al.*, 1959).

Materials and Methods

The experiment was conducted at 4 localities in British Columbia; on sandy clay loam at Kamloops, North Kamloops, and Kelowna and on peat at Kelowna. The design was a 5 x 5 latin square. Each plot was split into 3 sub-plots consisting of seed treatments with wettable powders at 1 oz of toxicant per lb of seed and furrow treatments with granular formulations at 1 and 2 lb of insecticide per acre. Half of each sub-plot received additional treatments with the fungicide captan. The materials, methods and rates of application are given in Table 1. The untreated plots consisted of 6 rows: 2 untreated, 2 in which the seed was treated with captan at 2 oz per lb of seed, and 2 in which captan was applied to the furrow at 2 lb per acre. Furrow treatments were applied by placing the chemicals in the V-belt of the seeder in contact with the seed; seed treatments were applied after the seed had been moistened with 5 per cent Methocel solution for a sticker. Seed of the variety Yellow Globe Danvers was sown at 6 lb per acre with 16-inch spacing between rows.

The effects of the insecticides were measured in three ways: by counting the number of seedlings which emerged, by assessing at weekly intervals the percentage of emerged plants that were damaged, and by weighing the yields of undamaged bulbs at harvest. Data were collected from 20 feet of row of each treatment for each of the 5 replicates at all locations.

Results

Effect on plants—Although the organophosphorus (OP) insecticides did not appear to affect the onion seedlings once they were above ground, some treatments significantly reduced the numbers which emerged (Table 2). This was more noticeable in loam soils than in peat and especially in plots treated with diazinon. Even in peat both diazinon seed treatments resulted in significantly fewer seedlings than the untreated check. In the loam soils, 17 of the 18 treatments with diazinon resulted in considerable reduction. Carbophenothion furrow treatments in particular, applied at 1 and 2 lb

[1] Contribution No. 90, Research Station, Research Branch, Canada Department of Agriculture, 6660 N.W. Marine Drive, Vancouver 8, B.C. from a thesis submitted to the University of Western Ontario in partial fulfilment of the requirements for the Ph.D. degree.

TABLE 1—Materials, methods and dosage used to assess organophosphorus insecticides at Kamloops, North Kamloops and Kelowna, B.C., 1959.

Treatment[3]			Application[4]	Formulation rate[1] oz Per lb seed Insecticide	Per lb seed Captan[2]	Per 1000 row-feet Insecticide	Per 1000 row-feet Captan[2]
Carbo-	25	WP	S	4.0	—	—	—
phenothion	25	WP	S	4.0	4.0	—	—
	5	G	F	—	—	10.0	—
	5	G	F	—	—	10.0	2.0
	5	G	F	—	—	20.0	—
	5	G	F	—	—	20.0	2.0
Diazinon	25	WP	S	4.0	—	—	—
	25	WP	S	4.0	4.0	—	—
	2.5	G	F	—	—	19.5	—
	2.5	G	F	—	—	19.5	2.0
	2.5	G	F	—	—	39.0	—
	2.5	G	F	—	—	39.0	2.0
Endrin	25	WP	S	4.0	—	—	—
	25	WP	S	4.0	4.0	—	—
	2	G	F	—	—	24.5	—
	2	G	F	—	—	24.5	2.0
	2	G	F	—	—	49.0	—
	2	G	F	—	—	49.0	2.0
Ethion	50	WP	S	2.0	—	—	—
	50	WP	S	2.0	4.0	—	—
	5	G	F	—	—	10.0	—
	5	G	F	—	—	10.0	2.0
	5	G	F	—	—	20.0	—
	5	G	F	—	—	20.0	2.0
Captan	50	WP	S	—	4.0	—	—
	50	WP	F	—	—	—	2.0
Untreated			—	—	—	—	—

[1] Based on 16-inch rows.
[2] Captan applied at 2.0 oz/lb with seed, or 2.0 lb/acre in the furrow.
[3] Figures=percent toxicant; WP=wettable powder; G=granules.
[4] S=seed treatment; F=furrow treatment.

per acre with the fungicide captan, resulted in much better seedling emergence than that in the checks. In general, seed treatments reduced the number of seedlings.

Effect on damage— The rounded averages of percentage damage where no chemicals were applied show that the populations were heavy. These were as follows: Kelowna (clay loam), 67; Kelowna (peat), 79; Kamloops (sandy clay loam), 88; and North Kamloops (clay loam), 98 per cent. These contrast with reductions to very low levels with OP chemicals (Table 3).

Although the insecticdal treatments at all the sites allowed significantly less damage than the untreated checks, there were still considerable variations between treatments. The relative ineffectiveness of endrin is marked.

The average percentage damage allowed by the various treatments at all sites, regardless of method and rate of application was as follows: diazinon, 1.2; ethion, 3.2; carbophenothion, 3.7; endrin, 20.8; captan alone on the seed, 56.3; captan alone in the furrow, 61.7; and the untreated checks, 83.2.

TABLE 2.—Average number of emergent seedlings in 20 row-feet of onions from seed after various treatments against the onion maggot, **Hylemya antiqua** (Meig.), at several locations in British Columbia, 1959.

Treatment oz tox./lb seed or lb tox./A	Application[1]	Average emergent seedlings North Kamloops (loam)	Kamloops (loam)	Kelowna (loam)	Kelowna (peat)
Carbophenothion					
1	S	154	163	157	189
1	S & C	145	167	143	315
1	F	230	212	265	299
1	F & C	243	299	321	315
2	F	204	212	285	320
2	F & C	269	277	311	329
Diazinon					
1	S	147	121	57	217
1	S & C	117	79	87	198
1	F	110	119	76	292
1	F & C	141	161	98	318
2	F	100	44	38	254
2	F & C	83	78	63	270
Endrin					
1	S	150	165	188	232
1	S & C	176	146	199	247
1	F	178	182	147	308
1	F & C	184	170	186	333
2	F	139	149	110	295
2	F & C	158	166	141	315
Ethion					
1	S	151	196	129	260
1	S & C	145	170	122	260
1	F	212	227	252	303
1	F & C	222	296	255	323
2	F	179	184	170	315
2	F & C	213	240	221	309
Captan	S	160	211	247	257
Captan	F	233	246	326	317
Untreated		212	235	288	301
Diff. necessary for significance at 5%		62	59	54	63

[1] S = seed treatment; F = furrow treatment; C = captan, at 2 oz/lb seed or 2 lb/A in furrow.

Effect on yield— Onion seed is normally sown at 4 lb per acre. In these experiments the seed was sown at 6 lb because diazinon had already been shown to reduce germination. The distance between rows remained 16 inches. The increased numbers of seedlings which emerged made it necessary to thin the rows. Thus, although diazinon may have reduced the emergent seedlings by 25 to 50 per cent, the stands remaining had heavy yields of marketable onions.

The untreated checks produced very low yields. There was little difference in yield between the various organophosphorous treatments. In the peat soil at Kelowna 14 out of 18 treatments resulted in significantly higher yields of onions than the untreated checks. There were no significant differences in yield between any of the treatments at this site.

Discussion

The OP insecticide diazinon reduced the number of emergent onion seedlings significantly and more than any other insecticide used. On peat soil, however, the difference was not great. Howitt (1958) reported that the stand was reduced only when diazinon was applied in the furrow at rates in excess of 1 lb per acre. Although the numbers of emergent seedlings were clearly reduced in our experiments, the severe phytotoxic symptoms with lindane reported previously (Finlayson, 1952, 1957) were never observed. Greenhouse experiments and petri-dish tests with diazinon have since shown that germination is not reduced directly by seed treatment. It may be, therefore, that under the field conditions prevailing in the mineral soils, there was some reaction that inhibited germination.

The field experiments with OP insecticides took place in a season of great and continuing abundance of *H. antiqua*. The first generation produced at least 2 additional destructive generations despite being reduced in June by a fungus disease (probably *Empusa muscae* Cohn; Miller and McClanahan, 1959; Perron and Crete, 1960). Nevertheless, the 3 organophosphorus insecticides, carbophenothion, diazinon, and ethion, gave economic control of the onion maggot regardless of method and rate of application.

Compensating for the reduction in stand known to occur with diazinon by sowing more seed made it necessary to thin large numbers of seedlings to allow proper sizing of the bulbs, but treatments having many

TABLE 3.—Average percentage damage in 20 row-foot of onions from seed after various treatments against the onion maggot, **Hylemya antiqua** (Meig.), at several locations in British Columbia, 1959.

Treatment oz tox./lb seed or lb tox./A	Application[1]	Percentage damage North Kamloops (loam)	Kamloops (loam)	Kelowna (loam)	Kelowna (peat)
Carbophenothion					
1	S	6.4	1.0	0.1	1.9
1	S & C	5.8	2.6	0.0	6.6
1	F	6.9	1.4	0.7	9.3
1	F & C	14.0	1.2	0.7	6.7
2	F	6.0	1.0	0.3	3.2
2	F & C	5.5	1.2	0.6	3.6
Diazinon					
1	S	2.2	0.7	0.9	0.8
1	S & C	5.0	1.4	2.2	1.0
1	F	3.1	0.4	0.0	0.8
1	F & C	0.5	0.1	0.0	0.5
2	F	1.1	1.9	1.8	0.5
2	F & C	0.8	0.7	1.0	1.2
Endrin					
1	S	78.5	62.5	34.0	38.6
1	S & C	62.7	43.7	14.4	35.0
1	F	41.2	29.6	4.9	11.1
1	F & C	37.6	23.8	4.8	9.1
2	F	24.0	14.2	3.6	7.2
2	F & C	33.1	20.6	1.7	7.9
Ethion					
1	S	5.8	1.0	1.3	3.2
1	S & C	6.8	2.6	1.3	11.9
1	F	5.1	1.3	1.0	2.3
1	F & C	7.1	1.0	2.7	4.2
2	F	2.9	0.8	0.8	1.9
2	F & C	2.1	1.0	0.4	2.3
Captan	S	83.7	65.9	25.9	49.8
Captan	F	95.4	62.4	29.3	69.9
Untreated		98.3	87.7	67.2	79.0
Diff. necessary for significance at 5%		11.0	17.3	5.1	15.7

[1] S=seed treatment; F=furrow treatment; C=captan at 2 oz/lb seed or 2 lb/A in furrow.

TABLE 4.—Average marketable yield of 20 row-feet of onions from seed after various treatments against the onion maggot, **Hylemya antiqua** (Meig.), at several locations in British Columbia, 1959.

Treatment oz tox./lb seed or lb tox./A	Application[1]	Yield, lb North Kamloops (loam)	Kamloops (loam)	Kelowna (loam)	Kelowna (peat)
Carbophenothion					
1	S	19.9	11.3	10.8	12.9
1	S & C	20.5	12.3	10.8	13.9
1	F	18.7	13.8	10.5	14.5
1	F & C	18.3	15.8	11.0	11.3
2	F	18.8	11.6	11.3	15.5
2	F & C	21.9	14.9	10.6	15.9
Diazinon					
1	S	24.0	14.5	6.4	14.3
1	S & C	20.9	9.2	7.8	16.9
1	F	25.0	16.1	9.6	15.0
1	F & C	24.2	17.6	10.4	15.7
2	F	20.3	6.7	5.5	13.3
2	F & C	19.0	9.6	6.5	14.4
Endrin					
1	S	8.9	4.2	11.5	10.5
1	S & C	12.9	6.1	13.6	11.7
1	F	20.0	10.9	11.4	13.7
1	F & C	21.5	8.8	9.8	15.0
2	F	21.5	12.1	9.8	16.2
2	F & C	20.7	12.3	10.8	14.3
Ethion					
1	S	19.0	13.9	11.3	13.5
1	S & C	20.9	14.2	10.6	14.6
1	F	19.6	14.2	12.3	15.3
1	F & C	20.5	12.7	12.6	13.0
2	F	17.4	14.7	11.7	12.4
2	F & C	18.6	12.6	12.9	14.0
Captan	S	6.0	3.8	12.0	8.2
Captan	F	2.2	5.4	11.0	7.1
Untreated		1.1	2.1	3.7	3.8
Diff. necessary for significance at 5%		5.7	6.9	4.3	9.4

[1] S = seed treatment; F = furrow treatment; C = captan at 2 oz/lb seed or 2 lb/A in furrow.

emergent seedlings produced no greater yields than those with fewer. Inhibition of germination and emergence is still a factor to be reckoned with in using diazinon.

Endrin was comparatively ineffective allowing damage as high as 78.5 per cent at 1 oz per lb of seed. This was the calendar recommendation in British Columbia and the treatment had reduced damage to less than 1 per cent in experiments only 3 years previously (Finlayson *et al.,* 1959). The maggots have been shown to be resistant to all the cyclodiene insecticides.

The degree of resistance shown by strains from British Columbia corresponds closely to that from Washington, Oregon and Idaho (personal communications), Michigan (Elmosa *et al.,* 1959), and Ontario (McClanahan *et al.,* 1959). Strains resistant to these insecticides are reported from all onion-growing areas of North America. Each strain appears to have developed independently.

Summary

In the interior of British Columbia, carbophenothion, diazinon, endrin, and ethion were tested for control of onion maggot, *Hylemya antiqua* (Meig.). They were applied as granular formulations to the furrow at 1 or 2 lb toxicant per acre or as wettable powder to the seed at 1 oz per lb of seed. Captan was added to half of each plot for smut control. The three organophosphate insecticides gave good to excellent control in mineral and peat soil. Endrin, to which resistance had arisen, allowed various amounts of damage up to 78.5 per cent. Diazinon caused considerable reduction in the number of emergent seedlings, especially in sandy loam. The other treatments had little or no effect on emergence, nor were other phytotoxic symptoms noted. Average yield in lb of marketable onions from 20 row-feet were: ethion, 14.7; carbophenothion, 14.5; diazinon, 14.4; endrin, 12.9; and untreated, 2.7.

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CONTROL OF MOUNTAIN PINE BEETLE, *Dendroctonus ponderosae* HOPK. BROOD IN LOGS WITH LINDANE EMULSION

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Introduction

In the southwestern United States, lindane in oil, to a great extent has replaced other chemicals in the control of *Dendroctonus* spp. in logs and slash. In British Columbia, Kinghorn (1955) demonstrated that ethylene dibromide or lindane in oil-in-water emulsion was effective against the mountain pine beetle in lodgepole pine. Nevertheless, ethylene dibromide, without exception, has been recommended and used as the bark beetle control insecticide in the interior of British Columbia. Ethylene dibromide in oil-in-water emulsion has proved inconvenient to handle and recently the insecticide has become difficult to obtain. Therefore, the following test was carried out in order to assess the effectiveness of lindane emulsion against mountain pine beetle, *Dendroctonus ponderosae* Hopk., in white pine, *Pinus monticola* Dougl., under conditions in the interior of British Columbia.

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Methods and Results

On 4 May 1964 at Trinity Valley, a white pine tree infested by *D. ponderosae* in 1963 was felled and cut into 14 three-foot-long bolts.

On 25 May every second bolt from the tree bole was sprayed with one per cent emulsion*. The emulsion was applied with a hand sprayer to all sides of the test bolts at the rate of one gallon per 100 square feet. The alternate bolts were left unsprayed as a check.

A two-foot-long section of each bolt was caged individually at Vernon on 15 July, and adult emergence was recorded daily until the test was discontinued on 24 August. A one-foot-long section of each bolt was peeled and the numbers of living and dead *D. ponderosae* were recorded.

The number of emerged adults and the numbers of living larvae, pupae and unemerged adults per square foot are shown for each bolt in Table 1. Data from paired adjacent treated and untreated bolts are given beginning with the basal pair "A" to the uppermost pair "G."

Total emergence was 1,268 adults. The adults were segregated by date of emergence in screen-topped jelly jars in the insectary and the date of death of each individual was noted. Fifty per cent mortality of adults occurred 2.5 days after emergence from the lindane treatment bolts and 6.8 days after emergence from the check bolts. The beetles emerging from the treated logs died with their elytra open and wings extended; almost all beetles from untreated logs died with elytra closed.

TABLE 1—Number of **Dendroctonus ponderosae** larvae, pupae and adults, per square foot of white pine bolt, 24 August, 1964.

	Lindane			Check			
Bolt	Emerged adults	Living L.P.A.	Total living	Emerged adults	Living L.P.A.	Total living	% Survival treated
A	1.2	13	14.2	32.4	7	39.4	36
B	0	11	11.0	56.8	2	58.8	19
C	5.8	6	11.8	12.9	25	37.9	31
D	1.0	14	15.0	27.0	4	31.0	48
E	0	2	2.0	16.5	15	31.5	6
F	0	1	1.0	0.3	35	35.3	3
G	0	4	4	2.4	58	60.4	0

Discussion

The total number of adults emerging from the treated bolts was only about five per cent of the number that emerged from the untreated bolts. The former lived for a shorter time after emergence than did the adults from untreated bolts. All adults that emerged from the sprayed bolts died with elytra open. Lyon and Wickman (1960) observed that *Dendroctonus* "—had their elytra locked open, which is the most conspicuous symptom of lindane poisoning." Probably sufficient poison was picked up to produce a debilitating effect making them incapable of reproducing during their shortened lifetime.

Adults were removed from the cages only once daily and therefore those from the treated logs may have been exposed to poison on the bark longer than they would have been under normal field conditions. However it is believed that the most critical period of exposure to the poison may have occurred as the adults chewed their way out through the bark, particularly since dead adults were more numerous in the exit galleries of the treated than the untreated bolts.

The test was adequate but not complete since a number of living adults and larvae were still in the bolts on 27 August. Living larvae and pupae in the check bolts were more numerous in the sections from the upper bole, whereas they were more

* 8 fl. oz. of Lintox (an emulsible concentrate containing 20% lindane) per Imp. gal. of water.

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 rainfall. 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.

Acknowledgements

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RELEASES OF CINNABAR MOTH, *Hypocrita jacobaeae* (L.), (LEPIDOPTERA: ARCTIIDAE) ON TANSY RAGWORT IN BRITISH COLUMBIA[1]

A. T. S. WILKINSON

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 (½-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 8.5 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
Agonum mulleri Hbst.	—	—	1
Amara obesa Say	—	—	1
Amara sp.	—	—	1
Anisodactylus sp.	2	—	—
Calathus fuscipes Goeze	25	101	—
Calosoma tepidum LeC.	—	2	2
Carabus granulatus L.	15	6	3
Carabus nemoralis Müll.	8	1	1
Harpalus affinis Schrk.	2	—	52
Pterostichus melanarius 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 wooly-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.

Acknowledgements

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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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A NOTE ON THE ACCEPTABILITY OF LEAF MACERATES ON FILTER PAPER OF PLANTS FROM PEAT BOGS BY ADULT BLACK VINE WEEVILS, *Brachyrhinus sulcatus* (F.)

W. T. CRAM

Foliage of Himalaya blackberry and salal, common weeds in and around blueberry and cranberry bogs, when fed to adults of the black vine weevil, *Brachyrhinus sulcatus* (F.), significantly shortened the preoviposition periods and produced greater numbers of total and viable eggs than the other common weeds: labrador tea, fireweed, and sheep sorrel, or even the crop plants blueberry and cranberry (Cram and Pearson, 1965).

To test the preference of adult weevils for these hosts, 750 mg of fresh leaves were ground in 2 ml of water with sand to destroy the physical characteristics of the leaf and the resulting macerate was assessed by two methods. In the first, macerate was immediately spotted on the edge of a narrow strip of Whatman No. 1 filter paper (2.7 by 55 cm). Each of the seven hosts mentioned was spotted six times at random. The strip was suspended in a vertical glass tube (3.5 by 58 cm) containing water-saturated cotton wool at the lower end (Fig. 1A). Twenty adults were introduced and the upper end of the tube was sealed with a rubber stopper. The tube was placed in the dark at room temperature. After 20 hours the strip was removed and the amount of feeding at the spots was rated (Table 1). Himalaya blackberry was clearly the preferred host followed by salal and labrador tea. Blueberry and cranberry were low in acceptability followed by fireweed and lastly sheep sorrel.

In the second method using stacked 4.5 cm filter paper disks (Fig. 1B) closely similar feeding ratings were recorded except that salal was rated below blueberry (Table 1). In this test a spot of macerate was placed in the centre of each disk, and was contained by a separating glass ring. Distilled water (.1 ml) was added to each spot so that only plant solubles reached the outer area of the filter paper where the adults fed. The stack was covered by an inverted glass jar to maintain high humidity and keep the papers from drying out. Results are from 20 weevils run concurrently with the strip test.

These observations correlate with results obtained at the same time by Cram and Pearson (1965) on the reproductive behaviour of this weevil. Labrador tea appears to be preferred as a macerate more than would be expected from the amount of damage seen in the field. Possibly the physical nature of this rather tough and densely hairy foliage is a deterrent to feeding.

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TABLE 1—Rating of the amount of feeding by the black vine weevil, **B. sulcatus**, on filter paper spotted with leaf macerates of plants from peat bogs.

Plant	Strip test Replicates 1	2	3	4	5	6	Sum	Disk test
Himalaya blackberry	++	++	++	++	+	+++	12	++++
Salal	++	++	++	—	+	+	8	++
Labrador tea	+	+	+	+	+	+	6	+++
Blueberry	—	+	+	+	—	+	4	+++
Cranberry	—	+	+	+	—	—	3	++
Fireweed	—	+	—	—	+	—	2	+
Sheep sorrel	—	—	+	—	—	—	1	+
Untreated	—	—	—	—	—	—	0	—

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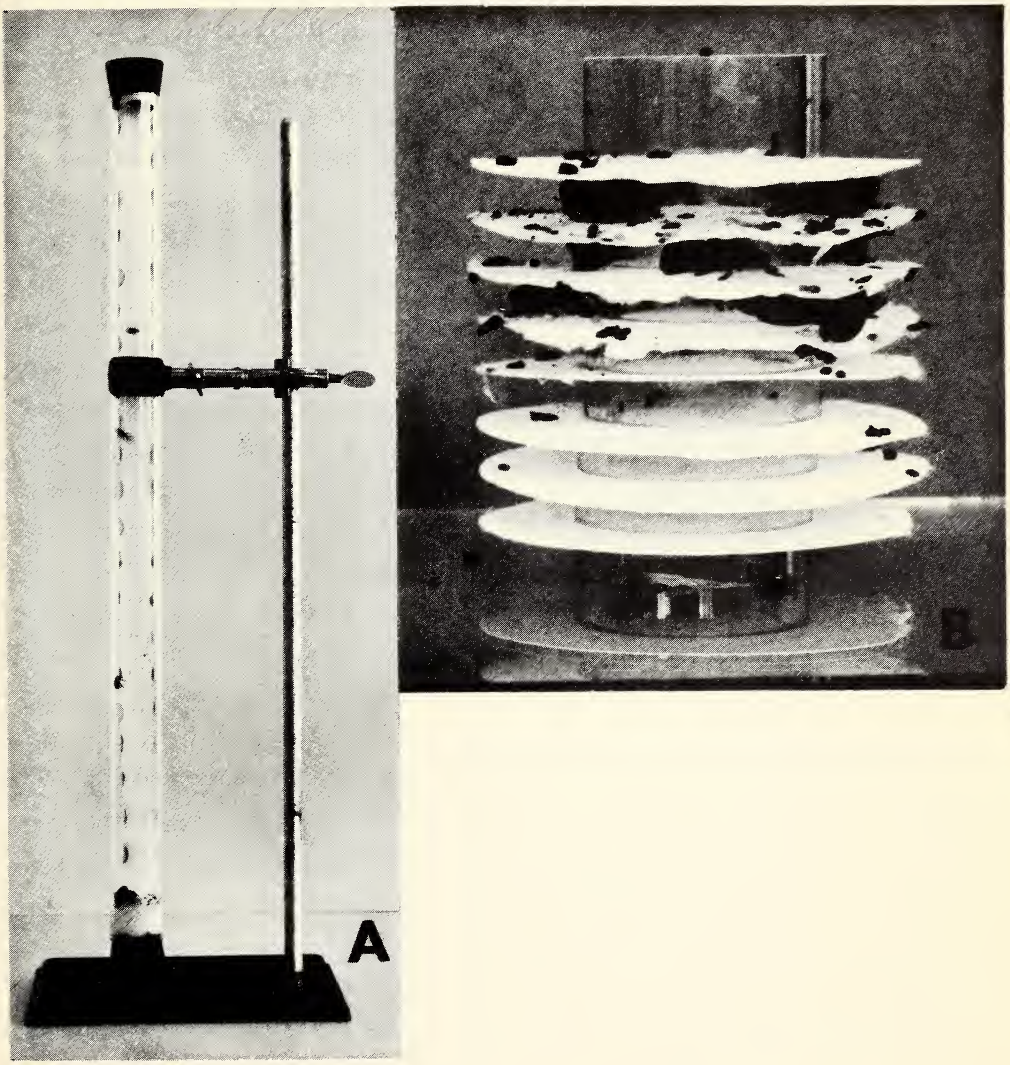

Fig. 1—Apparatus for appraising the acceptability of leaf macerates of various plants on filter paper to the adult black vine weevil, **B. sulcatus.** A. Strip test. B. Disk test.

MOISTURE AND FAT CONTENT IN THE AMBROSIA BEETLE *Trypodendron lineatum* (OLIV.)[1]

W. W. NIJHOLT[2]

Little is known about the metabolic changes that take place during the life cycle of the ambrosia beetle, *Trypodendron lineatum* (Oliv.) (Chapman, 1956). An understanding of the changes in the amount of fat in relation to certain physiological conditions and behaviour would be of fundamental value (Lees, 1955). Subjective ratings of the size of the fat body have been tried but were found to be inadequate as a means of studying changes in fat content. To increase our knowledge of the amount of water, fat, and dried matter in these beetles and to lay the basis for further studies of this subject a method was needed which would make it possible to determine these factors in individual beetles (Bursell, 1959). The small size of the beetles (2.5 - 4.5 mg.) makes this difficult, but we devised a simple method for making these determinations with sufficient accuracy and in a relatively short time.

Most of the data were secured in March 1964, with beetles collected from overwintering sites in bark during January and March 1964. After removal from the bark, the beetles were stored in moist bark flakes in a refrigerator until they were used. Some collected in the spring of 1963 and stored in a refrigerator were also used.

The first objective was to establish average values for fat, moisture, and dry weights for male and female beetles. Beetles used for the experiments were given a walking test to exclude those that were injured or did not appear to be normal. Groups of 25 beetles were killed with ethyl acetate fumes and weighed in a previously dried thimble (folded Whatman glass paper -GF/A- 9 cm.). They were then dried for 16 hours in an oven at 70° C with forced air circulation, cooled over anhydrous calcium sulfate and weighed. Additional drying did not cause any further change in weight. The thimble was put into a micro-soxhlet apparatus and extracted continuously with petroleum ether for six hours. An additional 6 hrs. extraction did not significantly alter the results. Next the thimble was air dried until the excess ether had evaporated and after oven drying overnight at 70° C it was placed in a desiccator over anhydrous calcium sulfate prior to weighing. Glass paper was used because it was non-hygroscopic. As the beetle remains did not absorb an appreciable amount of moisture, accurate and reproducible weighings were possible to within 0.01 mg.

It was first thought that the well developed sclerotization of these beetles would be an obstacle to efficient fat extraction from intact insects. However, crushing the beetles and repeated extraction did not result in significant change in weight.

The results of the determinations presented in Table I show that the female beetles were approximately 0.5 mg. heavier than the males, and that the fat content of females was usually greater. The average total weights of beetles that were stored since spring 1963 were about the same as those of the freshly collected beetles, but the weights of fat in the former were very small.

After making determinations using groups of beetles the same method was used for individuals. Small gelatin capsules perforated at both ends were used as in a recent study on

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TABLE I—Average Values in mg. of Moisture, Dry Weight, and Fat Content of **Trypodendron** ambrosia beetles in groups of 25.

Collection Date	Sex	Total wt/ beetle	Moisture /beetle	Dry wt. /beetle	Fat/ beetle after 3 hrs.	Fat/ beetle after 6 hrs.	% fat /dry wt
7/1/'64	F	3.65	2.01	1.64	.52		
	F	3.80	2.04	1.75	.57		
	F	3.71	2.05	1.66	.49	.54	32.6
	F	3.81	2.08	1.73	.51		
	M	3.22	1.87	1.34	.36		
	M	3.24	1.83	1.41	.38		
	M	3.27	1.81	1.46	.37	.40	27.7
25/3/'64	F	3.70	2.04	1.66	.54	.56	34.1
	F	3.70	2.04	1.66		.57	34.1
	M	3.27	1.84	1.43	.39	.42	29.2
	M	3.11	1.76	1.35		.37	27.2
Spring '63	F	3.68	2.40	1.29		.14	11.1
	M	3.19	2.08	1.11		.07	6.1

uptake of water by *Trypodendron* (Nijholt and Chapman, 1964). These capsules stood the heat used for drying fairly well and were not affected by warm petroleum ether. Each beetle was weighed separately after it had been killed with ethyl acetate fumes, and placed inside a capsule with a numbered piece of paper. After drying overnight the capsules were cooled in a desiccator. Then the beetles were removed, weighed individually with as little exposure to the air as possible and returned to their capsules. Ten to twelve beetles in their capsules were then placed in a micro-soxhlet extractor with a glass wool plug to hold them in position. After 6 hrs. of continuous extraction in petroleum ether the capsules were blotted with filter paper and dried overnight at 70° C. The beetles were then taken from their capsules and weighed so that the fat content could be calculated on the basis of dry weight.

The data for individual beetles (Table II) show that females varied more than males. Three females appeared normal but had extraordinarily low fat contents of 8.3%, 7.0% and 10.6%. These influenced the average value.

TABLE II—Moisture, Dry Weight, and Fat Content in mg. of 20 male and 20 female **Trypodendron** ambrosia beetles determined individually.

	Total fresh wt	Moisture wt	Dry wt	Total fat after 6 hrs*	% fat/ dry wt
MALES					
Range	3.90-2.42	2.16-1.36	1.93-1.05	0.62-0.17	33.3-15.6
Average	3.26	1.87	1.40	0.35	24.6
Standard deviation	0.369	0.186	0.243	0.127	4.937
FEMALES					
Range	4.43-2.76	3.03-1.56	2.16-0.86	0.88-0.06	40.7- 7.0
Average	3.59	2.06	1.25	0.45	26.9
Standard deviation	0.552	0.332	0.380	0.813	10.494

* After extraction over an additional period of 6 hours the average total fat for males was 0.36 mg. and for females 0.47 mg.

Summary

A method is described to determine the amount of moisture, fat, and dry matter in groups and individuals of adult ambrosia beetles, *Trypodendron lineatum* (Oliv.), using standard laboratory equipment. Average and individual values for fat extracted by petroleum ether are given for beetles of both sexes taken during overwintering. The results show that females have a greater variability in weight and a larger percentage fat based on dried weight.

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NOTES ON THE LIFE HISTORIES OF THREE MOTHS FROM SOUTHERN VANCOUVER ISLAND (LEPIDOPTERA: PHALAENIDAE AND GEOMETRIDAE)

G. A. Hardy[1]

Orthosia ferrigera Sm.

Eight species of the genus *Orthosia* are recorded for British Columbia, all of which occur on Vancouver Island.

O. ferrigera has a wingspread averaging 35 mm and is of a general rusty colour with the veins on the primaries indicated by a darker colour. It is scarce in my experience, being taken about once a year.

A specimen taken by day on a grass stem in April, 1963 laid 60 ova on the sides of the box in small groups of from 1 to 25, in a single layer. The resultant caterpillars died because I did not know the correct food plant. Another one taken at light in late March, 1964 laid 47 ova. It was found that Garry Oak (*Quercus garryana*) was avidly eaten, but to get the caterpillars started it was necessary to cut open the swelling buds for the trees were not in leaf at the time.

Ovum

Size 1 mm by 0.75 mm. Hemispheric, finely ribbed with about 40 ribs and cross-ribbed, having the effect of quadrangular reticulations since the height of the ribs and cross-ribs is equal; white slightly tinged with green, soon acquiring a pale orange dot on the micropyle and a ring of orange on the shoulder. A light lead grey at maturity. Hatched April 19.

Larva—1st Instar

Length 4 mm. Head smooth, translucent, with a pale brownish tinge. Body translucent with a bluish cast; both head and body heavily dotted with black; a short hair on each dot.

2nd Instar

April 25. Length 7 mm. Head as described. Body somewhat translucent, pale greenish with white dorsal, subdorsal and spiracular lines, the last-named being the widest; conspicuous black tubercles.

3rd Instar

May 1. Length 10 mm. Head smooth, semi - transparent, sordid white with a faint bluish tinge, conspicuously dotted with widely spaced black dots. Body smooth, yellowish green tinged with fuscous on sides and venter, with thin yellow dorsal, subdorsal and supraspiracular lines, the spiracular band yellow, interruptedly threaded with broad fuscous dashes on the centre of each segment; tubercles conspicuous and black, each bearing a minute black hair; a short, thin, slightly raised transverse bar on dorsum of A. 9; legs and claspers sordid.

4th Instar

May 8. Length 15 mm. Head a pale sordid flesh colour, sparsely dotted with black; plate tinged with blue, with three white lines as extensions of the dorsal and subdorsal lines. Body smooth, general colour russet,

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[1] Provincial Museum, Victoria, B.C. (Rtd.)

dorsal and subdorsal lines yellowish, spiracular band luteous threaded with interrupted fuscous dashes; A. 1 to 8 with fuscous V marks on the dorsum of each; A. 9 humped and topped with a conspicuous transverse white bar; tubercles black on pale cream bases, most noticeable on the anterior segments, the whole body minutely dotted with fuscous; spiracles small, white ringed with black; legs and claspers sordid with black dots on the bases, venter sordid along the centre.

5th Instar

May 12. Length 30 mm. Head as described. Body similar to 4th instar but dorsal, subdorsal and spiracular lines indistinct; the dorsum of A.9 dark with conspicuous transverse white bar; the dorsal V marks and yellow bases of the outer dorsal tubercles more pronounced.

Full-fed by May 21, the larva was 45 mm long, and considerably duller in colour. Pupation was in an earthen cocoon on May 24.

Pupa

Size 17 mm by 6 mm. Smooth, shiny, wing cases finely vermiculated, anterior border of A. segments finely and closely punctate; colour a bright mahogany brown; cremaster set on the rounded tip of the last segment, and consisting of two short, fine, close-set spines with outwardly recurving tips and four minute similar hairs at the base.

Remarks

When not feeding the larva retired amongst the bud scales at the base of the leaf clumps where the russet colour rendered the caterpillar very inconspicuous. If disturbed it curled into a ring.

Mesothea viridipennata Hulst

M. viridipennata is the only species of the genus recorded for British Columbia. It has a wingspread of 20 mm and is coloured uniformly light green, soon fading to a thin washed-out brownish yellow. It commonly flies by day in open brush land.

A specimen taken in the Malahat district on May 15, 1964, had laid 30 ova by May 20, scattered irregularly over an alder leaf in the container.

Ovum

Size 0.8 by 0.5 by 0.3, a broad oval, laid broad side down, depressed in the centre of the upper surface, smooth, shiny, without reticulations; pale green. Hatched May 29.

Larva—1st Instar

Length 2 mm. Head large in proportion, smooth, dull, honey-colour. Body slender, smooth, creamy with the dark line of the alimentary canal showing through.

The june-berry or service berry, *Amelanchier florida,* was the preferred food plant, but *Geum macrophyllum* was readily consumed.

2nd Instar

June 6. Length 6 mm. Head markedly bi-lobed, dull, honey-colour. Body, T.1 with two fleshy projections directed forward, A.9 with one fleshy process directed backward; a light dun colour; faint whitish subdorsal, supraspiracular and spiracular lines, resulting in part from aggregation of many minute, rough, slightly raised white dots which thickly cover the body; spiracles small, black.

3rd Instar

June 10. Length 8 mm. Head strongly bi-lobed, rough, dull honey-colour. Body a light reddish fuscous, with a thin dark dorsal line, and very thin whitish subdorsal, supraspiracular and spiracular lines; venter, legs and claspers concolorous with upper parts.

4th Instar

June 14. Length 15 mm. As described with the general colour a light orange or rusty brown; the sides with very faint irregular lines.

5th Instar

June 24. Length 20 mm. Head strongly bi-lobed, the lobes pointed, rough, dark brown with crimson tinge. Body rough, rusty brown with a tinge of green, dorsal line dark crimson or purplish brown, lower sides, below the black spiracles, with faint, dark, suffused, widely spaced dashes on A.1 to 5; venter concolorous with the upper parts; legs dark crimson below, claspers with a tinge of crimson which extends to the adjacent body.

July 5. Length 30 mm. Full grown. Pupated in a very loose cocoon of brownish silk among the debris on the bottom of the container.

Pupa

Size 10 mm by 3.5 mm. Dull, wing cases with prominent veins, chocolate; abdomen beige with a black dorsal line flanked by two black dots on each segment; venter with two black dashes on the sides, the lower one much the thicker, black dots between the dashes; cremaster a shiny, tapering projection with a pair of minute setae near the base and another pair near the tip, which is finely pointed.

Remarks

There was considerable individual variation in larval colour ranging from a greenish to brownish cast. The dorsal line was often broken and in some a thin dark subdorsal line was evident. The markings were always subdued.

When at rest the body was held rigidly at an angle to the substrate and the legs tightly appressed towards the head which was folded along the venter. The projections on T.1 were prominent so that the head looked like a bud at the end of a twig. The general effect was of a leaf stalk from which the blade had been removed.

Plagodis approximaria Dyar

Only one species of this genus is recorded for British Columbia where it occurs in the south including Vancouver Island.

P. approximaria has a wingspread of 32 mm. The primaries are luteus with a purple suffusion from a large purple blotch on the outer angle; the secondaries are similar, and the general effect is responsible for the popular name "The Scorched Wing."

A female taken in a light trap on June 8, 1964 laid 30 ova by June 11. These were in rows or heaps at the edges of alder leaves or on stems.

Ovum

Size 1 mm by 0.5 mm by 0.3 mm Oval, slightly broader at one end, a little depressed in the centre of the upper side, smooth, shiny, showing very faint reticulations. Pale yellow becoming orange towards maturity. Hatched on June 20.

Larva—1st Instar

Length 2 mm. Head large in proportion, honey-colour. Body slender, honey-colour, very active. Fed on *Alnus rubra.*

2nd Instar

June 30. Length 8 mm. Head honey-coloured with a darker feathered spot on each side of the vertex. Body very slender. A variously shaded bluish fuscous band on the dorsum, a light lemon band on the sides and dark brown band on the venter. Legs dark brown.

3rd Instar

July 7. Length 18 mm. Head pinkish, mottled with light and dark brown, more marked on the vertex. Body mostly fuscous purple with whitish streaks on T. and A. segments, less evident posteriorly; a small hump on T. 3, and a larger black hump on A.6 having a transverse white dash on top.

July 10. Some larvae with a green base colour with brown blotches on the sides adjacent to the humps.

4th Instar

July 15. Length 30 mm. Head dull, smooth, beige, closely mottled with pale purple. Body, general colour a dull purple streaked with white especially on the sides of T. segments, white patches on the sides of A.1 - 4; T.2 and 3 with continuous dorsal humps, larger on T.1, bordered in front with a transverse white line, as also on T.1; a hump on A.5, darker, divided by a white cross-bar; venter ashy with black W lines on the centre of segments A.1 - 5, most evident on A.1 - 3.

One pupated on July 28 in a silken cocoon spun in a fold of paper.

Pupa

Size 15 mm by 4 mm. Slender, wriggled actively when touched; wing-cases dull, fuscous; A. segments smooth, shiny, sparsely punctate on anterior borders, medium brown; cremaster two larger hairs with recurved tips and about six smaller similar ones at the base, all set on a rugose projection at the tip of the last segment.

Remarks

This larva is an excellent example of twig simulation in form, colour, and attitude, especially when resting with its body held out at an angle of about 45° to the twig.

SOME RECORDS OF LYCTIDAE IN VANCOUVER

G. J. Spencer[1]

In the Proceedings, Vol. 4, pages 129-148, of the Seventh Pacific Science Congress held in New Zealand, February 1949, under the heading Regional Pest Faunas, is an article "The more important Insect Pests of British Columbia" assembled by K. M. King from contributions by H. Andison, E. R. Buckell, R. Glendenning, J. D. Gregson, K. M. King, J. Marshall and H. A. Richmond, all of the Federal Entomological Laboratories in British Columbia.

On page 147 of this paper is the statement "structural timber is not, on the whole, subject to any extensive damage by insects. However, on the coast, powderpost beetles, *Lyctus* species, have in a number of instances heavily attacked house timbers, occasionally necessitating the replacement of cellar beams."

I have been interested in household insects in this Province for many years especially those attacking structural timbers and have not yet come across an instance of this sort since all our wooden buildings are of native soft woods; also in the past 20 years I have inspected many buildings suffering from insect attack and have found that if a species of *Lyctus* was present, it occurred only in timber imported into the Province as flooring, veneer, panelling or carved ornaments and that building timbers were attacked NOT by lyctids but by native and introduced anobiid beetles, termites and carpenter ants; the emergence holes of lyctids and anobiids are very similar, hence the mistake.

The family Lyctidae[2] is tropical or semi-tropical containing only 66 species known so far, included in 12 genera of which 10 occur in the New World. The genus *Lyctus* contains 25 species; other genera, 41 species. So far in Vancouver I have taken five species of *Lyctus* and one of *Trogoxylon,* making six in all. However, according to distribution lists in Gerber's monograph and in Hatch's Vol. III of the Beetles of the Pacific Northwest, seven species have so far been found in this Province, one being a single record.

Considering these species alphabetically, we have:—

Lyctus africanus Lesne

In June 1963 an importer of medicinal herbs brought in a pint of orris roots in which a few holes were showing; in a few days some beetles emerged which traced out to *L. africanus* Lesne which is very similar to *L. brunneus* except that the fourth abdominal sternite of the female has a dense conspicuous fringe of hairs. The insects are still actively breeding in the orris rhizomes in about equal numbers of males and females (March 1965),

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[2] Gerber, Eugene J. The New World Species of Powder-post beetles belonging to the Family Lyctidae. U.S.D.A. Technical Bulletin No. 1157, Wash., D.C. April, 1957.

and have reduced much of the roots to dust. Orris or orrice roots are the rhizomes of three varieties of Iris, cultivated in France, Italy and Morocco and are imported into North America for making a hair tonic and into Vancouver as one of 14 flavors used in making London Dry Gin and therefore this beetle can definitely be considered a hostile species and a menace to our conviviality. It is the most active of four species of lyctids that I have reared out in captivity and if the lid is removed from the container it flies out readily instead of crawling out as other species do.

Other record of *L. africanus:*—four specimens emerged on 5 May 1953 from a child's toy made of liquorice wood, *Glycyrrhiza lepidota* (Nutt.) Pursh, imported from California; one, on 9 October 1955, from a figurine from Kenya and 18 specimens from one panel only of an insect spreading board purchased from a supply company. The board lay around in the laboratory for three years before beetles started to emerge from it and the latest one emerged on 14 March 1964. Both halves of the board are made of "obeche" wood *Triplochiton schleroxylon* imported from west Africa, identified for me by Professor R. W. Wellwood of this University who stated that the wood is well known to have a high sugar content (a necessity for lyctid attack).

Also from this same side of the board there emerged from 28 January to 15 March 1965, 34 specimens of *Lyctus brunneus* (Stephens) and from 26 November 1963 to 8 October 1965, 8 specimens of *Trogoxylon prostomoides* Gorham, all from one strip of wood 12 ins by 2 ins by ⅝ inch thick. Just when this strip was infested by each species is anybody's guess.

Lyctus brunneus Stephens, the Old World Powder Post beetle.

This species ranges in color from medium to dark brown and is only slightly smaller than *L. planicollis,* the largest lyctid to occur in the Province.

The first specimen was obtained in spring 1934 from thin bamboo rods from Japan. The next three, obtained 3 January 1955 and 9 on 14 April 1955, came from a window blind of thin round bamboo strips of not much greater diameter than the beetles themselves. In April 1958, 18 were obtained from mahogany panelling that had been installed in a house for one year; in 1963, 10 from orris root and the last group of 34 from the obeche wood spreading board as recorded for *L. africanus,* making 79 in all.

Lyctus cavicollis Le Conte, the Western Powder Post beetle.

On 20 July 1955, a druggist brought in a handful of bamboo cigarette holders (source unknown but probably from China) which were heavily perforated by tunnels; from these emerged only two beetles which key out to *cavicollis* in Hatch's key[3], having a narrow prosternal process between the pro-coxal cavities instead of a broad one as in *planicollis.*

Lyctus fuscus Linn. 1758 *(Lyctus linearis* Goeze 1777) the European Powder Post beetle.

This species was my first record of *Lyctus* in Vancouver, obtained on 14 May 1926 from a hickory axe handle imported from Arkansas; the importer said he had a bushel of handles from which beetles were emerging but he brought up only one which I placed on a radiator and in short order, six beetles emerged. These were identified for me by the late Ralph Hopping who returned me only one specimen. It is amazing that any beetles can develop in hickory which is almost as hard as ivory but close examination shows that the tracheae are quite large and where these occur in any hardwood, the females insert their astonishingly long ovipositors and deposit eggs. If

[3] Hatch, M. H. Beetles of the Pacific Northwest, Vol. III. University of Washington Press, Seattle, Wash.

the tubes are slit open, the beetles press the elongated eggs lengthways into the grooves. Close-grained wood like maple is consequently free from attack by lyctids as is any wood which is varnished or painted to close the tracheae.

Lyctus planicollis Le Conte, the Southern Powder Post beetle.

This is the largest lyctid to come into this Province and the darkest, some being nearly black; females may measure 5.5 mm in length. This is the chief species attacking oak and was a problem during the second World War when oak for flooring was either improperly kiln-dried or not dried at all. I have 17 records of this beetle in oak flooring dating from 1950 to 1960 involving shipments from Cookeville, Tenn. and Calico Rock, Arkansas. One firm alone in Vancouver averaged importations of 13 acres per year of oak flooring, mostly from Arkansas and within one or two years of being laid, the floors produced beetles. The oak came in two forms, as 16-foot planks which were sawn locally into 3-inch wide strips for first flooring, and bundles of tongue-and-groove short ends ¾ inch thick for bedrooms; these short ends 2 or 3 inches wide and 12 to 16 inches long were most heavily infested, sometimes necessitating the entire re-laying of a bedroom floor.

I conducted many experiments with fresh non-infested wood and varying numbers of beetles, under varying conditions of humidity and temperature but was never able to get a fresh infestation started: the last of these experiments was discarded in 1963 having allowed four years for a new generation to develop.

Apart from 72 pinned specimens, I have a good reserve of this species in alcohol.

Lyctus opaculus Le Conte

In the Stace Smith addition to our collections is one specimen collected in Vancouver on 9 July 1930, identified in 1944 or 1946 by H. B. Leech as *L. opaculus*, in 1957 by M. Hatch as *L. planicollis* and in 1964 by Spencer as *L. brunneus;* definitely it is not *opaculus* and contains characteristics of all three species.

Also in the Stace Smith collection is one specimen collected 21 July 1934 by W. Mathers from "seasoned African wood" in Vancouver and identified by H. B. Leech as *Minthea stichothrix* Reit. without further details.

Finally is the species *Trogoxylon prostomoides* Gorham, the smoothest-looking of the species on hand, with only traces of elytral ridges and confused silky pubescence on the elytra. My first record was 4 specimens (identified by Hatch) from a Mexican bamboo basket, on 27 January 1947. On 21 July 1961, 8 specimens emerged from Monkeypod (*Samanea saman* Jacq.) wood bowls brought in from Hawaii; on 5 Dec. 1961, 2 were sent in from a bamboo basket in Vancouver and on 20 Nov. 1962, 3 were sent in from a North Vancouver home where the owner could not find the source of the beetles.

On 2 Nov. 1962 a citizen brought in a Mexican bamboo basket which showed a few emergence holes; in the laboratory it produced a steady stream of beetles which averaged 10 per week from Dec. 1963 to March 1964, when it was discarded. On 22 April 1963 a man brought in one beetle which had emerged from a ¾ inch oak strip from a floor. From 4 April to 9 May 1963, 13 beetles emerged in the laboratory from a carved Mexican figurine of unknown wood. On 26 November 1963, 6 were obtained from the insect spreading board of west African obeche wood, previously noted. On 3 March 1964, one specimen was sent down from Powell River in a mass of termite frass; the beetle must have come from a bamboo basket and was accidentally included in the frass. On 17 March 1964, 20 specimens were sent in from Coquitlam which were in process of emerging from the half-inch thick panelling of American ash in a large living room. Emergence of this brood from the ash started precisely 2½ years after the house was built and had continued up to the time the beetles were first sent in for identification. The emergence from the panelling became so general by the end of September 1965 that the owners had it all ripped off, the area behind it thoroughly sprayed with a 1 per cent solution of lindane in oil and the panelling replaced by plywood of a different species of wood. The danger from this infestation lies in the fact that several beetles have emerged from the polished oak flooring nearest to the infested panels, one from the next room and one from a room beyond that. Apparently the beetles spread under the subfloor and the extent of their infestation from the underside of the oak flooring may not become apparent for several years.

Now it has long been known that beetles of the family Lyctidae are attracted to wood of a high sugar content, so *T. prostomoides* in a container were given grains of cane sugar upon which they fed for periods up to one hour, apparently by licking it.

To test the possible selectivity of this species, one small block each of fine grain, hard, eastern European oak, Arkansas oak flooring, coarse-grain northeastern American oak possibly from Ontario, 40-year old hickory and chips of the same ash were placed into a can and some 16 adults of both sexes were carefully dropped on to the blocks. A few grains of sugar were then placed on the block of hickory and wetted with a drop of water which sank into the wood as if it was blotting paper. The beetles remained longer on the surface of this sugared hickory than on any of the other blocks. In 12 days all the beetles had died so 18 new living ones were dropped on to the blocks. It may be several years before the results of this test are known.

On 8 February 1965, six specimens were sent in from Keremeos where they were emerging from Bongo drums purchased in Mexico; identity of the wood in the drums was unknown.

This species, *Trogoxylon prostomoides,* has occurred in Vancouver in more species of wood than any other —in bamboo from China or Japan, in monkeypod wood, heavily in bamboo from Mexico, in oak, in Mexican hardwood, in African obeche wood and in eastern American ash. It seems to be the one species of Lyctid beetle that may become acclimatized and capable of developing in hardwood in British Columbia.

To my knowledge, NO softwood has ever been attacked by *Lyctus* beetles in British Columbia.

Finally, a ninth species is emerging (November 1965) from boards of a packing case recently received from south India. It closely resembles *L. brunneus* in elytral and leg characters but the front and vertex are different. It is being cultured out in the same way as *T. prostomoides* to see if it will attack hardwoods other than the so-far unidentified wood from which it is emerging.

FECUNDITY OF THE BLACK VINE WEEVIL, *Brachyrhinus sulcatus* (F.), FED ON FOLIAGE OF BLUEBERRY, CRANBERRY AND WEEDS FROM PEAT BOGS[1]

W. T. CRAM AND W. D. PEARSON[2]

Introduction

Larvae of the black vine weevil, *Brachyrhinus sulcatus* (F.), severely damaged roots of blueberry (Cram, 1963), and cranberry grown on well-drained peat bogs on Lulu Island and at Pitt Meadows. Adult weevils were observed feeding, or their feeding damage was seen on these plants and on several weeds of peat bogs. A laboratory study was conducted to determine the suitability of the weeds and the economic plants as hosts of this flightless, parthenogenetic weevil, using as criteria weight gain, preoviposition period, rate of egg laying, and egg viability.

Methods

Newly-emerged adults were collected from the duff under blueberry bushes on Lulu Island in mid-June. Only soft, incompletely hardened weevils were used. Single adults were confined at 20° C with 16 hours of shaded fluorescent light in closed plastic snap-cap vials (Anglo 2.5 by 9 cm) each with a leaf from a particular plant. Thirteen replicates of seven plant species were started. Foliage was changed at weekly intervals. The amount consumed by each weevil was judged by a rating scheme. Weevils were weighed when captured, three weeks later, and on the day of first oviposition. Weekly records of total and viable eggs were kept for each weevil. Viability was determined by holding the eggs for four days before counting, by which time the viable eggs had darkened. Counts were discontinued in mid-September when oviposition normally ceases in the field (Cram, 1965a). The data presented are from the first 10 weevils to oviposit in each treatment.

The plants chosen for study were: Himalaya blackberry, *Rubus thyrsanthus* Focke; salal, *Gaultheria shallon* Pursh; labrador tea, *Ledum groenlandicum* Oeder.; cranberry, *Vaccinium macrocarpon* Ait. var. MacFarlane; highbush blueberry, *Vaccinium corymbosum* (Aust.) var. Rancoccus; fireweed, *Epilobium angustifolium* (L.); sheep sorrel, *Rumex acetosclla* L. Selected undamaged current-season foliage from all but cranberry was collected periodically at the same blueberry plantation on Lulu Island and stored in air-tight plastic bags at 0° C until needed. Cranberry was collected from a nearby plantation.

Results

Blackberry and salal produced similar and significantly greater mean weight gains than the other plants after three weeks but none gave significantly different weight gains at the time of first oviposition (Table 1). Blackberry induced a significantly shorter mean preoviposition period than the other plants. Salal and cranberry gave the next shortest followed by labrador tea, fireweed and blueberry; no weevils survived to oviposit when fed sheep sorrel. There appeared to be excessive moisture in the closed vials containing sheep sorrel. The addition of strips of filter paper absorbed the excess moisture but did not halt mortality on this host.

Blackberry produced a significantly greater mean number of total and viable eggs than other plants (Table 1). Weevils fed blackberry laid more than 2.5 times as many eggs as those fed cranberry and 4 times as many as those fed blueberry. Salal produced significantly more eggs than blueberry or fireweed. There was a significant positive correlation between the number of eggs laid and the viability of the eggs, and a

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TABLE 1.--Means and standard deviations of weight gains, preoviposition periods, numbers of total and viable eggs and percentages of viable eggs of *B. sulcatus* fed excised leaves of various plants growing in peat bogs on Lulu Island.

Plants	Weight Gains		Pre-oviposition Periods	Eggs		
	At 3 weeks	At first egg				
	mg	mg	Days	Total	Viable	% Viability
Blackberry	23.2 (±3.6)a[1]	24.1 (±5.0)a	28 (±2.5)a	380 (±81.4)a	346 (±90.9)a	86 a
Salal	23.2 (±2.7)a	22.0 (±3.7)a	35 (±5.8)b	217 (±105.2)b	187 (±108.9)b	71 ab
Labrador Tea	13.8 (±4.3)bc	24.7 (±3.3)a	45 (±2.8)c	165 (±63.9)bc	150 (±67.7)bc	88 a
Cranberry	17.2 (±6.0)b	22.4 (±6.4)a	38 (±3.2)b	163 (±132.2)bc	133 (±136.0)bc	74 ab
Blueberry	15.6 (±4.7)b	20.1 (±4.4)a	48 (±12.1)c	99 (±58.5)cd	72 (±56.6)cd	59 b
Fireweed	11.2 (±5.0)bc	20.6 (±6.7)a	48 (±7.1)c	53 (±30.8)d	32 (±24.6)d	60 b
Sheep Sorrel	9.4 (±4.0)c	-[2]	-[2]	-[2]		
General mean	16.2 (±4.5)	22.3	40 (±9.7)	180	154	73

[1]Means within the same column which have the same letter are not significantly different at the 5% level, Duncan's New Multiple Range Test.

[2]No survivors

significant negative correlation between weight gain in the first three weeks and the length of the preoviposition period. The amounts of the various plants consumed were not judged to differ significantly.

Discussion

Observations on host selection by adult *B. sulcatus* indicated that they wander randomly at night and encounter hosts fortuitously. They become negatively geotropic at dusk and appear to climb any plant encountered and feed on the foliage, hence the wide range of plants showing leaf notches. It is not certain that weevils reject unsuitable plants after initial feeding but there is an indication that this might be the case with labrador tea which suffered least from feeding in the field (Cram, 1965b).

Since no significant differences occurred between plants in the amounts of leaf consumed but significant differences did occur between plants in initial weight gain, preoviposition period and egg production, certain hosts appear to be nutritionally superior to others for weevil increase. The best-suited hosts, indicated by this laboratory study, appear to be Himalaya blackberry and salal, both serious weeds of blueberry plantations and the headlands of cranberry bogs. Reduction of these weeds in and around commercial plantations might help appreciably to keep the numbers of the black vine weevil below damaging levels.

Summary

The roots of blueberry and cranberry grown in well-drained peat bogs are severely damaged by larvae of the black vine weevil, *Brachyrhinus sulcatus* (F.). The adults feed on the foliage of these commercial plants and several weed plants. A laboratory experiment using excised foliage from seven common plants as food for the adults revealed that Himalaya blackberry and salal were significantly superior hosts, on the evidence of shorter preoviposition periods and higher egg production. Inferior hosts in descending order were: labrador tea, cranberry, blueberry, fireweed and finally sheep sorrel. Adults did not survive to oviposit when fed sheep sorrel. Removing blackberry and salal in and around commercial plantations of blueberry and cranberry might help appreciably in reducing damage by this pest.

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Cram, W. T. 1965b. A note on the acceptability of leaf macerates on filter paper of plants from peat bogs by adult black vine weevils, **Brachyrhinus sulcatus** (F.). Proc. Entomol. Brit. Columbia 62: 14-15.

A FIRST RECORD OF PARALYSIS OF A DEER BY *Dermacentor andersoni* (STILES) AND NOTES ON THE "HOST-POTENTIAL" OF DEER IN BRITISH COLUMBIA

P. R. WILKINSON[1]

Despite the large numbers of records of paralysis of domestic animals and man by *Dermacentor andersoni* Stiles in the northwestern part of its range, the only record of paralysis of native ungulates concerns *Bison bison* (Linnaeus) in Montana (Gregson, 1958). In winter and spring mule deer, *Odocoileus hemionus hemionus* (Rafinesque), frequent lightly timbered or open south-facing slopes, attracted by freedom from snow and presence of browse shrubs (e.g. *Amelanchier, Mahonia*) (Klebenow, 1965). This shrub-growth, which is often associated with rocky or coarse soils, provides food and refuge to rodent hosts of the immature stages of *D. andersoni,* and soil-temperatures on these warm slopes are favourable to the development of the free-living stages (Wilkinson, 1964). Fresh deer signs are frequently seen on heavily infested tick foci, so deer presumably pick up many ticks. As spring is not the hunting season, there are fewer records of *D. andersoni* on deer than might be expected, and it is still unknown whether the tick engorges readily on deer.

Of about 190 records of ticks on mule deer at the Kamloops laboratory only seventeen concern *D. andersoni,* and of these only four of the original specimens are still available for examination. Only one of these (four females and one male from Creston, B.C., 15 April, 1941) contains fully engorged *andersoni* with a note that it was taken from a deer 'nearly dead and covered with ticks.' Cowan (1944), after describing heavy infestations with *Dermacentor albipictus* Packard on deer in Banff and Jasper National Parks, noted that *D. andersoni* was 'of regular occurrence on the deer range' but 'in its present numbers is not known to be detrimental to game.' Bishopp and Trembley (1945) recorded four lots of *D. andersoni* from mule deer of which three lots contained five females ranging from unfed to fully engorged. Cooley (1938) summarising the work of several authors gives *O. hemionus* as a host of *D. andersoni but does not* state the degree of engorgement observed.

Milne (1949), in his studies of *Ixodes ricinus* introduced the term 'host-potential', defining it as the number of the host animals in the study area multiplied by the average number of ticks infesting each animal. This should be qualified by a term to cover the proportion of these ticks maturing to the next instar, or the number of eggs layed by adult female ticks maturing on this host species, since some hosts develop hypersensitive reactions which prevent ticks engorging (Trager, 1939, Riek, 1962, Wilkinson, 1962), or they remove ticks by scratching, rubbing, licking or biting. Where the range of the host animal is considerably greater than the size of the tick focus, a term covering the proportion of engorged ticks returned to the focus would be needed.

Considering situations in North America without domestic animals, if ticks are picked up by deer and fail to engorge, the presence of deer would tend to reduce tick populations. If ticks maturing on deer produce more eggs than if the same ticks had been dependant on alternative hosts such as porcupines, the presence of deer would tend to increase the number of ticks, unless the wide range of the deer caused a large proportion of the engorged

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ticks to fall in places with unsuitable microclimate, or without suitable rodent hosts for the next generation of immature stages.

As part of a program to obtain more information on the 'host-potential' of deer, a bottle-fed male fawn about one month old was infested with 20 male and 20 female *D. andersoni* on 3 July, 1964. The ticks had been taken on 18 March, 1964 by 'flagging' vegetation and had since been kept at 6-10 C over water. The ticks were shaken into a girdle covering the underneath and sides of the belly, and the deer was examined daily between 7 and 11 July. At 9 AM on 9 July there were three females on the head, one on the neck and seven on the side of the chest; a female nearing repletion and weighing 476 mg was removed, so that it would not be lost. At 9 PM paralysis of the hind quarters had developed and female ticks weighing 338, 253 and 150 mg were removed to assist the deer's recovery. On 10 July the paralysis involved the forelegs as well as the rear legs, and a pair of ticks was removed from the neck, the female weighing 470 mg. At 1 PM a movie of the paralysis symptoms was taken and the remaining female ticks, which were in the partly engorged 'tan-coloured' stage, were removed and preserved. On 11 July the deer had recovered.

From this it appeared that if the ticks had not been removed and the deer had not succumbed to paralysis, the majority of ticks would have matured and oviposited. Two engorged ticks placed in an incubator at 25 C produced viable larvae, with a normal percentage of eggs hatching. Tests with ticks fed on sheep have shown that the number of eggs laid is approximately related to the weight of the female (W.F., in mg) by the expression N=10.5 (W.F. - 12.5), for ticks weighing between 420 - 750 mg.

To test the ability of ticks to engorge on older animals, and to obtain more information while the fawn was available, it was reinfested on 11 December with 31 male and 24 female ticks taken from vegetation in the spring of 1964, and stored as before. On 20 December an almost replete female weighing 645 mg was removed from the back of the neck. Another female engorged slowly, and a further eight males were added on 21 December in case this was due to a shortage of males. This female tick was removed tightly distended on 31 December, but weighed only 390 mg. The smaller proportion of ticks maturing may be accounted for by the long storage of the ticks and the loss of some of them during the struggles of the deer. An infestation with 10 males and 10 females obtained by sweeping vegetation on 13 March, 1965, and placed on the deer on 25 March yielded a female of 668 mg on 2 April. The fawn did not become paralysed during the December and March infestations.

Considering the repeated observation of engorgement of ticks on the fawn, and the marked paralysis produced by the first infestation, the scarcity of records of paralysis and tick engorgement is surprising. Possibly most fawns are born too late to encounter many ticks, because ticks are commencing aestivation and because deer are migrating to summer feeding grounds, while adult deer in spring may be resistant. Gregson (personal communication) has suggested that immune reactions to *D. albipictus*, with which most B.C. deer are infested from fall to spring, may cause a cross-resistance to the engorgement of *D. andersoni*. The possibility of this cross-resistance should be amenable to investigation on tethered deer and stalled cattle, meanwhile further information is needed on tick infestations of deer in spring.

Acknowledgements

Thanks are due to Mr. R. Ritcey, Game Biologist, Kamloops for providing the fawn.

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REPOSITORIES OF SYMBIOTIC FUNGUS IN THE AMBROSIA BEETLE *Monarthrum scutellare* LEC. (COLEOPTERA:SCOLYTIDAE)

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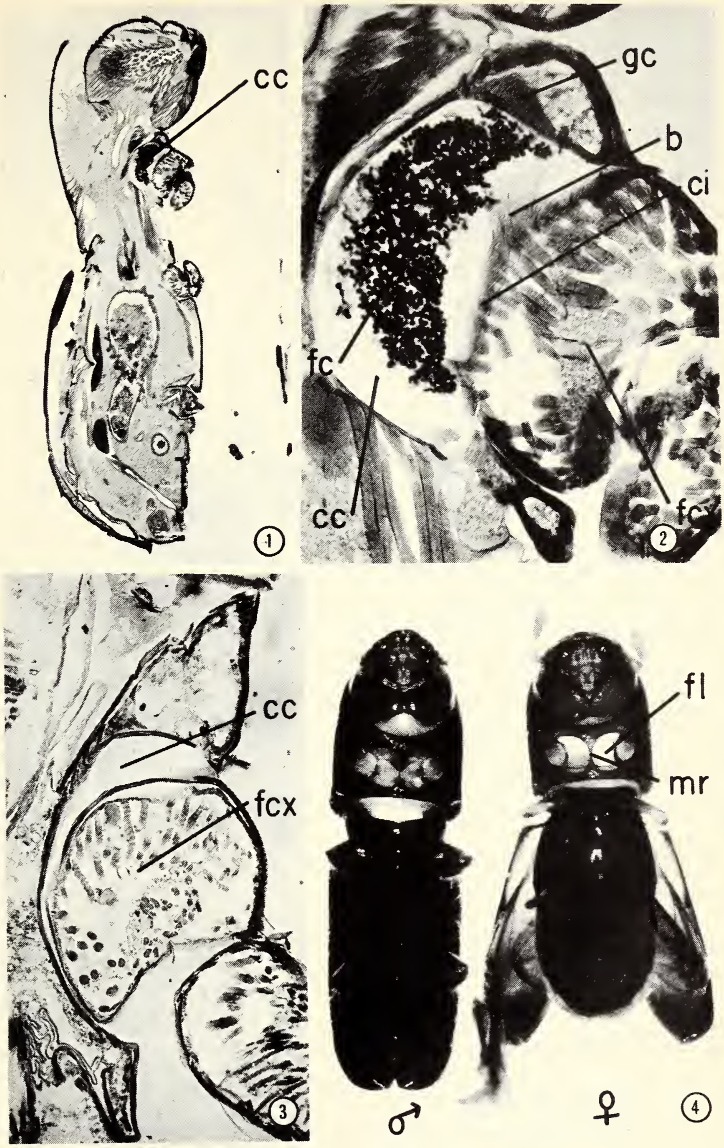
Introduction

Specialized structures or mycangia that contain symbiotic fungi have been identified by several workers in a number of scolytid ambrosia beetles. Since Francke - Grosmann (1956a) first described structures with this function in *Trypodendron lineatum* Oliv., workers have reported mycangia in other species (Francke - Grosmann, 1956b, 1958; Fernando, 1960; Schedl, 1962; Finnegan, 1963; Farris, 1963; Batra, 1963). Only females of most species possess these structures but in *Corthylus punctatissimus* Zimm. (Finnegan, 1963), *Gnathotrichus retusus* Lec., and *G. sulcatus* Lec. (Farris, 1963) only males have mycangia.

Batra (1963), working with *Monarthrum faciatum* Say and *M. mali* Fitch found mycangia to be enlargements of the forecoxal cavities in the female beetles. Because of this and the previous work of Francke-Grosmann and Batra (Francke-Grosmann, 1963) with these two species of *Monarthrum* it seemed reasonable to suspect that *Monarthrum scutellare* Lec. would possess mycangia in a similar position. This insect attacks logs or weakened trees of the genus *Quercus* from British Columbia south to California (Chamberlin, 1958), its host on Vancouver Island being *Q. garryana* Dougl.

Materials and Methods

Adult beetles were excavated from their host and either kill-fixed in alcoholic Bouin's solution for sectioning or stored alive in a refrigerator for dissecting and culturing later. Specimens for sectioning were dehydrated with tertiary butyl alcohol (Johansen, 1940), embedded with Fisher's "Tissuemat," and serial sagittal sections were cut at 15 and 20 microns on a rotary microtome. The sections were treated with a modified Gram-Weigert stain (Leach, 1940) and counter stained with eosin Y, previously used by Fernando (1960),



Illustrations

Fig. 1.—Sagittal section, 15 microns, of a whole ♀ **M. scutellare** stained with a modified Gram-Weigert stain, showing the location (cc) of the mycangia. 22X.

Fig. 2.—Sagittal section, 20 microns, of the enlarged ♀ forecoxal cavity (cc), stained with a modified Gram-Weigert stain to show the fungous cells (fc), glandular tissue (gc), brush (b) and coxal indentation (ci). 180X.

Fig. 3.—Sagittal section, 15 microns, of a ♂ coxal cavity (cc). 180X.

Fig. 4.—Ventral view of ♂ and ♀ **M. scutellare** adults with forecoxae removed to show whitish fungous layer (fl) and complete median ridge in ♀ (mr), and the lack of same in ♂. 20X.

Symbol Legend

cc —Coxal cavity
fl —Fungous layer
gc —Gland cells
b —Brush
ci —Coxal indentation
fc —Fungous cells
mr —Median ridge
fcx—Forecoxae

Farris (1963) and Farris and Funk (1965), to differentiate fungous deposits from other tissue in beetle sections.

To corroborate findings in the stained sections, the forecoxae were removed from refrigerated beetles of both sexes and the coxal cavities examined under a dissecting microscope. Cultures were made from the cavity contents and the fungus identified as *Monilia brunnea* Verrall (Funk, 1965).

Results and Discussion

Stained sagittal sections of female beetles showed enlargements of the forecoxal cavities (Figs. 1 and 2) containing blue and pink coloured fungous material consisting of globose cells and short hyphal filaments (Fig. 2). The male forecoxal cavities were not enlarged (Fig. 3) and did not contain fungous material. The mesocoxal and metacoxal cavities of both sexes were not enlarged and likewise contained no fungous material. A whitish layer of fungous material was visible when the forecoxae of the female were removed from their sockets. This was absent in the male (Fig. 4).

After staining with the modified Gram-Weigert stain and eosin Y, some of the globose fungal cells found in the forecoxal cavities showed a Gram-positive reaction by retaining the blue stain, and others showed a Gram-negative reaction by turning pink. When these cells were viewed under polarized light, a portion of the walls of the Gram-positive cells was birefringent but no birefringence was seen in the Gram-negative cells. The significance of the birefringence is unknown. Fresh fungous material taken from the coxal cavities showed no birefringence.

The median ridge between the forecoxal cavities of the female is complete, forming part of the mycangial wall (Fig. 4) separating the two cavities. This ridge is incomplete in the male (Fig. 4).

The fungous cells are not contained in a structure with a separate specialized opening as in *T. lineatum,* but lie in a loosely compressed hemispherical cake in the cavity (Fig. 2).

Within the anterior wall of the cavity in the female there is a series of gland cells which appear to lead into the cavity (Fig. 2), but these are absent or greatly reduced in the male. In her work with several species of ambrosia beetles Francke-Grosmann suggested that secretions from similar cells are beneficial to the fungous spores. Possibly the gland cells serve a similar function in *M. scutellare.*

Not only are the female cavities enlarged, making a place for fungus transport, but the forecoxae have a slight indentation which makes the cavity even larger (Fig. 2). At the anterior edge of this indentation, opposite the glandular tissue, there arises a sclerotized group of bristles forming a brush (Fig. 2). The bristles are pointed or bent away from the main body of fungous cells. The orientation of the brush on the coxae indicates that it could move the fungous cells forward and out of the cavity when the beetle walks about in its gallery, thus inoculating the host with the fungus.

Schedl (1962) has described similar mycangia and methods of host inoculation in the ambrosia beetles *Pterocyclon brasiliensis* Schedl and *P. nudum* Schedl, both from Brazil.

Summary

Adult female beetles of *Monarthrum scutellare* Lec. carry symbiotic fungi in mycangia. These are enlargements of the forecoxal cavities similar to those described by Batra (1963) for other members of the genus. Male beetles do not have these structures.

Acknowledgements

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Neacoryphus SCUDDER, A NEW GENUS OF LYGAEINAE (HEMIPTERA :LYGAEIDAE)

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A study of Old World and New World species of Lygaeinae at present placed in the genus *Melanocoryphus* Stal 1872, has shown that they cannot be considered as all belonging to one genus. The New World species must be placed in a new genus, which is described below.

Genus **Neacoryphus** Scudder *gen.nov.*

Red - orange and black bugs; dorsum more or less glabrous.

Head triangular and black; eyes adjacent to antero-lateral angles of pronotum and not stylate; antennae black, with typical ratio 10:22:18:21; bucculae elevated and gently convex throughout, extending to posterior part of head; rostrum variable in length, reaching middle or hind coxae, or just beyond.

Pronotum ecarinate; posterior margin more or less straight or slightly convex, and without caudad extensions of humeral angles; disc of pronotum somewhat punctate, especially near calli; thoracic pleura if contrasting black and ochraceous, then fuscous half anteriorly; pleura rather punctate, especially posteriorly; posterior margin of metapleura distinctly convex; ostiolar peritreme present, black and auriculate. Scutellum not tumid and swollen, but with a shallow excavation on each side of mid-line.

Hemielytra usually macropterous; corium and clavus variously coloured, but never red with a central round black spot; membrane black, black with pale margin, or pale with black veins—never black with one or two white spots in central area; veins of hemielytra prominent.

Legs black; femora unarmed.

Abdomen pale or dark; if venter bicoloured, then usually black in centre with lateral margins of sterna only pale—venter never red with only sternum VII completely black.

Spermatheca with distal portion relatively short and with distinct bulb—not complexly coiled (figs. 1-2).

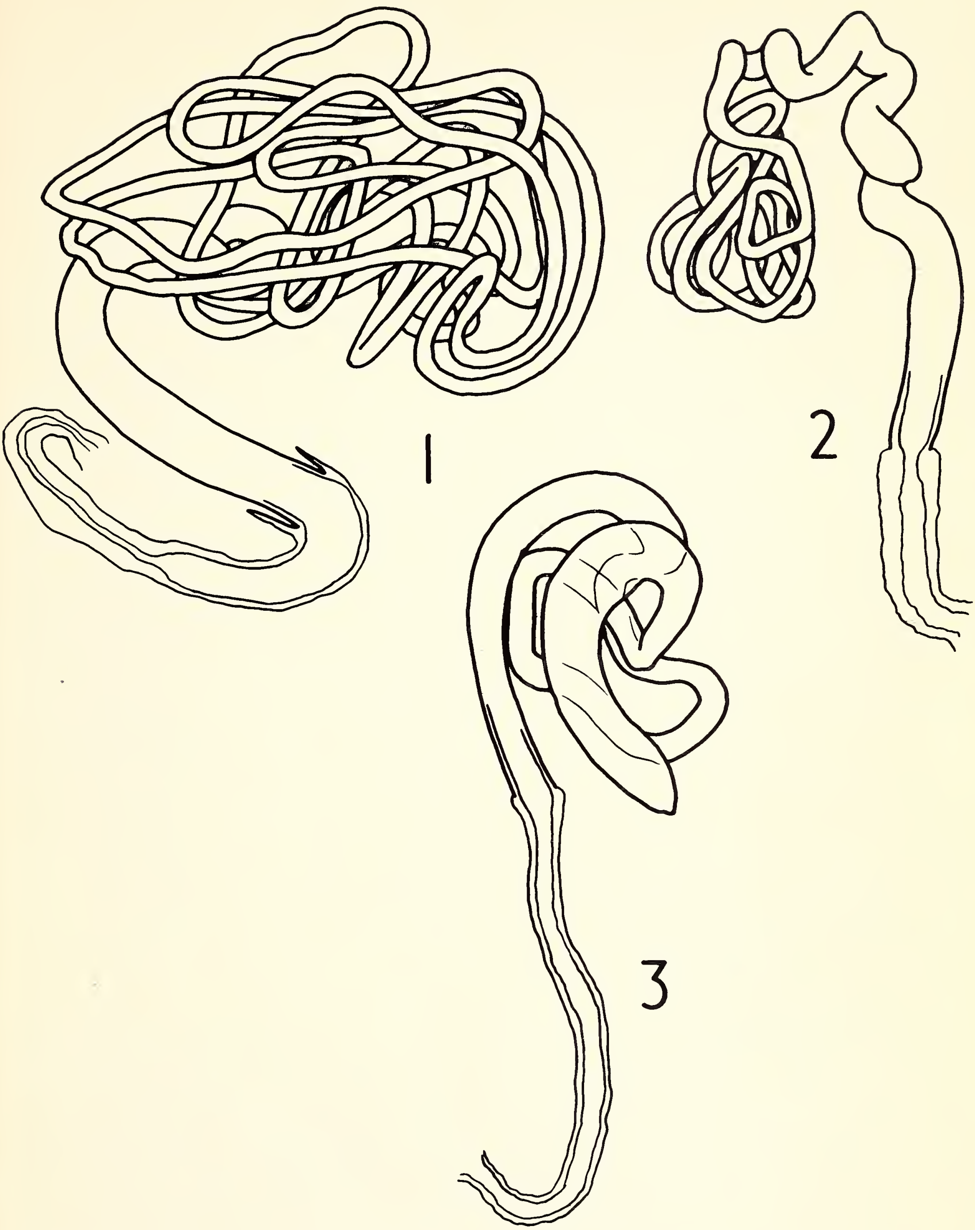
Type species: *Lygaeus bicrucis* Say 1825

This genus is erected to contain the New World species which have until the present been placed in the genus *Melanocoryphus* Stal 1872: the latter is a genus confined to the Old World. *Neacoryphus* can be separated from neighbouring genera of the *Melanocoryphus*-complex, by the following key, and the spermathecae shown in figs. 3-6.

Characters of *Melanocoryphus*-complex: head generally black (at least black at base and without red or pale spot or streak in centre); legs and ostiolar peritreme black; postero-dorsal corner of metapleura non-angulate; eyes adjacent to antero-lateral angles of pronotum; scutellum somewhat excavate on each side of midline.

Key to genera of **Melanocoryphus**-complex

1. Corium red with a distinct discoidal black spot in middle; membrane black with a central discoidal pale spot and apically with a pale spot or a pale margin (never all black or black with **only** a pale margin); thoracic pleura if partly black, then black part posteriorly; spermatheca as in figs. 1-2; Old World .... **Melanocoryphus** Stal
— Corium not red with a central discoidal black spot; membrane black, or marked with white, but never with white markings as above; thoracic pleura if partly pale, then pale markings posteriorly; New World 2
2. Membrane with a median white discoidal spot or variegated with white; species small and pilose .... **Lygaeospilus** Barber



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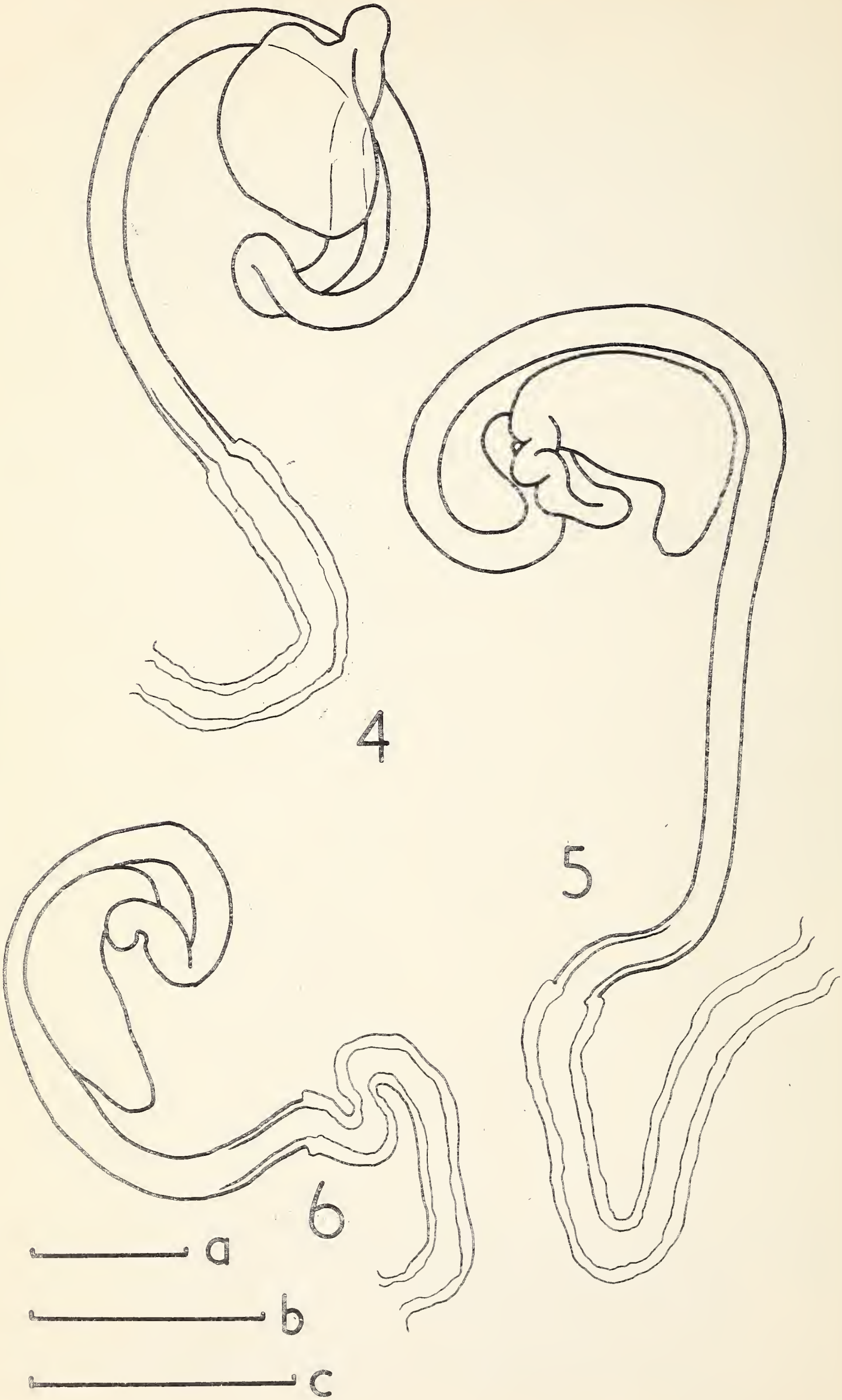
Figs. 1-6—Spermathecae. 1. **Melanocoryphus albomaculatus** (Goeze) [Florence]; 2. **M. superbus** (Poll.) [Channel Is., Jersey, St. Catherine's Bay, 22. iv. 1957, G. G. E. Scudder]; 3. **Neacoryphus bicrucis** (Say) [B.C., Victoria, 26. vi. 1923, K. F. Auden]; 4. **N. lateralis** (Dallas) [Wyo., Buffalo, 13. ix. 1963, G. G. E. Scudder]; 5. **N. circumlitus** (Stal) [Mexico, Jalisco, Puerto Vallarta, 7-12. vii. 1961, P. R. Grant]; 6. **N. admirabilis** (Uhler) [Ore., Steens Mts., Fish Lake, 7000 ft., 10. vii. 1927, H. A. Scullen]. Scale lines = 0.25 mm. Figs. 1-2 to scale c, figs. 3-4 to scale b, and figs. 5-6 to scale a.


4
5
6
a
b
c

— Membrane without a median white discoidal spot, entirely fuscous, black with pale margin, or pale with fuscous veins; larger species, not conspicuously pilose .... **Neacoryphus** Scudder

In the genus **Neacoryphus** should be placed the following species:

1. **Neacoryphus admirabilis** (Uhler 1872) **comb. nov.**
   Lygaeus admirabilis Uhler 1872, in Hayden, Rept. U.S. Geol. Surv. Mont.: 405 [O.D.]
   Melanocoryphus admirabilis Slater 1964, Cat. Lyg. 1:120 [Bibliogr.]

2. **Neacoryphus albonotatus** (Barber 1923) **comb. nov.**
   Lygaeus (Melanocoryphus) albonotatus Barber 1923, Amer. Mus. Novit. 75:1 [O.D.]
   Melanocoryphus albonotatus Slater 1964, Cat. Lyg. 1:125 [Bibliogr.]

3. **Neacoryphus bicrucis** (Say 1825) **comb. nov.**
   Lygaeus bicrucis Say 1825, J. Acad. Nat. Sci. Phil. 4:322 [O.D.]
   Melanocoryphus bicrucis Slater 1964, Cat. Lyg. 1:126 [Bibliogr.]

4. **Neacoryphus circumlinitus** (Distant 1882) **comb. nov.**
   Lygaeus (Melanocoryphus) circumlinitus Distant 1882, Biol. Centr. Amer. Hem. Het. 1:186 [O.D.]
   Melanocoryphus circumlinitus Slater 1964, Cat. Lyg. 1:129 [Bibliogr.]

5. **Neacoryphus circumlitus** (Stal 1862) **comb. nov.**
   Lygaeus circumlitus Stal 1862, Stett. ent. Zeit. 23:309 [O.D.]
   Melanocoryphus circumlitus Slater 1964, Cat. Lyg. 1:129 [Bibliogr.]

6. **Neacoryphus circumplicatus** (Distant 1882) **comb. nov.**
   Lygaeus (Melanocoryphus) circumplicatus Distant 1882, Biol. Centr. Amer. Hem. Het. 1:186 [Bibliogr.]
   Melanocoryphus circumplicatus Slater 1964, Cat. Lyg. 1:129 [Bibliogr.]

7. **Neacoryphus circumseptus** (Stal 1867) **comb. nov.**
   Lygaeus circumseptus Stal 1867, Berl. ent. Zeit. 10:162 [O.D.]
   Melanocoryphus circumseptus Slater 1964, Cat. Lyg. 1:129 [Bibliogr.]

8. **Neacoryphus consanguinitas** (Distant 1882) **comb. nov.**
   Lygaeus (Melanocoryphus) consanguinitas Distant 1882, Biol. Centr. Amer. Hem. Het. 1:187 [O.D.]
   Melanocoryphus consanguinitas Slater Slater 1964, Cat. Lyg. 1:130 [Bibliogr.]

9. **Neacoryphus facetus** (Say 1831) **comb. nov.**
   Lygaeus facetus Say 1831, Desc. Het. Hem. N. Amer. (Fitch Rep.) :773 [O.D.]
   Melanocoryphus facetus Slater 1964, Cat. Lyg. 1:131 [Bibliogr.]

10. **Neacoryphus lateralis** (Dallas 1852) **comb. nov.**
   Lygaeus lateralis Dallas 1852, List Hem. B.M. 2:550 [O.D.]
   Melanocoryphus lateralis Slater 1964, Cat. Lyg. 1:134 [Bibliogr.]

11. **Neacoryphus nigriguttulus** (Stal 1874) **comb. nov.**
   Melanocoryphus nigriguttulus Stal 1874, K. Vet. Akad. Handl. 12(1): 113 [O.D.]
   Melanocoryphus nigriguttulus Slater 1964, Cat. Lyg. 1:136 [Bibliogr.]

12. **Neacoryphus nigrinervis** (Stal 1874) **comb. nov.**
   Melanocoryphus nigrinervis Stal 1874, K. Vet. Akad. Handl. 12(1): 112 [O.D.]
   Melanocoryphus nigrinervis Slater 1964, Cat. Lyg. 1:136 [Bibliogr.]

13. **Neacoryphus rubicollis** (Uhler 1894) **comb. nov.**
   Melanocoryphus rubicollis Uhler 1894, Proc. Cal. Acad. Sci. (2)4: 244 [O.D.]
   Melanocoryphus rubicollis Slater 1964, Cat. Lyg. 1:136 [Bibliogr.]

14. **Neacoryphus rubriger** (Stal 1862) **comb. nov.**
   Lygaeus rubriger Stal 1862, Stett. ent. Zeit. 23:309 [O.D.]
   Melanocoryphus rubriger Slater 1964, Cat. Lyg. 1:137 [Bibliogr.]

15. **Neacoryphus variegatus** (DeGeer 1773) **comb. nov.**
   Cimex variagatus DeGeer 1773, Mem. Serv. Hist. Ins. 3:342 [O.D.]
   Melanocoryphus variegatus Slater 1964, Cat. Lyg. 1:145 [Bibliogr.]

It is also possible that *Lygaeus aureus* Distant 1882 (Biol. Centr. Amer. Hem. Het. 1:188) belongs in *Neacoryphus,* but I have not seen the type of this species.

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THE NOTONECTIDAE (HEMIPTERA) OF BRITISH COLUMBIA

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A study of the Notonectidae in British Columbia has shown that six species are present in the Province. Distribution, habitat notes and a key to species is given below.

Subfamily **Notonectinae**

Notonecta borealis Bueno & Hussey. — Cariboo, Springhouse, 15. vii. 1962, 18. viii. 1962, 31. viii. 1962, 26. v. 1963 (G. G. E. Scudder); Chilcotin, 21. ix. 1963 (G. G. E. S.) [U.B.C.]. Hungerford (1933) records *N. borealis* from Michigan, Minnesota, Quebec and Bearfoot Mountains, B.C.: the latter record was repeated by Downes (1927). I have been unable to locate the Bearfoot Mountains locality, and so it is possible that this record refers to some neighbouring state or province.

To the above distribution, also can be added the Northwest Territories and Alberta. Material examined includes:- N.W.T., M. 37, Yellowknife, 21. vii. 1961 (T. G. Northcote); N.W.T., M. 10. 5, Yellowknife, 21. vii. 1961 (T. G. N.); N.W.T., trib. to Birch Lake, 4 mi. E. Birch Lake at mi. 74 E. of Fort Providence, on Ft. Providence—Fort Rae Hwy., 31. vii. 1961 (C. C. Lindsey). ALTA., Hay River, 8 mi. N. of Meander River, 20. vii. 1961 (T. G. N.) [U.B.C.].

The specimens from near Birch Lake, N.W.T. and Hay River, Alta. were taken in slow flowing rivers. At the former the river was 10 feet wide, 4 feet deep and with a weed bed at margin; at the latter, the river was 80 feet wide, 2 feet deep and the bottom was mud with small stones and some *Potamogeton*. In contrast to this, the B.C. specimens were taken in small ponds.

The captures of *N. borealis* in the Interior of British Columbia, indicate that in this area, the species overwinters in the adult instar: Hungerford (1933) states that unpublished records of the species in Michigan, indicate that there it overwinters in the egg stage. The B.C. specimens were captured in small freshwater ponds, of less than an acre in extent and with a profuse growth of submerged and emergent vegetation. These ponds had a pH of 8.03 - 8.35, and a water conductivity of 300 - 1050 microhmos/cm. (equivalent to 0.0135 - 0.0525 % NaCl).

N. kirbyi Hungerf. — Comox, vii (J. L. Jones); Forbidden Plateau, vii; Malahat, viii (W. Downes); Metchosin; Saturna Is., v (J. Boone); 20 mls. S. Port Clements, iii (A. B. Acton); Hope, ii (G. H. Asche); Milner, v (K. Graham); Nancy Lake, Mt. Seymour, ix (R. E. Leech); Stanley Park, Vancouver, iv (G. G. E. Scudder); Vancouver, vii (H. B. Leech); Oliver, ix (J. Boone); Keremeos, ix (W. Downes); Olalla, viii (G. G. E. S.); Westbank, ix (W. D.); Enderby, vi (W. D.); Vernon, 29. iv. 1918, in flight on road (M. Ruhmann); Vernon, ix (H. B. L.), x (W. D.); Salmon Arm, v (H. B. L.); Quick, viii (G. J. Spencer); Nicola, vi (G. J. S.); Kamloops, vii-viii (G. J. S.); Edith Lake, viii; Savona, vii; Clinton, 6 mls. S., ix (G. G. E. S.); 13 ml. Lake, Dog Creek Rd, N. Clinton, x (H. B. L. & C. V. Morgan); 149 mile, Cariboo Hwy., ix (G. G. E. S.); Chilcotin, v-ix (G. G. E. S.); McIntyre Lake, Chilcotin, x (G. G. E. S.); Boitano Lake, Cariboo, v (G. G. E. S.); Westwick Lake, Cariboo, iv-ix (G. G. E. S.); Springhouse, Cariboo, iv-x (G. G. E. S.); Kootenay (Horseshoe Lake, New Lake), x (H. Sparrow); Fort St. John, vi (A. B. Acton) [U.B.C.]. Oliver, v (J. E. H. Martin); Peachland, x (A. N. Gartrell); Summerland, ix (A. N. G.); Westbank, v (A. Thrupp); Kaleden, xii (A. N. G.);

Kelowna, xi (A. N. G.); Creston, vii (A. A. Dennys); Princeton, v (P. N. Vroom); Lavington, vi. (A. Thrupp); Copper Mt., ix (G. Stace Smith); Minnie Lake, vii (N. Criddle); Clinton, v (R. Hopping); 134 mile, viii (R. Hopping); Barkerville, ix (G. Stace Smith); Revelstoke, 6000 ft., vii (E. R. Buckell); Courtenay, vii (J. G. Gregson) [C.N.C.].

Hungerford (1933) notes material in the C.N.C. from Mt. Cheam, iii; Rolla, viii (P. N. Vroom), Aspen Grove, v (P. N. Vroom), and reports the species as being confined to the western United States and Canada. Previous to 1933 *N. kirbyi* was confused with *N. insulata* Kirby.

In the B.C. Interior, *N. kirbyi* has been taken in a wide variety of lakes, with pH 7.03 - 9.23 and conductivity 60 - 6,800 microhmos/cm., but has not so far been taken in waters above 7000 microhmos/cm. (about 0.4% NaCl). Some preliminary measurements have been made on the haemolymph of this species: the results are tabulated below.

Lake	Osmolarity of lake water (osmoles)	Osmolarity of insect haemolymph (osmoles)
A	0.005	0.30
B	0.135	0.36
C	0.270	0.37

In Lake B there was 47 meq. Na/L and in the insect haemolymph 153 meq. Na/L (based on five insects pooled).

N. undulata Say.—Comox, vii (J. L. Jones); Colwood, x (W. Downes); Courtenay; Forbidden Plateau, 3000 ft., vii (Jones); Goldstream, vii (K. F. Auden); Lower Quinsam Lake, iv (in cop. 30. iv. 1960) (J. Lanko); Malahat, viii (W. D.); Metchosin, viii (W. D.); Nanaimo, v (G. J. Spencer); Saanich Distr., viii-ix (W. D.); Tofino, vi-viii (G. J. S.); Victoria, vi (K. F. A.); Agassiz, vii; Haney, ix (W. D.); Prince Rupert, muskeg pool (N. Carter); Nr. Squamish, viii (G. G. E. Scudder); Steelhead, ix (G. G. E. S.); Vancouver, x (D. C. Buckland); Oliver, viii (W. D.); Vaseaux Lake, viii (W. D.); Westbank, ix (W. D.); Keremeos, ix (W. D.); Kamloops, viii (G. J. S.); Sheridan Lake, ix; Williams Lake Distr., v (G. G. E. S.); Chilcotin, v-x (G. G. E. S.); McIntyre Lake, Chilcotin, x (G. G. E. S.); Green Timbers Plateau, vi-x (G. G. E. S.); Beaverdam Lake, Cariboo, x (G. G. E. S.); Springhouse, Cariboo, v-x (G. G. E. S.); Batholemew Lake, S. of Kimberley, v (I. Stirling); Kootenay (Horseshoe Lake,Jim Smith Lake, Enid Lake, Lillian Lake, Hiawatha Lake, Bednorski Lake, New Lake), x (H. Sparrow) [U.B.C.]. 134 Mile (R. Hopping); Vernon (R. Hopping) [F.I.S., Vernon]. Matson Lake, V.I., x (Downes & Hardy); Wellington, iii [Prov. Mus. Victoria]. Peachland, x (A. N. Gartrell); Salmon Arm, ix (A. Thrupp); Summerland, x (A. N. G.); Oliver, x (A. N. G.); Victoria, vi (K. F. A.) [C.N.C.]. Hungerford (1933) also gives Chilliwack, ix; Mt. Cheam, ix, and notes that *N. undulata* has a wide range, extending from coast to coast in North America and from Canada to the Gulf of Mexico.

In British Columbia, *undulata* seems to be relatively more abundant in the south than in the central interior, and is more common in the south-east, than is *kirbyi*. In the Cariboo and Chilcotin *undulata* and *kirbyi* frequently occur in the same lake. They have a similar range of salinity tolerance and haemolymph values appear identical.

N. spinosa Hungerf. — Oliver, 15. viii. 1937 (W. Downes); Vernon, 4. x. 1921 (W. D.), 13. ix. 1930 (H. Leech) [U.B.C.]. Kelowna, xi (A. N. Gartrell) [C.N.C.]. Downes (in litt.) reports this from slow flowing streams. It appears to be confined to the Okanagan Valley in B.C. Hungerford (1933) records the species from B.C., Oregon, Montana, Nevada and Utah.

N. unifasciata andersoni Hungerf. — Osoyoos, 29. iii. 1941 (H. B. Leech); Westbank, 12. ix. 1954 (W. Downes) [U.B.C.]. Oliver, v (A. N. Gartrell); Peachland, x (A. N. G.); Penticton, x (A. N. G.); Summerland, iv (A. N. G.); Vernon, vi (R. Hopping) [C.N.C.]. Like *spinosa,* apparently confined to the Okanagan Valley in B.C. This subspecies extends from B.C. through the Western United States to Mexico, the type locality being Oliver, B.C.

Subfamily **Anisopinae**

Buenoa confusa Truxal — Duncan, 4. ix. 1926 (W. Downes); Beaver Lake, Saanich Dist., 9. viii. 1919 (W. D.); Malahat, 30. viii. 1939 (W. D.); Sooke,19. viii. 1923 (K. F. Auden); Nr. Squamish, 25. viii. 1961 (G. G. E. Scudder); Oliver, 15. viii. 1957 (W. D.); Premier Lake, Kootenay, 4. ix. 1963 (I. Stirling). These constitute the first definite records of this species in the Province: material from Vancouver Island was recorded under *B. elegans* (Fieb). by Downes (1927). Truxal (1953) has shown that the North American specimens referred to *elegans* are incorrectly named, most of them being *confusa.*

B. confusa has a very interesting distribution in that it occurs only in the southern drier and warmer areas of the Province: it does not apparently penetrate far into the Interior, but also it is not confined to the Okanagan. The locality near Squamish is a very small road-side pond, with floating logs and a little vegetation. In August 1961 the species was abundant and both adults and larvae were captured. Truxal (1953) reports *confusa* from Alberta, Manitoba, eastern and southern United States and the West Indies. In the northern part of its range, specimens are larger than those to the south and the species seems to show a clinal type variation. Further, Truxal (loc. cit.) reports a variation in flight wing development in different populations. In Manitoba and Alberta 32% were short-winged, while those from Connecticut, Michigan, New York, New Jersey and Kansas were all short winged. Other states had varying percentages of short-winged individuals and the sample from the Grand Cayman Island was all long-winged. All specimens so far studied from British Columbia are short-winged and thus the reduced wing condition seems not to have a geographical basis. Perhaps it is related to habitat stability, similar to the conditions in Corixidae and other Notonectidae (Young, 1961, 1965; Scudder, 1964).

Key to Notonectidae of British Columbia

1. Hemielytral commissure with definite hair-lined pit on anterior end; hemielytra hyaline; fore tarsi of male with two tarsomeres; male fore femora widened at apex and with stridulatory area on inner surface; greatest width of head at least 7x width of vertex; pronotum tricarinate, the median carina distinct; synthlipsis narrow, less than half anterior width of vertex. .... **Buenoa confusa** Trux
— Hemielytral commissure without definite hair-lined pit on anterior end; hemielytra opaque 2
2. Keel of fourth abdominal sternum bare, hairs confined to sides. 3
— Keel of fourth abdominal sternum not bare 4
3. Insects pale and more or less uniform ochraceous; anterior margin of corium sometimes narrowly fuscous; membrane and scutellum flavo-ochraceous; male genital capsule with distinct ventral finger-like process .... **Notonecta borealis** B. & H.
— Insects usually distinctly marked with black; membrane fuscous in basal half; scutellum completely black; male genital capsule with slight ventral conical projection **N. kirbyi** Hung.
4. Mesotrochanter angulate or spinose 5
— Mesotrochanter rounded .... **N. undulata** Say
5. Mesotrochanter produced into a long spine .... **N. spinosa** Hung.
— Mesotrochanter angulate .... **N. unifasciata andersoni** Hung.

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