

**BIOLOGICAL CONTROL INVESTIGATIONS IN BRITISH COLUMBIA<sup>1</sup>**

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Since the initial introduction of natural enemies of insects into British Columbia in 1917, 42 species of parasites and predators have been released against 21 species of pest insects. This comparatively large-scale importation of beneficial insects was undertaken in an effort to control the important insect pests that have become established in the Province without their natural enemies. The geographic location and topography of British Columbia presented barriers that prevented these enemies from reaching the area unassisted.

The topography and climate of British Columbia separate it ecologically from the rest of Canada, and subdivide it into a number of more or less clearly

defined ecological islands. The mountains form natural physical barriers that restrict the movement and distribution of insect species and through their effect on climate produce a wide range of temperature and precipitation that places a further restriction on distribution. This increases the number of problems in biological control of insects, but also provides many advantages for the application of this method of control that are not found in less restricted areas.

An indication of the wide range of climate in British Columbia is given in the following records provided by the Meteorological Division of the Department of Transport. The statistics are annual averages.

	Maximum	Minimum
Precipitation . . . . .	Northern coast, 112.11"	Interior, 9.02"
Snowfall . . . . .	Eastern interior, 390.2"	Vancouver Island, 6.3"
Extreme High		
Temperature . . . . .	Central interior, 103° F.	Northern coast, 75° F.
Extreme Low		
Temperature . . . . .	Northern interior, -45° F.	Vancouver Island, 20° F.
Sunshine . . . . .	Vancouver Island, 2207 hrs.	Northern coast, 1053 hrs.

These extremes of climate are responsible for great variation in the flora in the different areas, and this has an important effect on the insect species through restricting them to the areas where their host plants grow. The number of plant species has been greatly increased through the introduction of new crops that are continually being added to the diversified agricultural areas. Many of the economically important insect pests accompanied the original or later importations of their

host plants before the Division of Plant Protection reduced this hazard to the minimum. There are still ways by which new insect pests may be introduced and become established in the Province in spite of the most careful inspection at ports of entry. Evidence of the continued increase in the number of insect pests that have become established in British Columbia is contained in Table I, which includes a partial list of the species that have been recorded since 1900.

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TABLE I

A partial list of insect pests recorded for the first time in British Columbia since 1900.

COMMON NAME	SCIENTIFIC NAME	DATE FIRST RECORDED
Codling moth.....	<i>Carpocapsa pomonella</i> (L.) (Vancouver Island).....	1900
	(Interior).....	1905
Greenhouse whitefly.....	<i>Trialeurodes vaporariorum</i> (Westw.).....	1907
Apple mealybug.....	<i>Phenacoccus aceris</i> (Sign.).....	1913
Pea weevil.....	<i>Bruchus pisorum</i> (L.).....	1915
European earwig.....	<i>Forficula auricularia</i> L.....	1916
Satin moth.....	<i>Stilpnotia salicis</i> (L.).....	1920
Lecanium scale.....	<i>Lecanium coryli</i> (L.).....	1923
Larch sawfly.....	<i>Pristiphora erichsonii</i> (Htg.).....	1930
Cabbage seedpod weevil.....	<i>Ceutorhynchus assimilis</i> (Payk.).....	1931
Pea moth.....	<i>Laspeyresia nigricana</i> (Steph.).....	1933
Carrot rust fly.....	<i>Psila rosae</i> (F.).....	1936
Soft scale.....	<i>Coccus hesperidum</i> (L.).....	1938
Lodgepole needle miner.....	<i>Recurvaria milleri</i> (Busck).....	1942

The first introduction of natural enemies of insects into British Columbia occurred in 1917, when the predacious mite *Hemisarcoptes malus* (Shimer) was obtained in New Brunswick and released on Vancouver Island, on the lower mainland, and in the Okanagan Valley against the oystershell scale.

A few additional parasite species were introduced before 1929, but prior to that time there were no suitable facilities in Canada to provide pure parasite cultures for release. After the establishment of the Dominion Parasite Laboratory at Belleville, Ontario, in 1939, a modern laboratory with quarantine facilities was constructed, and under the direction of A. B. Baird, Officer-in-Charge, Biological Control Investigations, the importation, propagation, and distribution of parasites proceeded rapidly. The distribution and successful establishment of many of the species that have been introduced into British Columbia would not have been possible, however, without the active co-operation of the local entomologists. The method by which a parasite of the European earwig, i.e., *Bigonichaeta setipennis* (Fall.), was established provides a good example of this co-operation. Colonies of this parasite obtained from England through the Belleville laboratory and

released at New Westminster between 1920 and 1931 did not give evidence of becoming established. Arrangements were made by A. B. Baird in 1933 to procure breeding stock from the city of Portland, Oregon, where propagation and distribution of the parasite was then in progress. A breeding station was set up at the Dominion Entomological Laboratory at Victoria, and R. W. Smith of the Belleville laboratory assisted W. Downes in the development of suitable facilities and the establishment of propagation routine. The work was continued for several years by W. Downes and H. Andison, and more than a quarter of a million parasites were released during the period 1934 to 1939 with the result that the species became established over a wide area.

Reports concerning the establishment of many of the introduced parasites have been published by a number of entomologists including Venables (1923, 1931), Glendenning (1931), Downes and Andison (1941), Hopping, Leech, and Morgan (1943), Wishart (1947), Spencer (1947), and Baird and McLeod (1949).

An alphabetical list of all species of parasites and predators introduced and the pest species against which they have been released is given in Table II.

TABLE II  
Species of parasites and predators introduced into British Columbia during the period 1917 to 1949.

SPECIES	HOST	LOCALITY	YEAR	ORIGIN	NUMBER RELEASED
<b>Allotropa sp.</b>	Apple mealybug, <i>Phenacoccus aceris</i> (Sign.)	Nelson .....	1938	Nova Scotia .....	2,080
<b>Allotropa utilis</b> Mues.	Apple mealybug, <i>Phenacoccus aceris</i> (Sign.)	Boswell .....	1939	Nova Scotia .....	44
		Boswell .....	1940	" .....	190
		Creston .....	1940	" .....	240
		Long Beach .....	1940	" .....	17
		Kelowna (Okanagan Mission) .....	1941	" .....	21
		Okanagan Mission .....	1942	" .....	106
		Robson .....	1942	" .....	252
		Bonnington & S. Slocan .....	1943	" .....	1,340
		Gray Creek .....	1943	" .....	1,535
		Queen's Bay .....	1943	" .....	777
		Boswell & Dist. ....	1944	N. S., through B. C. ....	628
		Queen's Bay .....	1944	" .....	427
		Willow Pt. & Nelson .....	1944	" .....	762
		Okanagan Mission .....	1945	" .....	2,732
		Royal Oak (Victoria) .....	1948	" .....	133
<b>Apanteles solitarius</b> (Ratz.)	Satin moth, <i>Stilpnotia salicis</i> (L.)	Nicomen Is. ....	1933	Europe, through U. S. A. ....	737
<b>Aphelinus mali</b> (Hald.)	Woolly apple aphid, <i>Eriosoma lanigerum</i> (Hausm.)	Vernon .....	1929	Ontario .....	516
		Vancouver .....	1921	" .....	?
<b>Aphelinus sp.</b>	Aphids	Victoria .....	1938	Belleville .....	2,500
<b>Ascogaster carpocapsae</b> (Vier.)	Codling moth, <i>Carpocapsa pomonella</i> (L.)	Kelowna .....	1933	Ontario .....	1,097
		Winfield .....	1934	" .....	421
		Kelowna .....	1935	" .....	599
		Penticton .....	1935	" .....	622
		Victoria .....	1935	" .....	1,739
		Winfield .....	1935	" .....	1,043
		Victoria .....	1936	" .....	1,144
		Kamloops North .....	1937	" .....	1,156
		Keating .....	1937	" .....	871
		Kelowna .....	1937	" .....	3,295
		Oyama .....	1937	" .....	572

SPECIES	HOST	LOCALITY	YEAR	ORIGIN	NUMBER RELEASED
<b>Ascogaster carpocapsae</b> (Vier.)		South Okanagan .....	1937	" .....	291
		Vernon .....	1937	" .....	725
		Victoria .....	1937	" .....	560
		Winfield .....	1937	" .....	2,845
		Victoria .....	1939	" .....	570
		Vernon .....	1939	" .....	33,250
<b>Ascogaster quadridentata</b> Wesm.	Pea moth, <i>Laspeyresia nigricana</i> (Steph.)	Chilliwack .....	1936	Ontario .....	300
		Sumas Prairie .....	1936	" .....	966
		East Chilliwack .....	1937	" .....	50
<b>Bessa harveyi</b> (TT) <i>selecta</i> Mgn. of American auth.)	Pea moth, <i>Laspeyresia nigricana</i> (Steph.)	Sumas Prairie .....	1937	England .....	34
		Chilliwack .....	1938	" .....	127
		Musselwhite .....	1938	" .....	753
		Chilliwack .....	1939	" .....	4,377
		Cloverdale .....	1947	" .....	3,592
<b>Bigonichaeta setipennis</b> (Fall.)	European larch sawfly, <i>Pristiphora erichsonii</i> (Htg.)	Edgewood .....	1942	New Brunswick & Ontario .....	3,750
		Vernon .....	1942	" .....	2,245
	European earwig, <i>Forficula auricularia</i> (L.)	New Westminster .....	1928	England & U.S.A. ....	165
		New Westminster .....	1929	" .....	212
		New Westminster .....	1930	" .....	326
		New Westminster .....	1931	" .....	373
		Sidney .....	1934	" .....	200
		Chemainus .....	1935	" .....	2,000
		Victoria .....	1935	" .....	17,500
		Alberni .....	1936	" .....	1,000
		Courtenay .....	1936	" .....	1,000
		Cumberland .....	1936	" .....	1,000
		Forbes Landing .....	1936	" .....	1,000
		Gordon Head .....	1936	" .....	1,000
		Keating .....	1936	" .....	1,000
		Ladysmith .....	1936	" .....	1,000
		Little Qualicum .....	1936	" .....	1,000
		Nanaimo .....	1936	" .....	5,000
		New Westminster .....	1936	" .....	5,000
		North Vancouver .....	1936	" .....	4,000
		Parksville .....	1936	" .....	1,000
		Port Alberni .....	1936	" .....	1,000
		Powell River .....	1936	" .....	4,000
		Qualicum .....	1936	" .....	1,000
		Royston .....	1936	" .....	1,000

SPECIES	HOST	LOCALITY	YEAR	ORIGIN	NUMBER RELEASED
<b>Bigonichaeta setipennis</b> (Fall.) <sup>1</sup>		Salt Spring Is.	1936	"	1,000
		Vancouver	1936	"	32,019
		Victoria	1936	"	4,200
		Agassiz	1938	Europe, through U. S. A. (Victoria) <sup>2</sup>	5,000
		Campbell River	1938	"	3,000
		Cloverdale	1938	"	1,000
		Cobble Hill	1938	"	2,000
		Comox	1938	"	2,000
		Courtenay	1938	"	4,000
		Craig's Crossing	1938	"	1,000
		Duncan	1938	"	4,000
		Errington	1938	"	2,000
		Haney	1938	"	5,000
		Horseshoe Bay	1938	"	1,000
		Ladysmith	1938	"	1,000
		Langford Lake	1938	"	1,000
		Lantzville	1938	"	1,000
		Milner	1938	"	1,000
		Nanoose	1938	"	1,000
		Nelson	1938	"	8,000
		New Westminster	1938	"	1,000
		Parksville	1938	"	1,000
		Port Coquitlam	1938	"	5,000
		Powell River	1938	"	8,000
		Qualicum Beach	1938	"	2,000
		Quathiaski Cove	1938	"	1,000
		Salt Spring Is.	1938	"	3,000
		Sandwick	1938	"	1,000
		Saseenos	1938	"	1,000
		Sooke Village	1938	"	2,000
		Squamish	1938	"	1,000
		Ten Mile Point	1938	"	2,120
		Union Bay	1938	"	1,000
		Vancouver	1938	"	3,000
		Vernon	1938	"	2,000
		Victoria	1938	"	15,775
		West Bay	1938	"	1,000
		Westview	1938	"	1,000
		Wildwood Heights	1938	"	1,000
		Brentwood	1939	"	1,000
	Cowichan Lake	1939	"	1,000	
	Esquimalt	1939	"	1,893	

<sup>1</sup> Comprised of parasitized earwigs and parasite puparia.

<sup>2</sup> European earwig parasites propagated at the Dominion Entomological Laboratory, Victoria, B. C., from breeding stock obtained in Portland, Ore.

SPECIES	HOST	LOCALITY	YEAR	ORIGIN	NUMBER RELEASED
<b>Bigonichaeta setipennis</b> (Fall.) <sup>1</sup>		Gibson's Landing	1939	..	2,000
		Mt. Douglas	1939	..	1,000
		North Galiano Is.	1939	..	1,000
		Royal Oak	1939	..	1,000
		Westholme	1939	..	1,000
<b>Blastothrix sericea</b> (Dalm.)	Lecanium scale, <i>Lecanium coryli</i> (L.)	Vancouver	1928	England	263
		Vancouver	1929	..	779
<b>Bracon sp.</b>	Cabbage seedpod weevil, <i>Ceutorhynchus assimilis</i> (Payk.)	Victoria	1944	British Columbia	443
		Gordon Head	1945	..	133
		Blenkinsop Rd.	1946	..	55
		Mattick's Farm	1946	..	610
<b>Calosoma sycophanta</b> (L.)	Oak looper, <i>Lambdina somnaria</i> (Hulst)	Vancouver Is.	1917-1918	Europe, through U. S. A.	?
<b>Chrysocharis gemma</b> (Wlk.)	Holly leaf miner, <i>Phytomyza ilicis</i> (Curt.)	Victoria	1936	England	3,166
		Victoria	1937	..	10,331
		Victoria	1938	..	21,067
		Burnaby	1939	..	2,136
		Essondale	1939	..	2,550
		Vancouver	1939	..	4,696
		West Vancouver	1939	..	2,011
<b>Chrysocharis syma</b> Wlk.	Holly leaf miner, <i>Phytomyza ilicis</i> (Curt.)	Victoria	1936	..	469
		Saanich (Finnerty Bay)	1937	..	1,035
		Victoria	1938	..	474
		Vancouver	1939	..	179
<b>Coccophagus scutellaris</b> (Dalm.)	Soft scale, <i>Coccus hesperidum</i> (L.)	Victoria	1942	U. S. A.	139
<b>Compsilura concinnata</b> (Meig.)	Satin moth, <i>Stilpnotia salicis</i> (L.)	Coquitlam	1929	Europe, through U. S. A.	526
		Agassiz	1930	..	834
		Agassiz	1931	..	589
		Agassiz	1932	..	242
		Seton Lake	1933	..	694
		Agassiz	1934	..	45
		Lillooet	1934	..	662
<b>Cryptus sexannulatus</b> Grav.	Codling moth, <i>Carpocapsa pomonella</i> (L.)	Kelowna	1942	Europe (Belleville) <sup>3</sup>	54
		Kelowna	1946	..	2,185
		Penticton	1946	..	2,014

SPECIES	HOST	LOCALITY	YEAR	ORIGIN	NUMBER RELEASED
<b>Cryptus sexannulatus</b> (Grav.)		Brilliant .....	1947	"	23
		Salmon Arm .....	1947	"	193
<b>Cyrtogaster vulgaris</b> Wlk.	Holly leaf miner, <i>Phytomyza ilicis</i> (Curt.)	Saanich .....	1937	England	148
		Victoria .....	1938	"	2,079
		Vancouver .....	1939	"	332
		West Vancouver .....	1939	"	139
<b>Dacnusa gracilis</b> (Nees)	Carrot rust fly, <i>Psila rosae</i> (F.)	Cloverdale .....	1949	"	1,153
<b>Dahlbominus fuscipennis</b> (Zett.)	Hemlock sawfly, <i>Neodiprion tsugae</i> Midd.	Yale .....	1941	Europe (Belleville) ‡	100,000
		Sugar Lake region 40 mi. from Vernon .....	1941	"	300,000
<b>Drino (Prosturmia)</b> <b>bohemica</b> Mesnil	Hemlock sawfly, <i>Neodiprion tsugae</i> Midd.	Kwuna Point .....	1946	Europe (Belleville) ‡	201
		Welcome Point (Skidegate Inlet) .....	1946	"	314
<b>Eucarsia formosa</b> Gahan	Greenhouse whitefly, <i>Trialeurodes vaporariorum</i> (Westw.)	British Columbia .....	1934	Belleville	119,700
		British Columbia .....	1935	"	126,400
		British Columbia .....	1936	"	77,145
		British Columbia .....	1937	"	194,600
		British Columbia .....	1938	"	410,400
		British Columbia .....	1939	"	415,300
		British Columbia .....	1940	"	394,000
		British Columbia .....	1941	"	472,000
		British Columbia .....	1942	"	275,000
		British Columbia .....	1943	"	172,000
		British Columbia .....	1944	"	217,000
		British Columbia .....	1945	"	337,000
		British Columbia .....	1946	"	223,000
		British Columbia .....	1947	"	101,000
		British Columbia .....	1948	"	191,500
British Columbia .....	1949	"	135,000		
<b>Ephialtes caudatus</b> Ratz.	Codling moth, <i>Carpocapsa pomonella</i> (L.)	Vernon .....	1941	Europe (Belleville) ‡	160
		Kelowna .....	1946	"	1,265
		Penticton .....	1946	"	1,369
		Brilliant .....	1947	"	44
		Creston .....	1947	"	35
		Salmon Arm .....	1947	"	157
<b>Eupteromalus nidulans</b> (Thoms.)	Satin moth, <i>Stilpnotia salicis</i> (L.)	Boston Bar .....	1933	Europe, through U. S. A.	30
		Chilliwack .....	1933	"	2,500
		Rosedale .....	1933	"	1,783

‡ Parasites propagated at the Dominion Parasite Laboratory, Belleville, Ont., from imported breeding stock.

SPECIES	HOST	LOCALITY	YEAR	ORIGIN	NUMBER RELEASED
<b>Eupteromalus nidulans</b> (Thoms.)		Seton Lake	1933	"	2,470
		Lillooet	1934	"	4,900
<b>Glypta haesitator</b> Grav.	Pea moth, <i>Laspeyresia nigricana</i> (Steph.)	Chilliwack	1938	England	734
		Chilliwack	1939	"	809
		Cloverdale	1947	England, through B. C.	371
<b>Habrocytus sp.</b>	Cabbage seedpod weevil, <i>Ceutorhynchus assimilis</i> (Payk.)	Sardis	1949	Europe	183
<b>Hemisarcoptes malus</b> (Shimer)	Oystershell scale, <i>Lepidosaphes ulmi</i> (L.)	Agassiz	1917	New Brunswick	1000+
		Mission	1917	"	1000+
		Royal Oak	1917	"	1000+
		Vernon	1917	"	1000+
<b>Horogenes spp.</b>	Pea moth, <i>Laspeyresia nigricana</i> (Steph.)	E. Chilliwack	1937	England	14
		Chilliwack (sp. A.)	1939	"	3
		Chilliwack (sp. B.)	1939	"	18
<b>Leptomastidea abnormis</b> (Gir.)	Citrus mealybug, <i>Pseudococcus citri</i> (Risso)	British Columbia	1940	Sicily, through U. S. A. (Belleville) <sup>3</sup>	400
		British Columbia	1941	"	1,300
<b>Leptomastix dactylopii</b> How.	Citrus mealybug, <i>Pseudococcus citri</i> (Risso)	British Columbia	1939	South America, through U. S. A. (Belleville) <sup>3</sup>	600
		British Columbia	1940	"	450
		British Columbia	1941	"	6,500
		British Columbia	1942	"	1,000
<b>Macrocentrus ancyli- vorous</b> Rohw.	Pea moth, <i>Laspeyresia nigricana</i> (Steph.)	Sumas Prairie	1935	U. S. A. (Belleville) <sup>3</sup>	175
		Chilliwack	1936	"	402
		Sumas Praisie	1936	"	324
<b>Mantis religiosa</b> L.	Grasshoppers, <i>Melanoplus</i> and other spp.	Kamloops	1937	Europe, through U. S. A. (Belleville) <sup>3</sup>	38
		Vernon	1937	"	123
		Salmon Arm	1938	"	175
<b>Mantis religiosa</b> L. <sup>4</sup>	Grasshoppers, <i>Melanoplus</i> and other spp.	Vernon	1937	Europe, through U. S. A. (Belleville) <sup>3</sup>	491
		Vernon	1938	"	175
<b>Mesoleius aulicus</b> (Grav.)	European larch sawfly, <i>Pristiphora erichsonii</i> (Htg.)	Fernie	1934	England, through Que., Ont. & N. B.	673
		Hosmer	1935	"	1,861
		Rosen Lake	1935	"	335
		Fernie	1936	"	49
		Kitchener	1936	"	388

<sup>4</sup> Egg masses.



SPECIES	HOST	LOCALITY	YEAR	ORIGIN	NUMBER RELEASED
<b>Mesoleius aulicus</b> Grav.		Lumberton	1936	"	105
		Rosen Lake	1936	"	239
		Edgewood	1941	"	330
		Inonoaklin River	1941	"	294
		Edgewood	1942	"	302
		Vernon	1942	"	400
<b>Metaphycus stanleyi</b> (Comp.)	Soft scale, <i>Coccus hesperidum</i> (L.)	Victoria	1942	U. S. A.	40
<b>Meteorus versicolor</b> (Wesm.)	Satin moth, <i>Stilpnotia salicis</i> (L.)	Lillooet	1934	Europe, through U. S. A.	520
<b>Opius ilicis</b> Nixon	Holly leaf miner, <i>Phytomyza ilicis</i> (Curt.)	Victoria	1938	England	33
		Vancouver	1939	"	10
<b>Pristomerus vulnerator</b> Panz.	Pea moth, <i>Laspeyresia nigricana</i> (Steph.)	Chilliwack	1938	England	5
<b>Protodexia australis</b> Bl.	Grasshoppers, <i>Melanoplus</i> and other spp.	Kamloops	1947	Argentina	280
<b>Sphegigaster flavicornis</b> Wlk.	Holly leaf miner, <i>Phytomyza ilicis</i> (Curt.)	Victoria	1936	England	1,795
		Saanich	1937	"	1,306
		Saanich	1938	"	70
		Victoria	1938	"	3,188
		Vancouver	1939	"	852
<b>Triaspis thoracicus</b> Curt.	Pea weevil, <i>Bruchus pisorum</i> (L.)	Armstrong	1942	Europe	2,850
		Salmon Arm	1942	"	914
<b>Trichomalus fasciatus</b> (Thoms.)	Cabbage seedpod weevil, <i>Ceutorhynchus assimilis</i> (Payk.)	Dewdney	1949	"	108
		Sardis	1949	"	90
<b>Xenocrepis sp.</b>	Cabbage seedpod weevil, <i>Ceutorhynchus assimilis</i> (Payk.)	Dewdney	1949	"	1,063
		Sardis	1949	"	208
<b>Zarhopalus corvinus</b> (Gir.)	Grape mealybug, <i>Pseudococcus maritimus</i> (Ehrh.)	Victoria	1939	U. S. A. (Belleville) <sup>3</sup>	88
		British Columbia	1940	"	1,707
<b>Zenillia nox</b> Hall.	Larch sawfly, <i>Pristiphora erichsonii</i> (Htg.)	Hosmer	1935	Japan	1,112
		Rosen Lake	1935	"	153

In addition to the importation of beneficial insects into British Columbia, the Biological Control Investigations Unit has obtained 21 parasite species in the Province for distribution against 8 pest species in other provinces. Many of the parasites obtained in British

Columbia for distribution elsewhere in Canada were native species, but 5 of them were imported species that had become established and were sufficiently numerous to warrant collection for redistribution. The 5 species are listed in Table III.

TABLE III  
Parasites imported into British Columbia and redistributed to other provinces of Canada.

Parasite	Year of Release in B.C.	Number of Release Points	Size of Colonies	First Date of Redistribution	Province
<i>Apanteles solitarius</i> (Ratz.).....	1933	1	737	1940	Nfld.
<i>Meteorus versicolor</i> (Wesm.).....	1934	1	520	1942	Nfld.
<i>Mesoleius aulicus</i> (Grav.).....	1934-36 1941-42	11	49-1861	1944	Nfld., Ont., Man., Sask.
<i>Ascogaster quadridentata</i> Wesm....	1937-39	5	34-4377	1945	P.E.I., N.S., N.B., Que., Ont.
<i>Glypta haesitator</i> (Grav.).....	1938-39	3	734-809	1945	P.E.I., N.S., Que.

There has been a considerable amount of theorizing by those who are interested in biological control problems regarding the optimum size of parasite colonies necessary to ensure establishment and the length of time required to build up an effective parasite population. Table III indicates that for some species at least, the release of small colonies under favourable conditions may result in the establishment and reasonably rapid increase of parasites. It is significant that only one colony of *Apanteles solitarius* and of *Meteorus versicolor* was released in British Columbia, and from the single colony of 737 specimens of *Apanteles solitarius* and 520 specimens of *Meteorus versicolor* the former had increased sufficiently in 7 years and the latter in 8 years to warrant collection for redistribution in

other provinces of Canada. This indicates that the original colonies were effective species well suited to climatic conditions in the new environment, and that they were properly handled prior to and during their release in the field. Probably the most important factor was that there was an abundant host supply and their release was timed to synchronize with the right stage of development of the host for parasitism.

Further evidence of the establishment of a small colony of parasites was obtained in 1949. A survey of the holly leaf miner in Vancouver and the surrounding districts revealed that the parasite *Opius ilicis* Nixon was present at 13 collection points. This parasite was originally released in the area in 1939 and the single colony consisted of only 4 males and 6 females.

#### LITERATURE CITED

- Baird, A. B. and J. H. McLeod, 1949. Biological control of insect pests in British Columbia. Proc. 7th Pacific Sci. Congr. In press.
- Downes, W. and H. Andison, 1941. The establishment in British Columbia of parasites of the holly leaf miner, *Phytomyza ilicis* Curtis. J. Econ. Ent. 33 (6): 948.
- Glendenning, R., 1931. The progress of parasite introduction in British Columbia. Proc. Ent. Soc. B. C. 28: 29-32.
- Hopping, G. R., H. B. Leech and C. V. G. Morgan, 1943. The larch sawfly, *Pristiphora erichsonii* (Hartig), in British Columbia with special reference to the cocoon parasites *Mesoleius tenthredinis* Morley and *Tritneptis klugii* (Ratzeburg). Sci. Agr. 24 (2): 53-63.
- Spencer, G. J., 1947. The 1945 status of *Digonochaeta setipennis*, Tachinid parasite of the European earwig, *Forficula auricularia* Linn., in West Point Grey, Vancouver, B. C. Proc. Ent. Soc., B. C. 43: 8-9.
- Venables, E. P., 1923. The relation of the predatory mite, *Hemisarcoptes malus* Shimer, to the oyster-shell scale in British Columbia. Proc. Ent. Soc. B. C., 17 & 19: 164-167.
1931. *Aphelinus mali* Hald., a parasite of the woolly aphid. Proc. Ent. Soc. B. C. 28: 16-18.
- Wishart, Geo., 1947. Important reduction of three introduced pests in British Columbia by introduced parasites. 77th Ann. Rept. Ent. Soc. Ontario, 1946, pp. 35-37.