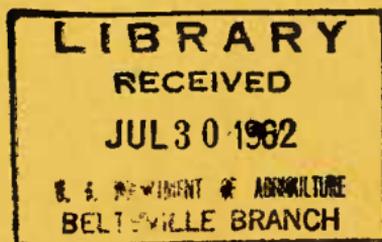


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No. 226

**Parasites and Predators
of Forest Insects
Liberated in the United States
Through 1960**



**Agriculture Handbook No. 226
U.S. Department of Agriculture
Forest Service
July 1962**

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by Philip B. Dowden

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Parasites and Predators of Forest Insects Liberated in the United States Through 1960

by Philip B. Dowden ¹

For over 60 years parasites and predators of forest insect pests have been imported and released in the United States. Most of the records of this work are concentrated at the Northeastern Forest Experiment Station's Forest Insect Laboratory, New Haven, Conn. With time these files become more and more obscure, and similar data are being filed elsewhere. Because this information is often important, the purpose of this handbook is to summarize all work of this nature in the United States through 1960.

Canada has done more in introducing and liberating parasites and predators of forest insects than has the United States; therefore, Canadian reports should be referred to for a complete record of work done against pests occurring in both countries. The Canadian work is briefly mentioned in this publication under the principal host species.

The subject matter is presented in two sections, in much the same way that it was in the report by C. P. Clausen, *Biological Control of Insect Pests in the Continental United States* (U.S.D.A. Technical Bulletin 1139, June 1956), which included all importations and establishments in this country through 1950. Data for forest and shade tree insects only are included in this handbook, thus presenting in greater detail the work already done with each species.

In the first section, all species that have been imported and liberated are listed under their hosts, which are arranged alphabetically. In the second section, a short sketch is presented about each species successfully established. A few species are included that have been recovered in Canada but not in the United States, and there may be others successfully established but not yet recovered. Unfortunately, attempts to recover introduced species have varied greatly. For some species almost no attempt has been made for recovery, and in others it is still too early to determine whether a species is successfully established or not. No evaluation is made of the effectiveness of the numerous biotic factors that operate against a single host. However, figures regarding "percentage parasitization" are frequently used, for they often tell much about the relative importance of individual species in the work of control.

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Nomenclatural and taxonomic difficulties and divergent views in the dipterous family Tachinidae have made it seem best to record most of the species under the names or combinations used in 1956 when Technical Bulletin 1139 was published. Where these names differ from those now commonly used, changes are indicated in the text.

The general plan of listing a parasite or predator according to the host species against which it was released has been adhered to, but it should be kept in mind that many parasites and predators attack a number of host species. The index cites those species liberated against more than one host.

In the tables, an asterisk shows that a species is known to be established. Under "Origin" the source of the first specimens received and liberated is given. Under "Living Insects Released" the numbers of males and females are shown separately where records by sex are available.

References to literature have been omitted except where noted in the text.

A RECORD OF LIBERATIONS LISTED UNDER HOST SPECIES

Asterolecanium bambusae (Bdv.), bamboo scale, and *Asterolecanium variolosum* (Ratz.), golden oak scale

Small collections of *Asterolecanium variolosum* (Ratz.) were made in New England and sent to Puerto Rico in 1937 and to California in 1952. The scales were parasitized by *Habrolepis dalmani* (West.), and it was planned to release the adult parasites, when they emerged, against the bamboo scale in Puerto Rico and the golden oak scale in California. So far as is known the parasite did not become established in either area.

Chermes piceae Ratz. = *Adelges piceae* (Ratz.) balsam woolly aphid

Canadian entomologists introduced several predators of the balsam woolly aphid, *Chermes piceae* Ratz., from Europe between 1933 and 1937 for release in the Maritime Provinces. *Leucopis* (*Neoleucopis*) *obscura* (Hal.) was the only one that became established at that time. The work was reactivated on a much larger scale in Europe in 1951. Since 1957, collectors have also searched for predators in Australia, Pakistan, India, and Japan. The work in Japan was done by the U.S. Forest Service in the summer of 1958.

Several European predators in addition to *Leucopis* have now been successfully established in Canada. Recently, with the discovery that the balsam woolly aphid is present in Washington and Oregon and also in North Carolina, colonies of imported material have been made available for release in these new infestations. In 1959 a number

of species, which were introduced for the first time from Pakistan, were released in the Pacific Northwest.

At present four predators are known to be established in the Canadian Maritimes. They are *Leucopis obscura* (Hal.), *Laricobius erichsoni* Rosenh., *Scymnus (Pullus) imperus* (Muls.), and *Cremifania nigrocellulata* Cz. The first two are also established in New England. *Leucopis* spread naturally into Maine; and from there it has been recolonized at several points in New England and the Pacific Northwest. *Laricobius* was recovered at a liberation point in southern Vermont, and it is anticipated that it will be recovered in Maine from large liberations made in the summer of 1959.

Leucopis, *Laricobius*, and a Cecidomyiid (*Aphidoletes thompsoni* Möhn) have been established in the Pacific Northwest. *A. thompsoni* has not yet been established in Canada.

The predators that have been liberated against the balsam woolly aphid are recorded in table 1.

Choristoneura fumiferana (Clem.)

spruce budworm

From studies made during the outbreak of the spruce budworm, *Choristoneura fumiferana* (Clem.), of 1913-22 in eastern Canada, it was learned that several western budworm parasites did not occur in the East. Therefore, Canadian workers reared larvae collected in British Columbia to obtain these parasites for release in eastern infestations from 1943-47. The United States conducted similar work in Colorado and Oregon from 1945-50. The two countries cooperated in some of this work (table 2). One western species, *Phytodietus fumiferanae* Roh., was propagated for several seasons in both Canada and the United States, particularly by the State of Maine, to obtain colonies for liberation. Oddly enough, none of the western parasites seem to have become established in the East.

Canada also imported from Europe parasites of a closely allied species, *Choristoneura muriana* (Hbn.). A number of these parasites were released in Canada, but none seem to have become established.

Cnidocampa flavescens (Wlkr.)

oriental moth

In 1929 and 1930, large shipments of cocoons of the oriental moth, *Cnidocampa flavescens* (Wlkr.), heavily parasitized by *Chaetoxorista javana* B. & B., were sent to the Gypsy Moth Laboratory at Melrose Highlands, Mass., from Japan. The parasite was established and has become very effective throughout the known area of infestation in the environs of Boston, Mass. (table 3). A second parasite, *Chrysis shanghaiensis* Smith, which was released in 1917, was recovered in 1919 in small numbers, but it apparently failed to persist for it has not been recovered since then.

TABLE 1.—Liberations against the balsam woolly aphid, *Chermes piceae* Ratz.

Species	Origin	Where liberated	Year	Where collected	Number shipped	Living insects released				
						♂ ♂	♀ ♀	Total		
<i>Adalia luteopicta</i> Muls.	India	Portland, Oreg.	1960	India	26			26		
<i>Adalia tetraspilota</i> Hope var. <i>bispilota</i> Wse.	do	Monmouth, Oreg.	1959	do	17			14		
		Portland, Oreg.	1959	do	55			54		
		Santiam Pass, Oreg.	1959	do	21			21		
<i>Aphidecta oblitterata</i> (L.)	Europe	Mount Mitchell, N.C.	1960	Europe	1,300			1,230		
		Corvallis, Oreg.	1958	do	395			395		
		Green River, Wash.	1958	do	325			325		
		Wind River, Wash.	1959	do	718			718		
* <i>Aphidoletes thompsoni</i> Möhn	do	Bradley, Maine	1959	do				1,185		
		Asheville, N.C.	1959	do	21,216	3,236	5,573	8,809		
		Black Rock, Oreg.	1957, 1959	do		4,357	7,163	11,520		
		Corvallis, Oreg.	1957	do		68	132	200		
		McKenzie Pass, Oreg.	1959	do		1,348	2,502	3,850		
		Monroe, Oreg.	1958, 1959	do		1,149	1,485	2,634		
		Willamette Pass, Oreg.	1959	do		3,201	5,961	9,162		
		Green River, Wash.	1957	do		124	244	368		
		Coldwater Creek, Wash.	1957, 1959	do		1,576	1,984	3,560		
		Randle, Wash.	1959	do			742	1,320	2,062	
		<i>Ballia eucharis</i> Muls.	Pakistan	Black Rock, Oreg.	1959	Pakistan	85			85
		<i>Chilocorus kuwanae</i> Silv.	Japan	Monroe, Oreg.	1958	Japan	55			55
				Coldwater Creek, Wash.	1958	do	80			80
<i>Cremifania nigrocellulata</i> Cz.	Europe	Corvallis, Oreg.	1959	Europe	159			159		
		Monroe, Oreg.	1959	do	830			830		
		Willamette Pass, Oreg.	1958	do	385			385		
<i>Exochomus lituratus</i> Corh.	Pakistan	Santiam Pass, Oreg.	1960	Pakistan	44			44		
<i>Exochomus uropygialis</i> Muls.	do	Corvallis, Oreg.	1959	do	316			316		
		Portland, Oreg.	1960	do	300			300		
		Santiam Pass, Oreg.	1960	do	2,400			2,400		
		Green River, Wash.	1959	do	1,641			1,641		
		do	1960	do	1,100			1,100		
		Toutle River, Wash.	1960	do	925			925		

<i>Harmonia breiti</i> Mader	India	Portland, Oreg.	1959	India	11		10
* <i>Laricobius erichsoni</i>	Europe	Bradley, Maine	1959	Europe	15,958		15,210
Rosenh.		Mount Mitchell, N.C.	1959	do.	624		619
		do.	1960	do.	1,200		1,100
		Lincoln, N.H.	1955	do.	500		494
		Black Rock, Oreg.	1958	do.	1,675		1,550
		Corvallis, Oreg.	1958	do.	1,705		1,705
		Monroe, Oreg.	1959	do.	1,640		1,600
		Willamette Pass, Oreg.	1958	do.	1,200		1,200
		Somerset, Vt.	1955	do.	500		489
		Green River, Wash.	1958	do.	1,600		1,600
		Coldwater Creek, Wash.	1958	do.	1,320		1,320
		Wind River, Wash.	1958	do.	1,150		1,150
<i>Leis dimidiata</i> (F.)	India	Monmouth, Oreg.	1959	India	15		15
		Willamette Pass, Oreg.	1959	do.	9		8
<i>Leucopis</i> (<i>Neoleucopis</i>) n.sp.	Pakistan	Monroe, Oreg.	1959	Pakistan	200		15
* <i>Leucopis obscura</i> (Hal.)	Europe	Mount Mitchell, N.C.	1960	New England	142		142
		Grantham, N.H.	1937	New Brunsw- wick	569		569
		Lincoln, N.H.	1955	New England	888		888
		Cedar River, N.Y.	1956	do.	522		485
		Willamette Pass, Oreg.	1959	do.	2,085		2,085
		Somerset, Vt.	1954	do.	452		452
		Texas Falls, Vt.	1956	do.	730		730
		Wallingford, Vt.	1956	do.	620		620
		Green River, Wash.	1958	do.	700		700
<i>Scymnus</i> (<i>Pullus</i>) <i>impevus</i> (Muls.)	do.	Mount Mitchell, N.C.	1960	Europe	300		290
		Monroe, Oreg.	1960	do.	400		400
		Somerset, Vt.	1955	do.	270		268
<i>Scymnus</i> (<i>Diomus</i>) <i>pumilio</i> Wse.	Australia	Mount Mitchell, N.C.	1960	Australia	2,000		1,900
		do.	1960	do.	1,400		1,400
		Green River, Wash.	1960	do.	2,000		2,000
		Toutle River, Wash.	1959	do.	859		859
<i>Synharmonia conglobata</i> (L.)	India	Santiam Pass, Oreg.	1959	India	57		30
		Randle, Wash.	1959	do.	91		91

*Known to be established.

TABLE 2.—Liberations against the spruce budworm, *Choristoneura fumiferana* (Clem.)

Species	Origin	Where liberated	Year	Where collected	Number shipped	Living insects released		
						♂ ♂	♀ ♀	Total
<i>Agria affinis</i> (Fall.) ¹	British Columbia.	Castle Hill, Maine.....	1948	British Columbia.	335	154	169	323
		Harrietstown, N.Y.....	1947	do	500	247	247	494
<i>Ceromasia auricaudata</i> Tns.	United States.	North Elba, N.Y.....	1947	do	500	245	250	495
		Santa Clara, N.Y.....	1946	do	50	20	24	44
		Castle Hill, Maine.....	1948	Oregon.....	46			46
		New Canada, Maine.....	1950	do	122	70	52	122
		T5 R16, Maine.....	1947	Colorado.....	1,232	593	625	1,218
		T16 R5, Maine.....	1949	Oregon.....	959	467	492	959
		Altamont, N.Y.....	1946	Colorado.....	483	150	316	466
		Brighton, N.Y.....	1946	do	962	464	498	962
		Colton, N.Y.....	1946	do	1,020	520	500	1,020
		Harrietstown, N.Y.....	1947	do	221	113	108	221
		do.....	1947	British Columbia.	500	249	247	496
		<i>Compsilura concinnata</i> (Meig.)	Europe.....	Long Lake, N.Y.....	1946	Colorado.....	951	451
North Elba, N.Y.....	1946			do	1,000	500	500	1,000
Santa Clara, N.Y.....	1946			do	700	200	500	700
Wilmington, N.Y.....	1946			do	500	250	250	500
Uncompahgre N. F., Colo.	1947			New England. ²	1,000		70	70
El Rito, N. Mex.....	1947			do	434	78	353	431
<i>Itopectis</i> ¹ <i>4-cingulatus</i> (Prov.).	United States.	Taos, N. Mex.....	1947	do	430			160
		Colton, N.Y.....	1947	Colorado	30			30
		do.....						
<i>Phytodietus fumiferanae</i> Roh.	British Columbia.	Castle Hill, Maine.....	1948	British Columbia.	200	50	150	200
		Hamlin, Maine.....	1954	Lab. reared...	400	50	350	400
		New Canada, Maine.....	1951	do	80	27	56	83
		do.....	1952	do	164	66	98	164

Portage, Maine.....	1958	do.....	35			35
Stockholm, Maine.....	1955	do.....	830	420	410	830
T11 R7, Maine.....	1955	do.....	39			37
T13 R12, Maine.....	1954	do.....	295		295	295
T14 R6, Maine.....	1956	do.....	70		70	70
T14 R6, Maine.....	1957	do.....	30		30	30
T14 R9, Maine.....	1953	do.....	67		63	63
T16 R4, Maine.....	1951	do.....	152	30	122	152
T16 R4, Maine.....	1952	do.....	212	110	102	212
T16 R5, Maine.....	1950	do.....	36			26
T16 R5, Maine.....	1951	do.....	157	35	115	150
T16 R5, Maine.....	1954	do.....	95	10	85	95
T16 R5, Maine.....	1952	do.....	114	70	44	114
Colton, N.Y.....	1946	British Columbia.	350	174	173	350
North Elba, N.Y.....	1947	do.....	525	260	262	522

¹ Recorded in the East prior to liberation.

² Puparia.

TABLE 3.—Liberations against the oriental moth (*Cnidocampa flavescens* (Wlkn.))

Species	Origin	Where liberated	Year	Where collected	Number shipped	Living insects released, total
* <i>Chaetoxorista javana</i> B. & B.	Japan-----	Boston, Mass-----	1930	Japan-----	6, 395	6, 395
		Cambridge, Mass-----	1930	do-----	7, 129	7, 129
		Chelsea, Mass-----	1930	do-----	5, 680	5, 680
		Dorchester, Mass-----	1929	do-----	2, 221	2, 221
		do-----	1930	do-----	5, 848	5, 848
		do-----	1930	do-----	6, 011	6, 011
		Everett, Mass-----	1930	do-----	4, 947	4, 947
		Medford, Mass-----	1930	do-----	7, 076	7, 076
		Nahant, Mass-----	1930	do-----	4, 983	4, 983
		Neponset, Mass-----	1930	do-----	5, 865	5, 865
		Quincy, Mass-----	1930	do-----	5, 854	5, 854
		Revere, Mass-----	1929	do-----	2, 326	2, 326
		do-----	1930	do-----	5, 146	5, 146
		do-----	1930	do-----	4, 457	4, 457
		Saugus, Mass-----	1930	do-----	6, 171	6, 171
<i>Chrysis shanghaiensis</i> Smith.	China-----	Winthrop, Mass-----	1930	do-----	5, 063	5, 063
		Boston, Mass-----	1917-20	China-----	?	(¹)

*Known to be established.

¹ Small numbers.

Coleophora laricella (Hbn.)

larch casebearer

Both Canada and the United States imported parasites of the larch casebearer, *Coleophora laricella* (Hbn.), from Europe during the early thirties (table 4). Two valuable parasites, *Agathis pumilus* (Ratz.) and *Chrysocharis laricinellae* (Ratz.), have become widely established in both countries and very high parasitization, particularly by *Agathis*, has been recorded. *Agathis* spread rapidly in Michigan after being recolonized there, and it was liberated in a newly discovered infestation of the casebearer in Idaho during 1960.

Dendroctonus frontalis Zimm.

southern pine beetle

In 1892-93, A. D. Hopkins, while studying in Germany, noted that a predaceous clerid beetle, *Thanasimus formicarius* (L.), was abundant and appeared to be valuable in controlling bark beetles. He accordingly arranged for the shipment of 6,098 adult beetles and larvae to this country. When they arrived, 2,200 were released in the forests of West Virginia against the southern pine beetle *Dendroctonus frontalis* Zimm. There is no record that any were ever recovered. This shipment was the first attempt to import a natural enemy of a forest insect into this country.

Diprion frutetorum (F.)

Diprion frutetorum (F.) is a European species of sawfly that was first discovered in this country in 1932. In 1941 it was abundant at Southington, Conn., and at that time cocoons were heavily parasitized by *Dahlbominus fuscipennis* (Zett.). This is interesting because no direct releases of the parasites were made to control *D. frutetorum*. The nearest release point was Orange, Conn., some 25 miles to the southwest where this parasite was liberated in 1936 against *Diprion hercyniae* (Htg.). Canada has liberated several species against *D. frutetorum* in southern Ontario.

Diprion hercyniae (Htg.)

European spruce sawfly

The program of parasite release against the European spruce sawfly, *Diprion hercyniae* (Htg.), in Canada ranks as one of the greatest efforts of its kind that has ever been made against a forest insect (table 5). The sawfly outbreak was terminated about 1939 by an accidentally introduced polyhedrosis virus disease. Before then very large numbers of parasites were released. By far the most common of these was a small gregarious cocoon parasite, *Dahlbominus fuscipennis* (Zett.). This species proved to be easily propagated in

TABLE 4.—Liberations against the larch casebearer, *Coleophora laricella* (Hbn.)

Species	Origin	Where liberated	Year	Where collected	Number shipped	Living insects released				
						♂♂	♀♀	Total		
<i>*Agathis pumilus</i> (Ratz.)	Europe.....	Woodstock, Conn.....	1934	Europe.....	806	264	542	806		
		Calder, Idaho.....	1960	Rhode Island.....	1,000	-----	-----	768		
		Rocky Point, Idaho.....	1960	do.....	500	-----	-----	404		
		St. Joe, Idaho.....	1960	do.....	500	-----	-----	419		
		Thorn Creek, Idaho.....	1960	do.....	1,025	-----	-----	305		
		do.....	1960	do.....	500	-----	-----	464		
		Bremen, Maine.....	1936	Europe.....	72	14	18	32		
		Sydney, Maine.....	1933	do.....	234	-----	-----	156		
		do.....	1934	do.....	850	350	500	850		
		Lynfield, Mass.....	1932	do.....	78	26	52	78		
		Ann Arbor, Mich. (E. S. George Preserve).	1937	do.....	1,796	882	893	1,775		
		Ann Arbor, Mich. (Mud Lake Swamp).	1937	do.....	833	336	386	722		
		Elmwood, Mich.....	1950	do.....	1,215	-----	-----	1,215		
		Berlin, N.H.....	1934	do.....	718	218	500	718		
		Saranac, N.Y.....	1934	do.....	534	234	300	534		
		Sharon, Vt.....	1934	do.....	908	403	505	908		
		Rhineland, Wis.....	1953	do.....	-----	-----	-----	173		
		Three Lakes, Wis.....	1953	do.....	-----	-----	-----	174		
		<i>*Chrysocharis laricinellae</i> (Ratz.)	do.....	Woodstock, Conn.....	1935	do.....	3,960	1,960	2,000	3,960
				Bremen, Maine.....	1936	do.....	1,650	885	629	1,514
Sydney, Maine.....	1933			do.....	1,140	550	590	1,140		
Lee, Mass.....	1936			do.....	2,136	1,022	1,042	2,064		
Lunenburg, Mass.....	1932			do.....	800	300	500	800		
do.....	1933			do.....	848	369	479	848		
Winchester, Mass.....	1935			do.....	1,512	168	1,344	1,512		
Berlin, N.H.....	1935			do.....	4,038	2,001	2,037	4,038		
Lempster, N.H.....	1935			do.....	1,775	1,100	675	1,775		
Saranac, N.Y.....	1933			do.....	1,050	-----	-----	1,025		

		Tupper Lake, N.Y.	1936	do.	2,001	973	1,003	1,976
		Sharon, Vt.	1935	do.	4,022	2,016	2,006	4,022
		Rhineland, Wis.	1953	do.				221
		Three Lakes, Wis.	1953	do.				222
<i>Dicladocerus westwoodi</i>	do.	Lee, Mass.	1936	do.	231	158	73	231
Westw.								
<i>Horogenes laricinellae</i>	do.	Woodstock, Conn.	1934	do.	580	275	305	580
(Strobl.)		Melrose, Mass.	1932	do.	26		26	26
		Sydney, Maine	1934	do.	700	200	498	698
		Berlin, N.H.	1933	do.	100		100	100
		do.	1934	do.	700	200	500	700
		Saranac, N.Y.	1934	do.	700	200	500	700
<i>Horogenes nana</i> (Grav.)	do.	Sharon, Vt.	1934	do.	545	245	300	545
		Lee, Mass.	1936	do.	231	158	73	231

*Known to be established.

TABLE 5.—Liberations against the European spruce sawfly, *Diprion hercyniae* (Htg.)

Species	Origin	Where liberated	Year	Where collected	Number shipped	Living insects released			
						♂♂	♀♀	Total	
<i>*Aptesis basizonia</i> (Grav.).	Europe-----	Allagash, Maine-----	1941	Lab. reared---	1 5, 630			5, 630	
		Appleton, Maine-----	1943	do-----	2, 646			2, 646	
		Castle Hill, Maine-----	1940	do-----	1 1, 000			1, 000	
		Cyr, Maine-----	1942	do-----	1 6, 430			6, 430	
		Grafton, Maine-----	1943	do-----	50			50	
		Harpswell, Maine-----	1941	do-----	1 5, 630			5, 630	
		Harrison, Maine-----	1942	do-----	767			767	
		Jefferson, Maine-----	1942	do-----	1, 000			1, 000	
		Kibbie, Maine-----	1941	do-----	1 5, 630			5, 630	
		Mt. Desert, Maine-----	1940	do-----	1, 200			1, 200	
		do-----	1940	do-----	1 1, 000			1, 000	
		do-----	1941	do-----	1 5, 630			5, 630	
		Mt. Katahdin, Maine-----	1941	do-----	1 5, 630			5, 630	
		Parlin Pond, Maine-----	1940	do-----	51			51	
		T1 R6, Maine-----	1942	do-----	1 6, 430			6, 430	
		T2 R13, Maine-----	1942	do-----	1 6, 430			6, 430	
		T2 R13, Maine-----	1942	do-----	1 6, 430			6, 430	
		T5 R9, Maine-----	1942	do-----	2, 646			2, 646	
		T6 R7, Maine-----	1942	do-----	1 6, 430			6, 430	
		T9 R5, Maine-----	1939	do-----	400			380	
		T9 R5, Maine-----	1940	do-----	1, 067		460	607	1, 067
		T9 R5, Maine-----	1940	do-----	1 919			919	
		T14 R6, Maine-----	1935	Europe-----	3, 930		1, 580	2, 350	3, 930
		T15 R11, Maine-----	1942	Lab. reared---	1 6, 430				6, 430
		T34, Maine-----	1941	do-----	1 5, 630				5, 630
		Jaffrey, N.H-----	1939	do-----	617				617
		Rensselaerville, N.Y-----	1939	do-----	238				238
		Shandaken, N.Y-----	1940	do-----	3, 000				3, 000
		Jacksonville, Vt-----	1940	do-----	597		298	299	597
		Marlboro, Vt-----	1939	do-----	522				522
		Wilmington, Vt-----	1938	Europe-----	35		5	30	35

<i>Aptesis subguttata</i> (Grav.)	do	Dublin, N.H.	1938	do	220	110	110	220
		Wilmington, Vt.	1938	do	65	19	46	65
* <i>Dahlbominus fuscipennis</i> (Zett.)	do	(?)	(?)	(?)	(?)	(?)	(?)	(?)
<i>Delomerista japonica</i> Cush. ²	Oregon	Orange, Conn.	1936	Oregon	348	268	80	348
		Natchaug, Conn.	1937	do	500		500	500
		Tupper Lake, N.Y.	1936	do	330	245	85	330
<i>Exenterus abruptorius</i> (Thnb.)	Europe	Orange, Conn.	1937	Europe	1,400			1,351
		Ashland, Maine	1937	do	2,468			2,336
		Days Grant, Maine	1939	do	2,000			1,200
		Friendship, Maine	1939	do	2,340			1,340
		do	1939	do	2,343			1,343
		T12 R16, Maine	1939	do	5,000			5,000
		Square Lake, Maine	1937	do	2,256			1,912
		T9 R5, Maine	1939	do	4,800			4,535
		T9 R5, Maine	1939	do	4,800			4,320
		T15 R10, Maine	1937	do	2,600			1,680
		T16 R10, Maine	1937	do	2,800			2,075
		Westfield, Mass.	1939	do	815			773
		do	1939	do	1,000			958
		Dublin, N.H.	1938	do	3,270			2,671
		do	1938	do	3,130			2,601
		do	1939	do	3,420			888
		Temple, N.H.	1938	do	3,148			2,927
		do	1938	do	3,202			2,979
		Tupper Lake, N.Y.	1936	do	1,490			1,460
		Lincoln, Vt.	1938	do	3,200			2,378
		do	1938	do	3,200			2,475
		Marlboro, Vt.	1938	do	3,200			2,830
		do	1939	do	1,800			1,660
		do	1939	do	2,580			733
		Wilmington, Vt.	1938	do	3,200			2,834
		do	1939	do	40,800			36,877

See footnotes at end of table.

TABLE 5.—Liberations against the European spruce sawfly, *Diprion hercyniae* (Htg.)—Continued

Species	Origin	Where liberated	Year	Where collected	Number shipped	Living insects released		
						♂ ♂	♀ ♀	Total
<i>Exenterus amictorius</i> (Panz.).	Europe.....	Ashland, Maine.....	1937	Europe.....	100	25	72	97
		T9 R5, Maine.....	1940	do.....	281	75	206	281
		T14 R6, Maine.....	1935	do.....	2, 696	75	2, 529	2, 604
		Dublin, N.H.....	1938	do.....	51	21	30	51
		Dover, Vt.....	1940	do.....	173	65	108	173
		Jacksonville, Vt.....	1940	do.....	340	121	219	340
		Marlboro, Vt.....	1939	do.....	400			315
<i>Exenterus claripennis</i> Thoms.	do.....	T9 R5, Maine.....	1940	do.....	102	11	91	102
		Shandaken, N.Y.....	1940	do.....	450	200	250	450
		Dover, Vt.....	1940	do.....	397	174	223	397
		Jacksonville, Vt.....	1940	do.....	246	82	164	246
		do.....	1940	Nebraska.....	64	38	26	64
<i>Exenterus pini</i> Cush.....	do.....	Dublin, N.H.....	1938	Europe.....	37		37	
<i>Exenterus tricolor</i> Roman.....	do.....	Marlboro, Vt.....	1939	do.....	120		119	
<i>Exenterus</i> sp.....	do.....	do.....	1939	do.....	50		47	
<i>Ischnojoppa luteator</i> (Thnb.).	do.....	T14 R6, Maine.....	1935	do.....	253	92	158	253
		Wilmington, Vt.....	1938	do.....	144			136
<i>Itoplectis 4-cingulatus</i> (Prov.) ³	Oregon.....	Kent, Conn.....	1935	Oregon.....	290	174	116	290
		Orange, Conn.....	1935	do.....	325	125	200	325
		do.....	1936	do.....	17	1	16	17
		Petersham, Mass.....	1936	do.....	237	100	137	237
		Tupper Lake, N.Y.....	1936	do.....	413	65	348	413
<i>Lamachus eques</i> (Htg.).....	Europe.....	Wilmington, Vt.....	1938	Europe.....	163	37	126	163
		do.....	1939	do.....	600	200	400	600
		do.....	1939	do.....	65	19	43	62
<i>Lamachus marginatus</i> Brischke	do.....	Westfield, Mass.....	1939	do.....	25			25
		Dublin, N.H.....	1938	do.....	35			35
		Marlboro, Vt.....	1939	do.....	116			115
		Wilmington, Vt.....	1939	do.....	474			309
<i>Lamachus</i> sp.....	do.....	Marlboro, Vt.....	1939	do.....	125		114	
<i>Lydella</i> sp.....	do.....	do.....	1939	do.....	350	148	200	348

<i>Monodontomerus dentipes</i> (Dalm.)	do	Wilmington, Vt	1938	do	368	8	360	368
<i>Olesicampe ratzeburgi</i> (Tschek)	do	Marlboro, Vt	1939	do	182	82	92	172
<i>I horocera</i> (?) <i>hamata</i> A. & W.	Nebraska	Wilmington, Vt	1938	do	295			257
		Jacksonville, Vt	1940	Nebraska	394	204	190	394
<i>Spathimeigenia spinigera</i> Townes.	do	Westfield, Mass	1939	do	39			39
		Jacksonville, Vt	1940	do	572	274	298	572
<i>Sturmia</i> sp.	Europe	Marlboro, Vt	1939	Europe	400	195	197	392

*Known to be established.

¹ Parasitized cocoons.

² In 1935 Canada supplied 30,000 *Dahlbominus fuscipennis* for release in Maine. The next year about 500,000 were made available, and the parasite was liberated at a number of points throughout New England and New York. Further shipments were received in 1937. By 1938 the States of Maine, New Hampshire, Vermont, and New York began propagating and liberating *Dahlbominus* on such a large scale that it is hardly necessary to list all liberation points. Virtually all spruce stands, showing even light infestations, were colonized in the next few years. Total liberations of this species may be summarized as follows:

State	Number liberated
Maine	226, 173, 000
New Hampshire	5, 410, 000
Vermont	15, 540, 000
New York	10, 420, 000
Massachusetts	140, 000
Connecticut	90, 000
Total	257, 773, 000

³ Recorded in the East prior to liberation.

the laboratory, and large rearing programs were conducted in both Canada and the United States, where the sawfly also was a pest. Well over a billion individuals were liberated.

In addition to *Dahlbominus* another cocoon parasite, *Aptesis basizonia* (Grav.), and five larval parasites became established. The larval parasites are *Exenterus claripennis* Thoms., *E. amictorius* (Panz.), *E. vellicatus* Cush., *E. tricolor* Roman, and *Drino* (*Prosturmia*) *bohemica* Mesn. The most effective of the above species have been *Dahlbominus fuscipennis* and *E. claripennis* under conditions of high outbreak density, and *E. vellicatus* and *Drino bohemica* at lower densities.

Canada sent substantial numbers of all imported parasites of the sawfly to the United States for release in this country, and large numbers of *Dahlbominus* were propagated and released by several State organizations. This species became generally established. Since the sawfly outbreak was terminated by disease even earlier in the United States than in Canada, no concerted effort was made to recover most of the other species released. It is very likely, though, that those that were established in New Brunswick are now present in Maine.

Diprion similis (Htg.)

introduced pine sawfly

No liberations have been made against the introduced pine sawfly, *Diprion similis* (Htg.), in the United States; but it is commonly parasitized in this country by *Monodontomerus dentipes* Dalm., one of its European enemies. Undoubtedly the latter was introduced with its host from Europe. *M. dentipes* is considered an important parasite of *Diprion polytomum* (Htg.), as well as *D. similis* in Europe.

Galerucella xanthomelaena (Schr.)

elm leaf beetle

No egg parasites of the elm leaf beetle, *Galerucella xanthomelaena* (Schr.), are known to be established in this country in spite of the fact that large numbers of *Tetrastichus galerucae* (Fonsc.) [formerly called *T. xanthomelaenae* (Rond.)] and *Tetrastichus* sp. from Europe have been released in the East, and large numbers of *Tetrastichus* sp. from Japan have been released in California (table 6). Attempts to introduce a tachinid parasite, *Erynniopsis rondani* Towns., in the East were also unsuccessful, but this species took hold rapidly in California, and in recent years several good colonies have been collected there and released throughout the United States. No concerted efforts have yet been made to recover *Erynniopsis* or *Tetrastichus* spp. in the East, however, and their establishment is a possibility. A native pupal parasite, *T. brevistigma* Gahan, which is common in the East, was successfully established in California.

Gossyparia spuria (Mod.)

European elm scale

Three species of parasites that attack the European elm scale, *Gossyparia spuria* (Mod.), in Europe have been imported into this country and released in California. This work, which was done by the State of California, has been summarized by S. E. Flanders in the Journal of Economic Entomology 45:1078-79, 1952.

Shipments of host material were sent from Germany (1908), Italy (1939), and France (1948-53). The parasites obtained were *Coccophagus insidiator* (Dalm.), *Trichomasthus cyanifrons* (Dalm.), and *Microterys* sp. *C. insidiator* (Dalm.) is the only one which was recovered and that only at Redlands, but parasitization at the point of release was 85 percent 2 years after colonization. C. P. Clausen has written² that the scale has been adequately controlled by *Coccophagus* in several localities.

Hemerocampa leucostigma (J. E. Smith)

white-marked tussock moth

One of the parasites, *Apanteles solitarius* (Ratz.), introduced against the satin moth, and two of the parasites, *Compsilura concinnata* (Meig.) and *Ooencyrtus kuwanai* (How.), introduced against the gypsy moth, are easily reared on the white-marked tussock moth, *Hemerocampa leucostigma* (J. E. Smith), in the laboratory. They have, therefore, been released against this host in a few locations (table 7). *Compsilura* and *Apanteles* are frequently found parasitizing tussock moth larvae in the field in New England, but there is no record of *Ooencyrtus* having been recovered from *H. leucostigma* eggs in Washington, D.C., or Illinois where special liberations were made against that host.

Hemerocampa pseudotsugata McD.

Douglas-fir tussock moth

Two imported gypsy moth enemies, *Calosoma sycophanta* (L.) and *Compsilura concinnata* (Meig.), and a polyphagous pupal parasite, *Pimpla turionellae* L., originally reared from the European pine shoot moth, were released against the Douglas-fir tussock moth, *Hemerocampa pseudotsugata* McD., in the West (table 8). They have not been recovered, but no concerted effort has been made to do so.

² Personal communication.

TABLE 6.—Liberations against the elm leaf beetle, *Galerucella xanthomelaena* (Schr.)

Species	Origin	Where liberated	Year	Where collected	Number shipped	Living insects released, total
<i>Erynniopsis rondani</i> Towns. ¹	Europe-----	Morrilton, Ark-----	1957	California-----	638	638
		Rogers, Ark-----	1957	do-----	638	638
		Russellville, Ark-----	1957	do-----	638	638
		Castaic, Calif-----	1955	do-----	15	15
		do-----	1956	do-----	60	60
		do-----	1957	do-----	1,600	1,600
		Castle Crag, Calif-----	1957	do-----	1,650	1,650
		Manteca, Calif-----	1939	Europe-----	31	31
		Hamden, Conn-----	1935	do-----	371	221
		Parma, Idaho-----	1958	California-----	750	650
		Assonet, Mass-----	1936	Europe-----	55	52
		Woburn, Mass-----	1934	do-----	510	510
		College Park, Md-----	1955	California-----	150	115
		Reno, Nev-----	1958	do-----	325	200
		do-----	1958	do-----	150	100
		Forty-Fort, Pa-----	1944	do-----	130	4
		Alexandria, Va-----	1955	do-----	500	387
Warwick, Va-----	1956	do-----	785	737		
<i>Lebia scapularis</i> Faure-----	do-----	Woburn, Mass-----	1934	Europe-----	40	40
* <i>Tetrastichus brevistigma</i> Gahan	Massachusetts-----	Fresno, Calif-----	1934	Massachusetts-----	2 25,000	2 25,000
		Orangevale, Calif-----				
		Port Costa, Calif-----				
		Visalia, Calif-----				
		Richmond, Va-----	1934	do-----	2 15,000	2 15,000
<i>Tetrastichus galerucae</i> (Fonsc.) and <i>Tetrastichus</i> sp. (at least 95 percent <i>galerucae</i>).	Europe-----	Fresno, Calif-----	1932	Europe-----	3,400	3,400
		do-----	1933	do-----	3,605	3,605
		Hamden, Conn-----	1932	do-----	3,000	3,000
		Greenwich, Conn-----	1932	do-----	1,000	1,000
		Washington, D.C-----	1908	do-----	?	?
		do-----	1932	do-----	1,200	1,200
		do-----	1933	do-----	2,000	2,000
		Blackstone, Mass-----	1925	do-----	620	620
		Cambridge, Mass-----	1908	do-----	600	600
		Kingston, Mass-----	1933	do-----	4,000	4,000

		Melrose, Mass.-----	1908	do-----	1, 200	1, 200
		do-----	1911	do-----	643	643
		Taunton, Mass.-----	1933	do-----	1, 000	1, 000
		Wakefield, Mass.-----	1925	do-----	55	55
		Woburn, Mass.-----	1933	do-----	2, 000	2, 000
		do-----	1935	do-----	825	825
		Newfield, N.H.-----	1932	do-----	600	600
		Dunellen, N.J.-----	1935	do-----	1, 260	1, 260
		New Brunswick, N.J.-----	1908	do-----	?	?
		Plainfield, N.J.-----	1935	do-----	224	50
		Rutherford, N.J.-----	1932	do-----	1, 000	1, 000
		Ithaca, N.Y.-----	1908	do-----	?	?
		Saratoga Springs, N.Y.-----	1932	do-----	1, 000	1, 000
		Cincinnati, Ohio-----	1932	do-----	3, 000	3, 000
		Dayton, Ohio-----	1933	do-----	2, 000	2, 000
		Arlington, Va.-----	1932	do-----	750	750
		Braddock Heights, Va.-----	1932	do-----	750	750
		Richmond, Va.-----	1933	do-----	2, 000	2, 000
<i>Tetrastichus</i> sp.-----	Japan-----	Central California-----	1934, 1936, 1938	Japan-----	14, 000	14, 000

*Known to be established.

¹ A small colony was also liberated in Virginia in 1925.

² Approximate.

TABLE 7.—Liberations against the white-marked tussock moth, *Hemerocampa leucostigma* (J. E. Smith)

Species	Origin	Where liberated	Year	Where collected	Number shipped	Living insects released, total
<i>Apanteles solitarius</i> (Ratz.)	Europe-----	Everett, Mass.-----	1929	Lab. reared-----	1, 200	1, 200
<i>Compsilura concinnata</i> (Meig.)	do-----	Washington, D.C.-----	1910	New England-----	437	115
<i>Ooencyrtus kuwanai</i> (How.)	Japan-----	Illinois-----	1917	Lab. reared-----	5, 000	5, 000
		do-----	1921	do-----	12, 000	12, 000
		Washington, D.C.-----	1921	do-----	20, 000	20, 000

Hemileuca oliviae Ckll.

range caterpillar

Three of the imported enemies of the gypsy moth, which have become established in the East, were liberated against the range caterpillar, *Hemileuca oliviae* Ckll., in Arizona and New Mexico between 1913 and 1929, but none of them became established (table 9).

Heterarthrus nemoratus (Fall.) (= *Phyllotoma nemorata* Fall.)

birch leaf-mining sawfly

The birch leaf-mining sawfly, *Heterarthrus nemoratus* (Fall.), is a European species which was recorded from Nova Scotia as early as 1905. In 1926 it appeared abundantly in Maine. A number of parasites were shipped to this country from central Europe between 1930 and 1934. Two of them, *Chrysocharis laricinellae* (Ratz.) and *Phanomeris phyllotomae* Mues., became established (table 10). The host has been of practically no economic importance since that time, however, and no attempt has been made to determine the importance of the parasite in recent years.

Malacosoma disstria Hbn.

forest tent caterpillar

Two imported parasites were released against the forest tent caterpillar, *Malacosoma disstria* Hbn., at Cass Lake, Minn., in 1937; a colony of 4,711 (1,726 ♂♂ and 2,985 ♀♀) *Compsilura concinnata* (Meig.) and a colony of 2,985 *Pimpla turionellae* (L.). *Compsilura* is known to attack *M. disstria* in the East. *Pimpla* is a polyphagous pupal parasite that was originally reared from European pine shoot moth pupae from Europe; but it attacks a wide variety of hosts, among them *M. disstria*, under laboratory conditions. No recoveries were made following these liberations.

Malacosoma fragilis (Stretch)

great basin tent caterpillar

Compsilura concinnata (Meig.) and *Calosoma sycophanta* (L.) have been collected in the East and liberated against *Malacosoma* spp. in the West. A colony of 590 *Calosoma* was sent to Alhambra, Calif., in 1918 for release against either *Malacosoma fragilis* (Stretch) or *M. pluriale* Dyar. In 1929, 1,000 *Calosoma* were released on the Santa Fe (N. Mex.) National Forest and 300 were released in Alamogordo, N. Mex. In 1942, 1,000 *Calosoma* and 800 *Compsilura* puparia were released on the Santa Fe National Forest. Neither species has been recovered.

TABLE 8.—Liberations against the Douglas-fir tussock moth, *Hemerocampa pseudotsugata* McD.

Species	Origin	Where liberated	Year	Where collected	Number shipped	Living insects released, total
<i>Calosoma sycophanta</i> (L.)	Europe	Northport, Wash.	1930	New England	1,200	1,002
<i>Compsilura concinnata</i> (Meig.)	do	Hailey, Idaho	1937	do	1,000	985
<i>Pimpla turionellae</i> (L.)	do	do	1937	Lab. reared	2,000	1,968

TABLE 9.—Liberations against the range caterpillar, *Hemileuca oliviae* Ckll.

Species	Origin	Where liberated	Year	Where collected	Number shipped	Living insects released, total
<i>Calosoma sycophanta</i> (L.)	Europe	Cimarron, N. Mex.	1928	New England	100	100
		Koehler, N. Mex.	1913	do	30	30
		Koehler and Maxwell, N. Mex.	1914	do	1,400	1,400
<i>Compsilura concinnata</i> (Meig.)	do	Raton, N. Mex.	1929	do	2,000	1,199
		Tempe, Ariz.	1915	do	12,000	?
		Raton, N. Mex.	1929	do	12,200	700+
		Roswell, N. Mex.	1914	do	13,150	400+
<i>Ooencyrtus kuwanai</i> (How.)	Japan	do	1915	do	12,005	?
		Maxwell, N. Mex.	1914	Lab. reared	?	?

¹ Puparia.

TABLE 10.—Liberations against the birch leaf-mining sawfly, *Heterarthrus nemoratus* (Fall.)

Species	Origin	Where liberated	Year	Where collected	Number shipped	Living insects released		
						♂♂	♀♀	Total
<i>*Chrysocharis laricinellae</i> (Ratz.).	Europe-----	Bar Harbor, Maine-----	1933	Europe-----	1,345	603	742	1,345
		Bethel, Maine-----	1933	do-----	1,350	600	750	1,350
		Eustis, Maine-----	1935	do-----	1,940	500	1,440	1,940
		Strong, Maine-----	1931	do-----	63	15	48	63
		North Andover, Mass-----	1935	do-----	567	130	290	420
		Stark, N.H.-----	1935	do-----	1,700	500	1,200	1,700
		Bolton, Vt.-----	1934	do-----	450	150	300	450
<i>Chrysocharis</i> sp-----	do-----	Bar Harbor, Maine-----	1933	do-----	404	79	325	404
		Eustis, Maine-----	1935	do-----	125	25	100	125
		Bar Harbor, Maine-----	1933	do-----	275	-----	-----	273
<i>*Phanomoris phyllotomae</i> Mues.	do-----	Bethel, Maine-----	1933	do-----	200	-----	-----	200
		Eustis, Maine-----	1935	do-----	1,116	488	628	1,116
		North Conway, N.H.-----	1931	do-----	88	60	28	88
		do-----	1932	do-----	28	-----	28	28
		Keene, N.Y.-----	1934	do-----	210	110	100	210
<i>Scambus foliae</i> (Cush.)-----	do-----	Eustis, Maine-----	1935	do-----	50	-----	50	
<i>Tranosema pedella</i> (Hlmgr.).	do-----	North Conway, N.H.-----	1931	do-----	12	-----	12	

* Known to be established.

Miscellaneous releases of *Calosoma*

The large carabid, *Calosoma sycophanta* (L.), which was successfully introduced into New England from Europe against the gypsy moth, is known as a rather omnivorous feeder, although it prefers gypsy moth larvae and pupae. Because of this, small colonies of *Calosoma* beetles were collected in New England and colonized against a variety of hosts widely distributed throughout the United States. *Calosoma* has never been recovered in any of these release areas, but a list of host species is presented here because of possible interest (table 11).

Miscellaneous releases of *Compsilura*

The tachinid fly, *Compsilura concinnata* (Meig.), which was successfully established in this country as a parasite of the gypsy and brown-tail moths, also attacks the imported satin moth and more than 200 native hosts. Because of its exceptionally polyphagous habits, it was collected in New England and released against a few crop and fruit insects in some rather widely separated areas. It has not been recovered from these hosts, but the liberations are listed in table 12. They may prove of interest in their distribution even if *Compsilura* fails to attack the host against which the release was made.

Neodiprion abietis (Harr.)

balsam fir sawfly

In 1943 the imported European spruce sawfly cocoon parasite, *Dahlbominus fuscipennis* (Zett.), was liberated against the balsam fir sawfly, *Neodiprion abietis* (Harr.), in the New Harbor, Maine, area by entomologists of the State of Maine. A note in the Biennial Report of the Forest Commissioner for the State of Maine for 1943-44, page 37, states that cocoons collected at the liberation point were heavily parasitized.

Neodiprion fulviceps (Cress.)

In 1941 a shipment of 200,000 *Dahlbominus fuscipennis* (Zett.) was sent to Deadwood, S. Dak., for release in the Harney National Forest against *Neodiprion fulviceps* (Cress.). The parasite has not been recovered, but no special collections have been made for that purpose.

Neodiprion lecontei (Fitch)

red-headed pine sawfly

When large numbers of the parasite *Dahlbominus fuscipennis* (Zett.) were being reared for liberation against the European spruce sawfly from 1939 to 1941, a considerable number were also liberated against the red-headed pine sawfly, *Neodiprion lecontei* (Fitch). About 580,000 were released on pine plantations of the Tennessee Valley Authority. Three hundred thousand of these were liberated in northwestern Alabama near Wilson Dam in 1940. The remainder were put out in the same general area in western Tennessee in 1941.

TABLE 11.—Miscellaneous releases of *Calosoma sycophanta* (L.)

Host species	Locality	Year	Calosoma beetles	
			Shipped	Released
<i>Alsophila pometaria</i> (Harr.)-----	Blowing Rock, N.C.-----	1921	?	12
	Linville, N.C.-----	1921	166	158
<i>Anticarsia</i> sp.-----	Gainesville, Fla.-----	1915		16
<i>Carpocapsa pomonella</i> (L.)-----	Bentonville, Ark.-----	1915		457
	Grand Junction, Colo.-----	1915		963
	Greenwood and Winchester, Va.-----	1915		600
<i>Datana integerrima</i> G. & R.-----	Farmington, Del.-----	1917		35
<i>Epilachna varivestris</i> Muls.-----	Birmingham, Ala.-----	1921		50
<i>Hyphantria cunea</i> (Dru.)-----	Sacramento, Calif.-----	1913		30
<i>Phryganidia californica</i> Pack.-----	Alhambra, Calif.-----	1918		590
<i>Rhopobata naevana</i> (Hbn.)-----	Seaview, Wash.-----	1919	400	45

TABLE 12.—Miscellaneous releases of *Compsilura concinnata* (Meig.)

Host species	Locality	Year	<i>Compsilura</i>	
			Puparia shipped	Adults released
<i>Colias philodice eurytheme</i> Bdv.-----	Tempe, Ariz.-----	1918	10, 635	?
	Sacramento, Calif.-----	1923	1, 000	?
	Riverside, Calif.-----	1924	1, 000	?
<i>Harrisina brillians</i> B. and McD.-----	San Diego County, Calif.-----	1952	9, 000	4, 790
<i>Hyphantria cunea</i> (Dru.)-----	Portland, Oreg.-----	1933	-----	74
<i>Laphygma frugiperda</i> (J. E. Smith)-----	Gainesville, Fla.-----	1915	896	?
		1916	2, 125	?

That same year 200,000 were released on the Manistee National Forest in Michigan. In New York 530,000 were released in 20 towns in and around the Adirondack region. In 1946 a shipment from Canada was released near Cadillac, Mich. Few attempts were made to recover the parasite at any of these liberation points, and the only place where the parasite is known to have been established is near Cadillac, Mich.

In 1932 a colony of 120 *Sturmia inconspicua* (Meig.) (= *Drino bohemica* Mesn.) was liberated at Mont Alto, Pa. It was not known whether this European species would attack *Neodiprion lecontei* or not, but it seemed a possibility. No recoveries were made.

***Neodiprion pratti pratti* (Dyar)**

During the summer of 1959 the Division of Forestry of Virginia recovered *Dahlbominus fuscipennis* (Zett.) from *Neodiprion pratti pratti* (Dyar) cocoons collected in several counties in the central part of the State. More than 23,000 *Dahlbominus* were reared in the laboratory and colonized at a number of points that season, and more than a million were reared and released in 1960. No releases of this parasite were made previously in Virginia, so it must have spread naturally from New Jersey or Maryland.

***Neodiprion pratti paradoxicus* Ross**

A colony of 6,000 parasites, *Exenterus abruptorius* (Thnb.), supplied by Canada from European collections, was liberated against the sawfly *Neodiprion pratti paradoxicus* Ross at Ashby, Mass., in 1940. The parasite has not been recovered.

Three small colonies of *Aptesis basizonia* (Grav.) reared from European stock at New Haven, Conn., were released against a *Neodiprion* sp. in 1940. It is believed that this was the same species later described by Ross (Forest Sci. 1: 196-209, 1955) as *N. pratti paradoxicus*. Liberations were as follows: Groton, Mass., 200; Greenwood, N.Y., 103; Pittsford, Vt., 100.

E. E. McCoy of the New Jersey State Department of Agriculture has reported that *Aptesis basizonia* (Grav.) has been recovered from "paradoxicus" in New Jersey.³

The State of New Jersey has also reared *Dahlbominus fuscipennis* (Zett.) on a large scale for release against this pest. Since 1957, 1,863,000 have been colonized in *Neodiprion pratti paradoxicus* infestations and according to Mr. McCoy a number of good field recoveries have been made.³

***Neodiprion sertifer* (Geoff.)**

European pine sawfly

Canada has conducted an intensive program of parasite introduction against the European pine sawfly, *Neodiprion sertifer* (Geoff.), and large colonies of several species of parasites have been released in that country. Shipments of these species have also been sent to

³ Personal communication.

the United States for release (table 13). In addition, the State of New Jersey has propagated large numbers of *Dahlbominus fuscipennis* (Zett.) for release in *N. sertifer* infestations. Three species are known to be established. Of these, *Dahlbominus* is generally distributed throughout the State, and *Aptesis basizonia* (Grav.) is also well established. Limited recoveries of the larval parasite, *Exenterus abruptorius* (Thnb.), have also been made by the Northeastern Forest Insect Laboratory. (It is worth noting in this connection that Canada also imported a polyhedrosis virus disease of *N. sertifer* from Europe and that it has been used effectively against the larvae in both Canada and the United States.)

Neodiprion swaini Midd.

Swaine's jack-pine sawfly

Professor R. D. Shenefelt released about 100,000 *Dahlbominus fuscipennis* (Zett.) against Swaine's jack-pine sawfly, *Neodiprion swaini* Midd., in Iowa County, Wis., in 1953.

Nygmia phaeorrhoea (Donov.)

brown-tail moth

Large scale importations of parasites and predators of the brown-tail moth, *Nygmia phaeorrhoea* (Donov.), were conducted concurrently with those of the gypsy moth from 1905-11. The work has been described in detail in U.S. Department of Agriculture Technical Bulletin 86 (1929), and the summary of liberations made through 1927 (table 14) is taken from table 34 in that publication. In order to expedite dispersion into the Maritime Provinces, the Canadian entomologists collected *Calosoma sycophanta* (L.) and *Meteorus versicolor* (Wesm.) adults and *Compsilura concinnata* (Meig.) puparia in New England for recolonization during 1912-15. Releases of two additional species in the United States are recorded in table 15.

Nine beneficial species became established in this country. Two of them, *Compsilura concinnata* (Meig.) and *Exorista larvarum* (L.), are perhaps more properly listed, however, as gypsy moth parasites inasmuch as they are even more important enemies of that pest. The most effective of the brown-tail moth parasites are *Townsendiellomyia nidicola* (Tns.) [now called *Alsomyia nidicola* Tns.], *Apanteles lacticolor* Vier., and *Meteorus versicolor* (Wesm.).

Porthetria dispar (L.)

gypsy moth

The work done to establish predators and parasites of the gypsy moth, *Porthetria dispar* (L.), in the United States is so well known that it need not be described in detail here. Large scale importations from Europe were made from 1905 to 1914 and from 1922 to 1933. Several species were also obtained from Japan during the early period. Table 16 summarizing this work through 1927 is taken from U.S.D.A.

TABLE 13.—Liberations against the European pine sawfly, *Neodiprion sertifer* (Geoff.)

Species	Origin	Where liberated	Year	Where collected	Number shipped	Living insects released		
						♂ ♂	♀ ♀	Total
* <i>Aptesis basizonia</i> (Grav.).	Europe-----	East Orange, N.J.-----	1940	Lab. reared---	1,000			1,000
		Millburn, N.J.-----	1940	do-----	317			317
		do-----	1940	do-----	952			952
		Lamington, N.J.-----	1940	do-----	1,000			1,000
		Peapack, N.J.-----	1940	do-----	1,000			1,000
* <i>Dahlbominus fuscipennis</i> (Zett.).	-----do-----	New Jersey-----	(¹)		(¹)		(¹)	
		Ohio-----	(²)		(²)		(²)	
<i>Delomerista japonica</i> Cush. ³	Oregon-----	Far Hills, N.J.-----	1937	Oregon-----	400			400
* <i>Exenterus abruptorius</i> (Thnb.).	Europe-----	Gladstone, N.J.-----	1941	Europe-----	4,800	612	4,188	4,800
		Harding, N.J.-----	1941	do-----	2,654	1,148	1,506	2,654
		Lamington, N.J.-----	1941	do-----	3,190	253	2,937	3,190
		do-----	1941	do-----	6,400	3,088	3,312	6,400
		Millburn, N.J.-----	1941	do-----	6,400	1,954	4,446	6,400
<i>Exenterus amictorius</i> (Panz.).	-----do-----	Harding, N.J.-----	1941	do-----	75	57	18	75
<i>Ischnojoppa luteator</i> (Thnb.).	-----do-----	do-----	1941	do-----	112	64	48	112
		do-----	1941	do-----	83	13	70	83
<i>Lamachus eques</i> (Htg.)	-----do-----	Gladstone, N.J.-----	1941	do-----	94	24	70	94
		Harding, N.J.-----	1941	do-----	13	3	10	13

*Known to be established.

¹ In 1939 the U.S. Department of Agriculture liberated 480,000, and from 1939-45 the State of New Jersey liberated 12,644,000 *Dahlbominus* in *N. sertifer* infestations scattered throughout the State.

² In 1939 the U.S. Department of Agriculture supplied the Ohio Agricultural Experiment Station with 390,000 *Dahlbominus* which were liberated in *N. sertifer* infestations in Brainbridge and Clyde, Ohio.

³ Recorded in the East prior to liberation.

TABLE 14.—Foreign enemies of *Nygmia phaeorrhoea* (Donov.) liberated in North America through 1927¹

Species	Individuals of foreign stock liberated	Subsequently liberated—		Total enemies liberated
		By reproduction from foreign stock	From New England field collections	
	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>
* <i>Apanteles lacticolor</i> Vier.....	55,000		255,245	310,245
* <i>Carabus auratus</i> L.....	478			478
* <i>Carcelia laxifrons</i> Vill.....	9,742			9,742
* <i>Compsilura concinnata</i> (Meig.).....	25,134		122,625	147,759
* <i>Eupleromalus nidulans</i> (Thoms.).....	?	530,000		530,000
* <i>Ezorida larvarum</i> (L.).....	42,152			42,152
* <i>Meteorus versicolor</i> (Wesm.).....	3,113		7,887	11,000
* <i>Monodontomerus aereus</i> Wlkr.....	15,541			15,541
* <i>Townsendiellomyia nidicola</i> (Tns.).....	3,500			3,500

*Known to be established.
¹ From U.S.D.A. Tech. Bul. 86.

TABLE 15.—Liberations against the brown-tail moth in the United States, 1928-59

Species	Origin	Where liberated	Year	Where collected	Number shipped	Living insects released, total
<i>Blondelia piniariae</i> (Htg.)...	Europe.....	York, Maine.....	1929	Europe.....	12,169	12,169
		Nashua, N.H.....	1929	do.....	9,335	9,335
<i>Carcelia rutila</i> Meig.....	do.....	York, Maine.....	1929	do.....	120	120

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TABLE 16.—Foreign enemies of *Porthetria dispar* (L.) liberated in North America through 1927¹

Species	Individuals of foreign stock liberated	Subsequently liberated—			Total enemies liberated
		By reproduction from foreign stock	By reproduction from established stock	From New England field collections	
<i>Anastatus disparis</i> Ruschka	133, 680			65, 505, 513	65, 644, 193
<i>Apanteles liparidis</i> (Bouché)	76, 702	37, 370			114, 072
* <i>Apanteles melanoscelus</i> (Ratz.)	23, 476		132, 177		155, 653
<i>Apanteles porthetriae</i> Mues.	12, 065	22, 522			34, 587
<i>Apanteles solitarius</i> (Ratz.) ²	22, 546				22, 546
<i>Blepharipoda scutellata</i> (R.-D.)	11, 097			73, 546	84, 643
<i>Blondelia nigripes</i> (Fall.)	10, 692				10, 692
<i>Brachymeria intermedia</i> (Nees)	20, 798				20, 798
<i>Brachymeria obscurata</i> (Walk.)	394				394
<i>Calosoma chinense</i> Kirby	140	128			268
<i>Calosoma inquisitor</i> (L.)	259	27			286
<i>Calosoma reticulatum</i> (Fab.)	83	27			110
* <i>Calosoma sycophanta</i> (L.)	2, 711			63, 870	66, 581
<i>Carabus arvensis</i> Fab. (= <i>arcensis</i> Herbst.)	108				108
* <i>Carabus auratus</i> L. ³	478				478
<i>Carabus glabratus</i> Payk.	63				63
<i>Carabus violaceus</i> L.	136				136
* <i>Carabus nemoralis</i> Müll.	9, 742				9, 742
<i>Carcelia laxifrons</i> Vill.	17, 061				17, 061
<i>Carcelia separata</i> Rond.	25, 134			122, 625	147, 759
* <i>Compsilura concinnata</i> (Meig.) ²	700				700
<i>Crossocosmia flavoscutellata</i> Schiner	42, 152				42, 152
<i>Crossocosmia sericariae</i> (Rond.)	9, 323				9, 323
* <i>Exorista larvarum</i> (L.)	23				23
<i>Exorista segregata</i> (Rond.)	5	395			400
<i>Masicera sylvatica</i> (Fall.)					
<i>Meteorus japonicus</i> Ashm.					

<i>Meteorus pulchricornis</i> (Wesm.)	4	118		122
* <i>Ooencyrtus kuwanai</i> (How.)	1, 703		25, 675, 884	25, 677, 587
<i>Pales pavidus</i> Meig.	582			582
* <i>Parasetigena silvestris</i> (R.-D.)	18, 445	2, 278		20, 723
* <i>Phobocampe disparis</i> (Vier.)	12, 543			12, 543
<i>Pimpla examinator</i> (Fab.)	402			402
<i>Pimpla instigator</i> (Fab.)				
<i>Procrustes coriaceus</i> L.	75			75
<i>Sturmia inconspicua</i> Meig. (= <i>Drino bohémica</i> Mesn.)	13, 364			13, 364
<i>Tachina japonica</i> Towns.	471			471
<i>Tachina magnicornis</i> (Zett.)	4, 568			4, 568
Tachinids unclassified ⁴	9, 420			9, 420
Tachinids unclassified ⁵	10, 499			10, 499
<i>Telenomus phalaenarum</i> Nees ⁶		4, 650		4, 650
<i>Trichogramma</i> spp. ⁶		76, 000		76, 000
<i>Xylodrepa quadripunctata</i> Schr.	100	15		115
<i>Zenillia libatrix</i> (Panz.)	504			504

*Known to be established.

¹ From U.S.D.A. Tech. Bul. 86, p. 142.

² Some doubt as to this species.

³ Also liberated against *Nygmia phaeorrhoea* (Donov.).

⁴ Includes some multibrooded species liberated in 1906-07.

⁵ Mostly *Exorista larvarum* in 1926.

⁶ Number of foreign stock received unknown.

Technical Bulletin 86. Table 17 summarizes work done since 1927. Nine parasites and two predators were established in this country. Two of the parasites are egg parasites. Both are well distributed and often abundant throughout the infested areas. One of these, *Ooencyrtus kuwanai* (How.), is from Japan and is the only parasite established from that country. The other, *Anastatus disparis* Ruschka, is from central Europe.

Four tachinid larval parasites are also well distributed and abundant. They are *Compsilura concinnata* (Meig.), *Exorista larvarum* (L.), *Parasetigena silvestris* (R.-D.), and *Blepharipoda scutellata* (R.-D.). One hymenopterous larval parasite, *Apanteles melanoscelus* (Ratz.), can also be placed in this category. Two other larval parasites, *Phobocampe disparis* (Vier.) and *Monodontomerus aereus* Wlkr., are rather scarce and unimportant. One predator, a large carabid, *Calosoma sycophanta* (L.), is very abundant and destructive. The other, *Carabus auratus* L., is of no practical importance.

Generally speaking there is an excellent sequence of insect enemies operating against the gypsy moth in this country, but the almost universal use of insecticides when defoliation occurs complicates an evaluation of the long-term results of this work.

Pristiphora erichsonii (Htg.)

larch sawfly

An ichneumonid parasite, *Mesoleius tenthredinis* Morley, was imported from England and successfully colonized against the larch sawfly, *Pristiphora erichsonii* (Htg.), in Canada in 1910-11. For many years it was an extremely effective parasite, and it spread naturally throughout the Lake States west to Montana and east as far as Pennsylvania. A few small colonies were also released in the United States, but it is doubtful if they affected spread of the parasite.

According to information supplied by Prof. S. A. Graham, in 1911 a small colony of *Mesoleius* was released on Grand Island near Munising, Mich. Dr. H. J. MacAloney of the U.S. Forest Service reports that eight colonies were liberated in 1953 in two general areas in northern Minnesota. In 1929, 14 specimens were released in Rindge, N.H., and in 1931 two small colonies of 42 and 35 specimens, respectively, were released at Lunenburg, Mass.

In 1953 Prof. R. D. Shenefelt released about 100,000 *Dahlbominus fuscipennis* against the larch sawfly in Douglas County, Wis., and about the same number in Burnett County, Wis. Two colonies were also released in New York State, one at Kent in 1940, and one at Sanford in 1939. Each of these contained 10,000 parasites.

Rhyacionia buoliana (Schiff.)

European pine shoot moth

Both the United States and Canada have undertaken extensive programs of parasite introduction against the European pine shoot moth, *Rhyacionia buoliana* (Schiff.), and large numbers of parasites from England and the Continent have been released in this country

TABLE 17.—Liberations against the gypsy moth, *Porthetria dispar* (L.), 1928-59

Species	Origin	Where liberated	Year	Where collected	Number shipped	Living insects released		
						♂ ♂	♀ ♀	Total
<i>*Anastatus disparis</i> Ruschka	Europe	New England ¹	(1)					(1)
<i>Apanteles liparidis</i> (Bouché).	do	Duxbury, Mass.	1932	New England	2, 880			2, 880
<i>*Apanteles melanoscelus</i> (Ratz.).	do	Ashburnham, Mass.	1929	do	352	275	77	352
<i>*Blepharipoda scutellata</i> (R.-D.).	do	(2)	1928	do	3, 336	1, 522	1, 814	3, 336
<i>Blondelia nigripes</i> Fall.	do	Thompson, Conn.	1932	Europe	163			163
		Middleborough, Mass.	1931	do	360			360
		Bow, N.H.	1930	do	7			7
		Nashua, N.H.	1928	do	53			53
<i>Blondelia piniariae</i> Htg.	do	Amherst, N.H.	1929	do	12, 177			12, 177
		Rye, N.H.	1928	do	1, 454			1, 454
		Cranston, R.I.	1929	do	10, 981			10, 981
<i>Brachymeria intermedia</i> (Nees).	do	Dighton, Mass.	1930	do	895			895
		Plymouth, Mass.	1931	do	304			304
<i>*Calosoma sycophanta</i> (L.)	do	Barkhamstead, Conn.	1930	New England	800			800
		Wethersfield, Conn.	1930	do	800			800
		Woodstock, Conn.	1934	do	168			168
		Limerick, Maine	1934	do	193			193
		Agawam, Mass.	1930	do	916			916
		Belchertown, Mass.	1933	do	142			142
		Bernardston, Mass.	1930	do	750			750
		Carlisle, Mass.	1928	do	³ 716			716
		Deerfield, Mass.	1930	do	1, 400			1, 400
		Dighton, Mass.	1930	do	³ 35			35
		Erving, Mass.	1934	do	100			100
		Gill, Mass.	1934	do	100			100

See footnotes at end of table.

TABLE 17.—Liberations against the gypsy moth, *Porthetria dispar* (L.), 1928-59—Continued

Species	Origin	Where liberated	Year	Where collected	Number shipped	Living insects released				
						♂ ♂	♀ ♀	Total		
<i>*Calosoma sycophanta</i> (L.)—Continued.	Europe-----	Greenfield, Mass-----	1934	New England	100			100		
		Hatfield, Mass-----	1930	do	950			950		
		Holden, Mass-----	1928	do	275	149	126	275		
		Mendon, Mass-----	1929	do	5,000			5,000		
		Middleton, Mass-----	1929	do	66			66		
		Montague, Mass-----	1934	do	90			90		
		Northampton, Mass-----	1929	do	5,000			5,000		
		Princeton, Mass-----	1929	do	5,000			5,000		
		Ware, Mass-----	1933	do	127			127		
		Westford, Mass-----	1928	do	150	75	75	150		
		Windham, N.H-----	1928	do	557	345	212	557		
		East Greenwich, R.I-----	1928	do	506	238	268	506		
		Wakefield, R.I-----	1928	do	364	198	166	364		
		Brattleboro, Vt-----	1930	do	700			700		
		Granby, Vt-----	1930	do	1,000			1,000		
		Westfield, Vt-----	1930	do	1,423			1,423		
		Westminster, Vt-----	1930	do	1,000			1,000		
		<i>Carcelia separata</i> Rond.	do-----	Chelmsford, Mass-----	1929	Europe	3,870			3,870
				Middleborough, Mass-----	1931	do	1,559			1,559
				Saugus, Mass-----	1932	do	6			6
Bow, N.H-----	1930			do	2,034			2,034		
Nashua, N.H-----	1928			do	1,052			1,052		
do-----	1929			do	30			30		
do-----	1928			do	484			484		
<i>*Compsilura concinnata</i> (Meig.).	do-----	Boxford, Mass-----	1928	do	120			120		
		Chelmsford, Mass-----	1929	do	250			250		
		Middleborough, Mass-----	1931	do	2,300			2,300		
		Rowley, Mass-----	1928	do	3,978			3,978		
		Bow, N.H-----	1930	do	66			66		
		Nashua, N.H-----	1929	do	16			16		
		Rye, N.H-----	1928	do	3,184			3,184		
		Westerly, R.I-----	1928	New England	3,184			3,184		

<i>Ernestia</i> sp.	do	Bow, N.H.	1930	Europe	5			5
* <i>Exorista larvarum</i> (L.)	do	Canton, Conn.	1941	do	65	23	42	65
		Thompson, Conn.	1932	do	1, 112			912
		Chelmsford, Mass.	1929	do	1, 530			1, 530
		Saugus, Mass.	1932	do	21			21
		Bow, N.H.	1930	do	23, 221			23, 221
		Manchester, N.H.	1930	do	3, 323			3, 323
		Nashua, N.H.	1928	do	2, 370			2, 370
		do	1929	do	149			149
* <i>Ooencyrtus kuwanai</i> (How.)	Japan	Easton, Mass.	1928	Lab. reared	224, 000			224, 000
		Foxboro, Mass.	1928	do	144, 000			144, 000
		Mansfield, Mass.	1928	do	56, 000			56, 000
		Norton, Mass.	1928	do	88, 000			88, 000
* <i>Parasetigena silvestris</i> (R.-D.)	Europe	Thompson, Conn.	1933	Europe	2, 880	1, 200	1, 680	2, 880
		Union, Conn.	1941	do	199	100	99	199
		Acton, Mass.	1932	do	16, 782	5, 759	11, 023	16, 782
		do	1933	do	2, 880	1, 200	1, 680	2, 880
		Boxford, Mass.	1928	do	9, 622	4, 137	5, 485	9, 622
		Chelmsford, Mass.	1929	do	⁶ 6, 538			
		Duxbury, Mass.	1933	do	11, 429	5, 322	6, 107	11, 429
		Holden, Mass.	1930	do	⁵ 10, 318			
		Rehoboth, Mass.	1931	do	200		200	200
		do	1932	do	129		129	129
		Sherborn, Mass.	1930	do	11, 875	4, 800	7, 075	11, 875
		Sudbury, Mass.	1931	do	22, 017	6, 224	15, 793	22, 017
		Biddeford, Maine	1930	do	1, 197		1, 197	1, 197
		Sebago, Maine	1933	do	1, 830	1, 300	530	1, 830
		Hillsdale, N.Y.	1942	do	⁸ 3, 650			
* <i>Phobocampe disparis</i> (Vier.)	do	Attleboro, Mass.	1930	do	⁵ 10, 946			
		Barnstable, Mass.	1929	do	2, 576	300	2, 276	2, 576
		Dighton, Mass.	1931	do	112	45	67	112
		do	1932	do	1, 862	1, 120	742	1, 862
<i>Phobocampe</i> sp.	do	Stow, Mass.	1930	do	500			500
				do	194	126	68	194
				do	58	23	35	58
				do	73	23	50	73

See footnotes at end of table.

TABLE 17.—Liberations against the gypsy moth, *Porthetria dispar* (L.) 1928-59—Continued

Species	Origin	Where liberated	Year	Where collected	Number shipped	Living insects released		
						♂♂	♀♀	Total
<i>Sturmia inconspicua</i> Meig. (= <i>Drino bohemia</i> <i>ica</i> Mesn.).	Europe-----	Beverly, Mass-----	1928	Europe-----	13, 314	-----	-----	13, 314
		Lunenburg, Mass-----	1928	do-----	11, 598	-----	-----	11, 598
		do-----	1931	do-----	980	-----	-----	980
		Middleborough, Mass-----	1931	do-----	1, 495	-----	-----	1, 495
		Saugus, Mass-----	1929	do-----	245	-----	-----	245
		do-----	1930	do-----	624	-----	-----	624
		Bow, N.H.-----	1930	do-----	492	-----	-----	492
		Nashua, N.H.-----	1928	do-----	116	-----	-----	116
		Middleton, R.I.-----	1928	do-----	2, 963	-----	-----	2, 963
		<i>Zenillia libatrix</i> (Panz.)-----	do-----	Chelmsford, Mass-----	1929	do-----	24	-----
Melrose, Mass-----	1933			do-----	16	-----	-----	16
Saugus, Mass-----	1929			do-----	7	-----	-----	7
do-----	1932			do-----	3	-----	-----	3
Bow, N.H.-----	1930			do-----	21	-----	-----	21
Nashua, N.H.-----	1928			do-----	1, 004	-----	-----	1, 004

*Known to be established.

¹ More than 65 million *Anastatus disparis* were colonized throughout New England from 1908 through 1927. About 8½ million were released from 1928 through 1932. It is unnecessary to list individual releases for such a widespread program, but numbers by States from 1928 to 1932 are given in order to complete the early record published in bulletin 86.

State	Number liberated
Connecticut-----	500, 000
Maine-----	2, 818, 000
Massachusetts-----	4, 431, 000
New Hampshire-----	620, 000
Rhode Island-----	50, 000
Total-----	8, 419, 000

² From 1928 through 1933 large numbers of *Blepharipoda scutellata* puparia obtained from gypsy moth pupal collections were recolonized throughout the infested area. Since the species is widely dispersed, individual liberation points have not been given. A summary by States follows:

State	Liberation points	Puparia liberated
Connecticut-----	9	20, 847
Massachusetts-----	53	118, 030
Vermont-----	13	32, 957
Total-----		171, 834

In addition 300 adults were liberated at Hillsdale, N.Y., in 1942, and 5,594 adults were liberated at Westerly, R.I., in 1928.

³ Larvae.

⁴ Puparia.

⁵ Parasitized host larvae.

and Canada (table 18). At least four species have become established, although one of them, the larval parasite *Orgilus obscurator* (Nees), was undoubtedly present in the United States prior to liberation. The other, *Temelucha interruptor* Grav., a larval parasite, and two pupal parasites, *Tetrastichus turionum* (Htg.) and *Pimpla turionellae* (L.), have never been recovered in substantial numbers, although both are important parasites at times in Europe. *P. turionellae* has been recovered in Canada but not in the United States. The shoot moth is especially difficult to control with insecticides, and it is unfortunate that its parasitic enemies have been of such little consequence in this country.

Rhyacionia frustrana bushnellii (Busck)

pine tip moth

Tip moths are very serious pests of pine on the extensive man-made pine forests of the Nebraska National Forest. In 1925 pine tips infested with *Rhyacionia frustrana* (Comst.) were collected in Virginia and taken to Nebraska in order to obtain parasites for liberation against *R. frustrana bushnellii* (Busck). Several species were liberated that year, and work was supplemented by some further collections from Massachusetts in 1926 (table 19). *Campoplex frustranae* Cush. took hold immediately and within 5 years appeared to be bringing the pest under control. Unfortunately about this time another variety of tip moth, *R. frustrana neomexicana* Dyar, increased very rapidly. *Campoplex frustranae* does not parasitize *neomexicana*, so conditions were not substantially improved.

Setora (Miresa) nitens Wlk.

nettle grub

In 1932, at the request of the Commonwealth Institute of Biological Control, 5,000 oriental moth cocoons, some of which were parasitized by *Chaetexorista javana* B. & B., were sent to Ceylon from Melrose Highlands, Mass. It was hoped that this parasite could be recovered from these cocoons for release against the nettle grub, *Setora (Miresa) nitens* Wlk. About 500 *Chaetexorista* adults were obtained.

Stilpnotia salicis (L.)

satin moth

The satin moth, *Stilpnotia salicis* (L.), was first discovered in this country at Medford, Mass., in 1920. That same year it was also found at Westminster in British Columbia, and 2 years later at Bellingham, Wash.

Several species of parasites that attack the gypsy and brown-tail moths also attack the satin moth, so it is not surprising that some of them were found attacking *Stilpnotia salicis* when it was discovered in New England. Between 1927 and 1934 several more species were

TABLE 18.—Liberations against the European pine shoot moth, *Rhyacionia buoliana* (Schiff.)

Species	Origin	Where liberated	Year	Where collected	Number shipped	Living insects released		
						♂♂	♀♀	Total
<i>Actia nudibasis</i> Stein	Europe	Branford, Conn	1935	Europe	294			285
		Easton, Conn	1934	do	157			134
<i>Campoplex borealis</i> (Zett.)	do	Malden, Mass	1932	do	49	16	33	49
		Meriden, Conn	1937	do	96	41	55	96
<i>Campoplex multicinctus</i> Grav.	do	do	1937	do	60	29	31	60
<i>Campoplex mutabilis</i> (Holmg.)	do	do	1937	do	24	12	12	24
<i>Campoplex rufifemur</i> (Thoms.)	do	Chester, N.J	1937	do	101	45	56	101
		Buffalo, N.Y	1935	do	18	7	10	17
<i>Campoplex</i> sp.	do	Branford, Conn	1932	do	39	7	32	39
		Fairfield, Conn	1936	do	55	21	34	55
<i>Copidosoma geniculatum</i> (Dalm.)	do	Brookline, Mass	1933	do	43	13	30	43
		Chester, N.J	1937	do	504	168	334	502
		Branford, Conn	1932	do	1,666	633	1,033	1,666
		do	1933	do	15,000	5,000	10,000	15,000
		Easton, Conn	1934	do	7,000			6,878
		Fairfield, Conn	1937	do	10,000			9,674
		Hamden, Conn	1932	do	1,503	352	1,151	1,503
		do	1933	do	15,000			15,000
		Meriden, Conn	1937	do	12,380			12,380
		North Greenwich, Conn.	1933	do	15,000			15,000
		Brookline, Mass	1933	do	7,500			7,500
		Hingham, Mass	1932	do	1,162	214	948	1,162
Wakefield, Mass	1933	do	15,000			15,000		
Winchester, Mass	1933	do	14,000			14,000		
Boonton, N.J	1937	do	10,000			9,000		
Chester, N.J	1937	do	19,500			18,500		
New Vernon, N.J	1937	do	10,000			9,000		

		Carmel, N.Y.	1932	do	1, 100	400	700	1, 100
		do	1933	do	15, 000			14, 925
		North Castle, N.Y.	1934	do	3, 000			2, 970
		do	1937	do	10, 000			9, 605
		Oyster Bay, N.Y.	1932	do	1, 100	400	700	1, 100
		do	1933	do	15, 000			14, 900
		Plainview, N.Y.	1934	do	10, 000			7, 000
		Rockland Lake, N.Y.	1933	do	15, 000			14, 925
		Southeast, N.Y.	1932	do	1, 100	400	700	1, 100
		Syosset, N.Y.	1937	do	10, 000			9, 000
		Washington, N.Y.	1933	do	15, 000			14, 900
		Bristol, Pa.	1933	do	15, 000			15, 000
<i>Ephialtes ruficollis</i>	do	Fairfield, Conn.	1936	do	554	243	311	554
(Grav.).		Buffalo, N.Y.	1935	do	38	11	24	35
		Lewiston, N.Y.	1935	do	94	8	75	83
		Niagara Falls, N.Y.	1935	do	304	67	203	270
<i>Lypha dubia</i> (Fall.)	do	Branford, Conn.	1935	do	74			71
		Easton, Conn.	1934	do	200			189
		Hamden, Conn.	1938	do	41	2	39	41
		Brookline, Mass.	1933	do	113	45	68	113
		Jericho, N.Y.	1934	do	500			492
<i>Macrocentrus</i> sp.	do	Meriden, Conn.	1937	do	252	139	113	252
		Chester, N.J.	1937	do	150	50	100	150
<i>Orgilus obscurator</i> (Nees)	do	Branford, Conn.	1932	do	100		100	100
		Easton, Conn.	1934	do	92	34	55	89
		Fairfield, Conn.	1935	do	150	46	104	150
		Meriden, Conn.	1936	do	278			278
		Brookline, Mass.	1931	do	72	32	40	72
		Wakefield, Mass.	1933	do	10		10	10
		Winchester, Mass.	1933	do	110		110	110
		Oceana County, Mich.	1959	do	100	33	67	100
		Boonton, N.J.	1937	do	170	86	65	151
		New Vernon, N.J.	1936	do	372	185	184	369
		Buffalo, N.Y.	1935	do	28	14	11	25
		Jericho, N.Y.	1932	do	50		38	38
		Lewiston, N.Y.	1935	do	799	166	577	743
		Niagara Falls, N.Y.	1935	do	799	166	577	743
		Southeast, N.Y.	1932	do	100		100	100
		Syosset, N.Y.	1936	do	320	152	167	319

		Brookline, Mass.	1931	do	390	155	235	390
		Hingham, Mass.	1931	do	275	75	200	275
		Wakefield, Mass.	1933	do	10		10	10
		Winchester, Mass.	1933	do	140		140	140
		Boonton, N.J.	1937	do	80	27	48	75
		New Vernon, N.J.	1936	do	985	485	495	980
		Buffalo, N.Y.	1935	do	272	120	132	252
		Jericho, N.Y.	1932	do	218		218	218
		Lewiston, N.Y.	1935	do	7, 172	1, 431	5, 144	6, 575
		North Castle, N.Y.	1936	do	986	474	496	970
		Roslyn, N.Y.	1936	do	1, 000	495	500	995
		Southeast, N.Y.	1932	do	225		225	225
		Syosset, N.Y.	1936	do	1, 000	500	500	1, 000
	do	Branford, Conn.	1933	do	20, 000			20, 000
		Easton, Conn.	1934	do	2, 000			2, 000
		Fairfield, Conn.	1935	do	10, 675			10, 475
		North Greenwich, Conn.	1936	do	42, 000			42, 000
		Brookline, Mass.	1933	do	20, 000	6, 250	13, 750	20, 000
		Newton, Mass.	1933	do	20, 000			20, 000
		Chester, N.J.	1937	Lab. reared	5, 000			5, 000
		New Vernon, N.J.	1935	Europe	10, 000	4, 000	6, 000	10, 000
		Bedford, N.Y.	1933	do	20, 000			19, 950
		Matinecock, N.Y.	1933	do	20, 000	6, 150	13, 300	19, 450
		North Castle, N.Y.	1933	do	22, 000	9, 450	12, 550	22, 000
		Plainview, N.Y.	1934	do	5, 600			5, 600
	do	Fairfield, Conn.	1937	Lab. reared	35, 000			35, 000
		Meriden, Conn.	1936	do	4, 500			4, 500
		do	1937	do	40, 000			40, 000
		Chester, N.J.	1937	do	35, 000			35, 000
* <i>Tetrastichus lurionum</i> (Htg.)								
<i>Trichogramma evanescens</i> Westw.	do							

*Known to be established.

TABLE 19.—Liberations against the pine tip moth, *Rhyacionia frustrana bushnelli* (Busck)

Species	Origin	Where liberated	Year	Where collected	Number shipped	Living insects released, total
<i>*Campoplex frustranae</i> Cush.	Virginia	Halsey, Nebr.	1925	Virginia	369	369
<i>Eurytoma pini</i> Bugbee	do	do	1925	do	1, 437	1, 437
<i>Ezeristes comstockii</i> (Cress.)	Massachusetts	do	1926	Massachusetts	?	(1)
<i>Glypta varipes</i> Cress.	do	do	1926	do	?	(1)
<i>Habrocytus thyridopterigis</i> How.	Virginia	do	1925	Virginia	13	13
<i>Haltichella rhyacioniae</i> Gahan	do	do	1925	do	254	254
<i>Hyssopus rhyacioniae</i> Gahan	do	do	1925	do	?	(1)
<i>Hyssopus thymus</i> Gir.	do	do	1925	do	?	(1)
<i>Lixophaga mediocris</i> Ald.	do	do	1925	do	?	(1)
<i>Lixophaga plumbea</i> Ald.	do	do	1925	do	?	2
<i>Temelucha epagoges</i> (Cush.)	do	do	1925	do	15	15

*Known to be established.

1 "A few."

imported from central Europe, and all the promising species were also colonized in the Pacific Northwest (table 20). Those known to be established in the Northeast are *Apanteles solitarius* (Ratz.), *Eupteromalus nidulans* Thoms., *Compsilura concinnata* (Meig.), and *Exorista larvarum* (L.). The first three have become established in the West and, in addition, *Meteorus versicolor* (Wesm.) has also become established there. This is rather surprising because it has never become established in the East.

In both areas parasites are generally credited with holding the pest at very low levels. *Apanteles solitarius* seems to be the most important species in both areas. *Meteorus* is very important in the West; *Compsilura* and *Eupteromalus* in the East.

TABLE 20.—Liberations against the satin moth, *Stilpnotia salicis* (L.)

Species	Origin	Where liberated	Year	Where collected	Number shipped	Living insects released			
						♂♂	♀♀	Total	
<i>*Apanteles solitarius</i> (Ratz.).	Europe-----	Chatham, Mass-----	1932	Europe-----	472			472	
		Danvers, Mass-----	1927	Lab. reared---	443	266	177	443	
		do-----	1927	do-----	21, 250				
		Ipswich, Mass-----	1929	do-----	13, 659				
		Natick, Mass-----	1928	do-----	1, 389	853	536	1, 389	
		do-----	1929	do-----	200			200	
		Yarmouth, Mass-----	1927	do-----	205	76	129	205	
		Nashua, N.H-----	1928	do-----	1, 150	525	625	1, 150	
		Kent, Wash-----	1932	New England--	335	13	234	247	
		<i>Calosoma sycophanta</i> (L.)	do-----	Orting, Wash-----	1930	do-----	100		
Puyallup, Wash-----	1930			do-----	100			100	
Seattle, Wash-----	1929			do-----	200			198	
Sumner, Wash-----	1930			do-----	30			30	
New Haven, Conn-----	1933			Europe-----	420			351	
<i>Carcelia gnava</i> Meig.	do-----	Augusta, Maine-----	1930	do-----	5, 000			5, 000	
		Danvers, Mass-----	1927	do-----	860			860	
		Natick, Mass-----	1939	do-----	3, 188			3, 188	
		Yarmouth, Mass-----	1930	do-----	1, 813			1, 813	
		Nashua, N.H-----	1928	do-----	1, 115			1, 115	
		Newmarket, N.H-----	1930	do-----	2, 758			2, 758	
		Kent, Wash-----	1932	do-----	9			3	
		do-----	1933	do-----	300			92	
		Nashua, N.H-----	1928	New England--	415			405	
		Newmarket, N.H-----	1928	do-----	13			13	
		<i>*Compsilura concinnata</i> (Meig.).	do-----	Bellevue, Wash-----	1930	do-----	2, 350		
Kent, Wash-----	1930								
Puyallup, Wash-----	1929			do-----	1, 850			300	
Tacoma, Wash-----	1929								
Puyallup, Wash-----	1935								
Sumner, Wash-----	1931			do-----	230			143	
do-----	1931			do-----	1, 000			59	
									?

	do	1932	do	2	1,996			?
	do	1933	do		340			260
	do	1933	do	2	1,100			180
	Silvana, Wash	1933	do	2	2,045			158
	Sumner, Wash	1934	do		443			1,713
	Tenino, Wash	1932	do		1,885			224
<i>Eupteromalus nidulans</i>	do	1933	do		650			1,885
Thoms.	do	1934	do		1,500			630
	do	1932	do		2,656			1,500
	do	1931	do		3,000			1,731
	do	1932	do		3,755			2,975
	do	1933	do		180			3,755
<i>Exorista larvarum</i> (L.)	do	1933	Europe		309			180
	do	1929	do		247			309
	do	1928	do		120			247
	do	1930	do		1,000			120
	do	1933	do		2,500	1,258	1,242	605
	do	1933	do		1,500			2,500
	do	1933	do		1,500			1,500
	do	1933	do		1,000			1,500
	do	1934	do		1,000	181	819	1,000
	do	1933	do		1,500			1,500
	do	1932	do		600	220	380	600
	do	1932	do		900	400	500	900
	do	1929	do		1,531	273	1,258	1,531
	do	1929	do		1,636			1,636
	do	1933	do		1,500			1,500
	do	1932	do		874	192	682	874
	do	1933	do		400			400
	do	1932	do		1,085	267	818	1,085
	do	1931	do		2,000	391	1,609	2,000
	do	1930	do		1,840			1,840
	do	1934	do		1,000			862
	do	1934	do		1,000			985
	do	1932	do		1,200	504	696	1,200
	do	1933	do		1,250			887
	do	1934	do		1,000			819
	do	1933	do		1,250			837

See footnotes at end of table.

TABLE 20.—Liberations against the satin moth, *Stilpnotia salicis* (L.)—Continued

Species	Origin	Where liberated	Year	Where collected	Number shipped	Living insects released		
						♂ ♂	♀ ♀	Total
<i>Pales pavida</i> Meig.	Europe	Natick, Mass.	1929	Europe	61			61
		Lexington, Mass.	1932	do	33			33
		Nashua, N.H.	1928	do	757			757
<i>Rogas unicolor</i> (Wesm.)	do	Kent, Wash.	1932	do	56			46
		New Haven, Conn.	1934	do	300			293
		Portland, Conn.	1933	do	500			500
		South Harpswell, Maine.	1934	do	500			500
		Topsham, Maine	1933	do	500			500
		South Yarmouth, Mass.	1933	do	500			500
		Taunton, Mass.	1932	do	200			200
		Concord, N.H.	1933	do	150			150
		Woonsocket, R.I.	1934	do	500			500
		Bellingham, Wash.	1934	do	500			497
		Kent, Wash.	1934	do	500			492
		Olympia, Wash.	1934	do	432			430
		Stanwood, Wash.	1934	do	500			457
<i>Tachinomyia similis</i> (Will.)	Washington	Waterbury, Conn.	1938	Washington	104			104
<i>Zenillia libatrix</i> (Panz.)	Europe	Natick, Mass.	1929	Europe	75			75
		Kent, Wash.	1932	do	75			2

*Known to be established.

† Parasitized host larvae.

‡ Puparia.

INDIVIDUAL SPECIES SUCCESSFULLY ESTABLISHED IN THE UNITED STATES

Agathis pumilus (Ratz.) (Braconidae)

Agathis pumilus (Ratz.) was introduced into Canada and the United States from Europe in the late twenties and early thirties along with several other larch casebearer parasites. It was rare in England but fairly important in southern France and Austria, where it parasitized 12 to 20 percent of the host population. It became established readily and is now common throughout the range of the casebearer in North America except in a newly discovered infestation near St. Maries, Idaho. It was colonized there in 1960.

Collections by A. R. Graham in southern Ontario in 1957 showed average parasitism by *Agathis* of 41 to 67 percent. In 1960 limited collections in Connecticut, Massachusetts, and Pennsylvania showed equally high parasitism in some isolated stands of larch. Parasitism in generally infested natural stands in Nova Scotia ran about 25 percent.

Agathis has shown remarkable power of dispersion. For example, in 1937 it was liberated by Prof. S. A. Graham near Ann Arbor, Mich., and by 1951 had spread north of the Straits of Mackinac. In 1950 it was released near Iron River, Mich., by F. E. Webb, and in 1953 it was recovered 50 miles to the east.

Agathis has one generation a year. The winter is spent as a first instar in overwintering casebearer larvae. The parasite does not develop beyond the first instar until the host larva ties its case down preparatory to pupation. The parasitized larva never pupates. The parasite completes development and pupates within the host; adults emerge during late June or early July.

Anastatus disparis Ruschka (Eupelmidae)

Anastatus disparis Ruschka, an important egg parasite of the gypsy moth, occurs in both Europe and Japan. It was first introduced into this country in 1906 and first recovered in 1910. It can be readily propagated and easily collected. More than 65 million parasitized eggs have been distributed throughout the infested region. Detailed records of parasitism were kept for many years at regular collection points, most of which were somewhat north of Boston, Mass. The highest average percentage parasitism was 28 percent in 1921-22. This declined to 6 percent 5 years later, but undoubtedly these figures are closely associated with host population fluctuations and other factors.

In late years *Anastatus* has been scarce in southern Massachusetts and Connecticut, and another egg parasite, *Ooencyrtus kuwanai*, has

been abundant in that area. It is, therefore, generally believed that *Anastatus* is more important in the northern range, and *Ooencyrtus* more important in the southern range of the gypsy moth in this country. This needs confirmation. *Anastatus* is often important in southern climates, such as that in Spain, so it can hardly be considered "a more northern species."

Observations by D. E. Parker indicate that there is little conflict between the two parasites. Nevertheless, both species are rarely, if ever, abundant in one location.

Anastatus has one generation a year. The winter is spent as a full-grown larva in the host's egg. Adults emerge in June and July. Females oviposit in newly laid egg clusters, and often *Anastatus* can be seen ovipositing in fresh eggs, as they are being laid by the female gypsy moth. Larval development requires about 2 weeks, and the full-grown larva remains inactive until the following spring.

Apanteles lacteicolor Vier. (Braconidae)

Apanteles lacteicolor Vier. became established in this country in 1908. It is now generally distributed throughout the area infested by the brown-tail moth. In 1925, parasitism of overwintering larvae in 28 towns averaged almost 7 percent. In some places it was as high as 25 percent in single webs.

Apanteles lacteicolor overwinters in brown-tail moth larvae. Adults emerge in the spring, and two summer generations may develop on other hosts, including the gypsy moth. Females oviposit within the body cavity of the host. The mature larva emerges to spin its silken cocoon in the brown-tail web or on tree trunks or leaves. Hibernating brown-tail moth larvae are attacked in August.

Apanteles melanoscelus (Ratz.) (Braconidae)

Apanteles melanoscelus (Ratz.), a European parasite of the gypsy moth, is at times very important locally, particularly in the southern range of the host in Europe. Large numbers were sent to this country in 1911 and 1912. The parasite became established almost immediately and was recolonized widely. Average parasitism is rather low, but almost every year it is abundant locally in widely separated areas. This parasite is very heavily attacked by hyperparasites, which must cut down its effectiveness tremendously.

Apanteles melanoscelus is primarily a solitary parasite of the gypsy moth, although it occasionally attacks other hosts. It completes two generations annually upon the gypsy moth. Winter is spent in the cocoon stage. Adults appear soon after gypsy moth larvae hatch in May, and eggs are laid internally in first instar host larvae. Parasite larvae complete development, and emerge from second and third instar larvae to form cocoons. Adults emerge 7 or 8 days later, and third-stage host larvae are attacked by second generation females of the parasite. The second generation larvae form cocoons which overwinter, and since they are usually in exposed places they are subject to attack by hyperparasites over a very long period.

Apanteles solitarius (Ratz.) (Braconidae)

Apanteles solitarius (Ratz.) was successfully introduced into New England from Europe against the satin moth in 1927. It became established immediately, and dispersed rapidly throughout the infested area. In 1932 it was colonized in the State of Washington where it took hold equally well. *A. solitarius* has been an exceptionally effective parasite in both areas. For example, parasitism of hibernating larvae at a number of collection points in New England in 1933 averaged between 15 and 67 percent, and in Washington in 1935 from 0 to 55 percent. Host populations were very much reduced in New England in 1935, and parasitism averaged 6 to 11 percent. These figures represent a minimum, however, for they are based upon hibernating host larvae, and *A. solitarius* also kills some larvae before they enter hibernation and others after they emerge in the spring.

The species is a solitary internal parasite, which has been reared from several hosts in the laboratory but only from the satin moth in the field.

The seasonal history of *Apanteles solitarius* is somewhat complex because it may overwinter as a first instar larva within the host larva or within a cocoon. From both places adults emerge and attack small satin moth larvae in the spring. Cocoons formed at this time may overwinter, or they may produce adults that attack the small hibernating host larvae in late summer.

Aphidecta oblitterata (L.) (Coccinellidae)

Aphidecta oblitterata (L.) is widely distributed in northern and central Europe where it feeds on a number of Chermids. Canadian entomologists have imported it since 1951 for release against the balsam woolly aphid, *Chermes piceae*, and colonies have been sent to the United States for release in the Pacific Northwest and North Carolina. Although it had completed a summer generation the year of release in New Brunswick, it apparently cannot survive Canadian winters. It is included here because it has recently completed a summer generation in North Carolina and may have a better chance of survival there than in New Brunswick.

Little is known regarding the effectiveness of *Aphidecta*, but it is reported as feeding commonly on *Chermes* on twigs in Europe, and a predator with this feeding habit might be of considerable value here.

Aphidecta has one generation a year. The winter is spent as an adult in the ground. Eggs are deposited on the needles or trunks of infested trees. Both adults and larvae attack all stages of the balsam woolly aphid except the first instar larvae.

Aphidoletes thompsoni Möhn (Cecidomyiidae)

Aphidoletes thompsoni Möhn is a Cecidomyiid predator of *Chermes piceae* in Europe. Large numbers have been collected, particularly in Czechoslovakia, and shipped to Canada. Canadian entomologists in turn have sent excellent colonies to the United States for release in New England, the Pacific Northwest, and North Carolina. So far, it has not been recovered in Canada or New England, but it has become

established at several places in the Pacific Northwest. It is too early to determine whether it has taken hold in North Carolina. Judging from the large numbers collected in Europe, it may be of some importance as a control factor there. Since it is very small and requires little food to complete development, it might be effective at low host population levels.

In Europe there are three to five generations annually. Adults apparently do not feed. The females lay eggs in wax masses of the *Chermes* and on the bark surface. The larvae feed on *Chermes* eggs and larvae. Pupation occurs in the soil within a silken cocoon. Winter is spent as an immature larva in the soil.

***Aptesis basizonia* (Grav.) (Ichneumonidae)**

Aptesis basizonia (Grav.) is a European parasite of sawfly cocoons, and at times it parasitizes *Neodiprion sertifer* heavily. It was sent originally to Canada for release against the European spruce sawfly, and several colonies were made available for liberation in the United States. These were augmented with stock reared by the U.S. Department of Agriculture and the State of Maine. Releases in this country, as in Canada, were made against *N. sertifer* and *Diprion hercyniae*. *Aptesis* has not been recovered as a parasite of the European spruce sawfly in the United States, but small numbers were recovered from that host in New Brunswick. It was recovered from *N. sertifer* at several points in New Jersey in 1948. E. E. McCoy, New Jersey Department of Agriculture, has also reared it from the native *N. pratti paradoxicus* in New Jersey.

Aptesis completes two to four generations a year in Europe. Winter is spent as a prepupa within the host's cocoon. Adults emerge quite early and oviposit in overwintering sawfly cocoons. Larvae feed externally and one parasite develops per host. In the field, the host larva or prepupa is paralyzed within its cocoon, but in the laboratory this ability seems to weaken successively so that the host remains active and is able to crush the parasite's eggs.

***Blepharipoda scutellata* (R.-D.) (Tachinidae)**

Blepharipoda scutellata (R.-D.) is one of the most common tachinid parasites of the gypsy moth in central Europe. It was liberated in this country as early as 1908 and known to be established by 1911. It was recolonized extensively, but this was probably unnecessary for it dispersed very widely by itself. In Europe it has been recorded from several hosts, but apparently it is restricted to the gypsy moth in this country. *B. scutellata* is one of the most abundant gypsy moth parasites here. In 1923, when it seemed to reach its maximum, 49 percent of the female pupae were parasitized in collections from 25 towns. Generally speaking, parasitism runs high in most areas, with average parasitism fluctuating from 5 to 25 percent.

Blepharipoda scutellata is a large tachinid fly, which lays a microtype egg on the foliage. The egg hatches after it is ingested, and the parasite remains in the first instar until the host has pupated. It then develops rapidly. The full-grown maggot emerges and drops

to the ground, where it forms its puparium and overwinters. Parasitism of female gypsy moths is considerably higher than that of males because female caterpillars pass through an additional instar and consequently eat considerably more foliage that may bear *Blepharipoda* eggs.

Calosoma sycophanta (L.) (Carabidae)

The large, brilliant carabid beetle, *Calosoma sycophanta* (L.), was introduced from Europe and released in this country against the gypsy moth in 1906. The beetle became established right away, and with further importations and recolonization soon spread throughout most of the infested area and beyond. It feeds freely on a wide variety of insects, especially lepidopterous larvae and pupae, but the gypsy moth is especially suited to its taste and habits. A number of colonies were also released throughout the South and West against a variety of pests, but *C. sycophanta* has not been recovered in those areas.

Calosoma is a conspicuous predator on gypsy moth larvae and pupae, and it undoubtedly destroys enormous numbers annually; but, as is true of other predators, it is difficult to estimate the actual number of hosts killed. Collins and Holbrook found that the average number of both larvae and pupae destroyed over a 6-year period in several selected plots was about 25 percent. *Calosoma* populations build up rapidly in heavy infestations but fall off rapidly when the gypsy moth becomes scarcer. In a medium infestation in Freetown, Mass., in 1927, for instance, about 2,000 beetles were trapped per acre. The following year when the infestation was very light, and no defoliation occurred, the number dropped to 224. Populations as high as 4,000 per acre have been recorded.

Adult *Calosoma* beetles live from 2 to 4 years. Winter is spent as an adult beetle in the ground, and emergence takes place about June 1. Eggs are laid in the ground, and the young beetle larvae soon climb trees to feed upon caterpillars and pupae on the trunk and larger branches. When they are full fed, they construct a pupal cell in the soil. The adult beetle remains in the pupal cell during the winter.

Campoplex frustranae Cush. (Ichneumonidae)

Campoplex frustranae Cush. is a common parasite of the Nantucket pine tip moth, *Rhyacionia frustrana* (Comst.), in the East. In 1925 it was liberated in the Nebraska National Forest against *R. frustrana bushnelli* (Busck), which was severely damaging extensive young pine plantations, particularly ponderosa and yellow pine. The parasite became established immediately and increased very rapidly. In fact, by 1930 parasitism had reached 82 percent at the original liberation point, and hopes ran high that the parasite would hold the pest under effective control. Unfortunately, another tip moth, *R. frustrana neomexicana* Dyar, in which *C. frustranae* cannot develop, increased very rapidly about this time and conditions were not substantially improved. Parasitism of *bushnelli* dropped as *neomexicana* populations increased. It has been suggested that the parasite may have

become less effective on *bushnelli* because it deposited many of its eggs in *neomexicana*.

The life history of *Campoplex frustranae* is well synchronized with that of *Rhyacionia frustrana bushnelli* in Nebraska, where both have two complete broods each year. The first parasites emerge after the peak of moth emergence is passed. Young host larvae are available when the parasites appear. Parasitized tip moth larvae complete their development and pupate. The parasite spins its white cocoon within the shattered pupal skin of the host. In the overwintering brood the cocoon is not spun until spring. Since the second-brood host larvae spin their cocoons in the sand or litter, the spring adults emerge from host pupae formed on the ground. This is in contrast to the situation that prevails when *R. frustrana* is parasitized in the East. Here *C. frustranae* overwinters as a pupa within a pine bud.

***Carabus* spp. (Carabidae)**

Carabus auratus L. and *C. nemoralis* Müll. were imported from Europe in the early years to attack the gypsy and brown-tail moths. Records regarding them are incomplete, and they have not been recorded as feeding on these pests in this country, but both species are now widely distributed in New England. *C. nemoralis* was actually recorded here prior to the gypsy moth importation program, and as Dr. M. E. Smith notes (Ent. Soc. Wash. Proc. 61(1): 7-10. 1959) both species may have arrived through accidental introductions. Prof. C. O. Dirks, University of Maine, notes that both species are present in Orono, Maine. Both species reportedly feed upon earthworms.

***Carcelia laxifrons* Vill. (Tachinidae)**

The brown-tail moth parasite, *Carcelia laxifrons* Vill., was easily established in New England about 1908. It has spread throughout the infested area. Occasionally an individual collection of larvae will be quite heavily parasitized, but the average percentage parasitism is very low.

The only known host of *Carcelia laxifrons* in this country is the brown-tail moth on which one generation is completed annually. The winter is passed as a puparium in the soil. Adult flies emerge in the spring and oviposit on small brown-tail moth larvae soon after they emerge from hibernation. The maggot feeds internally completing development in the full-grown larva.

***Chaetexorista javana* B. & B. (Tachinidae)**

Chaetexorista javana B. & B. is a large tachinid parasite of the oriental moth. It was imported into the United States from Japan in 1929 and 1930, and several large colonies were released in the area infested by the moth in the environs of Boston, Mass. The parasite took hold immediately, and parasitization reached about 60 percent in 1933 and again in 1940. Heavy mortality of parasite larvae occurs during subzero temperatures, but the parasite increases rapidly during milder winters.

Chaetexorista javana completes only one generation annually. Winter is spent as a second instar larva within the hibernating host prepupa. A puparium is formed within the host cocoon. The adult fly emerges by pushing off the cap at the end of the cocoon, which normally serves as an exit for the adult moth. The female fly deposits a large egg on the integument of the host larva, to which it is attached by means of an integumental funnel. Only one parasite per host larva develops to maturity.

Chrysocharis laricinellae (Ratz.) (Eulophidae)

Chrysocharis laricinellae (Ratz.) was introduced into Canada and the United States from Europe in the late twenties and early thirties to combat the larch casebearer, *Coleophora laricella*. The parasite had not been reared from the casebearer in North America previously, but it may have been present. About this time it was recovered from the elm leaf miner, *Fenusa ulmi* Sund., many miles from the closest liberation point. Studies by A. R. Graham in Canada (Ent. Soc. Ont., 79th Rpt., 1948) showed that *Chrysocharis* acts as a secondary parasite of *Coleophora* at times, attacking *Agathis* in the early summer, and that it is not an effective parasite of the casebearer.

Chrysocharis laricinellae is also a parasite of the birch leaf-mining sawfly, *Heterarthrus nemoratus* (Fall.). It was also established against this host in New England in the early thirties. It is the most effective parasite of *Heterarthrus* in Austria, but this host has been relatively unimportant in New England for many years, so effectiveness of this parasite has not been checked.

Chrysocharis laricinellae may have three generations annually in the larch casebearer. The parasite hibernates as a full-grown larva in the host larval case. Pupation takes place in early May, and the emerging adult attacks the overwintering casebearer larva. The adults producing the second generation emerge from the middle of June to the middle of July, and the early ones parasitize larvae already parasitized by *Agathis*. Late emergents parasitize very small needle mining larvae. Adults producing the third generation emerge from mid-September to early October. In the birch leaf-mining sawfly, there is one and a partial second generation annually. The winter is spent as a full-grown larva in the mine of the host. The adult females feed heavily on the body fluids of the sawfly larvae, and kill large numbers of the host.

Coccophagus insidiator (Dalm.) (Eulophidae)

Coccophagus insidiator (Dalm.) is a European parasite successfully introduced into California, where it has adequately controlled the European elm scale in several localities. The same species was apparently accidentally introduced in the East, for it was found parasitizing the European elm scale quite heavily at Ithaca, N.Y., in 1924.

Coccophagus insidiator is a solitary parasite. The female is an endoparasite of the elm scale, the male an ectoparasite of the larval stage of the female parasite. Females oviposit in the body cavity of the elm scale, and development is completed in about 3 weeks. There are three and possibly five generations annually.

Compsilura concinnata (Meig.) (Tachinidae)

Compsilura concinnata (Meig.) is undoubtedly one of the best known larval parasites of the gypsy moth. It is exceptionally polyphagous, and attacks at least 200 lepidopterous hosts, including the brown-tail and satin moths. Oddly enough it never appeared to be of exceptional importance in rearing work conducted in central Europe in the twenties and thirties; but it has been consistently valuable in much of the area infested by the gypsy moth in New England, achieving parasitism of 10 to as high as 50 percent. Even higher parasitism is common in brown-tail and stain moth infestations. It was successfully established in the Pacific Northwest against the latter and recovered there in 1932.

Compsilura is multibrooded, completing three or four generations each year. The winter is passed as an immature larva within the hibernating host larva or cocoon. Development is completed in the spring, and the full-grown maggot emerges to form its puparium in the duff or litter. Adult females pierce the skin of the host larva with a sharp ovipositor and insert a first instar maggot that becomes full grown in about 2 weeks. From one to four maggots may develop in a single caterpillar.

Copidosoma geniculatum Dalm. (Encyrtidae)

Large numbers of *Copidosoma geniculatum* Dalm. collected in Europe from 1932 to 1937 were released against the European pine shoot moth in this country. It has never been recovered in the United States, but J. L. Martin recovered it from *Exoteleia dodecella* L. in southern Ontario in 1956 and 1957 (Canad. Ent. v. 91, May 1959), and it is believed it reached Canada on nursery stock infested by that host. *Rhyacionia buoliana* and *E. dodecella* frequently infest the same trees, and Arthur and Juillet⁴ have noted that *Copidosoma* has been abundant in European shipments containing both *R. buoliana* and *E. dodecella*, but absent from English shipments where *E. dodecella* was not present. It therefore seems likely that *Copidosoma* was actually reared from *Exoteleia* and liberated against the wrong host.

Copidosoma geniculatum is a tiny polyembryonic Chalcidoid which overwinters in an immature stage with the host larva. Development is completed about the time host larvae complete development in early summer, and an average of about 16 parasites pupate within each larval skin. There is one generation annually.

Cremifania nigrocellulata Cz. (Chamaemyiidae)

Cremifania nigrocellulata Cz. is a European chamaemyiid fly predaceous on the balsam woolly aphid throughout central Europe. It has been released by Canadian entomologists in New Brunswick each year since 1952, and has become established at all release points. The predator has also been released in Oregon and recovered the

⁴ Arthur, A. P. and Juillet, J. A. The introduced parasites of the European pine shoot moth, *Rhyacionia buoliana* (Schiff.), with a critical evaluation of their usefulness as control agents. Canad. Ent. 93 (4): 297-312. 1961.

same season (1959). Fairly large numbers have developed on some stem infestations in New Brunswick, but spread has been very slow.

Cremifania has up to three generations a year. The first preys upon the spring generation of *Chermes piceae* and the second and third on the summer and fall generations. It overwinters as a puparium, mostly in the ground but also on the bark. Approximately 95 percent of the first generation puparia remain in diapause during the summer, and one-half of these continue in diapause through the winter.

Dahlbominus fuscipennis (Zett.) (Eulophidae)

Dahlbominus fuscipennis (Zett.) is a European parasite of several sawflies. Nearly 8 million were collected in cocoons of *Neodiprion sertifer* Geoff. in Europe in 1934 and sent to Canada for release against the European spruce sawfly. Owing to the ease with which the species can be propagated, very large numbers have been reared and released by Canada, the U.S. Department of Agriculture, and several States.

Summarizing very briefly: About 226 million were released against the European spruce sawfly in Maine, and another 30 million were released against this same pest in New York, New Hampshire, and Vermont. About 13 million were released against *Neodiprion sertifer* in New Jersey. About 1 million were released against the red-headed pine sawfly in several States. In addition, smaller colonies have been released against several sawflies in different States, and the State of Virginia is currently rearing *Dahlbominus fuscipennis* for release against *N. pratti pratti*.

In Europe *Dahlbominus fuscipennis* has been found parasitizing up to 78 percent of the *Neodiprion sertifer* cocoons on the Adriatic Coast, where soil temperatures are high and cocoons are exposed. In other locations, such as Austria, where soil temperatures are cool and the cocoons are usually formed in the duff, parasitism usually runs much lower often being nil or around 2 to 10 percent.

Dahlbominus fuscipennis became established quickly in Canada and the United States, and it has been recovered at many points throughout the colonized area. In New Brunswick it reached its highest level in 1939, when 11 percent of the European spruce sawfly cocoons in the southern part of the Province and 2 percent in the northern part were parasitized.

In the United States it has been recovered in at least small numbers from *Diprion hercyniae* (Htg.) in New England, *Neodiprion sertifer* (Geoff.) in New Jersey, *N. lecontei* (Fitch) in Michigan, *N. pratti pratti* Dyar in Virginia, *N. pratti paradoxicus* Ross and *N. pini-rigidae* (Norton) in New Jersey, *N. nanulus* Schedl. in Wisconsin, *N. abietis* (Harr.) in Maine and *D. frutetorum* (F.) in Connecticut. The latter is of interest because the nearest release point was some 25 miles distant (Orange, Conn.), where the parasite was released against *D. hercyniae*.

Percentage parasitism by *Dahlbominus fuscipennis* has run rather low in this country, except locally. In New Jersey about 47 percent of the *Neodiprion sertifer* cocoons in the top of the litter were parasitized in a representative pine plantation in 1943, and parasitization

of *Diprion frutetorum* averaged about 25 percent for 3 years in a small plantation in Southington, Conn.

Dahlbominus fuscipennis is an external parasite of sawfly larvae and pupae within their cocoons. Several eggs are laid with one insertion of the ovipositor, and an average of 34 parasites develop in one cocoon. Two and a partial third generation are completed annually in southern New Brunswick. The winter is spent as a full-grown larva or pupa within the host cocoon.

Drino (Prosturmia) bohémica Mesn. (Tachinidae)

Drino bohémica Mesn. is a European parasite of sawfly larvae, which was successfully established in Canada against the European spruce sawfly. It has maintained itself better than any of the other European spruce sawfly parasites at low host population levels, and fairly high percentages of parasitism occur when the sawfly is scarce. It has also been reared from *Pikonema alaskensis* (Roh.) and *P. dimmockii* (Cress.), and its ability to attack other hosts successfully when *Diprion hercyniae* is not available is undoubtedly important to its survival.

Drino bohémica is probably the same species that was introduced into the United States from central Europe as *Sturmia inconspicua* (Meig.). At least a good part of that material originally came from sawfly hosts. It was released in this country against the gypsy and brown-tail moths and also against *Neodiprion lecontei*. *D. bohémica* persisted at one of the gypsy moth colonization sites for several years, but apparently it failed to become permanently established in this country at that time. It undoubtedly occurs now in northern Maine, for it is abundant just across the border in New Brunswick and Quebec.

Drino bohémica completes one and a partial second generation annually in central New Brunswick. The majority overwinter as puparia in the forest floor, but some overwinter as larvae within the host. Most puparia are formed outside the host's cocoon. Adults emerge the latter part of June. Females oviposit on the integument of fifth instar larvae. The parasite maggot feeds internally usually completing development after the host cocoon is spun.

Erynniopsis rondani Towns. (Tachinidae)

Erynniopsis rondani Towns. is a European tachinid fly parasitic on the elm leaf beetle, particularly in southern France. Several small colonies were imported and liberated on the East coast, but it was never recovered. In 1939 the University of California imported 55 puparia and succeeded in liberating 31 mated females at three colonization sites. These releases resulted in establishment, and in 1940-41 parasitization reached 20 percent at one collecting point. From 1955 to 1958 collections were made in California for release in Arkansas, Idaho, Nevada, Washington, D.C., and Virginia. It is not yet known whether any of this work was successful.

Erynniopsis rondani overwinters as an immature maggot in the hibernating elm leaf beetle adult. The puparium is formed within the dead beetle. The adult flies that emerge in the spring oviposit on

beetle larvae. The parasite maggot develops internally, and there are two summer generations. The second generation maggot remains in the host, however, when it transforms into an adult.

Eupteromalus nidulans (Thomson) (Pteromalidae)

Very large numbers of *Eupteromalus nidulans* (Thomson) were obtained from the overwintering webs of the brown-tail moth collected in Europe from 1905-08, and the species soon became distributed throughout the infested area in this country. It has never been reared in substantial numbers from the brown-tail moth in the United States, but it has proved to be a common hyperparasite of *Apanteles* and other Braconids. Fortunately, it also attacks the overwintering larvae of *Stilpnotia salicis*. Often 20 percent of the overwintering larvae are parasitized by *Eupteromalus*, and probably many more are killed for the adult parasite has the habit of puncturing and feeding on hibernating larvae. The species was also established in the Pacific Northwest against the satin moth.

Eupteromalus has several generations a year. The winter is spent as a full-grown larva in the web or hibernaculum of its host. Pupation takes place in the spring, and the adults emerge in May and June. The ovipositing female paralyzes the host larva and deposits her egg on the body. The parasite larva feeds externally. The female often feeds upon the body fluids of the host and frequently it constructs a feeding tube for this purpose.

Exenterus abruptorius (Thnb.) (Ichneumonidae)

Large numbers of *Exenterus abruptorius* (Thnb.) were imported by Canada and released against the European spruce sawfly, and the European pine sawfly. Large colonies were also made available for release in the United States. A few specimens were recovered 7 years after liberation in New Jersey from *Neodiprion sertifer*, proving definite establishment, but host populations in that area were reduced almost to the vanishing point by an energetic spray program. Further attempts at recovery have not been made. *E. abruptorius* is a very important *N. sertifer* parasite in Europe.

Exenterus abruptorius has one generation a year. Adults are active in early summer. The females embed their eggs under the skin of prepupae or large larvae. Hatching does not take place until the host larva has spun its cocoon. Larval development may be retarded, but when it reaches maturity a cocoon is spun within the host cocoon and the winter is spent in this stage.

Exenterus spp. (Ichneumonidae)

Canadian entomologists successfully established four European species of *Exenterus*: *E. confusus* Kerrich, *E. amictorius* (Panz.), *E. vellicatus* Cush., and *E. tricolor* Roman, against the European spruce sawfly during the period of extensive parasite introduction against that pest from 1934-49. Colonies were also made available for release in the United States. Because of the sudden collapse of the infestation, due principally to a virus disease, few attempts were

made to recover the parasites in this country, and the only one ever reared in the United States was *E. confusus* from three cocoons collected in southern Vermont. Nevertheless, it seems proper to mention all four species, because the fact that they are in New Brunswick almost guarantees that eventually they will be found in the United States, even though the sawfly remains at the low ebb at which it has persisted for the last 20 years.

Exenterus confusus was the predominant species of *Exenterus* recovered in New Brunswick, but it has been very rare in the extremely low levels of host population prevailing since 1941. *E. amictorius* was second to *E. confusus* in numbers, but it seems especially dependent on host density and has not been recovered in recent years. *E. vellicatus* is more capable than either *E. confusus* or *E. amictorius* in maintaining itself at low host population levels. It has been recovered in New Brunswick, Nova Scotia, and Newfoundland, and has been consistently reared in small numbers from study plots in New Brunswick. Only one specimen of *E. tricolor* was recovered.

The life histories of all four species are similar. Eggs are laid on the integument of large larvae. Hatching normally occurs within the host cocoon. The winter is usually spent as a last instar or prepupa. In New Brunswick one and a partial second generation develop annually with about 50 percent of the summer generation remaining in diapause until the second year.

Exorista larvarum (L.) (Tachinidae)

Exorista larvarum (L.) is one of the important larval parasites of the gypsy, brown-tail, and satin moths in Europe. It was extensively colonized in the United States from 1923 to 1932, but it was not recovered until 1940. In 1941 it was reared from larvae collected in 11 different townships extending from Standish, Maine, to Waterbury, Conn. Since that time no extensive collections have been made, and no figures are available regarding its importance. It is multibrooded, and its value will depend to some extent on the abundance of alternate hosts. In Europe it has been reared from at least 45 different lepidopterous hosts, many of which are forest pests.

Exorista larvarum lays a large white macrotype egg on the integument of the host larva. The parasite maggot bores through the skin and forms a respiratory funnel. When parasitizing the gypsy moth, the full-grown larva emerges and drops to the ground to form its puparium. The puparium may be formed within the skin of the host or the cocoon of some other species. From one to several maggots may develop in a single host larva. The winter is spent as an immature larva within an overwintering host.

Laricobius erichsoni Rosenh. (Derodontidae)

Laricobius erichsoni Rosenh. is a derodontid beetle. It preys upon a number of adelgids in Europe, but its preferred prey is the balsam woolly aphid. Canadian entomologists have imported it since 1951, and it has become generally established. They have also made colonies available for release in New England, the Pacific Northwest,

and North Carolina. It is still too early to say whether or not it is established in North Carolina, but it has been recovered at the other liberation points. In 1959, 15,000 adults were released on the Penobscot Experimental Forest near Bangor, Maine, in an attempt to use this predator for direct control on a limited area. This was a cooperative project of the U.S. Forest Service (Division of Pest Control and Northeastern Forest Experiment Station), U.S. Agricultural Research Service, and the Commonwealth Institute of Biological Control. It is too early to report on results.

Laricobius is an effective predator. At some liberation points in New Brunswick, the spring generation of the aphid has been almost completely destroyed and stem attacks have been terminated by the beetles. The predator spreads very slowly, though, and is only occasionally found in very light infestations. European workers do not believe that *Laricobius* alone is capable of cleaning trees heavily infested with the aphid.

Adult *Laricobius* overwinter in the duff. They attack all stages of *Chermes piceae* except the first instar larvae. Eggs are laid in the wax of the prey, and larvae feed on eggs and adult aphids. When feeding is complete they drop to the ground to pupate. Newly emerged beetles appear on the trees in early summer and feed some before entering the soil to hibernate. Adult beetles live approximately one year.

Leucopis (Neoleucopis) obscura (Hal.)

(Chamaemyiidae)

Leucopis obscura (Hal.) is a chamaemyiid fly, native to Europe, which was successfully introduced into Canada against the balsam woolly aphid in 1933. It became established immediately and by 1947 was present throughout most of the infested area. It spread naturally into Maine. In 1954 *L. obscura* was colonized and established in southern Vermont, and during 1955 and 1956 several more colonies were released in Vermont, New Hampshire, and New York. In 1958 and 1959 the fly was colonized in Washington and Oregon, and in 1959 it completed at least a summer generation in Oregon. In 1960 it was released in North Carolina.

Leucopis is abundant in heavy balsam woolly aphid stem infestations. In 1958, for instance, an average of 15 *Leucopis* adults were recovered per square foot of bark surface on thirteen 5-foot logs cut from heavily infested trees near Bangor, Maine. *Leucopis* is dependent on high prey density, and it is seldom found except on rather heavily infested stems. It fails to prevent heavy oviposition because it feeds mostly on adults that have laid many eggs. On the other hand, it reduces the number of larvae produced in late stages of attack thus enabling some trees to recover, and it reduces the number of crawlers dispersed from heavily infested trees. *Leucopis* undergoes heavy winter mortality in Maine and New Brunswick. It will be interesting to know if it is more effective in warmer areas, such as Oregon and North Carolina. It also attacks *Pineus strobi* (Htg.) and *P. pini* Koch in England.

Leucopis completes two generations a year. The winter is spent as a larva or puparium in crevices in the bark. Adults emerge in the spring and deposit eggs singly in the "wool" of their prey. Larvae of *Leucopis* feed upon adelgid adults and larvae. A generation is completed in the spring, and adults emerge to attack the autumn generation of the aphid.

Mesoleius tenthredinis Morley (Ichneumonidae)

Mesoleius tenthredinis Morley was first imported into Canada from England in 1910-11 and liberated against the larch sawfly in Ontario and Quebec. A small colony was also liberated on Grand Island near Munising, Mich. In 1912-13 liberations were made in Manitoba. This work was highly successful. According to A. R. Graham parasitization averaged 75 percent over a wide area in Manitoba in 1927 (Canad. Ent. v. 63, 1931).

About 1940 it became apparent that the effectiveness of *Mesoleius* had decreased greatly in Manitoba and Saskatchewan. Apparently the host developed a high immunity to the parasite in the general region, because a very high proportion of the parasite's eggs became encapsulated and failed to hatch. This immunity does not seem to have developed as yet in British Columbia, the Maritime Provinces, or Pennsylvania.

There is one generation of *Mesoleius tenthredinis* annually. The winter is spent as a third or fourth instar larva within the cocooned host larva. Feeding is resumed in the spring, and pupation takes place within the host cocoon. Adults appear from late June to early August and lay internal eggs in larch sawfly larvae. One parasite develops in a host larva.

Meteorus versicolor (Wesm.) (Braconidae)

Meteorus versicolor (Wesm.) was one of the first brown-tail moth parasites established in this country. It has become dispersed throughout the whole of the infested area, but it never has parasitized large numbers of this host. In fact, parasitism rarely exceeds 5 percent. In Europe *M. versicolor* also attacks satin moth larvae. Attempts to establish it on the satin moth in New England have failed, but it became quickly established on this host in the Pacific Northwest, and it is considered an important control factor there. Parasitism of hibernating larvae up to 31 percent and of later instars up to 17 percent were recorded at one point soon after establishment.

The possibility that *Meteorus versicolor* reared from the brown-tail moth differs from *M. versicolor* reared from the satin moth cannot be disregarded in spite of the fact that the two appear morphologically identical.

Meteorus overwinters as a first instar larva in brown-tail moth larvae. Development is completed in the spring, and large larvae are in turn attacked. Undoubtedly other hosts are also parasitized during the summer. In early fall hibernating brown-tail moth larvae are again parasitized. The cocoon is spun in an unusual way. The full-grown larva leaves the host and after crawling some little distance along a twig or branch suspends itself by a long silken thread. The

cocoon is spun in this position. It is thus fully exposed and consequently is often attacked by hyperparasites.

Monodontomerus aereus Walk. (Torymidae)

Monodontomerus aereus Walk. was introduced into New England in 1906 with brown-tail moth hibernation webs. It became established readily and by 1910 was distributed over most of the infested area. It was originally released as a primary parasite, and it does occasionally act as a primary internal parasite of lepidopterous pupae, including the brown-tail and gypsy moths. It is a much more common hyperparasite, however, attacking both hymenopterous cocoons and tachinid puparia, and it is often a serious hyperparasite of such beneficial species as *Compsilura*.

There is usually only one generation a year. The winter is spent as an adult, and brown-tail moth webs are a favorite hibernating site. Ovipositing females usually place three or four eggs externally on the host within the cocoon, puparium, or pupa, but when oviposition occurs in living lepidopterous pupae the eggs are deposited internally. The females feed extensively on their hosts. A feeding tube extending from the body of the host to the outer surface of the cocoon or puparium is formed with the ovipositor. Body fluids are sucked up through this tube. Undoubtedly large numbers of hosts are killed in this way instead of being parasitized. The adults are long lived, often living for 11 or more months.

Monodontomerus dentipes (Dalman) (Torymidae)

Monodontomerus dentipes (Dalman) is a European species, which has been recorded from a number of hymenopterous and lepidopterous hosts, and it frequently acts as a secondary parasite. It is, however, an important primary parasite of several pine sawflies. It was already parasitizing *Diprion similis* (Htg.) when that pest was discovered in the United States, and it is credited with being one of the most effective checks upon that pest in New Jersey and Pennsylvania. H. C. Coppel also reports that it is the most important biotic agent controlling *D. similis* in Wisconsin, although it was never released there.

There are probably two generations of *Monodontomerus dentipes* annually. The winter is spent as a prepupa inside the host cocoon. Adults emerge in the spring, and there may be as much as a month's difference between the emergence of the first and last adult from one cocoon. The female oviposits through the host cocoon laying several eggs externally upon the prepupa. The parasite larvae feed externally completing development in 3 or 4 weeks. Four or five adults usually emerge from one cocoon, but occasionally as many as twelve may develop.

Ooencyrtus kuwanai (How.) (Encyrtidae)

Ooencyrtus kuwanai (How.), native to Japan, is an egg parasite of the gypsy moth. Small numbers were introduced into this country in 1908 and 1909, and the species was very successfully reared in the

laboratory. By 1910 more than a million individuals were released. The parasite became established almost immediately, and through extensive colonization was dispersed throughout the infested area. It is now considered an important parasite in the southern range of its host. Parasitism of 40 to 45 percent of the eggs is frequently recorded in Massachusetts and Connecticut.

In the laboratory *Ooencyrtus kuwanai* has been reared from the eggs of several other Lepidoptera, but there are no records of it as an egg parasite of other species in the field. It has been reared occasionally as a hyperparasite of *Apanteles*. It is poorly adapted to this host, however, and there is no doubt that it is normally a primary egg parasite.

Ooencyrtus spends the winter as an adult. A generation is completed in the spring on overwintered gypsy moth eggs, and females are sufficiently long lived to attack the newly laid eggs in July. At least two generations are completed in the fall, and adult *Ooencyrtus* are conspicuous on egg masses well into November in southeastern Massachusetts and Connecticut. The female lays an egg within the egg of the gypsy moth, and if the host larva is developed, as is usual, the parasite egg is placed within the caterpillar. The host embryo is entirely consumed except the hair and some hard chitinous parts. Pupation takes place within the egg shell and the new adults cut their way out.

***Orgilus obscurator* (Nees) (Ichneumonidae)**

Orgilus obscurator (Nees) is one of the European pine shoot moth parasites imported from Europe by Canada and the United States in the thirties. It apparently had been accidentally introduced with its host at an earlier date for it was reared from the shoot moth in Rhode Island in 1925. There is little doubt, however, that importations were responsible for much of its rapid spread throughout Connecticut, southern New York, and New Jersey. It is also well established in Ontario and the Niagara region.

Orgilus seems to vary greatly in effectiveness. Percentage parasitism varied from 0 to 50 in 23 collections of host larvae overwintering in 1946 and 1947 in Connecticut, southern New York, and New Jersey. While it was present in 18 of the collections, average parasitization was only 7 percent. In western New York, near Chautauqua, it was present in 7 of 11 collections, but average parasitization was only 2 percent. In this country it has only been reared from the shoot moth, but in Europe several other hosts are listed.

Orgilus has a single generation each year. It overwinters as a first instar larva within the hibernating host larva. When development is complete, it emerges from the host larva or pupa and spins a thin white cocoon in the host larva's mine. The adults oviposit internally in the new generation of larvae.

***Parasetigena silvestris* R.-D. (Tachinidae)**

Parasetigena silvestris R.-D. is one of the predominant parasites of the gypsy moth in central Europe. Large numbers were colonized in the United States from 1924 to 1933, but definite establishment was

not confirmed until 1937. By 1941 it had spread throughout most of the infested region and at one point, where 500 gypsy moth larvae were collected, 18 percent of them were parasitized by this species.

Parasetigena silvestris has a single generation each year overwintering as a puparium in the duff. Adult flies emerge in early spring. The females lay large macrotype eggs on the cuticle of the host larva, and the parasite maggot bores through the skin forming a respiratory funnel at the point of entry. The full-grown maggot drops to the earth to form its puparium.

In Europe *Parasetigena* is also an important parasite of the nun moth. It is occasionally reared from the brown-tail moth.

***Phanomeris phyllotomae* Mues. (Braconidae)**

Phanomeris phyllotomae Mues. was collected in Austria and liberated against the birch leaf-mining sawfly in New England in the early thirties. It became established at several liberation points but host populations dropped drastically, and further checks on the effectiveness of the imported parasites were discontinued. In Austria *P. phyllotomae* parasitized a rather small proportion of the *Phyllotoma* collected. At one collection point parasitizations of 21 and 18 percent were recorded in 1932 and 1933, but at most points it was rare.

Phanomeris has one generation a year. The winter is spent as a larva within a cocoon spun in the host larval mine. Adults emerge in early summer, and eggs are laid near the semiparalyzed host larva. The parasite crawls to its host and feeds externally, completing feeding in late summer or early fall.

***Phobocampe disparis* (Vier.) (Ichneumonidae)**

Almost 300,000 cocoons of *Phobocampe disparis* were collected in a gypsy moth infestation in Sicily in 1911 and 1912, and large colonies of adults were liberated at several points in New England. The species became established readily, but it has not dispersed widely and, as a rule, only a small proportion of the larvae collected at any one point is parasitized by this species. In fact, with the exception of the early work, it has never again been recovered in large numbers in Europe.

Phobocampe disparis has one generation a year. The winter is spent as a cocoon on the forest floor. Adults attack first or second instar larvae, and the full-grown parasites emerge from fourth instar larvae and drop to the ground to spin their cocoons. The cocoons are heavily attacked by hyperparasites. There is also a considerable mortality of parasite larvae within the host. These two factors undoubtedly limit the potential effectiveness of the species tremendously. *Phobocampe* appears to favor the shaded part of infested woodlands, and parasitism by this species is frequently much higher in dense woodland than along the woods' edge.

Phytodietus fumiferanae Roh. (Ichneumonidae)

Phytodietus fumiferanae Roh. is an ichneumonid parasite of the spruce budworm. It is distributed throughout western North America from Arizona to British Columbia, but it does not occur in the East. Rather high percentage parasitism by this species was recorded locally in British Columbia between 1917 and 1920. From 1943 to 1947 Canadian entomologists collected large numbers of spruce budworm larvae in the same general area near Lillooet in order to procure this species and others for liberation in the East. Similar work was conducted between 1945 and 1949 by American and Canadian entomologists in Colorado and Oregon, and this work was further supplemented by laboratory rearing of *Phytodietus* in both countries. In the United States almost all laboratory propagation was conducted by the State of Maine. Colonizations were apparently unsuccessful, for *Phytodietus* has not yet been reared from larvae collected in the East, except a few, one year after releases were made at a point near Belleville, Ont.

Phytodietus fumiferanae has only one generation a year. It overwinters as a mature larva in a silken cocoon spun on the foliage. Adults emerge in early summer, and the female lays an external egg on the partially paralyzed host larva. The parasite larva feeds externally, spinning its cocoon when fully grown.

Pimpla turionellae (L.) (Ichneumonidae)

Pimpla turionellae (L.) is a common pupal parasite of many Lepidoptera in Europe. In the early thirties it was reared in large numbers from European pine shoot moth pupae in Austria. Adults sent to this country from Austria arrived too late to attack shoot moth pupae here, but it was successfully reared on pupae of *Cacoecia cerasivorana* (Fitch) for general release. It has not been recovered in the United States. Canadian entomologists have recovered a few specimens in southern Ontario, but it does not appear to be well adapted to the region.

Pimpla turionellae completed several generations a year in the laboratory. The adult females lay an internal egg in the host pupa, and the parasite larva feeds internally. Pupation takes place inside the pupal shell. The winter is spent as an adult, and possibly at times in an immature stage.

Scymnus (Pullus) impevus (Muls.) (Coccinellidae)

Scymnus (Pullus) impevus (Muls.) is a coccinellid beetle found from central Europe to north Africa. It preys upon the balsam woolly aphid, and Canadian entomologists have imported it each year since 1951 for release against that pest. They have also made colonies available for release in southern New England, North Carolina, and the Pacific Northwest. It has become established at most liberation points in Canada and has spread short distances, but populations have remained small.

The life cycle of *Scymnus impexus* is well synchronized with that of its host. There is one generation a year. The winter is spent as an egg, which is laid in bark crevices, or as an adult, which hibernates in the bark particularly around old knots. Oviposition is practically confined to the autumn. Adults usually live 12 to 13 months. Both adults and larvae feed on aphid eggs, large larvae, and adults. Full-grown larvae pupate on the bark. There seems to be heavy winter mortality in Canada.

***Temelucha interruptor* (Grav.) (Ichneumonidae)**

Temelucha interruptor (Grav.) [formerly called *Cremastus interruptor* Grav.] is one of the most common parasites of the European pine shoot moth in England and in Europe. Large numbers were imported from England, Austria, and Holland in the thirties, and it was well colonized in Canada and the United States. It became established readily and recoveries were made in Connecticut, New Jersey, and southern New York in 1937. Apparently, though, conditions are unsuitable for the parasite in this general region since it was recovered in just 1 of 23 collections of host larvae overwintering there in 1946 and 1947. The recovery was at Branford, Conn. Eight of 100 larvae were parasitized.

Temelucha interruptor has been reared from several European hosts. It completes one generation a year in *Rhyacionia buoliana*, overwintering as a first instar larva. Development is completed in the spring, and full-grown larvae emerge from host larvae or pupae to spin their delicate cocoons in the host larval mine. Adults are present in June and July.

***Tetrastichus brevistigma* Gahan (Eulophidae)**

Tetrastichus brevistigma Gahan is a native species that heavily parasitizes the pupae of the imported elm leaf beetle in New England. It was first discovered in 1932 near Boston, Mass. Percent parasitization increases toward the end of summer. In 1934 and 1935, by late August, it averaged 76 and 47 percent, respectively, at five collection points. It was colonized in California in 1934 and became established immediately. It is now also abundant in the infested areas in that State.

Tetrastichus brevistigma overwinters as a full-grown larva in the dead host pupa, and an average of 12 larvae complete development in one pupa. The parasite passes through three to four partial generations a year, the second generation adults emerging about the time that beetle pupation is at its peak.

***Tetrastichus turionum* (Htg.) (Eulophidae)**

Tetrastichus turionum (Htg.) is a European parasite of the European pine shoot moth which was collected in large numbers in Austria in the early thirties, and colonized throughout the infested area in New England, southern New York, and New Jersey. It was recovered in Massachusetts, New Jersey, and on Long Island. Canadian entomologists have recovered it from southern Ontario, where they had

liberated it. In spite of early recoveries the parasite is apparently poorly adapted to conditions in the United States, for it has been absent or very rare in numerous collections made to determine its effectiveness.

Tetrastichus turionum is a gregarious pupal parasite that completes one generation annually. The full-grown larvae overwinter in a tightly packed mass within the pupal shell of the host. Pupation occurs in the spring, and adult females emerge about the time the host larvae are pupating. Females oviposit an average of about 20 eggs internally in each host pupa.

Townsendiellomyia nidicola (Tns.) (Tachinidae)

Townsendiellomyia nidicola (Tns.) [= *Alsomyia nidicola* (Tns.)] was one of the first brown-tail moth parasites established in this country. It spread rapidly throughout the infested areas, and now it frequently parasitizes an average of 17 percent of the hibernating larvae. In some collections parasitism runs as high as 40 percent. The brown-tail moth is the only known host in this country.

Townsendiellomyia nidicola has one generation a year. The winter is spent as a first instar maggot in the overwintering host larva. Development is completed in the full-grown larva, and the puparium is formed in the dead host larva's skin. First instar maggots are fully developed in the eggs that the female deposits on the venter of the small host larvae.

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