

# PARASITES OF THE ORIENTAL PEACH MOTH, *LASPEYRESIA MOLESTA* BUSCK, IN NORTH AMERICA<sup>1</sup>

By G. J. HAEUSSLER

*Assistant Entomologist, Division of Deciduous Fruit Insects, Bureau of Entomology,  
United States Department of Agriculture*

## INTRODUCTION

Because of the continued failure to discover a satisfactory control measure for the oriental peach moth (*Laspeyresia molesta* Busck), a pest which is spreading rapidly each year in the more eastern peach-producing areas of the United States and Canada, considerable attention is now being devoted to the insect parasites which attack it.

Complete records of the presence and effectiveness of parasites of this insect have been published thus far for only a few localities. In view of the fact that a search is soon to be made for foreign parasites which might be introduced into this country to aid in combating this insect, it seems advisable at this time to prepare a list of those species which have been recorded to date as parasitic on the pest in North America.

Before parasites from other sources are brought into this country a thorough study should be made throughout the entire range of the host to determine what parasites are already present in each locality, and their abundance and effectiveness. The writer has conducted such a study at Riverton, N. J., for the peach district represented by that locality. The information obtained regarding the parasites in that district is presented here in detail, with a description of some of the methods which proved to be most satisfactory for conducting a survey of oriental peach moth parasites in any locality.

## INSECTS RECORDED AS PARASITIC ON THE ORIENTAL PEACH MOTH IN NORTH AMERICA

In connection with biological studies on the oriental peach moth conducted at Riverton and Moorestown, N. J., during four seasons (1925 to 1928, inclusive) the writer found 28 species of primary parasites attacking this host, and 5 species of secondary parasites. By supplementing these records with those obtained from published data and through correspondence,<sup>2</sup> the list of insects recorded as parasitic on the oriental peach moth and presented in Table 1 has been prepared.<sup>3</sup> Information regarding the locality from which each

<sup>1</sup> Received for publication Apr. 2, 1930; issued September, 1930.

<sup>2</sup> In February, 1927, a survey of the more important parasites and predators of the oriental peach moth was compiled by Alvah Peterson and the writer from reports submitted by several cooperators through correspondence and from published data. For the records taken from that survey, from published data, and from correspondence, the writer is indebted to the following workers (who furnished data from the Province and States named in parentheses): W. A. Ross (Ontario, Canada); Philip Garman (Connecticut); D. M. Daniel (New York); L. A. Stearns, B. F. Driggers, and Alvah Peterson (New Jersey); A. B. Champlain, J. R. Stear, S. W. Frost, and J. R. Eyer (Pennsylvania); Philip Garman, H. S. McConnell, and L. A. Stearns (Maryland); L. A. Stearns, W. B. Wood, and E. R. Selkregg (Virginia); and O. I. Snapp (Georgia).

<sup>3</sup> The writer is also indebted to R. A. Cushman and A. B. Gahan, of the Division of Taxonomy and Interrelations of Insects, Bureau of Entomology, and J. M. Aldrich, of the Division of Insects, U. S. National Museum, for the determination of specimens, and particularly to Mr. Cushman for checking the list of species in Table 1.

species has been recorded, the stage of the host which is attacked, and the relation of the parasite to the host is included. The list contains 57 species of primary parasites, 5 of which are questionable, and 8 species of secondary parasites. Ten families of Hymenoptera are represented, including 33 species of Ichneumonidae, 16 of Braconidae, 3 of Eupelmidae, 2 of Pteromalidae, and 1 each of Bethyidae, Eulophidae, Eurytomidae, Perilampidae, Tetrastichidae, and Trichogrammatidae. Five species of the dipterous family Tachinidae are also included.

TABLE 1.—List of insects recorded as parasitic on the oriental peach moth in North America

PRIMARY PARASITES

Species	Order	Family	Stage of host attacked	Relation to host	Recorded from—
<i>Actia pilipennis</i> Fallen <sup>a</sup>	Diptera	Tachinidae	Larva	Internal	New Jersey.
<i>Aenoplax betulaecola</i> Ashm. <sup>a</sup>	Hymenoptera	Ichneumonidae	Prepupa <sup>b</sup>	do	Ontario, New Jersey, and Pennsylvania.
<i>Aenoplax carpocapsae</i> Cush.	do	do	do <sup>b</sup>	do	Pennsylvania.
<i>Allocota thyridopterygis</i> Riley. <sup>c</sup>	do	do	Larva <sup>b</sup>	do	Do.
<i>Angitia</i> sp. <sup>a</sup>	do	do	do	do	New Jersey.
<i>Apanteles harti</i> Vier. <sup>a</sup>	do	Braconidae	do	do	Do.
<i>Apanteles</i> sp. <sup>a</sup>	do	do	do	do	New Jersey, Virginia, and Georgia.
<i>Ascogaster carpocapsae</i> (Vier.) <sup>a</sup>	do	do	Egg	do	Ontario, New Jersey, Pennsylvania, Maryland, and Virginia.
<i>Bassus carpocapsae</i> Cush. <sup>a</sup>	do	do	Larva	do	New Jersey.
<i>Calliephialtes grapholithae</i> (Cress.) <sup>a</sup>	do	Ichneumonidae	Cocoon <sup>d</sup>	External	New Jersey and Pennsylvania.
<i>Calliephialtes</i> n. sp. <sup>a</sup>	do	do	do	do	New Jersey.
<i>Centeterus ineptifrons</i> Gahan. <sup>a</sup>	do	do	do	Internal	New Jersey, Pennsylvania, and Virginia.
<i>Cremastrus forbesii</i> Weed <sup>a</sup>	do	do	Larva	do	New Jersey.
<i>Cremastrus minor</i> Cush. <sup>a</sup>	do	do	do	do	Ontario and New Jersey.
<i>Cremastrus</i> sp.	do	do	do	do	New Jersey.
<i>Cryptus vinctus</i> (Say)	do	do	Cocoon <sup>b</sup>	do	Do.
<i>Diapetimorpha orba</i> (Say) <sup>a</sup>	do	do	Larva <sup>b</sup>	do	Virginia.
<i>Diocetes obliteratus</i> (Cress.) <sup>a</sup>	do	do	do	do	Ontario and New Jersey.
<i>Encyrtaspis semirufus</i> Gahan.	do	Eupelmidae	do	do	Georgia.
<i>Ephialtes aequalis</i> (Prov.) <sup>a</sup>	do	Ichneumonidae	Cocoon <sup>b</sup>	do	Ontario, New Jersey, and Virginia.
<i>Epiurus indagator</i> (Cress.) <sup>a</sup>	do	do	Larva or prepupa <sup>b</sup>	External	New Jersey and Maryland.
<i>Epiurus</i> n. sp.	do	do	do <sup>b</sup>	do	Ontario.
<i>Eubadizon gracilis</i> Prov. <sup>f</sup>	do	Braconidae	Larva	Internal	New Jersey and Virginia.
<i>Eubadizon pleuralis</i> Cress. <sup>f</sup>	do	do	do	do	Ontario and New Jersey.
<i>Eubadizon</i> sp. <sup>a, f</sup>	do	do	do	do	Ontario, Connecticut, New Jersey, and Georgia.
A species of the family Eupelmidae.	do	Eupelmidae	do	External	Maryland.
<i>Glypta phoxopteridis</i> Weed <sup>a</sup>	do	Ichneumonidae	do	Internal	New Jersey.
<i>Glypta rufiscutellaris</i> Cress. <sup>a</sup>	do	do	do	do	Ontario, Connecticut, New York, New Jersey, Pennsylvania, and Maryland.

<sup>a</sup> Bred from *L. molesta* by the writer.

<sup>b</sup> The stage of host attacked is not known, but the probable stage is given.

<sup>c</sup> This species is usually bred from bagworms and tussock moths. Cushman is inclined to doubt that it is parasitic on *L. molesta*.

<sup>d</sup> By cocoon is meant either prepupa or pupa within the cocoon.

<sup>e</sup> Normally parasitic on spider eggs. Cushman doubts the record.

<sup>f</sup> Cushman and Gahan are of the opinion that all these are probably the same and are neither *gracilis* nor *pleuralis* but represent undescribed species.

TABLE 1.—List of insects recorded as parasitic on the oriental peach moth in North America—Continued

## PRIMARY PARASITES

Species	Order	Family	Stage of host attacked	Relation to host	Recorded from—
<i>Glypta varipes</i> Cress.	Hymenoptera.	Ichneumonidae.	Larva	Internal	Ontario.
<i>Glypta vulgaris</i> Cress.	do	do	do	do	Virginia.
<i>Goniozus</i> sp.	do	Bethylidae.	do	External	Do.
<i>Hoplocryptus incertulus</i> Cush. <sup>a</sup> (= <i>incertus</i> Prov.)	do	Ichneumonidae	Cocoon <sup>b</sup>	Internal	New Jersey.
<i>Itoplectis conquisitor</i> (Say) <sup>a</sup>	do	do	do	do	New Jersey, Pennsylvania, and Virginia.
<i>Leskiomima tenera</i> Wied.	Diptera	Tachinidae.	Larva	do	Maryland.
<i>Leucodesmia nigriventris</i> Gir.	Hymenoptera.	Eulophidae.	do	do	Virginia.
<i>Lixophaga plumbea</i> Aldr.	Diptera	Tachinidae.	do	do	Do.
<i>Lixophaga variabilis</i> Coq. <sup>a</sup>	do	do	do	do	New Jersey, Maryland, Virginia, and Georgia.
<i>Macrocentrus ancylivora</i> Roh. <sup>a</sup>	Hymenoptera.	Braconidae.	do	do	Connecticut, New Jersey, Pennsylvania, Maryland, and Virginia.
<i>Macrocentrus delicatus</i> Cress. <sup>a</sup>	do	do	do	do	New York and New Jersey.
<i>Macrocentrus</i> sp.	do	do	do	do	Ontario, New Jersey, and Virginia.
<i>Meteorus hyphanthrae</i> (Riley)	do	do	do	do	New Jersey.
<i>Microbracon gelechia</i> (Ashm.)	do	do	do	External	New Jersey, Maryland, and Virginia.
<i>Microbracon hebetor</i> (Say) <sup>a</sup>	do	do	do	do	New Jersey.
<i>Microbracon mellitor</i> (Say)	do	do	do	do	Ontario.
<i>Microcryptus</i> sp.	do	Ichneumonidae	Cocoon <sup>b</sup>	Internal	New Jersey.
<i>Nemorilla phycitae</i> LeB.	Diptera	Tachinidae.	Larva	do	Maryland.
<i>Phanerotoma tibialis</i> Hald. <sup>a</sup>	Hymenoptera.	Braconidae.	Egg	do	New Jersey.
<i>Phygadeuon</i> sp.	do	Ichneumonidae	Larva	do	Do.
<i>Pristomerus ocellatus</i> Cush. <sup>a</sup>	do	do	do	do	Do.
<i>Rogas platypterygis</i> Ashm.	do	Braconidae.	do	do	Virginia.
<i>Sagaritis consimilis</i> (Ashm.)	do	Ichneumonidae	do	do	New Jersey.
<i>Sagaritis patsuketorum</i> Vier.	do	do	do	do	Do.
<i>Spilocryptus</i> sp.	do	do	Cocoon	do	Maryland and Virginia.
<i>Stilbopoides sesiavora</i> Roh.	do	do	Larva	do	New Jersey.
<i>Syntomosphyrum esurus</i> Riley.	do	Tetrastichidae.	Pupa	do	Do.
<i>Trichogramma minutum</i> Riley. <sup>a</sup>	do	Trichogrammatidae.	Egg	do	Connecticut, New York, New Jersey, Pennsylvania, and Maryland.
<i>Triclistus curvator</i> (Fab.) <sup>a</sup>	do	Ichneumonidae	Pupa	do	New Jersey and Maryland.

## SECONDARY PARASITES

Species	Order	Family	Recorded from—
<i>Cerambycobius</i> sp. (probably <i>Eupelmus amicus</i> Gir.)	Hymenoptera	Eupelmidae	Virginia.
<i>Dibrachys boucheanus</i> (Ratz.) <sup>a</sup>	do	Pteromalidae	Ontario, New Jersey, Pennsylvania, Maryland, and Virginia.
<i>Dibrachys</i> ( <i>Tritneptis</i> ) <i>hemerocampae</i> Gir. <sup>a</sup>	do	do	New Jersey.
<i>Eurytoma</i> sp.	do	Eurytomidae.	Maryland.
<i>Gelis</i> sp. <sup>a</sup>	do	Ichneumonidae.	New Jersey.
<i>Hemiteles tenellus</i> (Say) <sup>a</sup>	do	do	Do.
<i>Hemiteles</i> sp.	do	do	Do.
<i>Perilampus</i> sp. <sup>a</sup>	do	Perilampidae.	Do.

<sup>a</sup> Bred from *L. molesta* by the writer.<sup>b</sup> The stage of host attacked is not known, but the probable stage is given.<sup>c</sup> Normally a parasite of meal moths.

Although the oriental peach moth has so many insect parasites, very few seem to be of much importance. Those of chief importance are *Macrocentrus ancylivora* (fig. 1) and *Glypta rufiscutellaris* (fig. 2), both of which attack the larval stage, and *Trichogramma minutum*, which attacks the egg.

*Macrocentrus ancylivora* particularly, and *Glypta rufiscutellaris* to a certain extent, are aiding considerably in reducing the annual infestation in

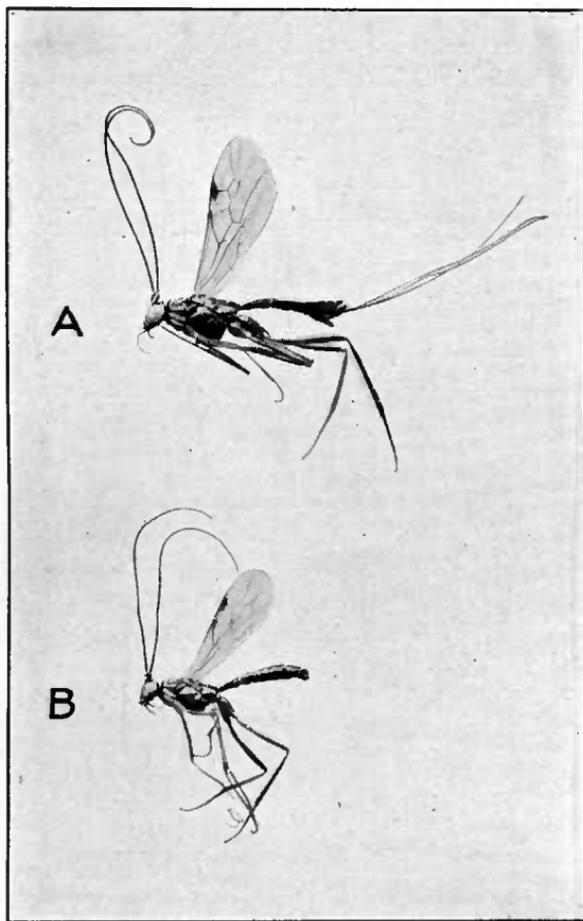


FIGURE 1.—Adults of *Macrocentrus ancylivora*: A, Female, B, male.  
X 5

those sections of New Jersey where they have become established. The work of these two species is confined largely to the earlier broods of host larvae that feed in peach twigs. By destroying large numbers of larvae of the first and second broods early in the season they bring about a considerable reduction in the number of individuals produced in the later broods, most of which feed in the fruit.

As pointed out by Stearns,<sup>4</sup> these two species are apparently limited in their distribution by environmental factors. Thus far, both species have not seemed able to become successfully established and effective in the same locality.

The egg parasite

*Trichogramma minutum* has been found to attack large numbers of oriental peach-moth eggs placed in peach orchards at Riverton,

N. J. Garman<sup>5</sup> and McConnell<sup>6</sup> both record this species as attacking eggs of the oriental peach moth in Maryland. Garman also records it from Connecticut,<sup>7</sup> and Stear records it from Pennsylvania.<sup>8</sup>

Of the remaining species, only a few have been recorded as fairly abundant in some localities. The majority are merely occasional records, usually of only a few individuals.

<sup>4</sup> STEARNS, L. A. THE LARVAL PARASITES OF THE ORIENTAL PEACH MOTH (*LASPEYRESIA MOLESTA* BUSCK) WITH SPECIAL REFERENCE TO THE BIOLOGY OF *MACROCENTRUS ANCYLIVORA* ROHWER. N. J. Agr. Expt. Sta. Bul. 450, 24 p., illus. 1928.

<sup>5</sup> GARMAN, P. THE ORIENTAL PEACH PEST (*LASPEYRESIA MOLESTA* BUSCK), A DANGEROUS NEW FRUIT INSECT OF MARYLAND. Md. Agr. Expt. Sta. Bul. 209, 16 p., illus. 1917.

<sup>6</sup> MCCONNELL, H. S. THE ORIENTAL FRUIT MOTH. Md. Agr. Expt. Sta. Bul. 298: 179-180. 1928.

<sup>7</sup> GARMAN, P. WORK WITH THE ORIENTAL PEACH MOTH IN 1926. Conn. Agr. Expt. Sta. Bul. 285: 234-239. 1927.

<sup>8</sup> STEAR, J. R. THE ORIENTAL FRUIT MOTH IN PENNSYLVANIA. Penn. Dept. Agr. Bul. v. 12, no. 8, Gen. Bul. 477, 13 p., illus. 1929.

PARASITISM OF THE ORIENTAL PEACH MOTH IN THE VICINITY  
OF RIVERTON, N. J.

METHODS OF OBTAINING RECORDS

The presence of parasites which attack and develop within the egg of the host was determined by placing oriental peach-moth eggs, which had been deposited on the leaves of peach or pear twigs in the insectary, in peach orchards. The twigs, in small bottles of water, were placed on posts in such a position as to be in the foliage of the peach trees. After being exposed for 24 hours or longer, the eggs were taken to the insectary and examined to see if they were parasitized.

Most of the information regarding the species of parasites, which attack or develop within the larva of the oriental peach moth previous to the time the cocoon is spun, was obtained by collecting peach twigs infested with the larvae. Collections were made from several orchards during the four consecutive seasons from 1925 to 1928, inclusive, usually once a week in each orchard from the time the first infested twig was found in the spring until twigs containing larvae could no longer be found in early fall. The collecting was usually continued for a definite number of minutes in each orchard, and the twigs were taken to the insectary immediately. During the first three seasons all the larvae were removed from the twigs, sorted into various size,

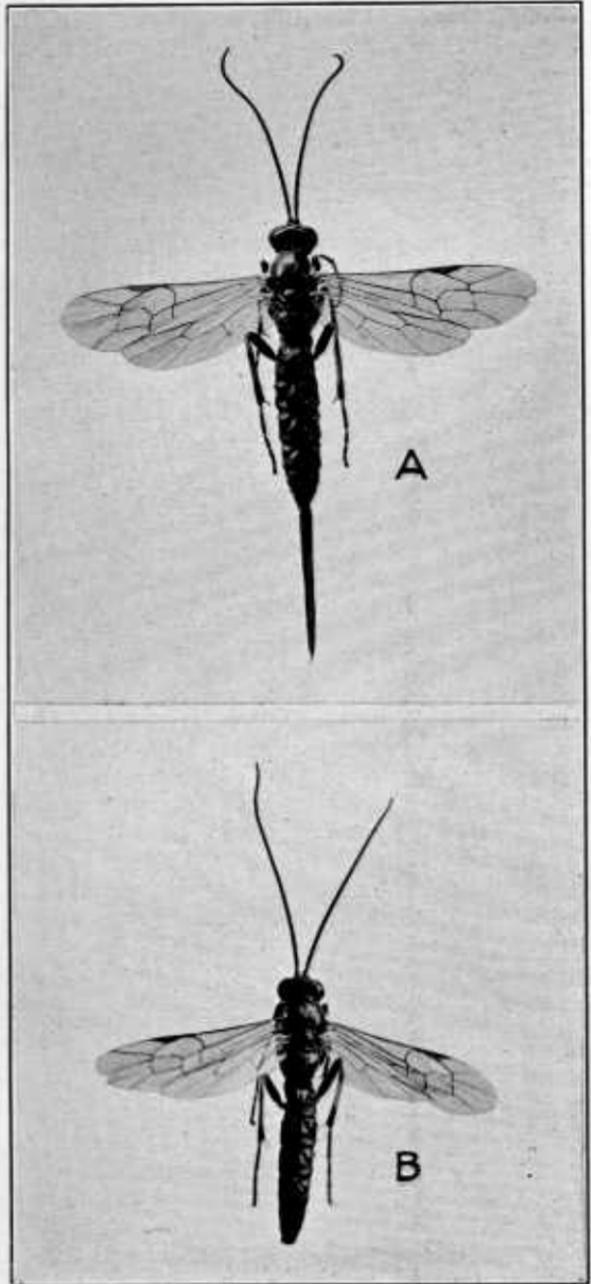


FIGURE 2.—Adults of *Glypta rufiscutellaris*: A, Female, B, male.  $\times 4$

according to their length in millimeters, and placed on fruit (peaches or apples) in jelly glasses covered with cheesecloth held in place by rubber bands. They continued their development in the fruit, and then spun cocoons in strips of corrugated straw paper, which were placed in the glasses. The cocoons were removed daily and placed in individual homeopathic vials in which the adult moths or parasites later emerged.

It was found that in rearing the larvae in the insectary after having removed them from the twigs a high mortality occurred, especially in the case of young larvae. Many larvae were injured while being removed from the twigs and died before they could eat their way into the fruit upon which they were placed. Preliminary trials in 1927 indicated that lower mortality resulted if the larvae were not removed from the twigs but were allowed to crawl out at will and go to the fruit. Consequently, throughout 1928 the larvae were removed from only one-half of the twigs taken at each collection. The leaves were trimmed from the remaining twigs, which were shortened to the 3 or 4 inches that contained the larvae. These stems were then placed in 6 by 8 inch glass jars about half full of apples. The more mature larvae, which were able to complete their development within the small portion of twig, crawled out when full grown and spun cocoons in strips of corrugated paper placed in the jars. Larvae which were unable to complete their growth before the twigs dried out abandoned the twigs and completed their feeding in the apples. These also eventually spun cocoons in the corrugated-paper strips. The cocoons were removed about once a week and placed in individual vials until the moths or parasites emerged. Although the same number of infested twigs was handled by each method throughout the entire season, only 1,030 adults (moths and parasites) emerged from the larvae which were removed from the twigs, as compared with 1,433 adults which emerged from the larvae that were allowed to come out of the twigs at will. In other words, 39.1 per cent more individuals completed their development successfully when the larvae were handled by the second method. By being able to rear a larger number of larvae to maturity, a more accurate record can be obtained of the percentage of parasitism occurring in the field. In addition, considerable time is saved because it is not necessary to remove larvae from the twigs.

Additional records of parasites of the larvae were obtained by collecting infested peach and quince fruit in the summer and fall and rearing the larvae to maturity.

Records of the parasites which attack the oriental peach moth while it is a prepupa or a pupa within the cocoon were obtained by collecting cocoons that were spun under the bark of peach and quince trees and rearing the insects to maturity in the insectary. Occasionally larval parasites also emerged from these cocoons, when the host larva had been parasitized before the cocoon was formed. On several occasions strips of corrugated paper containing prepupae or pupae in cocoons were tacked to the trunks or branches of peach trees for several days, but no parasitism occurred.

## PARASITISM OF EGGS

*Trichogramma minutum* was the only parasite found that attacks and develops entirely within the egg of the host. This parasite was present at various times throughout each growing season, and on some occasions 50 per cent or more of the host eggs that were placed on posts in peach orchards were parasitized. Information is not yet available concerning the percentage of parasitism by this species in eggs deposited normally by the oriental peach moth in the orchards near Riverton.

Two species of parasites, *Ascogaster carpocapsae* and *Phanerotoma tibialis*, oviposit in the egg of the host but complete their development within the larva. These two species are treated as larval parasites.

## PARASITISM OF LARVAE FEEDING IN PEACH TWIGS

## RELATIVE ABUNDANCE AND IMPORTANCE OF THE VARIOUS SPECIES

In the four orchards from which twigs were collected during the seasons of 1925 to 1928, inclusive, 14 species of parasites were found which attack or develop within the larva of the oriental peach moth while the larva is feeding in peach twigs. Table 2 shows the species present each season and the relative importance of each. For the four seasons, 91 per cent of all the larval parasites present were of the species *Macrocentrus ancyliwora*. *Cremastrus minor* accounted for about 3 of the remaining 9 per cent, *M. delicatus* for between 2 and 3 per cent, *C. forbesii* and *Glypta rufiscutellaris* for about 1 per cent each, and all the other species together for only about 1 per cent. *Dibrachys (Tritneptis) hemerocampae* is a secondary parasite bred from a cocoon of *M. ancyliwora*. *Perilampus* sp. also is a secondary parasite. The table shows the percentage of oriental peach-moth larvae that were parasitized by each species during each season and for the four seasons combined. Parasitism by *M. ancyliwora* alone ranged from 41.6 per cent in 1928 to as high as 55.3 per cent in 1926, with an average of 48.23 per cent for the four seasons. The percentage of parasitism by no other single species exceeded 2.69 per cent in any given season, and the highest average parasitism over the 4-year period by any species other than *M. ancyliwora* was 1.65 per cent by *C. minor*.

*Macrocentrus ancyliwora* is the only larval parasite of importance in the Riverton district, as is clearly indicated in Table 2.

TABLE 2.—Relative abundance and importance of each species of larval parasite of the oriental peach moth present in peach orchards at Riverton, N. J., during the seasons of 1925 to 1928, inclusive, as determined by collections of twigs from orchards 2 to 6 years old <sup>a</sup>

Species	1925			1926			1927			1928			4 seasons (1925 to 1928)		
	Number of individuals emerged	Percentage of larvae parasitized	Percentage of all parasites	Number of individuals emerged	Percentage of larvae parasitized	Percentage of all parasites	Number of individuals emerged	Percentage of larvae parasitized	Percentage of all parasites	Number of individuals emerged	Percentage of larvae parasitized	Percentage of all parasites	Number of individuals emerged	Percentage of larvae parasitized	Percentage of all parasites
Macrocentrus ancylovora Roh	437	49.27	91.6	532	55.30	91.0	1,003	52.79	89.0	1,027	41.60	93.3	2,999	48.23	91.2
Cremastrus minor Cush	18	2.03	3.8				47	2.48	4.2	38	1.54	3.4	103	1.65	3.1
Macrocentrus delicatus Cress				9	.94	1.5	51	2.69	4.5	25	1.01	2.3	85	1.36	2.6
Cremastrus forbesii Weed	17	1.92	3.6	25	2.60	4.3	1	.05	.1	2	.08	.2	45	.72	1.3
Glypta rufiscutellaris Cress	3	.34	.6	17	1.77	2.9	5	.26	.4	4	.16	.4	29	.46	.9
Ascogaster carpocapsae (Vier.)	1	.11	.2				11	.58	.9	3	.12	.3	15	.24	.5
Lixophaga variabilis Coq				2	.21	.3	1	.05	.1				3	.05	
Pristomerus ocellatus Cush							3	.16	.3				3	.05	
Apanteles harti Vier							2	.11	.2				2	.03	
Bassus carpocapsae Cush										1	.04	.1	1	.02	
Phanerotoma tibialis Hald	1	.11	.2										1	.02	.4
Diocetes obliteratus (Cress.)							1	.05	.1				1	.02	
Dibrachys (Tritneptis) hemerocampae Gir. <sup>b</sup>							1	.05	.1				1	.02	
Perilampus sp. <sup>b</sup>							1	.05	.1				1	.02	
Parasitism of larvae by all species	477	53.78	100.0	585	60.81	100.0	1,127	59.32	100.0	1,100	44.55	100.0	3,289	52.89	100.0
Total oriental peach moths	410			377			773			1,369			2,929		

<sup>a</sup> The collections in 1925 were from 2 orchards, in 1926 from 3 orchards, and in 1927 and 1928 from 4 orchards, <sup>b</sup> Secondary parasite.

#### SEASONAL PARASITISM

The total parasitism of larvae for each season by all species combined and the average parasitism for the four seasons are also given in Table 2. The seasonal parasitism was highest in 1926, when 60.81 per cent of the larvae collected in twigs were parasitized. The lowest parasitism occurred in 1928, when only 44.55 per cent were parasitized. An average of 52.89 per cent of all the larvae collected in peach twigs during the entire 4-year period was killed by various species of larval parasites.

In Table 3 the collections from the several orchards each week during a given season have been combined. This table gives the number of individuals which emerged, including both moths and parasites, the total percentage of parasitism by all species, the percentage of parasitism by *Macrocentrus ancylovora* alone, and the percentage by all other species combined, as they occurred in the weekly collections. In the collections made June 23 and 24, 1925, and July 15, 1926, as high as 95 per cent of the larvae were parasitized. The maximum parasitism in weekly collections in 1927 was considerably lower, 68 per cent, and occurred in the collections of

June 7 to 10 and of July 5 to 7. In the collection of July 3 to 5, 1928, there was a maximum parasitism of 72.1 per cent. In each instance indicated above, the percentage of parasitism by *M. ancyliivora* alone also reached the maximum. The figures given in Table 3 further indicate the importance of *M. ancyliivora* in the Riverton district.

TABLE 3.—Percentage of parasitism in individuals which emerged from weekly collections of peach twigs infested with larvae of the oriental peach moth at Riverton, N. J.

Collection dates	Number of individuals emerged	Percentage of larvae parasitized	Percentage of larvae parasitized by—		Collection dates	Number of individuals emerged	Percentage of larvae parasitized	Percentage of larvae parasitized by—	
			<i>M. ancyliivora</i>	All other species				<i>M. ancyliivora</i>	All other species
1925					1927				
May 18-21	58	67.2	67.2	—	May 11-13	7	57.1	42.8	14.3
May 26, 27	148	66.9	64.2	2.7	May 17-19	28	28.6	28.6	—
June 2, 3	130	36.9	36.9	—	May 24-26	153	59.5	59.5	—
June 9, 10	92	13.0	13.0	—	May 31-June 2	300	63.3	63.0	0.3
June 16, 17	98	24.5	23.5	1.0	June 7-10	399	68.2	64.4	3.8
June 23, 24	109	95.4	92.7	2.7	June 14-16	284	59.1	53.5	5.6
June 30, July 1	96	93.8	71.9	21.9	June 21-23	222	54.0	44.6	9.4
July 7, 8	41	73.2	58.6	14.6	June 28-30	218	52.3	28.0	24.3
July 14, 15	13	46.2	38.5	7.7	July 5-7	152	68.4	63.2	5.2
July 21, 22	6	33.3	33.3	—	July 12-14	89	51.7	44.9	6.8
July 27, 28	6	50.0	33.3	16.7	July 19-21	7	42.9	28.6	14.3
Aug. 2-6	8	50.0	37.5	12.5	July 26-28	10	10.0	10.0	—
Aug. 11, 12	14	21.4	14.3	7.1	Aug. 2-4	20	25.0	15.0	10.0
Aug. 18	10	20.0	20.0	—	Aug. 9-12	10	10.0	10.0	—
Aug. 25, 26	21	33.3	28.7	4.7	Aug. 17-19	1	—	—	—
Sept. 1	15	6.7	6.7	—	1928				
Sept. 8	17	5.9	5.9	—	May 16-19	32	6.3	6.3	—
Sept. 15	4	50.0	50.0	—	May 22-24	268	45.9	45.9	—
Sept. 22	1	—	—	—	May 29-June 1	453	50.1	49.9	.2
1926					June 5-8	622	42.3	39.4	2.9
May 17-19	1	—	—	—	June 12-15	276	29.7	25.7	4.0
May 25, 26	34	47.1	47.1	—	June 19, 20	168	20.2	17.9	2.3
June 2, 3	87	40.2	40.2	—	June 26-28	173	40.5	29.5	11.0
June 8, 9	60	33.3	31.7	1.6	July 3-5	237	72.1	67.9	4.2
June 16, 17	60	11.7	11.7	—	July 10-13	149	69.1	64.4	4.7
June 23	64	9.4	7.8	1.6	July 17, 18	41	43.9	41.5	2.4
June 30	118	37.3	35.6	1.7	July 24, 25	36	11.1	5.6	5.5
July 6, 7	157	88.5	83.4	5.1	July 31-Aug. 2	2	50.0	50.0	—
July 15	107	95.3	84.1	11.2	Aug. 7-10	7	14.3	14.3	—
July 21	122	86.9	76.2	10.7	Aug. 14, 15	1	100.0	100.0	—
July 28	74	58.1	45.9	12.2	Aug. 21	4	—	—	—
Aug. 4	66	90.9	80.3	10.6					
Aug. 11	3	66.6	66.6	—					
Aug. 18	5	60.0	60.0	—					
Aug. 25	4	50.0	50.0	—					

With the exception of 1926 (when only one individual emerged from the first collection) parasitism varying from 6.3 to 67.2 per cent occurred in the first collection each season. It is thus apparent that the parasites emerge early enough in spring to attack the first larvae which enter the twigs. This was checked in the case of *Macrocentrus ancyliivora* in the spring of 1928. It was found that these parasites began to emerge on May 11 after having hibernated in host larvae kept outdoors throughout the winter in a wire-screen cage hung on the south side of a pole, a method similar to that used by Peterson and Haeussler<sup>9</sup> to determine the spring-brood emergence of oriental peach moths. This was five days earlier than the first oriental peach-moth larvae were found in twigs in the orchard (May 16).

<sup>9</sup> PETERSON, A., and HAEUSSLER, G. J. DETERMINATION OF THE SPRING-BROOD EMERGENCE OF ORIENTAL PEACH MOTHS AND CODLING MOTHS BY VARIOUS METHODS. Jour. Agr. Research 37: 399-417, illus. 1928.

The most abundant parasitism occurred each season when larvae were most abundant in the twigs, as shown in Figure 3. The bars of this chart also indicate the number of moths, of *Macrocentrus ancylivora*, and of all other species of parasites combined which emerged from infested peach twigs collected weekly each season. The cross-hatched areas indicate the number of oriental peach moths,

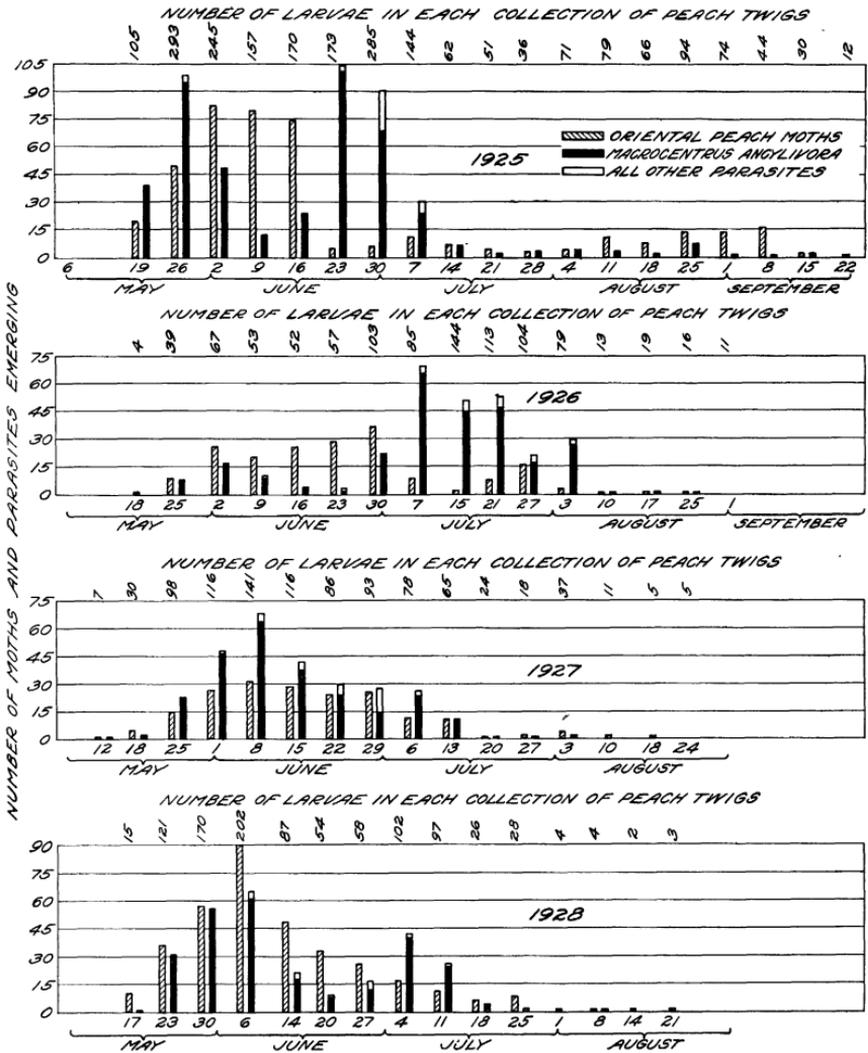


FIGURE 3.—Parasitism of oriental peach-moth larvae feeding in peach twigs at Riverton, N. J., 1925 to 1928, inclusive, as indicated by the number of individuals which emerged from infested twigs collected weekly in 15-minute periods

the solid black areas the number of *M. ancylivora*, and the white outlined areas the total number of parasites of all other species combined. The number of larvae taken in each collection is also given, and, as each collection was made during a 15-minute period, the figures indicate the relative intensity of infestation on each date of collection.

In 1925 a large population of first-brood host larvae was present in the twigs. These larvae were heavily parasitized in May, thus building up a strong population of parasites, chiefly *Macrocentrus ancylivora*, which in turn severely attacked the large second brood of host larvae. The heavy parasitism during the latter part of June and early July caused a decided decrease in twig infestation after the collection of July 7, but larvae were present in the twigs throughout August and until the collection of September 22. Parasitism after the second brood was comparatively low. There were five broods of host larvae at Riverton in 1925.

Host larvae of the first brood were not very abundant in the twigs in 1926, and parasitism of these larvae was low. Host larvae of the second brood were abundant in twigs throughout July and were heavily parasitized. Although twigs suitable for infestation were present in the orchards well into September, very few twigs were attacked after the collection of August 3. Only four broods of host larvae occurred at Riverton in 1926.

In 1927 the host larvae were abundant in the twigs from the collection of May 25 to the collection of July 13, and in every collection made during this period 50 per cent or more of the larvae were parasitized. This continuously heavy parasitism reduced the host population to such an extent that very few larvae were present in twigs after the middle of July. Four broods of host larvae occurred this season.

The situation in 1928 was, in some respects, similar to that in 1925. Larvae of the first brood were the most abundant and were heavily parasitized. Parasitism of larvae of the greatly reduced second brood was very severe early in July, and few host larvae were found in twigs after July 25, although a supply of twigs suitable for infestation was available until about August 10. There were five broods of host larvae in 1928.

#### PARASITISM OF LARVAE FEEDING IN FRUIT

Parasitism as high as 28 per cent by *Macrocentrus ancylivora* and 7 per cent by *M. delicatus* has been found in larvae feeding in peaches during the months of June, July, and August at Riverton. It is possible that many of these larvae were parasitized while feeding in twigs and that they abandoned the twigs later to complete their feeding in the fruit. From a large number of larvae cut from peaches from late August to early November in 1926, a total of 673 oriental peach moths and 10 *M. ancylivora* emerged the following spring. This was only 1.46 per cent parasitism, all by one species of parasite, in wintering larvae. These larvae probably fed almost entirely in the fruit.

From larvae collected in the fall of 1928 while feeding in quince fruit, five species of primary parasites and one secondary parasite emerged, as shown in Table 4. Of the 949 individuals which emerged, 40 were parasites, a parasitism of 4.21 per cent in larvae feeding in quince fruit at harvest time. *Phanerotoma tibialis*, which oviposits in the egg of the host and develops in the larva, was the most abundant species. The 24 individuals of this species and one of the two *Macrocentrus ancylivora* hibernated in the larvae of the host and did not emerge until the following spring. The other *M. ancylivora* and all the individuals of the remaining species emerged in the fall

of 1928. Of the 40 parasites which emerged from this material, 10 were *Glypta rufiscutellaris*, whereas there were only 4 individuals of this species among 1,100 parasites obtained from larvae feeding in peach twigs collected earlier the same season. (Table 2.)

TABLE 4.—Parasitism of oriental peach moth larvae feeding in quince fruit at Riverton, N. J., 1928

Species	Number of individuals emerged		
	Trans-forming	Winter-ing	Total
<i>Phanerotoma tibialis</i> Hald.....		24	24
<i>Glypta rufiscutellaris</i> Cress.....	10		10
<i>Macrocentrus ancylovora</i> Roh.....	1	1	2
<i>Calliephialtes grapholithae</i> (Cress.).....	2		2
<i>Pristomerus ocellatus</i> Cush.....	1		1
<i>Hemiteles tenellus</i> (Say) <sup>a</sup> .....	1		1
Total parasites emerged.....	15	25	40
Oriental peach moths emerged.....	31	878	909
Total individuals emerged.....	46	903	949
Percentage of parasitism.....			4.21

<sup>a</sup> Secondary parasite.

PARASITISM AND MORTALITY OF ORIENTAL PEACH MOTHS IN COCOONS COLLECTED FROM UNDER QUINCE BARK

From a number of oriental peach moth cocoons collected under quince bark in the fall of 1928, only 74 individuals emerged, 15 of which, or 20.27 per cent, were parasites. (Table 5.) Eleven of the parasites were *Aenoplex betulaecola*, which attacks the host in the cocoon, probably when it is a prepupa. One of these emerged in the fall of 1928, and 10 hibernated. All the other species represented attack the host while in the cocoon, with the exception of *Pristomerus ocellatus*, a parasite of the larva.

TABLE 5.—Parasitism and mortality of oriental peach moths in cocoons collected under quince bark at Riverton, N. J., 1928

Species	Number of individuals emerged		
	Trans-forming	Winter-ing	Total
<i>Aenoplex betulaecola</i> Ashm.....	1	10	11
<i>Centeterus ineptifrons</i> Gahan.....	1		1
<i>Ephialtes aequalis</i> (Prov.).....		1	1
<i>Hoplocryptus incertulus</i> Cush.....		1	1
<i>Pristomerus ocellatus</i> Cush.....		1	1
Total parasites emerged.....	2	13	15
Oriental peach moths emerged.....	2	57	59
Total individuals emerged.....	4	70	74
Percentage of parasitism.....			20.27

Number of oriental peach-moth larvae dead.....	162
Number of oriental peach-moth pupae dead.....	15
Total individuals dead.....	177
Percentage of mortality.....	70.52

As shown in Table 5, 70.52 per cent mortality occurred in the larvae and pupae in the cocoons collected under quince bark. Most of these were apparently killed by a fungous disease which is common in oriental peach-moth larvae that hibernate in cocoons spun under bark.

#### SUMMARY

Fifty-seven species of primary parasites attacking the oriental peach moth in North America have been recorded thus far. Those of chief importance are the larval parasites *Macrocentrus ancylihora* and *Glypta rufiscutellaris*, and the egg parasite *Trichogramma minutum*. Eight species of secondary parasites have also been found.

Records of the parasites of larvae occurring in the vicinity of Riverton, N. J., were obtained by making weekly collections throughout the season of peach twigs infested by the host larvae, and rearing these larvae to maturity. By trimming off the leaves and placing the portion of stems containing the larvae on apples in glass jars, 39.1 per cent more individuals were able to complete their development than when each larva was removed from the twig and placed on fruit.

*Trichogramma minutum* was the only parasite found at Riverton which develops entirely within the egg of the host. *Ascogaster carpocapsae* and *Phanerotoma tibialis* oviposit in the egg of the host but complete their development within the larva.

Fourteen species of parasites of larvae were found in larvae feeding in peach twigs at Riverton during the seasons of 1925 to 1928, inclusive. *Macrocentrus ancylihora* is the only important parasite of larvae in the Riverton district. During the 4-year period, 91 per cent of all the parasites of larvae present were *M. ancylihora*, and parasitism by this species alone averaged 48.23 per cent.

The seasonal parasitism by all species of parasites combined varied from 60.81 per cent in 1926 to 44.55 per cent in 1928, with an average of 52.89 per cent for the four seasons.

Parasitism as high as 95 per cent occurred in weekly collections of larvae in 1925 and 1926.

*Macrocentrus ancylihora* emerges early enough in the spring to attack the first host larvae that feed in peach twigs.

The most abundant parasitism occurred each season when host larvae were most abundant in twigs. Parasitism of larvae of the first and second broods caused a decided decrease in the number of twigs infested each season.

Parasitism of 28 per cent by *Macrocentrus ancylihora* and 7 per cent by *M. delicatus* occurred in larvae feeding in peach fruit in the early part of the season, but less than 2 per cent parasitism was found in wintering larvae collected while feeding in peaches in the fall.

About 4 per cent of the larvae collected while feeding in quince fruit at harvest time were parasitized, and *Phanerotoma tibialis* was the most abundant parasite. Parasitism by *Glypta rufiscutellaris* was much more abundant in these larvae than in larvae feeding in twigs.

*Aenoplex betulaecola* was the most common parasite of the stages within the cocoon. High mortality, due to disease, occurred in oriental peach-moth larvae hibernating in cocoons spun under quince bark.

