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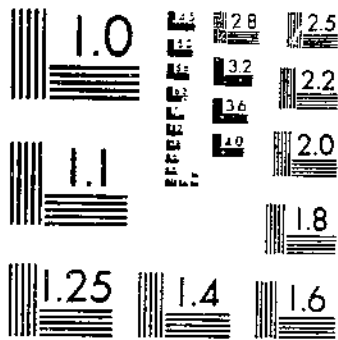
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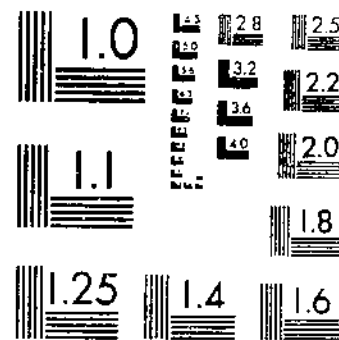
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PARASITES OF THE ORIENTAL FRUIT MOTH IN JAPAN AND CHOSSEN AND THEIR LIFE HISTORY
HAEUSSLER G. J.

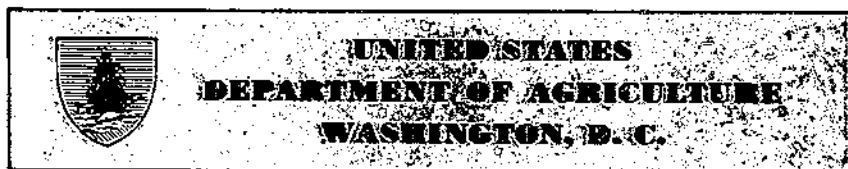
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Parasites of the Oriental Fruit Moth in Japan and Chosen and their Introduction into the United States¹

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INTRODUCTION

The search for parasites of the oriental fruit moth (*Grapholitha molesta* (Busck)) in the Orient was begun in January 1932, headquarters being established at Yokohama, Japan. This work has been in progress continuously in Japan and Chosen, but this bulletin deals only with the activities carried on during 1932 and 1933.

¹ Submitted for publication October 25, 1933.

² Several Japanese assistants rendered valuable aid in these investigations, particular recognition being due to the work of N. Suyetake, A. Kuwano, and K. Sato. The writer appreciates the valuable cooperation and the helpful information received by him and his assistants from officials of the Imperial Ministry of Agriculture, the directors and entomologists of various prefectural agricultural experiment stations, and members of other agricultural agencies both in Japan and Chosen, too numerous to mention here by name. Particular acknowledgement is made of the many kindnesses and invaluable help rendered by the late S. I. Kuwana, of the Imperial Department of Agriculture and Forestry. Thanks are due to F. Oda, entomologist of the Yukuhashi branch of the Fukuoka Agricultural Experiment Station, for his kind cooperation in helping to obtain numerous survey collections from the vicinity of that station, and to C. Harukawa, then entomologist of the Obara Agricultural Institute at Kurashiki, for information concerning the biology and distribution of the oriental fruit moth in Japan. C. Tanabe, entomologist of the Nagano Agricultural Experiment Station, and S. Matsumoto, entomologist of the Okayama Agricultural Experiment Station, rendered valuable cooperation in connection with investigations made in their prefectures. The general attitude of the native orchardists and their willingness to allow work to be undertaken on their properties was of material aid in carrying out the parasite surveys and the mass-collection work. Determination of parasite specimens and descriptions of species found to be new were made by C. F. W. Muesebeck, R. A. Cushman, and A. B. Gahan (Hymenoptera) and D. G. Hall (Diptera), all of the Division of Insect Identification, Bureau of Entomology and Plant Quarantine; by the late J. M. Aldrich, Curator of Insects, U. S. National Museum (Diptera); and, in the case of certain Ichneumonidae, by Toichi Uchida, of the Hokkaido Imperial University.

According to Harukawa (8),³ it is not known when *Grapholitha molesta* was first noticed in Japan, although he indicates that its damage attracted the attention of a horticulturist of Okayama Prefecture in 1901 and 1902, and that the presence of this insect has been known in Chosen since about 1915 or 1916. This same author mentions that a record of this pest in Japan was first published in 1905. It has since been given considerable attention by entomologists of both Japan and Chosen, and numerous publications concerning it are now available. There is little known concerning the distribution of *G. molesta* on the Asiatic mainland other than in Chosen, although it is believed that this insect occurs in the Shantung area of China. There is a possibility that it may have been introduced to Japan through spread from the mainland. The fact that it was observed in Japan before it attracted attention in other countries supports the belief that this insect originated somewhere in Asia. Comparatively little attention had been given to the parasites that attack this pest in the Orient, but in view of the above-mentioned facts it would appear that Asia should be a logical place to search for parasites of this insect.

The results of the first 2 years of investigations indicate that *Grapholitha molesta* is the host of numerous species of parasites in Japan and Chosen. Several of these attack it in as abundant numbers and to about the same extent as do certain of the indigenous North American parasites that have so readily accepted this species as a host since its introduction into the United States. Since 1932 most of the species of primary parasites discovered in Japan and Chosen have been collected in those countries by the Division of Foreign Parasite Introduction of the Bureau of Entomology and Plant Quarantine, reared at Yokohama, and shipped to the United States where they are being colonized throughout the infested area by the laboratory engaged in investigations of oriental fruit moth parasites, located at Moorestown, N. J. (2).

FIELD OF INVESTIGATION AND SCOPE OF WORK

The preliminary search for parasites attacking *Grapholitha molesta* in the Orient was confined to Japan and Chosen. Through contacts with Japanese entomologists and from various Japanese entomological and agricultural publications information was acquired concerning the oriental fruit moth in Japan and the distribution of its more important food plants. Since it was apparent that this insect was generally distributed in Japan throughout the islands of Honshu, Shikoku, and Kyushu, and also in Chosen, it was decided to conduct preliminary investigations of the parasites only in the important peach-, quince-, and pear-growing centers of those regions. It was anticipated that knowledge of the parasite fauna over much of the area of known distribution of the host species would thus be acquired in a relatively short time. With such information as a background, additional knowledge of the parasite complex could be obtained as desired during future seasons by extension of investigations to the less important fruit-growing centers or by more detailed study of the centers already scouted. The island of Hokkaido was not included in the area covered by these investigations, since available information indicated

³ Italic numbers in parentheses refer to literature cited, p. 61.

that the preferred food plants of the fruit moth are grown there in comparatively small numbers and the moth had not been reported as occurring on that island.

Investigations during 1932 consisted almost entirely in scouting work to ascertain the species of parasites present and to acquire information regarding the distribution, host relationship, and relative abundance of the various species discovered. Scouting for the parasites present in hibernating cocoons of the fruit moth was begun in Shizuoka Prefecture in February and extended during the late winter months to include the prefectures of Kanagawa, Tokyo, Saitama, and Nagano. Soon after larvae of the first brood of the fruit moth began to infest peach twigs in the vicinity of Yokohama, May 13, scouting for the parasites of twig-infesting larvae was begun in that area and also in Kyushu and Shikoku and was eventually extended northward to include the northernmost Prefecture, Aomori, in Honshu. Throughout June the Chosen Peninsula was scouted as far north as Kaijo for parasites of twig-infesting larvae. During the summer months studies were made of parasites attacking eggs of the fruit moth in Kanagawa and Tokyo Prefectures. From July to October, inclusive, investigations of parasites that attack the stages of the fruit moth within its cocoon were conducted in six Prefectures conveniently accessible to the headquarters at Yokohama. Only three small shipments, consisting chiefly of surplus parasites obtained from the survey work, were forwarded to the United States during 1932.

On the basis of information obtained during the previous season regarding the distribution and relative abundance of several new species of fruit moth parasites considered desirable for introduction into the United States, it appeared advisable to devote the major effort of the 1933 season to procuring and shipping certain of the more important and most readily obtainable species. This work, which involved the collection and rearing or breeding of parasites attacking the egg, larval, and pupal stages of the host, was distributed over the greater part of the year and required a large amount of field work in several selected areas. Some additional data, however, concerning the parasites of hibernating larvae were obtained during March in Kanagawa and Chiba Prefectures, and scouting for parasites of twig-infesting larvae was continued on a small scale during the summer months to include several localities not previously scouted. Investigations of parasites attacking the egg stage were continued in Kanagawa and extended to include localities in the Prefectures of Nagano, Shizuoka, and Okayama in Honshu, and also Keikido Province in Chosen. The study of parasites attacking larvae and pupae of the fruit moth within the cocoon was emphasized particularly during the late summer and early fall of 1933 and included investigations in several widely separated parts of Japan and the Province of Keikido, Chosen.

During the 2 years, 99 localities in 25 Prefectures of Japan and 13 localities in 3 Provinces of Chosen were scouted for the parasites that attack one or more stages of the oriental fruit moth. The approximate locations of the areas scouted are indicated in figure 1. Table 1 gives the name of each locality scouted, together with the name of the Prefecture in which it is located, the principal host plants of the fruit moth grown, and the approximate altitude.

TABLE 1.—List of localities in Japan and Chosen scouted for parasites of *Grapholitha molesta* during 1932 and 1933

Locality	Prefecture or Province	Principal host plants	Approximate altitude (in feet)
Honshu:			
Mukai-mura	Aomori	Peach and apple	0-300
Okubo-mura	Akita	Peach, pear, apple	0-300
Morioka	Iwate	do	300-1,500
Sakata	Yamagata	do	0-300
Sodeura-mura	do	do	0-300
Tendo-mura	do	Peach	300-1,500
Yamagata	do	Peach, pear, apple	300-1,500
Miya-mura	Miyagi	do	300-1,500
Sendai	do	do	0-300
Kakizaki	Niigata	do	0-300
Kariba-mura	do	do	0-300
Kuzutsuka	do	do	0-300
Nakanoshima-mura	do	do	0-300
Nuttari	do	do	0-300
Seiro-mura	do	do	0-300
Yukyuzan	do	do	0-300
Date-mura	Fukushima	do	0-300
Hirakubo-mura	do	do	300-1,500
Kamisuwa	Nagano	Quince, pear	1,500-3,000
Kyowa-mura	do	Pear	300-1,500
Mitsuoka-mura	do	Peach, pear, apple	1,500-3,000
Nagano	do	do	1,500-3,000
Nakasu	do	Apple, pear, quince	1,500-3,000
Nakazato-mura	do	Peach, apple	1,500-3,000
Oshima-mura	do	Peach, pear, apple	1,500-3,000
Suimotowa-cho	do	Peach, apple, quince	1,500-3,000
Tovoda-mura	do	Quince, pear	1,500-3,000
Mito	Ibaragi	Peach, pear, apple	0-300
Angyo	Saitama	Nursery plantings	0-300
Fujitsuka	do	Peach	0-300
Masubayashi	do	Peach, pear	0-300
Obukuro	do	Peach	0-300
Osawa	do	do	0-300
Ichikawa	Chiba	do	0-300
Matsudo	do	Peach, pear	0-300
Sugano	do	do	0-300
Yawate	do	do	0-300
Futagotamagawa	Tokyo	Peach	0-300
Higashi-naganuma	do	Peach, pear	0-300
Komazawa	do	Peach	0-300
Tamagawa	do	Peach, pear	0-300
Todoroki	do	do	0-300
Yoga	do	do	0-300
Atagoyama	Yamanashi	Peach	1,500-3,000
Nishio	do	do	300-1,500
Hirama	Kanagawa	do	0-300
Hiratsuka	do	do	0-300
Inadatamagawa	do	Peach, pear	0-300
Kashimada	do	Peach	0-300
Kawasaki	do	do	0-300
Kikuna	do	do	0-300
Mizonokuchi	do	do	0-300
Motosumiyoshi	do	do	0-300
Mukaigawara	do	Peach, pear	0-300
Musashinakahara	do	Peach	0-300
Musashimakanoshima	do	do	0-300
Ninomiya	do	Peach, pear	0-300
Nohorito	do	do	0-300
Okurayama	do	Peach	0-300
Shikugawara	do	do	0-300
Shimosoga	do	Peach, pear	0-300
Shinmaruko	do	Peach	0-300
Soga-mura	do	Peach, pear	0-300
Takatsu	do	Peach	0-300
Tsunashima	do	do	0-300
Yokohama	do	do	0-300
Hara	Shizuoka	do	0-300
Makado	do	do	0-300
Miho	do	do	0-300
Mochimune	do	Peach, pear	0-300
Okitsu	do	do	0-300
Suzukawa	do	do	0-300
Togo	do	Peach	0-300
Kono-mura	Osaka	do	0-300
Kuroyoshi	Tokyo	do	0-300
Kotori	do	do	0-300
Kurashiki	Okayama	do	0-300
Mantomi-mura	do	do	0-300
Nishiyama-mura	do	do	300-1,500
Niiyama-mura	do	do	300-1,500

TABLE 1.—List of localities in Japan and Chosen scouted for parasites of *Grapholitha molesta* during 1932 and 1933—Continued

Locality	Prefecture or Province	Principal host plants	Approximate altitude (in feet)
Honsbu—Continued			
Saiden.....	Okayama.....	Peach, pear.....	0- 300
Yokoi-mura.....	do.....	Peach.....	300-1, 500
Hiro-mura.....	Hiroshima.....	do.....	300-1, 500
Koi.....	do.....	Peach, pear.....	0- 300
Mukaishima.....	do.....	Peach.....	0- 300
Suiba-mura.....	do.....	do.....	0- 300
Shikoku:			
Daushi-mura.....	Kagawa.....	Peach, pear, apple.....	300-1, 500
Sakamoto-mura.....	do.....	Peach.....	300-1, 500
Zota-mura.....	do.....	do.....	300-1, 500
Baishinji.....	Ehime.....	do.....	0- 300
Dogo.....	do.....	Peach, pear.....	300-1, 500
Gogoshima.....	do.....	Peach.....	0- 300
Kyushu:			
Ono-mura.....	Fukuoka.....	do.....	0- 300
Yukubeshi.....	do.....	do.....	0- 300
Osada.....	Oita.....	do.....	0- 300
Kurosaki.....	Kumamoto.....	do.....	0- 300
Shimazaki-cho.....	do.....	do.....	0- 300
Takae-mura.....	Kagoshima.....	do.....	0- 300
Toso.....	do.....	do.....	0- 300
Chosen:			
Anyo.....	Kelkido.....	do.....	300-1, 500
Enseuri.....	do.....	do.....	300-1, 500
Heitaku.....	do.....	do.....	300-1, 500
Kaijo.....	do.....	Pesch, pear, apple.....	0- 300
Keijo.....	do.....	Peach.....	300-1, 500
Sosha.....	do.....	Peach, pear.....	300-1, 500
Suigen.....	do.....	Peach, pear, apple.....	0- 300
Kaigaameu.....	Keisho Hokudo.....	Peach.....	0- 300
Taikyu.....	do.....	Peach, pear.....	0- 300
Chosetho.....	Keisho Nando.....	Peach.....	0- 300
Fukkin.....	do.....	do.....	0- 300
Fusan.....	do.....	do.....	0- 300
Kiho.....	do.....	Peach, pear.....	0- 300

METHODS USED IN CONDUCTING PARASITE SURVEYS

SURVEY FOR PARASITES THAT ATTACK THE EGGS OF THE FRUIT MOTH

Field records of parasites attacking the egg stage of the fruit moth were obtained by suspending peach or pear twigs, on the foliage of which eggs had previously been deposited under insectary conditions, among the branches of peach, sand pear, or quince trees for about 48 hours, after which they were returned to the laboratory for observation. All larvae that hatched from eggs thus exposed were allowed to continue their development on apples in the laboratory.

SURVEY FOR PARASITES THAT ATTACK THE TWIG-INFESTING LARVAE

Modifications of the method used in conducting somewhat similar studies at Riverton, N. J., previously described by the writer (6), were used in making a survey of the parasites of immature larvae of *Grapholitha molesta* in the Orient. As the larvae that feed in fruit are usually not readily accessible to attack by parasites while in the immature stages, investigations were confined to larvae feeding within succulent twigs of the food plants. Such larvae were found most abundant in the twigs of peach trees, but occasionally collections of larvae feeding within the twigs of flowering cherry trees were included. An attempt was made to obtain samples of 100 or more infested twigs once, or more often when possible, during the season

from localities considered representative of the more important peach-growing districts of Japan and Chosen. At the time of collection, all foliage was trimmed from the twigs which were then wrapped in bundles of 50 in a good grade of absorbent-paper toweling and packed

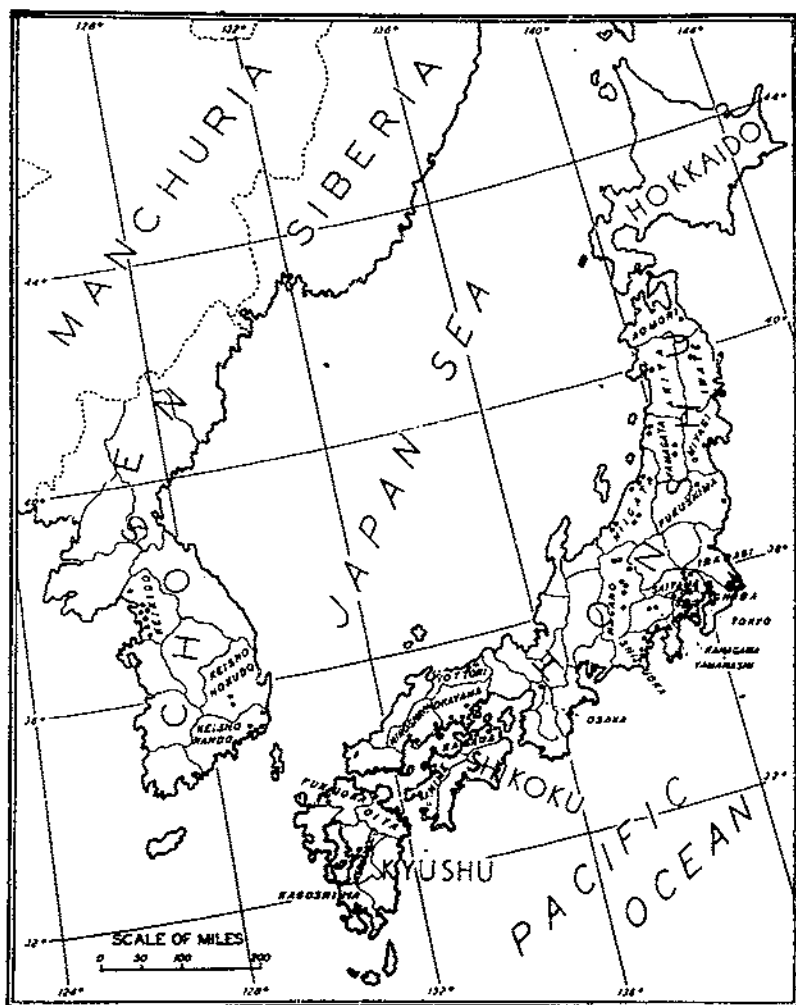


FIGURE 1.—Map of Japan and Chosen showing the areas scouted for parasites of the oriental fruit moth during 1932 and 1933.

for shipment in specially prepared ventilated metal cans that were equipped with tight-fitting covers to prevent escape of the larvae. These cans (fig. 2, A) were made in 3 sizes to permit nesting when empty and accommodated from about 350 to 600 trimmed twigs. A narrow strip of corrugated paper was placed on the top of the twig bundles to provide suitable cocooning space for larvae that might complete feeding and abandon the twigs during shipment. A gummed label bearing the date and place of collection, the number of infested twigs included, and the collector's name was attached to the cover of

each can. Care was taken to include in each can only those twigs collected from one locality, although such a collection often included twigs obtained from more than one orchard within the territory designated by the nearest village, town, or city. To prevent its being crushed during shipment, each can was slipped into a fitted corrugated box and this in turn was enclosed in strong wrapping paper (fig. 2, B). The twigs were usually shipped, the same day they were collected, by special express direct to the laboratory at Yokohama for rearing of the larvae.

At the laboratory the twigs from each collection were placed in wide-mouth glass jars covered by cheesecloth held firmly in place by rubber bands. In a few instances, particularly early and late in the season when development was slow, it was necessary to add a few sound apples to furnish additional food for the developing larvae. The mature larvae were removed from these jars daily and placed in individual small shell vials. The vials were plugged with cotton wadded into small squares of cheesecloth against which the larvae usually constructed their cocoons. The vials were filed in flat wooden trays, those containing the larvae from each collection being segregated within the trays by small wooden blocks. The trays were stacked in a rack at room temperature, and the vials were examined daily until emergence of the adults occurred. For most species of parasites, records of the date of issuance from the host and of the duration of the parasite cocoon stage were obtained from the daily examination. All adults of the fruit moth were recorded and destroyed soon after emergence, but the adult parasites were retained for identification. Complete records were kept for each individual collection.

SURVEY FOR PARASITES THAT ATTACK THE STAGES WITHIN THE COCOON

Three general methods were used in investigating the parasites that attack the mature larvae and the pupae of the oriental fruit moth within the cocoon. These were (1) the collection of hibernating individuals and occasionally those of summer generations within cocoons located in cracks and crevices or beneath the bark of trees of the favorite food plants of the fruit moth, (2) trapping larvae of the summer and fall generations beneath bands placed on the trunks and larger branches of such trees, and (3) exposing cocoons spun in narrow strips of corrugated paper by pinning them to the trunks and branches of the trees for several days and then returning them to the laboratory for emergence.

Cocoons containing hibernating fruit moths were readily found in considerable numbers beneath the flaky bark of quince trees and were occasionally found in small numbers on the bark of sand pear and peach trees. Consequently the majority of the records of parasites reared from hibernating fruit moths were obtained from localities in the rather extensive quince-growing section near Lake Suwa in Nagano Prefecture. Such cocoons were collected from December to early in April. When collected from quince trees, flakes of bark to which the cocoons were attached were removed from the trees and shipped to the laboratory without disturbing the contained insects any more than necessary. The cocoons were then examined to eliminate those of other species, and those containing larvae or pupae of the fruit moth were placed in individual vials for rearing.

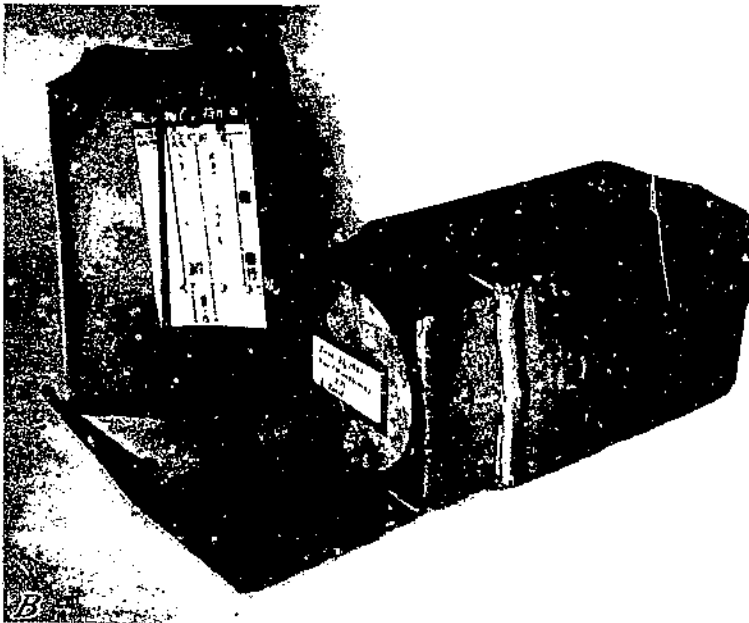
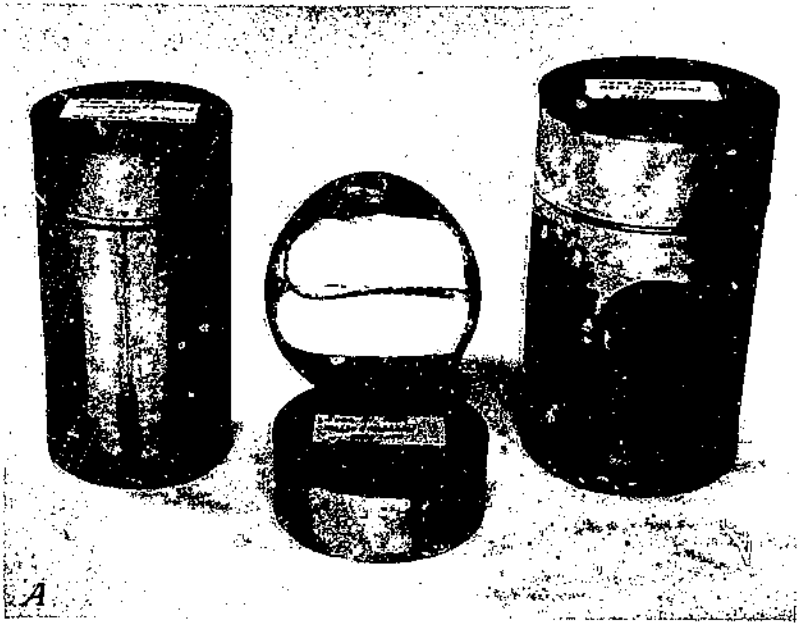


FIGURE 2.—Method of packing infested twigs for shipment: *A*, Three sizes of shipping cans, showing bundle of twigs; *B*, cans packed in corrugated-paper boxes and wrapped for shipment.

Burlap bands, made from old rice sacks cut into strips 5 inches wide, and narrow bands of corrugated paper were used to trap fruit moth larvae of the summer and fall generations as they crawled to the trunk and larger branches of peach, sand pear, and quince trees in search of cocooning quarters. The bands were undisturbed for periods ranging from 1 to several weeks, depending on the time of season, to allow the parasites to attack the larvae or pupae within the cocoons. Burlap bands trapped much larger numbers of larvae than the corrugated-paper bands and were used in most instances in 1932 and entirely during 1933. The kind of tree also influenced the number of larvae trapped. For the 2 seasons, the burlap bands used on sand pear trees averaged 57 larvae per 100 bands and those on peach trees 67 larvae per 100 bands, whereas on quince trees 208 larvae were obtained per 100 bands. All fruit moth larvae or pupae collected from trap bands were placed in individual vials and reared to emergence in the laboratory.

To obtain additional information regarding the parasites that attack cocoons of the summer and fall generations of the oriental fruit moth, larvae that had been allowed to spin cocoons in small strips of corrugated paper were exposed to parasitization in the field by pinning them to the trees for several days and then returning them to the laboratory previous to the time for adult emergence. It was found that very few larvae escaped from the cocoons if they were allowed at least 24 hours in which to spin a substantial cocoon before being placed on the trees. The exposure period ranged from 1 to 5 days for different lots, but in the majority of instances the cocoons were left on the trees for 4 days. In 1932 this work was concentrated at localities not far distant from Yokohama, and the cocoons exposed contained chiefly larvae that had been bred entirely under laboratory conditions. In 1933 the work was carried on in several regions too far distant to permit of using laboratory-reared cocoons. The cocoons exposed, therefore, contained field-collected larvae originating from infested twigs collected locally and reared to the cocoon stage. Many such larvae had been attacked by larval parasites while in the twigs, and as a result the exposure of these cocoons frequently furnished information regarding the host relationships of parasites that attack stages of the fruit moth within the cocoon. When returned to the laboratory, each cocoon was isolated in a small vial for emergence.

SPECIES OF PARASITES REARED FROM THE ORIENTAL FRUIT MOTH IN JAPAN AND CHOSEN

During the course of these investigations 61 species of parasites were reared from *Grapholitha molesta* in Japan and Chosen. A complete list of the species reared is presented in table 2, with the relation of each species to the host and the country from which each species was reared as a parasite of the fruit moth. The species are listed according to the stage of the host attacked; namely, the egg, the immature larva, and the mature larva or pupa.

The information obtained for each species of parasite is presented in the following pages. The total parasitization of the several stages of the fruit moth in various regions and also the comparative importance of the different species of twig-larval parasites are discussed under those respective headings.

TABLE 2.—Parasites reared from *Grapholitha molesta* collected in Japan and Chosen

Parasites	Relation to host	From material collected in—
<i>Of the egg</i>		
Trichogrammidae:		
<i>Trichogramma minutum</i> Riley	Primary	Japan, Chosen.
<i>Of the immature larva (twig-infesting stages)</i>		
Braconidae:		
<i>Apanteles molestae</i> Mues	do	Do.
<i>Apanteles taragamae</i> Vier	do	Do.
<i>Apanteles</i> A.	do	Japan.
<i>Apanteles</i> B.	do	Do.
<i>Bassus conspicuus</i> (Wesm.)	do	Japan, Chosen.
<i>Bassus diversus</i> Mues	do	Japan.
<i>Eubadizon extensor</i> (L.)	do	Do.
<i>Macrocentrus thoracicus</i> (Nees)	do	Japan, Chosen.
<i>Meteorus ictericus</i> (Nees)	do	Japan.
<i>Orgilus longiceps</i> Mues	do	Do.
<i>Phanerotoma grapholithae</i> Mues	do	Japan, Chosen.
Ichneumonidae:		
<i>Chorinæus</i> sp.	do	Japan.
<i>Cremastus stacoorbitalis</i> (Oam.)	do	Japan, Chosen.
<i>Cremastus</i> 1.	do	Chosen.
<i>Cremastus</i> 2.	do	Japan.
<i>Inareolata molestae</i> (Uchida)	do	Japan, Chosen.
<i>Glypta cymolomiae</i> Uchida	do	Japan.
<i>Plectochorus imatensis</i> (Uchida)	Primary (possibly secondary)	Do.
<i>Pristomerus ounerator</i> (Panzer)	Primary	Japan, Chosen.
Tachinidae:		
<i>Elodia flavipalpis</i> Ald.	do	Do.
<i>Elodia subfasciata</i> Ald.	do	Japan.
<i>Phorocera pumilio</i> Ald.	do	Japan, Chosen.
<i>Of the mature larva or pupa (stages within the cocoon)</i>		
Bethylidae:		
<i>Goniozus</i> sp.	do	Japan.
<i>Peristeria</i> n. sp.	do	Do.
Braconidae:		
<i>Clinocentrus</i> n. sp.	do	Do.
<i>Meteoridae</i> n. sp.	do	Japan, Chosen.
Calliceratidae:		
<i>Callicerat</i> n. sp.	Primary and secondary	Do.
<i>Callicerat</i> sp.	Secondary	Japan.
Chalcididae:		
<i>Antrocephalus</i> n. sp.	Primary	Do.
<i>Brachymeria exarimata</i> Gahan	do	Do.
<i>Haltichella</i> n. sp.	Primary and secondary	Japan, Chosen.
Eulophidae:		
<i>Pleurotropis nawai</i> (Ashm.)	do	Japan.
Eupelmidae:		
<i>Eupelmus formosae</i> Ashm.	do	Japan, Chosen.
Eurytomidae:		
<i>Eurytoma appendigaster</i> (Swed.)	do	Do.
Ichneumonidae:		
<i>Aenoplax molestae</i> (Uchida)	do	Japan.
<i>Aenoplax</i> A.	Primary	Do.
<i>Aenoplax</i> B.	do	Do.
<i>Aenoplax</i> C.	do	Do.
<i>Caenocryptus</i> n. sp.	Undetermined	Do.
<i>Calliephialtes laspeyresiae</i> (Uchida)	Primary	Do.
<i>Calliephialtes</i> sp.	do	Do.
<i>Cryptus suzuki</i> (Mnts.)	do	Do.
<i>Ephialtes disparis</i> (Vier.)	do	Do.
<i>Ephialtes</i> n. sp.	do	Do.
<i>Epiurus glycinivorellae</i> Uchida	Undetermined	Do.
<i>Epiurus vesicarius</i> (Ratz.)	do	Do.
? <i>Hemiteles bicolorinus</i> Grav.	Secondary, possibly also primary	Do.
? <i>Hemiteles pulchellus</i> Grav.	Primary and secondary	Japan, Chosen.
<i>Hemiteles</i> A.	Primary	Japan.
<i>Hemiteles</i> B.	Primary and secondary	Japan, Chosen.
<i>Herpestomus</i> sp.	Primary	Japan.
<i>Ichnus</i> n. sp.	Primary, possibly secondary also	Japan, Chosen.
<i>Ichnus</i> sp.	Primary	Japan.
<i>Hoplectis epinothiae</i> Uchida	Primary, possibly secondary also	Japan, Chosen.
<i>Phaenogenes hoenussleri</i> (Uchida)	Primary	Japan.
<i>Phaenogenes</i> sp.	do	Do.
<i>Spilocryptus grapholithae</i> Uchida	Primary, possibly secondary also	Japan, Chosen.
Pteromalidae:		
<i>Dibraehys cærus</i> (Walk.)	Primary and secondary	Do.
Tetrastichidae:		
<i>Syntonoxphyrum</i> sp.	do	Do.
<i>Tetrastichus ibeni</i> Gir.	do	Do.

PARASITE OF THE EGG

Only one species (*Trichogramma minutum* Riley) was reared as a parasite of the egg stage of the oriental fruit moth in the Orient. This cosmopolitan egg parasite was reared from Honshu, Japan, and from Keikido, Chosen, where it attacked eggs exposed at the following localities: Hirama, Kashimada, Kawasaki, Mizonokuchi, Moto-sumiyoshi, Mukaigawara, Musashinakahara, Okurayama, Shikugawara, Shinmaruko, Tukatsu, Tsunashima, and Yokohama, all in Kanagawa Prefecture; Futagotamagawa, Higashinaganuma, and Todoroki in Tokyo Prefecture; Kamisuwa in Nagano Prefecture; and Suigen, in Keikido Province. As this parasite destroys the eggs and is present in orchards of the food plants most favored by *Grapholitha molesta*, having been reared from hosts found in peach, sand pear, and quince orchards, it is probable that it effects some degree of control of this pest in the Orient. Further studies were not undertaken, since this same species of *Trichogramma* is already widely distributed in North America as a parasite of the fruit moth and other insects.

Two consignments, however, comprising a total of 1,580 oriental fruit moth eggs parasitized by *Trichogramma minutum* were forwarded to Moorestown, N. J., in 1933 for experimental use. The first shipment consisted of 330 insectary-deposited eggs parasitized while exposed in orchards in Kanagawa Prefecture in July and the second consignment contained 1,250 fruit moth eggs parasitized with *T. minutum* under insectary conditions. The number of adult parasites obtained from these importations was not reported, although the stock was ample to initiate breeding of the species at Moorestown.

PARASITES OF THE TWIG-INFESTING LARVAE

Twenty-two species of parasites were reared from twig-infesting larvae of *Grapholitha molesta* collected from Japan and Chosen during 1932 and 1933. All of these emerged as primary parasites of that host and only one species, *Plectochorus iwaiensis* (Uchida), is related to a group recorded as being secondary parasites.

APANTELES spp.

Four species of *Apanteles* were reared from twig-infesting larvae of the oriental fruit moth. These are internal parasites of the immature larval stages of the host and only one parasite has been observed to develop from a parasitized fruit moth larva except in the single instance noted under the discussion of *A. molestae*. These *Apanteles* larvae frequently become mature and leave the host larva before the latter has completed its feeding, or at least prior to formation of the fruit moth cocoon. As a result, when collections of infested twigs were being held, *Apanteles* adults often emerged in the rearing jars from parasite cocoons formed among the mass of twigs and frass. Occasionally the *Apanteles* cocoons were found inside the twigs, in the tunnel formed by the feeding of the former host larva. Parasitization by these species is not always fatal to the host, as evidenced by the fact that in several instances field-collected fruit moth larvae from which *Apanteles* had been produced were successfully reared to the adult stage.

The first shipments of *Apanteles* were forwarded from Yokohama to Moorestown in 1933. Owing to the difficulty of identifying living

adults, no attempt was made to distinguish the species included in or reared from shipments. An average mortality of 63.5 percent occurred in the 2 consignments containing a total of 587 host-free *Apanteles* cocoons and 4 adults, and from these 216 parasites were received alive at Moorestown. Only 34 *Apanteles*, all originating from larvae collected in Japan, were reared at Moorestown from shipments of field-collected fruit moth larvae. A total of 250 *Apanteles*, 154 of which were females, were obtained from all shipments.

Apanteles molestae Mues. was described by Muesbeck (9) from specimens reared from twig-infesting larvae of *Grapholitha molesta* collected in Japan and Chosen in 1932. This species was reared from 11 localities in 7 Prefectures of Honshu, from 3 localities in 2 Prefectures of Shikoku, from 1 locality of Kyushu, and from 2 localities in 1 Province of Chosen. It emerged as the dominant parasite in 11 collections from 9 localities. All localities from which this species was reared and the highest percentage of larvae parasitized by it in any collection are listed below.

	Highest percentage of parasitization		Highest percentage of parasitization
Honshu:		Honshu—Continued.	
Miyagi:		Okayama—Continued.	
Sendai.....	5.5	Niiyama-mura.....	3.3
Niigata:		Saiden.....	30.4
Kariha-mura.....	.2	Yokoi-mura.....	2.9
Fukushima:		Shikoku:	
Date-mura.....	2.7	Kagawa:	
Hirakubo-mura.....	2.9	Danshi-mura.....	21.0
Nagano:		Zota-mura.....	11.8
Nakasu (reared from cocoons trapped under bands).....	(¹)	Ihime:	
Kanagawa:		Dogo.....	.3
Noborito.....	1.3	Kyushu:	
Shizuoka:		Fukuoka:	
Mochimune.....	3.1	Ono-mura.....	.4
Okayama:		Chosen:	
Mantomi-mura.....	(¹)	Keikido:	
		Kaijo.....	2.7
		Suigen.....	.7

¹ Percentage of parasitization not known.

Apanteles molestae was of particular importance at Saiden, Danshi-mura, and Zota-mura. It was reared in comparatively small numbers from the other localities and in general seemed to attain its maximum abundance about the second week of June. Although only 1 adult of this species usually develops from a host, superparasitism may occur, as evidenced by the rearing, in a single instance, of both a male and a female of *A. molestae* from the same host larva parasitized in the field at Danshi-mura. Females predominated when this species was reared from fruit moth larvae parasitized under field conditions, 63.6 percent of 250 adults reared from survey collections during 1932 being of that sex. Attempts to breed this parasite under laboratory conditions at Yokohama were unsuccessful. When confined in small wooden cages maintained at room temperature (about 65° to 80° F.) and provided with lump sugar and water, adults of both sexes remained alive from 1 to 17 days, the average longevity of the females being 4.8 days and of the males 10 days. When confined in similar cages maintained in an ordinary ice refrigerator at temperatures of 52° to 57°, the minimum life of both sexes was increased to 3 days, but the maximum and average longevity were reduced considerably.

Apanteles taragamae Vier. was the most widely distributed species of the genus reared from twig-infesting larvae of the oriental fruit moth. It was reared from 32 localities in 12 Prefectures of Honshu from Aomori to Hiroshima, from 2 localities in Kagawa in Shikoku, from 2 localities in 2 Prefectures of Kyushu, and from 2 localities in Keikido, Chosen. It emerged as the dominant parasite in 28 collections from 20 localities. The localities from which this species was reared and the highest percentages of parasitization are listed below.

	Highest percentage of parasitization		Highest percentage of parasitization
Honshu:		Honshu—Continued.	
Aomori:		Kanagawa—Continued.	
Mukai-mura.....	0.9	Shikugawara.....	4.1
Yamagata:		Soga-mura.....	1.3
Sakata.....	1.3	Takatsu.....	2.1
Yamagata.....	.9	Tsunashima.....	8.8
Niigata:		Shizuoka:	
Kakizaki.....	.5	Hara.....	12.2
Kariha-mura.....	.7	Mochimune.....	3.0
Nagano:		Okitsu.....	.6
Mitsuoka-mura.....	19.9	Okayama:	
Oshima-mura.....	4.2	Kurashiki.....	9.8
Saitama:		Mantomi-mura.....	.7
Obukuro.....	3.0	Saiden.....	7.5
Chiba:		Yokoi-mura.....	9.7
Sugano.....	3.4	Hiroshima:	
Tokyo:		Hiro-mura.....	.3
Higashinaganuma.....	8.3	Shikoku:	
Todoroki.....	18.0	Kagawa:	
Yoga.....	4.3	Danshi-mura.....	1.0
Yamanashi:		Sakamoto-mura.....	3.2
Nishino.....	2.6	Kyushu:	
Kanagawa:		Fukuoka:	
Kashimada.....	2.6	Yukuhashi.....	2.3
Kawasaki.....	2.5	Kagoshima:	
Motosumiyoshi.....	1.0	Toso.....	.6
Musashinakanoshima.....	2.6	Chosen:	
Ninomiya.....	3.0	Keikido:	
Noborito.....	7.5	Suigen.....	1.4
Okurayama.....	2.6	Sosha.....	2.6

Although widely distributed, *Apanteles taragamae* was reared as an important parasite of the fruit moth only at certain localities in Honshu. It was of importance at Mitsuoka-mura, where it was the dominant species in each collection and occurred in fairly abundant numbers; at each of the localities from which it was reared in Tokyo Prefecture, where it was also the dominant species in each collection; and at several localities in Kanagawa and Okayama Prefectures, where it became the dominant parasite in some collections. It was of little importance on the other islands of Japan and in Chosen. In most instances, when this parasite was reared from twigs collected at different times of the year from the same locality, increased parasitization occurred as the season progressed, the maximum being reached usually in August.

Females predominated among *Apanteles taragamae* reared from host larvae that had been parasitized in the field, 62.1 percent of 499 adults obtained at Yokohama from survey collections reared during 1932 and 1933 being of that sex. Attempts to breed this parasite under laboratory conditions at Yokohama were unsuccessful.

Two undetermined species of *Apanteles*, designated in the list of species on page 10 as *Apanteles A* and *Apanteles B*, were reared in

only very small numbers from larvae of *Grapholitha molesta* and were found only in Honshu. A single female of species A was reared from a survey collection taken at Shinmaruko, Kanagawa, and a male emerged from infested twigs collected at Mantomi-mura, Okayama, in connection with other work. One male and one female of species B were reared from survey collections obtained at Mitsuoka-mura, Nagano, and at Mochimune, Shizuoka, respectively, and two additional females emerged from twigs which were collected at the former locality for use in other work.

Those referred to in table 5 as *Apanteles* spp. represent individuals that developed only to the parasite-cocoon stage and were identified from the cocoons as being of the genus *Apanteles*. All these probably were of one or more of the four species mentioned above.

BASSUS CONSPICUUS (Wesm.)

The braconid *Bassus conspicuus* occurs as a minor parasite of *Grapholitha molesta* in Honshu and Chosen. All occurrences of this species in survey collections were from twigs collected from three localities in June 1932. It was reared from 1.5 percent of the larvae in 1 of the several collections obtained from Motosumiyoshi, Kanagawa, from 2 of 4 collections from Suigen, Chosen, where the maximum parasitization by this species was 3.7 percent, and from 0.7 percent of the larvae reared from 1 of 3 collections obtained from Taikyū, Chosen. Five individuals of this species also emerged from 30,695 infested twigs collected late in July and in August 1933, from Mitsuoka-mura, Nagano, in connection with other work.

Bassus conspicuus is an internal parasite of the immature larva of *Grapholitha molesta*, the parasite larva leaving the host after the latter has become mature and formed its cocoon. The parasite cocoon is constructed within that of the former host. During June and July at Yokohama the adult parasite emerged on an average of 11 days and a minimum of 8 days after the parasite larva had issued from the host. Females of this species appear to predominate under field conditions, as indicated by the fact that 21 (84 percent) of 25 individuals reared from the localities mentioned above were of that sex.

Bassus conspicuus was not obtained at Moorestown from shipments forwarded during 1932 and 1933.

BASSUS DIVERSUS (Mues.)

Muesebeck (9) described *Bassus diversus* as a new species from females reared from *Grapholitha molesta* in Japan in 1932. In his description Muesebeck states that *B. diversus*—

Differs from all other species of the genus known to me in combining an unusually thin head, sharply impressed and punctate notauli, strongly rugulose exareolate propodeum, foveolate mesopleural furrow, closely striate three basal abdominal tergites, and black body.

Bassus diversus was reared from only two Prefectures of Honshu, from Mitsuoka-mura and Oshima-mura, Nagano, the maximum parasitization by this species in any collection being 2.9 and 0.8 percent at the respective localities, and from Kawasaki and Noborito, Kanagawa, where at each locality 0.7 percent of the larvae reared were parasitized by it. It did not occur as the dominant species in any collection. This parasite was reared in 1932 from twigs collected during May, June, and August, and at all localities other than Noborito it occurred only in August or was more abundant in collections

made during that month than in those made earlier in the season. This species was reported to have been reared in small numbers at Moorestown from field-collected fruit moth larvae imported from Chosen in 1933. In view of the fact that *B. diversus* did not appear in any survey collections of infested twigs reared from several localities in Chosen in connection with other work during that same season, the record of its apparent occurrence in that country is questionable.

A total of 134 adults of *Bassus diversus*, all females,⁴ were reared at Yokohama during the 2 seasons. Five unmated females, held in small cages at Yokohama, were observed to oviposit in September 1932, in young fruit moth larvae feeding just beneath the skin of entire apples. When mature, these larvae hibernated and were carried over the winter in an open insectary. In April and May 1933, 20 females of *B. diversus* emerged from the parasitized host larvae, indicating thelytokous reproduction and also the ability of this parasite to hibernate successfully within hibernating larvae of the fruit moth.

Bassus diversus oviposits in immature fruit moth larvae and develops as a solitary internal parasite, the parasite larva issuing from the mature host larva after the latter has constructed its cocoon. The parasite cocoon is formed within that of the former host. Records for 15 individuals of this species reared at Yokohama during June, July, and September indicate that the adults emerged on an average of 8 to 9 days after formation of the parasite cocoon, 6 days being the minimum period observed.

This parasite was first sent to the United States in 1933. Four females were reared at Moorestown from 19 host-free parasite cocoons included in two consignments, and 76 females were reared from shipments of field-collected fruit moth larvae, making a total of 80 adults, all females, obtained from all importations.

EURADIZON EXTENSOR (L.) and MACROCENTRUS THORACICUS (Nees)

Two braconids of very similar appearance (*Eubadizon extensor* and *Macrocentrus thoracicus*) attack the twig-infesting larvae of the oriental fruit moth in the Orient. It is difficult to distinguish active living individuals of these two species. The method used has been to subject the adults, confined in glass vials, for a short time to a temperature sufficiently low to arrest activity in order to observe with a hand lens or binocular the single cubital cell in the forewing of *E. extensor* or the presence of two such cells in the forewing of *M. thoracicus*. Living adults of *M. thoracicus* can usually be distinguished from the several species of that genus parasitic on the oriental fruit moth in North America by the color of the head and abdomen, which is always almost entirely black in *thoracicus* and not so in other species.

No attempt was made to determine the number of adults of each of these 2 species reared at Moorestown from importations. Two preliminary consignments of adults of *Macrocentrus thoracicus* reared from survey collections were forwarded to Moorestown in July 1932. From a total of 198 adults shipped, 68 were received alive, the mortality in the two shipments being 70 and 63.3 percent, respectively. A shipment of 196 adults of *M. thoracicus* forwarded in July 1933 arrived at Moorestown with only 11.2 percent mortality, 174 parasites being received alive. Only 7 adults were obtained from cocoons of

⁴ The male of this species was not observed during the course of the investigations reported in this bulletin, but males have since appeared occasionally at Moorestown following continued breeding of the species under laboratory conditions.

both species included in consignments of miscellaneous parasite cocoons forwarded during 1933. From field-collected fruit moth larvae shipped from May to July 1933, 2,734 adults of the 2 species were reared at Moorestown, 58.9 percent of these emerging from host larvae that were collected in Chosen. A total of 2,983 adults of *Eubadizon extensor* and *M. thoracicus*, 1,923 of which were females, were obtained from all shipments during 1932 and 1933.

Eubadizon extensor was reared from only two localities in Kyushu and from one locality in Honshu. In 1933 it was of particular importance at Kurosaki, Kumamoto, where it was the dominant parasite and was reared from 16.4 percent of the fruit moth larvae collected on June 9. In a collection from Shimazaki-cho in the same Prefecture made 1 day previous, 3.9 percent of the larvae were parasitized by this species which was of minor importance at that locality. The other occurrence was from Nishino, Yamanashi, where only 0.4 percent of the larvae reared from a collection made on June 24, 1932, were parasitized by this species.

Of 32 individuals of *Eubadizon extensor* reared from the above-mentioned collections, 40.6 percent were females. In the rearings at Yokohama, the adult parasite was observed to emerge an average of 10 days and a minimum of 7 days after formation of the parasite cocoon. No attempt was made to breed this parasite in the laboratory.

Macrocentrus thoracicus is widely distributed in Japan and Chosen as a parasite of twig-infesting larvae of *Grapholitha molesta*. Its known range of distribution includes practically all localities scouted in Chosen from Fusan to Kaijo, Fukuoka Prefecture in Kyushu, Kagawa Prefecture in Shikoku, and 10 of the 19 Prefectures scouted in Honshu from Aomori to Hiroshima. The localities from which this species was reared are listed as for the preceding parasites.

Honshu:	Highest percentage of parasitization	Honshu—Continued	Highest percentage of parasitization
Aomori:		Okayama—Continued	
Mukai-mura.....	0.9	Mantomi-mura.....	0.9
Fukushima:		Niijama-mura.....	.3
Hirakubo-mura.....	1.4	Saiden.....	2.3
Nagano:		Yokoi-mura.....	2.6
Mitsuoka-mura.....	.4	Hiroshima:	
Oshima-mura.....	.9	Hiro-mura.....	.6
Ibaragi:		Shikoku:	
Mito.....	.4	Kagawa:	
Saitama:		Dunshi-mura.....	.8
Obukuro.....	13.7	Sakamoto-mura.....	8.4
Osawa.....	13.8	Zota-mura.....	4.6
Chiba:		Kyushu:	
Sugano.....	2.5	Fukuoka:	
Kanagawa:		Yukubashi.....	.7
Hirama.....	10.7	Chosen:	
Inadatamagawa.....	2.1	Keikido:	
Kawasaki.....	8.7	Kaijo.....	.4
Kikuna.....	7.4	Suigen.....	1.4
Mizonokuchi.....	3.4	Keisho Hokudo:	
Motosumiyoshi.....	11.9	Kaizanmen.....	14.8
Noborito.....	5.3	Taikyu.....	2.9
Okurayama.....	2.4	Keisho Naoto:	
Shinmaruko.....	2.2	Choseiho.....	22.5
Takatsu.....	16.2	Fukkin.....	.8
Osaka:		Fusan.....	59.3
Kono-mura.....	.4	Kiho.....	18.2
Okayama:			
Kurashiki.....	1.4		

This species was reared as the dominant parasite in 24 collections from 18 localities. The highest percentage of parasitization by it was recorded from Fusan in the extreme southern portion of the Chosen Peninsula, the only locality in Chosen at which *Inareolata molestae* was found to be of little importance. It was also reared in fairly abundant numbers from the Prefectures of Kagawa, Kanagawa, and Saitama, in all of which *I. molestae* either did not occur or was of practically no importance. *Macrocentrus thoracicus* was reared chiefly from localities at which *I. molestae* either did not occur or was relatively unimportant and, with very few exceptions, it either did not occur or failed to attain any degree of abundance at localities from which *I. molestae* was reared as an important parasite.

Macrocentrus thoracicus is an internal parasite of the immature larva of the fruit moth, only 1 parasite developing from each host. The manner of oviposition and of parasite development is similar to that described for *Bassus diversus*. From rearings at Yokohama of 294 individuals of *M. thoracicus* from host larvae parasitized in the field, the adult parasite was observed to emerge during the summer months on an average of 11 days and a minimum of 5 days from the date of parasite cocoon formation. Mating occurred readily and the sexes usually remained paired for less than 1 minute. Females predominated when this parasite was reared from fruit moth larvae parasitized in the field. Of all such adults reared at Yokohama during the 2 seasons, 67.5 percent were females, and of those reared at Moorestown in 1933 from importations of field-collected fruit moth larvae 63.4 percent were of that sex. Equal numbers of each sex were produced from very limited breeding experiments conducted under laboratory conditions at Yokohama.

METEORUS ICTERICUS (Nees)

One female of *Meteorus ictericus* was reared from a larva of the fruit moth in an infested twig collected at Ichikawa, Chiba, on June 7, 1932, and another specimen of this species emerged at Moorestown from field-parasitized fruit moth larvae imported from Japan during 1933. These are the only records of parasitization by this species.

ORGILUS LONGICEPS Mues.

Orgilus longiceps was described by Muesebeck (9) from specimens reared from *Grapholitha molesta* in Japan in 1932. In describing the species, he states (9, p. 52):

This species is very similar to *obscurata* (Nees) but is readily separated from that species by its even longer and more strongly compressed head, by its punctate rather than rugulose face, by having the propodeum broadly polished across the base, and by its paler clypeus, mandibles, antennae, and legs.

This parasite was reared only from the islands of Honshu and Kyushu, on each of which it was found to occur at 2 widely separated localities. It was the dominant parasite and emerged from 9.4 percent of the larvae reared from twigs collected at Togo, Shizuoka, on June 30, 1932. In a collection from Mito, Ibaragi, on July 19 of that same year only 0.8 percent of the larvae were found to be parasitized by that species. At Yukuhashi, Fukuoka, a series of 15 collections were made from June 6 to July 7, 1932, but *Orgilus longiceps* was reared only from twigs collected on June 28 and 29, and the maximum parasitization by it at that locality was 0.7 percent. This parasite occurred in most abundant numbers in a single collection made at

Shimazaki-cho, Kumamoto, on June 8, 1933, where it was the dominant species and emerged from 22.5 percent of the larvae reared.

This species is an internal parasite of the immature larva of the fruit moth and is similar to *Macrocentrus thoracicus* in its habits and development. The proportion of sexes produced when *Orgilus longiceps* was reared from larvae that had been parasitized in the field showed decided variation. In the collection from Togo in 1932, 12, or 70.6 percent, of 17 adults produced were females, whereas in the collection from Shimazaki-cho in 1933 only 11, or 37.9 percent, of 29 adults reared were of that sex. Out of 50 *O. longiceps* reared at Yokohama from larvae collected from all localities during both seasons 24, or 48 percent, were females; whereas 359, or 65.3 percent, of 550 adults of this species reared at Moorestown from importations of field-collected fruit-moth larvae in 1933 were females. At Yokohama the adults of this species were observed to emerge on an average of 7.3 days and a minimum of 4 days after the formation of the parasite cocoon.

PHANEROTOMA GRAPHOLITHAE Mues.

Phanerotoma grapholithae was described by Muesebeck (9) from specimens reared from larvae of the oriental fruit moth collected in Japan and Chosen in 1932. In describing the species Muesebeck states (9, p. 50):

Very similar to *tibialis* Haldeman [frequently reared as a parasite of the oriental fruit moth in the United States], but distinguished especially by having the first abscissa of the radius shorter than the second, by the anterior wings being only very indistinctly banded or maculated, by the more delicate sculpturing of the head, and by the weaker and shorter basal keels of the first tergite and the relatively longer third tergite.

In Japan *Phanerotoma grapholithae* occurs as a parasite of *Grapholitha molesta* chiefly in the north-central portion of Honshu, where it was reared from 23 localities. It was not reared from Shikoku and was recorded from only 1 locality in Kyushu. It is fairly well distributed in Chosen, where it was reared from 5 localities in the 3 Prefectures scouted. A list of the localities from which *P. grapholithae* was reared is presented below.

Honshu:	Highest percentage of parasitization	Honshu—Continued.	Highest percentage of parasitization
Yamagata:		Kanagawa—Continued.	
Sakata.....	0.5	Okurayama.....	6.8
Sodeura-mura.....	.7	Shikugawara.....	2.5
Niigata:		Takatsu.....	7.6
Seiro-mura.....	1.4	Tsunashima.....	8.5
Nagano:		Shizuoka:	
Mitsuoka-mura.....	3.5	Hara.....	4.1
Nakasu.....	(1)	Mochimune.....	.5
Saitama:		Okitsu.....	.6
Masubayashi.....	(1)	Okayama:	
Obukuro.....	(1)	Yokoi-mura.....	.7
Chiba:		Kyushu:	
Sugano.....	.3	Fukuoka:	
Tokyo:		Yukubashi.....	.4
Todoroki.....	1.5	Chosen:	
Yoga.....	.4	Keikido:	
Kanagawa:		Suigen.....	.3
Hiratsuka.....	6.9	Sosha.....	3.1
Kashimada.....	3.8	Keisho Hokudo:	
Kawasaki.....	1.5	Taikyu.....	.7
Motosumiyoshi.....	13.1	Keisho Nando:	
Musashinakanoshima.....	7.4	Choseiho.....	.8
Noborito.....	5.1	Kiho.....	.5

¹ Reared only from fruit moth cocoons collected under trap bands.

Although parasitization by *Phanerotoma grapholithae* did not exceed 13.1 percent in any collection, this species became the dominant parasite in Kanagawa Prefecture late in July and in August in many collections. Elsewhere it was of little importance as a parasite of *Grapholitha molesta*. It was reared as the dominant parasite from 22 collections in 11 localities.

The egg of *Phanerotoma grapholithae* is deposited within the egg of the fruit moth, and the parasite larva develops as an internal parasite of the host larva while the latter feeds in a twig or fruit. The parasite larva issues from the mature larva of the fruit moth and spins its cocoon within the cocoon made by its former host. The adult parasites emerged during the summer months at Yokohama on an average of about 8 days after formation of the parasite cocoon. Only 1 parasite develops from a host. Females oviposited readily in the laboratory when fruit-moth eggs, deposited on pear foliage, were introduced into glass vials or small wooden cages in which the parasites were confined. The larvae hatching from parasitized eggs were reared on apples. The average life cycle for 277 individuals of *P. grapholithae* bred in this manner at room temperature, 65° to 91° F., from eggs parasitized from July 11 to August 14, 1932, was 24.9 days. The minimum and maximum lengths of the life cycle were 19 and 37 days, respectively. The proportion of sexes produced by this species was not determined.

As *Phanerotoma grapholithae* was reared in only small numbers from fruit moth larvae parasitized in the field, the species was bred at Yokohama in the fall of 1932 to produce a stock for exportation. A consignment of 3,460 cocoons containing hibernating fruit moth larvae reared from eggs that had been exposed to parasitization by *P. grapholithae* was forwarded to the United States in December of that year. These cocoons were held in cold storage at Moorestown during the remainder of the winter, and 484 adults of *P. grapholithae* emerged the following spring. The emergence records indicated parasitization of 30.6 percent for the host individuals that survived and mortality of 54.3 percent for the total number of cocoons shipped. Five adults and 230 cocoons of this parasite, all reared from fruit moth larvae collected in the field, were included in 2 shipments forwarded in July and August 1933. From these, 78 adults were obtained alive at Moorestown, the mortality during shipment being 66.8 percent. Only 52 adults of this species were reared from shipments of field-collected larvae of the oriental fruit moth. A total of 614 adults of *P. grapholithae* were obtained at Moorestown from all consignments forwarded during the 2 seasons.

CHORINAEUS SP.

One male, identified by Cushman as *Chorinaeus* sp., probably new, was reared at Moorestown from field-collected larvae of the oriental fruit moth imported from Japan in 1933. This species was not reared from any of the survey collections, and the locality from which the single specimen originated is not known.

CREMASTUS spp.

Three species of *Cremastus* were reared from twig-infesting larvae of the oriental fruit moth in the Orient, but only one of these, *Cremastus flavo-orbitalis* (Cam), appears to be of any importance as a parasite

of that host. The other two are undetermined species reared only as occasional parasites.

All specimens of *Cremastus* shipped to the United States originated from parasitized fruit moth larvae reared from infested twigs collected in the field. No attempt was made to differentiate the various species when parasites of this genus were reared from importations received at Moorestown. The majority of those obtained from shipments were undoubtedly *C. flavoorbitalis*, although a few individuals of both undetermined species were possibly included. One consignment of 179 *Cremastus* adults reared from survey collections was forwarded in July 1932. Of these, 100 adults were alive upon arrival at Moorestown, the mortality having been 44.1 percent. Only 9 adults of this genus were reared at Moorestown from shipments of miscellaneous parasite cocoons forwarded in 1933. From field-collected fruit moth larvae shipped during that season 78 *Cremastus* adults were reared at Moorestown. A total of 187 adults, 133 of them females, of *Cremastus* spp. were obtained at Moorestown from all shipments forwarded during the 2 seasons.

The parasite *Cremastus flavoorbitalis* is widely distributed in Japan and also occurs in Chosen. It was reared from fruit moth larvae in twigs collected from the localities shown in the following list:

	Highest percentage of parasitization		Highest percentage of parasitization
Honshu:		Shikoku:	
Niigata:		Ehime:	
Kariha-mura.....	0.2	Baislinji.....	3.0
Saitama:		Kyushu:	
Obukuro.....	2.6	Fukuoka:	
Osawa.....	1.0	Yukuhashi.....	13.1
Chiba:		Kumamoto:	
Sugano.....	.6	Shimazaki-cho.....	.8
Yamanashi:		Chosen:	
Nishino.....	.2	Keisho Nando:	
Kanagawa:		Kiho.....	8.3
Takatsu.....	.4		
Shizuoka:			
Mochimune.....	.2		
Togo.....	.6		
Hiroshima:			
Hiro-mura.....	.3		
Koi.....	2.1		

As a parasite of the oriental fruit moth *Cremastus flavoorbitalis* was reared in most abundance at Yukuhashi, in Kyushu, where it appeared in each of 15 collections of infested twigs made during June and July 1932, and ranked second to *Inareolata molestae* in order of dominance. It was also reared in fair abundance from the 1 collection obtained at Kiho, Chosen, on June 10, 1932, where it ranked third in dominance. It was of minor importance at all other localities from which it was reared. Clark (4) records this species as one of the valuable primary parasites of the European corn borer (*Pyrausta nubilalis* (Hbn.)) in the Orient and particularly in Kyushu.

The biology of *Cremastus flavoorbitalis* as a parasite of the fruit moth has not been studied, but its biology as a parasite of *Pyrausta nubilalis* has been described in detail by Bradley and Burgess (3). Attempts to breed this parasite from the oriental fruit moth under laboratory conditions at Yokohama were entirely unsuccessful. A total of 288 adults of this species emerged during 1932 and 1933 from all field-parasitized fruit moth larvae reared in the Orient. Exactly 50

percent of these were females. Bradley and Burgess (3) record 62.1 percent of females of *C. flavoorbitalis* reared from field-parasitized larvae of *P. nubilalis* imported from the Orient. The proportion of sexes produced ranged from entirely males to as high as 72.7 percent of females in rearings of this parasite from 15 separate collections of twigs infested with oriental fruit larvae obtained at Yukuhashi during the period June 6 to July 7, 1932. The sex ratio for 228 adults reared from that locality was 49.6 percent of females. During the summer months at Yokohama the adult parasite was observed to emerge on an average of 10 to 11 days after formation of the parasite cocoon.

Uchida (14) identified certain specimens of *Cremastus* reared by the writer from *Grapholitha molesta* as *C. flavoorbitalis* (Cam.) form *coreanus* (Uch.). Cushman, from examination of some of the same and additional specimens, considers that these should be treated as a distinct species rather than as a form of *flavoorbitalis*. He explains, in correspondence, that "in this the first tergite extends below to the median line while in *flavoorbitalis* the ventral margins of the tergite are parallel and the sternite is visible throughout its length." For the sake of convenience this species is designated in this bulletin as *Cremastus* 1.

Specimens of this species were reared only from fruit moth larvae in infested twigs collected from Suigen and Sosha, Keikido, and from Kiho, Keisho Nando, in Chosen the highest percentages of larvae parasitized by it in any collection being 2.1, 0.4, and 1.1 percent at the respective localities. It appears to be of decidedly minor importance as a parasite of the fruit moth. Only 15 specimens, all females, were reared from survey collections. No attempt was made to breed this species in the laboratory.

Another unidentified species of *Cremastus*, designated in the present bulletin as *Cremastus* 2, was reared only from fruit moth larvae in Japan, where it was found to occur at six localities, as follows:

Honshu:	Highest percentage of parasitization	Honshu—Continued.	Highest percentage of parasitization
Nagano:		Kanagawa:	
Mitsuoka-mura.....	1.1	Motosumiyoshi.....	1.3
Ibaragi:		Shizaoka:	
Mito.....	.4	Hara.....	.6
Tokyo:		Shikoku:	
Higashinaganuma.....	1.0	Ehime:	
		Baishinji.....	.5

Cremastus 2 appears to be of little importance as a parasite of the fruit moth. Of 20 adults reared from survey collections, 40 percent were females. Breeding of this species was not attempted under laboratory conditions.

INAREOLATA MOLESTAE (Uchida)

An ichneumonid, *Inareolata molestae*, was described by Uchida (13) from females reared from the oriental fruit moth in Japan in 1932. The female can be distinguished from most other parasites of *Grapholitha molesta* by the short, sickle-shaped ovipositor, which is weakly curved upward and about half as long as the abdomen. The middle coxae, which are dark brown to black basally, reddish-brown markings on the abdomen, and coarser punctation of the thorax serve to distinguish this species from *I. obliteratedus* (Cress.), a North American

parasite of the fruit moth having entirely yellow to white middle coxae, entirely black abdomen, and extremely fine punctation of the thorax.

Inareolata molestae is the most abundant and the most widely distributed parasite of twig-infesting larvae of the oriental fruit moth in Japan and Chosen. In all survey collections made during 1932 and 1933 it was approximately eight times as abundant as either of its closest competitors, *Apanteles taragamae* and *Macrocentrus thoracicus*. *I. molestae* is very generally distributed in Chosen, where it was reared from each of the nine localities scouted from Fusan to Kaijo. It is present on each of the three islands scouted in Japan, and its known range of distribution there extends from Kagoshima Prefecture in southern Kyushu to Aomori Prefecture in northern Honshu. The localities from which this parasite was reared are listed below with the highest percentage of larvae parasitized by *I. molestae* in any single collection of infested twigs from that locality.

Honshu:		Highest percentage of parasitization	Shikoku:		Highest percentage of parasitization
Aomori:			Kaguwa:		
	Mukai-mura	2.8		Sakamoto-mura	1.5
Yamagata:			Ehime:		
	Sakata	3		Baishinji	63.7
	Sodeura-mura	7		Gogoshima	16.4
Niigata:			Kyushu:		
	Kakizaki	4.7	Fukuoka:		
	Kariha-mura	1.3		Yukubashi	65.6
	Nakanosima-mura	1.0	Oita:		
	Yukyuzan	7.1		Osada	10.6
Nagano:			Kumamoto:		
	Nakazato-mura	5		Shimazaki-cho	21.7
	Oshima-mura	4	Kagoshima:		
Saitama:				Toso	4.5
	Fujitsuka	1.5	Chosen:		
Yamanashi:			Keikido:		
	Atagoyama	5		Kaijo	27.9
	Nishino	6		Suigen	64.6
Shizuoka:				Sosha	54.5
	Hara	1	Keisho Hokudo:		
	Mochimune	2		Kaiganmen	29.6
Okayama:				Taikyu	46.3
	Mantomi-mura	5	Keisho Nando:		
	Yekoi-mura	1.0		Choseiho	45.6
Hiroshima:				Fukkin	39.0
	Hiro-mura	48.3		Fusan	2.2
	Koi	4.4		Kiho	29.9
	Mukaishima	20.6			
	Sanba-mura	5.9			

The highest percentage of parasitization by *Inareolata molestae* was recorded from Yukubashi, in the northern part of Kyushu, where this parasite occurred in abundance in all collections made throughout June and the early part of July 1932. It was considerably less important at all other localities scouted on that island. In Chosen it also attained a high degree of parasitization at all localities from which collections were obtained in the prefectures of Keikido and Keisho Hokudo, but in Keisho Nando, especially in the more southern localities at which *Macrocentrus thoracicus* occurred as an important parasite, *I. molestae* was relatively unimportant. It was reared as an important parasite at Baishinji in Shikoku and was the only parasite from Gogoshima, a small island off the coast of Shikoku

near Baishinji. In Honshu *I. molestae* was of very little importance except at Hiro-mura and Mukaishima, the latter being a small island off the coast. It was reared as the dominant parasite in 45 collections from 22 localities.

Only a few observations were made concerning the biology of *Inareolata molestae*. It is a solitary internal parasite of the immature larva of *Grapholitha molesta*, the only host from which it has been recorded. Oviposition usually occurs while the fruit moth larva is feeding within a twig where it is readily accessible to the rather short ovipositor of the female parasite. In the laboratory at Yokohama females oviposited in very young larvae that were feeding just beneath the skin of entire apples. After the parasitized host larva has completed feeding and constructed its cocoon, the parasite larva makes its way out of the host and, when mature, forms its cocoon within that of the former host. During the summer months, at Yokohama, the adult parasites issued, on an average, approximately 8 days after the date of parasite cocoon formation, and 4 days was the minimum time recorded for the cocoon period. The life cycle of 33 of the parasites bred entirely under laboratory conditions at Yokohama from larvae parasitized in July and August 1932, averaged 24 days. The minimum and maximum life cycles were 22 and 31 days, respectively. Mating occurs very readily, and the pairs usually remain in copula for several minutes.

The ratio of the sexes produced from field-collected hosts varied considerably at different localities and in the general regions from which this parasite was reared. However, when several collections were obtained from the same locality at different dates, the proportion of sexes produced remained fairly consistently in favor of one sex. The percentage of females produced from survey collections of infested twigs at the localities from which a total of 15 or more adults of this species were reared from all collections in 1932 ranged from 25.6 to 86.7 percent. Of 3,610 adults reared from all collections during that year, 51.2 percent were females. The percentage of females produced from the various regions was as follows: Honshu 36.2 percent, Shikoku 58.4 percent, Kyushu 42.9 percent, average for Japan 43.8 percent; Chosen 56.4 percent, and for all localities in Chosen it was over 50 percent. There appears to be no definite correlation between the proportion of females produced and the relative abundance of this species at different localities or in different regions.

Adults of *Inareolata molestae* will remain alive for a long period when confined under suitable conditions. Minimum, maximum, and average lives of 36, 75, and 63 days, respectively, were recorded for 25 females; and 34, 66, and 51.3 days, respectively, for 15 males held in small wooden cages at Yokohama during the summer of 1932. From the date the adults emerged, June 20, until August 3 the cages were kept in an ordinary ice refrigerator at approximately 52° to 61° F., and thereafter they were held in a darkened room at 75° to 85°. Lump sugar and water were constantly available, and the cages were removed to a lighted laboratory room for a few minutes daily to stimulate feeding by the parasites.

Stocks of this parasite were obtained for exportation entirely from field collections of twigs infested by larvae of *Grapholitha molesta*. In July 1932, 2 preliminary shipments containing a total of 1,700 adults

of *Inareolata molestae*, accumulated as a surplus from survey collections, were forwarded to Moorestown. Of these, 407 parasites were received alive. The mortality in the first shipment was 32.6 percent, but for some undetermined reason mortality of 99.6 percent occurred in the second shipment. Two more consignments of adults, 1 of which also included a few cocoons of the parasite, were forwarded in July and August 1933. From a total of 806 adults and 43 cocoons shipped, 639 adults were received alive. The mortality in these shipments was 19.1 percent for the one that included the cocoons and 47.1 percent for the later shipment which contained only adults. An additional 682 adults were reared at Moorestown in 1933 from cocoons of this parasite included in 3 shipments of miscellaneous parasite cocoons. The largest numbers of *I. molestae* were included in 4 shipments of field-collected fruit moth larvae forwarded during the summer of 1933. From this source, 7,585 adult parasites were reared at Moorestown, of which 75.6 percent emerged from larvae collected in Chosen. A total of 9,313 adults, of which 6,167 were females, were obtained alive at Moorestown from all shipments during the 2 years.

GLYPTA CYMLOMIAE Uchida

In 1932 Uchida (12) described *Glypta cymolomiae* as a parasite of *Cymolomia mori* Mats. from Katoni, Hokkaido. It was reared by the writer in 1932 as a parasite of twig-infesting larvae of *Grapholitha molesta* from Kariha-mura, Niigata, where 0.4 percent of the larvae collected June 30 were parasitized by it, from Mochimune, Shizuoka, where 0.1-percent parasitization by it occurred in a collection on June 10, and from Mitsuoka-mura, Nagano, percent parasitization unknown, from twigs collected during August 1933. This species is apparently only an occasional parasite of the oriental fruit moth and was found by the writer only in Honshu. Only four females and two males were reared at Yokohama from all survey collections and none emerged at Moorestown from importations of large numbers of field-collected fruit moth larvae.

PLECTOCHORUS IWATENSIS (Uchida)

A species described by Uchida (11) in 1928 as *Mesochorus iwatensis*, and in 1933 transferred by him (14) to the new genus *Plectochorus* was reared from fruit moth larvae in infested twigs collected from the following localities in Honshu:

Honshu:	Highest percentage of parasitization	Honshu—Continued.	Highest percentage of parasitization
Niigata:		Kanagawa—Contd.	
Seiro-mura.....	0.6	Takatsu.....	0.9
Kanagawa:		Tsunashima.....	.6
Motosumiyoshi.....	3.9	Shizuoka:	
Shikugawara.....	.5	Hara.....	1.0

Plectochorus iwatensis was reared as a solitary parasite of the immature larva of the oriental fruit moth. No evidence was found in the host cocoons from which adults emerged to indicate that these had not developed as primary parasites of that host species. However, many species of the closely related genus *Mesochorus* are recorded as secondary parasites. Equal numbers of both sexes occurred in the 24 specimens reared at Yokohama from survey collections during the

2 seasons. This species was unavoidably present in shipments of field-collected fruit moth larvae forwarded from Japan, but only 3 adults emerged at Moorestown from importations during 1933, and these were not released from quarantine.

PRISTOMERUS VULNERATOR (Panzer)

Pristomerus vulnerator, which is also present in France and Italy as a parasite of the oriental fruit moth, was reared from that host in both Japan and Chosen. A noticeable variation from the usual coloration occurs in certain specimens reared from the Orient. Uchida (14) has described these as a new form, *erythrothoracis*, distinguishable from the typical species by the entirely red thorax and the reddish-yellow legs, the propodeum in the male, however, being dark reddish brown. Cushman, in correspondence, has pointed out that in his opinion "the variation from *vulnerator* to *erythrothoracis* Uch. is so gradual that the only point of division is between those having no red on the thorax and those having more or less red." An attempt was made to distinguish this form only in the case of individuals reared from parasite survey collections. Unless definite mention is made concerning either form, the name *vulnerator* as used in this bulletin includes both forms.

Pristomerus vulnerator is very widely distributed in Japan and Chosen and, according to Uchida (14), also occurs as a parasite of *Gelechia gossypiella* Saund. and *Cymolomia morivora* Mats. The localities from which this parasite was reared are listed in table 3, the maximum percentage of larvae parasitized by *P. vulnerator* in any collection of infested twigs and the form of the species reared being indicated for each locality.

TABLE 3.—Localities in Japan and Chosen from which *Pristomerus vulnerator* was reared as a parasite of the oriental fruit moth, the maximum percentage of larvae parasitized by it in any collection, and the form of the species reared from each locality

Locality	Prefecture or Province	Maximum parasitization by <i>P. vulnerator</i>	Form of <i>P. vulnerator</i> reared
Honshu:			
Sakata	Yamagata	0.5	Typical species.
Date-mura	Fukushima	1.0	Do.
Hirakubo-mura	do	7	Do.
Mitsuoka-mura	Nagano	1.8	Do.
Oshima-mura	do	8	Do.
Mito	Ibaragi	.8	<i>Erythrothoracis</i> .
Obukuro	Saitama	2.3	<i>Erythrothoracis</i> .
Sugano	Chiba	.6	Form not determined.
Kawasaki	Kanagawa	2.2	<i>Erythrothoracis</i> .
Takatsu	do	(1)	<i>Erythrothoracis</i> .
Mochimune	Shizuoka	.1	Typical species.
Togo	do	1.7	<i>Erythrothoracis</i> .
Yokoi-mura	Okayama	1.0	Both forms.
Shikoku:			
Sakamoto-mura	Kagawa	.9	Typical species.
Zota-mura	do	.2	<i>Erythrothoracis</i> .
Kyushu:			
Yukuhashi	Fukuoka	.8	Typical form (possibly both).
Chosen:			
Kaijo	Keikido	10.6	Both forms.
Suigen	do	2.4	Do.
Kaiganmen	Keisho Hokudo	3.7	Form not determined.
Taikyu	do	3.3	<i>Erythrothoracis</i> (possibly both).
Fusan	Keisho Nando	3.7	Both forms.

¹ No data. Reared only from larvae in cocoons collected under trap bands.

² Some specimens determined only as *P. vulnerator*; records do not indicate the form.

The survey collections indicated that *Pristomerus vulnerator* is somewhat more abundant in Chosen than in Japan as a parasite of the oriental fruit moth. This species was reared as a parasite of importance only at Kaijo, Chosen, where 10.6 percent of the fruit moth larvae reared from twigs collected June 21, 1932, were parasitized by it. It was reared from twig-infesting larvae collected from late in May to late in August, and there was little variation in the degree of parasitization by this species at different times during that period.

Attempts to rear *Pristomerus vulnerator* under laboratory conditions at Yokohama from fruit moth larvae of various instars feeding in peach twigs and just beneath the skin of apples gave entirely negative results. It is, however, an internal parasite of the immature larva of the fruit moth, and in general its habits and development are similar to those of *Inareolata molestae*. When confined in small wooden cages maintained at room temperature, about 65° to 85° F., and constantly provided with lump sugar and water, females of *P. vulnerator* remained alive as long as 49 days and males as long as 59 days. In rearings from survey collections 57.9 percent of the 159 adults that emerged from field-parasitized fruit moth larvae collected during 1932 and 1933 were females. Of 59 adults reared at Moorestown in 1933 from importations of field-collected fruit moth larvae 50.8 percent were females. When reared at Yokohama during the summer months from field-collected larvae the adult parasites emerged, on an average, 8.5 days after the date of parasite-cocoon formation.

Pristomerus vulnerator was first included in shipments forwarded from the Orient in 1933. Eleven adults were reared at Moorestown from all consignments of miscellaneous parasite cocoons. From all shipments of field-collected fruit moth larvae 59 adults of this species were reared, 44.1 and 55.9 percent of which emerged from larvae collected in Japan and Chosen, respectively. Only 70 adults, 36 of which were females, were obtained from all importations during 1933.

TACHINIDAE

Three species of dipterous parasites were reared from the oriental fruit moth in the Orient. These were all described by Aldrich (1) as new species, two in the genus *Elodia* and one in the genus *Phorocera*. The adults of *E. flavipalpis* and *E. subfasciata* are jet black. Adults of *P. pumilio* are also black, but with cinerous pollen on the head, mesonotum, and humeri, and at the bases of the abdominal segments. In the puparia of both species of *Elodia* the posterior stigmata are stalked and are located on a distinct protuberance, whereas in the puparia of *P. pumilio* the posterior stigmata are not stalked and protrude very slightly. Aldrich has shown that the two species of *Elodia* can be differentiated from each other by the yellow palpi and absence of discals on the intermediate abdominal segments of *flavipalpis*, whereas in *subfasciata* the palpi are black and discals are present on at least the third abdominal segment. Except for such observations as were made when rearing individuals from hosts parasitized in the field, little is known regarding the biology and habits of these flies.

All tachinids shipped originated from oriental fruit moth larvae parasitized in the field. No attempt was made at Moorestown to differentiate the species of flies reared from importations. All 3 species were very probably included, but *Elodia flavipalpis* undoubt-

edly occurred in greatest numbers. Only 3 flies emerged from host-free puparia included in shipments and 210 were reared at Moorestown from consignments of field-collected fruit moth larvae. Of these latter, 90.5 percent emerged from larvae collected in Japan and 9.5 percent from larvae collected in Chosen. Tachinids were included only in shipments forwarded during 1933, a total of 213 flies being obtained from all importations.

A considerable number of *Elodia* adults failed to mature properly upon emerging from the puparia, and as a result it was impossible, in many such instances, to obtain specific identification of these specimens. Records of the distribution and abundance are accurate, therefore, for the genus, but not for the individual species.

Elodia spp. were reared from fruit moth larvae in twigs collected from the islands of Honshu, Shikoku, and Kyushu and also from Chosen. The localities from which they were reared and the highest percentage of larvae parasitized by all species of *Elodia* in any collection of infested twigs from each locality are as follows:

Honshu:	Highest percentage of parasitization	Honshu—Continued	Highest percentage of parasitization
Yamagata:		Shizuoka:	
Sakata.....	2.3	Okitsu.....	(¹)
Tendo-mura.....	.8	Togo.....	2.8
Yamagata.....	.9	Osaka:	
Miyagi:		Kono-mura.....	2.9
Miya-mura.....	.9	Okayama:	
Niigata:		Mantomi-mura.....	(²)
Kakizaki.....	1.8	Saiden.....	.9
Kariha-mura.....	3.5	Hiroshima:	
Fukushima:		Hiro-mura.....	1.7
Date-mura.....	2.6	Tottori:	
Hirakubo-mura.....	3.4	Tottori.....	1.1
Nagano:		Shikoku:	
Kamisuwa.....	(¹)	Kagawa:	
Mitsuoka-mura.....	.6	Danshi-mura.....	.6
Nakazato-mura.....	5.3	Zota-mura.....	1.7
Oshima-mura.....	8.5	Ehime:	
Saitama:		Dogo.....	.3
Fujitsuka.....	7.6	Kyushu:	
Masubayashi.....	(¹)	Fukuoka:	
Obukuro.....	19.7	Yukuhashi.....	1.1
Osawa.....	20.6	Oita:	
Tokyo:		Osada.....	1.2
Todoroki.....	(¹)	Chosen:	
Kanagawa:		Keikido:	
Ninomiya.....	1.2	Kaijo.....	3.1
Noborito.....	1.3	Sosha.....	.3
Shikugawara.....	1.0	Keisho Hokudo:	
Takatsu.....	.3	Taikyuu.....	2.1
Tsunashima.....	1.7		

¹ Reared only from fruit moth cocoons collected under trap bands.

² Reared only from fruit moth cocoons in corrugated-paper strips pinned to trees.

Specimens definitely identified as *Elodia flavipalpis* were reared from each of the localities listed with the exception of Yamagata, Noborito, Tsunashima, Mantomi-mura, and Dogo. All the specimens from Tendo-mura, Ninomiya, Takatsu, Kono-mura, Tottori, Danshi-mura, Osada, and Sosha were of that species. *E. flavipalpis* is unquestionably the most important species of *Elodia* parasitic on the fruit moth in Japan and Chosen.

Specimens identified as *Elodia subfasciata* were reared from Sakata, where this species was more abundant than *E. flavipalpis* in a collection of infested twigs obtained July 5, 1932. One specimen of *E. subfasciata* also emerged from hibernating cocoons of the fruit moth collected in April 1933 from quince bark at or near Kamisuwa in the vicinity of Lake Suwa, Nagano.

Elodia spp. were reared as the dominant parasites in 17 collections from 15 localities. The larvae develop as solitary internal parasites of the larva of the oriental fruit moth. The reddish-brown parasite puparium is usually formed within the pupa of the fruit moth, but occasionally occurs within the mature larva of the host. The posterior stigmata of the puparium are black, stalked, and protrude through the shell or skin of the host. Those of *E. flavipalpis* are about one-third longer and are more claviform than those of *E. subfasciata*.

The tachinid *Phorocera pumilio* Ald. is rather widely distributed in Honshu and was also reared from Shikoku and from the southern portion of Chosen. It occurred as a parasite of twig-infesting larvae of the oriental fruit moth collected at various localities from late in May to August, but was of decidedly minor importance in all instances. It was reared from the following localities:

	Highest percentage of parasitization		Highest percentage of parasitization
Honshu:		Honshu—Continued	
Yamagata:		Okayama:	
Sakata.....	0.1	Niiyama-mura.....	0.3
Nagano:		Hiroshima:	
Mitsuoka-mura.....	1.3	Koi.....	.7
Oshima-mura.....	.2	Shikoku:	
Saitama:		Kagawa:	
Fujitsuka.....	1.5	Zota-mura.....	1.5
Osawa.....	1.9	Chosen:	
Yamanashi:		Keisho Hokudo:	
Nishino.....	.4	Kaiganmen.....	1.9
		Keisho Nando:	
		Kito.....	.8

The larva of *Phorocera pumilio* develops as an internal parasite of the fruit moth larva. The yellowish-brown parasite puparium is usually formed within the pupa of the host. The posterior stigmata of the puparium are not stalked and barely protrude from the surface. Observations on individuals reared at Yokohama during June and July 1932, from fruit moth larvae parasitized in the field indicated that the adult of *P. pumilio* emerged, on an average, 7 to 8 days after the parasite puparium was first noted in daily examinations of the host cocoons.

PARASITES OF THE STAGES WITHIN THE COCOON

Thirty-eight species of parasites that attack the oriental fruit moth after the mature larva has spun its cocoon were reared from this host in the Orient during 1932 and 1933. Nineteen species were reared only as primary parasites, 3 species were reared to the adult stage as primary parasites only although in laboratory tests they attacked and destroyed certain primary parasites from which their progeny failed to complete development as true secondary parasites, 2 species were reared only as secondary parasites, 11 species were reared as primary

parasites and also as secondary parasites either under field conditions or in tests conducted in the laboratory, and the relationship to the host was not determined in the case of 3 species.

Goniozus sp.

One fruit moth larva, within a cocoon collected from trap bands at Ninomiya, Kanagawa, on July 30, 1933, was parasitized by a species of *Goniozus*. When collected, five small parasite larvae were present within the host cocoon along with the remains of the larva from which they had developed as primary parasites. All emerged as adults 5 days later.

Perisierola n. sp.

Another bethylid, identified by Muesebeck as a new species of *Perisierola*, was reared only from fruit moth cocoons in corrugated-paper strips pinned to trees during 1933. So far as known, it is limited in distribution to the southern part of Honshu, where it was reared from cocoons exposed at Kurashiki (3.7-percent parasitization), Mantomi-mura (2.9), Nishiyama-mura (5.2), and Yokoi-mura (2.9), all in Okayama Prefecture. Cocoons were exposed in Okayama Prefecture from July 18 to August 30 and this parasite was active throughout that entire period.

Perisierola is a primary parasite of the mature larva of the oriental fruit moth in the cocoon. The following observations were made in connection with the breeding of this parasite under laboratory conditions at Yokohama during August and September 1933: The small, black adults are very active. Their ability to run quickly, fly upon the slightest provocation, and work their slender, elongated bodies through even finely woven cheesecloth makes the handling of adults difficult. In attacking the host larva the female parasite first chews her way into the cocoon. All hosts attacked by this species became paralyzed. Although stinging was not actually observed, other species of Bethyilidae and also of this same genus are known to paralyze the host by stinging. Before ovipositing, the female parasite spends a considerable amount of time biting at the larva with her strong mandibles. In one instance under observation, the biting process continued for more than 24 hours, interspersed with periods of rest.

The eggs, which are minute and hardly visible to the naked eye, are milky white, elongated, and slightly broader at one end than at the other. They are deposited in a cluster or row externally upon the body of the paralyzed fruit moth larva. The egg is firmly attached at its broadest end to the dorsal or lateral surfaces of the host larva, usually from about the third to the ninth body segment, and when touched lightly with a needle the opposite end of the egg rises clear. From 5 to 13 eggs have been observed upon a single host, but it is not known whether all were deposited by 1 female. However, a single female has been known to deposit as many as 8 eggs upon 1 host and 6 of these were reared to maturity. One female was observed to paralyze 3 oriental fruit moth larvae and deposit a total of 16 eggs upon the 3 hosts over a period of 12 days. Another female also paralyzed 3 larvae, on 2 of which she deposited a total of 15 eggs.

The yellowish parasite larvae develop externally on the host. While feeding, the head is inserted into the body of the host, apparently at the same spot where the egg was attached, but the body often extends outward from the host at an acute angle. In 3 or 4 days the parasite

larvae become full grown, and the body of the host has usually become almost completely desiccated. The parasite larvae then construct small, white, cottony cocoons within the fruit moth cocoon. The life cycle for this species reared in the laboratory, at temperatures ranging from 68° to 89° F., from fruit moth larvae parasitized September 9 and 11, averaged 12.5 days; and from hosts parasitized on September 23 and 25 at from 62° to 78° it averaged 27 days. The life cycle of *Perisierola* reared from hosts parasitized in the field during July and August closely approximated the former average insofar as could be determined.

From 1 to 12, an average of 6, adults of *Perisierola* emerged from oriental fruit moth larvae parasitized in the field. Adults of both sexes often developed from the same host, whereas in other instances all adults produced from a single host would be either males or females. Adults confined in small glass vials without food or water were kept alive as long as 35 days in an ordinary ice refrigerator at 53° to 62° F. The stage in which this parasite hibernates has not been determined. This species was reared from the field only as a primary parasite of *Grapholitha molesta* larvae in cocoons, and in laboratory tests it showed no inclination to attack cocoons of *Inareolata molestae*, *Phanerotoma grapholithae*, *Pristomerus vulnerator*, *Bassus diversus*, or pupae of *G. molestae*.

One consignment containing 36 laboratory-reared cocoons of this species of *Perisierola* was brought from Yokohama to Moorestown by the writer on his return to the United States during the winter of 1933-34. No emergence was obtained from these cocoons.

CLINOCENTRUS n. sp.

Two males and one female identified by Muesebeck as a new species of *Clinocentrus* were reared from cocoons of *Grapholitha molesta* collected in trap bands at Obukuro, Saitama, in August and September 1932. These developed as solitary primary parasites, the adult parasite emerging in each instance from the inflated body of the mature fruit moth larva. The stage in which these attacked the host is not known, as parasitization may have occurred either while the larvae were feeding or after they had become mature and formed their cocoons.

METEORIDEA n. sp.

Two males, identified by Muesebeck as a new species of *Meteoridea*, were reared from oriental fruit moth cocoons that had been formed in corrugated-paper strips and later pinned to trees in Japan and Chosen in 1933. Both emerged as primary parasites from the pupal stage of the host, one from cocoons exposed at Mitsuoka-mura, Honshu, during the period July 28 to August 1, and the other from cocoons exposed at Heitaku, Chosen, from August 12 to 16. The host in each instance originated from field collections of infested twigs, and it is possible that parasitization might have occurred previous to the time the cocoon was exposed. However, since this braconid was not reared as a larval parasite from extensive collections of twig-infesting larvae, it is probable that parasitization occurred during the time the host cocoons were exposed.

CALLICERAS n. sp.

A parasite identified by Muesebeck as a new species of *Calliceras* was frequently reared from cocoons of the oriental fruit moth in Japan and Chosen from the following localities:

Honshu:	Chosen:
Nagano:	Keikido:
Kamisuwa.	Anyo.
Mitsuoka-mura.	Ensenri.
Saitama:	Heitaku.
Obukuro.	Keijo.
Kanagawa:	Sosha.
Motosumiyoshi.	Suigen.
Okayama:	
Mantomi-mura.	

It occurred most abundantly at Suigen, where it was reared from 6.6 percent of the cocoons collected from bands and from 0.9 percent of those pinned to trees during 1933. Parasitization by this species in all cocoons reared from other localities was considerably less than 1 percent.

This species of *Calliceras* is principally a secondary parasite of *Grapholitha molesta*, as evidenced by the fact that it was reared as such from 82 (96.5 percent) of the 85 fruit moth cocoons parasitized by it. In the 3 instances in which it occurred as a primary parasite, the adults emerged from the pupal stage of the fruit moth. Its known hosts as a secondary parasite are *Inareolata molestae*, *Pristomerus vulnerator*, and *Perisierola* n. sp. In one instance nine adults of *Perisierola* n. sp. were reared from a fruit moth larva in the cocoon and 2 adults of *Calliceras* n. sp. emerged from cocoons of the primary species. From 1 to 26 adults of this new species of *Calliceras* were reared from a single host, the average emergence from 84 hosts being 10.5 parasites. No record was made of the proportion of sexes produced.

CALLICERAS sp.

Twenty-three adults, identified as another undetermined species of *Calliceras*, emerged as secondary parasites from one cocoon believed to be *Bassus* sp. reared from fruit-moth cocoons in corrugated-paper strips pinned to trees at Mitsuoka-mura, Nagano, in August 1933.

ANTROCEPHALUS n. sp.

A chalcidid, reared from oriental fruit moth cocoons in corrugated-paper strips pinned to trees in Okayama Prefecture, Japan, in 1933, was identified by Gahan as a new species of *Antrocephalus*. It was reared from two localities, Kurashiki and Mantomi-mura, and occurred only in cocoons exposed during the latter half of August. Cocoons in lots that remained pinned to the trees for 4 days were exposed at Kurashiki continuously from August 6 to 30, but parasitization by this species first occurred in those exposed on August 18 and continued in all subsequent lots. At Mantomi-mura cocoons in lots that remained pinned to the trees for periods of 3 or 4 days were exposed continuously from July 18 to August 30, but *Antrocephalus* was reared only from those exposed during the period August 20 to 28. This species

parasitized from 15.2 to 26.7 percent of the cocoons in the lots that were exposed on different dates during the period of its occurrence at Kurashiki, but only 1.9 to 2.4 percent of the cocoons in the lots that were exposed on different dates at Mantomi-mura. This parasite was reared from 15.5 percent of all cocoons exposed at Kurashiki and from 0.3 percent of all cocoons exposed at Mantomi-mura.

Antrocephalus was reared as a primary parasite of the oriental fruit moth and no indication of secondary parasitism was noted in rearings of this species from cocoons parasitized in the field. In laboratory tests it showed no inclination to attack cocoons of *Inareolata molestae*, *Bassus* sp., *Aenoplex molestae*, or fruit-moth pupae previously parasitized by *Phaeogenes haussleri*. The egg of *Antrocephalus* is deposited internally in the fruit-moth pupa and the species develops as an internal solitary parasite of the pupal stage of the host. The parasite issues by breaking off the entire anterior end of the pupal shell of the host. When this species of *Antrocephalus* was reared from fruit-moth pupae in cocoons attacked in the field, 74.0 and 88.9 percent of the adults that emerged from cocoons exposed at Kurashiki and Mantomi-mura, respectively, were females. This species hibernates as a full-grown larva within the pupal shell of the host.

BRACHYMERIA EXCARINATA Gahan

The chalcidid *Brachymeria excarinata* was reared as a parasite of oriental fruit moth cocoons spun in corrugated-paper strips and pinned to trees in Obukuro, Yoga, Ninomiya, Okurayuma, and Mantomi-mura in Honshu; and in Zota-mura in Shikoku.

Although it occurred in all instances as a primary parasite, *Brachymeria excarinata* was of only minor importance and parasitized less than 1 percent of all cocoons exposed at each of the above localities. In laboratory tests *B. excarinata* showed no inclination to attack either mature larvae or pupae of *Grapholitha molesta*, cocoons of *Inareolata molestae*, or larvae of *Aenoplex* sp., either naked or enclosed in cocoons. When reared from hosts parasitized in the field it always emerged as a solitary parasite from the pupal stage of the fruit moth. The parasite adult issues through a small hole chewed in the ventral portion of the host pupa near the anterior end. At Mantomi-mura the sexes emerged in equal numbers, but males predominated at all other localities. Of all adults reared during the 2 years, 34.3 percent were females.

HALTICHELLA n. sp.

Another chalcidid, identified by Gahan as *Haltichella* n. sp., very close to *maculipennis* De Stefani, is one of the more common parasites of oriental fruit moth stages in the cocoon in Japan and Chosen. It was reared during both years from cocoons of the summer generations collected from trap bands and bark, and also from those exposed in corrugated-paper strips pinned to the trees; but it was not reared from cocoons of hibernating fruit moths. *Haltichella* is widely distributed, as is indicated by the fact that it was present in each of the nine Prefectures scouted for cocoon parasites. All the localities from

which this species was reared and the percentage of cocoons parasitized by it are listed below.

Honshu:	Percentage of cocoons parasitized	Honshu—Continued.	Percentage of cocoons parasitized
Nagano:		Shizuoka—Continued.	
Mitsuoka-mura.....	3.8	Miho.....	2.7
Nagano.....	3.3	Okitsu.....	1.2
Saitama:		Okayama:	
Obukuro.....	6.1	Kurashiki.....	14.6
Chiba:		Mantomi-mura.....	3.7
Sugano.....	18.5	Nishiyama-mura.....	8.6
Tokyo:		Saiden.....	2.6
Komazawa.....	2.8	Yokoi-mura.....	2.9
Kanagawa:		Shikoku:	
Motosumiyoshi.....	.6	Kagawa:	
Ninomiya.....	1.4	Zota-mura.....	15.1
Okurayama.....	.6	Chosen:	
Takatsu.....	5.5	Keikido:	
Shizuoka:		Ensenri.....	5.0
Hara.....	19.4	Keijo.....	.4
Makado.....	3.2	Suigen.....	.6

Haltichella occurred chiefly as a primary parasite of the oriental fruit moth. Only 1.6 percent of 951 individuals reared from field-parasitized fruit-moth cocoons emerged as secondary parasites, coming from the cocoons of *Inareolata molestae*, *Pristomerus vulnerator*, and *Apanteles* sp. It was also reared as a secondary parasite from a cocoon of *Phanerotoma grapholithae* attacked under laboratory conditions. When the adult emerged as a primary parasite, it was always from the pupal stage of the host although, under laboratory conditions, females were observed to attack both mature larvae and pupae of *Grapholitha molesta*. The complete life cycle averaged 18 days at temperatures of 73° to 88° F. When this species was reared from hosts parasitized in the field, 76.5 percent of 726 adults were females. Equal numbers of the sexes emerged when small numbers of this species were reared from the fruit moth under laboratory conditions.

PLEUROTROPIS NAWAII (Ashm.)

Pleurotropis nawai was reared as a parasite of fruit-moth stages in the cocoons in corrugated-paper strips pinned to trees at Mantomi-mura in Honshu, where it attacked four of the cocoons exposed during August 1933. It occurred once as a primary pupal parasite of the oriental fruit moth and three times as a secondary parasite of cocoons of *Perisierola* n. sp. When reared as a secondary parasite from *Perisierola*, *Pleurotropis nawai* did not always parasitize all individuals of the primary parasite. Adults of both species were reared from the same fruit-moth cocoon in two instances, those of *Perisierola* emerging as primary parasites of the mature fruit-moth larva and those of *Pleurotropis nawai* emerging as secondary parasites from *Perisierola* cocoons. Only one adult of *Pleurotropis nawai* emerged from the fruit-moth pupa that was attacked by this species, and examination of parasitized *Perisierola* cocoons indicated that probably only one adult of *Pleurotropis* emerged from each cocoon of that host.

EUPELMUS FORMOSAE Ashm.

Eupelmus formosae is a parasite of the oriental fruit moth in the cocoon in both Japan and Chosen. It was reared from cocoons collected from trap bands and also from those in corrugated paper pinned

to trees at Mitsuoka-mura, Nagano, Toyoda-mura, Masubayashi, Motosumiyoshi, Takatsu, and Tsunashima, in Honshu; and from Sossa and Suigen in Chosen. This species is of minor importance as a parasite of fruit-moth cocoons, but 2.7 and 3.5 percent, respectively, of all fruit-moth cocoons reared at Mitsuoka-mura and at Suigen during 1932 and 1933 were parasitized by it.

Eupelmus formosae develops as a solitary internal parasite of the host and has been reared as a secondary parasite as well as a primary parasite of the fruit moth, showing little preference with regard to choice of host. It emerged as a primary parasite from 55.7 percent and as a secondary parasite from 44.3 percent of 255 fruit-moth cocoons attacked in the field at all localities during the 2 years. When reared as a primary parasite, *E. formosae* sometimes developed from the mature larva and at other times from the pupa of the host. It was reared as a secondary parasite from cocoons of *Inareolata molestae*, *Aenoplex* sp., *Pristomerus vulnerator*, and *Fhanerotoma grapholithae*, all parasitized by it in the field. Females of *E. formosae* greatly outnumbered the males, 93.6 percent of 250 adults reared from hosts parasitized in the field being females. This parasite hibernates within both the mature larva and the pupa of the fruit moth and also within the cocoons of several primary parasites of that host.

EURYTOMA APPENDIGASTER (Swed.)

Eurytoma appendigaster is one of the more common cocoon parasites of the oriental fruit moth in Japan and Chosen. This species was reared by the writer (?) as one of the principal parasites of the fruit-moth cocoons in France and Italy, and it has also been reared as a parasite of fruit-moth cocoons in the United States. The localities from which *E. appendigaster* was reared in the Orient during 1932 and 1933 and the percentage of all fruit-moth cocoons collected from trap bands and in corrugated-paper strips pinned to trees that were parasitized by it at each locality are indicated below.

Honshu:	Percentage of cocoons parasitized	Honshu—Continued.	Percentage of cocoons parasitized
Nagano:		Kanagawa—Continued.	
Kamisawa.....	4.9	Okurayama.....	1.7
Mitsuoka-mura.....	3.2	Takatsu.....	3.3
Nagano.....	2.2	Tsunashima.....	1.1
Nakasu.....	7.6	Shizuoka:	
Oshima-mura.....	1.7	Okitsu.....	2.1
Shimosuwa-cho.....	8.9	Togo.....	1.0
Toyoda-mura.....	4.7	Okayama:	
Saitama:		Mantomi-mura.....	.2
Obukuro.....	3.5	Shikoku:	
Chiba:		Kagawa:	
Sugano.....	2.6	Zota-mura.....	.1
Tokyo:		Chosen:	
Higashinaganuma.....	1.1	Keikido:	
Komazawa.....	2.4	Anyo.....	1.0
Yoga.....	3.7	Heitaku.....	10.3
Kanagawa:		Keijo.....	1.6
Motosumiyoshi.....	2.9	Sossa.....	25.0
Ninomiya.....	.5	Suigen.....	17.1

Reared only from cocoons of the hibernating fruit moth.

This parasite was rarely reared from the cocoons of hibernating fruit moths collected from bark. It parasitized only 0.1 percent of several hundred individuals reared from such cocoons collected at

Kamisawa in March and April 1932, and also emerged from one of two such cocoons collected at Higashinaganuma in March of that year.

Eurytoma appendigaster emerged as a primary parasite from 42.2 percent and as a secondary from 57.8 percent of the cocoons attacked by it in the field in Japan and Chosen. It was reared as a hyperparasite from cocoons of *Inareolata molestae*, *Aenoplex* sp., *Pristomerus vulnerator*, *Phanerotoma grapholithae*, and *Apanteles* sp., and from those of a braconid which was either *Eubadizon extensor* or *Macrocetrus thoracicus*. As a primary parasite, *E. appendigaster* developed from either the mature larva or the pupa of the fruit moth. As a secondary parasite, the adults always emerged from the cocoon of the primary species. Usually only 1 adult was reared from each host, but in 1 instance 4 males emerged from the same fruit moth pupa and on another occasion 2 females emerged as secondaries from 1 cocoon of *P. vulnerator*. One instance of multiple parasitism was noted, in which 1 female of *E. appendigaster* and 2 adults of *Tetrastichus ibseni* all emerged as primary parasites from the same fruit moth pupa. *E. appendigaster* has been observed to hibernate successfully in both mature larvae and pupae of *Grapholitha molesta*, and also within the cocoons of *I. molestae*, *P. grapholithae*, and *Apanteles* sp. Females of *E. appendigaster* predominated, 79.9 percent of 1,350 adults reared from hosts parasitized in the field being of that sex.

AENOPLEX MOLESTAE (Uchida)

A parasite, described by Uchida (14) as a new species, *Hemiteles (Isadelphus) molestae*, was transferred by Cushman (5) to the genus *Aenoplex*. Cushman says (5, p. 549):

This Japanese parasite of *Grapholitha molesta* (Busek) is very similar to the American parasite of the same host, *Aenoplex betulaecola* Ashmead, but is easily distinguished by its dorsally more shining thorax and abdomen, and the distinct white base of the hind tibia.

Aenoplex molestae was reared from cocoons of hibernating fruit moths collected from bark and also from those of the summer generations collected from trap bands and exposed in corrugated-paper strips pinned to trees. It was reared only from Honsu and emerged from cocoons parasitized at Kamisawa, Kyowa-mura, Mitsuoka-mura, Nagano, Nakasu, Shimosuwa-cho, Toyoda-mura, Yawate, Ninomiya, Noborito, Shimosoga, and Okitsu.

Parasitization by this species ranged from 0.6 to 7.2 percent of the fruit moth cocoons obtained from all sources during 1 or both years at those localities from which the total emergence from all cocoons collected exceeded 100 individuals.

Aenoplex molestae occurred only as a primary parasite when reared from fruit moth cocoons parasitized in the field. It was reared from both the mature larval and pupal stages of that host. Mating occurred readily when adults were confined in small cages. The egg is deposited within the cocoon of the fruit moth but external to the host. Females have been observed to pierce through corrugated paper with the ovipositor in order to oviposit within fruit moth cocoons spun in the corrugations. The larva develops as an ectoparasite, and when full-grown constructs its cocoon within that of the fruit moth beside the remains of the host. Only 1 parasite was produced from each host. When reared from cocoons of fruit moths hibernating in the field and from those collected under trap bands, 62.7 percent of 83 parasites that

emerged were females. When reared from cocoons in corrugated-paper strips pinned to trees, the sex ratio was practically reversed, only 37.6 percent of 165 emerged parasites being females. Only 1 (3 percent) of 33 parasites bred under laboratory conditions was a female.

One consignment of 295 host-free parasite cocoons, identified as those of *Aenoplex molestae*, originating from cocoons of hibernating fruit moths collected from quince bark in the vicinity of Lake Suwa, Nagano, was forwarded to Moorestown in 1933, and from these 208 adults of *A. molestae* were reared. A second consignment of 103 laboratory-reared cocoons and 3 males of this species was forwarded later in the same season, and from the cocoons 30 adults were obtained at Moorestown. The 3 males included in the latter consignment survived shipment in the adult stage. A total of 241 adults (113 females) of *A. molestae* were obtained at Moorestown from all importations. The purpose of these shipments was to furnish material for study, under quarantine conditions at Moorestown, of the reactions of this parasite to the native and introduced parasites of the fruit moth. The workers at Moorestown (2) found that *A. molestae* would attack cocoons of *Glypta rufiscutellaris* and *Calliephialtes* sp. as readily as those of the fruit moth and reared it as a secondary parasite from both species. The entire stock of *A. molestae* was therefore destroyed and importations were discontinued.

AENOPLEX spp.

Three undetermined species of *Aenoplex* were reared as parasites of the oriental fruit moth in Honshu. For convenience these are designated in this bulletin as species A, species B, and species C. They emerged only from cocoons of hibernating fruit moths collected from bark. Species A was reared from Ninomiya and Shimosoga. Species B and C were both reared from the quince district near Lake Suwa and from Ninomiya. All three species are apparently only occasional parasites of the fruit moth, the percentage of cocoons from which each species was reared being extremely low at each locality. All emerged as primary parasites insofar as could be determined from examination of the available host remains.

CAENOCRYPTUS n. sp.

Four females and six males, identified by Muesebeck as *Caenocryptus* n. sp., were reared at Moorestown in 1933 from a shipment of *Aenoplex* cocoons that originated from cocoons of hibernating fruit moths collected from quince bark in the vicinity of Lake Suwa. This is the only record of this species. It is not known whether the adults emerged as secondary parasites from the *Aenoplex* cocoons or whether they were primary parasites of the fruit moth having cocoons resembling those of *Aenoplex*.

CALLIEPHIALTES spp.

Certain ichneumonid specimens reared from cocoons of *Grapholitha molesta* collected in Honshu were identified by Uchida (14) as *Ephialtes laspeyresiae* Uchida. Cushman (5) placed these in the genus *Calliephialtes* and points out that were it not for a very distinct difference in the male genitalia he would be inclined to consider this and *C. benefactor* Cush., an American parasite of the same host, no more than

racés of the same species. In correspondence he has indicated that the males bred from the fruit moth in Japan divide into two groups on the color of the antennae and apparently differ also in the form of the genital sheath, but there appears to be no character by which the females can be separated into two groups. Specimens of both sexes with the underside of the antennae pale he has identified as *C. laspeyresiae* (Uchida), while males with the underside of the antennae dark, he holds separate as *Calliephialtes* sp.

Parasites of the genus *Calliephialtes* were reared only from cocoons of hibernating fruit moths from quince trees in the district surrounding Lake Suwa and from peach and sand pear trees at Ninomiya, Kanagawa. Specimens definitely identified as *C. laspeyresiae* and also those which Cushman holds separate as *Calliephialtes* sp. were reared from both localities. Uchida also records *Ephialtes laspeyresiae* from Aomori.

Although these species of *Calliephialtes* occur only as primary parasites of the oriental fruit moth, they are not of very great importance as such in Japan. In rearings from all cocoons of hibernating fruit moths collected from the Lake Suwa district and from Ninomiya during the winters of 1931-32 and 1932-33 only 0.6 percent of approximately 26,900 individuals reared from the former locality and 7.9 percent of 139 individuals reared from the latter locality were parasitized by this genus. The males of *Calliephialtes* spp. greatly outnumbered the females. Of 120 adults reared at Yokohama and Moorestown from cocoons collected in the field in Japan only 15 percent were females. *Calliephialtes* bred under laboratory conditions at Yokohama and shipped to Moorestown for emergence ran entirely to males.

Two consignments of *Calliephialtes* spp. were forwarded to Moorestown in 1933. The first shipment included 155 host-free parasite cocoons obtained from the field, and from these 103 *Calliephialtes* were reared at Moorestown. The second shipment contained 6 males and 32 parasite cocoons bred in the laboratory at Yokohama. Four of the adults survived shipment and 27 additional males were reared from the cocoons. A total of 134 *Calliephialtes* adults, only 17 of which were females, were obtained at Moorestown from all importations.

CRYPTUS SUZUKII (Mats.)

The males of an ichneumonid reared from *Grapholitha molesta* by the writer and from the same host and also from *Kakiroria flavofasciata* Nagano by others in Japan were described by Uchida (14) as a new species, *Habrocryptus yagai*, the female being unknown at that time. Cushman, who subsequently identified a larger series including both sexes reared from the fruit moth, considers this species synonymous with *Cryptus suzukii* (Mats.) and explains in correspondence as follows:

I am convinced of the correctness of the above synonymy, *yagai* being the male of *suzukii*. We have females from another source that are certainly *suzukii*, and I find no difference except in size between these and females from the peach moth.

Cryptus suzukii was reared by the writer only from the cocoons of hibernating oriental fruit moths collected in Honshu. It was reared from Nagano, Kamisuwa, Ninomiya, Noborito, Shimosoga, and Suzukawa. At Kamisuwa this parasite was reared from 0.2 percent of 927 hibernating fruit moths collected during March and April 1932, and from less than 0.1 percent of approximately 26,900 hiber-

nating fruit moths collected from that general vicinity during December and January of the following winter. At Ninomiya it was reared from 6.5 percent of 31 fruit moth cocoons collected in February 1932 and from 16.7 percent of 108 cocoons collected in March 1933. The number of cocoons containing hibernating fruit moths collected from the other localities was too small, in each instance, to furnish data of significance with regard to the percentage of parasitization by this species. Uchida (14) records a male of *Habrocryptus yagoi* from Sapporo on the island of Hokkaido, a male reared by M. Yago from *Grapholitha molesta* in Shizuoka Prefecture, and a male reared from Gifu by K. Murase from the cosmopterygid moth *Kakiroria flavofasciata* Nagano, a serious pest of the persimmon in Japan.

The stage of the host when attacked by *Cryptus suzukii* was not determined. The cocoon of the parasite was usually present within the cocoon of the fruit moth at the time these were collected in the field, the parasite apparently having developed from the mature larva of the host. Only one adult of this species emerged from each parasitized host. Males predominated, only 12.2 percent of 49 adults reared from cocoons collected at all localities being females. *C. suzukii* was reared only as a primary parasite of the fruit moth, and there was no evidence to indicate that this species might also occur as a hyperparasite.

EPHIALTES DISPARIS (Vier.)

Four specimens of the ichneumonid *Ephialtes disparis* were reared from Honshu in 1933 as primary parasites of the cocoon stage of the oriental fruit moth. One emerged from a hibernating cocoon collected in January from the Lake Suwa district, two emerged from similar cocoons collected in March at Ninomiya, and one emerged from a summer cocoon taken under a trap band at Nakasu, Nagano, in August. Those from hibernating cocoons developed as internal parasites of the mature fruit moth larvae, the distended bodies of the host larvae serving as the cocoons from which the adult parasites emerged. The single specimen reared from a summer cocoon developed in the pupal stage of the host, the pupal shell serving as the cocoon from which the adult parasite emerged. Only males were obtained. This species is apparently not a common parasite of the oriental fruit moth.

EPHIALTES n. sp.

Another species of *Ephialtes*, identified by Cushman as new, was more frequently reared as a parasite of fruit moth cocoons in Japan. It was reared only from cocoons in corrugated-paper strips pinned to trees at 3 localities in Honshu, namely, Mitsuoka-mura, Nagano, and Obukuro. At Mitsuoka-mura 0.8 percent of the cocoons exposed during 1932 and 1.7 percent of those exposed during 1933 were parasitized by this species. At Nagano it attacked 6.7 and 1.5 percent, respectively, of the cocoons exposed during the 2 seasons, and at Obukuro it parasitized 0.5 percent of the cocoons exposed during 1932. This *Ephialtes* was reared only as a primary parasite of the oriental fruit moth and in every instance the adult parasite emerged from the pupal stage of the host. The fact that all the 99 individuals reared were males suggests the possibility that *Grapholitha molesta* may not be a suitable host of this parasite.

EPIURUS GLYCINEVORELLAE Uchida

Two females of the ichneumonid *Epiurus glycinevorellae* emerged from cocoons of hibernating fruit moths collected at Ninomiya in March 1933. This is the only information available with regard to the occurrence of this species as a parasite of *Grapholitha molesta*.

EPIURUS VESICARIUS (Ratz.)

One female of *Epiurus vesicarius* emerged at Moorestown from a shipment of parasite cocoons identified as those of *Aenoplex* sp., reared from cocoons of hibernating fruit moths collected in the quince district near Lake Suwa in 1933. This is the only instance in which this parasite was reared, and it is suspected that the single individual may have emerged as a secondary parasite from an *Aenoplex* cocoon.

? HEMITELES BICOLORINUS GRAY.

Cushman tentatively identified certain ichneumonid specimens reared in small numbers from cocoons of *Grapholitha molesta* collected in Honshu as *Hemiteles bicolorinus* Gray. These specimens were reared from 9.7 percent of the cocoons of hibernating fruit moths collected in February 1932, and from 8.3 percent of those collected in March 1933 at Ninomiya. Others were reared from 1.2 percent of the fruit moth cocoons collected at Shimosuwa-cho in August 1933. The host relationship could not be determined definitely for specimens reared from Ninomiya, but both of the two specimens reared from Shimosuwa-cho emerged as secondary parasites from cocoons of *Aenoplex* sp. Fourteen individuals, identified, with a query, as *H. bicolorinus* were reared and all were females.

? HEMITELES PULCHELLUS GRAY.

Other ichneumonid specimens, tentatively identified as *Hemiteles pulchellus* Gray., were more widely distributed as parasites of *Grapholitha molesta* and were reared from Honshu and Chosen. These specimens were reared, however, only from fruit moth cocoons in corrugated-paper strips pinned to trees. They attacked cocoons exposed at Mitsuoka-mura, Nagano, Obukuro, Komazawa, Moto-sumiyoshi, Okurayama, and Tsunashima in Honshu; and at Heitaku, Keijo, and Suigen in Chosen. At Suigen, 1.7 percent of all cocoons exposed during 1933 were parasitized by this species, but less than 1 percent of all cocoons exposed at each of the other localities were parasitized by it.

Hemiteles pulchellus was reared both as a primary and as a secondary parasite from cocoons of the oriental fruit moth. It emerged as a primary parasite from 47.5 percent and as a secondary from 52.5 percent of the hosts attacked by it in the field. From Japan it was reared only as a primary parasite, but in Chosen it was found as a primary parasite of the fruit moth and also as a secondary parasite from cocoons of *Inareolata molestae* and *Pristomerus vulnerator*. In laboratory tests, females of *H. pulchellus* were observed to attack cocoons of *I. molestae*, first paralyzing the larvae and then depositing eggs externally upon them. When oriental fruit moth pupae and cocoons of *I. molestae* were equally accessible in small cages, females of *H. pulchellus* showed a preference for attacking the *Inareolata* cocoons.

As a primary parasite, the larva developed as an ectoparasite, sometimes from the mature larva and at other times from the pupa of the host, the thin and transparent but strong cocoon of the parasite being formed within the fruit moth cocoon beside the remains of the host. When reared as a secondary parasite, the cocoon of the primary species served as the cocoon of *H. pulchellus*. Of 80 adults reared from hosts parasitized in the field, 88.8 percent were females.

HEMITELES spp.

Two undetermined species of *Hemiteles* were reared from cocoons of the oriental fruit moth, both being recorded only from cocoons in corrugated-paper strips pinned to trees in 1933. For convenience these are designated as *Hemiteles* A and *Hemiteles* B.

Hemiteles A was reared only from Mitsuoka-mura, where it parasitized less than 1 percent of all fruit moth cocoons exposed, although this parasite was active during practically the entire period of exposure, July 28 to September 4, inclusive. This species was reared only as a primary parasite and, insofar as could be determined from examination of available host remains, it developed only from the pupal stage of the host. Females predominated. 13 (81.3 percent) of the 16 specimens reared from hosts parasitized in the field being of that sex.

Hemiteles B was reared from Mitsuoka-mura and Okurayama in Honshu and from Suigen in Chosen. Less than 1 percent of all cocoons exposed at each of those localities was parasitized by this species. At Mitsuoka-mura it was active at least throughout the entire month of August, at Okurayama it was active only during the middle of August, although cocoons were exposed almost continuously from June 1 to August 23, and at Suigen this species appeared only after August 20, although cocoons were exposed from July 15 to August 28. In Japan *Hemiteles* B was reared only as a primary parasite from both the mature larval and pupal stages of the fruit moth. Only 2 specimens were reared from Chosen and both emerged as secondary parasites from cocoons of *Inareolata molestae*. Of 24 adults reared, 91.7 percent were females, the only males being the 2 specimens that emerged as secondary parasites.

HERPESTOMES sp.

Two males, identified as *Herpestomus* sp., emerged as primary parasites from pupae of *Grapholitha molesta* collected in August 1933 from trap bands at Shimosuwa-cho, Honshu.

ISCHNUS n. sp.

An ichneumonid identified by Cushman as a new species of *Ischnus* occurs in Honshu and Chosen as a parasite of cocoons of the oriental fruit moth. It was chiefly reared from cocoons in corrugated-paper strips pinned to trees, but occasionally occurred in those taken from trap bands. This parasite was reared from Mitsuoka-mura, Nagano, and Sugano in Honshu; and from Soshu, and Suigen in Chosen. It occurred most abundantly at Mitsuoka-mura, where it parasitized 3.1 percent of all cocoons in corrugated-paper strips pinned to trees in 1933 and was active at least throughout all of August. It was taken only occasionally and in small numbers from the other localities.

From cocoons parasitized in the field this species of *Ischnus* was reared only as a primary parasite of the pupal stage of *Grapholitha molesta*. The white, semitransparent cocoon was usually constructed within the pupal shell of the host which, being smaller than the contained parasite cocoon, became greatly distended and broken. In laboratory tests this parasite was observed to attack cocoons of *Inareolata molesta* and also fruit moth pupae previously parasitized by *Phaeogenes haeussleri*. The females of this new species of *Ischnus* punctured the cocoons or hosts of the primary parasites with their ovipositors, thereby causing the death, in almost every instance, of the parasite larvae or pupae within. It was not, however, successfully reared as a hyperparasite. Males of this species outnumbered the females, only 31.5 percent of 146 individuals reared from fruit moth cocoons parasitized in the field being females. The parasite hibernates as a mature larva within the pupa of the oriental fruit moth.

ISCHNUS sp.

One female and one male of an undetermined species of *Ischnus* were reared as primary parasites of fruit moth pupae within cocoons in corrugated-paper strips pinned to trees at Mitsuoka-mura in August 1933. The cocoon of this parasite is similar to that of *Ischnus* n. sp. and is similarly constructed within the pupal shell of the host.

ITOPLECTIS EPINOTIAE Uchida

Itopectis epinotiae is a frequent parasite of oriental fruit moth cocoons in several Prefectures in Honshu and also occurs in Chosen. Uchida (14) records this species from Sapporo, Hokkaido, and mentions it as a parasite of *Epinotia dimiana* Guen. It was reared most frequently as a parasite of fruit moth cocoons in corrugated-paper strips pinned to trees, but was also taken in cocoons of the summer generations collected from trap bands and from bark. The localities from which this parasite was reared and the percentage of all fruit moth cocoons found to be attacked by it in collections made from each locality are indicated below:

Honshu:	Percentage of cocoons parasitized	Honshu—Continued.	Percentage of cocoons parasitized
Nagano:		Tokyo:	
Kamisuwa.....	0.2	Komazawa.....	0.1
Mitsuoka-mura.....	20.6	Yoga.....	4.3
Nagano.....	.2	Kanagawa:	
Nakasu.....	.6	Motosumiyoshi.....	5.9
Shimosuwa-cho.....	.6	Takatsu.....	8.5
Toyoda-mura.....	1.4	Tsunashima.....	.7
Saitama:		Chosen:	
Obukuro.....	8.3	Keikido:	
		Suigen.....	.1

Itopectis epinotiae was reared from 1,260 fruit moth cocoons that were parasitized in the field during 1932 and 1933 and in every instance it occurred only as a primary parasite. In laboratory tests, however, females of this species were observed to attack cocoons of *Inareolata molesta* and *Apanteles* sp. Although no eggs of *I. epinotiae* were found in such cocoons, nor was the species reared as a hyperparasite, mortality of the primary parasites resulted in most instances. The *Itopectis* females were frequently observed feeding upon the exudation from ovipositor punctures made in *Inareolata* cocoons.

Itoplectis epinothiae was usually reared from the pupal stage of the fruit moth, but it also developed occasionally from the mature larva of that host. The adult parasite emerged from the pupal shell of the host or from the body of the mature host larva, depending upon the stage in which the host was parasitized. This species hibernated, under laboratory conditions, as a mature parasite larva within the pupal stage of fruit moths parasitized in the field. The sexes were produced in about equal proportions, 49.5 percent of 1,135 adults reared from fruit moth cocoons parasitized in the field during 1932 and 1933 being females.

PHAEOGENES HAEUSSLERI (Uchida)

The name *Phaeogenes haeussleri* was proposed by Uchida (15) for a species of *Phaeogenes* reared from cocoons of *Grapholitha molesta* in Japan and previously identified by him (14) as *P. japonicus* Ashmead. So far as known, this parasite occurs only in Japan. It was reared by the writer as a parasite of the oriental fruit moth from each of the Prefectures in Japan that were scouted for parasites that attack the cocoon stage of that host, namely, Nagano, Saitama, Chiba, Tokyo, Kanagawa, Shizuoka, and Okayama in Honshu, and Kagawa in Shikoku. Uchida records it as having been taken by others from the island of Hokkaido, from Aomori Prefecture in Honshu, and from Kumamoto Prefecture in Kyushu, the host from which it was reared in Aomori also being *G. molesta*. Adults of this species were also collected by the writer and his assistants in considerable numbers during the fall of 1933 from sweetpotato fields at Chigasaki, Kanagawa, and at Miho, Shizuoka. The localities from which *P. haeussleri* was reared as a parasite of *G. molesta* during the course of these investigations and the percentage of all fruit moth cocoons parasitized by it at each locality are as follows:

Honshu:	Percentage of cocoons parasitized	Honshu—Continued	Percentage of cocoons parasitized
Nagano:		Kanagawa—Continued.	
Kamisuwa.....	0.6	Noborito.....	3.1
Mitsuoka-mura.....	.3	Okurayama.....	7.4
Nagano.....	1.6	Takatsu.....	2.5
Saitama:		Tsunashima.....	1.2
Obukuro.....	5.7	Shizuoka:	
Chiba:		Chitsu.....	6.7
Sugano.....	9.0	Iogo.....	3.5
Tokyo:		Okayama:	
Komazawa.....	5.4	Mantomi-mura.....	.4
Todoroki.....	6.6	Nishiyama-mura.....	.4
Yoga.....	1.0	Shikoku:	
Kanagawa:		Kagawa:	
Motosumiyoshi.....	6.5	Zota-mura.....	.3
Ninomiya.....	1.0		

Phaeogenes haeussleri was of some importance as a parasite of fruit moth cocoons at most localities from which it was reared in the Prefectures of Saitama, Chiba, Tokyo, Kanagawa, and Shizuoka. It was of less importance in Nagano Prefecture and was of decidedly minor importance in the south of Japan in the Prefectures of Okayama and Kagawa. In Kanagawa, where comparable records were obtained from several localities for both years, parasitization by this species showed a considerable decrease in 1933 from that of the previous year.

This species was reared only as a primary parasite from 588 cocoons of the oriental fruit moth parasitized by it in the field during both

years. In laboratory tests at Yokohama, females showed no inclination to attack cocoons of *Inareolata molesta* or *Bassus diversus*. In its general habits and development *Phaeogenes haeussleri* was found to be similar to *P. nigridentis* Wesm., a European parasite of the European corn borer (*Pyrausta nubilalis* (Hbn.)); the biology of the latter parasite has been described in detail by Smith (10). *P. haeussleri* is a solitary internal parasite and attacks only the pupal stage of *Grapholitha molesta*, the only host from which it was reared in Japan. The fact that adults of this species occur in considerable numbers, however, during the fall in sweetpotato fields in Japan, located in sections where peach and other food plants of the oriental fruit moth are scarce, indicates the probability of there being other hosts of this parasite. This species hibernates in the adult stage, apparently only the females surviving the winter.

Three consignments of *Phaeogenes haeussleri* were forwarded to Moorestown during 1933. The first shipment, comprising 16 adults, of which 8 were females reared from fruit moth pupae parasitized in the field in the middle of the summer, reached Moorestown with no mortality. From the second shipment, which contained 260 pupae of this parasite bred in the laboratory at Yokohama during the early part of August, 180 adults were reared at Moorestown, the mortality being 30.8 percent. No record was kept of the number of females reared from this consignment. The third shipment consisted of 373 female parasites collected as adults from sweetpotato fields in Japan late in October and early in November. From these, 256 females were available for use at Moorestown after winter storage, the mortality during transit and storage being 31.4 percent. All shipments of *P. haeussleri* during 1933 provided a total of 452 parasites, of which at least 264 were females.

PHAEOGENES SP.

One female of an undetermined species of *Phaeogenes* was reared as a primary parasite from a fruit moth pupa in a cocoon exposed at Motosumiyoshi in July 1932. *Grapholitha molesta* is probably not a common host of this species, as this was its only occurrence in over 1,600 fruit moth cocoons reared from that locality.

SPILOCRYPTUS GRAPHOLITHAE Uchida

An ichneumonid described by Uchida (14) as *Spilocryptus grapholithae* was reared chiefly from the cocoons of *Grapholitha molesta* in corrugated-paper strips pinned to trees but was also taken occasionally from cocoons collected under trap bands and from hibernating cocoons collected from bark. This parasite was present in Mitsuoka-mura, Nagano, Obukuro, Komazawa, Yoga, Motosumiyoshi, Ninomiya, Okurayama, Takatsu, Tsunashima, Okitsu, and Mantomi-mura, in Honshu; and in Suigen, Chosen. It was reared from 1.9 percent of the hibernating cocoons collected at Ninomiya in 1933, from 2.9 percent of the cocoons collected from trap bands at Okitsu in 1932, from 1.1 and 1.8 percent of the cocoons pinned to trees at Komazawa and Okurayama, respectively, in 1932, and from 2.0 and 5.3 percent of the cocoons pinned to trees at Mitsuoka-mura and Nagano, respectively, in 1933. Less than 1 percent of all cocoons reared from any of the other localities was parasitized by this species.

Spilocryptus grapholithae was reared only as a primary parasite from cocoons of the oriental fruit moth parasitized in the field. In laboratory tests this parasite readily attacked each of 10 *Inareolata molestae* cocoons exposed to it. Although *S. grapholithae* failed to develop from that host, the larvae and pupae of *Inareolata* were killed in every instance as a result of its attack. Upon dissection of *Inareolata* cocoons that had been attacked by it, *Spilocryptus* larvae were observed in 2 instances feeding as ectoparasites upon pupae of *I. molestae*.

Spilocryptus grapholithae was most frequently reared from the pupal stage of the fruit moth, and the adult parasite emerged from a silky white cocoon constructed within the distended and usually broken pupal shell of the host. It also developed occasionally from the mature larva of the host, in which case the parasite cocoon occupied almost the entire fruit moth cocoon into one end of which the host remains were crowded. Males of *S. grapholithae* greatly outnumbered the females, only 9.5 percent of 200 adults reared during the 2 years from fruit moth cocoons parasitized in the field being females. No attempt was made to breed this parasite from the fruit moth under laboratory conditions.

DIBRACHYS CARVUS (Walk.)

Dibrachys carvus was reared as a parasite of oriental fruit moth cocoons in Kamisuwa, Mitsuoka-mura, Nagano, Nakasu, Shimosuwa-cho, Toyodo-mura, and Ninomiya in Honshu; and in Ensenri, Heitaku, Keijo, and Suigen in Chosen. *D. carvus* emerged from cocoons of hibernating fruit moths as well as from those of the summer generations collected from trap bands and in corrugated-paper strips pinned to trees. Parasitization by this species in no instance exceeded 5 percent of all cocoons reared from any locality from which adequate samples were obtained and was usually between 1 and 3 percent.

This species occurred chiefly as a primary parasite of the mature larvae and pupae of *Grapholitha molesta*. It was also reared as a secondary parasite from cocoons of *Aenoplex* sp., *Apanteles* sp., *Inareolata molestae*, *Macrocentrus thoracicus*, *Orgilus longiceps*, *Phanerotoma grapholithae*, and *Pristomerus vulnerator*, and from a puparium of *Elodia* sp., all which were attacked by it under field conditions. So far as could be determined from examination of the host remains, *Dibrachys carvus* was reared as a secondary parasite from 12.3 percent of 316 parasitized hosts collected from the field during the 2 years.

From 1 to 24 adults of *Dibrachys carvus* emerged from a single host, the average emergence from 298 hosts from which it was reared either as a primary or secondary parasite being 5.2 adults. No record was kept of the proportion of sexes produced, but adults of both sexes were frequently observed to emerge from the same host.

SYNTOMOSPHYRUM SP.

An undetermined species of *Syntomosphyrum* was reared from Honshu as an occasional primary parasite of the pupae of *Grapholitha molesta* and more frequently from Chosen as a secondary parasite from cocoons of *Inareolata molestae* and *Pristomerus vulnerator*. It emerged as a secondary parasite from 95.7 percent of the 46 hosts attacked by it in the 2 countries. The fact that it was not reared as a primary parasite from Chosen, where the cocoons exposed contained normal fruit moths as well as those previously attacked by larval parasites, indicates that it is by preference a secondary parasite.

Syntomosphyrum sp. was reared from Sugano and Motosumiyoshi in Honshu; and from Anyo, Keijo, Sosha, and Suigen in Chosen. It was most abundant at Anyo, where it was reared as a hyperparasite from 9.7 percent of 207 cocoons in corrugated-paper strips pinned to trees in 1933, and at Sosha where it similarly attacked 1.1 percent of 807 cocoons exposed during the same season. Parasitization by this species at each of the other localities was considerably less than 1 percent.

From 1 to 21, or an average of 10.6, adults of *Syntomosphyrum* sp. emerged from each of the 46 cocoons that were parasitized by this species. It is an internal parasite and the adults emerge through one or more small holes chewed through the cocoon or pupal case of the host. The majority of the adults produced were females.

TETRASTICHUS IBSENI Gir.

A minute chalcid (*Tetrastichus ibseni*) is a very common parasite of fruit moth cocoons in Japan and Chosen. It was found to occur at nearly all localities that were scouted for parasites that attack stages of the fruit moth within the cocoon. This parasite was reared chiefly from cocoons of the summer generations collected from bands and bark and in corrugated-paper strips pinned to trees. *T. ibseni* was reared from the following localities:

Honshu:	Percentage of cocoons parasitized	Honshu—Continued.	Percentage of cocoons parasitized
Nagano:		Kanagawa—Continued.	
Kamisuwa.....	0.4	Yokohama.....	0.2
Mitsuoka-mura.....	.1	Shizuoka:	
Nagano.....	3.1	Makado.....	2.5
Nakasu.....	1.3	Okitsu.....	18.7
Oshima-mura.....	3.3	Togo.....	1.0
Shimosuwa-cho.....	.6	Okayama:	
Saitama:		Kurashiki.....	6.8
Masubayashi.....	5.7	Mantomi-mura.....	6.6
Obukuro.....	3.3	Nishiyama-mura.....	8.2
Chiba:		Saiden.....	.3
Sugano.....	1.6	Yokoi-mura.....	.2
Tokyo:		Shikoku:	
Komazawa.....	1.2	Kagawa:	
Todoroki.....	15.8	Zota-mura.....	1.9
Yoga.....	4.3	Chosen:	
Kanagawa:		Keikido:	
Motosumiyoshi.....	7.7	Anyo.....	.5
Ninomiya.....	4.4	Heitaku.....	.7
Noborito.....	3.1	Sosha.....	.1
Okurayama.....	10.0	Suigen.....	1.6
Takatsu.....	2.0		
Tsunashima.....	12.4		

Tetrastichus ibseni is an internal, colonial parasite. When reared as a primary parasite of the fruit moth the adults usually emerged from the pupal stage of the host, although, in a few instances, they developed from the mature larva of the fruit moth. In both cases the shell of the host remained practically intact and the adult parasites emerged through 1 or more holes chewed through it, usually near the anterior end. This species was reared as a primary parasite from 97.1 percent of 1,084 fruit moth cocoons parasitized in the field during both years and as a secondary parasite from only 2.9 percent of the cocoons. It emerged as a secondary parasite from cocoons of the following species of primary parasites that were attacked by it in the field: *Aenopler* sp.,

PARASITIZATION ON EACH ISLAND OF JAPAN AND IN CHOSEN

A summary of the monthly parasitization of twig-infesting larvae in the four general regions, based on the percentage of larvae parasitized by all species of parasites, is also presented in table 4. A comparison of the parasitization in the four regions is available only for June 1932, and for each region except Shikoku during June 1933. It is apparent from these records that parasitization was considerably higher in Chosen than in any of the other regions and that it averaged in excess of 50 percent for all collections made from there during June of both seasons. Parasitization averaged 46.8 percent for all collections from Kyushu in June 1932, but averaged only 23.2 percent for all collections obtained from that island during June 1933. The difference in the parasitization recorded for that island during June of the 2 years does not necessarily indicate a decrease, since the collections in 1932 were confined entirely to one Prefecture, whereas those in 1933 were obtained from several other Prefectures. Parasitization in Kyushu was much higher, however, than that indicated for either of the other islands of Japan, and the highest percentage of parasitization recorded for any month occurred on that island in July 1932. Parasitization in Shikoku in 1932 showed a decided increase in June over that of May, but was much lower than that recorded for the regions previously discussed. Parasitization in Honshu was considerably lower than that of any other region, and the low percentage persisted throughout the entire season of 1932 and again during the 2 months for which records are available in 1933.

PARASITIZATION BY PREFECTURES

More detailed information regarding the parasitization of twig-infesting larvae is presented in table 5. This table summarizes the survey data for all collections reared from each Prefecture during each month and shows the number of localities scouted, the total number of individuals reared to emergence, and the percentage of all larvae parasitized. It will be noted that twig-larval parasites were reared from each of the Prefectures scouted with the single exception of Akita. In other Prefectures the average parasitization in all collections reared during any 1 month ranged from zero to 68.6 percent. In the 19 Prefectures scouted in Honshu average parasitization in excess of 10 percent during 1 or more months was recorded only from Nagano, Saitama, Tokyo, Kanagawa, and Hiroshima. In Shikoku the average parasitization recorded for Kagawa in May and June was lower than the corresponding averages for Saitama, but higher than for any of the other Prefectures of Honshu, while the average for Ehime in June exceeded that of any of the Prefectures of Honshu. In Kyushu the average parasitization recorded for Fukuoka in June and July 1932, exceeded that of any other Prefectures of Japan for the same months, and the average for Kumamoto in June 1933 was likewise the highest recorded during that year for any Prefecture of Japan. The monthly averages for other Prefectures scouted on that island were comparatively low. Records for the three Provinces scouted in Chosen are available only for the month of June. In Keikido and Keisho Hokudo the average parasitization recorded for that month in 1932 closely approximated the corresponding average for Fukuoka,

but in Keisho Nando the average for June of both years was considerably higher than that of any other Province scouted.

TABLE 5.—Average parasitization of larvae of the oriental fruit moth reared from infested twigs collected each month from each Prefecture of Japan and Chosen during 1932 and 1933

Year and Prefecture	May			June			July			August			September		
	Localities scouted	Total emerged	Larvae parasitized	Localities scouted	Total emerged	Larvae parasitized	Localities scouted	Total emerged	Larvae parasitized	Localities scouted	Total emerged	Larvae parasitized	Localities scouted	Total emerged	Larvae parasitized
1932															
Aomori							1	217	4.6						
Akita							1	78	0						
Iwate							1	83	1.2						
Yamagata							4	1,370	3.4						
Miyagi							2	684	1.3						
Niigata				2	928	7.0	3	651	2.0						
Fukushima							2	1,029	7.9						
Nagano				5	1,431	6.3				2	289	24.6			
Ibaragi							1	242	3.3						
Saitama	2	286	15.9	3	422	23.7	1	304	5.6						
Chiba	1	154	1.1	4	1,004	.3				1	292	3.8			
Tokyo	4	128	0				2	357	4.5	2	741	10.3	1	23	4.3
Yamaguchi				3	696	3.0									
Kanagawa	11	509	7.0	13	642	5.1	7	1,370	2.5	0	3,713	8.8	3	12	0
Shizuoka				3	235	2.9				4	803	8.1			
Osaka				3	278	3.2									
Okayama	3	730	2.1	5	2,032	9.4									
Hiroshima				4	1,307	17.0									
Kagawa	2	807	12.6												
Ehime				3	658	10.4									
Fukuoka				3	989	48.8	1	598	67.9						
Keikido					2,065	49.4									
Keisho Hokudo					1,182	48.1									
Keisho Nando				4	1,087	68.6									
1933															
Fukushima				1	138	2.0									
Kanagawa							3	1,341	13.2						
Tottori				2	150	.7	1	82	0						
Oita				1	85	12.9									
Kumamoto				2	281	39.9									
Kagoshima				3	198	4.0									
Keisho Nando				3	247	53.3									

COMPARATIVE IMPORTANCE OF THE VARIOUS SPECIES OF TWIG-LARVAL PARASITES

The emergence records for all survey collections of infested twigs reared during the 2 years are further summarized in table 6. *Inareolata molestae* was reared as the dominant parasite from 10 Prefectures, *Apanteles taragamae* from 7, *A. molestae* from 3, *Elodia flavipalpis* and *Macrocentrus thoracicus* each from 2, and *Phanerotoma grapholithae* and *Eubadizon extensor* were each dominant in 1 Prefecture. Average parasitization in excess of 10 percent was recorded from 7 of the Prefectures in which *I. molestae* was dominant, and from 1 of those in which *A. molestae*, *P. grapholithae*, *M. thoracicus*, and *E. extensor* were reared as the dominant species.

TABLE 6.—Percentage parasitization of larvae of the oriental fruit moth and number of parasites of each species reared from infested twigs collected in each Prefecture of Japan and Chosen in 1932 and 1933

Year and Prefecture	Localities scouted			Parasites of each species reared																											
	No.	No.	Pct.	<i>Apanteles molestae</i>	<i>Apanteles taragamae</i>	<i>Apanteles</i> sp. A	<i>Apanteles</i> sp. B	<i>Apanteles</i> spp. ¹	<i>Bassus conspicuus</i>	<i>Bassus dirersus</i>	<i>Eubodizon extensor</i>	<i>Macrocentrus thoracicus</i>	<i>Meteorus ictericus</i>	<i>Orgilus longiceps</i>	<i>Phanerotoma grapholithae</i>	<i>Cremastus flavo-orbitalis</i>	<i>Cremastus</i> sp. 1	<i>Cremastus</i> sp. 2	<i>Cremastus</i> spp. ¹	<i>Inareolata molestae</i>	<i>Glypta cymolomiae</i>	<i>Plectoborus icatensis</i>	<i>Pristomerus pulvenerator</i>	<i>Elodia flavipalpis</i>	<i>Elodia subfasciata</i>	<i>Elodia</i> spp. ¹	<i>Phorocera pumilio</i>	Dead parasite cocoons ²			
1932	No.	No.	Pct.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	
Aomori	1	217	4.0																												
Akita	1	78	0																												
Iwate	1	83	1.2																												
Yamagata	4	1,370	3.4		11			2																							
Miyagi	1	684	1.8	7																											
Niigata	1	1,579	4.0	1	6																										
Fukushima	2	1,029	7.9	29				1																							
Nagano	5	1,720	0.4		67																										
Ibaragi	1	242	3.3					1																							
Saitama	3	1,012	16.9		9																										
Chiba	4	1,480	1.1		10																										
Tokyo	6	1,240	7.4		78																										
Yamanashi	2	690	3.6		13																										
Kanagawa	10	6,555	6.9		112		1	1	1	2																					
Shizuoka	5	4,038	4.0	22	54			1																							
Osaka	1	278	3.2																												
Okayama	5	2,782	7.4	61	83			1																							
Hiroshima	4	1,502	17.0		1																										
Kiugawa	3	1,466	15.7	117	16			5																							
Ehime	3	957	20.7		1																										
Fukuoka	2	4,507	40.6		1		17																								
Kelkido	3	2,002	40.4		10		12		6	16																					
Keisho Hokudo	2	1,182	48.1							3																					
Keisho Nando	3	1,087	68.0					1																							
1933																															
Fukushima	1	138	2.0																												
Kanagawa	3	1,341	13.2		6																										
Tottori	2	232	4																												
Osaka	1	85	12.0																												
Kumamoto	2	281	30.9																												
Kagoshima	2	198	4.0		1																										
Keisho Nando	2	247	58.3																												
Total				250	408	1	2	18	20	15	32	608	1	50	354	288	15	15	3	4,137	3	24	105	130	9	118	32		723		

¹ Specimens determinable only to genus.

² Parasites died in the cocoon stage, genus and species uncertain.

PARASITIZATION OF STAGES WITHIN THE COCOON

The emergence obtained from 32,139 fruit moth cocoons collected or exposed in the field at numerous localities in Japan and Chosen during 1932 and 1933 indicates that 21.8 percent, approximately 1 out of every 5, of the cocoons were successfully parasitized by various species of parasites after the contained individuals had reached the cocoon stage. There was very little variation in the percentage of parasitization for cocoons handled by each of the three methods previously described. Of 1,112 cocoons containing hibernating fruit moths collected from bark and reared to emergence, 19.5 percent produced cocoon parasites. Cocoon parasites emerged from 18.0 percent of 3,147 cocoons reared from trap bands and bark and from 22.4 percent of 27,880 cocoons in corrugated-paper strips pinned to trees.

The percentage of oriental fruit moth cocoons parasitized varied considerably at different localities. At Kamisuwa, Nagano, 6.5 percent of 927 individuals reared from hibernating cocoons collected from quince bark from March 25 to April 7, 1932, were parasitized. Thirty-four individuals reared from hibernating cocoons collected from the bark of peach and sand pear trees at Ninomiya, Kanagawa, from February 20 to 23, 1932, showed 96.8 percent parasitization, and 86.1 percent of those reared from 108 hibernating cocoons similarly collected from the same locality on March 9 and 14, 1933, were parasitized. Hibernating cocoons were obtained from other localities in numbers too small to furnish significant data concerning the percentage of parasitization. At each locality, however, from which such cocoons were collected from peach or sand pear trees, the number parasitized exceeded the number not parasitized.

The number of fruit moth cocoons of the summer generations collected from trap bands and bark during 1932 and 1933 from which either moths or parasites were reared and the number and percentage of these that were parasitized by cocoon parasites at each locality from which at least 50 cocoons were reared to emergence during either season is shown in table 7.

TABLE 7.—Number of cocoons of the oriental fruit moth reared to emergence, and number and percentage of cocoons parasitized by cocoon parasites in all collections of the summer generations, obtained from trap bands and bark at various localities in Japan and Chosen, during 1932 and 1933

Locality	Prefecture	1932			1933		
		Cocoons reared	Cocoons parasitized		Cocoons reared	Cocoons parasitized	
		Number	Number	Percent	Number	Number	Percent
Kamisuwa	Nagano	202	25	12.4	223	34	15.2
Nakasu	do				157	20	12.7
Shimosuwa-cho	do				169	26	15.4
Toyoda-mura	do				278	23	8.3
Masubayashi	Saitama	106	8	7.5			
Obukuro	do	473	92	19.5			
Sugano	Chiba	88	18	20.5			
Todoroki	Tokyo	70	19	25.0			
Ninomiya	Kanagawa				51	3	5.9
Okurayama	do				102	19	18.0
Takatsu	do				50	5	9.6
Tsunashima	do				73	18	24.7
Okitsu	Shizuoka				271	107	39.5
Suigen	Keikido				635	110	17.3

In some instances a few of the larvae were attacked by twig-larval parasites, or cocoon parasites that developed as secondary parasites emerged from such cocoons. In table 7 the number of cocoons reared includes the total from which fruit moth adults, twig-larval parasites, and either primary or secondary cocoon parasites emerged. The percentage figures given indicate the percentage of the total number of cocoons reared from which cocoon parasites of various species emerged either as primary or secondary parasites. From 5.6 to 39.5 percent of the cocoons collected from bands and bark at these localities were attacked by parasites of the cocoon stage. Although it is not shown in the table, the records for comparative collections of cocoons obtained from quince trees at the four localities in Nagano Prefecture during August 1933 show that 19.3 percent of the cocoons obtained from bark were parasitized, as compared to 5.3 percent of those obtained from bands.

Similar records are shown in table 8 of the percentage of individuals within cocoons in corrugated-paper strips pinned to the trees that were parasitized by cocoon parasites at each locality. Many of the fruit moth larvae in these cocoons had been attacked by twig-larval parasites previous to the time the cocoons were exposed, so the number of cocoons reared includes the total number from which oriental fruit moth adults, twig-larval parasites, and either primary or secondary cocoon parasites emerged. From 0 to 78 percent of the cocoons exposed in corrugated paper pinned to the trees at these various localities were attacked by cocoon parasites.

TABLE 8.—Number of cocoons of the oriental fruit moth reared to emergence and number and percentage of cocoons parasitized by cocoon parasites from all exposures in corrugated-paper strips pinned to trees at various localities in Japan and Chosen during 1932 and 1933

Locality	Prefecture or Province	1932			1933		
		Cocoons reared	Cocoons parasitized		Cocoons reared	Cocoons parasitized	
		Number	Number	Percent	Number	Number	Percent
Kamisawa	Nagano	48	3	6.3			
Mitsuoka-mura	do	123	96	78.0	4,115	1,806	43.9
Nagano	do	88	26	29.2	1,102	218	19.8
Oshima-mura	do	58	3	5.2			
Obukuro	Saitama	799	277	34.7			
Sagano	Chiba	459	162	35.3			
Komazawa	Tokyo	731	162	22.2	575	1	.2
Yoga	do	703	102	14.5			
Motosumiyoshi	Kanagawa	253	130	51.6	1,345	243	18.1
Ninomiya	do				878	72	8.2
Okurayama	do	488	135	27.7	1,131	209	18.5
Takatsu	do	341	103	30.2	1,097	234	21.3
Tsunashima	do	379	11	2.9	377	108	28.6
Yokohama	do	488	1	.2			
Hara	Shizuoka	33	18	54.5			
Makino	do	249	16	6.4			
Miho	do				75	2	2.7
Okitsu	do				128	10	7.8
Suzikawa	do						
Togo	do	125	0	0			
Kurashiki	do	245	16	6.5			
Kurashiki	Okayama				322	131	40.7
Mantomi-mura	do				3,520	510	14.5
Nishiyama-mura	do				287	60	21.2
Yabito	do				640	10	1.6
Yokoi-mura	do				515	37	7.2
Yota-mura	do				740	137	18.5
Aryo	Kagawa				307	24	7.8
Ensoori	Keikoku				319	21	6.6
Heltaku	do				571	75	13.1
Keljo	do				513	19	3.7
Sesha	do				597	220	36.9
Suigen	do				2,689	785	29.2

In 1933 duplicate lots of parasite-free insectary-reared fruit moth cocoons were pinned to trees in adjacent peach and sand pear orchards and exposed during the same period for purposes of comparison. Two such exposures were located at Okitsu, Shizuoka, and two at Ninomiya, Kanagawa. At Okitsu 21 and 25 percent of the cocoons in the two exposures in peach orchards were parasitized, but no parasitization occurred in those exposed in pear orchards. At Ninomiya, 11 and 13 percent of the cocoons exposed on peach trees were parasitized, as compared to 3 and 6 percent parasitization of respective exposures on pear trees. A summarization of the rearings from all comparable exposures at both localities showed 15.9-percent parasitization of cocoons exposed on peach trees and only 3.4-percent parasitization of those exposed on pear trees. This indicated that parasites that attack stages of the fruit moth within the cocoon were apparently present in larger numbers in peach orchards than in sand pear orchards. The rearings further indicated that the apparent preference for the type of tree is common to cocoon parasites in general rather than to individual species, as three of the four species of parasites reared at Ninomiya occurred in both peach and sand pear orchards.

TABLE 9.—Relation of the location of oriental fruit moth cocoons on various parts of peach trees to attack by cocoon parasites

Locality	Location of cocoons on tree	Total hosts	Hosts parasitized	Hosts parasitized by each species											
				Parasitization	<i>Blerytona appendigaster</i>	<i>Phaenogenus hirsutari</i>	<i>Itoplectis epinautae</i>	<i>Spilocryptus grapholithae</i>	<i>Tetrastichus floeni</i>	<i>Brachymeria cecropiae</i>	<i>Hemiteles pulchellus</i>	<i>Exochus formosae</i>	<i>Lissonota</i>	<i>Synaldis</i>	<i>Synaldis phyllanthi</i>
		No.	Pct.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.		
Motsumiyoshi	Trunk	164	33.7	3	4	2	9	43							
	Branches	200	38.0	3	24	5	1	41							
	Terminals	150	20.0	3	18	2		14							
Okurayama	Trunk	47	25.5	1				9							
	Branches	51	35.3		8			10							
	Terminals	55	21.6	3	5			2	1						
Takatsu	Trunk	80	22.5	2				1	4	11					
	Branches	86	3.6						1						
	Terminals	105	8.6							9					
Tsunashima	Trunk	94	43.6	5	4			1	31						
	Branches	61	40.2						3						
	Terminals	60	30.0	1					3						
All localities	Trunk	405	32.8	10	9	2	11	87	12						
	Branches	398	31.9	3	32	8	1	79	2						
	Terminals	410	18.8	7	23	5		26	10						

In a series of exposures made at four localities in Kanagawa Prefecture in 1933 an attempt was made to determine the relation of the location of the fruit moth cocoon upon various parts of the tree to attack by cocoon parasites. In this experiment similar lots of parasite-free fruit moth larvae cocooned in corrugated-paper strips were pinned to the trunks of peach trees within 1 foot of the ground, to the larger branches about midway between the trunk and the terminal twigs, and at the base of the terminal twigs in close proximity to the foliage. The rearing records for this experiment are presented in table 9. The results indicate that cocoons located on the trunk and larger branches were generally much more subject to attack by para-

sites than those located near the terminal twigs. They also show that cocoons located in certain parts of the trees were more subject to attack by certain species of parasites than were those in other locations. For example, *Phaeogenes haeussleri* was reared in greater numbers at two localities from cocoons located on the branches and near the terminals, *Tetrastichus ibseni* was reared most frequently at all localities from cocoons located on the trunk and larger branches, and *Brachymeria excarinata* attacked chiefly those cocoons located on the trunk and near the terminal twigs.

EXTENT AND IMPORTANCE OF SECONDARY PARASITISM

Considerable information concerning the activity of secondary parasites was acquired in connection with the survey of parasites attacking stages of the oriental fruit moth within the cocoon. Of 7,021 hosts from which cocoon parasites of various species were reared, 82.0 percent were attacked by primary parasites, 16.3 percent were attacked by secondary parasites, and the parasite-host relationship of the remaining 1.7 percent could not be determined definitely. In the majority of cases it was possible to determine, by careful examination of the host remains, whether the secondaries had developed from twig-larval parasites or from primary cocoon parasites. Of the secondary parasites reared from 1,083 such hosts, 97.3 percent emerged from the cocoons of twig-larval parasites and only 2.7 percent emerged from those of primary cocoon parasites.

Insofar as could be determined, very few of the parasites reared from field-collected cocoons of hibernating fruit moth larvae were secondary parasites. Only 1.9 percent of the 108 parasitized hosts hibernating in cocoons collected from February to April 1932 showed evidence of secondary parasitism, and this was by a single species, *Dibrachys curvus*. Primary cocoon parasites emerged from 54.6 percent of the parasitized cocoons, and in the remaining 43.5 percent of the cases it was impossible to determine whether the cocoon parasites issued as primary or secondary parasites. None of the 110 parasitized hosts hibernating in cocoons collected in March 1933 showed evidence of attack by secondary parasites, but in 33.6 percent of the cases it could not be determined definitely whether the cocoon parasites issued as primary or secondary parasites. No evidence was found to indicate that the hosts hibernating within cocoons collected in the 2 years had been attacked by twig-larval parasites.

Only 1 percent of 205 parasitized hosts reared from fruit moth cocoons of the summer generations collected from trap bands and from bark during 1932 showed evidence of secondary parasitism, and that was by one species, *Calliceras* n. sp. The host remains failed to indicate whether these emerged from twig-larval or primary cocoon parasites. The host relationship of cocoon parasites reared from 16.1 percent of the hosts could not be determined. Twig-larval parasites were present in the collections as evidenced by the fact that specimens of 3 species emerged from 10.7 percent of the parasitized hosts.

In 1933 8 species (*Calliceras* n. sp., *Dibrachys curvus*, *Eupelmus formosae*, *Eurytoma appendigaster*, *Haltichella* n. sp., *Hemiteles bicolorinus*, *Syntomosphyrum* sp., and *Tetrastichus ibseni*) emerged as secondary parasites from 16 percent of 639 parasitized hosts collected from trap bands and bark. Of the secondaries, 80.4 percent emerged

from the cocoons of twig-larval parasites, 15.7 percent from primary cocoon parasites, and the hosts of the remaining 3.9 percent could not be definitely determined. Seven species of twig-larval parasites were reared from 40.2 percent of the parasitized fruit moth cocoons, indicating that twig-larval parasites were over three times as abundant in these collections as in those of 1932.

All but a few of the cocoons in corrugated-paper strips exposed by pinning them to the trees in 1932 contained insectary-bred fruit moth larvae free of twig-larval parasites and very little evidence of secondary parasitism was obtained from these exposures. Only 0.4 percent of 1,277 parasitized hosts reared from the cocoons appeared to have been attacked by secondary parasites, and these by 3 species (*Eurytoma appendigaster*, *Tetrastichus ibseni*, and *Calliceras* n. sp.) all of which emerged from cocoons of undetermined species of primary parasites. Two species of twig-larval parasites emerged from 0.5 percent of the parasitized hosts.

The records of secondary parasitism obtained by exposing cocoons in the same manner in 1933, when all but a few of the cocoons exposed contained field-collected fruit moth larvae originating from the same or from localities near to that of which exposed, and which had previously been accessible to attack by twig-larval parasites, corresponded very closely with those obtained from the rearing of cocoons collected from trap bands and bark during the same season. Eleven species (*Eurytoma appendigaster*, *Dibrachys cavus*, *Tetrastichus ibseni*, *Haltichella* n. sp., *Hemiteles pulchellus*, *Eupelmus formosae* *Hemiteles* sp., *Calliceras* n. sp., *Calliceras* sp., *Syntomosphyrum* sp., and *Pleurotropis nawaiii*) emerged as secondary parasites from 14.3 percent of 7,246 parasitized hosts recovered from cocoons exposed. Of the secondaries, 93.5 percent emerged from the cocoons of twig-larval parasites, 1.2 percent from those of primary cocoon parasites, and the hosts of the remaining 5.3 percent could not be definitely determined. Fifteen species of twig-larval parasites were reared from 31.4 percent of the parasitized fruit moth cocoons.

When the records for the cocoons containing larvae that originated in Japan and were exposed at various localities there in 1933 were compared with those for cocoons that originated and were exposed in Chosen, it was found that secondary parasitization was considerably higher in Chosen, where a much greater proportion of the cocoons exposed contained larvae that had previously been attacked by twig-larval parasites. The 11 species listed above emerged as secondary parasites from 1.2 percent of 4,369 parasitized hosts in Japan, and 15 species of twig-larval parasites emerged from 12.7 percent of the hosts. In Chosen 9 species, including all those listed above except *Calliceras* sp. and *Pleurotropis nawaiii*, emerged as secondary parasites from 34.2 percent of 2,877 parasitized hosts and 5 species of twig-larval parasites emerged from 59.8 percent of the hosts. Of those reared as secondary parasites from Japan, 56.6 percent attacked twig-larval parasites, 18.9 percent attacked primary cocoon parasites, and the host of 24.5 percent could not be definitely determined. Of those reared as secondary parasites from Chosen, 95.4 percent attacked twig-larval parasites, 0.3 percent attacked primary cocoon parasites, and the host of 4.3 percent could not be determined.

From the data obtained it is apparent that secondary parasites are of importance in relation to the biological control of the oriental fruit

moth, in that they destroy considerable numbers of twig-larval parasites by attacking them while the parasitized fruit moth larva is in the cocoon stage. The effect of secondary parasites upon primary cocoon parasites appears to be of considerably less importance.

COLLECTION, REARING, AND SHIPMENT OF ORIENTAL FRUIT MOTH PARASITES

FIELD-PARASITIZED LARVAE OF THE FRUIT MOTH FROM INFESTED TWIGS

A summary of the number of infested peach twigs collected from Japan and Chosen from May 16 to June 30, 1933, as a source of parasitized oriental fruit moth larvae for exportation to the United States and the number and percentage of larvae reared to the cocoon stage at Yokohama from twigs that originated in each country is given in table 10.

TABLE 10.—*Summary of infested twigs collected and fruit moth larvae reared therefrom to the cocoon stage at Yokohama, 1933*

Country of origin	Infested twigs collected	Larvae reared	
	Number	Number	Percent
Japan.....	313, 633	154, 991	49. 4
Chosen.....	80, 243	48, 775	60. 3
Total.....	393, 936	203, 756	51. 7

Two general methods were used in the mass collection of these infested twigs from 25 selected localities in the 2 countries. The majority were collected by day labor hired locally to collect the infested twigs and trim off the foliage under the supervision of a local foreman who also handled the packing and forwarding of the twigs to Yokohama. Each collector was required to include 10 uninfested twigs with each 50 infested ones as a source of additional food for the larvae. These were not included in the count of infested twigs collected. Collectors in the south of Japan, in the Prefectures of Okayama, Kagawa, and Fukuoka, averaged 376 per day for the entire period. In Chosen the collectors averaged 388 twigs per day for the entire period. In Japan approximately 37 percent more per day were collected in June than in other months, but in Chosen there was only slight variation in the average for each month. In the south of Japan infested twigs were obtained by this method at the rate of 258 per yen, and in Chosen they were obtained at the rate of 310 per yen. A yen, at that time, was equivalent to approximately 25 cents. Comparative figures are not available for collections made in other sections of Japan.

During the latter part of June, when the twig infestation became particularly abundant at 2 localities in the south of Japan, local residents were shown the type of twigs desired and an offer was made to purchase all brought in over a given period of time. At Mantomimura, Okayama, the offer was made to school children, who collected 49,265 twigs in 4 days, and these were purchased at the rate of 500 for 1 yen. As had been anticipated, approximately 21 percent of these twigs were unsatisfactory and were discarded at the time the twigs were packed for forwarding to Yokohama. The loss, however, was

compensated for by the low price paid. An average of 395 satisfactory twigs, trimmed of foliage, were obtained per yen; but a few complaints were received from growers of minor damage to trees caused by the young collectors. It appears probable that this method could be improved upon and that the purchase of infested twigs collected by school children could be used to advantage for procuring large numbers of twigs from a particular locality in Japan in a short period of time. Uninfested twigs for use as additional food for the larvae were purchased from the children at the rate of 1,000 trimmed twigs per 1 yen.

At Osada, Oita, a similar collection was made, the collected and trimmed twigs being purchased at that locality from the owners of the orchards at the rate of 333 for 1 yen. These collectors supplied 10 uninfested twigs gratis with each 50 infested ones. There was practically no waste due to the collection of unsatisfactory twigs, as the growers were anxious to rid their orchards of the fruit moth larvae and, of course, no complaints of damage were received. This method appears to be quite satisfactory, provided the collection is not desired at a time when the orchardists are busy with other work. The purchase system involves, however, the employment of at least two experienced assistants at the receiving point to handle the examination, purchase, and packing of the large quantities of twigs received in a short period.

Twigs obtained by all methods were packed in shipping cans such as were described on page 6 and were forwarded to Yokohama as promptly as possible by special express. At the Yokohama laboratory the twigs were placed in galvanized-metal pans 11 inches in diameter by 8 inches in height, the interior being enameled white. Approximately 500 twigs were placed in each pan, only those collected from Japan and Chosen being handled separately. Strips of corrugated paper, 10 mm. in width, were held against the inside of each pan and about 1 inch below the rim by 4 wire hooks attached to the rim. These furnished temporary cocooning quarters for the larvae as they became mature and left the twigs. The individual corrugations were sufficiently small to accommodate usually only 1 full-grown fruit moth larva, and the paper used was selected because of the ease with which the 2 layers could be torn apart in order to dislodge larvae that had begun to construct cocoons. The rearing pan was covered by cheesecloth held tightly in place by a strong rubber band. The mature fruit moth larvae were removed from each pan once every 24 hours and placed temporarily in small cloth-covered glass jars. Those that had begun to construct cocoons in the corrugated-paper strips were removed by ripping apart the 2 layers of paper, and these were also placed in the small glass jars.

The manipulation thus far described was accomplished almost entirely by unskilled labor under supervision, but from this stage on the material was handled entirely by the writer and trained assistants. The fruit moth larvae were next shaken from the jars onto a table covered with white oilcloth, at a point midway between a strong electric light and the operator. As the active larvae crawled away from the light and toward the operator they were readily inspected to eliminate any undesirable inclusions, counted, picked up by means

of a small camel's-hair brush, and returned to a glass jar containing a corrugated-paper pack, in which they were allowed to construct permanent cocoons for shipment. These packs, which could accommodate a maximum of 500 larvae, were held at laboratory room temperature for 24 hours to allow formation of strong cocoons and thereafter were confined, pending shipment, in an ordinary ice refrigerator maintained at temperatures of from 45° to 62° F.

For shipment to the United States the packs containing fruit moth cocoons were placed in small wooden boxes (fig. 3, *A*), which in turn were packed in wooden cases (fig. 3, *B*). A thick layer of moist sterile cotton between sheets of corrugated paper completely surrounded the inner boxes and served as insulation against sudden changes of temperature as well as furnishing humidity for the cocooned larvae. All shipments that contained host material were placed in cool storage at temperatures of about 35° to 42° F. aboard vessels at Yokohama and routed to New York via Panama,⁵ the time in transit between those ports being 32 days for each shipment.

PARASITE COCOONS, PUPARIA, AND ADULTS

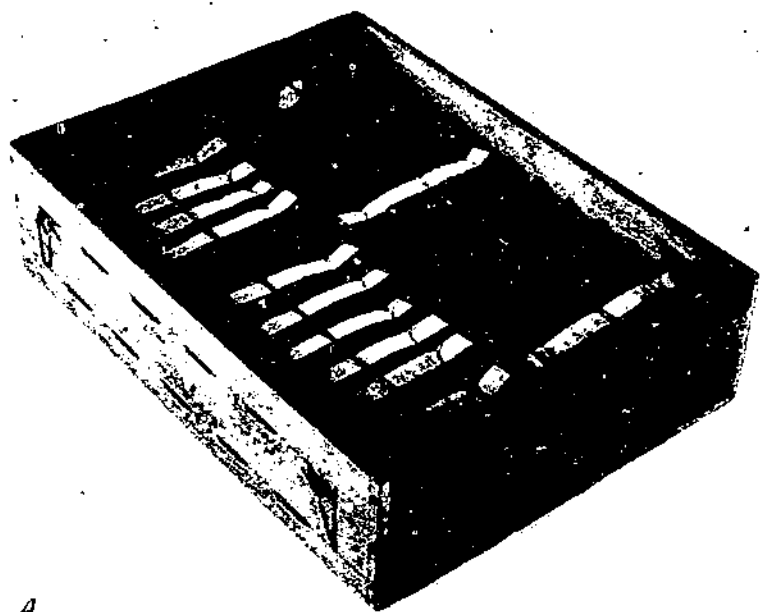
Cocoons, puparia, and adults of the various species of parasites were obtained for export by rearing collections of larvae of the oriental fruit moth that had been parasitized in the field, from breeding conducted in the laboratory at Yokohama, and by utilizing surplus stocks of adult parasites that were accumulated in connection with parasite-survey studies. All consignments that were free of host material were packed and insulated in a manner similar to that just described, placed in cool storage at temperatures of about 35° to 42° F. aboard vessels at Yokohama, and routed to Seattle. Immediately upon arrival at that port they were transshipped⁶ to trans-continental airplanes and forwarded without cool storage to Moorestown, the minimum and maximum time in transit for all such shipments being 11 and 13 days, respectively.

SUMMARY OF PARASITE MATERIAL SHIPPED AND NUMBER OF ADULT PARASITES OBTAINED AT MOORESTOWN FROM IMPORTATIONS

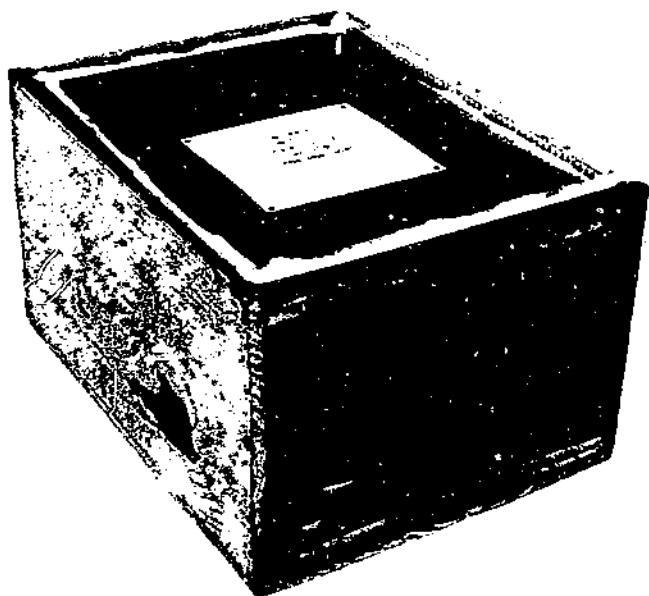
A summary of the parasite material shipped from Yokohama to Moorestown, N. J., during 1932 and 1933 is given in table 11, and a summary of the parasite adults obtained alive at Moorestown, N. J., from material listed in this table is given in table 12, the parasite survival being indicated for material shipped in each stage of development. By comparing the totals given in tables 11 and 12, it is found that only 2.7 percent of all fruit moth larvae collected from the field in Japan produced adult parasites at Moorestown, as compared to 17.9 percent produced from larvae collected in Chosen. Of the adult parasites shipped, 48.0 percent survived, and 47.6 percent of those shipped as host-free parasite cocoons and puparia produced adults.

⁵ Several of these shipments required transfer to other vessels at San Francisco. The transfer was made under the supervision of H. M. Armitage, collaborator in the Division of Foreign Plant Quarantines of the Bureau of Entomology and Plant Quarantine, to avoid undue exposure to unfavorable temperatures during transfer and to insure proper storage conditions for the remainder of the voyage.

⁶ Prompt transshipment of all consignments from boat to airplane at Seattle was accomplished through the courtesy of A. G. Webb, of the Division of Foreign Plant Quarantines.



A



B

FIGURE 3.—Method of packing field-collected larvae of the oriental fruit moth for shipment: *A*, Box containing packs of cocooned larvae; *B*, packing case, showing insulation.

TABLE 11.—Record of oriental fruit moth parasite material shipped from the Orient to Moorestown, N. J., during 1932 and 1933

Species	Parasites shipped in—						Total
	Field-collected fruit moth larvae		Host-free parasites		Insectary-inoculated host		
	From Japan	From Chosen	Adults	Cocoons or puparia	Eggs	Larvae	
Hymenoptera:	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>
<i>Aenoplex molestae</i>			3	398			401
<i>Apanteles</i> spp.....			4	587			591
<i>Bassus diversus</i>			6	19			19
<i>Calliephialtes</i> spp.....			170	187			193
<i>Cremastrus</i> spp.....			2,506	43			179
<i>Inareolata molestae</i>							2,549
<i>Eubadizon extensor</i> and <i>Macrocentrus thoracicus</i>			394				394
<i>Phaenogenes haeusleri</i>			389	260			649
<i>Phanerotoma grapholithae</i>			5	230		3,460	3,695
<i>Trichogramma minutum</i>					1,580		1,580
Miscellaneous species.....				1,556			1,556
Diptera:							
Tachinidae spp.....				8			8
Lepidoptera:							
<i>Grapholitha molestae</i>	145,443	41,742					187,185
Total.....	145,443	41,742	3,486	3,288	1,580	3,460	198,999

TABLE 12.—Record of oriental fruit moth parasites obtained alive as adults at Moorestown, N. J., from all importations from the Orient during 1932 and 1933

Species	Parasites imported in—						Total
	Field-collected fruit moth larvae		Host-free parasites		Insectary-inoculated host		
	From Japan	From Chosen	Adults	Cocoons or puparia	Eggs	Larvae	
Hymenoptera:	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>
<i>Aenoplex molestae</i>			3	238			241
<i>Apanteles</i> spp.....	34		5	211			250
<i>Bassus diversus</i>	65	11		4			80
<i>Casnocryptus</i> n. sp.....				10			10
<i>Calliephialtes</i> spp.....			4	130			134
<i>Chorinaeus</i> n. sp.....	1						1
<i>Cremastrus</i> spp.....	25	53	100	9			187
<i>Inareolata molestae</i>	1,852	5,733	1,046	682			9,313
<i>Epiurus ruscarius</i>				1			1
<i>Eubadizon extensor</i> and <i>Macrocentrus thoracicus</i>	1,123	1,611	342	7			2,983
<i>Metasorus ictericus</i>	1						1
<i>Orgilus longiceps</i>	546	2		2			550
<i>Phaenogenes haeusleri</i>			272	180			452
<i>Phanerotoma grapholithae</i>	46	6	2	76		484	614
<i>Plectocheilus icatensis</i>	3						3
<i>Pristomerus vulnerator</i>	26	33		11			70
<i>Trichogramma minutum</i>					1,580		1,580
Diptera:							
Tachinidae ¹	190	20		3			213
Total.....	3,912	7,469	1,674	1,564	1,580	484	16,683

¹ Estimated.² Probably chiefly *Elodia staripalpis* plus a few *E. subfasciata* and *Phorocera pumilio*.

SUMMARY

Sixty-one species of parasites were reared from the oriental fruit moth (*Grapholitha molesta* (Busck)) in a survey made during 1932 and 1933 in many of the important peach-, pear-, and quince-producing regions of Japan and Chosen.

Trichogramma minutum was the only true egg parasite reared, although the braconid *Phanerotoma grapholithae* also oviposits in that stage of the host. Eggs of the oriental fruit moth were parasitized at 18 of 21 localities surveyed for parasites attacking the egg stage, *Trichogramma* being reared from 69.5 percent of 59 lots of eggs exposed.

Twenty-two species, including *Phanerotoma grapholithae*, were reared as primary parasites of twig-infesting larvae. Among the braconids, *Apanteles molestae*, *A. taragamae*, *Macrocentrus thoracicus*, and *P. grapholithae* are the most widely distributed and were reared in the largest numbers. *Inareolata molestae*, the most important and the most widely distributed parasite of twig-infesting larvae, was approximately eight times as abundant as its closest competitor in the rearings and parasitized from 45.6 to 65.6 percent of the larvae reared from individual collections made at certain localities in the southern part of Japan and in the central and southern part of Chosen. Other ichneumonids of fairly wide distribution and of particular importance in certain sections were *Cremastus flavoorbitalis* and *Pristomerus vulnerator*. *Elodia flavipalpis* was the only one of three tachinids that attained any degree of importance.

Thirty-eight species were reared as parasites of oriental fruit moth stages within the cocoon. Of these, 19 species emerged only as primary parasites, 3 species were reared to the adult stage as primary parasites only although in laboratory tests they attacked and destroyed certain primary parasites but their progeny failed to mature as true secondary parasites, 2 species were reared only as secondary parasites, 11 species were found to occur both as primary and secondary parasites, and the host relationship could not be determined for 3 species.

Parasitization of twig-infesting larvae, as determined from comparable records obtained during June of 1932 and 1933, averaged in excess of 50 percent for all collections made from Chosen, where it was considerably higher than on any one of the three islands scouted in Japan. In Japan parasitization was highest in Kyushu, somewhat lower in Shikoku, and comparatively very low in Honshu, where the low percentage persisted throughout the entire season of 1932.

Inareolata molestae was reared as the dominant parasite from 10 Prefectures, *Apanteles taragamae* from 7, *A. molestae* from 3, *Elodia flavipalpis* and *Macrocentrus thoracicus* each from 2, and *Phanerotoma grapholithae* and *Eubadizon extensor* were each dominant in 1 Prefecture.

Approximately one out of every five cocoons of the oriental fruit moth either collected or exposed at numerous localities throughout Japan and Chosen in the 2 years were successfully attacked by parasites. Parasitization of hibernating cocoons ranged from 6.5 to 96.8 percent, parasitization of cocoons of the summer generations collected from trap bands and from bark ranged from 5.6 to 39.5 percent, and from 0 to 78.0 percent of the cocoons in corrugated-paper strips pinned to trees were attacked by cocoon parasites. On quince trees cocoons

collected from the bark were more heavily parasitized than those obtained from trap bands. Cocoons exposed on peach trees were more heavily parasitized than those simultaneously exposed on sand pear trees in adjacent orchards, although the same species of parasites were present in both types of orchards. Cocoons located on the trunk and larger branches of peach trees were found to be more subject to attacks by parasites than cocoons located near the terminal twigs. Some species of parasites appear to attack chiefly those cocoons located on certain parts of the trees.

Secondary parasites were found to be of importance in relation to the biological control of the oriental fruit moth in Japan and Chosen. Sixteen and three-tenths percent of the hosts from which parasites of the stages within the cocoon were reared had been attacked by secondary parasites, 97.3 percent of which emerged from the cocoons of twig-larval parasites. Secondary parasitism occurred chiefly in cocoons of the summer generations and was of greatest importance in Chosen, where the cocoons contained a much greater proportion of larvae previously attacked by twig-larval parasites than those in Japan.

Several of the more important species of parasites found to attack the oriental fruit moth in Japan and Chosen were exported to the United States during 1932 and 1933.

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