

## PARASITES OF AMORBIA AND THE OMNIVOROUS LOOPER IN AVOCADO ORCHARDS

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Recent surveys have disclosed that **Amorbia essigana** Busck (fig. 1) and the omnivorous looper, **Sabulodes caberata** Gu. (fig. 2), the two most destructive caterpillars feeding on avocado, are generally distributed throughout the avocado-growing areas of southern California, and in Tulare County. Numerous field experiments have demonstrated that in most areas these two species of insects are generally kept under excellent control by various complexes of natural enemies.

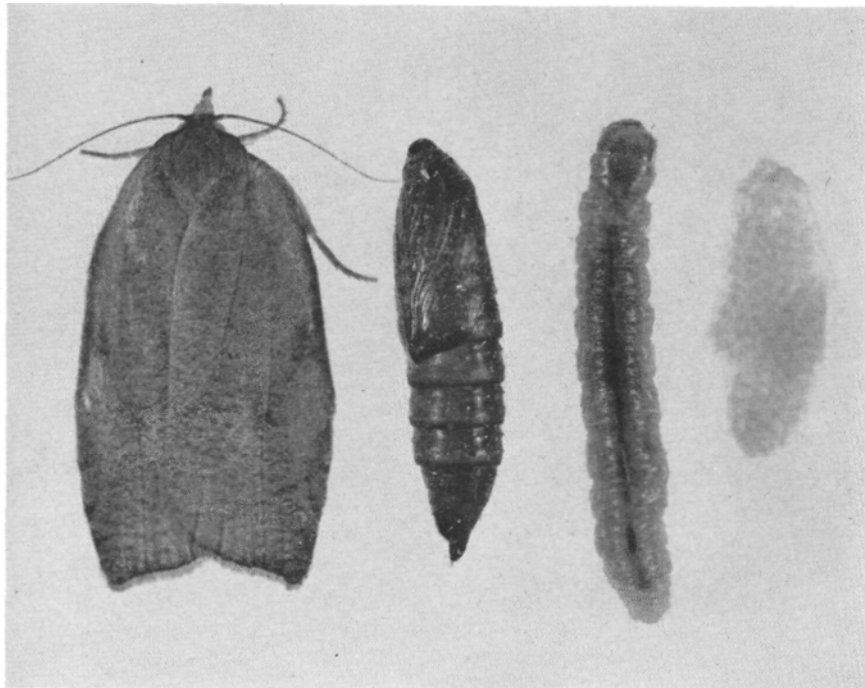


Fig. 1. Life-cycle stages of *Amorbia essigana* Busck. Left to right—adult, pupa, fully developed larva, and egg mass. Natural size of adult is about 17 mm. long.

During the past several years studies have been in progress to ascertain the life histories and habits of the natural enemies of both the *Amorbia* and the looper to determine their relative effectiveness in the control of each.

These investigations are a portion of the work now in progress on the University of California research project #1741 entitled "The Effect of Pesticides on the Natural Balance of Mites and Insects in Avocado Orchards." As this is a relatively new project, the studies of natural enemies of *Amorbia* and the looper are far from complete. The data given in this paper are a brief summary of the information obtained to date.

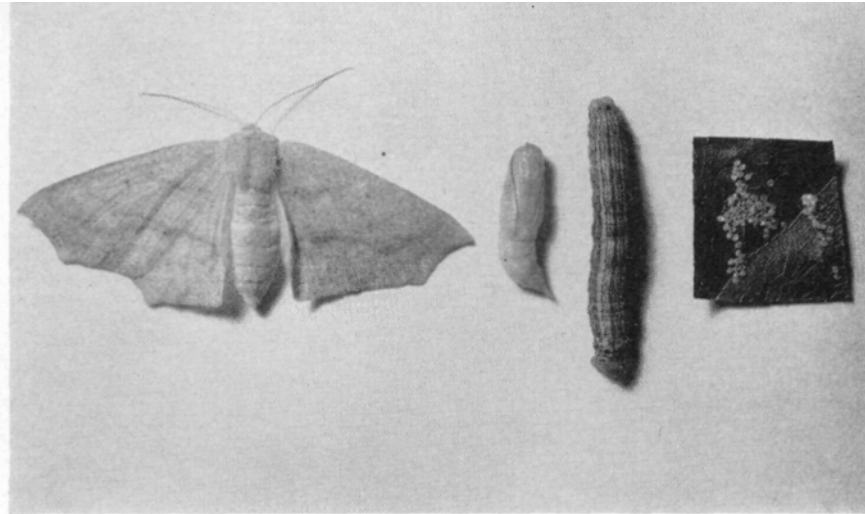


Fig. 2. Life-cycle stages of the omnivorous looper, *Sabulodes caberata* Gu. Left to right—adult, pupa, fully developed larva, and egg mass. Natural size of adult is about 45 mm. wingspread.

All of the life history records given here were obtained from parasites reared in the insectary at Riverside. During the course of these studies the temperature was maintained at about 80° F. with 50% relative humidity.

## PARASITES OF THE EGGS OF THE AMORBIA AND OF THE OMNIVOROUS LOOPER

Two egg parasites of these pests are known. One of them, ***Trichogramma minutum*** Riley, parasitizes the eggs of both species; the other, ***Telenomus*** sp., has been found only in eggs of the looper. These parasites in general play a relatively minor role in the control of *Amorbia* and the looper. ***Trichogramma*** is the more effective of the two.

***Trichogramma minutum***, a tiny parasitic wasp about ½ mm. in length (fig. 3), is a member of the family Trichogrammatidae. The adult female varies in color from lemon yellow to dark brown, depending on the temperature to which it is subjected during growth. The lower the temperature during its developmental stages, the darker the color of the adult. ***Trichogramma*** is a cosmopolitan parasite on the eggs of many insects. It has been recorded from over 150 host species representing seven orders of insects. The majority of its hosts are eggs of moths and butterflies.

In general from one to three, sometimes more, adults of ***Trichogramma*** emerge from a single egg of the *Amorbia* or of the looper. When the adult parasite is ready to leave the

egg, it gnaws an emergence hole in the shell. All parasites developing in an egg leave through the same exit hole. Females are able to oviposit the same day they emerge. A **Trichogramma** female will not oviposit in eggs already containing her own larvae or pupae or those of another female. The sex ratio of **Trichogramma** is about two females to one male. Completion of the life cycle of **Trichogramma** take about one week.

A method for the economic mass production of **Trichogramma** has been developed by S. E. Flanders of the Department of Biological Control, University of California. As a consequence of this development, **Trichogramma** is now being produced by the millions in commercial insectaries. Mass releases of these commercially-produced **Trichogramma** have been used with varying degrees of success in the control of pest species on a number of crops. It is planned to use periodic mass releases of **Trichogramma** experimentally in attempts to quickly reestablish control of the Amorbia and the looper in groves where the natural balance has been upset.

**Telenomus** sp., the other known parasite of looper eggs, is a small black parasitic wasp about  $\frac{3}{4}$  mm. long (fig. 4). The specific name of **Telenomus** has not yet been determined and very little study has been done on its life history. It is interesting to note, however, that 7 species of the family Scelionidae, to which **Telenomus** belongs, have been used successfully in biological control projects. Perhaps when more information is available on the life history and habits of **Telenomus**, it can be used more effectively in the biological control of the looper.

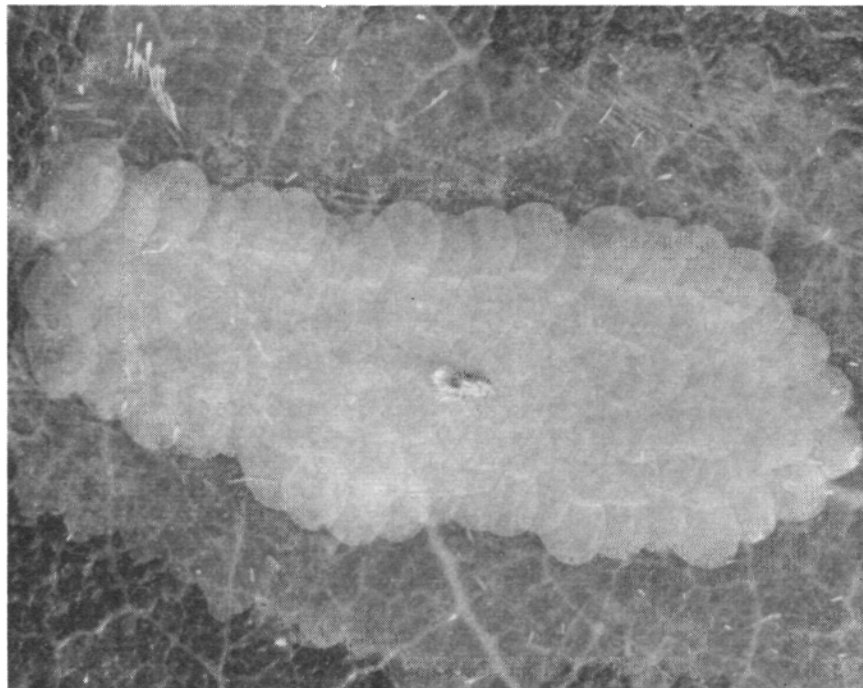


Fig. 3. Parasitic wasp *Trichogramma minutum* Riley, in center of egg mass of *Amorbia essigana* Busk.

## PARASITES OF AMORBIA CATERPILLARS

During the past year a small parasitic wasp, **Elachertus proteoteratis** Howard, was largely responsible for curtailing a potentially serious outbreak of the Amorbia in certain groves in the Riverside area. **Elachertus**, a member of the family Eulophidae, is about 1½ mm. long (fig. 5). It has a black thorax and brownish yellow abdomen and legs. **Elachertus** parasitizes Amorbia caterpillars from 6 mm. to 28 mm. long.

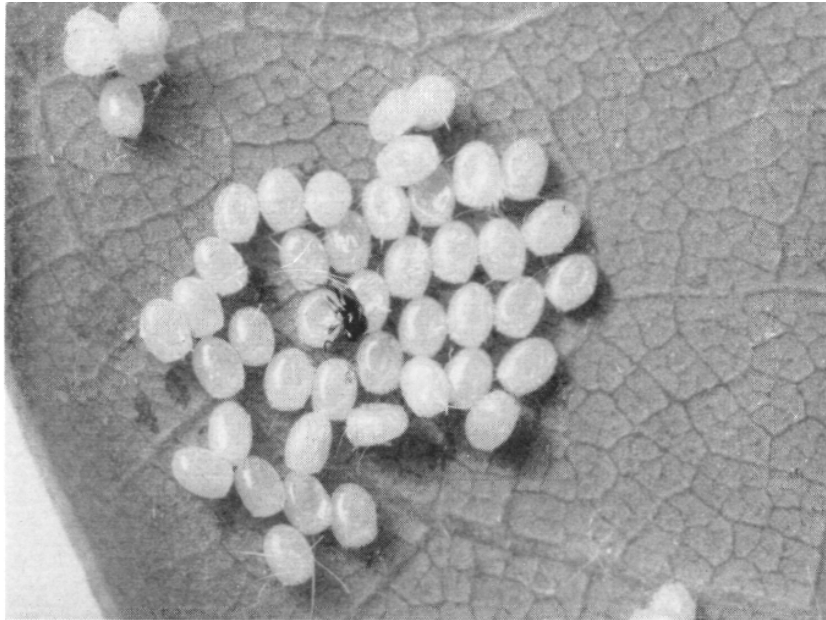


Fig. 4. Parasitic wasp *Telenomus* sp. in center of egg mass of the omnivorous looper.

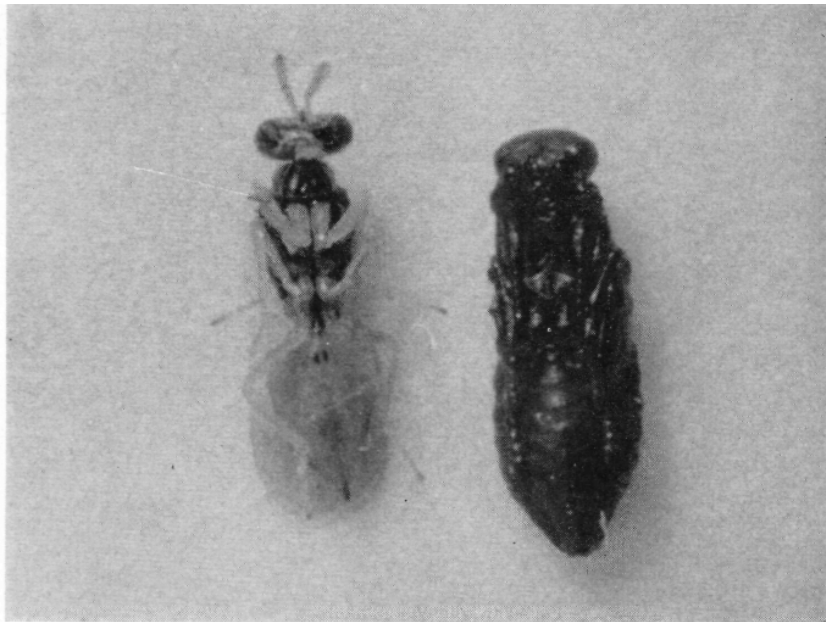


Fig. 5. Left to right—adult and pupa of the parasitic wasp *Elachertus proteoteratis* Howard, a parasite of Amorbia caterpillars.

The eggs of **Elachertus** are laid in the loose webbing which surrounds the caterpillar of *Amorbia*. This webbing, spun by the caterpillar, binds together the leaves or fruit between which the caterpillar feeds and it also forms a tunnel in which the caterpillar spends most of its time. Before oviposition the female parasite may sting the caterpillar in the vicinity of the mouthparts and paralyze it. This paralyzing action serves two purposes, to preserve the caterpillar in an edible condition and to prevent it from destroying the young larvae of the parasite. The eggs are very small, oblong, transparent, and almost invisible to the unaided eye. A single female of **Elachertus** will lay from 3 to 27 eggs in the webbing surrounding a single host. These eggs hatch within 36 to 42 hours.

The newly hatched white larvae of **Elachertus** apparently locate the host caterpillar through a sense of smell. Soon after feeding begins they become bright green and shortly before pupation they turn gray. The parasite larvae feed externally on the caterpillar (fig. 6) and complete their development in four to five days. As many as 27 **Elachertus** larvae have developed on a single host.

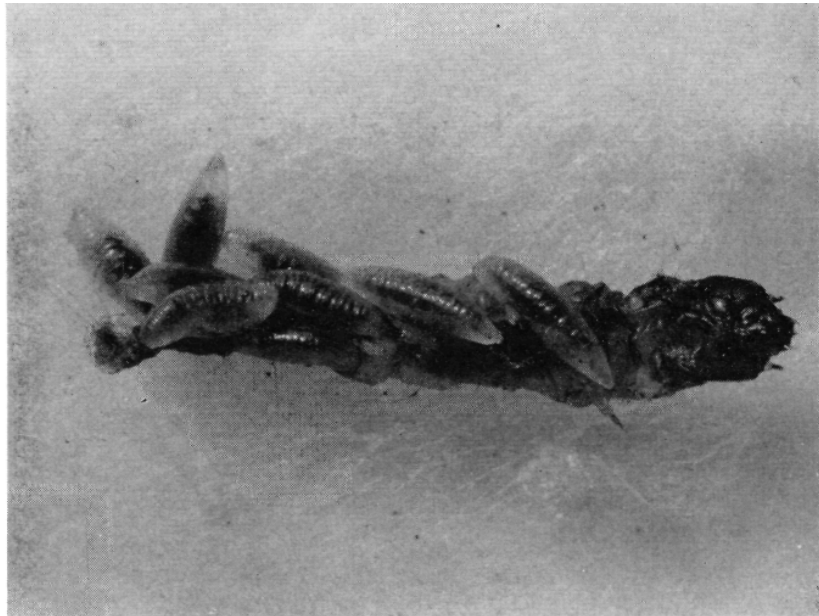


Fig. 6. Larvae of the parasitic wasp *Elachertus proteoteratis* Howard, feeding on *Amorbia* caterpillar.

Pupation and metamorphosis takes place near the host caterpillar. No cocoon is spun, the pupae develop naked (fig. 5). At first the pupa is yellowish white; later it turns yellow brown and finally black. The pupal stage is completed in about 7½ days.

The mating of **Elachertus** takes place soon after emergence. This is followed by a preoviposition period of from 2 to 6 days. Adults live from 14 to 37 days in the insectary. The life cycle of **Elachertus** is completed in about 16 days.

Another parasite of the *Amorbia* caterpillar commonly found in the Riverside area is an unidentified ichneumonid wasp belonging to the subfamily Pimplinae. For the present it

is referred to as Ichneumonid "A." It is a medium size, reddish-brown parasite with a body length of about 7 mm. The females have a long, conspicuous ovipositor which extends about 3½ mm. beyond the body proper (fig. 7).

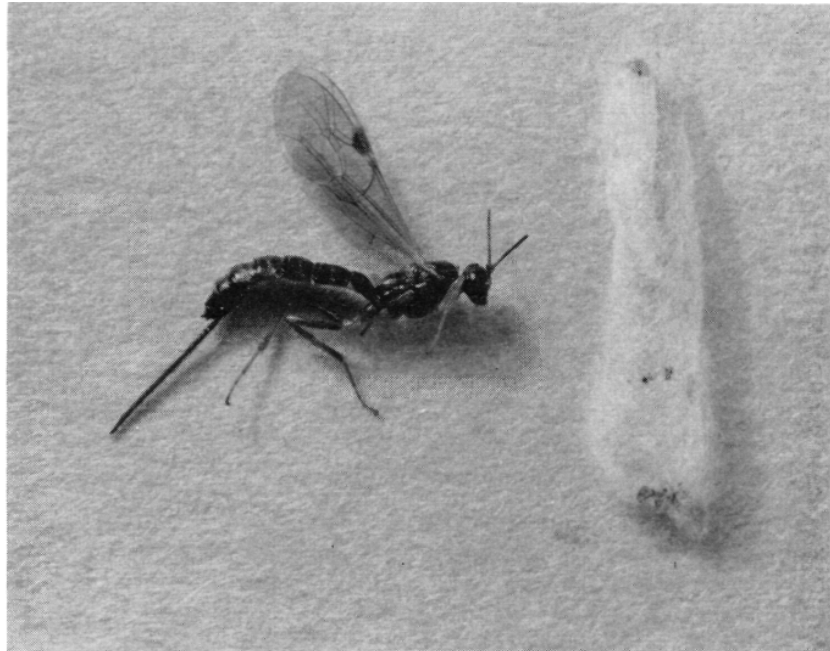


Fig. 7. Adult female and cocoon of Ichneumonid "A," a parasite of Amorbia caterpillars.

Although the life history of Ichneumonid "A" has not been fully determined, the following information has been obtained. A single female will lay about five eggs in the loose webbing surrounding the Amorbia caterpillar. The larvae feed externally. When newly hatched, the parasite larvae are white and clear, but as development proceeds a brownish body fluid containing white spots, probably fat bodies, can be seen through the transparent integument. They change feeding positions frequently, crawling rapidly from one spot to another. The larval period is completed within three days. As many as six Ichneumonid "A" will develop on a single host.

When fully developed the parasite larvae crawl a short distance away from the host to pupate. A loose, flimsy, white cocoon is spun (Fig. 7). The pupa is white at first but turns brown just before it completes development. The pupal period is between 10 and 12 days.

The female of Ichneumonid "A" in locating an Amorbia caterpillar in its tunnel between two leaves examines the exposed leaf surfaces with a tapping movement of her antennae. When a caterpillar is found, she pierces the leaf with her long ovipositor and deposits her eggs in the loose webbing surrounding the caterpillar.

## PARASITES OF AMORBIA PUPAE

The most effective and widely distributed parasite of *Amorbia* pupae is the tachinid fly, ***Phorocera erecta*** Coq. ***Phorocera*** is a black fly about 7 mm. long (Fig. 8).

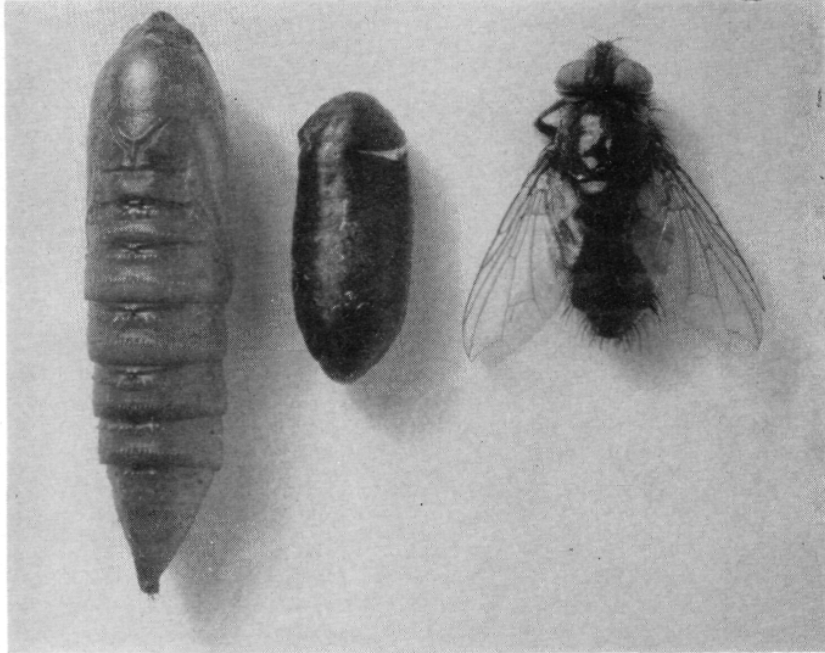


Fig. 8. Left to right—pupa of *Amorbia*, puparium and adult of *Phorocera erecta* Coq. *Phorocera erecta* is a parasite of *Amorbia* pupae.

It is rather common to find the brown parchment-like pupal case (Fig. 8) of ***Phorocera*** near the shells of the *Amorbia* pupa discarded by the full-fed ***Phorocera*** larva. Life history data on ***Phorocera*** have not yet been obtained.

Another parasite of *Amorbia* pupae is an undetermined ichneumonid currently designated as Ichneumonid "B." This is a reddish-brown parasitic wasp (Fig. 9), the female having a body length of about 9 mm., not including the ovipositor which extends about 2 mm. beyond the body proper.

The eggs of Ichneumonid "B" are laid in the loose webbing surrounding the *Amorbia* pupa, the latter being generally found between two leaves previously tied together with webbing produced during its caterpillar stage. Ichneumonid "B" locates the pupa by tapping the leaf surfaces with her antennae. When a pupa is located the parasite pierces the leaf with her ovipositor and deposits her eggs in the webbing near the pupa. Although several eggs may be deposited, competition permits only one parasite larva to complete its development.

The young parasite larva bites through the pupal case at the tip of the wing covering and begins feeding. While remaining mostly external with head inside its host, it grows rapidly, feeding first posteriorly then anteriorly into the *Amorbia* pupal case until the entire contents of the pupal case have been consumed (Fig. 9). The large larva then

spins a white cocoon partly within the anterior portion of the empty pupal case (Fig. 9). Mating takes place soon after emerging. Adult females generally live about 20 days in the laboratory.

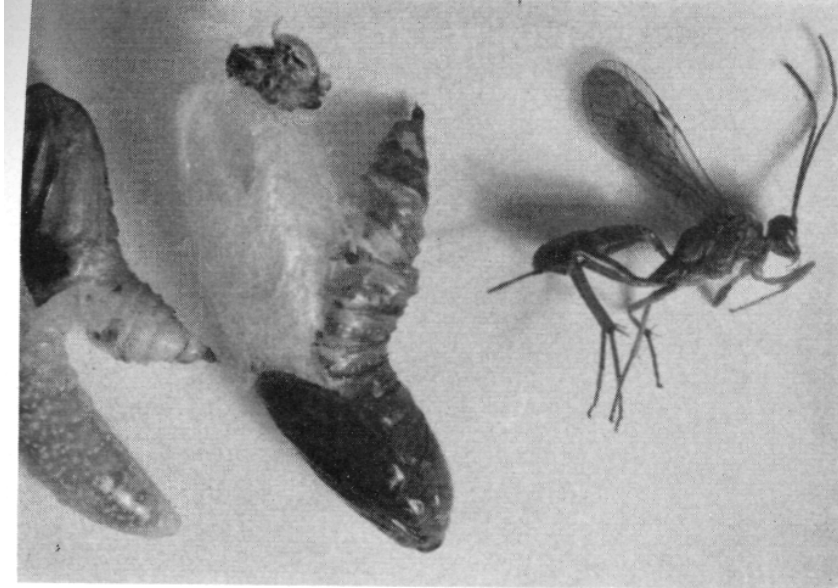


Fig. 9. Left to right—larva, cocoon, and adult of Ichneumonid "B," showing the parasite larva feeding on the pupa of *Amorbia* and the cocoon of the parasite partially contained within the pupal skin of *Amorbia*.

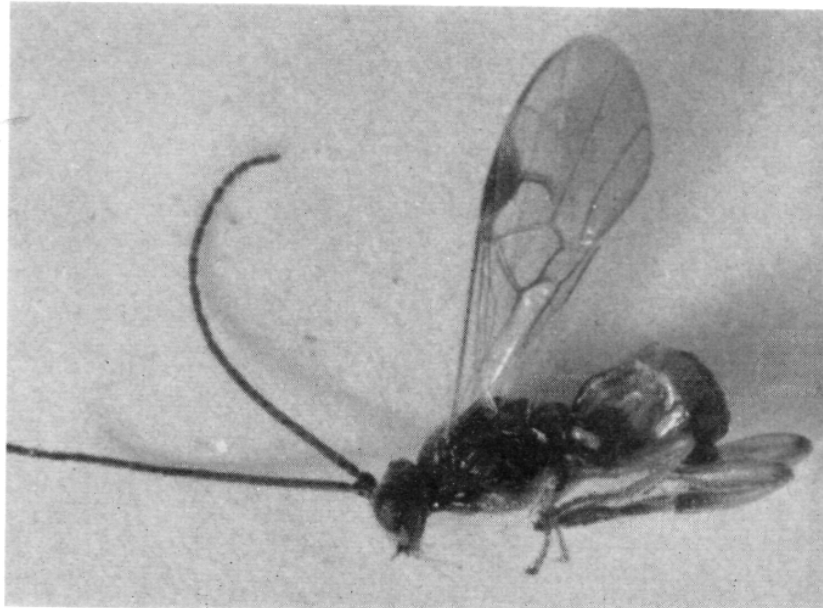


Fig. 10. Adult of *Apanteles caberatae* Mues., a parasite of omnivorous looper caterpillars.



## PARASITES OF OMNIVOROUS LOOPER LARVAE

One of the most widespread and effective parasites of looper larvae is **Apanteles caberatae** Mues. During a study in the Palmer Orchard in Carlsbad in the summer of 1954, it was observed that **A. caberatae** together with **Meteorus tersus** (discussed below) were responsible for perfect control of a potentially serious looper infestation (Fleschner 1955). Random samples of small loopers in the grove at this time were well over 90% parasitized by one or the other of these parasites. During the study as many as 11 **Apanteles** and 9 **Meteorus** adults were collected daily from a 200-leaf observational limb. **Apanteles** is an effective parasite of looper larvae in avocado orchards throughout southern California. **Meteorus**, however, has thus far been found only in San Diego County.

**Apanteles caberatae**, a member of the family Braconidae, is a black parasitic wasp about 2½ mm. in length (Fig. 10), which lays a single egg internally in small looper caterpillars (second or third instar). The caterpillar thus parasitized continues to feed until the parasite larva is fully developed. Upon completion of its development the **Apanteles** larva chews an exit hole in the side of its host near the posterior end and emerges; only then does the host die. The emerged larva generally pupates in an elongate white cocoon near its host. The completion of the life cycle of **Apanteles** takes from 17 to 20 days.

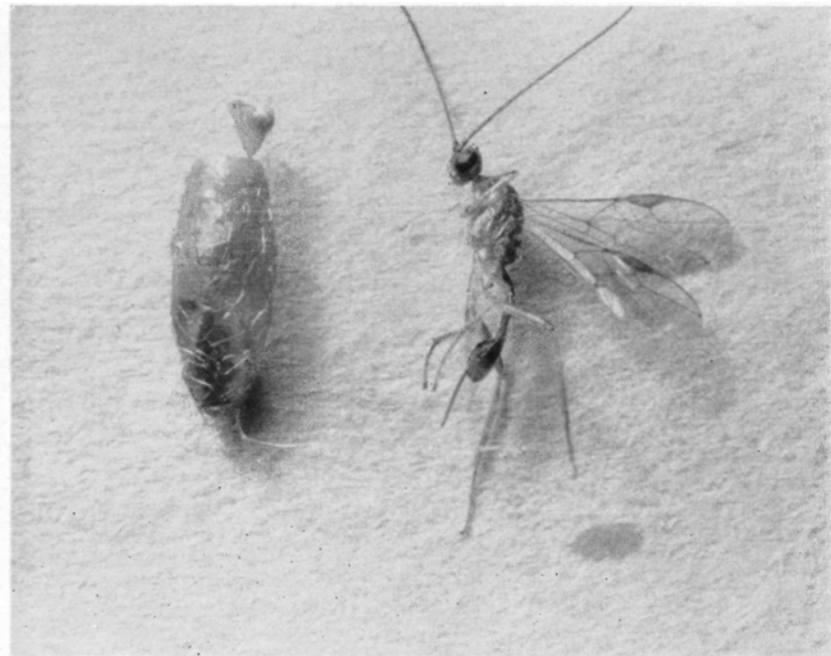


Fig. 11. Left to right—cocoon and adult of *Meteorus tersus* Mues., a parasite of omnivorous looper caterpillars.

**Meteorus tersus**, a member of the family Braconidae, is a yellowish brown parasitic wasp about 3½ mm. long (Fig. 11). The life cycle of **Meteorus** is similar to that of **Apanteles caberatae**, as noted above. The **Meteorus** female lays a single egg in a

small looper caterpillar. The caterpillar continues to feed until the **Meteorus** larva is fully developed. The parasite larva then emerges from the caterpillar and the caterpillar dies.

The cocoon of **Meteorus** (Fig. 11) differs strikingly from that of **Apanteles**. Soon after the larva of **Meteorus** leaves the body of its host it suspends itself nearby from a leaf or twig on a silken thread about 1½ inches long. At the lower end of this thread it spins a brown, parchment-like cigar-shaped cocoon.

At times large numbers of these conspicuous cocoons may be seen suspended from leaves in avocado orchards in the coastal areas of San Diego County. The life cycle of **Meteorus** is completed in the insectary in about 16 days.

Perhaps the second most important parasite of the looper is **Bracon xanthonotus** Ashm. **Bracon** is a parasitic wasp, about 3 mm. long (Fig. 12), and it has yellow-brown legs, a black thorax, and a white abdomen with brown spots. **Bracon** occurs in avocado orchards throughout southern California. A severe outbreak of looper, which developed in an experimental block of avocados on the Limoneira Ranch in the fall of 1956, was brought under excellent control by **Bracon**. During the same period loopers in experimental blocks on the Thille property in Santa Paula were heavily parasitized by **Bracon**.

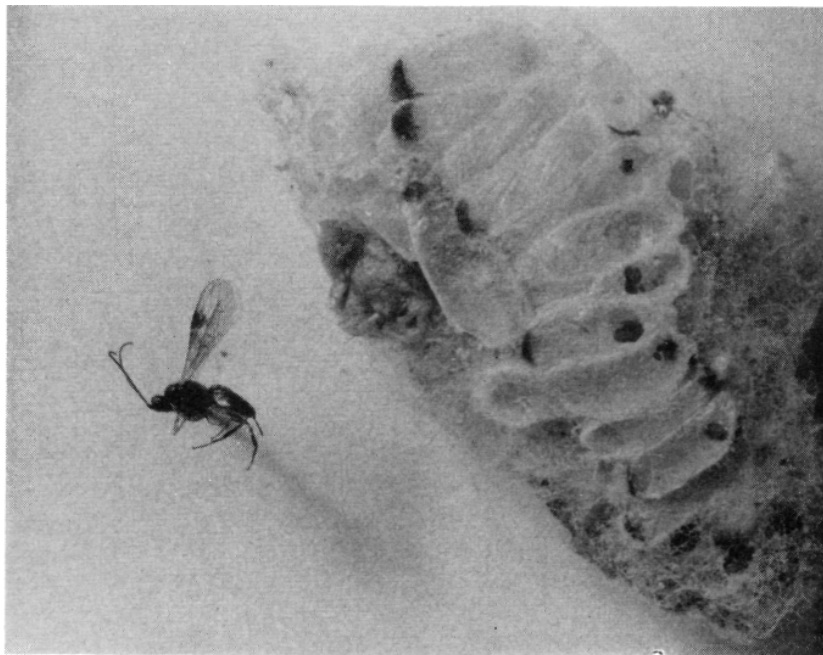


Fig. 12. Adult and cocoons of *Bracon xanthonotus* Ashm., a parasite of omnivorous looper caterpillars.

The female **Bracon** paralyzes the looper caterpillar by stinging it near the head; thereupon the parasite lays her eggs externally on various parts of the host, 15 to 78 eggs being laid on a single host. The eggs are elongate, pearly white, and so small that they are almost invisible to the unaided eye. The eggs mature in about 36 hours.

The **Bracon** larva is whitish and its body is covered with small protrusions. As it approaches pupation it works its way beneath the decaying caterpillar. The larval period is completed in about 5 days.

Generally, the entire group of parasite pupae developing from a single host is found enclosed in loose white cocoons, in a single cluster adjacent to the remains of the host (Fig. 12). The pupal period is completed in about 9 days. The adult parasite emerges through round holes in the end of the cocoon.

Another parasite of looper caterpillars of unknown importance, but worthy of mention at this time, is an undescribed species of the genus **Zebe**, which is currently designated **Zebe "A."** This is a reddish-orange parasitic wasp about 9 mm. long belonging to the family Braconidae. To date it has not been found in any commercial avocado-growing areas of southern California. It was, however, apparently working effectively as a parasite of looper caterpillars near Lemon Cove in December of 1956. In this instance, a half-hour search of a cluster of about 10 Mexican seedling avocado trees resulted in the discovery of 7 looper caterpillars ranging in developmental stages from the third to fifth instars. Subsequent insectary rearing of these seven caterpillars at Riverside disclosed that six of them were parasitized by **Zebe "A."** Because of the high degree of parasitism demonstrated by **Zebe** in this instance, efforts will be made to rear this parasite in large numbers in the insectary at Riverside and to get it established in all avocado-growing areas of southern California.

## **PARASITES OF OMNIVOROUS LOOPER PUPAE**

**Zenillia virilis** A. & W., a tachinid fly, is the only commonly occurring parasite of looper pupae thus far discovered. It is a gray-black fly about 8 mm. long (Fig. 13). The pupal case of **Zenillia** is elongate, dark-reddish brown and parchment-like (Fig. 13). Such pupal cases, either empty or containing pupae, are commonly found beside dead looper pupae which were parasitized by **Zenillia**.

**Zenillia** is widespread and at times very effective. In the Thille avocado orchard at Santa Paula in the fall of 1956, about 75% of the looper pupae collected at random were parasitized by **Zenillia**.

Complete life history studies will be made of **Zenillia** in the near future.

As was stated in the beginning, the information herein presented is somewhat fragmentary. Many natural enemies such as general predators and disease organisms have not been considered. However, the entire natural enemy complexes of **Amorbia essigana** and the Omnivorous looper are now being studied. Every effort will be made to utilize natural enemies more effectively in the control of these pest species.

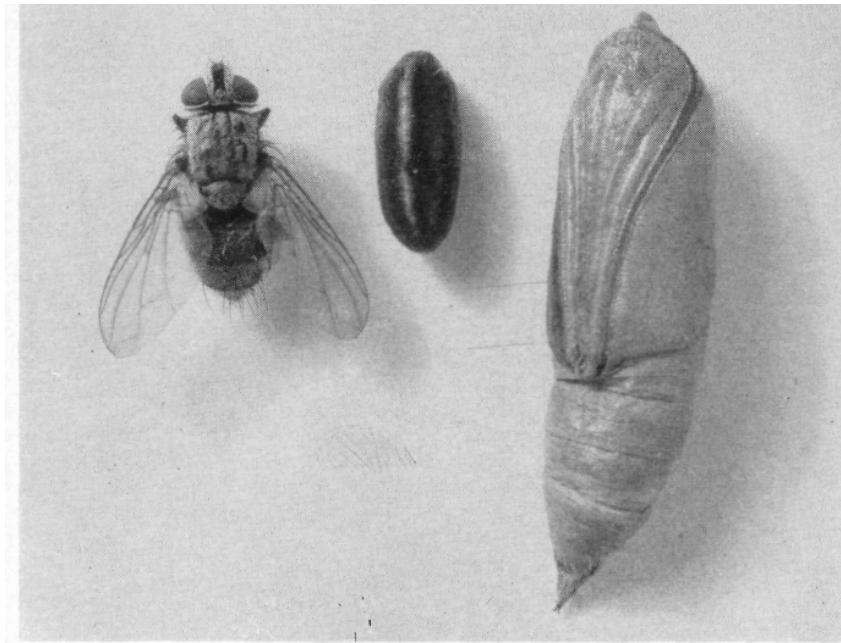


Fig. 13. Left to right—adult and cocoon of *Zenillia virilis* A. & W. and pupa of the omnivorous looper. *Zenillia virilis* is a parasite of omnivorous looper pupae.