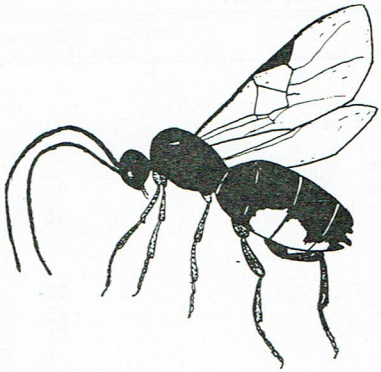

Fig. 16. *Apanteles militaris,* an important parasite of the armyworm. Greatly enlarged. Drawing by S. Marcovitch.

Fig. 17

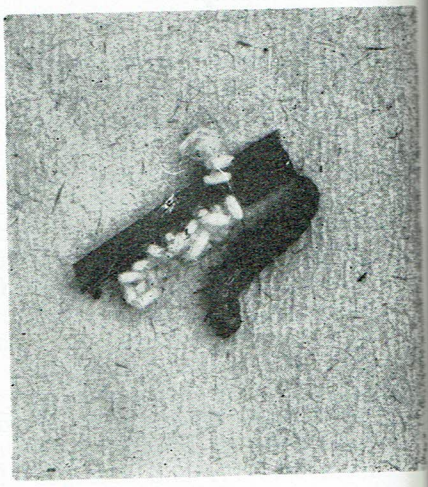

Fig. 18

Fig. 17. Larvae of *Apanteles militaris* emerging from an armyworm host. Slightly enlarged.

Fig. 18. Cocoons of *Apanteles militaris.* Natural size.

armyworm destroy an adult *Apanteles* in flight. The female parasite will attack any size armyworm, but the third and fourth stages seem to be the most vulnerable to their attacks in so far as success of the parasite is concerned. Extremely small armyworms are killed by the initial attack, and larger larvae being tough skinned, are more resistant, as well as too near maturity to allow time for *Apanteles* development.

In the early summer of 1957, four generations of *A. militaris* were reared by the writer. In these rearings the time from oviposition to cocoon spinning ranged from ten to twenty-one days and averaged thirteen days, and adults issued in from four to six days, for an average of five days after cocoon spinning for a total development time which averaged eighteen days. These records are given in table 31.

That *A. militaris* is capable of overwintering in the larva of the armyworm is evidenced by two such occurrences duing the winter of 1957. Two armyworms from a batch of larvae collected on January 9, 1957, near Dandridge, Tennessee, were parasitized by *A. militaris*. One of these armyworms, collected as a sixth instar larva, died February 20, 1957, and dissection yielded sixty-eight living larvae of *A. militaris*. The other specimen was collected as a fourth instar larva, moulted twice during the winter, and yielded seven *A. militaris* larvae which successfully spun cocoons on April 1, 1957. Thus, in this latter specimen, the parasitic larvae lived for a minimum of two and one-half months. The host worm died on April 6, 1957, six days after emergence of the parasitic larvae.

The biology of *A. militaris* has been studied and reported on by Tower (1915).

Meteorus autographae Mues. This parasite was reared from six armyworm specimens in 1956 and from eleven specimens in 1957, thereby accounting for 3.2 per cent and 5.6 per cent of all reared parasites for those two seasons respectively. The species has been collected only during the month of May in Tennessee, but was reared from an August collection of Nebraska worms sent to the writer by L. W. Anderson of the University of Nebraska.

Table 31. Duration of Larval and Cocoon Stages in Four Generations of *Apanteles militaris* During the Summer of 1957.

Date of			Duration in days	
Oviposition	Cocoons	Adults	Larvae	Pupae
May 14	June 4	June 8	21	4
June 8	June 18	June 24	10	6
June 24	July 5	July 10	11	5
July 10	July 21	July 26	11	5
Average of Four			13.2	5.0

The female of *M. autographae* apparently oviposits in the early larval stages of the armyworm and the solitary larva of the parasite emerges from the armyworm when the latter is in the fifth instar. The larva of the parasite spins a golden-brown, oval cocoon about 5 mm. in length and 1.7 mm. broad, which is attached to the host plant or other object by a silken thread. Rearing records of four specimens show that the cocoon stage lasts from three to eleven days.

The adult and cocoon of this species is shown in figure 19.

Rogas terminalis Cress. This parasite represented 5.4 per cent of all parasites reared during the 1956 season and 22.6 per cent during the 1957 season. According to Pennington (1916), the parasite copulates immediately upon emergence

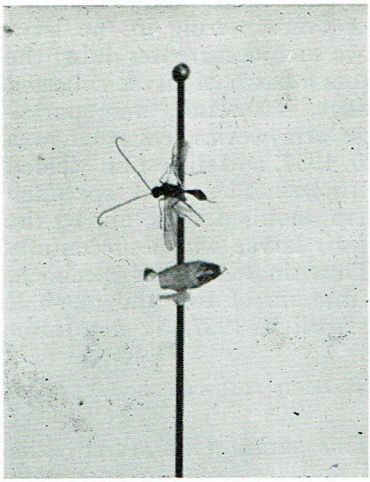

Fig. 19

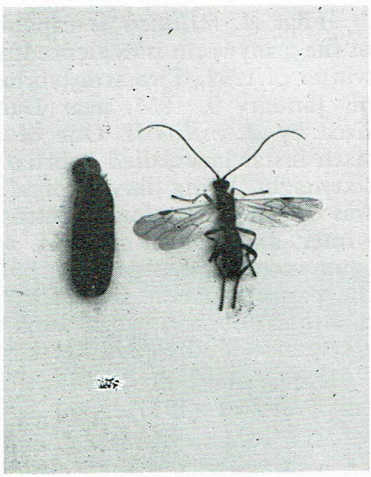

Fig. 20

Fig. 19. Cocoon and adult of *Meteorus autographae*. About twice natural size.

Fig. 20. Cocoon and adult of *Rogas terminalis*. About twice natural size.

with oviposition following rapidly. The white egg is elongate oval with the sides nearly parallel and measures .18 mm. in length and .09 mm. in diameter. Apparently only one egg is deposited. The cocoon of the species (figure 20) is made of the transformed and reinforced larval skin of the host. The shape is fusiform with the ventral surface flattened and affixed to the obpect on which it rests by a black exudation. The surface of the cocoon is turgid, almost obliterating the segmentation of the host larval skin, and is deep reddish-brown to black. The length measures from 9 to 10 mm. and the width about 3 mm. The adult parasite emerges by gnawing an irregular hole caudad in the dorsum of the host skin.

Records of twenty reared specimens show that the length of time spent in the cocoon ranges from six to fourteen days and averages ten days. Pennington (1916) states that the parasite hibernates in the pupal stage.

The adult and cocoon of *R. terminalis* are shown in figure 20.

Rogas aciculatus Cress. This species was reared from only one host armyworm captured May 16, 1957, in Blount County, Tennessee. It forms a cocoon similar to that of *R. terminalis* but somewhat smaller and a lighter brown color. The specimen formed its cocoon on May 30, 1957, and the adult parasite issued on June 13, 1957, after a total of fourteen days in the pupal stage.

Hymenoptera: *Ichneumonidae*

Enicospilus sp. A total of twenty-six specimens of a large ichneumonid parasite was reared during the two-year course of this study. The specimens were identified by the U. S. National Museum personnel as *Enicospilus* sp. Members of this genus are noted as being parasitic on larvae of the family Noctuidae. During 1956, *Enicospilus* parasites were reared from seventeen specimens, accounting for 9.24 per cent of all parasites, and in 1957 they were reared from nine specimens representing 4.5 per cent of all parasites.

This parasite was observed always to kill the armyworm host in the sixth instar. The parasitic larva, upon emergence from the host, spins a large golden to dark brown cocoon measuring about 10.0 mm. in length and 5.0 mm. in width. The duration of the cocoon stage in two specimens successfully reared to adult was eight and seventeen days respectively during June of 1956. The parasite apparently undergoes one and at the most two generations per year.

Campoletis oxylus (Cress.). This parasite was reared from only seven specimens of the armyworm, one in 1956 and six in 1957. The cocoon is of a medium brown color and measures 6.5 mm. in length and 2.5 mm. in width. No biological data were obtained on the species.

The adult and cocoon are shown in figure 21.

Hyposoter sp. This species was not recovered in 1956, but was one of the more abundant ones during 1957 when it accounted for 19.6 per cent of all parasites reared. It was found throughout the month of May in nearly all fields examined where armyworms were present. The solitary larvae emerges from the armyworm host and spins a white cocoon with an irregular black band at either end. The cocoon measures 6.0 mm. in length and 2.5 mm. in width. The adult issues from the cocoon in from three to fourteen days. The cocoon and adult are pictured in figure 22.

Hymenoptera: *Eulophidae*

Euplectrus plathypenae Howard. This parasite was reared from four armyworms collected July 20, 1956, from Hamblen County, Tennessee. A total of seven females and five males was reared from the four armyworms. One of the parasites was collected in the egg stage. The eggs hatched in three days. The larval developmental time was three days and the pupal period was nine days for a total developmental time of fifteen days. The larvae of this species feed in a cluster externally on the

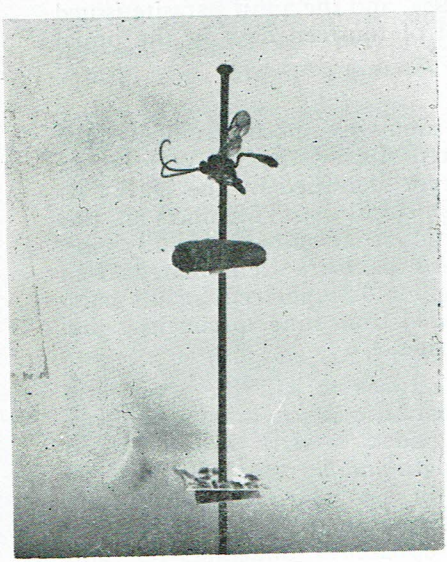

Fig. 21

Fig. 22

Fig. 21. Cocoon and adult of *Campoletis oxylus*. About twice natural size.
Fig. 22. Cocoon and adult of *Hyposoter* sp. Slightly enlarged.

host "worm." They finally destroy the host and spin their cocoons in a row under the outstretched skin of the dead host.

Diptera: *Larvaevoridae* (*Tachinidae*)

Tachinid flies have always played a large role in the parasitic destruction of armyworms during outbreaks. A brief review of the literature will serve to establish their importance. Riley (1883) states that "the worms never abound or travel from one field to another but they are accompanied by a number of two-winged flies, which are often so numerous that their buzzing reminds one of that of a swarm of bees." Howard (1896) says "hundreds of thousands of these flies (tachinid

flies) are usually seen buzzing about a field infested by the armyworm." The same author is quoted below.

> In 1880 we visited a large tract of land planted in timothy grass in the vicinity of Portsmouth, Virginia. A search for hours during the hot part of the day failed to show a single worm which did not bear tachinid eggs.

Knight (1916) stated that two species of parasitic flies, *Winthemia quadripustulata* Kabr. and *Goniomima unifasciata* Desv. parasitized from 50 to 60 per cent of the worms in certain fields in New York during 1914.

Sherman (1915) working in North Carolina, collected 534 armyworms with a total of 1,313 parasite eggs. A total of only 18 adult armyworm moths was obtained from this group and 296 parasitic flies were reared.

The writer has observed the buzzing flight of these parasitic flies on two occasions on the farm of Tinsley Allen in Monroe County, Tennessee, on May 21, 1956, and May 17, 1957. On the former date, hundreds of armyworms were examined, practically all of which had tachinid eggs.

During 1956, 52.17 per cent of all parasites reared from 569 field-collected armyworms was parasitized by flies of this family. During 1957 accurate records could not be obtained since rearings were made difficult by the presence of a virus disease among field-collected specimens.

It is unfortunate that tachinid parasites do not attack the host until the latter is nearly mature and thus has accomplished its most destructive work. In spite of this fact, these parasites of the armyworm function efficiently by destroying large numbers of a given generation of larvae and thus greatly reduce succeeding generations.

Winthemia rufopicta Big. (figure 23). The most important of eight tachinid fly species reared during the two-season study of the writer was *Winthemia rufopicta* Big. This species is discussed in detail, but other species were so infrequent that only brief notes are given. This fly oviposits on larvae of the fifth and sixth instars. Eggs are attached tightly to the dorsum of the thoracic segments of the host. The number of eggs placed on one larva is usually two or three; however, the writer on one occasion found thirteen eggs on one individual.

The egg hatches almost immediately upon deposition. The tachinid larva emerges from the side of the egg next to the "worm," and bores directly through the body wall of the host. The victim is active during most of the time the maggot is feeding, but dies before the parasite emerges. Usually more than one fly larva develops in the host armyworm. The number of fly puparia of this species obtained from twenty-one host armyworms ranged from one to nine and averaged 2.3 per

host. Figure 24 shows developing larvae of this species in a dead armyworm host.

It is interesting that this fly always deposits eggs on nearly mature larvae. If the eggs were placed on young larvae, there would be a chance of the eggs being eliminated with the exuvium before they had a chance to hatch.

A review of table 26 will show the effectiveness of tachinid flies in the control of an armyworm population.

Archytas apicifer Wlk. This species was reared from seven armyworm specimens during the 1956 season and from two during the 1957 season. In all cases, the host armyworm com-

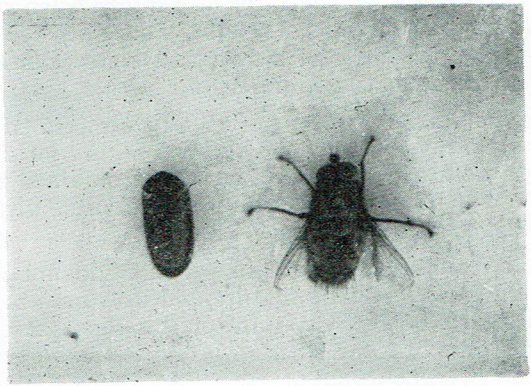

Fig. 23. Puparium and adult of *Winthemia rufopicta,* an important parasite of the armyworm. About twice natural size.

pleted development to the pupal stage and the adult parasite emerged. A normal puparium is formed inside the host pupa, and only one parasite develops per armyworm. The only accurate records obtained by the writer on the duration of development of this species are those from pupation of the armyworm to the emergence of the parasitic fly. This varied from eighteen to twenty-two days for six specimens between August 13 and September 4, 1956. This fly is illustrated in figure 25.

Other Larvaevoridae (*Tachinidae*). Aside from *Winthemia rufopicta* and *Archytas apicifer,* tachinid flies were scarce in number, though six other species were reared from the armyworm by the writer, all during the 1956 season. Three specimens

each of *Achaetoneura aletia* (Riley) and *Wagneria laevigata* (Wulp) were reared. The former species was reared in May and June from a Monroe County, Tennessee, collection and the latter during the same months from a Blount County, Tennessee, collection.

Two of the three specimens of *A. aletia* emerged from the armyworm pupa, while the other formed a puparium after the mature armyworm larva had died. The duration of the pupal

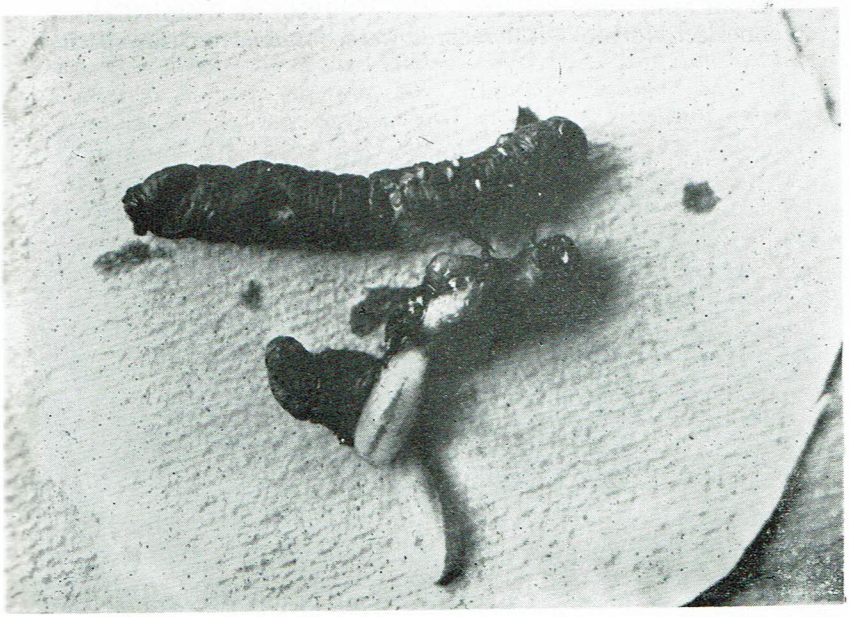

Fig. 24. Larvae of *Winthemia rufopicta* emerging from host armyworm. Note white egg shells of the fly attached to the armyworm skin just posterior to the head. Slightly enlarged.

stage of the other specimen of *A. aletia* observed was eight days, that is, from May 31, 1956, to June 8, 1956.

All specimens of *W. laevigata* formed puparia after the host armyworms had died, two in the sixth instar and one in the fifth. Eight adult flies were obtained from the three armyworm specimens. The pupal periods of the flies ranged from five to nine days.

Two specimens of the tachinid parasite, *Belvosia unifasciata* R. D., both from Monroe County, Tennessee, from armyworm

pupae were reared during June of 1956, and in each case ten days elapsed between pupation of the armyworm host and emergence of the adult fly.

The parasite, *Achaetoneura archippivora* Will. was reared from one armyworm sent to the writer by L. W. Anderson, of the University of Nebraska, from a Lincoln, Nebraska, collection. The host armyworm was isolated on August 9, 1956, and pupated on August 16, 1956. On August 21, 1956, the puparium was formed and on September 9, 1956, the adult emerged.

One specimen of *Encelatoria rubentis* (Coq.) was reared from an armyworm collected May 30, 1956, in Blount County, Tennessee. No biological records were obtained on this species.

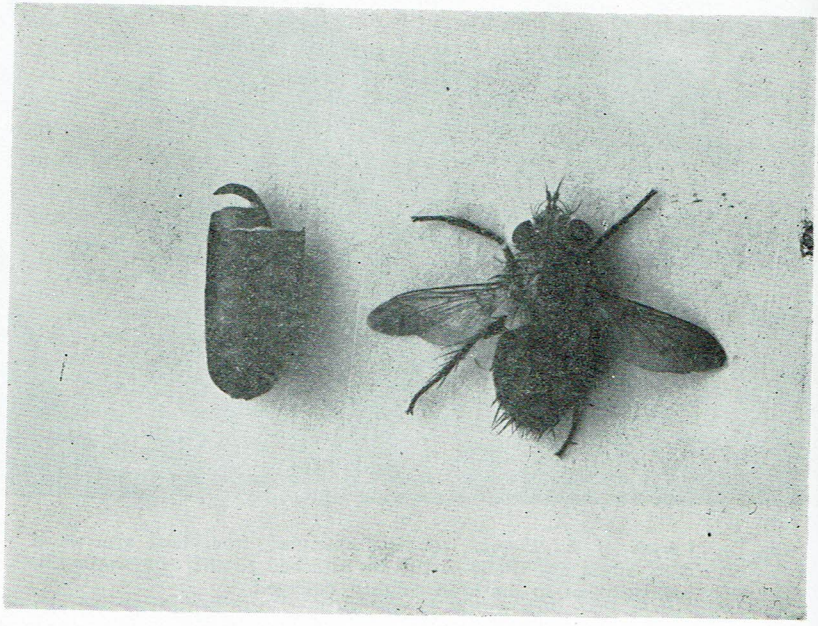

Fig. 25. Puparium and adult of *Archytas apicifer*. Greatly enlarged.

Blepharigena cinera (Coq.) was reared from a specimen from L. W. Anderson, Lincoln, Nebraska. The armyworm was isolated, in its sixth instar, on August 9, 1956. On August 13, 1956, the puparium was formed and on August 29, 1956, the fly emerged.

Predacious Enemies

The writer made no special study of armyworm predators. However, two species of carabid beetles, *Calosoma calidum* and

C. scrutator were consistently found in relatively large numbers in fields moderately to heavily infested with armyworms.

Since predaceous animals form a large segment of the natural enemy complex of the armyworm, the writer has reviewed the literature and compiled pertinent information on known predators of the insect. This information is presented below according to the various animal groups to which the predators belong.

Insects

Coleoptera. Always in fields heavily infested with the armyworm, a large number of predaceous beetles gather and feed extensively upon the worms. Riley (1883) lists fourteen species, namely: *Cicindela repanda* Dej., *Elaphrus ruscarius* Say, *Calosoma extermum* Say, *C. scrutator* (Fabr.), *C. calidum* (Fabr.), *C. wilcoxi* Lec., *Pasimachus elongatus* Lec., *Amara angustata* Say, *Harpalus caliginosus* (Fabr.), *H. pennsylvanicus* (Dej.), *Pterostichus sculptus* Lec., *Anisodactylus rusticus* Dej., *Cratacanthus dubius* (Beauv.), and *Selenophorus pedicularius* (Dej.).

Tryon (1921) lists *Calosoma australis* as a predator in Queensland.

Knight (1916) reports *Calosoma calidum* as the most conspicuous predaceous beetle in the New York outbreak of 1914, other beetles of importance in this outbreak being *Pterostichus lucublandus* Say, *Harpalus calignosus* Fabr., and *H. pennsylvanicus* (Dej.).

Annand (1947) reports that *Calosoma argentinense* Csiki was introduced from Argentina against *P. unipuncta* in Florida.

Engel'hardt (1929) reports that *Calosoma chinense* Kirby destroyed large numbers of first generation armyworm larvae in a Russian outbreak of 1926.

Hemiptera. Riley (1883) lists the thick-thighed *Metopodius femorata* (Fabr.), a large true bug, common in the South as a predaceous enemy of the armyworm.

Luginbill (1928) states that the bug, *Apteticus maculiventris* Say, probably ranks next to *Calosoma* beetles as a predatory enemy of the fall armyworm, *Laphygma frugiperda,* that it is a common enemy of other lepidopterous insects and is considered to be the most useful of our predaceous Hemiptera.

Hu and Tse (1936) list the following pentatomids as predaceous enemies of the armyworm in China: *Andrallus spinidens* F., *Nezara viridula* var. *torquata* F., *Menida histrio* F., *Piezodorus hybneri* Gmel. (*rubrofasciatus* F.), and *Scotinophora lurida,* Burm. These same authors list the coreid, *Cletus punctiger* Dall.

Amphibians

Toads are mentioned by several authors as destroying large numbers of armyworm larvae (Gibson, 1915; Severin, 1920; King and Barber, 1921; Bell, 1936; Lever, 1939). According to Bell (1936) the toad, *Bufo marinus,* was introduced from Hawaii into Queensland, successfully bred in confinement, and liberated for armyworm control. Lever (1939) states that the same species of toad was greatly responsible for reducing an armyworm population in Fiji.

Birds

Riley (1883) states that all of the insectivorous birds feed upon the "worms." He says that the most prominent bird is the bobolink (*Dolichonx oryzivorus*), which has been known to become so numerous in southern Illinois during armyworm years, that it has received the popular name of "armyworm bird." The same author mentions chickens and turkeys as important armyworm predators. King and Barber (1921) also give considerable credit to the bobolink, and Knight (1916) states that poultry were very useful for destroying armyworms in the 1915 New York outbreak. Knight reported that in one field turkeys destroyed the pests so fast that the armyworms had no chance to migrate to adjoining grain fields. Other birds listed in the literature as armyworm predators include: the robin, bluebird, blackbird, meadow lark, and pigeon woodpecker (Flagg and Field, 1896); the swallow, fly catcher, crow, catbird, thrush, sandpiper, screech owl, and sparrow hawk (Warren, 1896); the blue jay, golden-winged woodpecker, and chickadee (Soule, 1897); the starling (Kalmbach and Gabrielson, 1921); the mynah bird, English sparrow, and the golden plover in Hawaii (Swezey, 1908); and the duck in China (Hu and Tse, 1936).

Of the birds listed, some are due special mention. Criddle (1914) states that crows are great destroyers of cutworms and armyworms, and Kalmbach (1918) says that noctuid larvae, including armyworms, are among the first items supplied to newly hatched young of the crow. Kalmbach and Gabrielson (1921) state that the starling has few equals among the bird population of the northeastern United States as an effective destroyer of terrestrial insects which compose 41.55 per cent of its food. They further state that Lepidoptera, chiefly cutworms, are attractive to nestlings, forming 38.1 per cent of the food of young starlings. According to Swezey (1908) the mynah bird was introduced into Hawaii from India in the last nineteenth century to be used as predators against armyworms and cutworms. Swezey reports this bird to be one of the best checks against these in ects in Hawaii.

Mammals

Hogs are reported by Riley (1883) to be important armyworm predators, sometimes to the extent that they die in consequence. The skunk is mentioned by several authors as being predaceous on the armyworm (Warren, 1896; Gibson, 1915; Severin, 1920; Lever, 1939).

Diseases

Virus Diseases

During the summer of 1956 the writer lost a considerable portion of his insectary colony of armyworms from a virus disease, but finally managed to bring the infection under control by dividing the colony into smaller units and applying strict cleanliness. In November of 1956, several hundred apparently healthy "worms" were released into an outdoor cage only to be completely wiped out by the disease within a three-day period.

On May 3, 1957, Mr. W. W. Stanley, University of Tennessee Experiment Station Entomologist, brought a large collection of armyworms to the laboratory from Lincoln and Franklin counties, Tennessee, and reported that worms were numerous in that area. This collection was virtually 100 per cent infected with the same virus disease that had been in laboratory colonies the previous year. On May 7, 1957, Mr. R. P. Mullett, University of Tennessee Extension Entomologist brought in a collection of armyworms from Rutherford County, Tennessee; this, too, proved to be nearly 100 per cent diseased. The author made collections throughout the month of May, 1957, in the east Tennessee area, and all collections were very heavily diseased.

In all of these cases, original observations showed an unusually large number of early season armyworms which were preceded by the highest moth catches at light traps for the first generation since the 1953 outbreak. Subsequent observations, a week or two later, in the same areas examined earlier by Mr. Stanley, Mr. Mullett, and the writer respectively, showed a tremendous decrease in the armyworm population, and no outbreak occurred in any area of the state. The author and his colleagues are convinced that the widespread presence of the virus was of great importance in the destruction of early season armyworm populations in Tennessee in 1957. The disease reappeared in colony worms and persistent care was necessary to prevent the destruction of the colony. It might be noted that the writer's predecessor, Mr. B. K. Dozier, also had a colony of armyworms completely wiped out by the disease in the summer of 1955. Therefore, the disease has been present for three continuous years in Tennessee, 1955-57.

During the 1957 season, the writer sent a container of several specimens showing the symptoms of the virus disease to the U. S. Department of Agriculture Insect Pathology Laboratory, Belts-

ville, Maryland, for identification of the pathogen. This sample showed the presence of polyhedrosis virus. According to Dr. S. R. Dutky (*in litt.*) over nine billion polyhedra were recovered from the specimens submitted for identification.

Terminal stages of the disease are characterized by liquefaction and disintegration of tissues. The symptoms are first apparent when the armyworm becomes listless and begins to discolor, a condition which is rapidly followed by the terminal one. Stages of the disease are shown in figure 26. Tests at the Beltsville laboratory, according to Dr. Dutky, show that the larvae are much more susceptible to infection in the first instar.

Fig. 26. Progressive symptoms of the polyhedral virus disease of the armyworm. Note the complete liquefaction in specimen at the right.

The disease was described by Chapman and Glaser (1915) from whose work I quote.

Clinical Picture

The wilt is characterized by the formation in the bodies of infected caterpillars of polyhedral shaped, highly refractive, angular bodies, which have their origin in the nuclei of the trachel matrix, hypodermal cells, fat cells and blood corpuscles. Later some of these burst and the polyhedra are set free in the blood. When death results they make up a great part of the saponified body tissues of the caterpillars. The caterpillars hang by their prolegs, become flaccid and their skin disrupts at the slightest touch. An examination immediately after death reveals few or no bacteria and no bad

odor. The wilt appears in nature in both a chronic and an acute form. If, however, a dead caterpillar, on microscopic examination, shows no polyhedra it does not have wilt, even though all the gross symptoms may be present.

These authors report the disease from an armyworm outbreak in Long Island, Boston Harbor; Nantasket, Massachusetts; Hagerstown, Maryland; and Norfolk, Virginia. They also refer to the presence of the disease in North Carolina in 1914 and in Illinois and Oklahoma during the same year. This was a prominent armyworm year in the United States.

Glasser and Chapman (1916) state that several forms of polyhedral disease can be distinguished, each characterized by a special type of polyhedra caused by a virus which disintegrates nuclear material of certain tissue cells in such a way that polyhedral bodies are synthesized from the disintegrating proteins. They further state that the polyhedra are therefore not living organisms which are responsible for the disease.

Tanada (1956) reports a virus epizootic which almost exterminated a localized population of the armyworm in Hawaii in 1954. The same author studied some factors that might affect the susceptibility of *P. unipuncta* to this virus and another, a granulosis virus, for which Tanada must be given credit for the first record from the armyworm (1955). In his 1956 paper, Tanada states that resistance of the armyworm to virus infections increased directly with the age of the larvae. The first and second instar larvae were highly susceptible to both viruses, whereas the last four instars were much more resistant. He also made the point that the two diseases, polyhedrosis and granulosis, had a synergystic relationship in his tests, resulting in increased virulence of the pathogens.

Aside from the polyhedrosis and granulosis diseases discussed above, another virus, *Morator nudus* Wasser was described from *P. unipuncta* by Wasser (1952). Wasser believes this to be the first demonstration of a noninclusion type virus which has been verified by means of infectivity tests.

Bacterial Diseases

Gibson (1915) states that large numbers of armyworms were destroyed by a bacterial disease in Ontario in 1914.

In the specimens sent to the U. S. Department of Agriculture, Beltsville, Maryland, by the writer for pathogen identification, three of the diseased specimens were negative for polyhedra but had a heavy bacterial count. It is assumed that these specimens had died from the bacterial infection.

Fungus Diseases

The writer has observed a fungus of the genus *Empusa* from a collection of armyworm larvae collected near Morristown, Tennessee, in August, 1956. The fungus, *Metarrhizium anisop-*

liae (Metsch) was reported from *P. unipuncta* by Williams (1931) and Walkden (1950).

DISCUSSION

Outbreaks of the armyworm are the cause of heavy financial losses to our agriculture, and any practical means that can be devised to prevent their occurrence warrants investigation. Lack of good chemical control measures against the species is not the problem, since several insecticides now on the market give excellent control once an outbreak is discovered. The crux of the armyworm outbreak problem is the element of surprise. A potential outbreak population goes unnoticed since the individuals remain concealed by day and do little feeding until the final larval instar when they begin to feed voraciously as an army of "worms". One can imagine the consequences of a lack of vigilance during the critical "maturing" period of a field of these "worms". If a field harboring a large population of armyworms goes unobserved for a period of several days after the major portion of the armyworm larvae have matured, the application of an insecticide would be virtually useless in so far as that particular field is concerned.

The sporadic nature of armyworm outbreaks is evidenced by the history of the species. Invasions have always come at irregular intervals and no pattern has been set. For example, between 1861 and 1952, the armyworm appeared in Tennessee at intervals varying from one year to thirty-eight years. Thus, if history repeats itself, armyworm outbreaks cannot be expected to occur every year, or at regular intervals in the same area. There is, at present, insufficient information on causes of outbreaks to allow their being predicted on the basis of causative factors. Until we have information that may be relied upon as a basis for forecasting outbreaks, how can we defend our fields against such unpredictable invasions? The answer seems to lie in a thorough knowledge of the life history of the species with reference to its seasonal cycle in an area. The author is of the opinion that losses from the armyworm may be minimized by a simple application of life history knowledge in the proper season each year. A timely warning would do much to prevent armyworm damage in a region, and it is believed that a workable warning system can be developed with a minimum effort once the life history and seasonal cycle of the species is known.

A study of the armyworm has shown that the first brood is the only one which does damage in Tennessee. Knowing this, we need only to determine the time of this flight for the grain-growing regions of the state and calculate the minimum time required for development to the mature larval stage. The minimum expected time in days could be added to the date of the first flight of moths and the resulting date would be the very