LIFE HISTORY AND BEHAVIOR OF EGGPLANT FRUIT BORER, *Leucinodes orbonalis* Guenee

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ABSTRACT

The life history and behavior of the eggplant fruit borer, *Leucinodes orbonalis* Guenee, were studied in the laboratory with pieces of eggplant fruit as food. The insect had five larval instars, with a total developmental period of 23.45 days for the males and 24.39 days for the females. Fecundity was 210 eggs per female, with an average of 65.18 eggs laid per day in 3-4 days of oviposition. Adult females lived for 9.08 days, while males had a shorter longevity at 7.87 days. The insect was able to complete its life cycle on Irish potato tubers and tomato fruits, but had longer developmental period and shorter adult life span on these hosts than on eggplants.

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KEY WORDS: *Leucinodes orbonalis.* Eggplant fruit borer. Life history. Behavior. Development. Potential hosts.

INTRODUCTION

Data on the biology of pests are undeniably important in the formulation of efficient pest management strategies. For a number of species, however, only limited information on life history and behavior are available in literature. This is especially true for those whose status as serious pests has been recognized only recently as in the case of the eggplant fruit borer, *Leucinodes orbonalis* Guenee.

Esguerra and Gabriel (1969) and Gabriel (1976) had published lists of insect pests of eggplant and other solanaceous crops. Both lists, however, did not include the eggplant fruit borer which was first observed to attack eggplants in Bukidnon in 1975 (Repollo, 1979), and in ViSCA, Leyte in 1982 (Esguerra and Barroga, 1982).

Fig. 1. Fruit borer damage to eggplant shoots.

The larva is the destructive stage of the insect. In the absence of fruits, the larva feeds on above-ground growing points of the plant, causing wilting and eventual death of shoots (Fig. 1). It is likewise capable of boring into stems and leaf axils of eggplant. At the fruiting stage of the host plant, the larva tunnels into the fruit and feeds on the soft tissues inside (Fig. 2). Its feeding activity causes rotting and premature fruit fall (Fig. 3). Esguerra and Barroga (1982) attributed 42-90% yield reduction to the damage inflicted by *L. orbonalis* larvae.

MATERIALS AND METHODS

Mass Rearing of Stock Culture. — Infested fruits were collected from the field, brought to the laboratory and dissected to expose the borers in various stages of development.

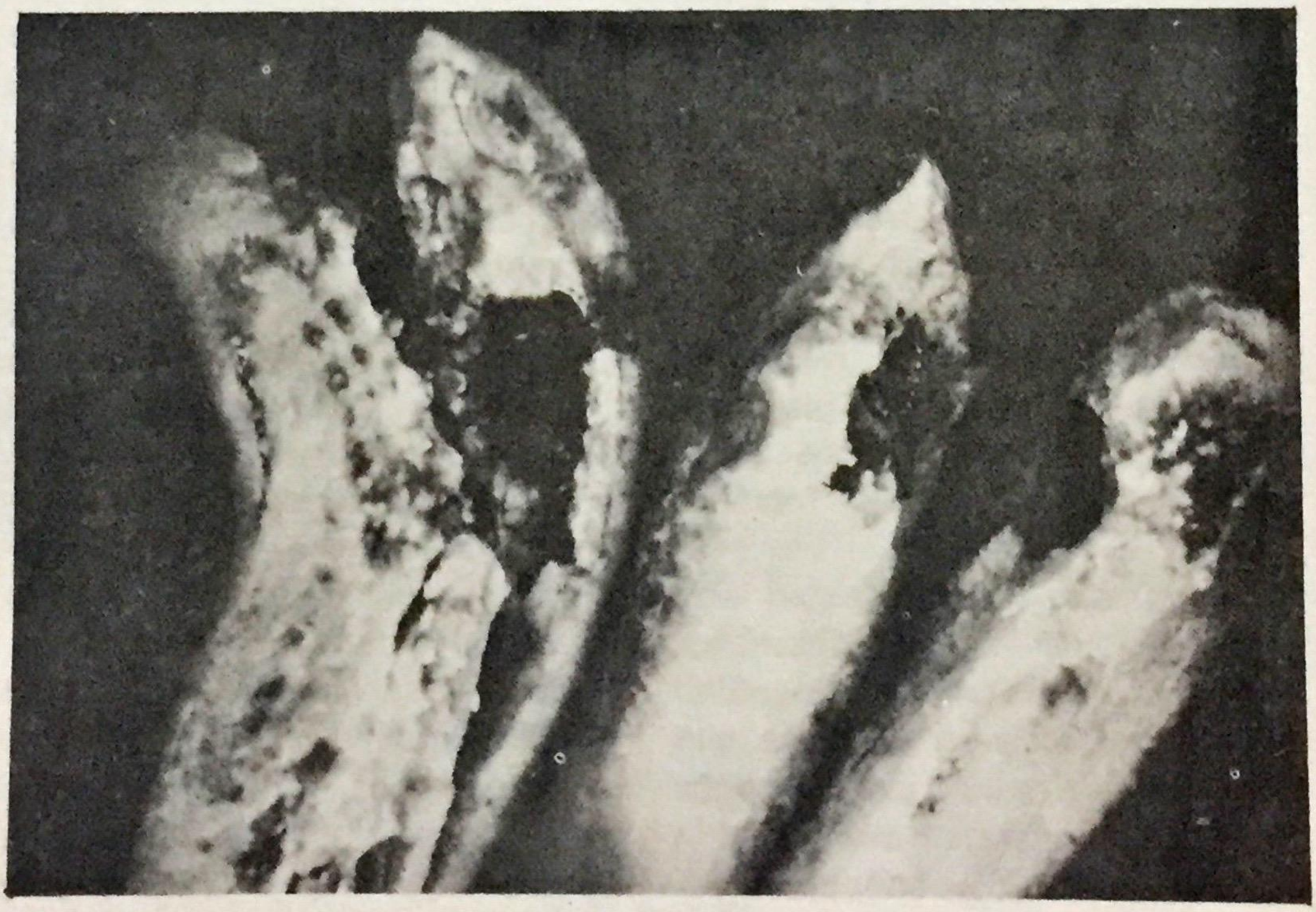

Fig. 2. Dissected fruits showing the tunnels made by the eggplant fruit borer larvae as they feed on the soft host tissues.

Fig. 3. Rotting and premature fruit fall caused by the feeding activity of eggplant fruit borer.

The insects were transferred to cut pieces of eggplant fruit in disinfected glass jars (9.5 cm H; 4.5 cm D) where they were allowed to develop, then periodically transferred to fresh pieces of fruit until they pupated. Adults that emerged were paired and allowed to mate and oviposit on fruit and stem pieces. A cotton ball soaked in 10% sugar solution was provided as food for the adults.

Eggs laid were collected and reared in the manner described. Emergent adults of this generation were again allowed to mate and oviposit in the rearing jars. The eggs laid by this generation were used in the biological studies conducted.

Life History and Behavior.— Life history and behavior of the eggplant fruit borer were studied in the laboratory for 2 successive generations. Whenever possible, biological data collected in the laboratory were augmented by field observations.

Newly-laid eggs from the stock cultures were collected, placed in petri dishes lined with absorbent paper and incubated at room temperature. One hundred of the resultant larvae were then reared individually in small disinfected jars as described for the stock culture.

Daily observations were made to record mortality, behavior, changes in appearance and duration of each developmental stage. Egg hatchability, adult longevity and female fecundity were likewise noted.

To establish the host range of the pest, laboratory-reared third instar larvae were offered succulent parts of different plant species. Plant parts which showed signs of feeding were considered potential hosts and were further evaluated in the laboratory.

Using the methods described earlier, 25 first-instar larvae were reared to adult stage on each potential host. Simultaneously, the same number of larvae was reared on pieces of eggplant fruits. Biological data obtained from cultures on potential hosts were then compared with those obtained from individuals reared on eggplant fruits.

RESULTS AND DISCUSSION

Duration of Developmental Stages.

The average durations (in days) of the developmental stages of the eggplant fruit borer are presented in Table 1. Both sexes passed through 5 larval instars, with the last instar terminating in a short pre-pupal period. The total developmental period (egg-laying to adult) indicated a slight variation between the sexes, covering an average of 23.45 days for the males and 24.39 days for the females. As with most insects, female adults lived significantly longer (9.08 days) than males (7.87 days).

Egg Incubation and Eclosion.

Newly-laid eggs were invariably ovoid and whitish-yellow. As the incubation period progressed, the eggs assumed a darker yellow hue, with tinges of orange becoming visible 24-36 hr prior to eclosion (Fig. 4). The outline of the larva in-

Table 1. Average duration (in days) of the developmental stages of the eggplant fruit borer.[1]

Developmental Period	Male (57 individuals)	Female (62 individuals)
Incubation of Eggs	2.97 ± 0.70	3.367 ± 0.72
Larval Period		
First stadium	1.25 ± 0.81	1.14 ± 0.34
Second stadium	1.69 ± 0.41	1.71 ± 0.43
Third stadium	3.05 ± 0.51	3.09 ± 0.78
Fourth stadium	3.14 ± 0.41	3.18 ± 0.41
Fifth stadium	2.56 ± 0.57	2.63 ± 0.49
Total Larval Period	13.16 ± 1.18	13.28 ± 0.88
Pupal Period	7.31 ± 0.95	7.73 ± 0.90
Egg-Laying to Adult Emergence	23.45 ± 1.77	24.39 ± 1.57
Longevity of Adults	7.87 ± 0.99	9.08 ± 1.29

[1]Data based on second-and third-generation individuals which developed to adult stage.

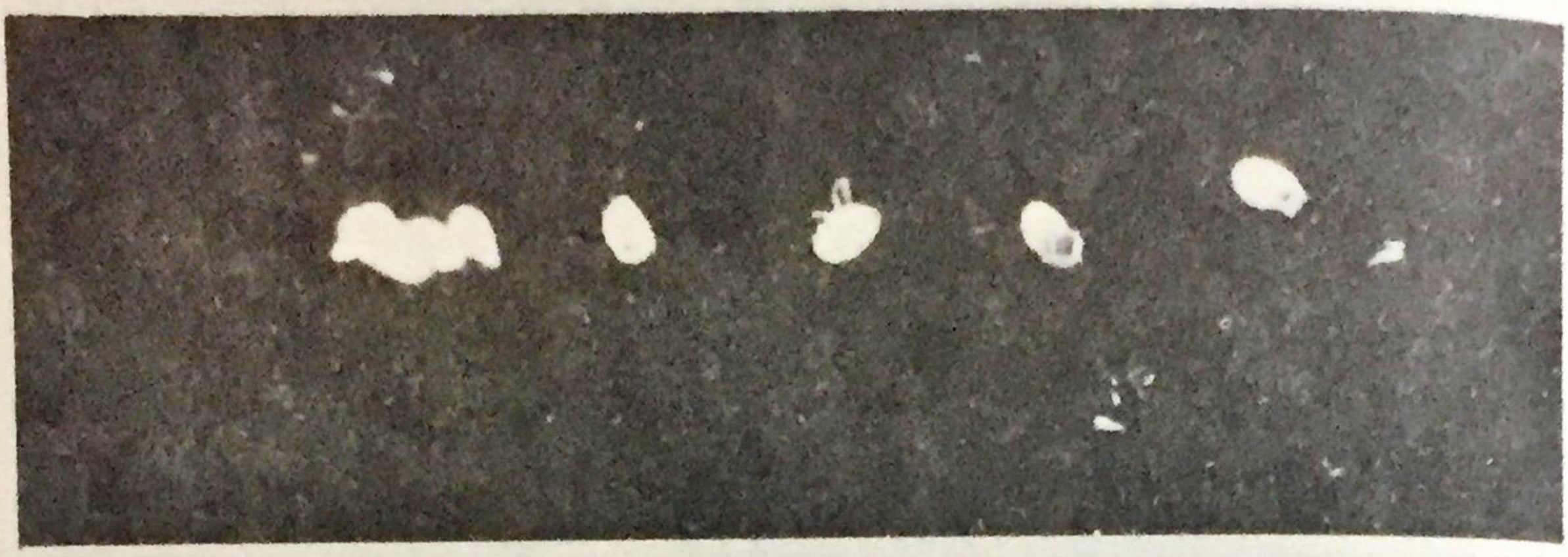

Fig. 4. Eggplant fruit borer eggs, left to right, showing appearance immediately after oviposition up to eclosion.

side the egg became distinct just before hatching. Hatchability in the laboratory was high (96.5%) following an incubation period of 3-4 days. Eggs destined to develop into female insects had a slightly longer period of incubation (Table 1).

Eclosion lasting about 20 to 30 min was observed to take place early in the morning. The emergent larva freed itself by ingesting a portion of the shell and creating a hole large enough for it to crawl through. It slowly wriggled out of the shell, with the anterior portion usually emerging ahead.

Larval Development.

Newly-hatched larva was whitish-yellow, with dark-brown head capsule turning pale yellow-orange few hours later, and with dark brown or black spot on the pronotum. Starting at the third instar, dark spots and spines became distinct in the abdominal region (Fig. 5). Body of the last instar was pinkish, with the integument shiny and waxy in appearance. Table 2 gives the average lengths of larvae at different instars.

Larvae during the first 2 instars were not active crawlers, but were immediately boring into the fruit pieces after eclosion or molting. As observed in the laboratory, those in the later instars usually crawled about the food substrate for some time before initiating a tunnel in fresh food pieces. In the field, the entire larval period was spent inside the fruit or shoot tissues. All larvae, except first instar larva, were voracious feeders.

Pupation.

The fifth-instar larva underwent a short pre-pupal period during which it ceased feeding. Larva emerged from the tunnel and searched for a dry surface where pupation took place. The pre-pupa then curved its body inward, decreasing its length, and slowly spinned a dark brown cocoon to enclose itself. During the spinning process, the pre-pupa contracted, thickened in body girth, and underwent its last molting inside the cocoon, forming an obtect golden brown pupa of about 9.0 mm long (Fig. 6). Cocoon-spinning and pupa-

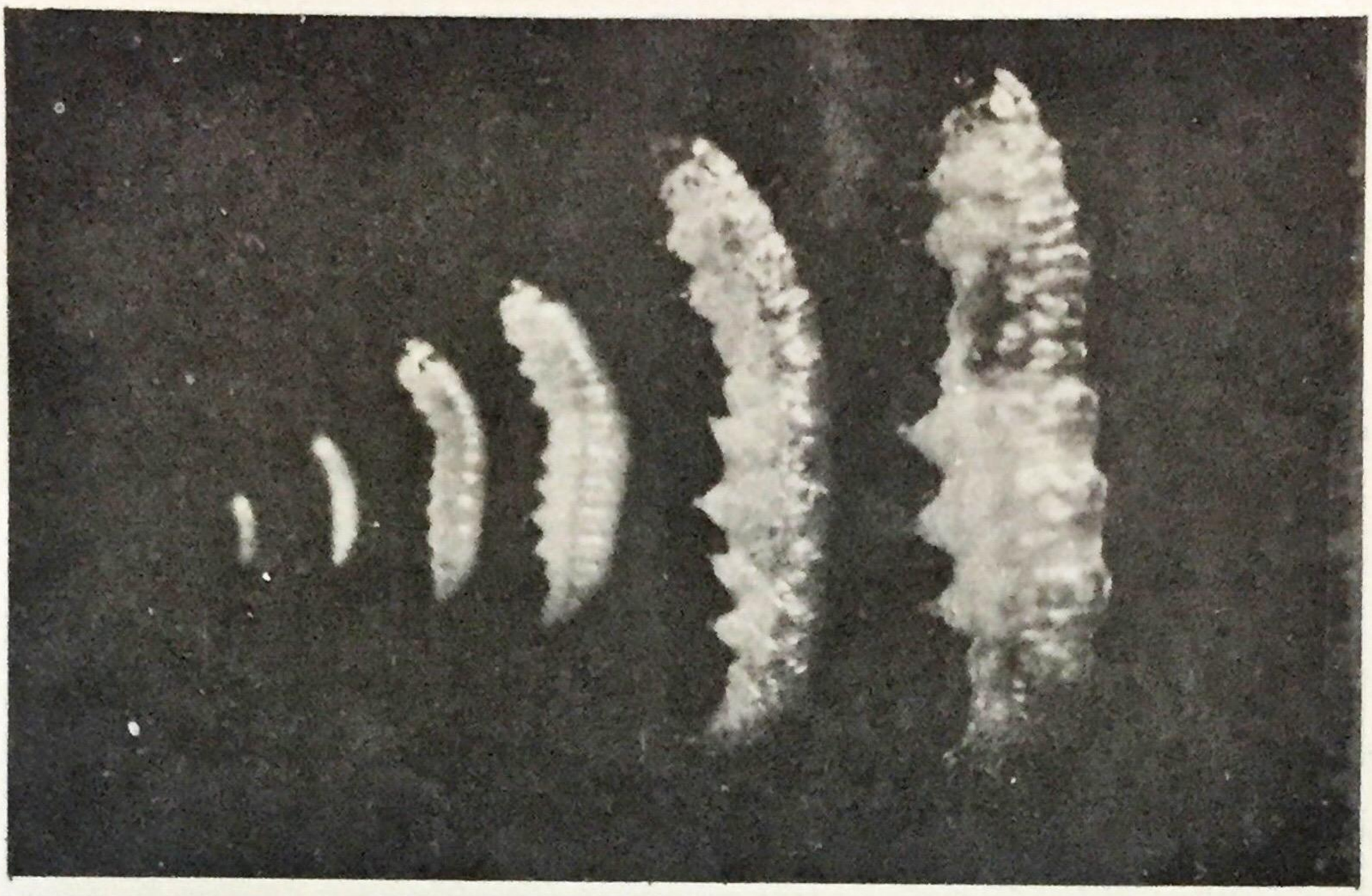

Fig. 5. Different larval stages of the eggplant fruit borer.

Table 2. Average length [1] of the eggplant fruit borer larvae at different instars.

Instar	Length (mm)
First	1.1
Second	2.5
Third	5.0
Fourth	9.0
Fifth	16.0

[1] Based on 10 individuals randomly selected from the culture maintained in the laboratory.

tion occurred at different times of the day.

In laboratory cultures, pupation usually occurred on the inner surfaces of the nylon tulle covers of the rearing jars. Under field conditions, however, the pre-pupa was observed to spin its cocoon on the calyx, nether surfaces of leaves, or on leaf axils. When the cocoon was inadvertently removed or destroyed, the pre-pupa was unable to repair the damage, but still underwent normal pupation and emerged as adult.

Adult Emergence and Sex Ratio.

Adults usually emerged from the cocoon early in the morning. Prior to emergence, the pupa moved its abdomen continuously, rupturing the cocoon in the process. The continuous movement eventually split the dorsothoracic region of the body, enabling the adult moth to thrust itself out quickly.

Newly-emerged moth had short, crumpled, overlapping wings that extended over half of its abdomen. Fairly active, the moth used its legs to wander about the emergence cage continuously for about 10 min.

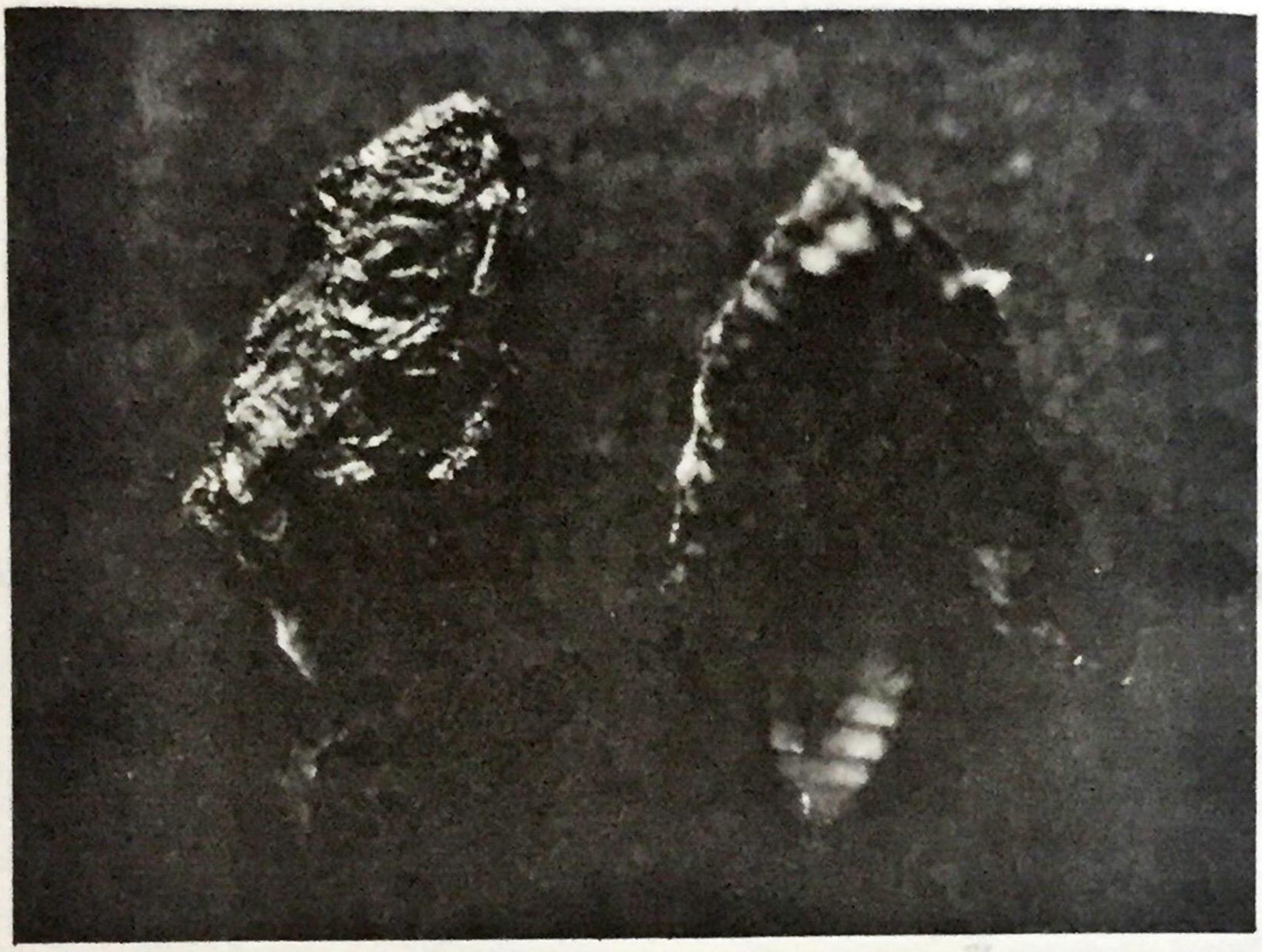

Fig. 6. The eggplant fruit borer cocoon enclosing the obtect pupa.

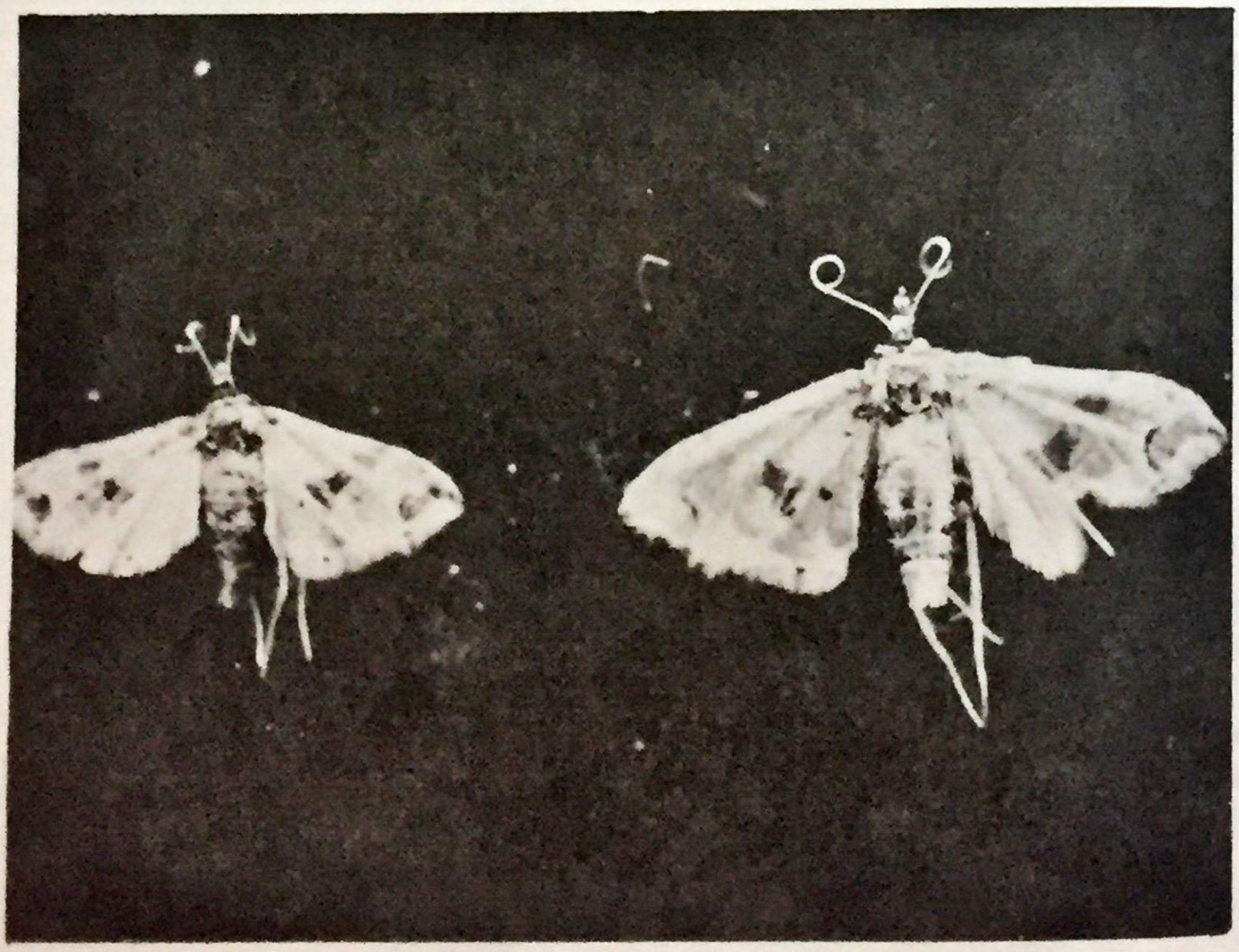

Fig. 7. Eggplant fruit borer adult male (left) and female (right).

It stopped, anchored its legs firmly on a rough surface and stretched its short wings. While expanding its wings, the moth remained torpid except for the rapid beating of the antennae. The wings got fully expanded after about 20 min, then the moth started to wander and fly.

The adult borer was a predominantly white and brown moth with reddish brown and black patterns on the wings (Fig. 7). The female was larger than the male. Both sexes had the peculiar habit of curving their abdominal tips upward when at rest. With a more slender body, the male moth was capable of curving its abdomen at greater angle than that of the female. The abdomen of the female moth was thicker and gradually tapered posteriorly while that of the male was more pointed and protruding. Both sexes had profuse tufts of hair at the abdominal tips.

Out of the 119 individuals which developed to adults, 57 were males, giving a male-to-female ratio of 1.0:1.1.

Mating, Oviposition and Fecundity.

Mating of *L. orbonalis* adults was not observed during daytime. Two to three days after pairing the female started laying eggs. Mated females laid an average of 210 eggs during the 3-4 days of oviposition, or an average egg production of 65.18 eggs/day. Eggs were indiscriminately laid on any rough surface singly or in groups. In the field, the eggs were observed on both sides of the leaves, on stems, on flower sepals and on rough surfaces of the fruits. In laboratory cultures, eggs were laid on the sides of the oviposition jars, on leaves, stems and fruit pieces provided, as well as on the strips of perforated wax paper. Unmated laboratory cultured females were observed to lay infertile eggs 2-3 days after emergence.

Table 3 presents the average mortality of the larvae and pupae of the eggplant fruit borer. Mortality was highest during the first 2 instars and during pupal stage. Death during the early instars may be attributed to gross handling when the more fragile larvae were transferred periodically to fresh food substrates.

Pupal mortality was calculated based on the number of pupae which failed to emerge into adults. Said pupae were harder and darker than the normal, and appeared mummified after 2 weeks of incubation.

Table 3. Average mortality (%) of larvae at various instars and pupae of the eggplant fruit borer.[1]

Developmental Stage	Percent Mortality
Larva	
First instar	8.5
Second instar	10.0
Third instar	5.5
Fourth instar	3.5
Fifth instar	2.5
Pupa	10.5
TOTAL	40.5

[1] Based on 200 individually-reared insects for 2 successive generations.

Host Range.

The feeding response of the eggplant fruit borer larvae to the different hosts offered is shown in Table 4. Among those tested, only Irish potato tubers and tomato fruits (both of the Solanaceae family) showed positive signs of feeding.

The insect was able to complete its life cycle on Irish potato and tomato, although developmental periods were longer on these 2 hosts (Table 5) than on eggplant. Lighter cocoons were spun by individuals reared on tomatoes and Irish potatoes, probably because these plants lack the darker pigments present in eggplant fruits. Adults which emerged from cultures reared on eggplant lived longer than those reared on either Irish potato or tomato.

Table 6 shows the average mortalities of the larval instars and pupae of the insect on the 3 hosts provided. Mortalities were higher on Irish potato and tomato than on eggplant especially in later instars. This observation, together with longer developmental period and shorter adult longevity, may be taken as an indication that the potential hosts did not contain sufficient or proper proportion of nutrients necessary for the normal development of eggplant fruit borers.

Table 4. Feeding response of eggplant fruit borer to different plant species offered as possible food.[1]

Plant Species	Plant Part Offered	Feeding Response[2]
Irish potato **(Solanum tuberosum)**	tuber	sustained feeding
Tomato **(Lycopersicon esculentum)**	fruit	sustained feeding
Ampalaya **(Momordica charantia)**	fruit	no feeding
Patola **(Luffa cylindrica)**	fruit	no feeding
Okra **(Hibiscus esculentus)**	fruit	no feeding
Sayote **(Sechium edule)**	fruit	no feeding
Pepper **(Capsicum annum)**	fruit	no feeding
Snap Beans **(Phaseolus vulgaris)**	pod	no feeding
Carrot **(Daucus carota)**	tuber	no feeding
Upo **(Lagernaria siceria)**	fruit	no feeding
Goat weed **(Ageratum conyzoides)**	stem with leaves	no feeding

[1] Insects were given the opportunity to feed on the hosts offered for 24 hr.

[2] Based on responses of five third instar larvae.

Table 5. Average duration (in days) of the developmental stages of eggplant fruit borer on three host plants.

Developmental Period	Eggplant (20 individuals)	Irish potato (16 individuals)	Tomato (16 individuals)
Incubation Period	2.32 ± 0.75	3.0 ± 0.0	3.0 ± 0.0
Larval Period			
First instar	1.39 ± 0.50	2.0 ± 0.0	1.68 ± 0.47
Second instar	1.45 ± 0.51	2.0 ± 0.0	2.0 ± 0.0
Third instar	2.95 ± 0.71	2.95 ± 0.87	3.75 ± 0.60
Fourth instar	3.35 ± 0.49	2.65 ± 0.67	4.2 ± 0.79
Fifth instar	2.35 ± 0.49	4.19 ± 0.54	4.75 ± 1.29
Total Larval Period	13.15 ± 1.42	15.0 ± 1.32	16.94 ± 2.05
Pupal Period	8.3 ± 0.80	10.00 ± 1.32	8.44 ± 0.73
Egg Laying to Adult Emergence	22.75 ± 2.24	28.5 ± 1.81	28.5 ± 1.63
Adult Longevity	8.95 ± 1.39	7.5 ± 1.13	7.87 ± 1.36

Although the insect was able to develop in the potential hosts, *L. orbonalis* has not been reported as a pest of Irish potato or of tomato. In the field, even when tomato was planted in the immediate vicinity of eggplant, the borer was never observed to infest tomato fruits unless when subjected to hunger stress, as was done in the laboratory.

Table 6. Average mortality (%) of larva at various instars and pupa of the eggplant fruit borer reared on three host plants. [1]

Developmental Stage	Percent Mortality		
	Eggplant	Irish Potato	Tomato
Larva			
First instar	8.0	0.0	0.0
Second instar	4.0	8.0	0.0
Third instar	4.0	4.0	0.0
Fourth instar	4.0	8.0	24.0
Fifth instar	0.0	16.0	12.0
Pupa	0.0	0.0	0.0
TOTAL	20.0	36.0	36.0

[1] Based on 25 insects reared individually on each test plant.

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