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LIFE HISTORY OF COMMON CUTWORM, Spodoptera Litura Fabricius (Noctuidae: Lepidoptera) IN BENGUET

ABSTRACT

Common cutworm, Spodoptera litura Fabricius underwent the holometabolous type of development. The insect duration of development is: egg (5.0 + 0.00 days), larva (23.9 + 0.71 days), pupa (17.80 + 2.33 days), adult female (12.10 + 2.65 days) and male (7.45 + 1.31 days). The egg is round and dirty white. The body of the newly emerged larva is cylindrical; the size of the head is wider than the body while the abdomen is tapering to-wards the caudal region. But during the 2nd instar until pupation, the body turns wider than the head. The true legs and pro legs are distinct. The newly emerged larva is whitish, yellow green an hour after with a pattern of red, yellow, and green lines from the head to the anal region. As the larva grew bigger, the body turns brown with 3 thin yellow lines down the back. The newly emerged larva singled out the leaf veins during feeding while the big larva includes them. Bigger larva is an excellent feeder and active at night. The larva hides in the soil at day time and ceaseless when about to molt. The body length and width of the smallest and full grown larva, respectively are: 2.16 + 0.14 mm and 0.32 + 0.02 mm; 46.91 + 2.25 mm and 6.87 + 0.16 mm.

Pupation was in the soil. The pupa is elongated oval and shiny red. The body length and width measures 22.29 + 0.71 mm and 7.51 + 0.36 mm, respectively. The adult female and male are hairy. The female is pale brown while the male is darker. The female is bigger with a stout abdomen while the male is narrower and tapering towards the tip. Courting the female lasted for 10 to 20 minutes while mating was 2-3 hours at between 2:00AM to 5:00AM. The eggs are laid in mass of 2-3 layers on the lower surface of the leaves near the petiole. Egg mass of 8.7 are laid within 12 days egg laying as the shortest and 14 days as the longest. There are 874.9 individual eggs in one egg mass.

INTRODUCTION

Common cutworm, Spodoptera litura Fabricius is widely distributed, polyphagous with vegetables and field crops as the preferred hosts. In the province of Benguet which is the haven for semi-temperate vegetables, the hard hit for infestation is cabbage, the crop with the widest area of cultivation. Through the insect's powerful mandible, it could destroy and dam-age all the stages of cabbage by cutting the stem and consume the whole seedlings, chewing the leaves of the plants in the open field causing irregu-lar holes and boring the developing heads with lace of larval excrements. If not controlled, the insect can reduce yield to as high as 50 % to 100 %. Despite of the insect's popularity, until now very little is known about its anatomical and behavioral characteristics.

Several studies have been undertaken on the life history of S. litura in the Philippines. Based on records, the first documented study was by Par-is (1968), and other studies were conducted by Agsaoay (1998) and Nava-sero (2002). These studies however, were carried out in the warm lowland area of the country and so far none were conducted in the semi temperate province of Benguet, which is the place with the largest area of cabbage cultivation and where the information is urgently needed. According to Ko-shihara (1985), the developmental duration of the insect varies according to climatic condition and diets thus, it is necessary to undertake a study of the life history of S. litura in the province of Benguet.

This paper presents the life history of S. litura in relation to its developmental duration, morphological and behavioral characteristics in anticipation that the information gathered may serve as guide in developing an alternative control for the insect particularly in the area of biological control through microbial organism like nulear polyhedrosis virus or NPV.

METHODOLOGY

Castor bean plants were raised around the perimeter of the Diadeg-ma rearing house at the Benguet State University as the host for the rearing of S. litura. Castor bean was the choice being the most suitable host plant for the rearing of the insect in comparison with the other host plants ac-cording to Cardona and Ligat (2007). The planting of castor bean was done

staggardly at weekly interval to come up with different ages of host plants and a sufficient supply of food when needed. The plants did not receive the application of insecticides in order not to affect the test insects.

The tests S. litura were the progenies that have under gone one generation rearing in the greenhouse. The steps include the collection of several pupae in the field. The pupae were brought to the greenhouse and allow

them to emerge to adult. The adults were provided with the leaves of castor bean with a petiole soaked on water through the Erlenmeyer flask for them to lay eggs. The eggs were incubated to larval stage and the larvae were kept until pupation in the test cages. All the pupae formed were collected, placed in a glass jar (5 x 8 mm), which was covered with mesh cloth to serve as the pool of parents for the experiment.

Duration of Development and Anatomical Characteristics

The eggs and the 1st instar larvae were observed directly on the leaves of castor bean plants; the petiole was soaked in water through the Erlenmeyer flask. In order to avoid confusion in managing the movement of the test insect, only one larva was maintained per leaf. The rest of the in-sects were eliminated using hair brush. The leaves were marked by the use of label tags to facilitate data recording.

As the larvae have attained 2nd instar, they were transferred on ven-tilated petri dishes. The petri dish was ventilated by way of 2.5 cm diameter hole in the middle of the lid covered by fine plastic net fixed with adhesive glue. Transfer of the test insects was carried out to prevent them from leav-ing the host because older insects are relatively gregarious. Fresh castor bean leaves were provided when older leaves were about to deteriorate. One larva per petri dish was maintained. Viewing the insects was facilitated by the used of hand lens.

The duration of the pupal stage was determined inside a transparent cylindrical jar (5 cm diameter and 1.8 cm in height) with a ventilated top cover, similar to petri dishes. One newly formed pupa was kept in a jar. The newly emerged adults were checked regularly.

The adults emerging in the glass jar were the test insects used in

determining the adult longevity. These adults were fed with diluted honey (30 %). Honey was supplied via ball of cotton soaked in honey. The adults were checked daily until they die. The longevity of adults which were not provided with food was likewise included as part of the study and served as the basis for comparison.

The duration of the different developmental stages of the insect namely; emergence of the different larval instars and pupa, and the longev-ity were determined by subtraction (AVRDC, 1989) based on the recorded dates. The larval instars were determined by the number of molts which were manifested by exuviae formed during molting. Ten insects were used as samples.

S. litura was collected at every stage of development and were examined under a lens and a dissecting microscope. Observation was focused on the general shape and color of the insects and on specific morphological traits. Measurement of the sizes of the eggs was taken by the use of a micro-scope equipped with an ocular and stage micrometer. A foot rule was used in measuring the larva, pupa and the adult. Ten sample insects were used in every stage of insect development. The newly laid eggs and the pupae were measured alive. The larvae and adults were killed first using 95 % ethyl alcohol before they were measured.

Larval Behavior

The behavior of the larva was observed directly on the leaves of cas-tor bean plants inside a ventilated transparent cube shaped cages (20 x 20x 20 cm) made of fiber glass. Observation was focused on the larval feeding behavior until population. The larval behavior every molt was likewise ob-served. A hand lens was used to magnify the insect.

Adult Behavior

Newly emerged females and males of the first greenhouse generation were the test insects inside the cage similar with the cage used for the larval behavior. The adults were fed with diluted honey via a soft cotton ball on petri dish. Specifically, the insects were observed with their manner of feeding, mating and oviposition behavior.

Fecundity

Newly mated adult female from the first generation in the green-house were used as the test insects. Castor bean leaves were placed inside the cage; the petiole was soaked on water through the Erlenmeyer flask for the oviposition of the female insect. The eggs oviposited on the leaves were counted everyday by withdrawing the plants from the cage and another fresh batch of plants were introduced for the subsequent oviposition. This procedure was carried out daily until all the sample test insects die. The test insects were fed with 30 % diluted honey via a soaked cotton plug in a petri dish. The greenhouse temperature ranged between 15 oC (minimum) to 26 oC (maximum) and a mean relative humidity of 79.6 %.

The fecundity of the adult was determined inside the 43 x 43 x 43 cm cage, which was made of transparent fiberglass. One side of the cage was made of fine netting. Fine circular holes were present in all sides of the cage, but were screened by fine netting and fixed by glue to serve as addi-tional ventilation.

RESULTS AND DISCUSSION

Duration of Development

In Table 1, the duration of development of S. litura is presented. The duration of egg was 5.00 + 0.0 days while the larva was 23.9 + 0.71 days. The larva underwent 5 instars. The duration of the first instar was 5.45 + 0.51 days, 4.15 + 0.58 days for the second instar, 5.55 + 0.60 days for the third, 2.90 + 0.44 days for the fourth, and 3.85 + 0.58 days for the full grown fifth instar larva. The duration of development of the pupa was 17.80 + 2.33 days.

The longevity of the adult female was 12.10 + 2.65 days signifi-cantly longer than the male with the longevity of 7.45 + 1.31 days. In the absence of food, the longevity of the female was significantly reduced to only 7.60 + 1.46 days and 4.90 + 0.96 days for the male. Regardless of diets, the females live longer than the males.

Table 1. Duration of development of *S. litura*

DEVELOPMENTAL STAGES	DURATION (DAYS) RANGE	MEAN
Egg	5	5 ± 0.0
Larva		
1st instar	5-6	5.45± 0.51
2nd instar	3-5	4.15± 0.58
3rd instar	4-6	5.55± 0.60
4th instar	2-4	2.90± 0.44
5th instar	3-5	3.85± 0.58
Total	17-26	23.9±0.71
Pupa	13-21	17.80 ± 2.33
Adult longevity		
Male with food	5-10	7.45± 1.31
Male without food	4-7	4.90± 0.96
Female with food	7-16	12.10 ± 2.65
Female without food	6-14	7.60± 1.46

Anatomical Characteristics

Egg. The eggs are round in shape (Plate 1a). The newly laid egg is pale green but it turns whitish an hour after. The eggs are laid in mass.

They are covered with a brown scales detached from the abdomen of the female moth during oviposition (Plate 1b). When about to hatch, the tip of the egg turns blackish which is the developing head of the larva. The egg measures 0.6 mm in diameter as presented in Table 2.

Larva. The newly hatched larva is cylindrical in shape. The head is prominently big, bigger than any part of the body (Plate 1c). As the larva advances to second instar (Plate 1d), the body grows faster and as a result the body turns wider than the head. The biggest part of the insect body is the third and fourth segment from the head. As early as the first instar, the three pairs of prothoracic legs are distinct. The tip of the leg is black. Prolegs are present in the abdomen particularly on the 6th, 7th, 8th and 9th segments. The true legs and the prolegs are more apparent as the insect advances in size and in ages.

Table 2. Body size of the different stages of *S. litura*

DEVELOPMENTAL STAGES	LENGTH (mm)		WIDTH (mm)	
	RANGE	MEAN	RANGE	MEAN
Larva				
1st instar	1.82 – 2.35	2.16 ± 0.14	0.30 – 0.38	0.32 ± 0.02
2nd instar	4.13 – 5.38	5.00 ± 0.28	0.87 – 1.15	1.07 ± 0.07
3rd instar	9.04 – 13.10	11.71 ± 1.33	2.00 – 2.78	2.45 ± 0.23
4th instar	22.60 – 29.93	26.97 ± 1.77	4.20 – 5.20	4.73 ± 0.26
5th instar	40.77 – 50.90	46.91 ± 2.25	6.43 – 7.15	6.87 ± 0.16
Pupa	21.0 – 23.40	22.29 ± 0.71	7.0 – 8.0	7.51 ± 0.36
Adult				
Male	18.1 – 21.00	19.30 ± 0.75	3.0 – 4.1	3.68 ± 0.31
Female	17.5 – 21.10	19.06 ± 0.92	4.9 – 6.2	5.63 ± 0.38

The newly hatched larva is whitish but it turns yellowish green an hour after. The skin is smooth with a pattern of red, yellow and green lines from the head to the caudal region. There are dark patches on the mesothorax. As it grew bigger (Plate 1e) or attained the fourth instar (Plate 1f), the larva became brown in color with three thin yellow lines down the back: one in the middle and one on each side. A row of black dots run along its side and conspicuous row of dark triangle decorate its side of the back (Plate 1g) of the larva during the 5th instar.

The body length of the newly hatched larva measures 2.16 + 0.14 mm while the width was 0.32 + 0.02 mm. The larva as it reaches the second instar, the body length grew to 5.00 + 0.28 mm while the width was 1.07 + 0.07 mm. During the third instar, the body length of the larva measures 11.71 + 0.33 mm while the body width was 2.45 + 0.23 mm. Upon reaching the fourth instar, the body length measures 26.97 + 1.77 mm and a body width of 4.73 + 0.26 mm. The body length of full grown larva was 46.91 + 2.25 mm and a body width of 6.87 + 0.16 mm.

Pupa. The pupa is elongated oval in shape. The eyes and the antennal case are prominent. The color is shiny red (Plate 1h). The covering of the wing is similarly prominent and it is darker than the rest of the body. The abdomen has movable incisures with dark spiracles. The body length measures 22.29 + 0.71 mm and a body width of 7.51 + 0.36 mm.

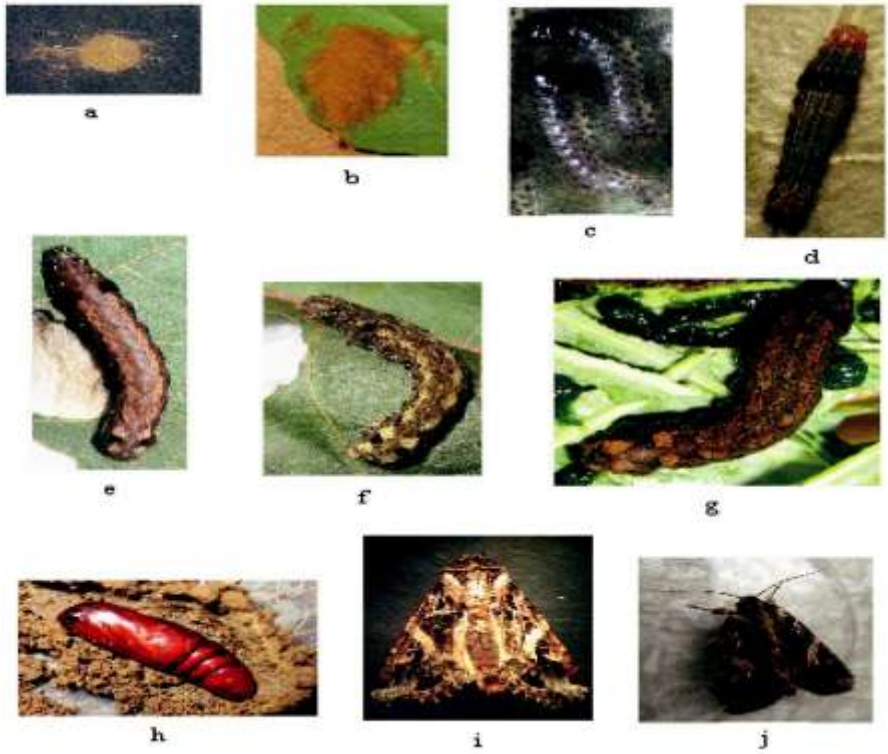

Plate 1. *Stages of development of S. litura: a-egg, b-eggmass, c-1st instar larva d-2nd instar larva e-3rd instar larva, f-4th instar larva g-5th instar larva, h- pupa, i-female adult, j-male adult*

Adult. The body of the adult is hairy. The color is brown. The head, thorax, and abdomen are distinct. The antennae and legs are dark brown. It has a very prominent rounded bluish black eyes occupying almost 1/3 of the facial head. Two long segmented antennae are located dorsally on the head and close to the compound eyes. It is grey to brown margins with pale veins. The lower edges of the wings are surrounded with hair like structure.

The female is generally bigger than the male. The abdomen is stout-er while the male is narrower that are relatively pointed in shape. In terms of body color, the female is pale brown (Plate 1i). The male was darker in color. The male has a bluish streak on the forewing at the wing base and tip (Plate 1j). The female has none.

Behavioral Studies

Feeding. The young larva is less mobile few minutes after hatching from the egg. It feeds by scraping the surface of the leaves. As the caterpillar matures, they produce regular holes on the leaves leaving the veins. Feeding is more active as it advances in age and at night time. The larva hides in the soil at daytime and return damaging the plants at night. This characteristic of the larva was observed upon reaching the third until the fifth instar. The larva cease on feeding few minutes before molting. The presence of exuvia manifest that the insect has undergone molting. Food consumption gener-ally increased as the insect developed to fifth instar.

Pupation. Few hours before pupation, the larva is immobile and cease on feeding. Later, the larva moves down and borrows into the soil that was provided into the rearing cage. The larva was more or less 1cm below the soil. Before it finally developed to pupa, the larva was active by its man-ner of moving the body with reversible C-shape position.

Mating behavior. Prior to mating, courting was observed. The male actively initiates the mating. It flies several times above the female. When it stops flying, it landed close with the female. The male gradually moves by walking close to the female. Using the antennae, the male touches the female. The male quickly mounted the female soon there was a downward movement of the insect antennae. Before there was successful mating, the male was observed courting the female for a period of 10 to 20 minutes. The male coiled proboscis was straightened during mating but returns to its original form as soon as the copulation was finished. Copulation lasted for 2-3 hours and usually done early morning at between 2:00 to 5:00 AM.

Oviposition. The oviposition site was first located by the female. After the site was identified, the insect cleans the leaf surface area by wip-ing using the tip of the abdomen. Oviposition took place immediately after.

The egg is laid in mass under the shade near the petiole. The egg is deposited in layers of 2-3. When disturbed, oviposition was stopped and continued few minutes after.

Fecundity. The egg is laid in mass instead of the singly egg laying as behaved by some insects. As a way probably of protecting the egg from

possible predators and adverse weather factors, the mass of egg is covered by scales which according to Paris (1968) come from the mother abdomen during the act of oviposition. An average egg mass of 8.7 are laid (Table 3) throughout the insect life span with 12 days egg laying as the shortest and 14 days as the longest. The peak of oviposition was 6 days (Fig. 1). Oviposi-tion abruptly declined 7 and 8 days after and descends gradually thereafter until the insect dies. There are 874.9 individual eggs in one egg mass.

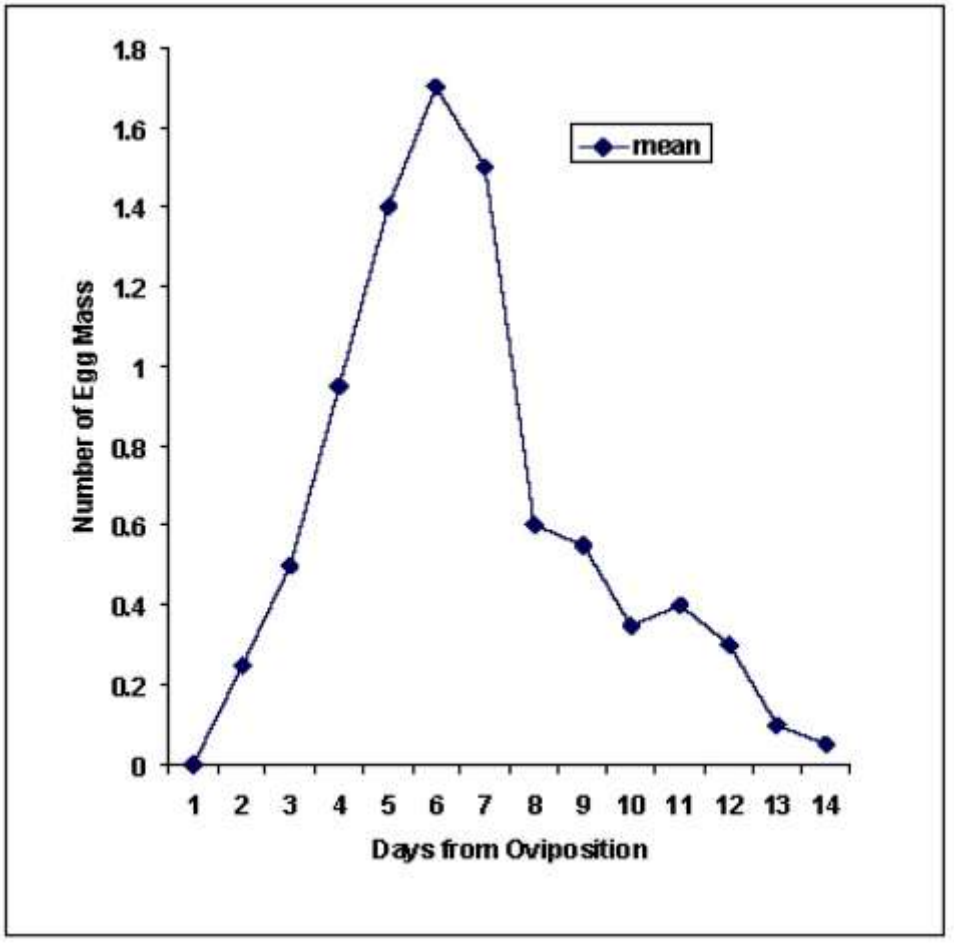

Fig 1. *Oviposition pattern of S. litura*

Table 3. Fecundity of *S. litura*

NUMBER OF SAMPLES	TOTAL NUMBER OF EGG MASS	TOTAL NUMBER OF INDIVIDUAL EGGS	MEAN NUMBER OF INDIVIDUAL EGGS/ EGG MASS
1	11.0	7,981	725.5
2	10.0	6,616	661.6
3	4.0	2,922	730.5
4	7.0	7,493	1,070.0
5	7.0	6,847	978.1
6	4.0	7,092	1,773.0
7	13.0	9,095	699.6
8	10.0	9,090	909.0
9	11.0	11,581	1,052.0
10	9.0	6,637	737.0
11	6.0	7,572	1,262.0
12	10.0	8,449	844.9
13	10.0	6,283	628.3
14	8.0	6,253	781.6
15	10.0	6,262	626.2
16	7.0	5,709	815.6
17	6.0	5,255	875.8
18	10.0	7,931	793.1
19	10.0	8,403	933.6
20	12.0	7,215	601.3
GRAND TOTAL	**174.0**	**14,168.6**	**17,498.7**
GRAND MEAN	**8.7**	**7,084.30**	**874.9**

CONCLUSIONS

1. The anatomical characteristics of S. litura can be utilized as the basis for the identification of both the immature and adult stages.

2. The female can lay thousands of productive eggs indicative that rear-ing in the greenhouse is not difficult and therefore it is advantageous for the NPV bio-con of S. litura in addition with the information gath-

ered that the correct diets prolong the survival of the adult insect.

3. The behavioral characteristics of larva and the adult may contribute to the management of the insect both in the greenhouse and in the open field.

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