# THE NOCTUID MOTH

## (*EUBLEMMA AMABILIS*, MOORE) ;

## A PREDATOR OF THE LAC INSECT, AND ITS CONTROL.

BY

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*(With one colour, 4 black and white plates and 10 diagrams.)*

### INTRODUCTORY.

*Eublemma amabilis* was first described and figured by Moore from Ceylon, but Witt was the first to study the general life history and refer to its injurious nature with regard to the lac insect. Stebbing has some notes on it and has figured its pupa and adult. Hampson records it only from Ceylon, but since his work was published, it has been found widely distributed in India. Lefroy has figured the male insect, but not accurately. Imms and Chatterjee have given a slightly improved account of its life history and distribution, but have given a misleading figure of the male. Misra, who was Entomologist in this Institute from January 1926 to April 1927, has also dealt briefly with the predator. Mahdihassan gives a short account of its presence in South Indian lac and quotes Subramanyam's life history data for one generation. References to it have been made by Lindsay and Harlow, and Withers and Simmons in their respective reports.

The present writers have been working on the predator for the last three years and have had opportunities of examining samples of lac from various parts of India, and it was found that not a single sample received was free from the attack of *Eublemma amabilis*.

### THE IMAGO

*General description.—*

Head with short, white pink hair-scales above ; face deflexed, smooth. Thorax silvery white, slightly pink. Antennae in repose stretched in front of the head, basal joint enlarged, clothed with white scales, succeeding joints pinkish yellow. Palpi upturned 3-jointed, clothed with white scales. Proboscis more or less flattened, yellowish in colour. Eyes large, brown, visible from above, facets comparatively large. Legs yellowish-pink ; femora and tibia clothed with long white, and the tarsus with short scales. Fore-wing more or less triangular in form, its description is well given by Moore ' With a broad discal pale pinkish-violet band, the inner border of the band being darkest and indented to the end of the cell, the outer border being also darker and angled outward at the middle median vein, upper radial, and at the costal end ; the entire angulated outer border is also bordered by a prominent white line, which is slightly speckled with black scales; the marginal border of the wing and the cilia suffused with pale pinkish-violet; hind-wing with a similar pinkish-violet discal band, which is waved and anular only towards the lower end, the outer border line is also pale pink and distinctly speckled with black scales along its entire length ; the outer border of the wing and the cilia also suffused with pale pinkish-violet.' Wing expanse in female (average of 15 specimens) 20·26 mm. in male (average of 15 specimens) 16·46 mm. According to Moore and Hampson respectively the wing expanse is 22·5 mm, and 24 mm.

Anterior half of the abdomen pinkish white, posterior half greyish pink and blackish brown ; genitalia protected by tufts of white hair scales. Length of the body in male about 6·86 mm., in female 8·2 mm. When the moth is at rest, the fore-wing completely overlaps the posterior.

*External differences between the male and female imago.*

| | Male (Pl. I, Fig. 1) | Female (Pl. I, Fig. 2) |
|---|---|---|
| 1. Size and colour. | Generally smaller and duller in colour than the female. | Generally bigger and brighter in colour than the male. |
| 2. Antennae. | 47-53 jointed and hairy | 41-57 jointed, bear small hairs. |
| 3. Shape of abdomen. | Gradually tapers posteriorly. | Bulges out a little in the middle and then gradually tapers posteriorly. |
| 4. 8th abdominal segment. | Complete ; posterior half slightly broader than the anterior. | Incomplete ventrally gradually tapers posteriorly. |
| 5. 8th abdominal segment viewed from the posterior end. | A complete outer circular ring of scales with two inner semi-circular rings of scales on the claspers (Fig. 1*a*). | An outer triangular ring of scales, through which the ovipositor may or may not be seen projecting (Fig. 2*a*). |

*Colour variation.*–

Normally the colour of the moth is creamy white, tinged with bluish, fuscous or pinkish violet with light yellow and brown markings dorsally. The lower surface of the wings in addition may have black spots ; but in some cases the moth may be creamy white, tinged with greenish, or greyish suffused with pink and fuscous, or it may have various other combination of these.

*Respiratory organs.*—

The moth has 8 pairs of open spiracles (Pl. V, Figs. 15, 15*a*) one in the prothorax, in the membrane behind the pronotum, and one in each of the first seven abdominal segments. Each spiracle of the abdominal segments is situated on the upper part of the membraneous pleura. The main tracheal system appears to be the same as that of the larva described in the following pages, but the tracheal trunks and their branches are extremely fine and difficult to follow in detail.

*Longevity.*—

Under laboratory conditions it has been found that the maximnm age of a female moth was 25 days in the month of January ; and shortest one day in June and December. For the male moth the maximum age was 24 days in January ; the minimum one day in June and October. The average age of a female was 6·5 days (average of 206 females) and of the male 6·9 days (average of 219 males).

*Reproduction.*—

Sexual reproduction is the only type prevalent in the species. However, unmated females at times lay eggs, but these eggs do not develop and shrivel up after two or three days. Copulation usually takes place at dusk though moths have been noticed copulating in the day in shady and cool places. In captivity copulation freely takes place at all times of the day.

*The egg* (Pl. II, Figs. 6, 6*a*, 6*b*).—

The freshly laid egg is spherical, depressed in the centre dorsally, pale yellow in colour and furnished with concentric protuberances from either end

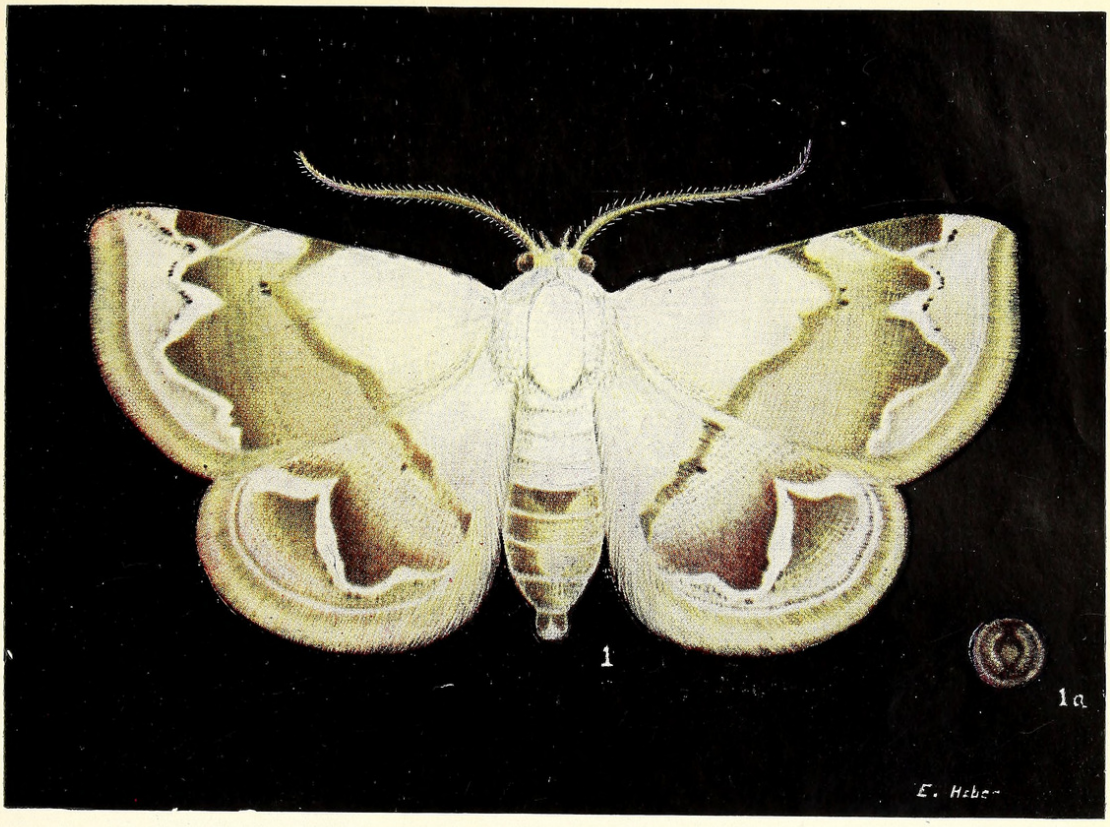



**Fig. 1.**

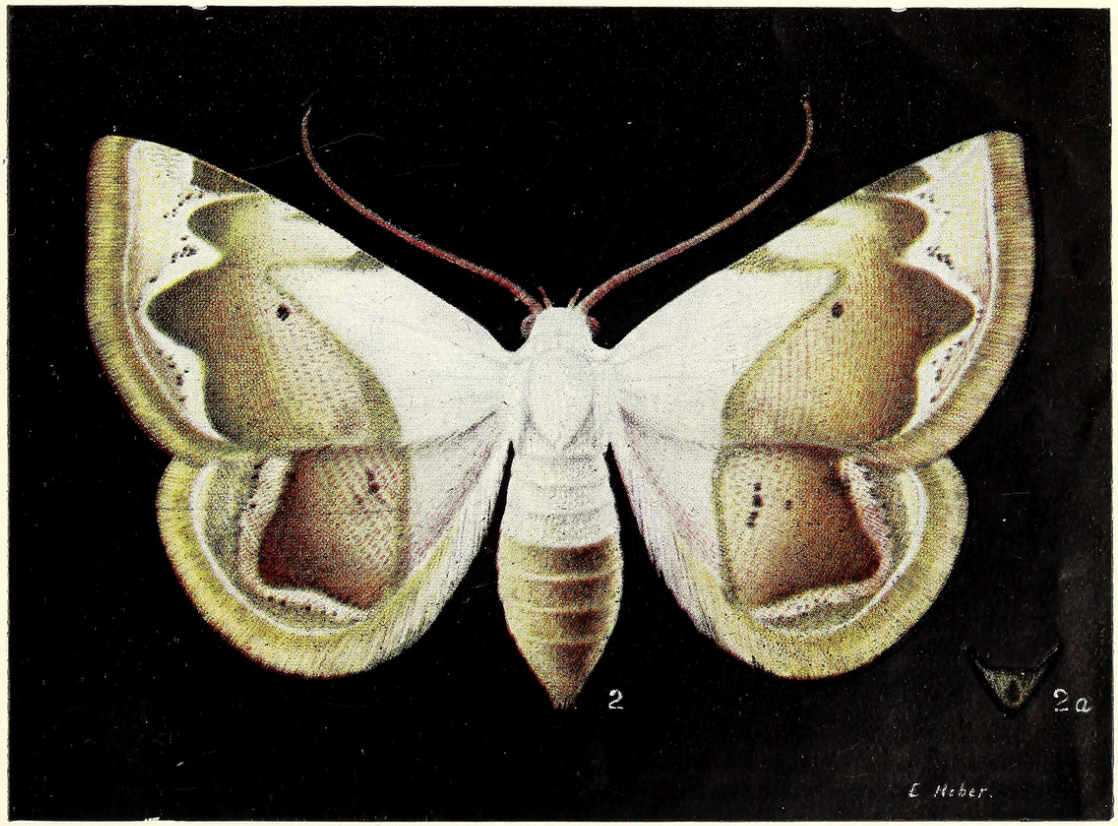



**Fig. 2.**

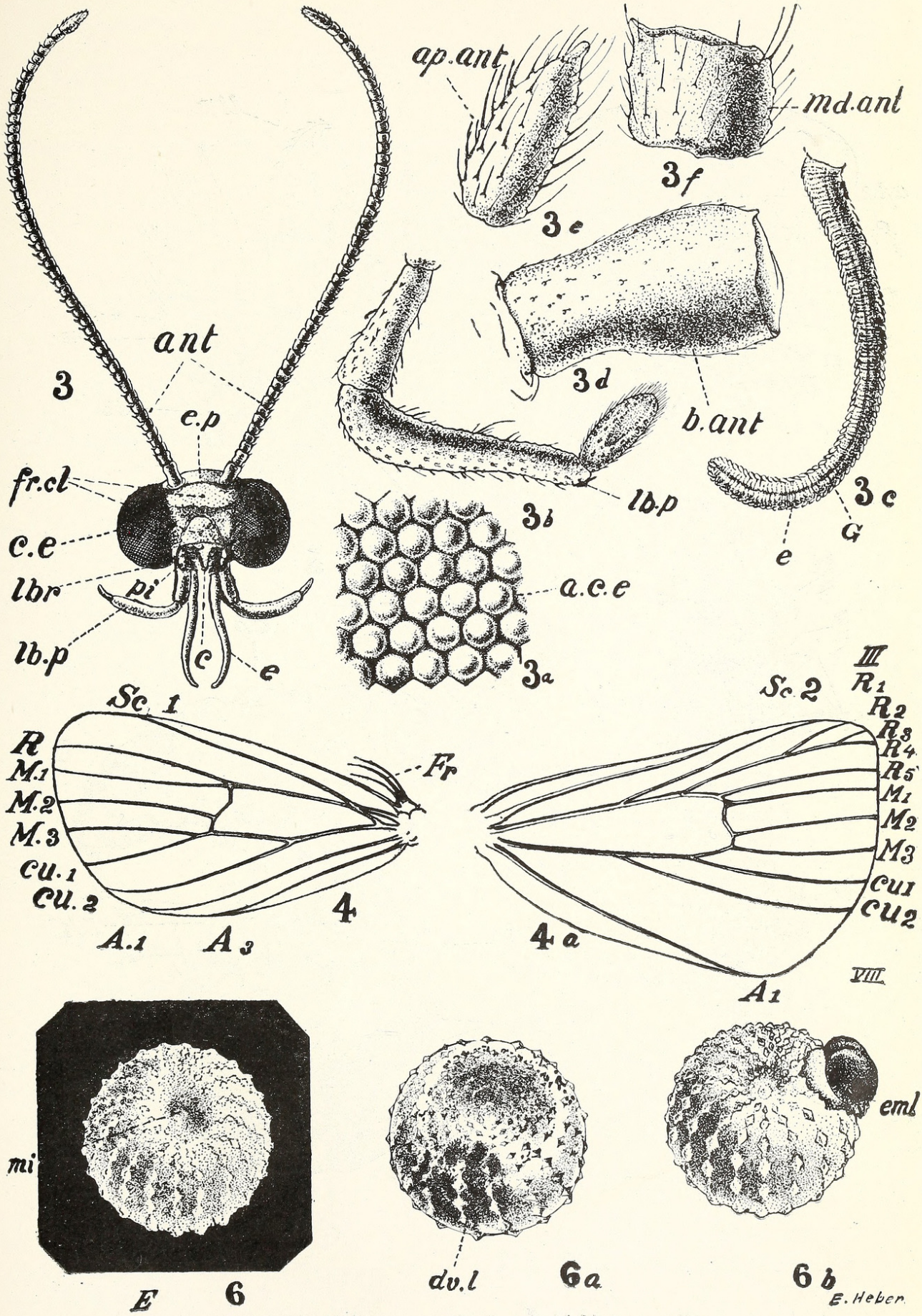
**The Noctuid Moth—*Eublemma amabilis*.**

Fig. 1. Male × 9.

1*a*. Posterior view of the last segment × 18.

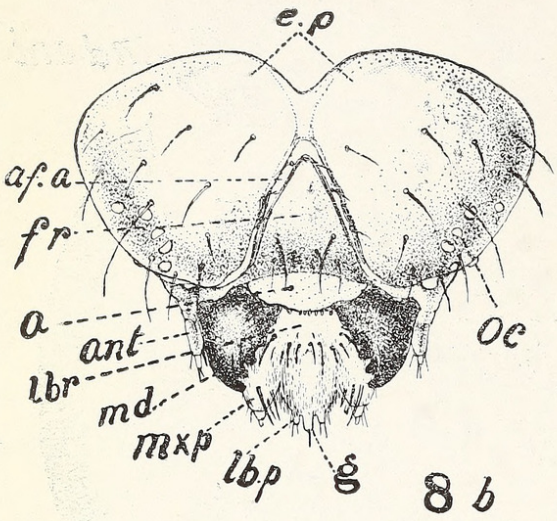
Fig. 2. Female × 9.

2*a*. Postero-ventral view of the last segment × 9.




The Noctuid Moth—*Eublemma amabilis*, Moore.

( *For explanation see end of article.* )

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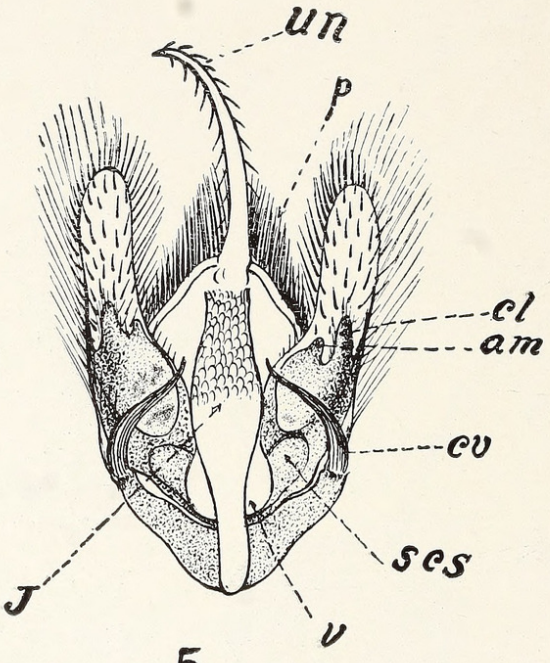


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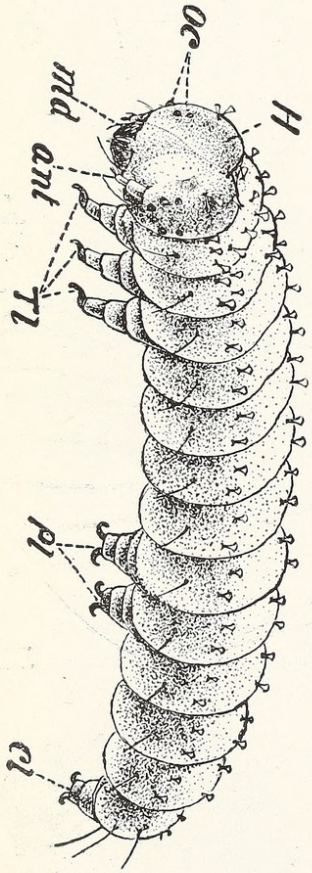


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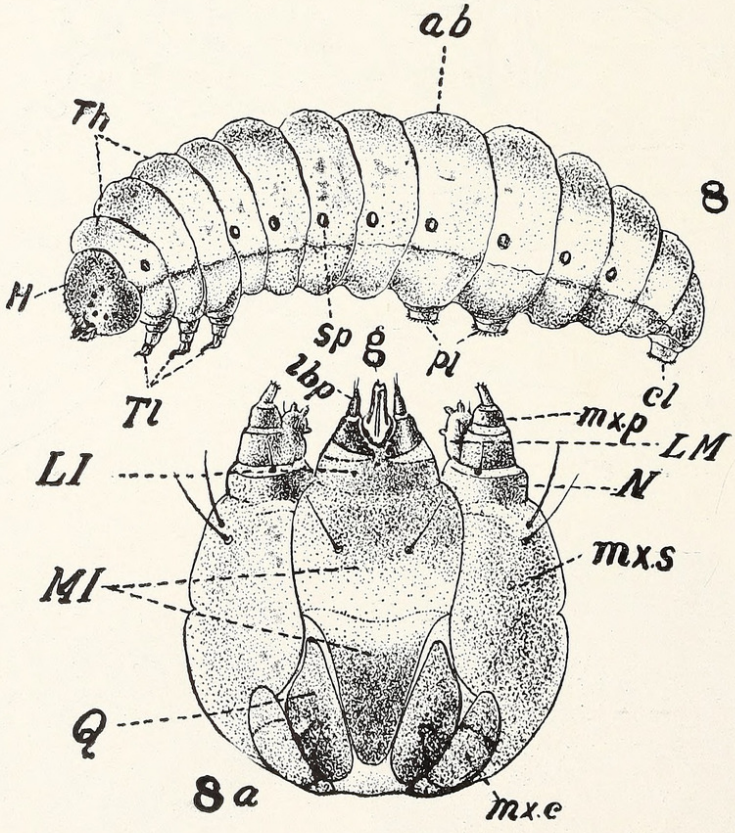


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The Noctuid Moth—*Eublemma amabilis*, Moore.

*(For explanation see end of article.)*

to the middle, but smooth and flat ventrally. The depression (the micropylar end) and the concentric protuberances become better marked in a fully developed egg, which measures ·325 to ·375 mm. in diameter and is deep brown in colour.

*The larva.*—

The newly emerged larva (Pl. III, Fig. 7) is about ·875 mm. in length creamy white and pinkish in colour. With feeding, slight changes occur in its colour till its maturity, but Imms and Chatterjee have gone too far when they say: 'In lac that is approaching the swarming period, the *Eublemma* larvæ are deeper crimson in colour, the colour being due to the ingested *Tachardiæ*.' And the same may be said about Mahdihassan, who says: 'The absence of red dye in the food of these caterpillars explains the yellow rather than the pink appearance of the adults.' The food contents are in the alimentary canal which cannot be seen through the body wall as the alimentary canal is surrounded by fat bodies. The only organ which can be seen from outside is the dorsal blood vessel which contains a dark red fluid. As such the ingested food can hardly affect the colour of the larva.

The mature larva (Pl. III, Fig. 8) measures about 9 mm. in length, is dirty yellowish white in colour; intersegmental indentations deeper yellow, the posterior eight abdominal segments more yellow than the thoracic and anterior two abdominal segments. It is broadest from 6th–8th abdominal segments and slightly flat dorsally, the 9th and 10th segments gradually tapering posteriorly. Head (Figs. 8*b*, 8*a*) is dark brown in colour and partly retractable into the prothorax; the cardo appears to be 3-jointed—a single maxillary lobe, and 3-jointed palpi; the antennae 3-jointed and small; just behind and a little above the base of each of them are situated six ocelli of unequal dimensions. The prothorax is dorsally brown and chitinous. Thoracic legs are 3-jointed, setose and terminate in large claws directed inwards. The prolegs are borne by abdominal segments 5th and 6th and 10th (anal); each proleg with nine crochets arranged in half rings. The dorsal blood vessel can be seen running from the head to the 8th abdominal segment, the heart being situated in the 4th and 5th abdominal segments.

*Points of difference between a newly hatched and mature larva.*

(Pl. III).

| | | Newly hatched larva (Fig. 7). | Mature larva (Fig. 8). |
|---|---|---|---|
| 1. | Abdominal segments 8th–10th. | The segments are not very marked; 8th and 9th segments coalesce ventrally. | The segments quite distinct, no coalescence in the 8th and 9th segments ventrally. |
| 2. | Prolegs on 5th, 6th and 10th abdominal segments. | Apparently three lobed, fleshy and end in two curved spines. | Neither lobed nor fleshy, with nine uniordinal hooks (crochets). |
| 3. | Setae. | Cup-shaped. | Bristle-like. |

*The Setal plan.* (Diag. Figs. 1-9).—

The setal arrangement of the first instar and the mature larva of *E. amabilis* differs in many important respects from that described by Fracker in *F. gladiaria* representative of the family Noctuidae studied by him. On the prothorax (Fig. 1) of the first instar larva of *E. amabilis* unlike that of *F. gladiaria*, eta of the kappa group, all the tau group, and sigma are present; gamma is absent and a small seta near the caudal end between beta and delta has made its appearance, which cannot be accounted for and adjusted within the present setal terminology, unless one is ready to accept that gamma has moved to the caudal border and the seta labelled delta is gamma and the small seta between it and beta is delta, but this is hardly plausible because there is no apparent reason for gamma alone to undergo this change; above

sigma at the base of the leg is more than one seta which represent the tau group. The meso-and meta-thorax (Fig. 2) unlike that of *F. gladiaria* show the presence of gamma, theta; and of rho close to epsilon at the cephalic border, and of tau group and sigma. Theta, though a sub-primary seta, seems to have become established on the meso-and meta-thorax of the first instar *Eublemma amabilis* larva. The only other seta for which it could be taken is delta, but comparison with the abdomen shows delta to be missing and this has been accepted by the other workers as a general case in all the *Frenatæ*, this is further confirmed by the fact that in the mature larva the seta occupying this position is theta. On the abdomen (Figs. 5–7) epsilon is distinctly represented as a minute point on the 8th segment but is not clear on other segments, this however goes to confirm the primary nature of the seta, tau is present on the first four and 9th segments and sigma is absent on the 9th. The homology of the setal plan of the 10th segment is not clear.

The mature larva (Figs. 3, 4, 8, 9) shows but slight modification of the chaetotaxy of the first instar larva. This modification is the arrival of mu on the first nine abdominal segments.

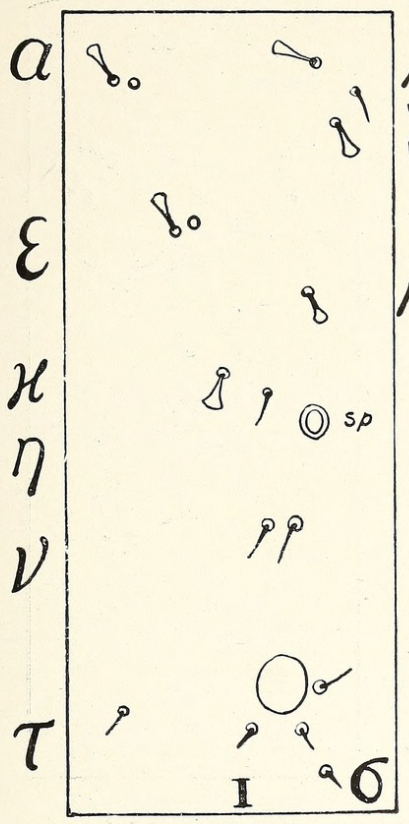
The setal plan of *Eublemma amabilis* larva seems to be of special interest, as it appears to be a connecting link between the *Jugatæ* and the *Frenatæ* and the Microlepidoptera. As in the Jugatæ on the prothorax in the first instar, eta of the kappa group, tau group and sigma are present, and on the meso and meta thorax tau and sigma group are present. Epsilon on the prothorax in the mature larva, as in the Microlepidoptera remains near the cephalic border and does not move as in the Bombycidae close to rho above the spiracle.

*Internal anatomy.—*

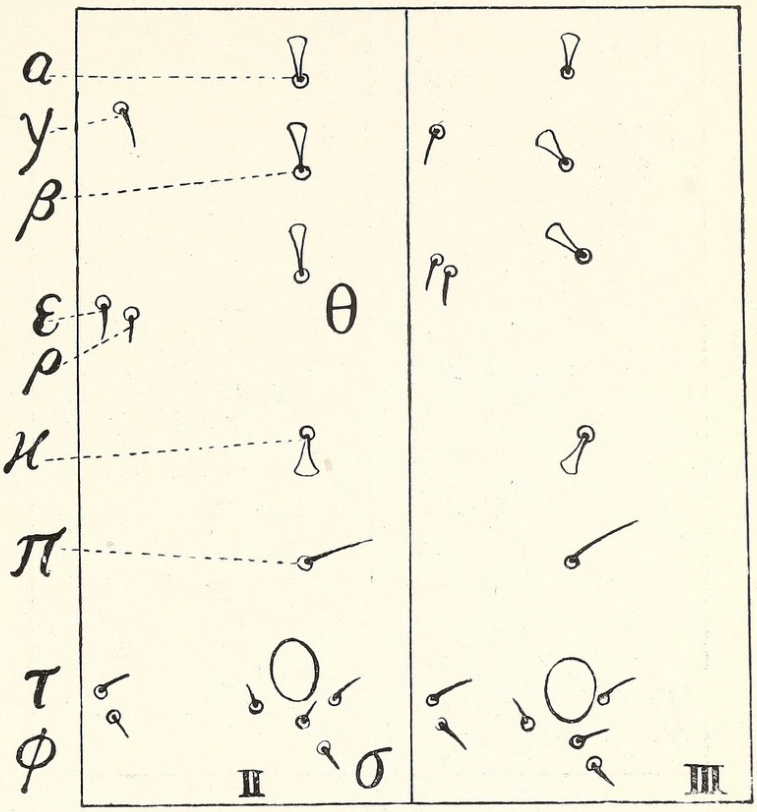
*The digestive system* (Pl. IV, Fig. 9).—The alimentary canal is a more or less straight tube, the hind intestine is divided into two chambers (colon and rectum). The six Malpighian tubes open on either side by means of a common duct into a small excretory chamber which in its turn opens into the hind intestine. The common duct bifurcates and one branch subdivides, thus giving rise to three tubes on each side. The pair of silk glands (Fig. 11) is most conspicuous, each one of them is an elongated cylindrical tube of nearly three-fourths the length of the entire body. The accessory or Fillipi's glands are reduced to a bifid lobe. The salivary or mandibular glands (Fig. 10) consist of three main lobes and lie in the thorax, one on each side of the fore-intestine and overlapping beneath it; the third is smaller in size and lies medio-dorsaliy on the fore intestine. Each lateral lobe opens by a duct into the base of the mandible of its side; and the dorsal lobe by a comparatively narrow duct directly into the buccal cavity.

*The nervous system* (Pl. IV, Fig. 12).—The central nervous system is typical and consists of supra-and infra-oesophageal ganglia, three thoracic and eight abdominal ganglia. The 7th and 8th abdominal ganglia lie on the 7th segment.

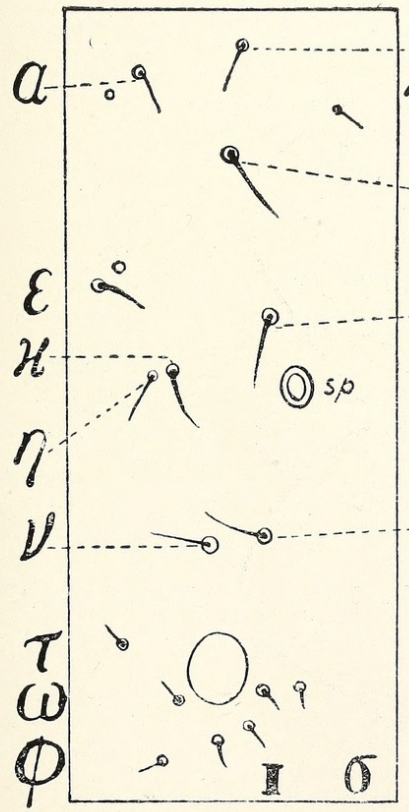
*The respiratory system* (Pl. V. Fig. 13, 16), is of the peripneustic type. There are 9 spiracles on each side of the body, one in the prothorax and eight in the first eight abdominal segments. Short wide tracheæ run inwards from the spiracles and give rise to three main branches; the smallest arises just near the spiracle, and divides and sub-divides to supply the body wall; the other two arise by the breaking of the main tube into two. One of these joins the lateral trunk, and the other (the dorsal) branch supplies the body wall and viscera, etc. The dorsal branches bifurcate and the sub-divisions further divide and sub-divide and loosely join those of the opposite side, thus forming a system of loops or arches. The principal ventral branches arise, from the lateral trunks in all the segments except the first and last (8th abdominal). Here they may be said to arise directly from the spiracular tube, immediately below the spiracle, and take a transverse course to join their fellows of the opposite side, thus forming a single ventral trunk running between the opposite spiracles. From these, branches are given off to the nerve cord and ventral musculature, etc. The lateral trunks run along the sides of the body. In the meso-and meta-thorax, though the spiracles have totally degenerated and the thin dorsal and ventral branches on either side are directly given off from the longitudinal trunks, yet there is in the meta-thorax, a thin rudimentary spiracular tube clearly seen running from the lateral trunk to the body wall attached in a corresponding position to that of the spiracle in other



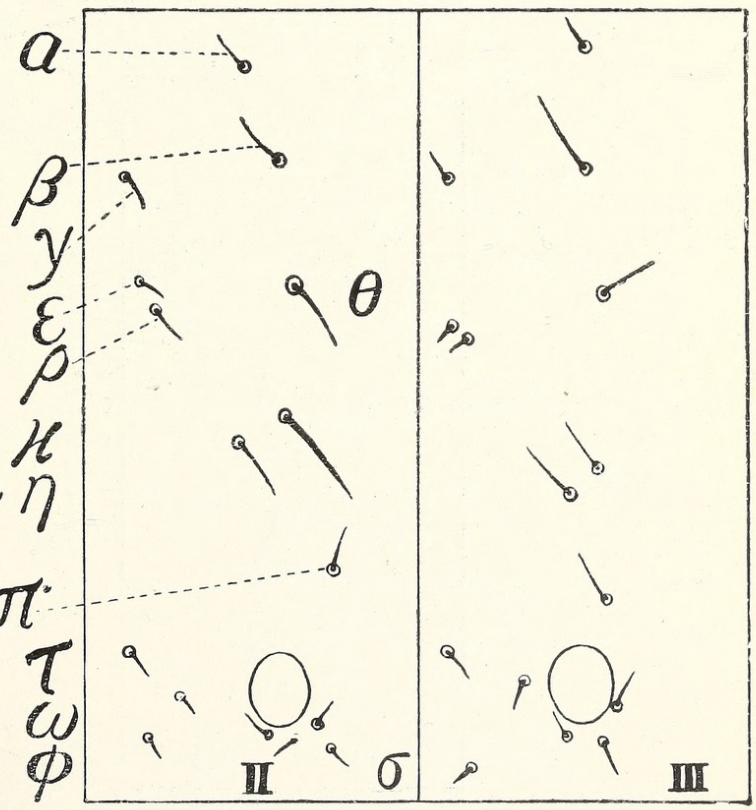

DIAG. FIG. 1




DIAG. FIG. 2

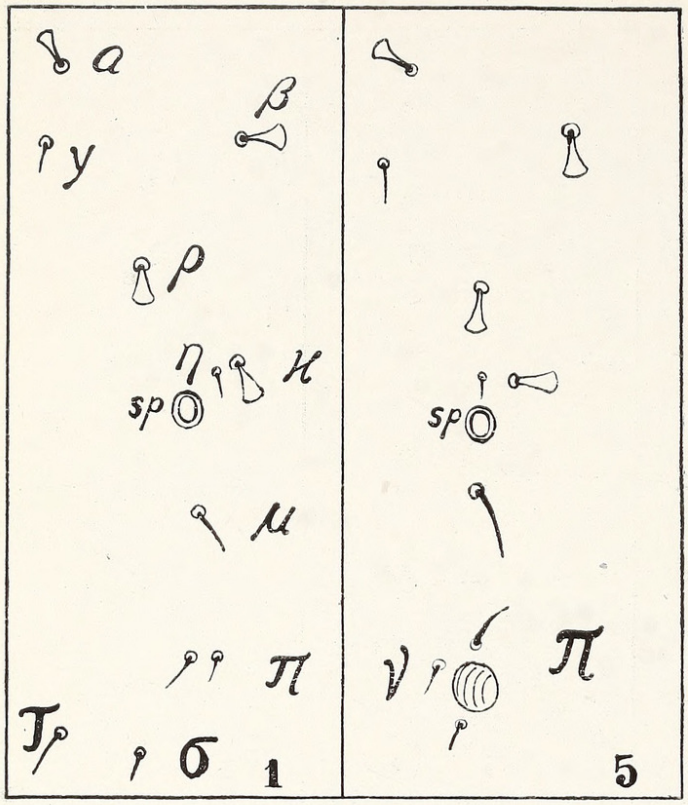



DIAG. FIG. 3




DIAG. FIG. 4

The Noctuid Moth—*Eublemma amabilis*, Moore. Seetal plan of Larva.

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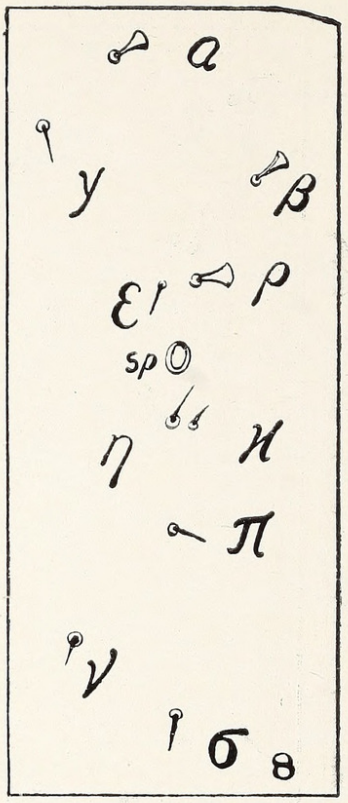
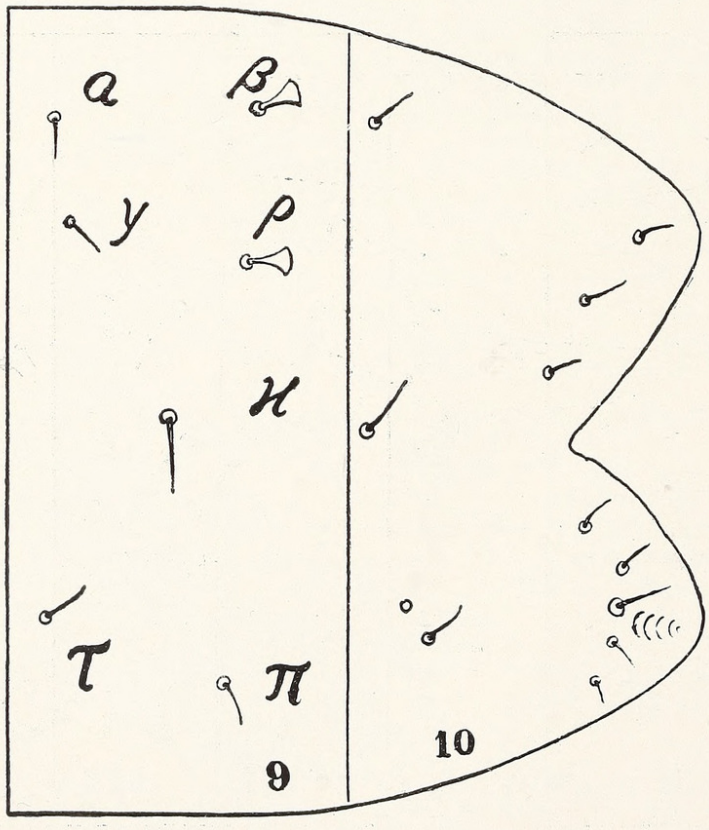
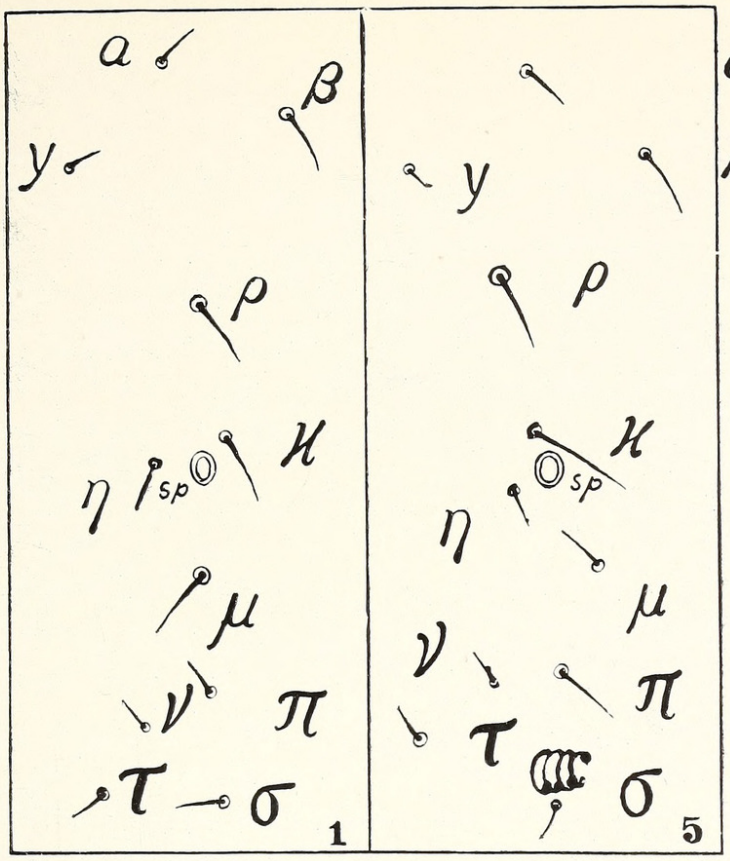



DIAG. FIG. 6

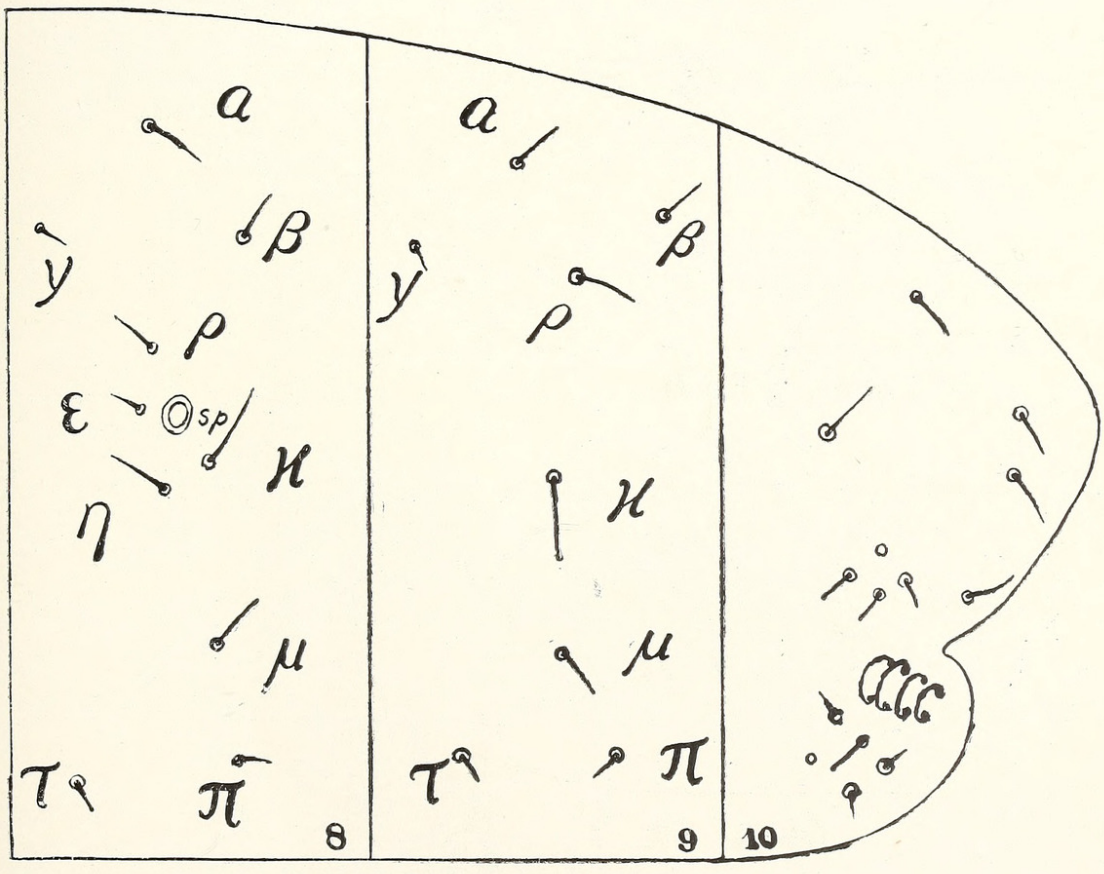



DIAG. FIG. 7

The Noctuid Moth—*Eublemma amabilis*, Moore. Seetal plan of Larva.

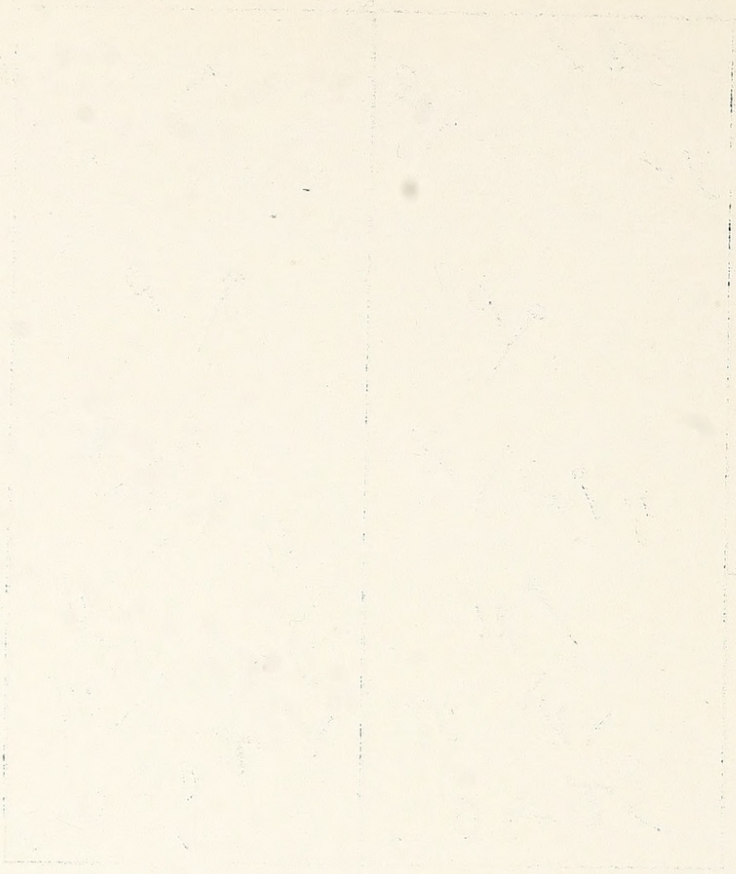


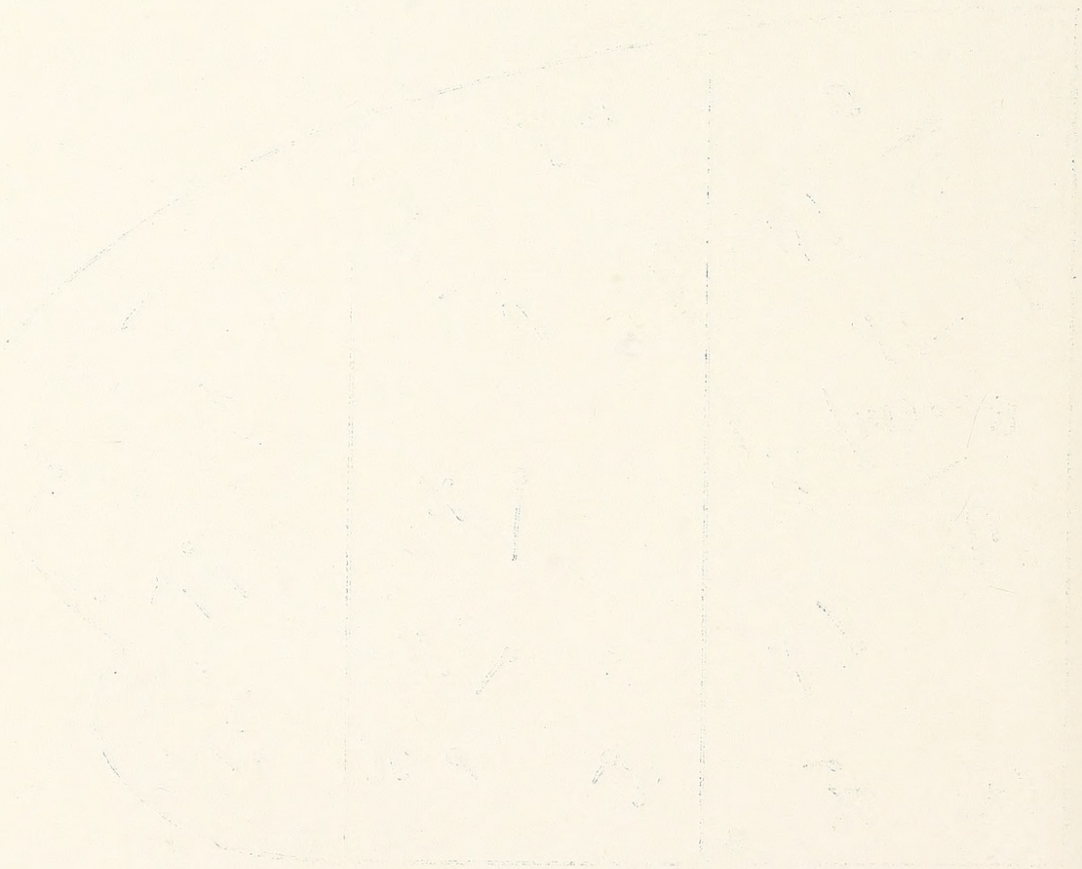

DIAG. FIG. 8




DIAG. FIG. 9

The Noctuid Moth –*Eublemma amabilis*, Moore. Seetal plan of Larva.





segments. The ventral trunks of the prothorax, unlike those of other segments, divide into three principal branches and the middle ones of the opposite sides join to form the ventral trunk just behind the epicranium. In addition to the principal ventral branches, practically in all the segments one or two secondary fine transverse branches are given off from the lateral trunks.

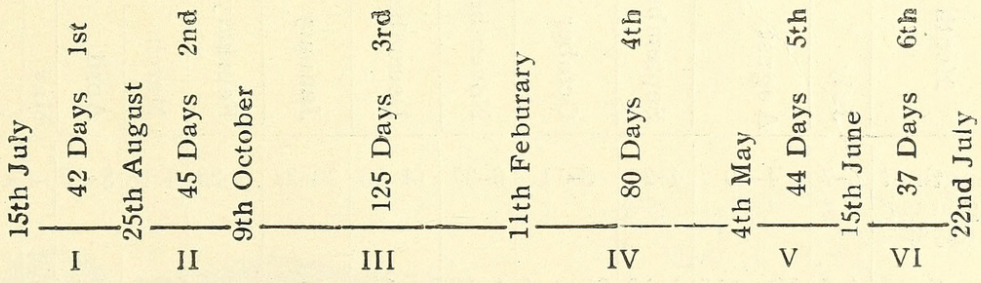
*The Pupa.* (Pl. V, Figs. 17, 18, and 19).—

It is first pale yellow in colour ; all other parts except the abdomen turning to deep brown when the moth is about to emerge. Thirteen segments are visible from above, the largest being the mesothorax, the eyes are small and dark brown, antennae and legs fused ventrally, cremaster present. The free segments in both the sexes are the 4th, 5th and 6th abdominals. The spiracles are present in the prothorax and in abdominal segments 1-7. The genital aperture in the male pupa is situated on the 9th sternum, in the female the 8th and 9th sterna coalesce in the middle line and the common opening for oviduct and bursa copulatrix lies more on the 8th than on the 9th ; the anus lies ventrally on the 10th segment.

The pupa lies in its larval passage lined with fine silk threads freely interspersed with the larval excreta, and with a circular hole at one end of the passage. The hole is cut prior to pupation and is lined from below with a silken covering, which is ruptured by the imago while emerging.

*Life History.*—

*Generations.*—Though the emergence from our parasite cages, the tables given by Imms and Chatterjee and the results of our breeding cages show the presence of *Eublemma* in large or small numbers in the field practically throughout the year, yet according to the mean life cycle periods in table ii, it seems to have six generations (diag. fig. 10) in twelve months and eight days in all places throughout India where only two crops, i. e., June-July (Jethwi) and October-November (Katki) including the Aghani (January-February) and Baisakhi (April-May) are reaped. This has also been pointed out by Mahdihassan in his *L. mysorensis* which is reported to take 13 lunar months to complete three life-cycles, though he does not support his conclusions with data. Imms and Chatterjee were therefore wrong in concluding : ' There are two generations in the year, and possibly in the hottest localities there are three such broods '. July has been chosen as the beginning of the year as it is more convenient from the point of view of lac cultivation, and by the 15th of this month practically throughout the country, brood lac for both the Katki (October-November) and Aghani (January-February) is infected on the host plants.




DIAG. Fig. 10.

The life cycle of the predator is not as simple as represented above. The complexity begins with the third generation. The eggs laid in October, as will be seen from Table Nos. 2, 3, 4, develop and a part of the adult emergence takes place in November and a part hibernates in the Aghani crop which matures in January-February and in the Katki stored lac, i.e., Ber (*Z. jujuba*) and Palas (*B. frondosa*), etc., which has been reaped and kept in store after and before the inoculations. A portion of the brood which hibernates nearing or in the pupal stage emerges in December-January and the remainder emerges in February-March. Thus the October generation (generation three)

emerges continuously from November to March. Most of the eggs laid by this generation on Baisakhi and Aghani do not develop due to cold, but those which survive, and develop further, emerge as adults in March-April and May. This is the fourth generation. The eggs laid by this develop and emerge as adults in different months till the first half of June. This is the fifth generation. The eggs laid by these in May and first half of June generally do not develop due to heat. A few that do develop emerge in June or along with those laid in the second half of June, in July and August. This is the 6th generation. The 4th and 6th generations develop under very trying conditions.

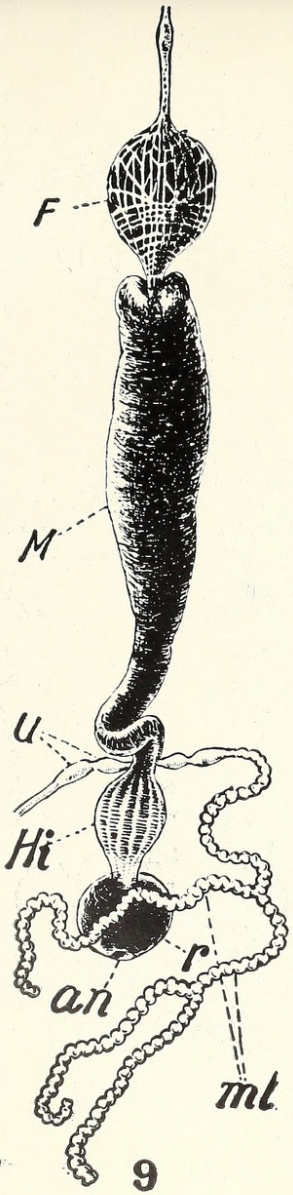
*Mating.*—As soon as the moths emerge, they seek shelter on the lower part of the leaves of the host plant or in a less lighted place in the vicinity till dusk, when they presumably fly about in search of mates. After a mate has been secured, the pair remain in copula until after dark, and do not separate easily even if disturbed. The eggs are laid soon after copulation. In the laboratory in six cases, the female began to deposit eggs from 2½-7 hours after copulation. Besides this, in the laboratory under confinement, eggs were laid by females hitherto virgins, 1-13 days after the introduction of males. Misra who has quoted this datum of ours has incorrectly put 1-13 days after fertilization. This shows that the mating does not begin as soon as a couple comes together. The female continues to deposit eggs from 1-10 days after she has begun egg laying.

*Egg-laying and hatching.*—In the field the eggs are laid singly as well as in batches of 2-40, the common number in a batch being 2-6. They are laid between the developing larvæ of the lac insect, in the crevices of the lac incrustation and sometimes on the incrustation also ; this depends on the stages of development of the lac insect ; in the early stages, *Eublemma* invariably lays eggs between the lac cells or at the side of a single cell, but when the incrustation becomes continuous, it lays eggs in the crevices generally and sometimes on the encrustation itself. In the laboratory the eggs are laid on the sides of the jar, on the papers covering the jar, round the holes for ventilation and sometimes in the holes too. The egg-laying period varied from 1-10 days. The female continues laying eggs even after the death of the male, but the rate becomes less. *Eublemma amabilis* moths are more fertile during the Katki crop than in the Baisakhi, they lay a much larger number of eggs in the months July-October than in the other months of the year. This has been observed both in the laboratory and in the field. The minimum and the maximum length of the egg stage and the period within which all the eggs laid on the same day hatch (i.e., duration of hatching) for eleven months are given in Table No. 1.

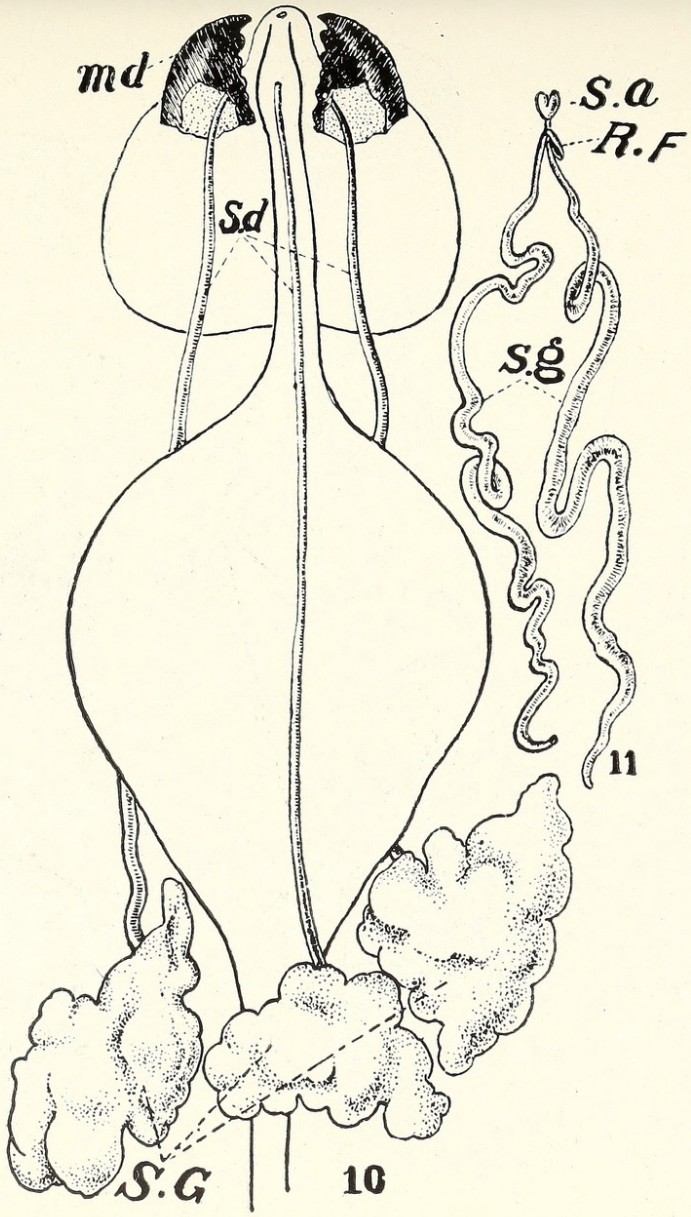
TABLE NO. 1.

| Month | July | August | September | October | November | December | January | February | March | April | May | June |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Length of egg stage in days. | 5-7 | 4-20 | 4-20 | 3-11 | 6-37 | 14-52 | 20-27 | 9-23 | 6-16 | 5-10 | — | 4-7 |
| Duration of hatching in days. | 1-2 | 6hrs.-15 | 1-15 | 6hrs.-5 | 1-18 | 1-31 | 1-8 | 1-4 | 1-5 | 1-2 | - | 1-3 |

The table shows that the length of the egg stage and the duration of hatching rises continuously from November-February (in generation 3) and begins to drop from March-June in (generations 4 and 5) and remains more or less at its lowest from June to October (generations 6, 1 and 2). The mortality of eggs laid from November-February and May to first half of June is much




9

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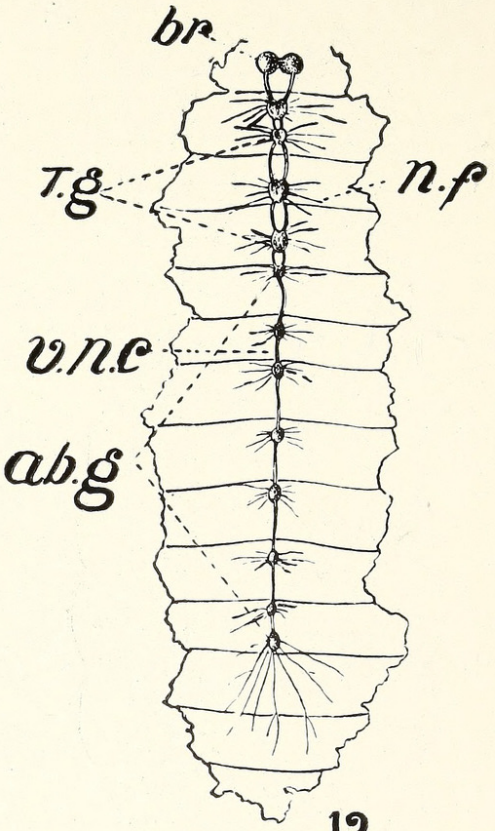
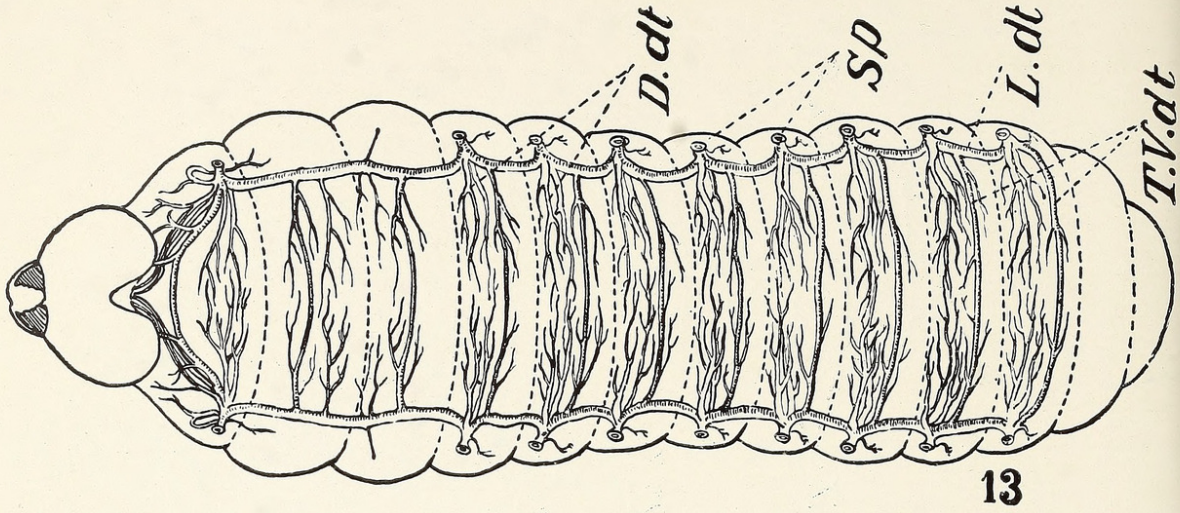


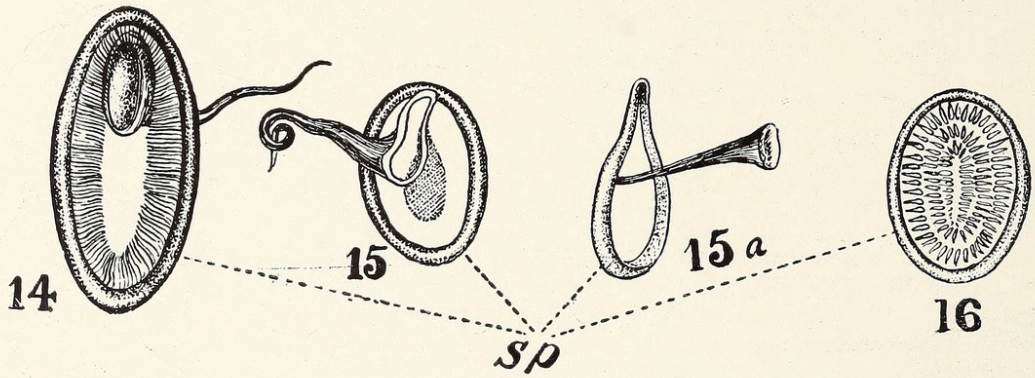

12

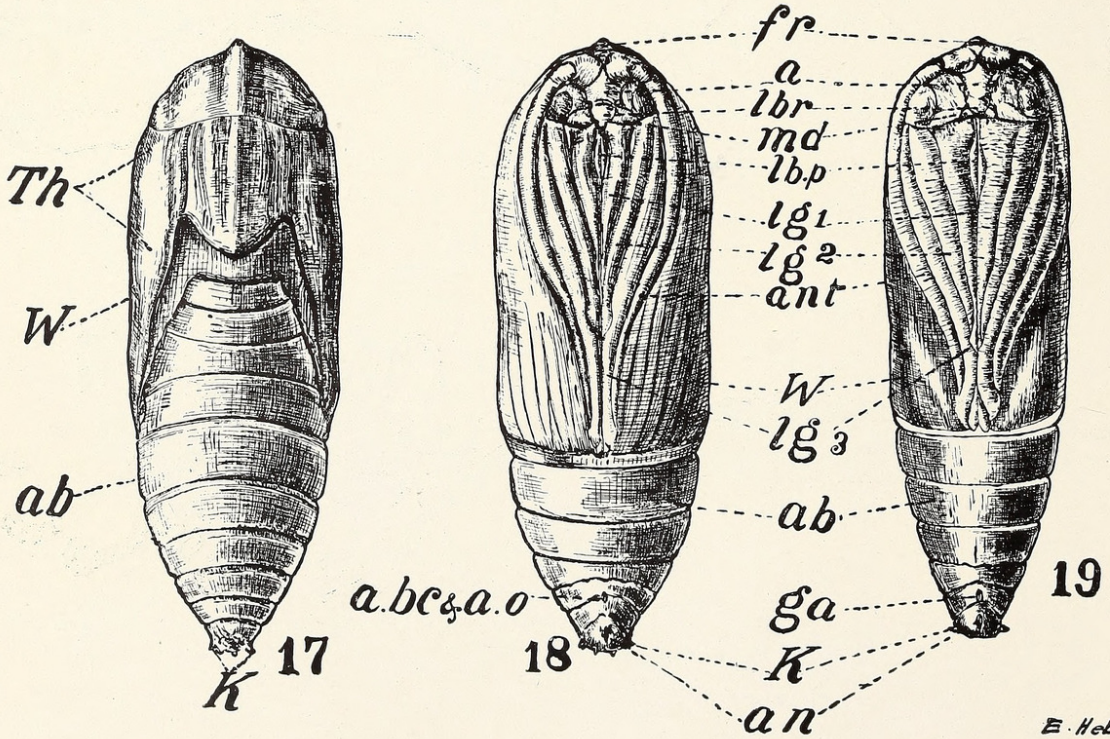
E. Heber

The Noctuid Moth—*Eublemma amabilis*, Moore.

(*For explanation see end of article.*)




The Noctuid Moth—*Eublemma amabilis*, Moore.

*(For explanation see end of article.)*