THE EXTERNAL MORPHOLOGY AND INTERNAL ANATOMY OF THE ADULT MOTH OF PRODENIA LITURA F.

(Lepidoptera, Noctuidae, Zenobiinae)

By

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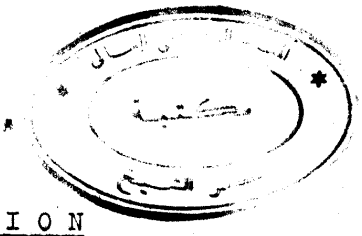


I. INTRODUCTION

The cotton leafworm, Prodenia litura F., is well-known as a major destructive pest of cotton and several other crops in many parts of the world. In Egypt, the annual loss in the cotton crop alone due to the ravages of the larvae of this pest amounts to several million pounds inspite of the extensive control programmes undertaken. The defoliation caused to cotton plants by these larvae certainly retards the formation of bolls and thus exposing these bolls to the severe attack by the spiny and the pink bollworms which increase the losses considerably.

Judging from the available literature, it is evident that the distribution, biology, and life-history of this pest have been thoroughly studied in Egypt and various other countries. Among the workers who contributed in these respects are Jones (1913), Ballard (1913 and 1914), Morststatt (1914), Duport (1914), Jack (1915), Gurney (1915), Mosseri (1917), Maki (1918), Jepson (1918), Brain (1918), Jhaveri (1920), Comus (1921), Fletcher (1922), Hutson (1924), Sarcouf (1925), Jyssière and Mimeur (1926), Ritchie (1926), Jardine, Reeve, and Jabaratnam (1926), Edwards (1926), Ballard (1927), Simmonds (1927), Agaion (1928), Golding (1928), Hopkins (1928), Bishara (1929), Janisch (1930), Leefmans (1930), Smee (1930), Bishara (1934), Froggatt (1936), Ghabn

(1937), Willcocks and Bahgat (1937), Sonan (1937), Chin (1937), Jukchan (1937), Frappa (1937), Swezey (1941), Basu (1944 and 1945), Bodenheimer (1950), Hassanein (1958), Hosny and Kotby (1960), Nizambioglù (1960), Moufid, Moussa, Zaher and Kotby (1960), Moussa, Nasr, and Hassan (1960), Abul-Nasr, Moufid, and Moussa (1960), and Abul-Nasr (1962).

Also, general descriptions of its different developmental stages have been given by several workers. Moreover, the external morphology and internal anatomy of the mature larva have been described in detail by Salem, Shehata, and Hammad (1958), while, Soliman (1958), in her work on the effect of certain insecticides on the different internal systems of the mature larva of Prodenia litura, described briefly and figured some of its internal organs.

However, except for a few descriptive notes given by certain few workers such as Willcocks and Bahgat (1937) and Hammad and Jarczyk (1958), practically nothing has yet been done on the morphology or anatomy of the adult moth of Prodenia litura.

In fact, as stated by Imms (1957), very little work has been carried out on the morphology and anatomy of the adults throughout the whole order of Lepidoptera. All that has been done in this respect may be the works of Burgass (1880) on Danais, Bwoudt (1880) on Sesiidae, Jackson and

Jordan (1893) on Lepidoptera in general, Packard (1894) on Lagoa crispata, Peterson (1906) on the principal anatomical features of Lepidoptera, Rothschild's monograph (1903) on Lepidoptera, Nigmann (1908) on Acentropus, Richard (1933) on the morphology of the Noctuid tympanum, Della Beffa (1938) on Gracillatiidae, Nadden (1944) on Sphingidae, Freeman (1947) on Christoneura fumiforana, Mottles (1948) on psychidae, and El-Sawaf, Hammad, and El-Sherif (1963) on Sesamia cretica, Chilo suppressalis, and pyrausta nubilalis.

Therefore, the present work is undertaken with the aim of contributing to the filling in of such a gap in the lepidopterous literature by carrying out a detailed study of the external morphology and internal anatomy of the adult moth of one of the more important species, namely, Prodenia litura.

II. METHODS AND TECHNIQUE

To study the external morphology, the fresh adult moths of Prodenia litura were boiled in a 10 per cent sodium hydroxide solution for about 10-15 minutes, washed in water, dehydrated in 70, 80, 90, and 100 per cent alcohols, respectively, then cleared in cedar-wood oil, and finally mounted in Canada-balsam.

For the histological study, alive moths were fixed in hot bouin's solution (About 60°C.) for about 12 hours. The moths were then transferred to several changes of 70 per cent ethyl alcohol, and then to 80, 90, and 96 per cent ethyl alcohols, respectively, in each of which they were kept for about 2 hours. Then the specimens were subjected to 2 changes of benzol for 15 minutes each, then to 2 changes of terbineol for about 12 hours each, and finally transferred to a mixture of terbineol and soft wax (m.p. 48°C.) for half an hour. Serial sections were then prepared and stained with Ehrlich's haematoxylin and counter-stained with eosin.

All figures were drawn from underneath the stereoscopic binoclar or the ordinary microscope with the use of a square eye-piece.

III. EXTERNAL MORPHOLOGY

The female moth of Prodenia litura is comparatively larger in size than the male. The wing-expanse is approximately 38-40 mm. in the former and 40-50 mm. in the latter. The body of the female is about 14-18 mm. in length and is generally brown in colour, with the fore-wings dark-brown with ochreous lines and bars running obliquely for longer or shorter distances along the veins. In the male, the ochreous lines are more pronounced than those of the female, and there is an ochreous big band on the lower edge of the fore-wing. The male's fore-wing has also a big bluish or purplish area near the apex and a small area of the same colour near the base. In both sexes, the outer margin of the fore-wing is cut by several ochreous bars. The hind-wing is of white colour indescent with dark-brown. The thorax and abdomen are ochreous to light-brown in colour with numerous tufts of hairs. The head is also covered with tufts of light and dark-brown scales.

A) The Head-Capsule.

The head-capsule (Figs. 1 and 2) is spherical in shape but slightly depressed antero-posteriorly. A wide conical fronto-clypeus occupies the area between the two large compound eyes. The ocelli are two in number and

Fig. 1: Head-capsule (dorsal view).

as, antennal sclerite; E, compound eye; Eph, epipharynx; Epi, epicranial plate; fr.clp, frontal clypeus; ga, galea; lbplp, labial palp; lbr, labrum; md, mandible; pf, pilifer; scp, scape; vx, vertex.

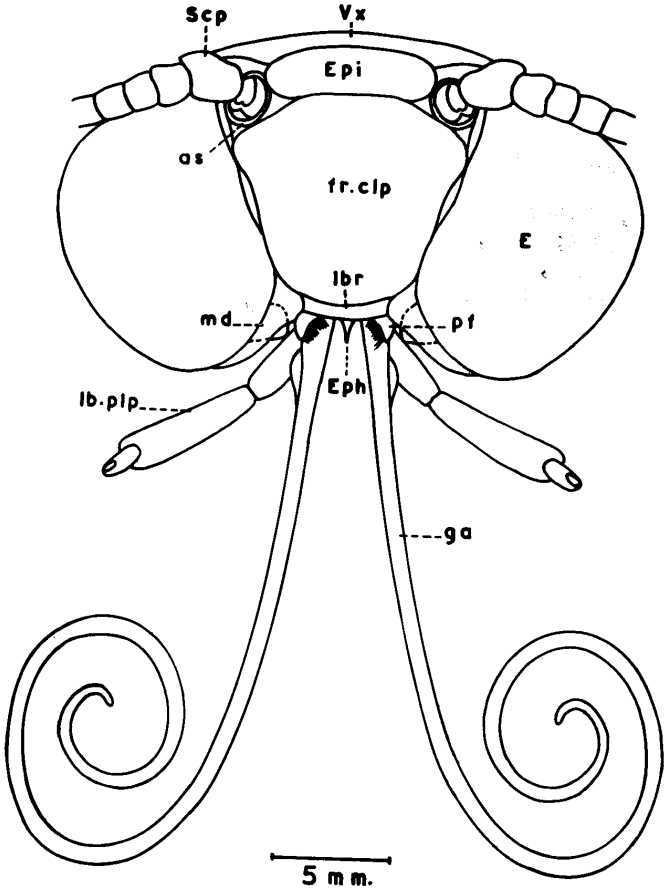
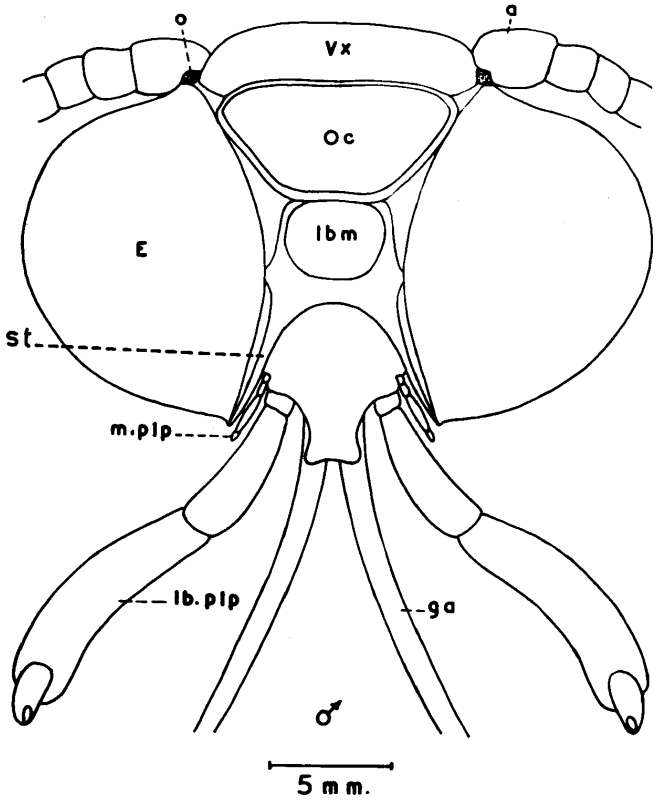

Scp
Vx
Epi
as
fr.clp
E
lbr
md
pf
Eph
lb.plp
ga
5 mm.

Fig. 2: Head-capsule (ventral view).

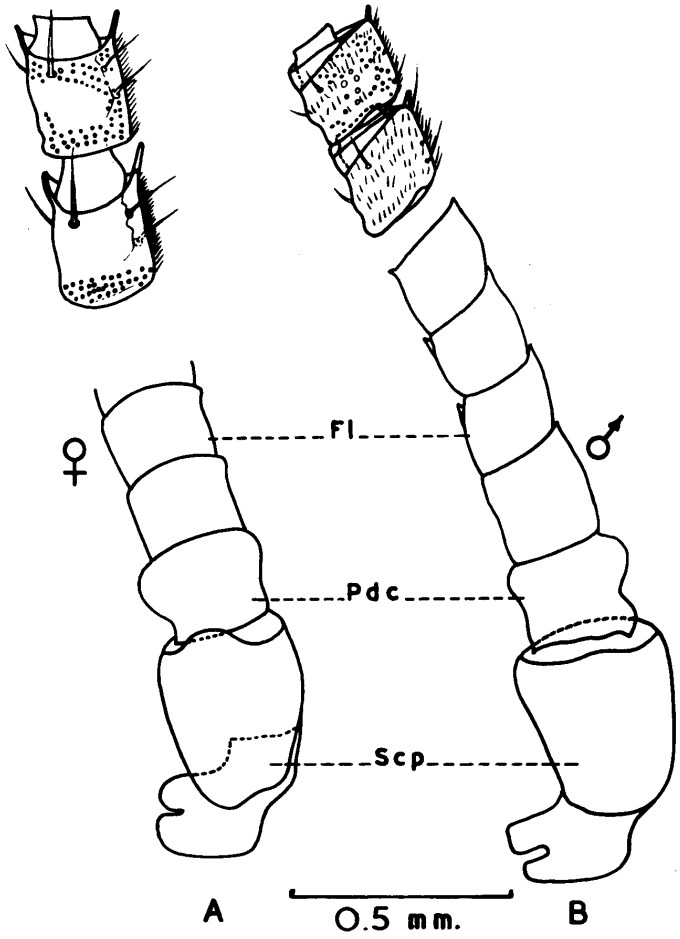
a, antenna; E, compound eye; ga, galia; lbm, labium; lb, plp, labial palp; m.plp, maxillary palp; o, ocellus; Oc, occipital foramen; st, stipes; vx, vertex.


o
a
Vx
Oc
E
lbm
st
m.plp
lb.plp
ga
♂
5 m m.

situated postero-laterally on the vertex as in other Lepidopterous moths. The greater part of the ventral aspect of the head-capsule is occupied by the occipital foramen. The antenna is composed of the scape, pedicel, and flagellum, the latter being about 75 segmented. In accordance with Willcocks (1925), it has been found that there are differences in the antennal characters between the two sexes. The antenna of the male possesses segments that are shorter, wider, and more hairy than those of the female's antenna (Fig. 3 A, B). It is worth-mentioning here that Jepson (1954) stated that in the family Noctuidae (Agrotidae), in general, the male antenna, being more or less strongly pectinate, bipectinate, or serrate, offers a character that can be used to separate groups of species within a genus.

As in the majority of Lepidoptera, the mouth-parts of the adult moth of Prodenia litura are adapted for sucking. Two small functionless mandibles are present on the sides of the narrow labrum which is provided with two lateral pilifers. The epipharynx is well-developed and appears as a V-shaped structure at the centre of the labrum. Each galea is greatly elongated and is channelled along its inner side and the two galeae are held together by means of spines to form a proboscis (Fig. 23 B). Similar to what has been stated by Imms (1937) for other Lepidoptera, the interior of each half of the proboscis is hollow and occupied throughout its length

Fig. 3: The antenna; A, of the female; B, of the male.
Fl, flagellum; pdc, pedicel; scp, scape.


♀
Fl
♂
Pdc
Scp
A
0.5 mm.
B

by a nerve and a trachea and sets of muscles which diagonally cross it (Fig. 23 B). The base of the proboscis is covered by the somewhat strong stout hairs arising from the inner margins of the pilifers. The two labial palps are very large and each is carried on a palpiger and is composed of three segments, the second segment being the longest and broadest, while the third or apical segment is very small. Each of the two maxillary palps is very small and rudimentary, consisting of three segments carried on a palpifer, and arising from a small narrow stipes. As in the labial palp, the second segment of the maxillary palp is the longest, while the third or last segment is very tiny. The labium is reduced to a small plate on the ventral aspect of the head-capsule. When not in use, the proboscis is spirally coiled beneath the thorax. According to Schmitt (1938), after Imms (1957), the proboscis is extended by means of blood-pressure created in the stipes of each maxilla. In Prodenia litura, the proboscis is functional, the two galeae being long and when their inner sides are firmly opposed they include a canal through which the liquid food is sucked up.

B) The Thorax (Figs. 4 and 5).

The thorax is composed of three segments, the pro-, meso-, and meta-thorax. As in all members of the higher families of Lepidoptera, the prothorax of Prodenia litura is

Fig. 4: The thorax.

ANP, anterior notal wing process; AxC, auxilliary cord; EM, emargination; i, median notal suture; PNP, posterior notal process; pph postphragma; prsc, meso-scutum; pt, patagia; Scl_1, mesocutellum; Scl_2, metascutellum; t, tegula; T_1, first tergite of abdomen; ts, transverse notal suture; vs, envertid V-shaped suture.

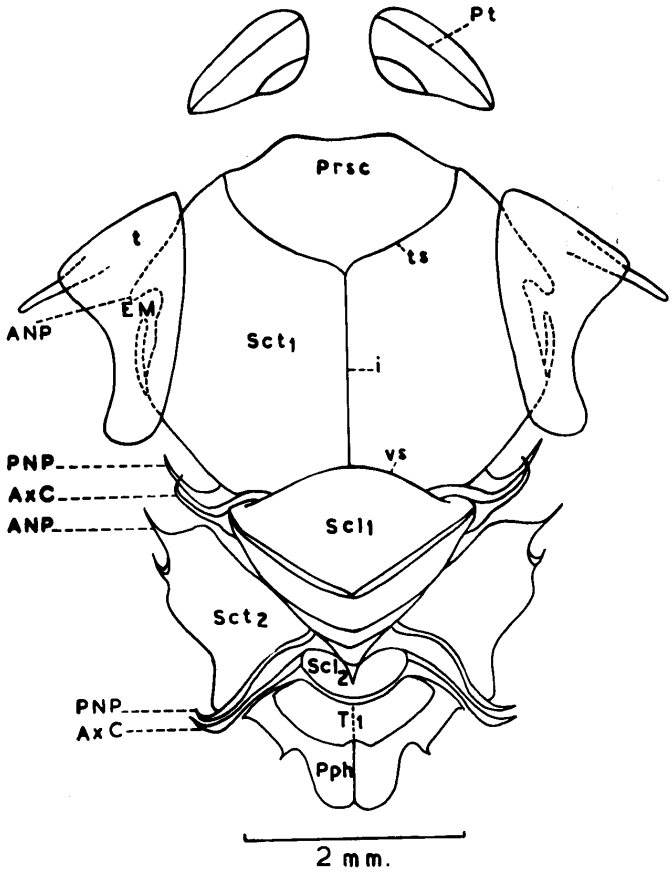
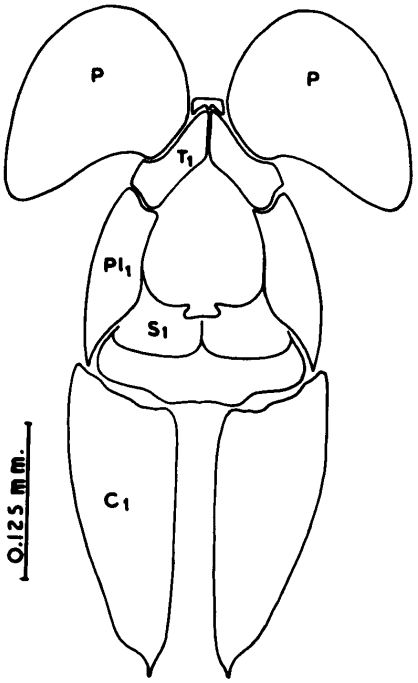

Pt
Prsc
t
ts
EM
ANP
Sct1
i
vs
PNP
AxC
ANP
Scl1
Sct2
Scl2
PNP
AxC
T1
Pph
2 mm.

Fig. 5: Frontal view of the prothorax.

c, coxa of fore-leg; p, patagia; pl_1, pleuron; S_1, sternum; T_1, tergum.


P
P
T1
Pl1
S1
C1
0.125 mm.

reduced and assumes the form of a collar which carries dorsally a pair of thin lobe-like lateral patagia.

The metathorax is the largest and most prominent thoracic segment, with its tergite consisting of three distinct plates, the prescutum, the large scutum, and the scutellum. The scutum is separated from the prescutum with the V-shaped transverse notal suture, and from the scutellum with the inverted V-shaped suture. This scutum is divided longitudinally into two equal parts by the median notal suture. On each side of the scutum, there is an emargination. Two large triangular tegulae are situated one on each side of the mesoscutum and overlying the anterior and posterior notal processes of the fore-wings. The scutellum is triangular in shape and bears many transverse ridges.

The metathorax is smaller than the mesothorax and consists of a small median rectangular plate, the metascutellum, and two lateral triangular plates which form the metaxcutum.

The anterior and posterior wing-processes are situated laterally on the anterior and posterior margins of either the meso- and the metathorax. There is an auxilliary cord attached laterally on each side of each of the meso- and metascutellum.

1. The Legs :

Each of the six thoracic legs consists of the usual parts: coxa, trachanter, femur, tibia, tarsus, and pretarsus.

The cox is always triangular in shape but differs in size in the different legs. That of the fore-leg is long and slender (Fig. 5). The middle coxa (Fig. 6) is the largest and broadest, nearly assuming the form of a rectangle. The coxa of the hind-leg (Fig. 7) is intermediate in size between the fore- and the mid-coxa. On the inner surface of each tibia occur some peculiar spurs with shape and form that give a differentiantive character between the three pairs of legs. The anterior tibia has but a single flattened spur, the epiphysis which is situated midway (Fig. 8), and opposite this epiphysis on the body of the tibia there is an invagination covered with very fine hairs. The epiphysis and the hairy invagination compose the antennal cleaning apparatus (Fig. 9). On the distal end of the tibia of each middle-leg is present a pair of such spurs, one of which is about half the length of the other (Fig. 10). The posterior tibia bears two pairs of spurs, one near its middle and the other on its distal end (Fig. 11), and in either pair one spur is always halfas long as the other. The tarsus of all the legs is five-segmented, the first segment being the largest. The pretarsus (Fig. 12) is composed of two claws, two hairy auxilliary sclerites, two pulvilli,

Fig. 6: Frontal view of the mesothorax.

c_2, coxa of the mid-leg; c.m, coxa meron; c.v, coxa vera; s_2, sternum.

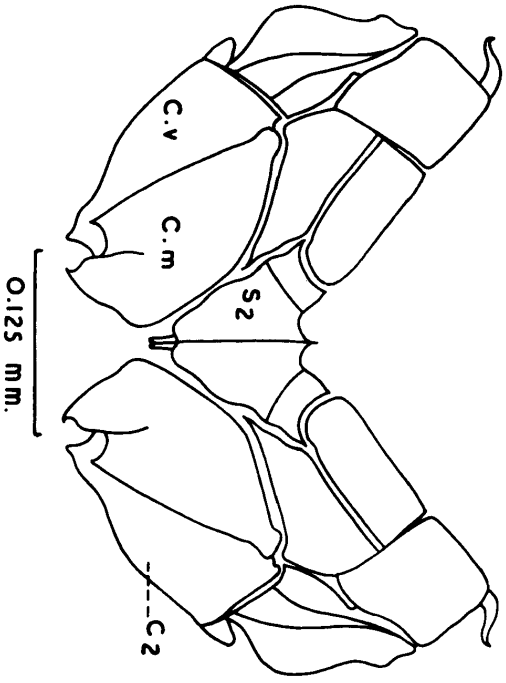

C.v
C.m
S2
0.125 mm.
C2

Fig. 7: Frontal view of the metathorax.

c_3, coxa of the hind-leg, c.m, coxa meron;
c.v, coxa vera; Pl_2, metapleuron; s_3, sternum.

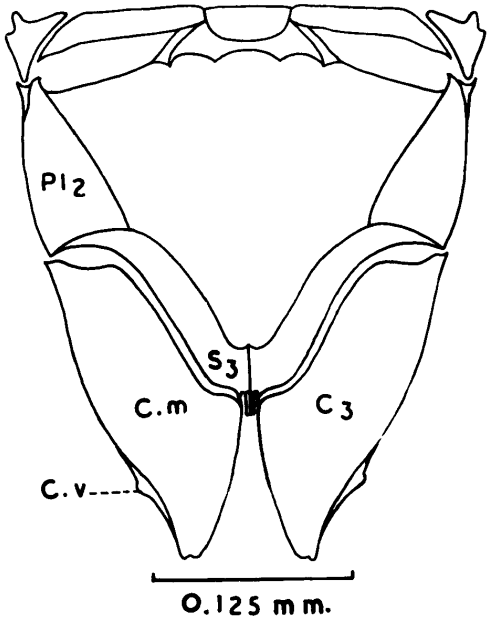

Pl2
S3
C.m
C3
C.v
0.125 mm.

Fig. 8: The fore-leg.

c, coxa; f, femur; spu_1, spur; t, trachanter; tb, tibia; ts, tarsus.

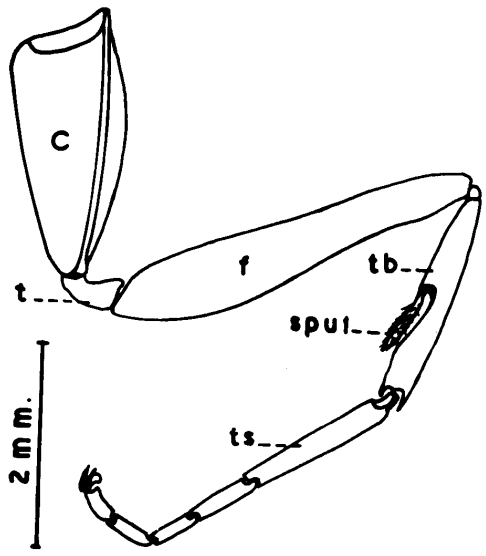

C
f
tb
t
spul
ts
2 mm.

Fig. 9: The antennal cleaning apparatus on the fore-leg (enlarged).

f, femur; spu_1, spur; tb, tibia.

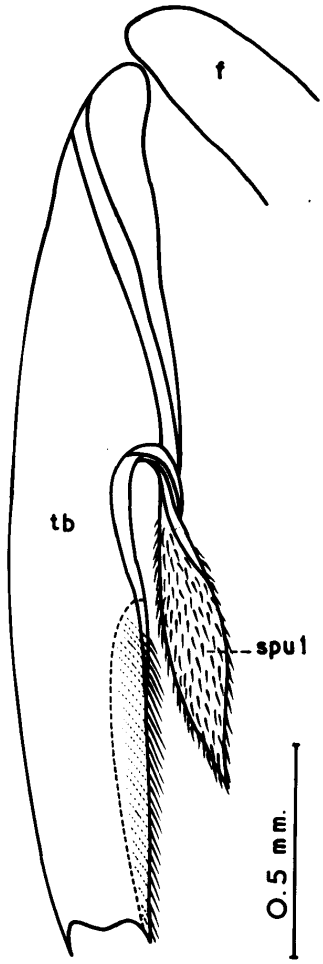

f
tb
spu1
0.5 mm.

Fig. 10: The mid-leg.

c, coxa; f, femur; spu_1, distal pair of spurs; t, trochanter; tb, tibia; ts, tarsus.

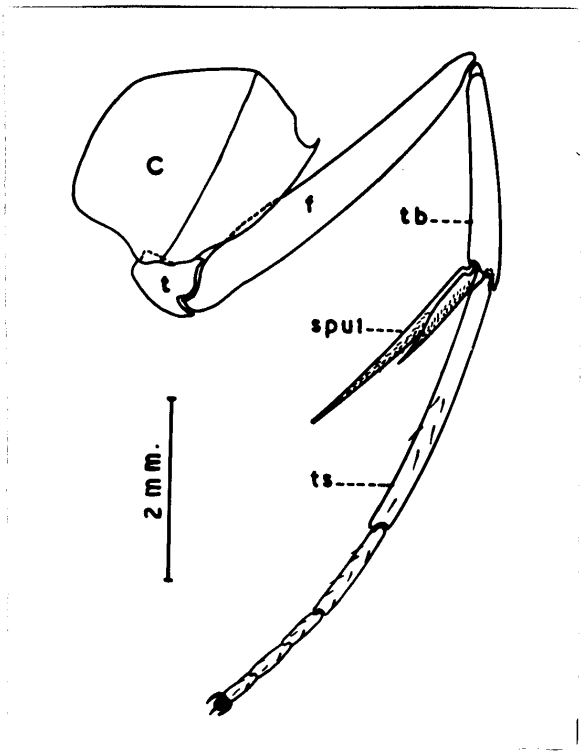

C
f
tb
t
spul
2 mm.
ts

Fig. 11: The hind-leg.

c, coxa; f, femur; spu_1, distal pair of tibial spurs; spu_2, middle pair of tibial spurs; tb, tibia; -s, tarsus.

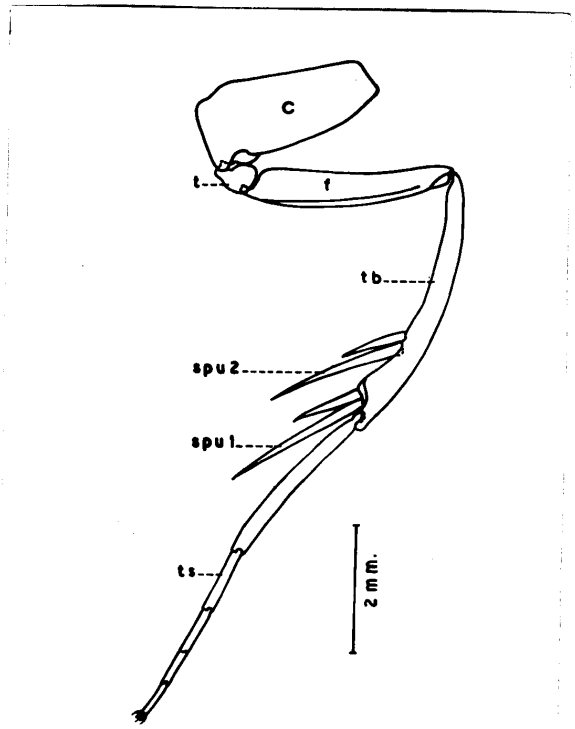
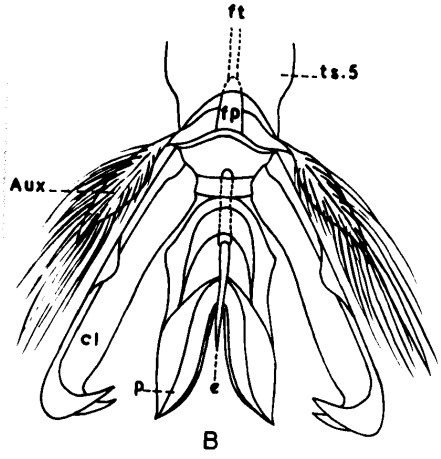

c
t
f
tb
spu 2
spu 1
ts
2 mm.

Fig. 12: The pretarsus.

Aux, auxiliary plate; cl, claw; e, empodium; fp, ungitractor plate; ft, flexar muscle of claws p, pulvillus; ts.5, fifth tarsal segment.



B

and an empodium. Each claw is forked distally into two pointed ends and has a tooth on its outer margin. The pretarsus is supported by a median unguitractor plate to which is attached the apodeme of the flexor muscle of the claws.

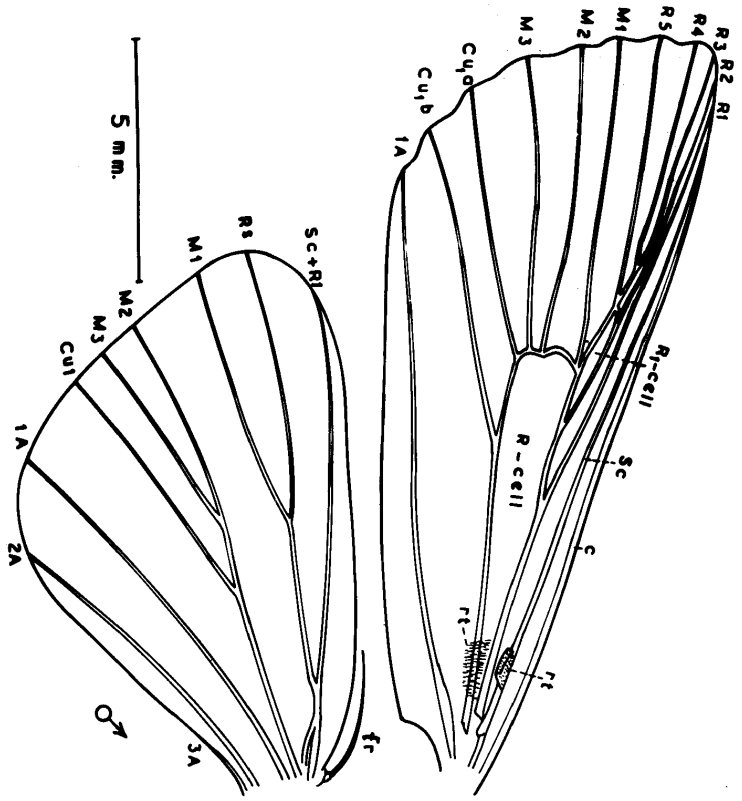
2. The Wing-Venation (Fig. 13) :

The fore-wing.--The three veins above Cu_1 a in the fore-wing are the three branches of the median vein, M_3, M_2, and M_1. At the upper corner of the main cell (R-cell) an areole or small closed cell (R_1-cell) occurs. Above the median vein M_1 is the radial vein (R) which consists of two main branches R_1 and R_s. The vein R_s is divided into its four branches, R_2 to R_5, which all originate from the areole or the R_1-cell. The subcostal vein (Sc) is simple and unforked and lies above the radius. The uppermost marginal vein is the costa (c). Below the median vein M_3, the R-cell of the fore-wing gives off the vein Cu_1a and then Cu_1b. The lowermost vein of the fore-wing is the anal vein 1A.

The hind-wing.--In the hind-wing, the midial veins M_2 and M_3 are stalked with Cu_1 about its middle. Above the main stem of Cu_1, the bases of the veins Sc + R_1, R_s, and M_1 are fused into a common stem from which Sc + R_1 first branches off as a single vein and then follows a common base for the veins R_s and M_1, which separate from each other towards

Fig. 13: The wing-venation.

1A, 2A, 3A, anal veins; c, costa; Cu_1a, Cu_1b, Cu_1, cubitus; fr, frenulum; M_1, M_2, M_3, the media; R_1, R_2, R_3, R_4, R_5, radius; R-cell, radial cell; R_1-cell, the first radial cell; R.s, radial sector; rt, retinaculum; Sc, subcosta; Sc + R_1, subcosta and radius.


5 mm.
Rs
M1
Sc+R1
M2
M3
Cu1
1A
2A
3A
♂
fr
R3
R2
R1
R4
R5
M1
M2
M3
Cu2
Cu1b
1A
R-cell
R-cell
Sc
C
rt-
rt

the middle of the hind-wing. Below Cu_1, are three anal viens, the vein 3A being very small and confined to the base of the hind-wing.

3. The Wing-Coupling Apparatus :

The wing-caupling apparatus of Prodinia litura is of the frenate type with a retinaculum and a frenulum that differ in both sexes.

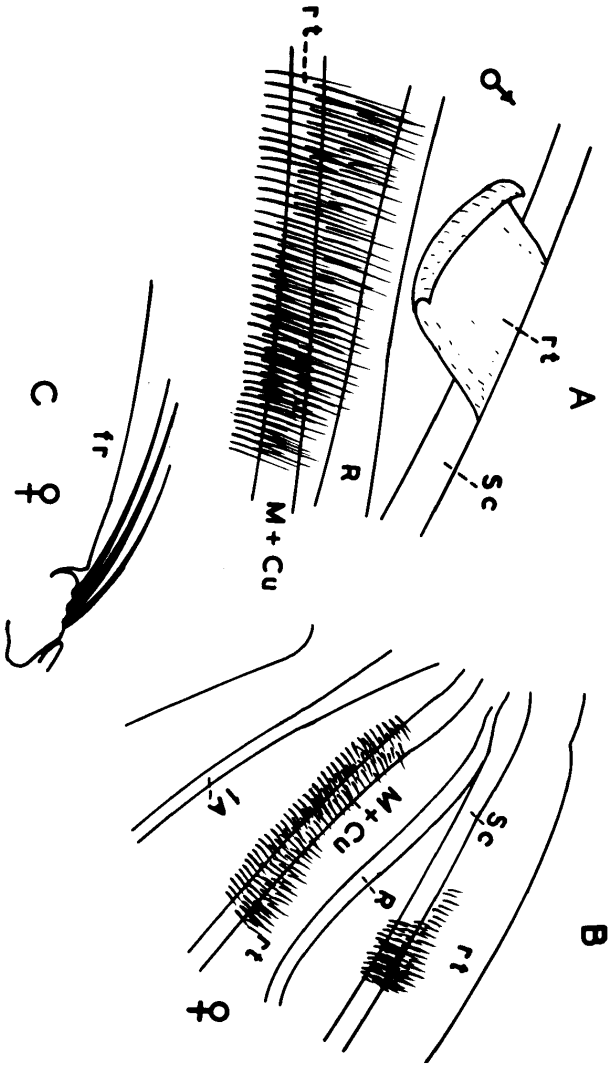
In the female adult, the retinaculum consists of two sets of fine setae of hairs from the base of the subcostal vein, while the lower set arises on the M + Cu vein (Fig. 14 B). From the upper surface of the hind-wing at the humeral angle arises a swelling which bears three separate bristles which represent the female frenulum (Fig. 14 C). The anterior brisle is somewhat shorter than the other two.

On the other hand, the male moth has the retinaculum composed of but the large tuft of hairs situated near the fused base of the two veins M + Cu on the underside of the fore-wing and an additional sclerotized curved plate originating from the thick base of the subcostal vein (Fig. 14 A). Moreover, the male's frenulum consists of but a single stout bristle arising, as in the female, from a projection of the upper surface of the hind-wing near the base of the costal vein (Fig. 13).

Fig. 14: The wing coupling apparatus.

A, retinaculum of the male; B, retinaculum of the female; C, the frenulum in the female.

A, anal vein; M+Cu, the media and the cubitus; R, the radius; rt, retinaculum; Sc, subcosta.


rt
♀
A
rt
Sc
R
M+Cu
C
♀
tr
1A
M+Cu
rt
Sc
R
tr
♂
B

C) The Abdomen.

As in other Lepidopterous moths, the abdomen consists of the usual ten segments (Figs. 15 and 16). The sternum of the first abdominal segment is wanting. A pair of spiracles is situated on the lateral sides of each of the abdominal segments 2-7 (Fig. 15 B). The terminal segments of the abdomen are modified to form the male genitalia and the female ovipositor. In both the male and female, the abdominal tergites 1-8 possess sclerotized shields.

1. The Female Ovipositor :

In the female moth of Prodenia litura, the ninth and tenth abdominal segments are modified to form a tube which acts as an ovipositor (Fig. 15 A). These two segments are retracted within the eighth segment by means of apodemes. Also, the eighth segment is retracted within the seventh abdominal segment by another pair of apodemes. The opening of the bursa copulatric, which is used for mating, is seen clearly at the posterior end of the eighth abdominal sternite.

2. The Male Genitalia (Figs. 17, 18, and 19) :

The male genitalia of Prodenia litura consists of the ninth and tenth segments of the abdomen. However, the

Fig. 15: A, The abdomen of the female (lateral view).
B, abdominal spiracle (enlarged).

ap.1, the first apodeme; ap.2, the second apodeme; bc, bursa copulatrix; SVIII, 8th abdominal sternite; sg. IX+X, abdominal segments 9, 10; sp, the second abdominal spiracle: T_1, first abdominal tergite; TVIII, 8th abdominal tergite.

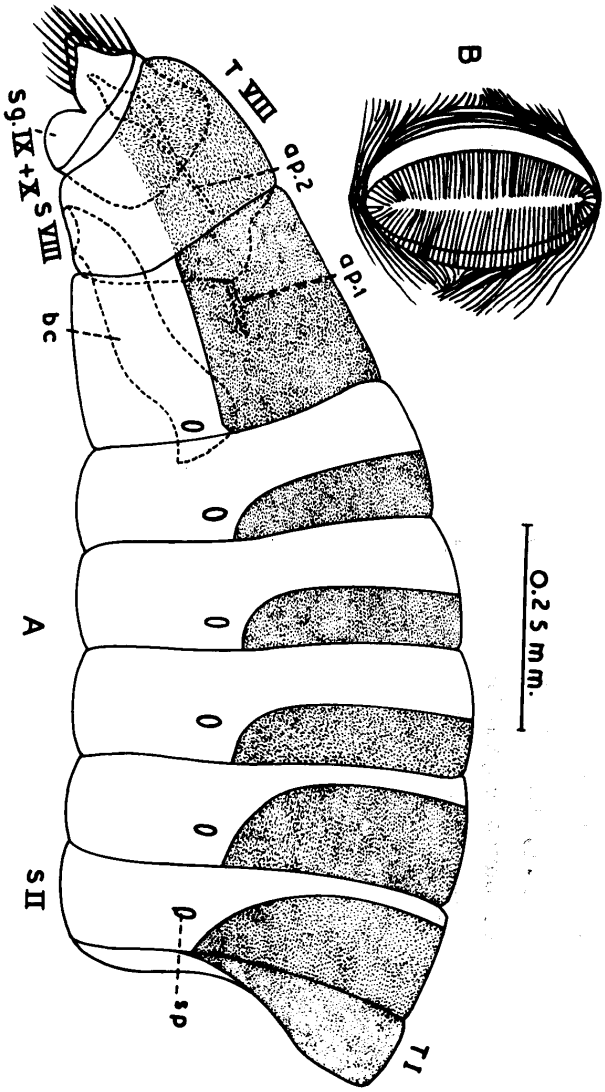

B
T VIII
ap.2
ap.1
Sg.IX+X
S VIII
bc
A
S II
sp
T I
0.25 mm.

Fig. 16: The male abdomen (lateral view).

Hrp, harp; sII, s VIII, SIX, 2nd, 8th, 9th sternites, respectively; sp, spiracle; T_1, the first tergite; TVIII, the 8th tergite.

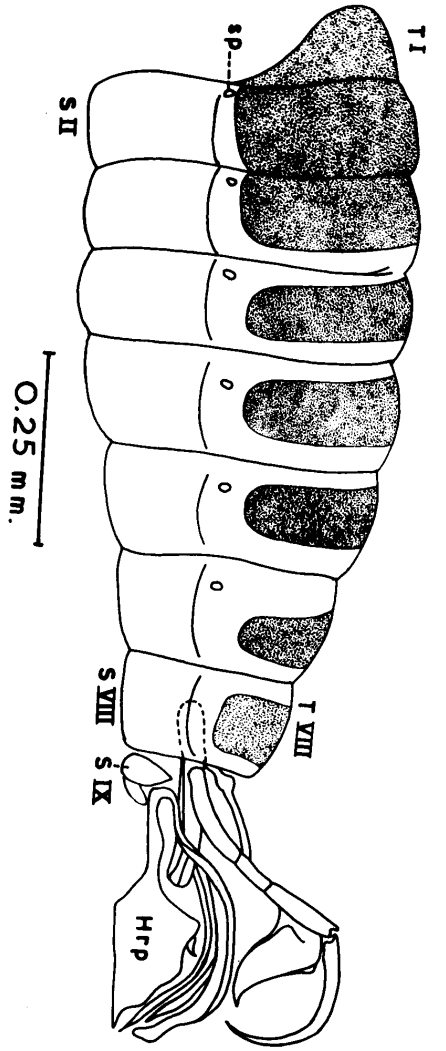

T I
sp
S II
0.25 mm.
S VIII
T VIII
S IX
Hrp

Fig. 17: The male genitalia (lateral view).

Aed, aedeagus; Aed.m, aedeagus membrane; Cl, claspers; crn, cornuti or sclerotized spine; ed, editum; ej, ejaculatory duct; gn, gnathus; Hrp, harp; tg, tegumen; unc, uncus; ves, vesica; vin, vinculum.

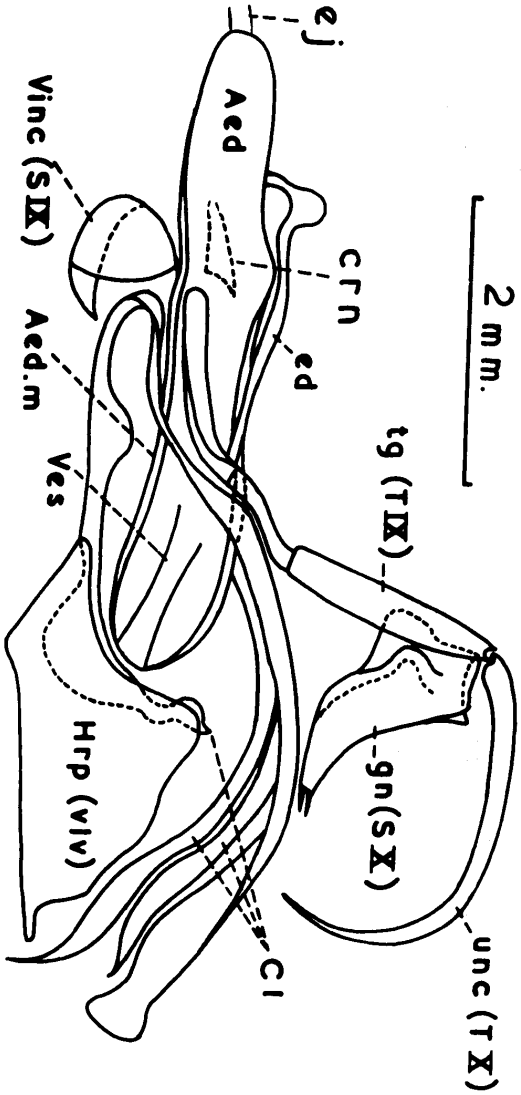

ej
Aed
Vinc (SIX)
crn
ed
2 mm.
Aed.m
Ves
tg (TIX)
gn(SX)
Hrp (vlv)
C I
unc (T X)

Fig. 18: The male genitalia (dorsal view).

Aed, aedeagus; Aed.m, aedeagus membrane; Cl, claspers; ed, editum; ej, ejaculatory duct; gn, gnathus; hrp, harp; tg, tegumen; unc, uncus; ves, vesica.

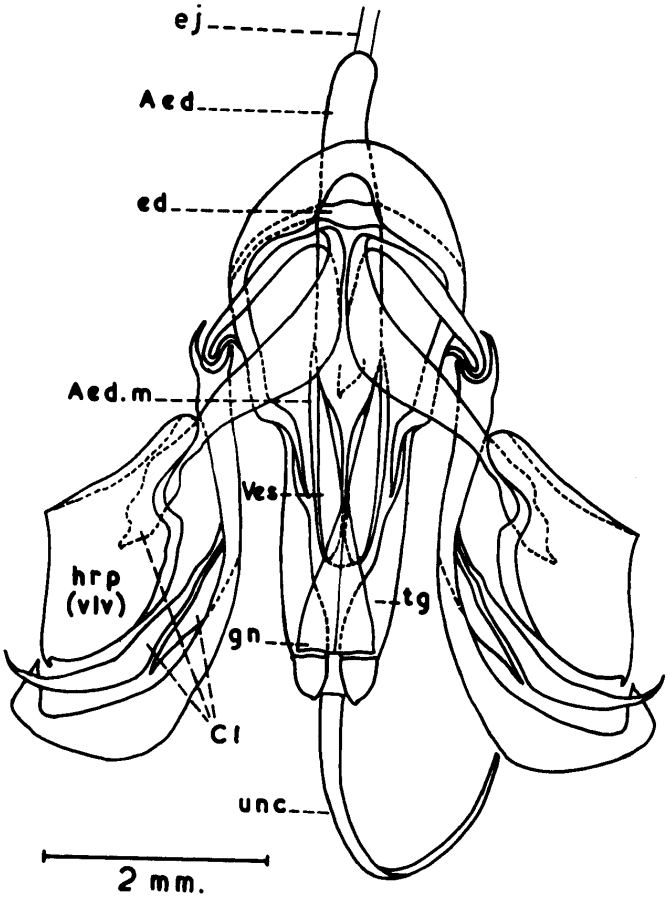
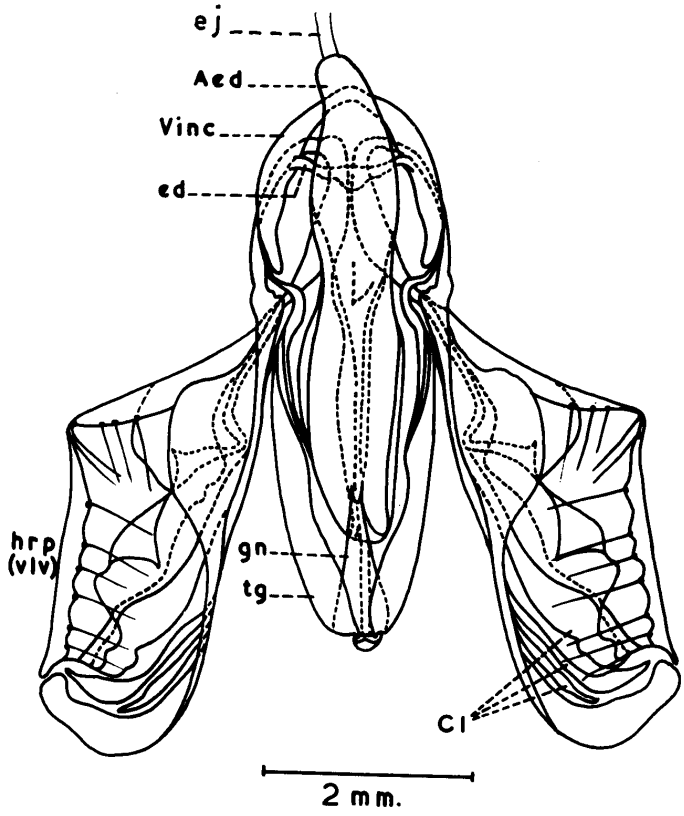

ej
Aed
ed
Aed.m
Ves
hrp
(vlv)
tg
gn
Cl
unc
2 mm.

Fig. 19: The male genitalia (ventral view).

Aed, aedeagus; Cl, claspers; ed, editum, ej, ejaculatory duct; gn, gnathus; hrp, harp; tg, tegumen; vinc, vinculum.


ej
Aed
Vinc
ed
hrp
(vlv)
gn
tg
Cl
2 mm.

nomenclature used here is adopted after Imms(1957). The vinculum, which is the ninth sternite, is situated below the aedeagus and attached to the anal angle of the harp. The latter is large and broad and carries internally three large claspers and a fourth smaller one. The ninth tergite composes the tegumen which is elongate in shape and bears at its terminal end a stout sickle-shaped spine, the so-called uncus which is considered to be the tenth tergite. The gnathus is composed of two triangular plates situated beneath the basal part of the uncus. This gnathus is also considered to represent the tenth abdominal sternite. The anal opening is present between the two plates of the gnathus. The editum, is composed of a slender - shaped plate situated towards the upper side of the aedeagus. The latter is enclosed in a sheath and possesses or triangular sclerotized plate from its inside. The vesica, which is an eversible part from the distal end of the aedeagus (Tuxen, 1956), bears a strong triangular spine, the so-called cornuti. According to Tuxen, the cornuti penetrates into the bursa copulatrix of the female during copulation.

V. INTERNAL ANATOMY

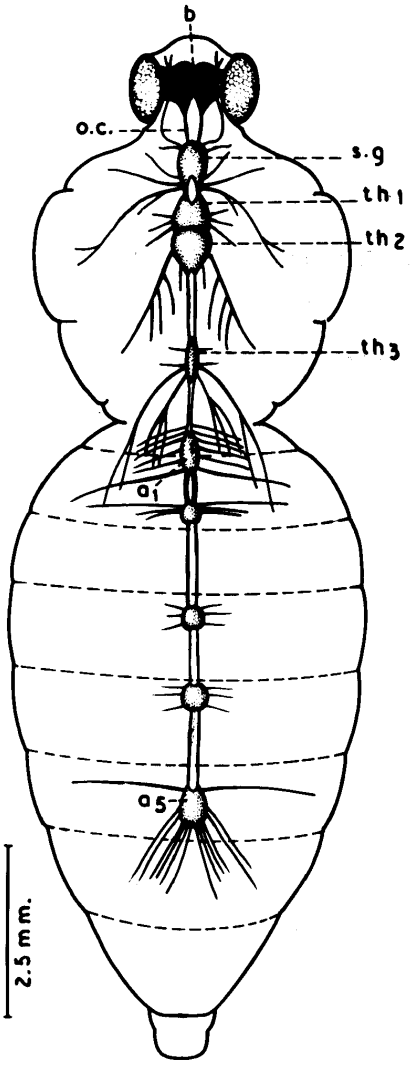
A) The Central Nervous System.

The central nervous system is divisible into the brain, the suboesophageal ganglion, and the ventral nerve-cord. The brain lies in the head-capsule just above the pharynx. It is joined to the suboesophageal ganglion by the circumoesophageal connectives. The suboesophageal ganglion is situated partly at the posterior end of the head-capsule and partly in the prothorax.

The ventral nerve-cord consists of eight ganglia, three thoracic and five abdominal. The suboesophageal and the first thoracic ganglia are connected together by two very short connectives. The first and second thoracic ganglia are united together without any obvious longitudinal connectives and lie both in the second thoracic segments. The third thoracic ganglion is rather small, slender and joined to the second thoracic ganglion by two relatively long connectives. The five abdominal ganglia lie in the first, second, fourth, fifth, and sixth abdominal segments, respectively. The fifth abdominal ganglion is larger than the other abdominal ones. The connectives joining the first abdominal ganglion with the third thoracic are very thin and

Fig. 20: The central nervous system.

a_1-a_5, first and fifth abdominal ganglia; b, brain, o.c., circumoesophageal connectives; s.g, suboesophageal ganglion; th, first thoracic ganglion; th_2, mesothoracic ganglion; th_3, metathoracic ganglion.


b
o.c.
s.g
th1
th2
th3
a1
a5
2.5 mm.

nearly as long as those joining the latter ganglion with the second thoracic. The connectives joining the first and second abdominal ganglia are very short but thick, while all the other abdominal connectives are rather long and thin.

B) The Digestive System.

1. The Alimentary Canal :

The alimentary canal is a tube running from the mouth to the anus (Fig. 21). The cavity of the proboscis communicates with the pharynx. The beginning of the latter is enlarged into the so-called pump which has powerful circular muscular walls and also provided with dilator muscles which pass outwards from between the fibres of the circular muscles to be attached to the head-capsule (Fig. 22 A). According to Imms (1957), when these dilator muscles contract the pharyngeal cavity, or pump, is enlarged and a partial vacuum is created and consequently the pump becomes filled with an ascent of fluid through the proboscis. The walls of the pump then contract, thereby forcing the food backwards into the rest of the pharynx and the oesophagus and the closure of the pharyngeal valve precludes the return flow down the proboscis. Following the pharynx is the oesophagus which is a very long narrow tube that runs backwards passing through the head and thorax. Distally, near the posterior margin of

Fig. 21: The digestive system.

An, anus; An.sph, anal sphincter; c.d.sg, common duct of salivary glands; cr, crop, co, colon; d.sg, duct of salivary gland; 1L, ileum, Mal.T, malphighian tube; Mg, mid-gut; oe, oesophagus, Rec, rectum; Rec; gl, rectal gland; sg, salivary gland.

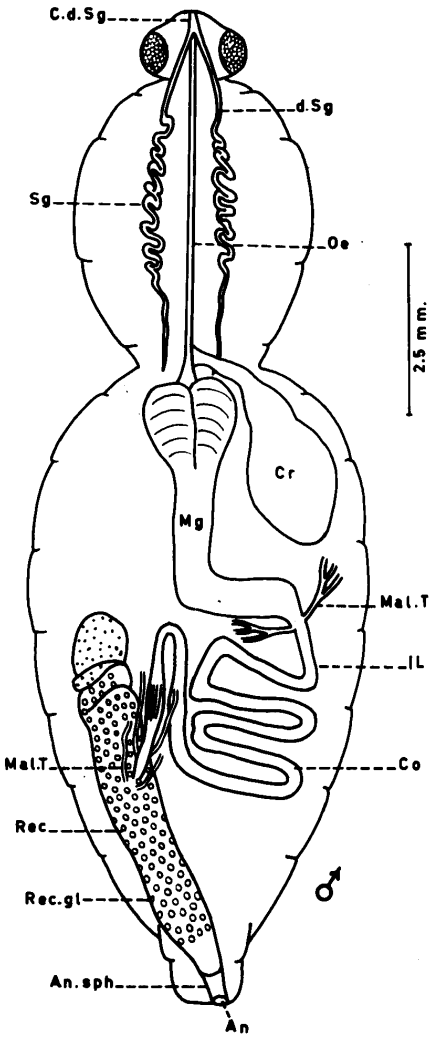
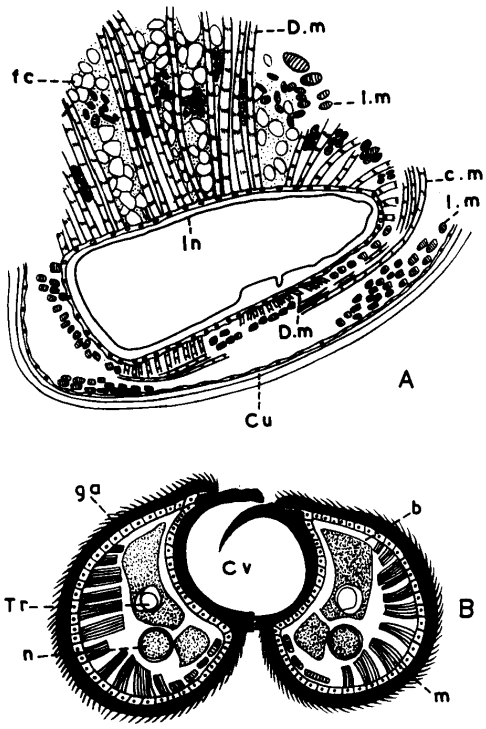

C.d.Sg
d.Sg
Sg
Oe
2.5 mm.
Cr
Mg
Mal.T
IL
Mal.T
Co
Rec
Rec.gl
An.sph
An
♂

Fig. 22: A, Transverse section of the stomodaeal pump.
B, Same of the proboscis.

b, blood; c.m, circular muscles; Cu, cuticle; CV, food canal; D.m, dilator muscles; fc, fat cells, ga, galea, In,intima; l.m, longitudinal muscles; m, muscles of galea; n, nerve; Tr, trachea.


D.m
fc
l.m
c.m
l.m
In
D.m
A
Cu
ga
b
Cv
Tr
B
n
m

the metathorax, the oesophagus gives off a well developed lateral crop. The latter is found at one side of the mid-gut, extending to about the third abdominal segment, and assuming the form of a large food reservoir connected with the oesophagus by means of a wide mouthed channel.

The mid-gut is a long sac-like tube following the gizzard and passes backwards to open into the ileum. It occupies the first four abdominal segments. The anterior part of this mid-gut is wider than the rest of it and has the walls possessing external transverse ridges.

The hing-gut extends from the posterior end of the mid-gut to where the anal sphincter begins. It is composed of the ileum, colon, and rectum. Six Malpighian tubes are present, each three being proximally combined together to form a common short canal which opens laterally at the junction of the mid-gut with the ileum. Distally, the six Malpighian tubes arrange in pairs and each ends separately into the rectal wall. The ileum runs backwards for a short distance and joins the colon which is relatively very long and coiled. This colon is attached to the rectum at its anterior third. The rectum is a large wide tube which possesses many rounded small inwardly projecting rectal palpillae.

The anal sphinter is the terminal part at the posterior end of the alimentary canal. It is a short tube lined

internally by the cuticle and the epidermis of the body-wall, while externally it is enveloped by strong circular muscle fibres.

The pharynx of Prodenia litura is eventually within the head-capsul. The epithelium of the pharynx is much folded inwards. It consists of cells with a smooth chitinous intima. The epithelium of the oesophagus (Fig. 23 A) and the crop (Fig. 23 B) is similar to that of the pharynx except that the epithelial cells of the crop are much less folded inwards. The intima of both the oesophagus and the crop is smooth, except in the posterior part of the former where the intima possesses sharp spines.

There is a well-developed oesophageal valve between the fore-gut and the mid-gut (Fig. 24). As wiggleswarth (1957) stated, this valve forms a mechanism for preventing regurgitation from the mid-gut to the fore-gut.

The mid-gut is made up of a layer of columnar or cubical epithelial cells which have striated borders. These cells are enveloped by a longitudinal layer of muscles followed externally by a circular mucle layer (Fig. 25 A). The contents of the mid-gut are enclosed by a peritrophic membrane which is nearly in contact with the striated border. This membrane, as pointed out by Wigglesworth (1957), protects

Fig. 23: A, Transverse section of the oesophagus,
B, Transverse section of the crop.

c.m, circular muscles; In, intima.

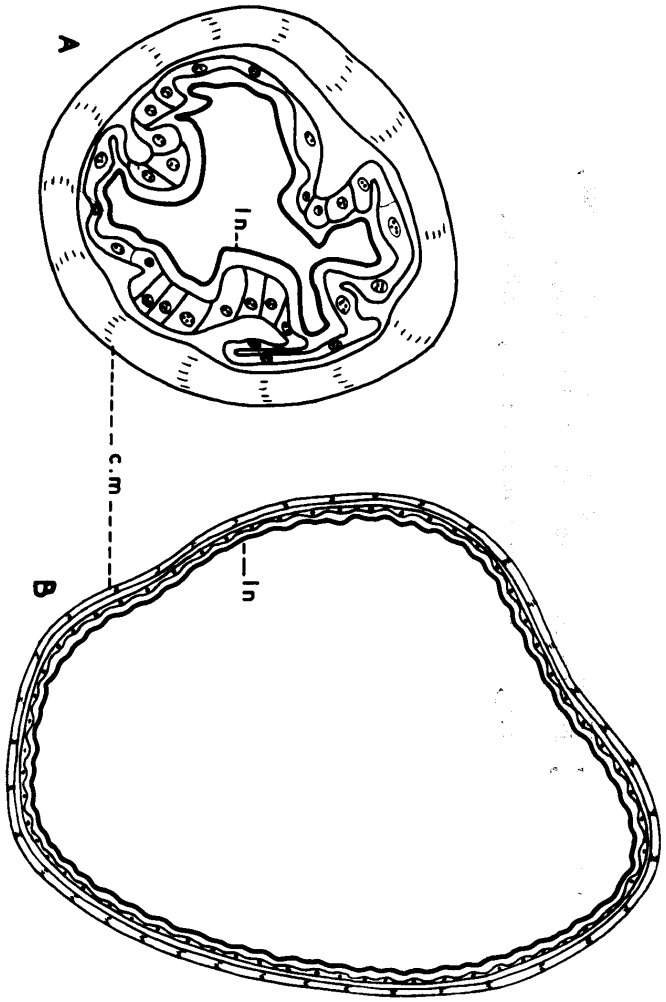

A
In
c.m
B
In

Fig. 24: The oesophageal valve.

c.m, circular muscles; Cr, crop; In, intima; l.m, longitudinal muscles; Mg, mid-gut; Oe, oesophagus; PMb, peritrophic membrane.

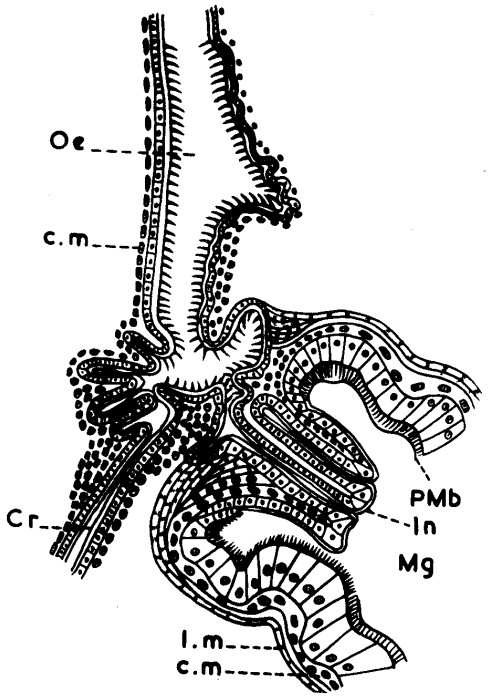
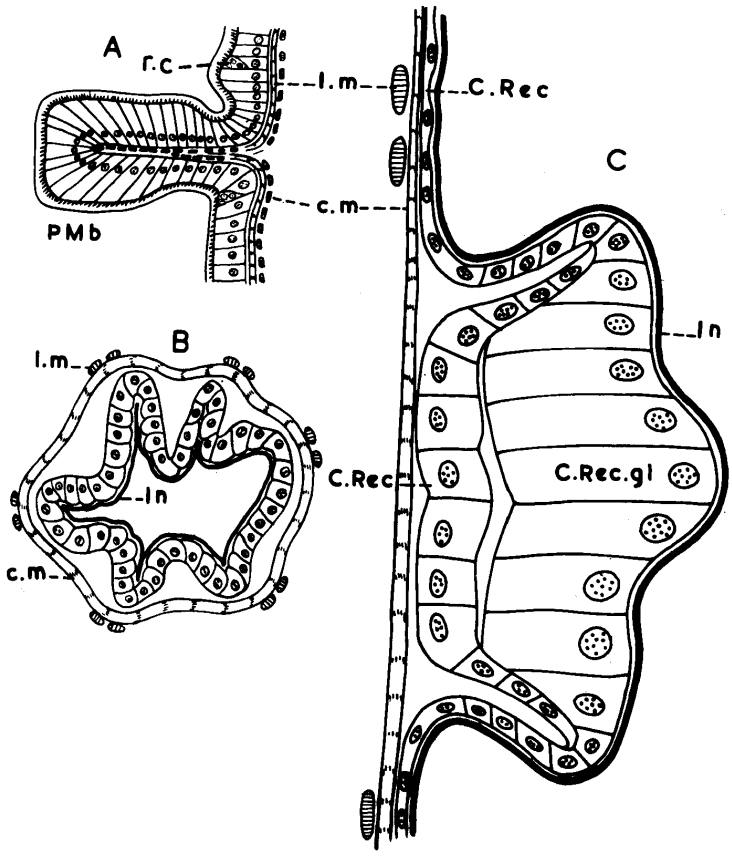

Oe
c.m
Cr
PMb
In
Mg
l.m
c.m

Fig. 25: A, Transverse section of the mid-gut.
B, Transverse section of the ileum.
C, Transverse section of the rectum.

c.m, circular muscle; C.Rec, rectal epithelial cells; C.Rec.gl, cells of rectal gland; In, intima; l.m, longitudinal muscle; PMb, peritrophic membrane; r.c, replacement cells.


A
r.c
l.m
C.Rec
C
c.m
PMb
B
l.m
In
C.Rec
C.Rec.gl
In
c.m

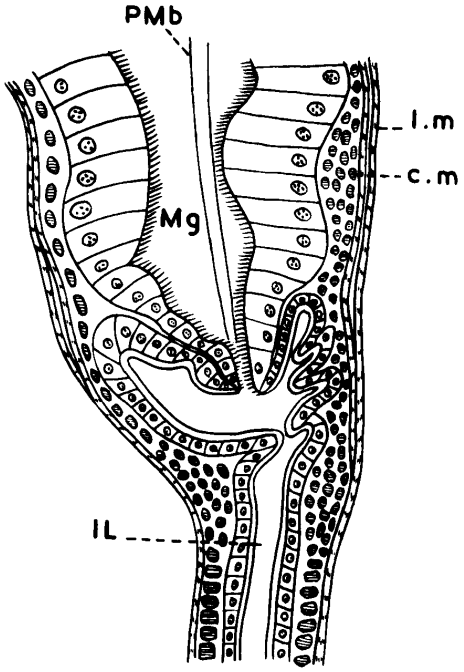
the mid-gut cells from injury by the gut contents. There are groups of deeply staining regenrative or replacement cells at the bases of the large epithelial cells. These replacement cells must have transferred from the larval stage to the adult without taking part in the formation of the imaginal mid-gut during metamorphosis.

The epithelium of the ileum is folded inwards along six sides (Fig. 24 B) and its intima is smooth. The ileum is invested by a thin layer of circular muscles outside which there are six pairs of longitudinal muscles bands. The colon also has the epithelium folded inwards along six sides, possesses a smooth intima, and has the same muscles as the ileum. The epithelium of the rectum is very thin and the rectal intima is smooth. There are numirous projections, each made up of about ten large columnar cells forming a rectal papilla and lying on the inner side of the rectal epithelial cells, thus, producing a two layered structure with a cavity between (Fig. 25 C). Wigglesworth (1957) considers that these papillae are sites at which water is conserved by resorption from the faeces and through which inorganic ions may also be resorbed.

There is also a well-developed pyloric valve between the mid-gut and the ileum (Fig. 26). This valve surrounds a small chamber which is coated externally by a thick layer of

Fig. 26: The pyloric valve.

c.m, circular muscles; IL, ileum; l.m, longitudinal muscles, Mg, mid-gut; PMb, peritrophic membrane.


PMb
l.m
c.m
Mg
IL

circular muscles followed by another layer of longitudinal muscle. This valve serves to regulate the passage of food from the mid-gut to the hind-gut.

2. The Malpighian Tubes :

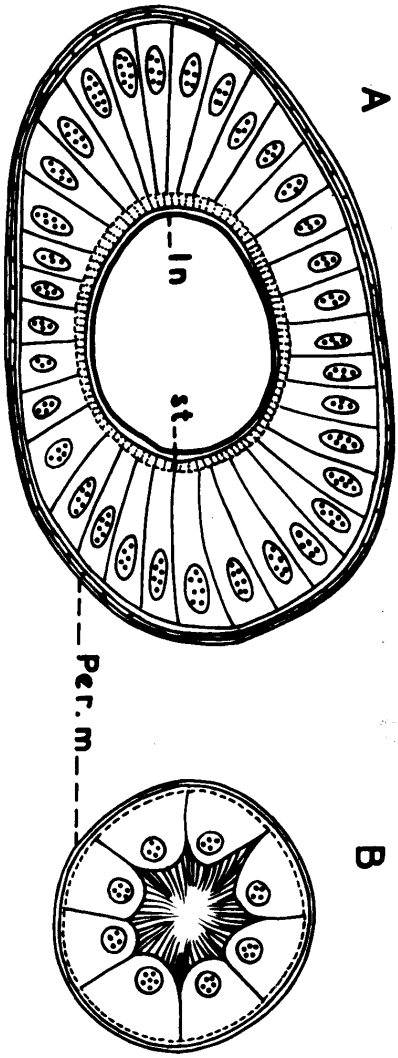
The Malpighian tubes (Fig. 27 B) are invested in a peritoneal coat. The cells enclosing the lumen of the tubes rest on a basement membrane, and the cytoplasm of the cells shows the usual fine striation at the periphery. Each Malpighian tube has its lumen surrounded by about eight cells. The striated border is composed of separate filaments which are of more or less equal length.

3. The Salivary Glands :

The salivary glands are a pair of simple convoluted tubes which unite together near the anterior end of the head capsule to form a common duct than opens at the beginning of the proboscis. They lie on either sides of the fore-gut and extend backwards until the first abdominal segment. Each tube is composed of large epithelial cells that have numerous striations near the lumen border (Fig. 27 A). There is a chitinous intima lining the whole tube. The tube is coated by a thin layer of circular muscles followed externally by a thin layer of circular muscles followed externally by a peritoneal membrane.

Fig. 27: A, Transverse section of salivary gland.
B, Transverse section of Malpighian tube.

In, intinia; Per.m, peritoneal membrane; st. striations.


A
In
St
Per.m
B

C) The Circulatory System and Its Associated Structures.

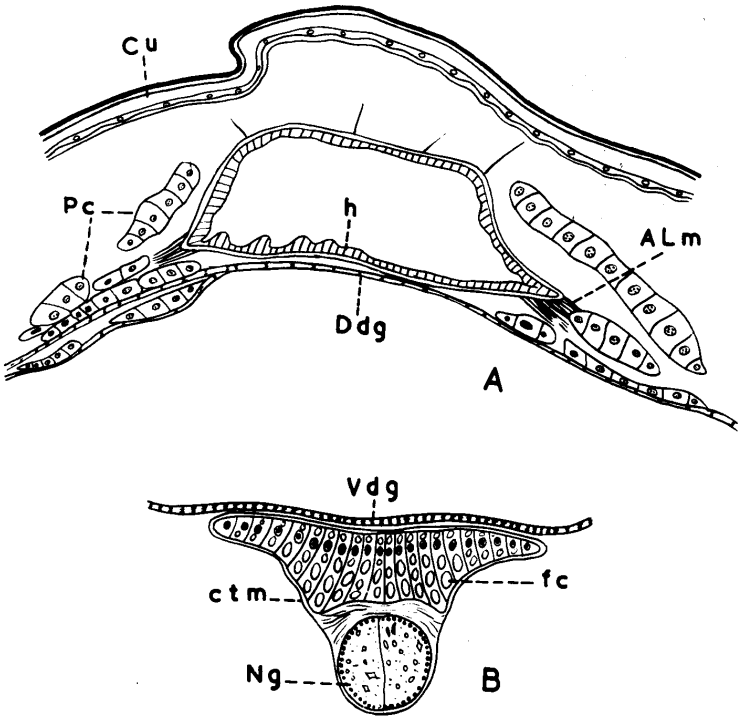
1. The Dorsal Vessel :

The dorsal vessel is composed of the heart and the aorta. The eight chambers of the heart lie in the first eight abdominal segments (Fig. 33). The aorta passes dorsal to the alimentary canal into the head to the terminate below the brain. The wall of the heart consists of bundles of circular muscles and is connected to the dorsal diaphragm and the body-wall with muscle-fibres (Fig. 28 A). There are seven pairs of alary muscles which arise from the terga and are attached to the walls of the heart. The pericardial sinus contains some fat-body and blood cells. Masses of pericardial cells lie on both sides of the heart. There are few other pericardial cells which are arranged singly. All the pericardial cells are yellowish-orange in colour and are full of small granules and vacules.

The blood or haemolymph of Prodenia litura moth is contained in the general body-cavity, where it freely pathes the various internal systems and also enters the appendages as well as the tubular cavities of the wing veins. It consists, as in other insects, of liquid plasma and numerous blood cells or haemocytes. In fact, Imms (1957) stated that Yeager had recognized 32 types of blood cells in the larva

Fig. 28: A, Upper portion of a transverse section in the body.
B, Ventral portion of same.

Alm, alary muscles; ctm, connective-tissue; Cu, cuticle; Ddg, dorsal diaphragm; fc, fat cells; h, heart; Ng, nerve ganglion; Pc, pericardial cells; Vdg, ventral diaphragm.


Cu
Pc
h
ALm
Ddg
A
Vdg
ctm
fc
Ng
B

of another species of Prodenia, namely P. peridania. Some of these types are the oenocytoids, proleucocytes, Nematocytoids, Macroplasmatocytes, palaeocystocytes, and the multiramous plasmatocytes.

2. The Fat Bodies :

As in other insects, the fat bodies lie in two regions of the body; one between the epidermis and the muscles, and the other in the viceral cavity. The fat body of the first region is composed of single or small groups of cells. In the second region, the main mass of the fat-body has a rounded nucleus and its cytoplasm is heavily vacuolated with globules of oil-like fat (Fig. 29). Other granules are also present in the meshes of the vacuoleted protoplasm. The fat body is invested in a delicate connective tissue membrane.

3. The Oenocytes :

The oenocytes are composed of a group of large cells situated in the body cavity close to each spiracle in the abdominal segments. The cells are irregular in shape with oval or rounded nuclei. The cytoplasm of the cells appears to be densely packed with small granules, but there are also some vacuoles.

Fig. 29: The fat-body.

ctm, connective-tissue membrane; gr, granules; nu, nucleus; Vc, vacuoles filled with oil-like fat.

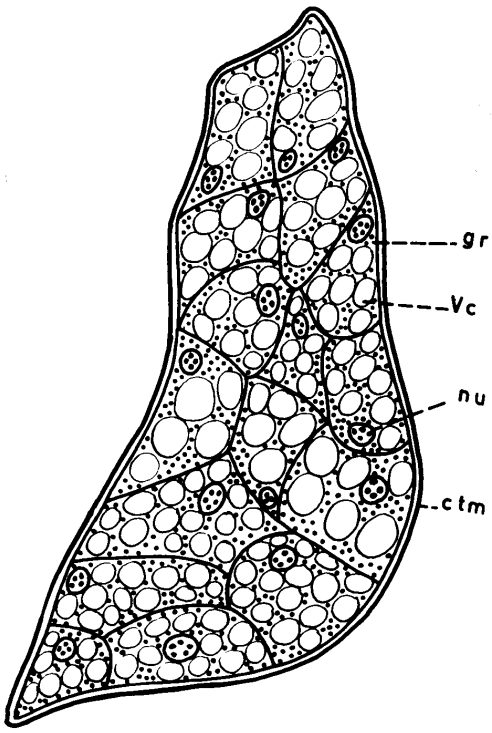
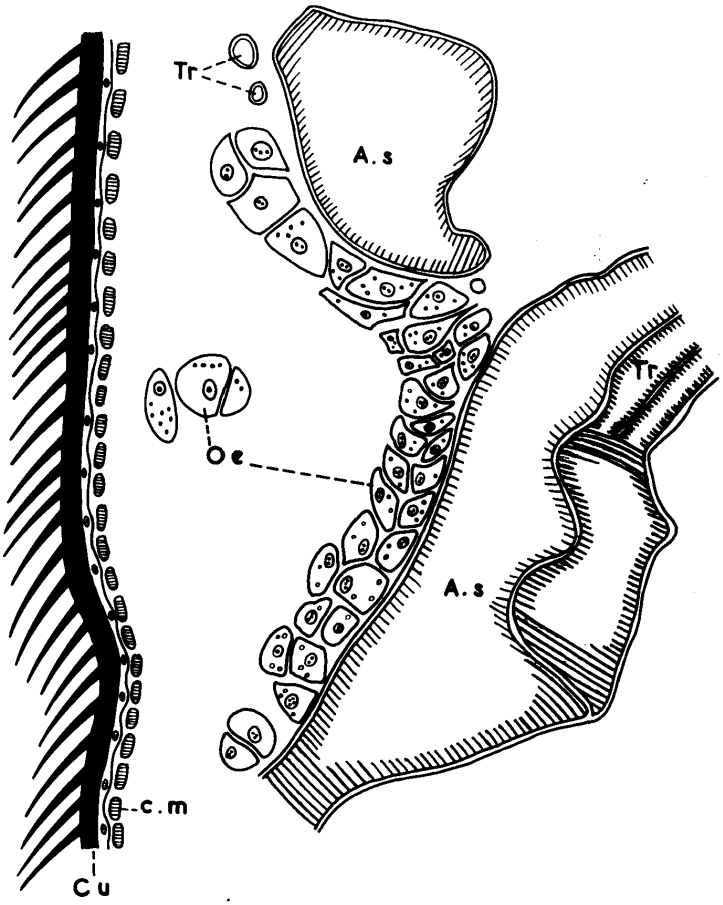

gr
Vc
nu
ctm

Fig. 30: The oenocytes.

A.s;, air-sac; c.m, circular muscles; Cu, cuticle; Oe, oenocytes; Tr, trachea.


Tr
A.s
Oe
Tr
A.s
c.m
Cu

D) The Reproductive System.

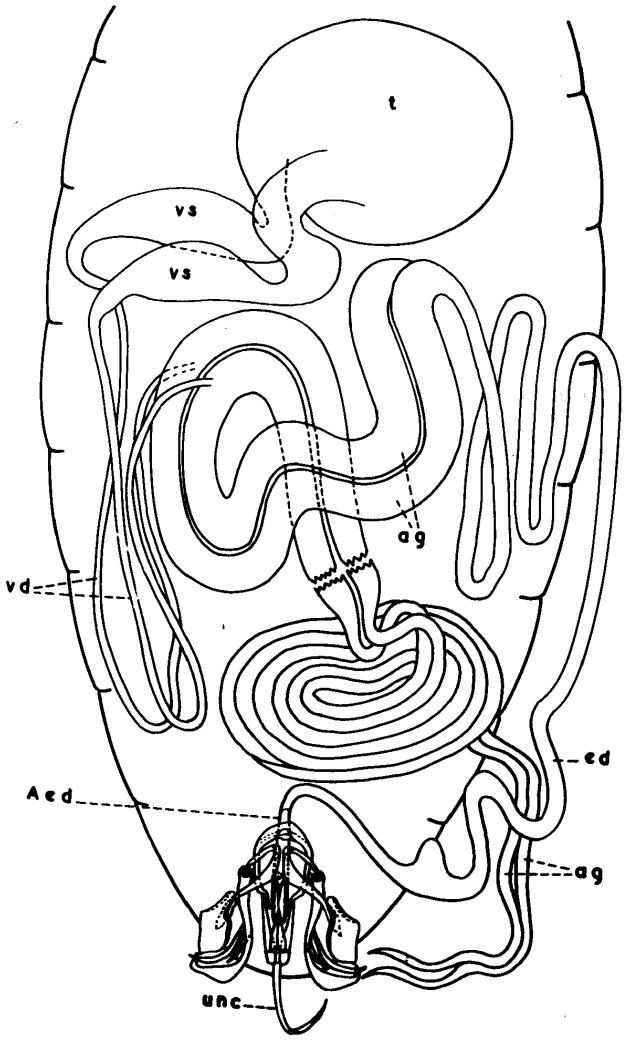
1. The Male Reproductive System :

The male reproductive organs (Fig. 31) are composed of two testis which are enclosed in a common sheath (scrotum) and lie below the mid-gut and beside the crop in the first 2 to 3 abdominap segments. The testis are yellowish in colour. From the testes come out two large vesiculae seminalis which open each into a narrow vas diferens. Each vas diferens receives a very long and convoluted accessory gland. Each of the two accessory glands ends freely at one end towards the posterior end of the body cavity, while from the other end, the two glands unite together to form a common thin ductus ejaculatorius which terminates at the base of the aedeagus.

According to Imms (1957), two principal types of reproductive systems are distinguisable in adult Lepidoptera. In the first type, the testis are paired and each is enclosed in a separate scrotum. This type is met with in the Micropterygidae, certain Saturniidae. Bombyx mori and others. In the second type, the testis are fused and enclosed in a common scrotum. In some cases, the paired nature of the gonad is still evident, while in others the fusion is complete. This last type is the prevalent and usually the

Fig. 31: The male reproductive system.

ag, accessory glands; Aed, eadeagus; ed, ejaculatory duct; t, testis; Vd, vasa deferentia; vs, vesiculae seminalis; unc, uncus.


t
vs
vs
ag
vd
ed
Aed
ag
unc

follicles are spirally wound around the longitudinal axis of the gonad. It is evident that the testis of Prodenia litura adult belong to the second type.

Each of the two testis (Fig. 32) is made up of a series of tubular follicles, each of which enveloped by a layer of epithelial cells resting on a basement membrane. Each follicle contains a succession of zones in which the six cells are in different stages of development. The two testis are enclosed in a strong pigmented connective tissue sheath. The wall of the vesicula seminalis consists of epithelial cells resting on a basement membrane. The epithelial cells at the beginning of the vesicula seminalis, at its attachment with the testis, are columnar, while they are cubical in the rest of the vesicula seminalis and in the vas diferens. The vesiculae seminalis are seen filled with spermatozoa. Each of the vesicula seminalis and the vas deferens is invested in a connective-tissue membrane. In the vas deferens there is a thin circular muscle layer between the epithelial cells and the connective tissue membrane.

The wall of the accessory gland is made up of a layer of epithelial cells resting on a basement membrane and lined with a thin chitinous intima. It is also surrounded by a thin layer of circular muscles covered with a connective-tissue membrane.

Fig. 32: Microscopical longitudinal section in part of the testis.

ctm, pigmented connective-tissue; ep, epithelium enveloping the tubular follicles; f, tubular follicle; Spz, spermatozoa; Ves, vesiculay seminalis.


Ves.

The wall of the ejaculatory duct consists of a thin layer of epithelial cells which are folded inwards. This ejaculatory duct is lined with a thin chitinous intima and is surrounded by a very thick layer of circular muscles.

2. The Female Reproductive System :

There are two ovaries lying in the body cavity of the abdomen on either side of the alimentary canal and extending anteriorly until the second abeominal segment. Each ovary consists of four ovarioles which open into the oviduct. Each ovariole is an elongated tube in which the developing eggs occur one behind the other in a single chain. The older oocytes are situated nearest to the union with the oviduct. The oocytes are seen inside their follicles owing to their orangish colour.

The two lateral oviducts join to form the common oviduct which joins the vagina. The latter opens at the posterior end of the ninth and tenth abdominal segments which form the ovipositor.

The bursa copulatri, which serves as a pouch or for the reception and storage of the spermatozoa opens by a duct, the seminal duct or ductus seminalis, into the dorsal wall of the vagina. Also, the bursa copulatrix open at the

Fig. 33: A, Transverse section of vesicula seminalis.
B, Transverse section of reservoir of accessory gland.
C, Transverse section of accessory gland.
D, Transverse section of ejaculatory duct.

c,m, circular muscles; ctm, connective tissue membrane; In, intima.

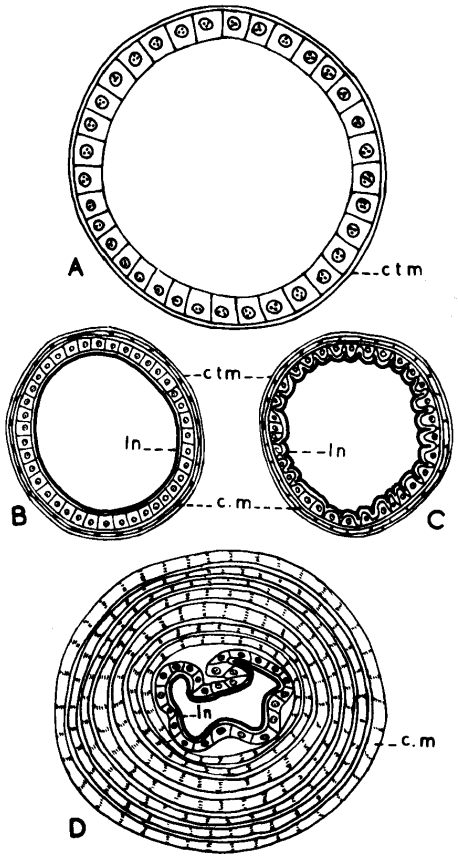
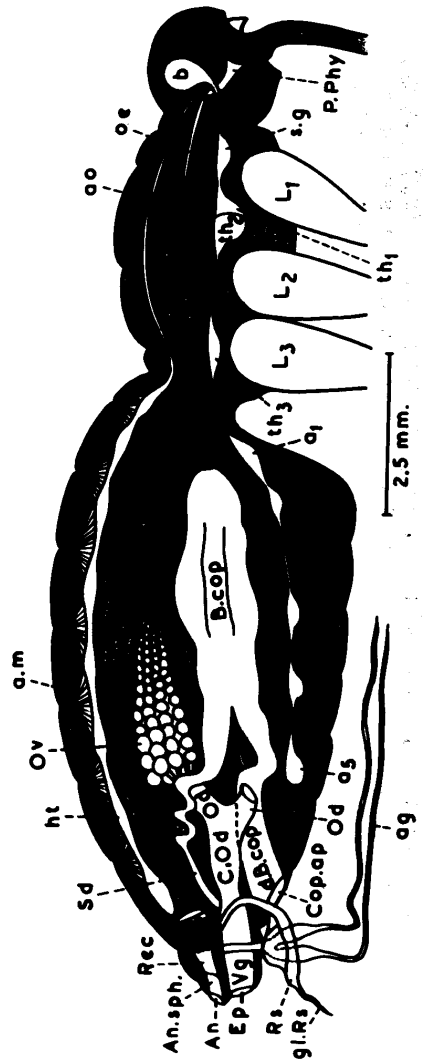

A
ctm
ctm
In
c.m
In
B
C
In
c.m
D

Fig. 34: Lateral view of the female moth showing the nervous system, the heart, and the reproductive system.

a_1, a_5, first and fifth abdominal ganglia; ag, accessory glands; a.m, alary muscles; An, anus; An, sph, anal sphincter; ao, aarta; B.cop, bursa copulatrix; C;Od, common oviduct; Cop.ap, aperture of bursa copulatrix; d.B.cop, duct of bursa copulatirx; Ep, aperature of egg laying; gl.Rs, gland of receptacular seminalis; ht, heart; L_1-L_3, thoracic legs 1-3; od, oviduct; oe, oesophagus; OV, ovary; p.phy, pharyngeal pump; Rec, rectum; Rs.receptacular seminalis; Sd, seminal duct; s.g, suboesophageal ganglion; th_1-th_3, thoracic ganglia 1-3; Vg, vagina.


D
P.Phy
s.g
oe
oo
L1
th1
L2
L3
th3
o1
2.5 mm.
B.cop
a.m
Ov
ht
Sd
Rec
An.sph.
An
Ep
Vg
Rs
gl.Rs
C.Od
Od
Cop.op
os
og

outside by a special duct, the ductus bursa, on the eighth abdominal sternite.

There are two accessory glands which open together into a common duct. The latter opens into the dorsal wall of the vagina. Each accessory gland takes the form of a long convoluted tube which opens in a small sac-like reservoir.

There is also a single receptaculum seminis which possesses a terminal tubular gland and opens into the dorsal wall of the vagina anterior to the opening of the common duct of the two accessory glands.

Each ovariole consists of a chain of developing ova (oocytes). Each is composed of a layer of epithelial cells resting on a basement membrane, and the whole ovariole is enclosed in a connective tissue membrane. The connective tissue membrane surrounding the four ovarioles in each ovary join together forming the so-called terminal filament. In Prodenia litura, the ovariole is of the polytrophic type, each oocyte has its number of nurse or nutritive cells enclosed in its follicle (Fig. 35).

The wall of each of the two lateral oviducts and the common oviduct consists of epithelial cells which rest on a basement membrane and coated by a thin layer of circular

Fig. 35: A, An enlarged oocyte.
B, Two oocytes.
ctm, connective tissue; fe, follicular epithelium; n, nutritive cells; o, oocyte.

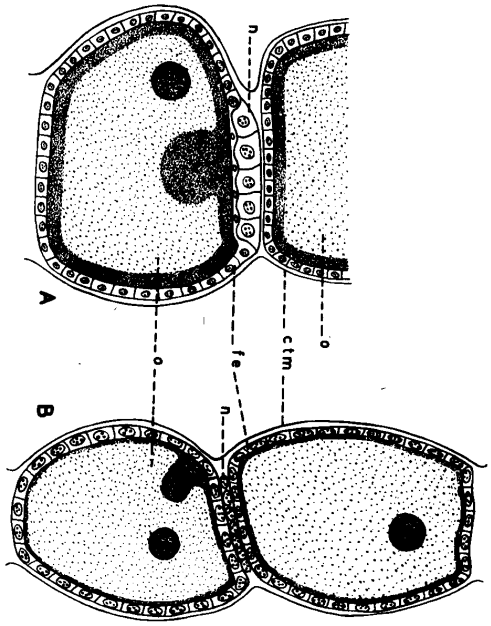
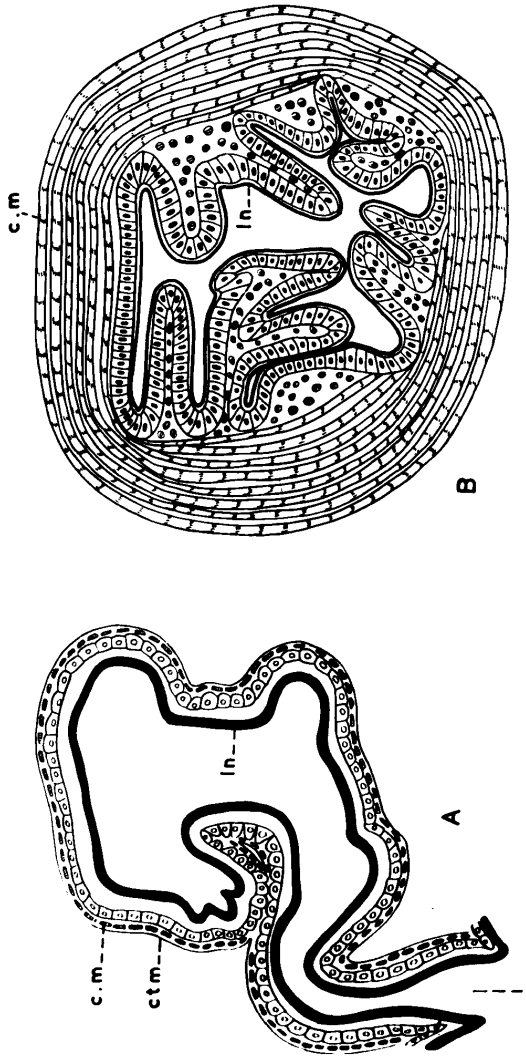

n
A
o
fe
ctm
o
B
n

Fig. 36: A, Longitudinal section of the bursa copulatrix.
B, Transverse section of the vagina.
c.m, cercular muscles; ctm, connective tissue membrane; In, intima.


c.m
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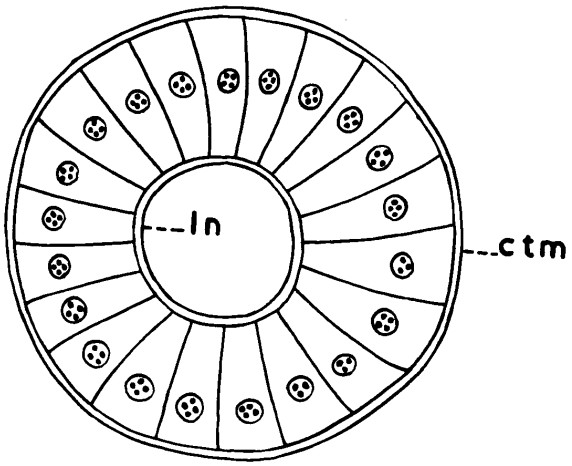
muscles. The vaginal wall (Fig. 36 B) consists of inwardly folded epithelial cells resting, as usual, on a basement membrane and covered externally with a very thick layer of muscles. The vagina is also lined with a thin chitinous intima. The wall of the accessory glands (Fig. 37) is composed of the ordinary epithelial cells which rest on a basement membrane, lined with a chitinous intima and coated with a connective-tissue membrane. The epithelial cells of the bursa copulatrix are lined with a thick intima and covered with a thin layer of circular muscles which is coated by a connective-tissue membrane.

Fig. 37: Cross section of the female accessory gland.
ctm, connective tissue membrane; In, intima.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V. SUMMARY

1. The external morphology and internal anatomy and histology of certain systems in the adult moth Prodenia litura are described in detail in the present work.

2. The female moth of Prodenia litura is easily differentiated from that of the male by its larger size, colour, and by its longer and less hairy antennal segments.

3. The head capsule, mouth-parts, thoracic segments, legs, antennal cleaning apparatus, wing-venation, and wing-coupling apparatus, abdomen, male genitalia, and female ovipositor are figured and described in detail. The wing-coupling apparatus in the female consists of two sets of fine setae comprising the retinaculum and three bristles which represent the frenulum. In the male, the retinaculum is composed of one tuft of hairs and a curved plate while the frenulum is made of one single bristle.

4. The central nervous system is divisible into the brain, the sub-oesophageal ganglion and the ventral nerve-cord. The latter is composed of eight ganglia, three thoracic and five abdominal. The first and second thoracic ganglia are connected together without any obvious external connectives.

5. The alimentary canal is composed of a pharyngeal pump, a thin long oesophagus, a lateral sac-like crop, a small gizzard, a mid-gut which possesses replacement cells at the bases of the large columnar epithelial cells, a short ileum, a long coiled colon, a large tubular-like rectum and an anal sphincter. The latter is an invagination of the body wall and surrounded with circular muscles. The rectum has many small rectal papillae projecting inwards from its wall. There are two labial (salivary) glands which open with a common duct on the beginning of the proboscis. Each three of the six Malpighian tubes open together by one tube on either side of the gut between the mid-gut and the ileum. Each of the six malpighian tubes ends separately in the rectal wall.

6. The dorsal vessel is composed of the heart and the aorta. The former has eight chambers, seven pairs of ostia, and seven pairs of alary muscles. The pericardial cells, the oenocytes and the fat-bodies are described in detail.

7. The male reproductive organs are composed of two yellowish testis which are enclosed in a common sheath or scrotum, two vesiculae seminalis, two vasa deferentia, and two accessory glands. The latter consist of two reservoirs

which lead from one end to two separate coiled long glands and unite in a single tube from the other end to join the ejaculatory duct. The histology of different components of the male reproductive organs as discribed in detail.

8. In the female, there are two ovaries, each composed of four ovarioles, two oviducts, a common duct which leads to two accessory glands; The bursa copulatrix bas its duct opening to the outside on the eighth abdominal sternite and is also connected to the vagina by a thin seminal duct. The histology of all the female reproductive organs is described in detail.

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VII. REFERENCES

Abou-El-Nasr, Moufied, Moussa (1960): Soil moisture in relation to pupation and moth emergence of the cotton leaf worm, Prodenia litura F., Bull. Soc. ent. Egypte, 44: 377-382.

_____ (1960): Factors affecting longevity and reproductive potentials of moths of the cotton leaf worm, Prodenia litura F. Bull. Soc. ent. Egypte, 44: 383-386.

_____ (1961): Abundance of the early stages and adults of Prodenia litura F., in berseem fields, Bull. Soc. ent. Egypt, 45: 229-232.

Aghion, E. (1928): Note sur le moyen de combattre le ver du cotton par l'arséniate de chaux. Bull. Min. Agric. Egypte, XXV No. 182: 135-143.

Ballard, E. (1914): A list of the more important insect pests of crops in the Nyasaland protectorate. Bull. entom. Research, London, IV: 347-351.

_____ (1913): Some cotton and tobacco pests of Nyasaland. Supplement to the Nyasaland govt. gazette, 30th April, 1913, Zomba, 9.

_____ (1927): Some insects associated with cotton in popua and the Mandate territory in New Guinea Bull. ent. Res., XVII:295-300.

Basu, A. C. (1945): Govt. Agric. lab. tejgaon, Dacca, India. Life-history and bionomics of the cauliflower pest pro. bt Fb. in Bengal Sci. and Culture, 10 (10): h20-h22.

_____ (1944): Effect of different foods on the larval and post larval development of the moth Prodenia litura F. (Lepidoptera, Noctuidae). J. Bombay Nat. Hist. Soc , 44, No. 2: 275-288.

Bishara, Ibrahim, M. (1929): Preliminary experiments with dusting and spraying against insect pest of cotton. Bull. Min. Agric. Egypt, No. 77: 11.

Bishara, Ibrahim, M. (1934): The cotton worm, Prodenia litura, in Egypt. Soc. Roy. ent. Egypte, 18 (3): 288-420.

Bodenheimer, F. S. (1950): Citrus Entomology. A text-book.

Brain, C. K. (1918): A preliminary report on the cotton pests of South Africa. Union S. Africa Dept. Agric., Pretoria, local Ser. No. 59: 29.

Comus, J. S. (1921): Rice in the Philippines. Philippine Bur. Agric. Manila, Bull. 37, 192: 90.

Chin, Ching-mu (1937): Preliminary observations on the Noctuid Prodenia litura (In Chinese). Ent. Phytopath.,4,No. 24-25: 478-480.

Chretien, P. (1917): Contribution à la connaissance des Lepidoptères du Nord de l'Afrique. Notes Biologiques et critique (A contribution to the Knowledge of North African Lepidoptère. Biological and Critical Notes),Ann. Soc. Entom. France, Paris, LXXXV, No. 3 h: 69-509.

Commun (1931): Travaux d'entomologie. Bull. econ. Indochine,XXXIII, No. 3 B. C. R. Trav. 1928-29, 11 ent. Cryptog: 1-28.

Duport, Ir. (1914): Notes sur quelques maladies et ennemies des plants cultivees en extreme orient. (Notes on certain diseases and enemies of cultivated plants in the far East.) Extrait du Bulletin edonomique de l'Indochine, Hanoi Haiphong, Bouvell Seric, No. 99: 147.

Edrozo, L. B. (1918). A study of tobacco worms and methods of control. Philippine Agriculturist and forester, Los Banos, VI, No. 7: 195-209.

Ediwards (1922): A third new British plastosciard (Lepidoptera, Sciaridae) Ent.Monthly Mag, London, No. 698: 160-161. additions.

Fletcher (1928): Report of the Imperial Entomologist Sci. Rep. Agric. Res. Inst. pusa: 56-67.

Frappa (1937): Les insects nuisibles an manioc sur pied et aux tubercules de manioc en magasin de Madagascar. Rev. Bo. appl., 18 nos. 197-198, 1: 17-29, 104-109.

Froggatt, I. L. (1936): Entomological notes. New Guinea Agric. Gaz., 2 No. 1: 10-14.

Fulmek, L. (1928): Ueber die Situation der Schadlingobekampfung in den Tabakkulturen auf Sumatra. (The position of work against Tobacco pests in Sumatra.) Verh. deits. Ges. angew. Ent., 6: h 9-55.

Gardiner, I. C. (1946): On larvae of the Noctuidae (Lepidotera), 11 (Trans., R. ent. Soc. Lond., XIVII: 237-252.)

Goco, A. I. (1922): Rice pests. Philippini Agric. Rev. Manila, XIV, No. 1: 57-62.

Golding, F. D., Leon, O. B., and Laycock, T. (1928): A critical comparison of the factors inhibiting the development of three species of cotton in Southern Nigeria. 6th. Ann. Bull. Agric. Dept. Nigeria., 5-69.

Gurney, W. B. (1915): Some insect pests of Apples and pears. Agric. Gaz. New. South. Wales, Sydney, XXVI: 303-312.

Hammad, S. M. and Jarczyk, H. I. (1958): Contribution to the biology and biochemistry of the cotton leaf worm, Prodenia litura F., III. The morphology and histology of the sexual scent glands in the female moth of Prodenia litura F. (Lepidoptera: Agrotidae, Zenobiinae). 2: 253-261.

Harris, W. V. (1934): Report of the acting Entomologist. Rep. Dept. Agric. Tanganyka, 1933, 69-75.

Hassan, El-Tabey Shehata, and Hammad (1958): The morphology and anatomy of the mature larva of Prodenia litura F. (Lepidoptera, Agrotidae). Bull. Soc. ent. Egypt, 42: 291-309.

Hassanein, M. H. (1958): Nocturnal Activity of insects as endicated by light-traps. Bull. Soc. Ent. Egypte, 40: 463-479.

Hopkins, G. H. E. (1928): Pests of Economic plants in Samoa and other Island Groups. Bull. Ent. Res., XVIII: pp. 23-32.

Hoangy, M. H. and Kotby (1960): Host plants favored by the cotton leaf-worm moth, Prodenia litura F. for egg-laying and their value as egg-mass trap crops. (Lepidoptera: Agrotidae - Zinobiinae). Bull. Soc. ent. Egypte, 44: 2223-234.

Hutson, J. C. (1924): Ceyleon Entomology. Trop. Agriculturist, IXII: 5 pp. 288-289, Peradeniya.

Imms, A.D.(1957): A text-book of Entomology.

Jack, R. W. (1915): Some injurious caterpillars. Rhodesia Agric. Yl. Salisbury, XII, No. 1.

Janirch, E. (1930): Experimentalle untersuchungen irber die wirkungder umweltfaktoren auf Inrecten. 1. Die Nossenvermahrung der Baumrvol leule pradinia littaralis in Aegypten "Experimintal investigations on the effects of environmental factors on insects. The outbreaks of meutal. Review of Applied Entomology.

Jhaveri, T. N. (1920): Swarming caterpillars of Northern Gujarat. Agric. Jl. India, Calcutta, XV, Part 2, pp. 181-184.

Jepson, F. P. (1918): Division of entomology. Dept. Agric. Fiji., Ann. Rept. for the Year 1916 Suva, 20th November, 1917: 16-25.

Jardine, N. K., Reeve, A. T., and Jebaratnam, M. R. M. (1925): Sur quilque ins et niusibles au cottonnier en Afrique occidental Française. Agron. Colon., No. 93, pp. 89-125.

Jones, C. R. (1913): Maize pests in the philippines. Philippine Agric. Review, Part 1, No. 3. 115-117.

_____ (1913): Insect notes from the Philippines. Philippine Agric. Review, VI: 246-250.

_____ (1913): The tobacco caterpillar (Prodenia litura, F.). Philippine Agric. Rev., Manila, VI, No. 9: 425-432.

Jukchan (1937): Notes on the life history of Prodenia litura (Lepidoptera, Noctuidae). Lingnon Sci. J. 16 No. 2: 261-266.

Jyssière, P. and Mimeur, J. (1926): Sur quelque insect nuisibles au cottonnier en Afrique occidental Françcaise-Agron. Colon, No. 93: 89-125.

King, C. B. R. (1936): Report of the Entomologist for the year 1935. Bull. Tea Res. Just. Ceylon. No. 13: 35-40.

Lamborn, W. A. (1915): The agricultural pest of the southern provinces, Nigeria. Bull. Entom. Research, London, V: 197-214.

Leefmans, S. (1928): Ziekten en plagen der Cultuirgewassen in Nederlandsch. Indie in 1928. (Diseases and pests of cultivated plants in the Dutch East India in 1926.) Meded. Inst. Plziek., No. 73: 60.

Lever, R. I. A. W. (1943):The cotton worm Prodenia litura F., Agric. J. Fyi. 14 No. 1: 11-13.

Light, S. S. (1929): Report of the entomologist. Bull. Tea Res. Inst., Cylon, No. 3: 37-48.

Maki, M. (1918): Farwansan soju Gaichu mikan suru chosa hokoku. (Report on injurious insects of the Mulberry tree in Formosa.) Formosan Government Agricultural Experiment Station, Publication No. 90, IXIV: 265.

Mason, C. (1918): Report of the government entomologist, Nyasaland Protectorate, Ann. Rept. Dept. Agric. for year ended 31st Zamba, 9-13.

Mendiz, Abalvillaba, M; (1941): Das nuvas plag as de nuestras cultivos meridionales: Prodenia litura F. (Lep. Noct.). J. Euprepocnemus Plorans Charp (Ord. Acr.) (Two pests of cultivated plants in Southern Spain, P. litura and E. plorans.) Bol. Part. Veg. ent. Agric., 9: 258-262.

Merino, G. (1921): The importance of plant Quarantin service in the Philippine. Philippine Agric. Rev. Manila, XIII, No. 2: 117-125.

Morstatt, H. (1914): Die Schadeinge der Baumwelle in Dentsch. Ostrafrika. (Cotton pests in German East Africa.) Beiheft zum pflazer, Dar-estSalaam, X: 50.

Mosseri, V. (1917): Coup d'ceil retrospectif sur la culture du tabac en Egypte. (A retrospective glance at tobacco cultivation in Egypt.) Bull. Union Agriculteurs d'Egypte, Cairo, No. 119: 53-54.

Moufied, A. Moussa, Zaher, M. A. and Kotby, F. (1960): Abundance of the cotton leaf worm, Prodenia litura F.; in relation to host plants. Bull. Soc. ent. Egypte, 44: 241-251.

Nizambioghi, K. (1960): Misir pamak Kurdu Prodenia litura F. nin pamuk da Zararia ye mucadelesi. (Damage by the Egyptian cotton worm, Prodenia litura, and its control.) Koruma (1) No. 5: 4-9.

Okumi, Keshi no Gaichu yoho (1921): Insects injurious to the pappy in Formosa. Prilimenary report. Formosa Agric. Sta. Bull., 139: 1-30.

Palm, B. T. (1924): Vers log van het Deli proefstation over 1 Juli 1922-30.

Pemberton, C. E. (1944): Entomology. Rep. Comm. exp. Sta. Hawaii Sug. pl. Ass., 1942-43, 32: 14-18. Honolulu.

Pomeroy, A. W. J. (1925): The cotton boll worms of Southern Nigeria. Nigeria the Ann. Bull. Agric. Dept. 89-108.

Ritchie, A. H. (1926): Entomological Report, 1924-25. Tangamjika Terr. Rept. Dept. Agric. 1924-25. 41-44, Dar-es-Salaam (1926).

_____ (1927): Entomological Report, 1925-26. Tonganika Terr. Rept. Dept. Agric. 1925-26. 33-63. Dar-es-Salaam.

_____ (1935): Report of the entomologist 1934. Rep. Dept. Agric. Tanganika 1934, 73-83.

Sarcouf, J. M. R. (1925): Sur un parasite de cottonnier vivant aussi sur le berseem. Rev. Bott. Appe. Agric. Colon., IV, Bull., 39, 13: 752-753.

Senior White, R. (1917): Insect pests. Trop.Agric. Peradenia IVIII, No. 2: 115-121.

Simmonds, H. W. (1927): Report by the acting government entomologist. Fiji Dept. Agric. Ann.

Smee, C. (1930): Insects in Tobacco seedbeds. Bull. ent. Dept. Agric. Nyasaland, ent. Ser. No. 5: 8.

Soliman, Soad A. and Soliman,A.A. (1958): Histopathological destruction caused to the cotton leaf worm, Prodenia litura, F., by some of the Newer insecticides, 42: 199-226.

Sonan, J. (1937): Studies on the Tobacco caterpiller, Prodenia litura F., in Formosa (in Japanese). Kontyu, 11 No. 1-2: 175-177.

_____ (1937): The grey-streaked moth, Prodenia litura Fab. in Formosa, No. 70: 69.

Swezey, O. H. (1941): A survey of the insect pests of cultivated plants in Guam. Hawaii. Plant. Res., 44 No. 3: 151-182.

_____ (1942): Observations on insect pests in Samoa which are not yet known to occur in Hawaii, Plant Res., 45 No. 1: 23-38.

Tuscen, S. L. (1956): Taxonomist's Glossary of Genitalia in Insects.

Van der Laan, P. A. (1940): On derzockngen over schuurvoat. (Investigation on Injury to tobacco leaves in drying sheds by Lepidopterous larvae.) Meded. Deli procfsr (3) No. 5: 19.

Van Hall, C. J. J. (1922): Ziekten en plagen der Cultuurgewassen in Niderlandsch. Indie in 1921. (Disease and pests of cultivated plants in the Dutch East India in 1921.) Meded. Inst. Planteuziekten Butenzorg No. 53: 46.

Wigglesworth, V. B. (1953): The Principles of Insect Physiology.

Willcocks, F. C. and Bahgat, S. (1937): The insect and related pests of Eygpt. Roy. Agric. Soc., 791.

دراسة التشريح الخارجي والداخلي للحشرة الكاملة
لدودة ورق القطن

=•=•=

ملخص :

ان دودة ورق القطن من أهم الافات التى تصيب القطن ومعظم المحاصيل الزراعية وأشجار الفاكهة ونباتات الزينة فى الجمهورية العربية المتحدة ومعظم بلاد العالم• ومع أهمية هذه الافة فلم يدرس الى الان تشريح الحشرة الكاملة لها وهى الفراشة ؛ لذا أريد بهذا البحث استكمال هذا النقص فى دراسة هذه الافة الخطرة حتى تساعد مثل هذه الدراسة على مقاومتها •

ولقد درس فى هذا البحث التشريح الخارجي والداخلي لبعض أجهزة هذه الفراشة • وذكر فى هذا البحث أيضا جميع الابحاث التى أجريت عن التشريح الخارجي والداخلي لفراشات رتبة حرشفية الاجنحة عامة وكذلك الابحاث المتعلقة بانتشار وأضرار وعادات وتاريخ حياة هذه الافة •

ويمكن التمييز بسهولة بين ذكر الفراشة وأنثاها اذ أن الانثى أكبر حجما ويختلف لونها عن لون الذكر ؛ اذ يوجد على الجهة الخارجية للاجنحة الامامية فى الذكر بقعة زرقاء كبيرة ؛ كما أن حلقات قرون الاستشعار فى الانثى أطول منها فى الذكر وتحمل شعرات أقل •

وبخصوص التشريح الخارجي للفراشة فقد وصف بالتفصيل الرأس وأجزاء الفم والصدر والارجل والاجنحة وجهاز تنظيف قرن الاستشعار فى الارجل الامامية وجهاز شبك الاجنحة فى الذكر والانثى • ووصفت كذلك البطن فى كل من الذكر والانثى بما تحمل من آلة السفاد وآلة وضع البيض •

وفى التشريح الداخلي وصف الجهاز العصبى المركزى والجهاز الهضمى والجهاز الدورى والجهاز التناسلى • ويتركب الجهاز العصبى المركزى من المخ

والعقدة تحت المرئ وثلاث عقد عصبية صدرية وخمس عقد بطنية ؛ والعقدتان الاولى والثانية فى الصدر ملتحمتان . و تتكون القناة الهضمية من طلمبة المص ثم البلعوم فالمرئ وهو طويل ورفيع وحوصلة جانبية وقناة وسطى (معدة) تحتوى على خلايا مجددة Replacement cells ؛ ويلى المعدة الامعاء الدقيقة وهى قصيرة ثم قولون طويل ثم المستقيم وهو كبير ويحتوى على كثير من حلمات المستقيم . يلى المستقيم جزء يسمى Anal aphincter الذى يتكون من انبعاج جدار الجسم للداخل ؛ ويحاط بعضلات دائرية سميكة . هذا مع العلم بأنه يوجد صمام مريئى أو فؤادى بين القناة الهضمية الامامية والمعدة وكذلك يوجد صمام آخر بوابى بين المعدة والامعاء الدقيقة . وتوجد غدتان لعابيتان رفيعتان على جانبى القناة الهضمية الامامية ويفتحان للخارج بقناة واحدة مشتركة تفتح عند بداية الخرطوم . ويوجد كذلك ست أنابيب مالبيجى كل ثلاثة منها تفتح بفتحة مشتركة واحدة على أحد جانبى اتصال المعدة بالامعاء الدقيقة ؛ وينتهى كل من هذه الانابيب الستة مستقلة فى جدار المستقيم . ويتكون الوعاء الظهرى من القلب والاورطة . والقلب مكون من ثمان حجرات وسبعة أزواج من فتحات الاوستيا وسبعة أزواج من العضلات الجناحية ؛ كما وصف أيضا من الجهاز الدورى الاجسام الدهنية والـ Pericardial cells وكذا الـ Oenocytes . أما الجهاز التناسلى فى الذكر فهو يتركب من خصيتين لونهما مصفر موجودتين داخل غلاف واحد مكون من النسيج الضام ؛ ويخرج من الخصيتين الملتحمتين حوصلتان منويتان تؤديان الى وعائين ناقلين يصب كل منهما فى خزان غدة زائدة رفيعة وطويلة وملتوية على بعضها البعض وتنتهى سائبة قرب نهاية الجسم . والجهة الاخرى من خزان كل غدة زائدة يلتحم مثيلتها فى الغدة الاخرى ويصب الاثنان بقناة واحدة مشتركة فى القناة القاذفة . أما فى الانثى فيتكون جهازها التناسلى من مبيضين يتكون كل منهما من أربعة فروع مبيضية تؤدى

الى قناة المبيض ، ثم تتحد قناتا المبيضين فى قناة مبيض مشتركة تؤدى الى المهبل الذى يفتح فى النهاية الخلفية للحلقة البطنية العاشرة . ويفتح فى الناحية الظهرية للمهبل قابلة منوية والقناة المشتركة المغدتين الزائدتين وكذلك القناة المنوية التى توصل المهبل بال Bursa capulatrix التى تفتح للخارج بفتحة مستقلة على النهاية الخلفية للحلقة البطنية الثامنة .

وعلاوة على ذلك ، فقد وصف التركيب الهستولوجى لهذا الجهاز التناسلى فى الذكر والانثى بالتفصيل .

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C O N T E N T S