The Annals of Zoology
ISSN (Print): 0003-5009
Annals of Zoology, Vol. 28, December 2012: 65-73

RESEARCH ARTICLE

Anatomy of *Agrotis ypsilon* Rott. (Greasy Cutworm) Mature Larva

Harish Kumar and Sunil Kumar Jain
Department of Zoology, Agra College Agra
Email: drhkumar.kumar@gmail.com

ABSTRACT

Agrotis ypsilon Rott is a pest of cruciferi crop specially cabbage (Brassica oleracee). The mature larva of Agrotis ypsilon Rott is called greasy cutworm. The greasy cutworm being noctural form, were larvae collected and studied during November 2003 to February 2007 at Etawah and Agra districts from cruciferi crop specially cabbage. Pest visits light points also and can be frequently caught by the light trap. For the study of anatomy of the mature larvae, it is a smooth fleshy cylindrical caterpillar with a well built body and clearly marked head, thorax and abdomen. A deep dorsal incision exposed the alimentary canal covered over by the fat body and tracheae. The fat body flakes are yellowish in colour and the mid-gut looks greenish because of the leaf bits contained inside. This portion has a profuse supply of the trachea that ramifies over the whole of its surface. In the posterior region the malpighian tubules form a big coiled and convoluted knot along with other organs. Removal of the malpighian tubules and fat body exposed the two white elongated glandular bodies on either side.
Key words: *Cabbage, Greasy Cutworm, larva*

INTRODUCTION:

The greasy cutworm *Agrotis ypsilon Rott (*Lepidoptera: Noctuidae) is a serious pest of cruciferi on a variety of economic plants (mainly cabbage) inflicting maximum loss during winter (December and January) in Uttar Pradesh. Gardner (1948), hassanein (1962) and Peterson (1912) has given general account of their morphology and anatomy. Hassanein *et.al.* (1962) again studies the morphology and anatomy of the mature larva of *Agrotis ypsilon Rott.*

METERIAL AND METHOD:

Works out the life history of the vegetable pest under investigation the pest were collected from the various field groves around the Agra and Etawah, during infested and breeding season. *Agrotis ypsilon Rott.* (greasy cutworm) being Noctural from were larvae collected during November to February from cruciferi crop specially cabbage (*Brassica oleracee*) pest visits light points also and can be frequently caught by the light trap ; the insect was friested studied at room temperature in the laboratory of department of Agra College Agra and the later the result were cofermend by observation in the field under mature condition .small potted host plant were kept in the muslin covered glass jars (8" x10" and 6" x 8") and a pair of insect were introduced in jars. *Agrotis ypsilon Rott* was feed on sugar solution kept along with potted host plant in the glass gars.

Micro dissections were performed under a lens with a spot light for studying the anatomy of the mature larvae. As far as possible fresh specimen were used for dissection following the technique of Hagmann (1940), Panten (1948), For studying the nervous system only, specimen preserved in 80% alcohol were employed or the fresh specimen were dept in 90% for 24 hours before dissection.

RESULT AND DISCUTION:

The mature larva of *Agrotis ypsilon* Rott is called greasy cut-worm also, Lefroy and Howlett (1909), Pradhan (1969) and Pruthi (1969) because of a thick waxy coating over its body. Due to this coating the larva can float without harm for some time. A deep dorsal incision exposed the alimentary canal covered over by the fat body and tracheae. The fat body flakes are yellowish in colour and the mid-gut looks greenish because of the leaf bits contained inside. This portion has a profuse supply of the trachea that ramifies over the whole of its surface. In the posterior region the malpighian tubules form a big coiled and convoluted knot along with other organs. Removal of the malpighian tubules and fat body exposed the two white elongated glandular bodies on either side. The ventral nerve cord and segmental ganglia are exposed only after taking out all other anatomical structures from the body cavity.

A. DIGESTIVE SYSTEM: The alimentary canal of *Agrotis ypsilon* R. represented the basic plan of the digestive tract in lepidopterous larvae, in the form of a straight tube of varying diameter. The entire alimentary canal is as long as the larva itself. When gorged with food matter it occupies the major portion of the body cavity. The different portions of the alimentary canal viz. fore gut, mid gut and hind gut can be marked externally also.

(i) Fore gut: The larva having mandibulate mouth parts forms a temporary preoral cavity while feeding, Snodgrass (1935). From the posterior extremity of this preoral cavity originates the fore gut to extend upto the posterior limit of the metathorax (Fig.1). The entire foregut measures 9.0mm. and represented about ¼ of the alimentary canal. Superficially it can be differentiated into pharynx, oesophagus, crop and proventriculus.

(a) Pharynx: The pharynx is the first and the smallest portion of the alimentary canal. It extends vertically from the posterior end of the preoral cavity upto the dorsal region of the cephalic cavity (Fig. 1, pH) and measures 3mm. (i.e. one third of the foregut). It is dirty white in colour and strong muscle fibres (both circular and longitudinal) can be clearly seen.

(b)Oesophagus: The oesophagus is the second and the largest portion of the fore gut (Fig. 1-A, OES). There are no morphological differentiation between the oesophagus and the adjoining portions externally.

(c)Crop: The crop is the most prominent portion of the fore gut and looks like a funnel occupying the entire space of the metathoracic region. It measures 1.5mm. in length and is dilated at the posterior end. It originates from the posterior limit of the second thoracic segment and extends up to the posterior limit of the metathorax (Fig. 1-A, CR).
It has smooth walls almost white in colour and devoid of trachea. The walls are extremely flexible and could be distended through a good deal (because of its circular muscle fibres). No values are however marked at the extremities. Its anterior limit is marked by the sudden widening of the oesophagus and posteriorly it is invaginated into the mid gut a little. This, however, does not form a valve. The lumen of the crop is wide and simple, its main function being storing the food, Snodgrass (1935). The outer surface of crop has transverse wrinkles that look like rough annulations, when the crop is not distended. These wrinkles almost vanish when the crop is gorged with the food matter. The small invagination marked the end of the crop.

(d)Proventriculus: At the posterior margin of metathorax the alimentary canal is invaginated a little. The posterior extremity of the crop is folded inside the anterior limits of the mid gut. This is termed as proventriculus, Snodgrass (1935). The structure is not so complicated as in adult insects. However, no external ceaca or diverticula exist as the walls run smooth (Fig. 1-A, PRV). This marks the end of the foregut and the beginning of the mid-gut.

(ii) Mid-gut: In the mature larva of *Agrotis ypsilon* R. the mid-gut is the largest and the simplest portion of the alimentary canal. It measures 20.0mm. in length and represents about two third of the entire alimentary canal (Fig. 1). It is a straight and wide tube of ample caliber measuring 4.0mm. in girth in the thickest region. From the posterior limit of the metathorax it originates as a wide tube.

Invagination of the fore-gut into its anteriormost portion makes it clear externally also. No external diverticulae or ceaca are present here. An indistinct longitudinal fold is present in the anterior region till the seventh abdominal segment and imperceptible in the posterior region. Dorsally the posterior 5/8 or the mid-gut is covered over by the malpighian tubules, (Fig.1-B,S). Both the ascending and descending arms of the malphighian tubules cover this portion of the gut from the initiation of hind-gut upto the region of third abdominal segment dorsally. Posteriorly it narrows a little to emerge as hindgut. The anterior region of the hind-gut is telescoped within the posterior most portion of the mid-gut, but an internal examination reveals not valves present.

(iii) Hind-gut: The hind-gut takes its origin from the region of seventh abdominal segment and runs upto the posterior end of the larva (Fig. 1-A). In total it measures 7.5 mm. and constitutes about 1/5 of the entire alimentary canal. In this larva the hind-gut is clearly differentiated into two distinct chambers viz. colon and rectum. Absence of the third portion or ileum in accordance with the present investigation has been recorded by Jain author.

The colon or the first portion is funnel shaped and in anteriorly telescoped within the mid-gut. It is an almost wide tapering tube that terminates in the eighth abdominal segment in a constriction. The colon is comparatively thin walled and the malpighian tubules running along its walls are clearly visible. The next or the last protion of the hind-gut is the rectum. It looks like an elongated pear shaped structure that originates from the eighth abdominal segment (identified from the colon by a constriction) (Fig.-A, R). Immediately after its origin it widenes a little and is thick walled also. It occupies the entire space in the posterior region of the body. In the region of tenth abdominal segment the rectum tapers to open through the anus situated at the posterior limit of the abdomen (Fig.1, AU). The anal plate over hangs the anus, attached to the tergite of the ninth abdominal segment.

B. GLANDS: The labial or salivary glands in Lepidoptera larva are specialized for silk production, Peterson (1912), Snodgrass, (1935). The silk material is used for various purposes (especially cocoon formation), hence this gland is more commonly known as silk gland in Lepidoptera larva and the function of actual saliva production is taken up by the mandibular glands, Snodgrass (1935). Both these glands are present in the mature larva of *Agrotis ypsilon* R.

(i)Mandibular gland: In the anterior thoracic region the mandibular glands are present as highly convoluted tubules on either side of the alimentary canal. They hardly reach beyond the metathorax posteriorly (Fig. 1-B, SG). In diameter they are 0.3 mm and remained in a loosely semicoiled condition.

They remain almost attached to the wall of the alimentary canal, partly embeded under the fat-body granules. In the fresh larva they are light yellow or cream coloured thin walled tubules, differing in thickness at the two ends. In stretched condition they reach the anterior limit of the third abdominal segment. On the anterior side they narrowed considerably to form the duct of the gland and entered the base of the mandible (Fig.1-B, DSG). In KOH treated mandibles the passage of this gland can be seen upto half its length and then it opened through a minute pore towards the inner side.

(ii) Silk gland: The silk glands are well developed tubular structures lying along the alimentary canal one on either side. In natural condition they are found embedded below the fat body and knotted and huddled up with the malpighian tubules and tracheae. Each gland is a thick fleshy tubular structure white or pale yellow in colour.

Commencing from the base of the hypo-pharynx, they extend upto the seventh abdominal segment (Fig.1,-B, SI). It travels a zig-zag course and in the region of third and fourth abdominal segment it has distinct ascending and descending limbs. Posteriorly they narrow down to a thin tube of 0.3mm. in diameter and have a blind end in the region of seventh abdominal segment. The main body of the gland is 1.5mm. thick and resembles an *Ascaris* (in shape and structure). Anteriorly again it continues as a tube 0.25mm. in thickness from the thoracic region. In the anterior cephalic region the two tubes pass below the oesophagus and form a common thin and narrow median salivary duct. At the base of the hypopharynx it forms a salivary pocket or salivarium (Fig.1-B, SVM). The common median duct of the salivary gland opens into its posterior end. In Lepidoptera larva Snodgrass (1935) described the salivarium to act as silk press. The body of main gland is wrinkled and remains folded. In this larva ample secretion is produced that is expelled through the spinneret (Fig.1-B. SPN). In the immature larvae this material is produced for spinning the web in which they take shelter, while the mature larva prepares cocoon out of it.

C. RESPIRATORY SYSTEM: The respiratory system in this larva is of a typical peripneustic type, Essig (1958). There are in all nine pairs of spiracles, one thoracic and rest eight abdominal, placed on the first thoracic and the first eight abdominal segments (Fig. 2-A). All the spiracles are similar in structure except for the posterior one, which is a little larger in size. Each spiracle is visible as a minute spot but the KOH treated preparation under a microscope shows the details. They are placed on a fairly chitinized surface, on the lateral aspect of the segmental pleura. There is a darker colored outer peritreme and an inner rim. On the rim numerous chitinized bars are attached, arranged transversely on each half. The bars help in regulating the passage of air.

The spiracles lead to an atrium Snodgrass (1935) emerging posteriorly as a minute spiracular trunk (Fig. 2-A, SPT) which communicates with the lateral longitudinal trunk (Fig,2-A, LIT). The atrium is a small thin walled space anteriorly guarded by the spiracle, and communicating with the spiracular trunk, which finally leads to the lateral longitudinal trunk. On either lateral side of the body the latter runs as a stout, thick tracheal vessel from the cephalic region to the posterior extremity, (Fig.2-A, LIT). In each segment the two lateral longitudinal trunks communicate with each other through a transverse trachea (Fig.2-A, TC). The transverse commissures are ventral in position in the first seven abdominal segments, while in the last (eighth) abdominal segment a dorsal as well as a ventral commissure is present (Fig.2-A, VCOM, DCOM). In the prothorax apart from the usual transverse commissure, the X-shaped commissure is also recorded, very similar to the Noctuid caterpillar, Snodgrass (1935). In the last abdominal segment the tracheation is not so regular as in the anterior ones. Here each segment receives several branches from the lateral longitudinal trunk or the transverse commissure to supply the internal structures present in the segment. Tracheation in this larva can be better described under the following heads:

1. Tracheation of the head,
2. Tracheation of the thorax,
3. Tracheation of the abdomen.

(i) Tracheation of the head: There being no spiracle in the cephalic region, the tracheae of this region are drawn from the prothoracic spiracle. From the lateral longitudinal trunk (at its joint with the spiracular trunk in the prothorax) there stout branches are given off that entered the head on either lateral side. The dorsal branch (Fig.2-A, DHT) supplies the brain, vertex region and the muscles therein. Later it travelled along the dorsal surface of the head capsule to meet the counterpart and thus formed the dorsal commissure in the head region (Fig. 2-A, HCO). The second branch that enters the head a little below the dorsal branch divides and redivides to give tracheal capillaries that ramify over the side walls of the cranium, labrum and its muscles. The ventral branches of the two sides came close together (Fig. 2-A, VHT) and supplies the lower lip (maxillolabial hypopharyngeal complex), its muscles and the ventral surface of the head capsule. The two arms of the X-shaped commissure are short and thin and meet below the joint of head and thorax and diverge again to continue in the prothorax in opposite direction towards the spiracles. Because of its characteristic X-shaped structure this complex vessel is defined as X-shaped commissure by Snodgrass (1935).

(ii) Tracheation of the thorax: The tracheation of the three thoracic segments are almost identical with slight difference in the prothorax only. There being a single spiracle in the thoracic region, tracheal branches supplying the prothorax take their origin from the junction of the spiracular trunk and lateral longitudinal trunk but in the meso and metathorax, these tracheal branches take their origin from a corresponding position from the lateral longitudinal trunk. The latter looks knotted and enlarged at the spot (from whence the branches take their origin), but there is no trace of any spiracle in the meso and metathoracic region externally. In the caterpillars the single spiracle present on the sides of the prothorax is actually the mesothoracic one, Snodgrass (1935), which is shifted forwards in the prothoracic region. Hence morphologically it is prothoracic but actually it is mesothoracic in origin. In some caterpillars the rudimentary metathoracic spiracle has been reported (Snodgrass 1935). However, the author could get no trace of the metathoracic spiracle in the present investigations.

A ventral commissure and a portion of lateral longitudinal trunk on either side is repeated in the thorax. In each of the thoracic segments a dorsal tracheal trunk is given out from the dorsal aspect to supply the dorsal body wall and muscles (Fig, 2-A , DBR). Two similar branches a lateral and a ventral originate from the middle and below respectively. The former (Fig. 2-A, LBR) supplies the lateral body wall and the muscles while the latter supplies the floor of the segment. Apart from these three branches the most conspicuous and dominant is the visceral branch (Fig.2-A, VIS), a pair in each segment. It takes an almost dorsal origin, inclines over the alimentary canal and is the thickest of all the tracheal branches of the segment. The main branch gives rise to six to seven stout branches to run along the surface of the gut and ramify over it.

From the inner lateral sides two delicate tracheal branches originate. The anterior supplies the segmental genglia and the portion of nerve cord in that segment while the posterior supplies the thoracic leg in that segment. The tracheal supply of the legs in this larva is more complicated. Each leg received a double supply, a small branch from the ventral commissure supplies the leg set in each thoracic segment. Besides, each leg is supplied by a Y-shaped branch. The arms of 'Y' being derived from the lateral trunk in the successive segments and the median portion enters the leg (Fig. 2-A, TLB). An almost similar description of the tracheal supply in the leg of Noctuid caterpillar has been given by Snodgrass (1935). Apart from these regular branches thin tracheal vassels emerge to supply the fat body and the glands here and there.

(iii) Tracheation of the abdomen: In the abdominal region again the tracheal supply is very regular in the first seven abdominal segments. It is on the same plan as the thorax, except that the four prolegs bearing segments viz. second, third, fourth and fifth received a pair of delicate tracheal branch from the ventral commissure. These tracheal branches supply the prolegs. Onwards the eighth segment, the tracheation is entirely different. The terminal portion of the lateral longitudinal trunk on either side gives off fine branches (four had been generally observed on either side). They reach the termination of the abdomen and ramify over the organs therein to supply them (Fig.2-A). In the median abdominal region, branches from the dorsal trachea supply the malpighian tubules and the silk gland also which is not very regular.

D. EXCRETORY SYSTEM: The excretory system in this larva comprises of thin and delicate malpighian tubules, six in number. They originate from the joint of the mid and hind gut in the region of seventh abdominal segment (Fig. 1-A). On either side of the alimentary canal a single tube takes its origin and divides twice to give rise to three malpighian tubules finally. The three tubules take a longitudinal route along the mid-gut symmetrically on either side. No malpighian tubules are present in the mid ventral position. They are placed only on the dorsal and lateral sides. The main tube that originates gives an offshoot and traverse dorsally, very near to its fellow of the other side. They ascend upto the region of the fourth abdominal segment and then take a descending route (Fig. 1-B, DMT).

The offshoot (given rise to by the main tubule) divides again to give a dorsolateral and a latero-ventral branch. These tubules take their respective routes and travel upto the third abdominal segment only, and then follow a descending course (Fig.1-B, VMT). Throughout their course the malpighian tubules are convoluted, dirty yellow, delicate, elliptical tubules not embeded or attached but only placed over the gut. Fine tracheal branches attached the tubules with the other organs viz. alimentary canal, gland and fat body. After descending to their starting point they are loosely packed along with other organs in the region of seventh abdominal segment into a big knot where they finally get lost with a blind end. It is difficult to isolate the individual malpighian tubules because of their extremely delicate nature and highly knotted condition.

E. NERVOUS SYSTEM: Nervous system in the mature larva of *Agrotis ypsilon* R. shows slight deviation from the typical adult insectan plan. The larva being hypognathous, the brain is not exactly dorsal but anterior and thereafter the ventral nerve cord persists with the chain of ganglia till the eighth abdominal segment to give off branches in each segment to supply the various organs. The detail of the nervous system is described under the following heads:

(i) The brain (ii) Ventral nerve cord (iii) Segmental supply

(i) The brain: The brain ring is horizontal and is in the plane of ventral nerve cord. All the basic components of the typical invertebrate brain ring (i.e. the supra-oesophageal ganglia, the circum oesophageal commissure and the sub-oesophageal ganglia) are present and well developed (Fig. 2-A, SUG, SOC and SOG). It occupies the posterior cephalic region, in the cranial cavity.

(ii) Ventral nerve cord: The structure of the ventral nerve cord differs in the thoracic and abdominal region. In the thorax the nerve cord is evenly present and two counterparts are wall apart, while the nerve cord in the abdomen is less cloven with the two counterparts a placed symmetrically on either side of the mid-ventral line close together.

(iii) Segmental supply: In each segment pair of ganglia, a portion of nerve cord and two pairs of fine nerve branches are regularly present to innervate the organs therein. (Fig. 2-B) The nature of ganglia and their branches differ in the thorax and abdomen. In the thorax they are larger and more prominent. In the thorax the individual ganglion is distinctly visible while in the abdominal region only a ganglionic mass in seen.

F. REPRODUCTIVE SYSTEM: The generative organs in this larva present themselves in a simple and under-developed condition. There is no sex differentiation also. Whitish oblong bodies on either side of the mid-ventral line in the third and fourth abdominal segments represent the gonads. They have shallow longitudinal marking over them and measures 5.2mm. by 0.2 mm. beyond the fourth abdominal segment it narrow and gives rise to a blunt conical tube. This posterior portion is extended a little beyond the posterior boundary of the sixth abdominal segment. No accessory gland or opening of the duct is present. Irregular tracheal supply holds the gonads in position, otherwise there being no binding tissue (Fig. 2-B, G).

Fig. 1: *Agrotis ypsilon* Rott.: A. Digestive System B. Excretory System

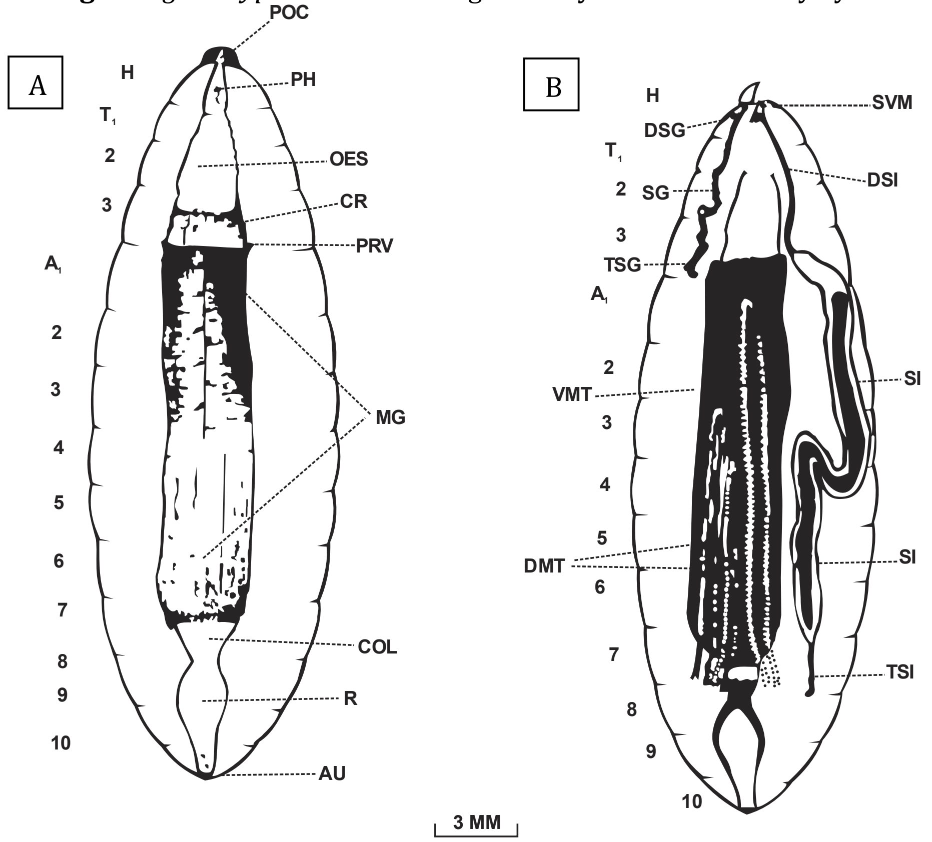
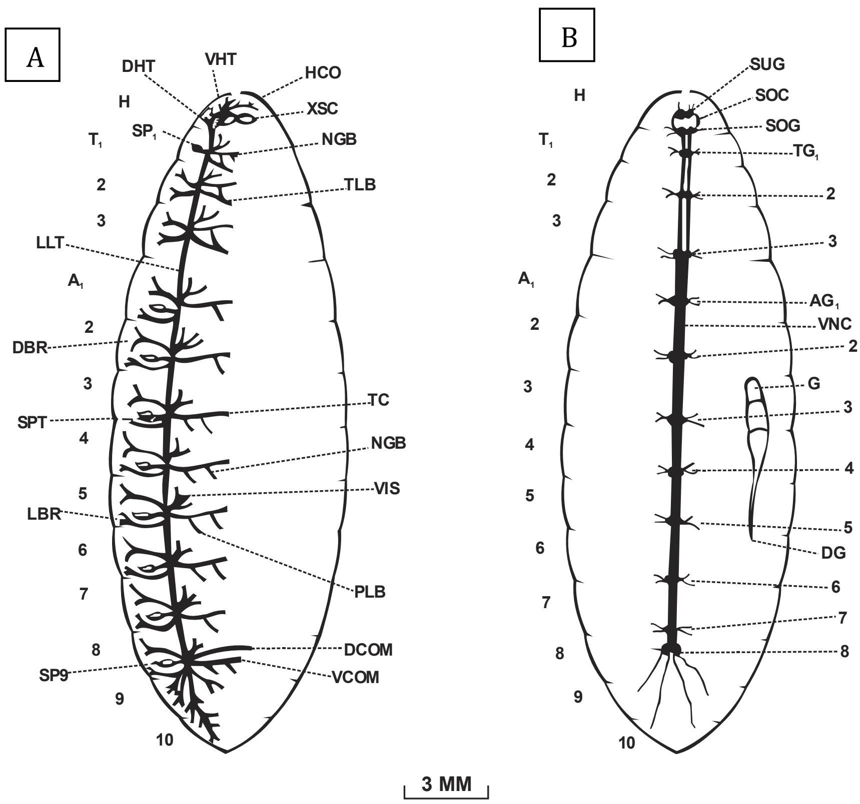


Fig. 2: *Agrotis ypsilon* Rott.: A.Tracheal System B. Nervous System and Left Gonads



APPENDIX:

For Fig. 1:

A_{1-10}	-	First to tenth abdominal segment
AU	-	Anus
COL	-	Colon
CR	-	Crop
DMT	-	Dorsal Malpighian tubule
DSG	-	Duct of the salivary gland
DSI	-	Duct of the silk gland
H	-	Head
MG	-	Midgut
OES	-	Oesophagus
PH	-	Pharynx
POC	-	Preoral cavity
PRV	-	Proventriculus
R	-	Rectum
SG	-	Salivary gland
SI	-	Silk gland
SVM	-	Salivarium
T_{1-3}	-	First, Second and third thoracic segment
TSI	-	Terminal portion of silk gland
TSG	-	Terminal portion of salivary gland
VMT	-	Ventral Malpighian tubule

For Fig. 2:

A_{1-10}	-	First to tenth abdominal segment
DBR	-	Dorsal branch
DCOM	-	Dorsal commissure
DG	-	Duct of the gonad
DHT	-	Dorsal head trunk
G	-	Gonad
H	-	Head
HCO	-	Commissure of the head
LBR	-	Lateral branch
LLT	-	Lateral longitudinal trunk
NGB	-	Nerve ganglia branch
PLB	-	Proleg branch
SOC	-	Circum-oesophageal commissure
SOG	-	Suboesophageal ganglia
SP_{1-9}	-	First to ninth spiracle
SPT	-	Spiracular trunk
SUG	-	Supra-oesophageal ganglia
T_{1-3}	-	First, second and third thoracic segment
TC	-	Transverse commissure
TLB	-	Thoracic leg branch
VCOM	-	Ventral commissure
VHT	-	Ventral head trunk
VIS	-	Visceral branch
VNC	-	Ventral nerve cord
XCS	-	X-shaped commissure

ACKNOWLEDGEMENT:

The authors are highly grateful to Dr.Sunil Kumar Jain, Dept. of Zoology, Agra College Agra for suggesting the problem, supervision and guidance in the spectrum of my thesis. We also thanks to Dr. A.V.Singh, Principal, Agra College Agra and Head of Zoology depart. Agra College Agra for given me the laboratory and library facilities and for several valuable suggestions for the excellent get-up of the present thesis.

REFERENCE:

1. Fletcher T.B.1921. Life histories of Indian Micro– Lepidopterous (1-9) *Me. Dep. Agric. India, (Ento. Ser.)* 6:1- 217.
2. Flatcher T.B. 1921. Hints on collecting and Preserving Insects. *Bull. Pusa Agric. Res. Inst.* 113: 937-973.
3. Flatcher T.B.and Ghose C.C. 1921. Notes on Rearing insects in hot climates. *Ibid*. 112: 875-92.
4. Gardner J.C.M. 1944 .Immature Stages of Indian Lepidoptera. *Indian J. Ento.* 5: 89-102.
5. Gardner J.C. M. 1946-1947. On Larval of the (Noctuidae: Lepidoptera) I. *Trans. Rent. Soc. Land.* 96 : 61-72; II *Ibid.* 97 : 237-252 ; II *Ibid*. 98 : 59-90; IV *Ibid*. 99 : 291 -318 .
6. Gardner J.C.M. 1948. Notes on Pupae of the Noctuidae. *Proc. R. Ento. Soc. London.* (B) 17:84 -92.
7. Gardner J.C.M. 1948. A list of described immature stage of Indian Coleoptera. *Indian Forest Record (New Series)* 7: 84 -90.
8. Hagmann L.E 1940. A method of injecting insect Tracheae Permanently Stain. *Technical Geneva N.Y.* 15:115 –118.
9. Hassanein M.H. and Radwan H. 1962. Morphology and anatomy of mature larva of *Agrotis ypsilon* Rott. *Bull. Soc. Entomol. d'Egypte.* 46: 385-400.
10. Oldroyel H.1959. Collecting preserving and studying insects Hutchinson, London, pp. 327.
11. Pantin C.F.A. 1948. Notes on the Microscopical technique for zoologists. Cambridge Uni. Press.
12. Smithers C.1981. Handbook of insect collecting (collection, preparation, preservation and storage). Sydney Reed.