Uttar Pradesh J. Zool. 1 : 50-56, 1981

MORPHOHISTOLOGY OF THE MIDGUT OF *TANYMECUS SCIURUS* OLIV. (COLEOPTERA : CURCULIONIDAE)

A. C. BHARDWAJ
DEPARTMENT OF ZOOLOGY, SANATAN DHARM COLLEGE, MUZAFFARNAGAR-251 001.

Histologically, the midgut of *T. sciurus* is trimorphic in nature. The epithelial cells of the promesenteron are short and possess granulo-vacuolated cytoplasm. The mesomesenteron is characterised owing to the presence of the digestive and absorptive cells with vacuolated and granular cytoplasm respectively. The metamesenteron although studied with numerous diverticulae but the nature of the epithelium discussed more related to absorption rather than digestion. The peritrophic membrane is non-conspicuous throughout the length of the mesenteron, whilst the musculature is poorly developed. The role of striated cell border is to release merocrine type droplets.

INTRODUCTION

Though morphohistological studies on the digestive system of both adult and larvae of Coleoptera have been a subject of great interest for several workers (Woods, 1918; Schinoda, 1927; Swingle, 1930; Pradhan, 1939; Jones, 1940; Umeya, 1960; Jackson & Crowson, 1969); weevils have received relatively less attention. Chorabik (1951), Jura (1957) and Chadbourne (1961) have undertaken a comprehensive study on the histology of the digestive tract of various curculionids. Shukla & Kumar (1970) recently described the histology of the digestive tract of *Odoiporus longicollis* (Oliv.). The present study is an attempt to enumerate the histomorphological characters of the midgut of yet another species of curculionid, *Tanymecus sciurus* Oliv. and to correlate further their secretory habit.

MATERIAL AND METHODS

Adult weevils were collected during monsoon from a wild species of *Zizyphus*, in the College campus. Weevils of almost same size were vivisected in physiological saline. The entire digestive tract was spreaded on plain slide with all exteraneous tissues removed. For histological studies the midgut was cut into morphologically distinct parts *viz.* the promesenteron, the mesomesenteron, and the metamesenteron; and fixed in alcoholic Bouins for about 24 hours (Fig. 1). Excess of fixative was removed by two or three washings in 70% alcohol, dehydrated in different grades of alcohol, cleared in xylol and cedarwood oil, and embeded in wax (at 56° C). Sections of 6 to 8 micra thickness were stained in haemotoxylin (aq.), counter stained in eosin (alco.) as recommended by Weesner (1968). Camera lucida drawings were made.

OBSERVATIONS

Gross morphology of the midgut

The mesenteron (MES) in *T. sciurus* is a coiled tube. Its diameter vary considerably. Being the longest segment of the digestive tract, morphologically it is distinct into three regions *viz.* the promesenteron, the mesomesenteron and the metamesenteron (Fig. 1). The promesenteron (PRO M) is dilated occupying almost entirly the abdominal cavity. It is transparent and delicate. The anterior limit of the promesenteron develops a few annulations. The promesenteron sharply declines posteriorly to demarcate the mesomesenteron (MES M) behind. The metamesenteron (MET M) which is opaque and characteristically possesses 40-50 short, pyriform, irregularly arranged diverticulae. Each diverticulum ends blindly with a secretory tubule (Fig. 1).

Histology of the midgut

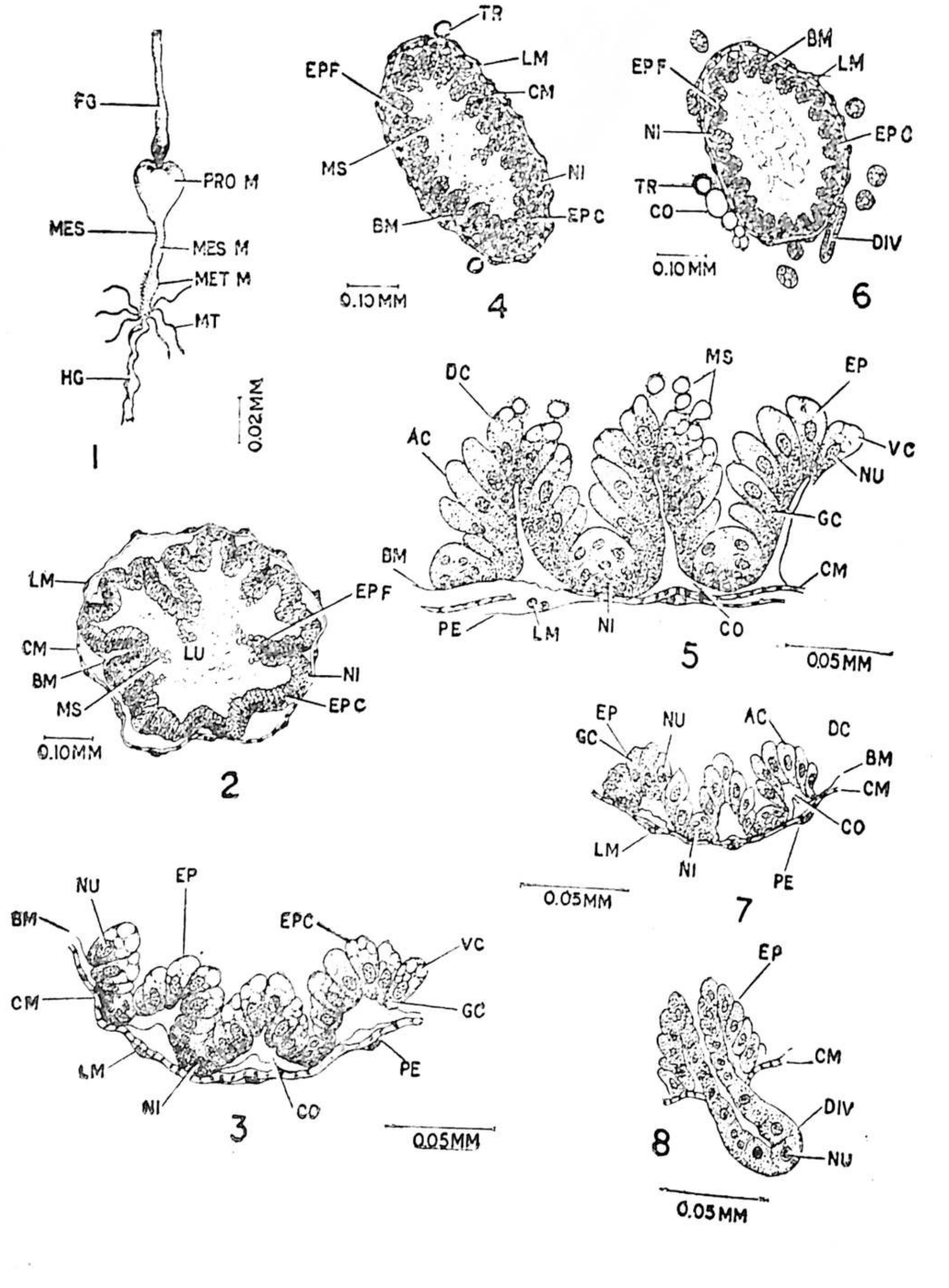
The mesenteron of *T. sciurus* has an epithelium, the basement membrane and poorly developed musculature wrapped by a thin peritoneum. The peritrophic membrane is indistinct.

The promesenteron

The promesenteron is a spacious chamber having a single layered columnar epithelium (EP) which is severely folded (EPF) (Fig. 2). The epithelial cells (EPC) are short with distinct cell boundaries and resting over a basement membrane (BM). The cytoplasm is densely granular (GC) and apically vacuolated (VC) (Fig. 3). Towards the lumen (LU) of the promesenteron the cell boundaries are distinctly convex with striated border. The nucleus (NU) is characteristically oblong, large, almost concentric with perceptible chromatin granules and nuclear membrane. The nucleolus could hardly be stained by the usual staining procedure. The vacuolated nature of the epithelial cells indicates secretory in function. The circular muscles (CM) are poorly developed represented by a single muscle strand. The longitudinal muscles (LM) are feebly scattered below each epithelial folds. A thin peritoneum (PE) is faintly visible.

The mesomesenteron

The epithelium of mesomesenteron is characterised by numerous well developed folds, obliterating the lumen (Fig. 4). The epithelial folds are uni-



Figs. 1–8. 1. Entire digestive tract of *Tanymecus sciurus*. 2. T.S. Promesomesnteron. 3. Part of Promesenteron. 4. T. S. Mesomesenteron. 5. Parc of mesomesenteron (magnified). 6. T. S. Metamesenteron. 7. Metamesenteron (magnified). 8. L. S. of Diverticulum opening into the lumen of Metamesenteron (Abbreviations with the text)

formly tall and are compactly packed, usually with distinct intercellular spaces towards the base of the cells filled with connective tissue (CO) (Fig. 5). Each cell has large, oblong, and centrally placed nucleus. Two different types of cells are recognized in the mesomesenteron *viz.* cells with apically vacuolated cytoplasm usually found at the top of each epithelial folds here referred to as the digestive cells (DC); cells with granular cytoplasm located on either side of the epithelial folds, here referred to as the absorptive cells (AC). The basement membrane (BM) is indistinct. The musculature is better developed than in the promesenteron. The circular muscles are in two muscle strands with longitudinal muscles occupying the same position as in the promesenteron and wrapped by a thin peritoneum (PE) (Fig. 5).

The metamesenteron

The epithelial cells of the metamesenteron are short and relatively less compact thereby increasing the lumen in the interior (Fig. 6). The epithelial cells are small and resting over the basement membrane. The striated border is less differentiated. The nuclei are oval, large and centrally placed and surrounded by the granular cytoplasm (Fig. 7). The epithelial lining of each diverticulum (DIV) consists of large, cuboidal, single layered cells and the lumen is narrow (Fig. 8). The midgut musculature around the diverticula is totally wanting.

The regenerative cells

The worn out and depleted epithelial cells are replaced by certain groups of cells called the regenerative cells or the nidi (NI). The nidi are oval, lying in confluent with the basement membrane. Each nidus lies at the base of the epithelial folds. Thus number of nidi corrosponds to the number of the epithelial folds (Fig. 3). Though the position of the nidus is similar throughtout the mesenteron, they are relatively larger in the mesomesnteron. Each nidus has five to eight small nuclei with granular cytoplasm. The cell boundaries are partly distinct around the outer nuclei in each nidus whereas proliferating nuclei are with inconspicuous boundaries (Fig. 5). The new cells are, therefore, continuously added at the base of the epithelial folds. Due to the continuous pressure at the regenerative cells, more and more cells are added at the base of the epithelial folds, thus making the epithelium ever functioning. The younger cells with granular cytoplasm undergo vacuolation when they reach the apex of such folds (Fig. 5).

Secretion

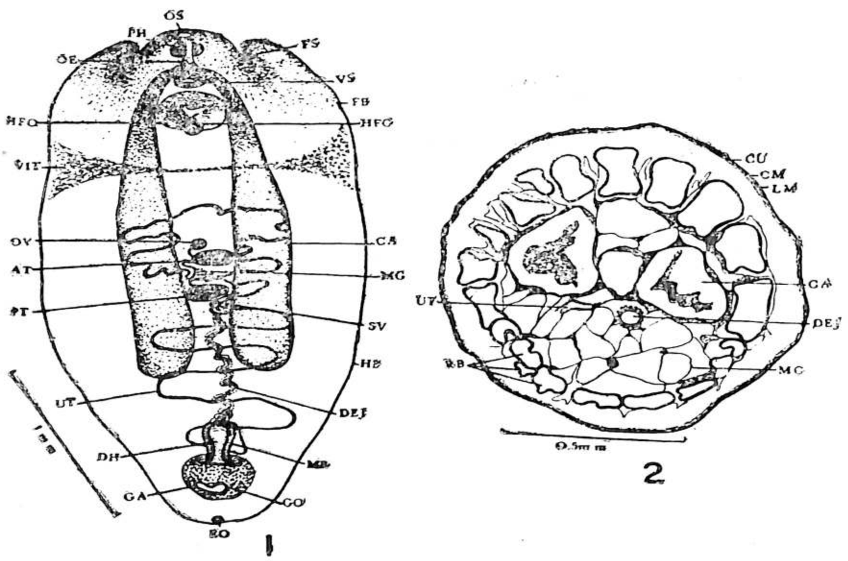
The vacuolations at the apical part of the epithelial cells in the pro-and mesomesenteron suggest releasing of the cell contents in the form of droplets which get mixed with the food. Such type of secretion as observed in *T. sciurus* has been designated as the merocrine type (MS). Absence of such vacuolated nature of cytoplasm in the cells of the metamesenteron is suggestive of absorbing rather than secretory in function. The digestive function is, therefore, presumably substantiated by the numerous diverticulae of the metamesenteron.

DISCUSSION

The tripartite mesenteron (=ventriculus of Weber, 1933) in *T. sciurus* is similar to that of Schroder (1928) having a sac-like proximal and tubular distal part. Chorabik (1951), Jura (1957), Sundman & King (1964), and Shuk a & Kumar (1969) have described a dimorphic midgut in curculionids in general. In *T. sciurus* the tubular distal part being further characterised into a proximal intervening part though externally smooth but histologically different, confirms a trimorphic midgut than the distal with numerous evaginations. Scheinert (1927) described these "evaginatiohs" as a seat of symbionts in weevils. The presence of micro organisms is negated in the present study. Chorabik (1951) and Jura (1957) were also unable to recognize symbionts in their respective studies. Such appendages although observed on the entire midgut of the *Anthonomous grandis* Boh. and *O. longicollis* by Chadbourne (1961), and Shukla & Kumar (1969) respectively; subdivisions of the midgut and regenerative function of these diverticulae were not discussed.

Though the entire epithelium of the mesenteron is folded in *T. sciurus*, the subdivisions are demarcated based on the degree of folding of the internal epithelium. Jura (1957) reported a folded nature of epithelium only in starved *Phyllobius glaucus* Scop. The epithelial folds of the pro-and mesomesemteron in *T. sciurus* possess distinctly vacuolated cytoplasm with granules at the base. The vacuolated, granular or spongy texture of the cytoplasm has also been reported by Chadbourne (1961), and Shukla & Kumar (1970). In *P. glaucus*, however, Jura (1957) reported granulofibrous cytoplasm, an additional nature different from that of the present description. In *T. sciurus* such cells would appear to be secretory in function since vacuolated cytoplasm is thought to be engaged in secretion (Wigglesworth, 1965). The capacity of digestion is found to be high in the pro-and mesomesenteron of *T. sciurus* (Goel & Bhardwaj, 1981), as secretory nature of the epithelium of these parts is significantly high. The depleted enzymatic activity as reported earlier in the metamesenteron, is probably due to the secretions substantiated by the diverticulae.

The prescence of striated cell border in *T. sciurus* is in conformity with the



Figs 1—2. 1. *Tetracotyle chauhani n. sp.* (dorsal view). 2. T. *chauhani n sp.* (T. S.) (Abbreviation with the text))

Body pyriform, aspinous, freely divided into forebody (FB) and hind body (HB), body length 2.42–3.37; forebody length 0.70 0.84 width 1.12–1.35, hindbody length 1.72–2.53 width 1.34–1.65; forebody and hindbody not sharply demarcated. Oral sucker (OS) terminal, transversely elongated, length 0.05–0.07, width 0.11 0.14. Ventral sucker (VS) immediately behind the caecal bifurcation, transversely elongated, length 0.05–0.09, width 0.12–0.14. Two pseudosuckers (PS), each on the lateral sides of oral sucker. Prepharynx absent, pharynux (PH) barrel-shaped, length 0.08 0.11, width 0.10–0.12. Oesophagus (OE) small, length 0.03–0.032; caeca (CA) inflated terminating between posterior testis and ductus hermaphroditicus (DH). Holdfast organ (HFO) length 0.22–0.30, width 0.24–0.34, in the centre of forebody, spherical, opening semicircular, holdfast gland (HFG) spherical diameter 0.07, on the posterior margin of holdfast organ, bearing a minute opening.

Reproductive analgens very clear. Testes two, entire, transversely elongated, in the anterior third of the hindbody, may or may not be overlapped by caeca;

DEEGENER, P. 1910. Beitrage zur kenntnis der Dermsekertion II. *Macrodytes* (Dytiscus) *circumcintus*. *Archiv. Naturg.* **76** : 27-43.

GOEL, S.C. & BHARDWAJ, A.C. 1981. Physiology of digestion in the midgut of *Tanymecus sciurus* Oliv. *Indian J. Ent.* **43** : 259–265.

JACKSON, G.J. & CROWSON, R.A. 1969. A comparative anatomical study of the digestive, excretory and central nervous system of *Malachus viridis* F. (Coleoptera : Cantharidae), with observations on diet and taxonomy. *Entomol. Month. Mag.* **105** : 93-98.

JONES, C.R. 1940. The alimentary canal of *Diplotaxis liberta* (Scarabaeidae: Coleoptera). *Ohio. J. Sci.* **40** : 94-101.

JURA, C. 1957. The anatomy and histology of the alimentary canal In the weevil *Phyllobius glaucus* Scop. (Curculionid : Coleoptera). *Zool. Pol.* **7** : 399-410.

POYARKOFF, E. 1910. Secretion in the gut of *Galerucella* larva Coleoptera : *Arch. d'Anat. Microsc.* **12** : 333-474.

PRADHAN, S. 1939. The alimentary canal and proepithelial regeneration in *Coccinella septempunctata*, with comparision of carnivorous and harbivorous coccinellids. *Quart. J. Micro. Sci.* **81** : 451-478.

RENGEL, C. 1898. Uber die periodische Abstosseung und Neubildung des gesammten Mitteldarmepicheles bei *Hydrophilus*, *Hydrus* und *Hydrobius*. *Z. wiss. Zool.* **63** : 440-444.

SANFORD, E.W. 1918. Experiments on the physiology of digestion in Blattidae. *J. exp. Zool.* **25** : 265-411.

SCHEINERT, W. 1927. Symbiose und Embryonalentwicklung bei Riisselkfern Zeitschr. f. *Morph. U. Oekol. d. Tiere*, Bd. **27**.

SCHRODER, Ch. 1928. Handbuch der Entomologie. Jena.

SCHINODA, O. 1927. A comparative histology of midintestine in insects. *Z. Zellforsch. Nikr. Anat.* **5** : 278-292.

SHUKLA, G.S. & KUMAR, K. 1969. Studies on the alimentary canal of *Odoiporus longicollis* I-Morphology. *Ann. ent. Soc. Am.* **62** : 664-665.

1970. Studies on the alimentary canal of *Odoiporus longicollis* (Oliv.) (Coleoptera : Curculionidae) Part II-Histology. *Bull. Ent.* **11** : 75-84.

SNODGRASS, R.E. 1935. Principles of Insect Morphology. McGraw Hill, New York.

SUNDMAN, J.A. & KING, D.R. 1964. Morphological, histological and histochemical studies on the alimentary canal and malpighian tube of the adult Boll Weevil, *Anthonomous grandis* (Coleoptera: Curculionidae). *Ann. ent. Soc. Am.* **57** : 89-95.

SWINGLE, M C. 1930. Anatomy and physiology of the digestive tract of the Japanees beetle. *J. agric. Res.* 41 : 181-195.

UMEYA, K. 19?0. A comparative morphology of alimentary tract in the adults of Lamellicorn beetles (Coleoptera). *Mem. Fac. Agr. Hokkaido Univ.* **3** : 60-113.

WEBER, H. 1933. Lehrbuch der Entomologie, Jena.

WEESNER, F.M. 1968. General Zoological Microtechniques. Williams & Wilkins Co., Baltimore, U.S.A.

WIGGLESWORTH, V.B. 1965. The Principles of Insect Physiology. Methuen & Co., London.

WOOD, W.C. 1918. The alimentary canal of *Altica bimarginata* Say. *Ann. ent. Soc. Am.* **11** : 283-314.