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Organs of Distribution and Elimination of Indian Water Scorpion, *Laccotrephes maculatus* Fabr.

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Abstract : The organs of distribution and elimination of Indian water scorpion, *Laccotrephes maculatus* Fabr. includes a median dorsal vessels, six pairs of alary muscles, dorsal diaphragm and six pairs of malpighian tubules.

Key Words : *Laccotrephes maculatus* Fabr. Alary Muscles, Diaphragm, Haemocytes, Leucocytes, Malpighian Tubules.

Introduction :

Laccotrephes maculatus Fabr., 1775 is an aquatic insect of family *Nepidae* (Latreille) 1802 of order Hemiptera, Linnaeus, 1758. These insects are commonly found in shallow fresh water and are at once recognized due to their flat and elongate body with nearly parallel sides; the anterior legs being raptorial in somewhat the same manner as those of mantis and are commonly known as water scorpions because of their fancied resemblance to a scorpion due to their long anal respiratory filaments. The present contribution deals with the organs of distribution and elimination of Indian water scorpion, *Laccotrephes maculatus* Fabr. (Hemitera : Heteroptera, Nepidae).

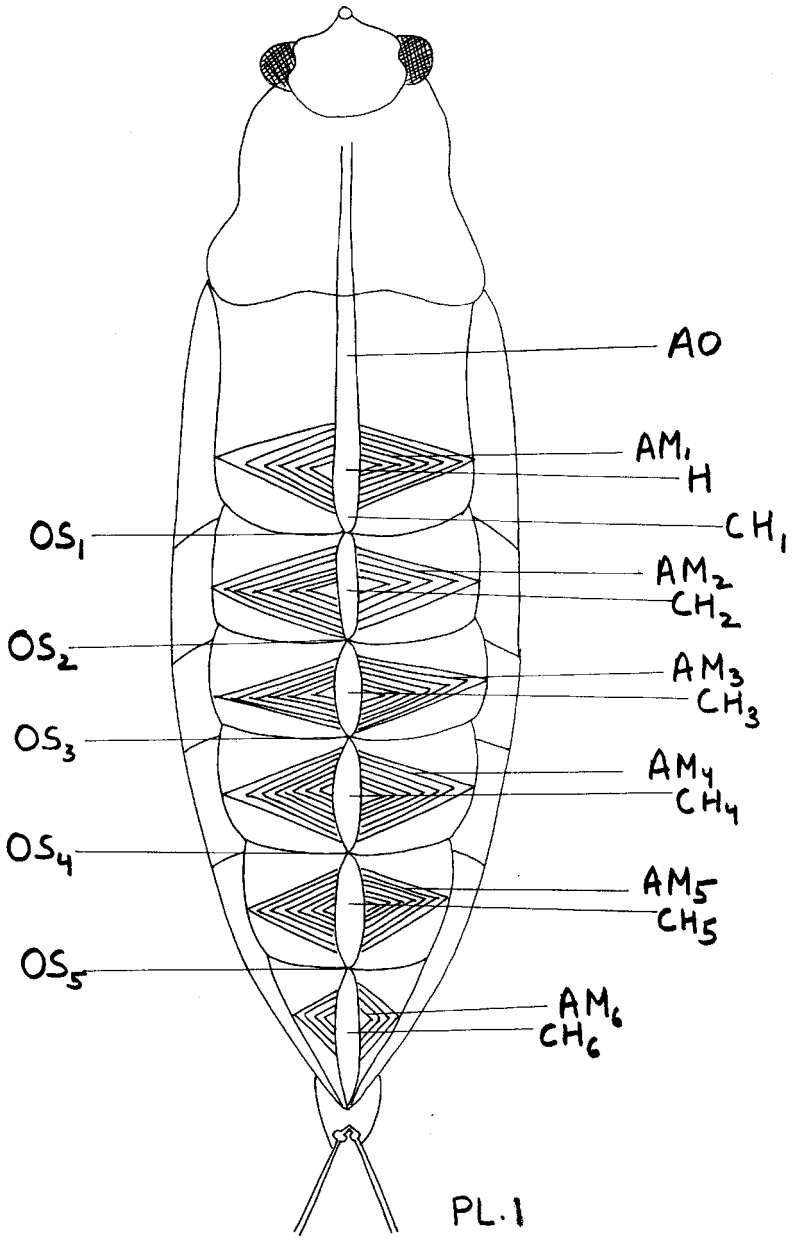
Materials and Methods :

The water scorpion, *Laccotrephes maculatus* Fabr. for the present investigation, were collected during July to November from various ponds and ditches of Mathura and its near by areas. Organs of distribution were studied by dissecting the freshly chloroformed bugs in Ringer's solution. An extra precaution was taken while dissecting the bugs from dorsal surface, for the heart lies immediately beneath the tergum. The histology of circulatory organs was studied by cutting microtome section of heart and aorta and staining with Mann's methyl blue eosin, Mallory's triple stain and haemotoxylin - eosin. The organs of elimination were also studied in freshly killed specimens.

Results and Discussion :

Organs of distribution (Pl. 1, Fig. I, Pl. II, figs. 1,2,4 & 6) : The organs of distribution in water scorpion, *Laccotrephes maculatus* Fabr. includes a median dorsal vessel, six pairs of alary muscles and a dorsal diaphragm. The median dorsal vessel is a delicate narrow tube, responsible for the distribution and circulation of haemolymph. It is situated mid dorsally along the longitudinal axis of the body just beneath the tergum and extends forwards from the posterior margin of the eight abdominal segment upto the base of the protocerebrum in the head. It is distinguishable into an anterior tubular non pulsatile aorta (AO) and a posterior extended pulsatile heart (H). The

heart is situated in the pericardial sinus of the abdominal cavity. The dorsal pericardial sinus is separated from the ventral perivisceral sinus by a thin membranous dorsal diaphragm. The entire dorsal vessel is of about 9.6 to 11.3 mm. in length of which about 5.6 to 6.1 mm. is the portion of the heart.



Pt. I : **Heart with Aorta, ostia and Alary muscles, *Laccotrephes maculatus* Fabr.**
AO = Aorta; AM = Allary muscles; CH = Chambers; H = Heart; OS = Ostia.

(A) Heart : The heart is the posterior pulsatile portion of the dorsal vessel. It is wider than the aorta and extends backwards from the second to the eight abdominal segment as an elongated tube in both the sexes. It continues in front as a narrow tubular aorta. It is suspended by six pairs of wedge shaped alary muscles. The alary muscles after their origin from the para sternite fan out and pass transversely beneath the heart. The heart is divided into six chambers by the presence of six pairs of ostial slits. Each chamber of heart occupies the length of a segment and measures about 0.9 mm. length. The seventh or the last chamber is relatively wider and gradually tapers behind to terminate as a narrow blind tube in the posterior portion of eight abdominal segment.

The number of chambers in the heart varies greatly in various Heteroptera. In *Nepa cinera* (Hamilton, 1931) the heart is five chambered with four pairs of ostia; in *Nezara viridula* (Malouf, 1933) and *Belostoma indicum* (Kaushik, 1971) it is four chambered with three pairs of ostia; in *Leptocorisa variornis* (Akbar, 1958) and in *Disdercus koenigii* (Khanna, 1964) is three chambered with two pairs of ostia and in *Leptocorisa trivittatus* (Wooley, 1951) it is single chambered.

It is significant that the posterior chambers of the heart is somewhat dorsoventrally flattened unlike the anterior ones which are tubular. In the posterior chamber is found a mid dorsal (DLF) and a mid ventral longitudinal furrow (VLF) (Pl. II, Fig. 2) which devide the lumen into two parallel lateral longitudinal channels. These channels are full of blood cells. The two streams of blood become a single stream in the anterior chambers of heart and aorta and create pressure quite sufficient for the haemolymph to circulate the effectively through the body cavity.

There are six pairs of ostia divide the heart into seven chambers. A pair of posterior is found on the postero-dorsal wall of each chamber. The lips of the ostia are folded into the lumen of the heart and projects as ostial flaps (OSF) of the ostial water (OSB) which allow haemolymph to enter into the lumen of the heart and prevents the riverse flow. On contraction of circular muscles (CM) fibres of the heart and alary muscles. The ostial valves begin to act.

Aorta : The aorta is the anterior, slender narrow part of the dorsal vessel. It originates from the anterior most region of the heart from the front margin of the second abdominal segment and extends in front in the thorax and the head. It is a long narrow thick walled tube of about 4.7 to 5.3 mm. length. The aorta runs forwards along the dorsal surface of the midgut and thereafter continuous anteriorly above the dorsal wall of the oesophagus and pharynx. On entering the head capsule, just a little behind the brain in front of the level of corpus allatum, it dilates to form an extremly thin walled chamber which opens into a thin haemocoel underneath the brain water scorpion, *Laccotrephes maculatus* Fabr. resemble most of the heteropterus species such as *Nepa cinerea* (Hemilton, 1931), *Leptocorisa Varicornis* (Akbar, 1957) and

Dsydescus coenigii (Khanna, 1964), in that the aorta is shorter than the heart.

There is a small triangular structure formed of connective tissues and embedded in the fat cells in the middle of the mesothorax one on either side of aorta. These structures greatly resemble the alary muscles in their shape. Similar type of structures have also been reported by Locy (1884) and Kaushik (1971) is *Belostoma indicum.*

In *Nepa cinerea* (Hamilton, 1931), *Leptocorisa vericornis* (Akbar, 1958) and *Dysdercus koenigii* (Khanna, 1964) the aorta is shorter than the heart. In *Leptocorisa trivittatus* (Wooley, 1951) and *Belostoma indicum* (Kaushik, 1971) the aorta is much longer than the heart and extends upto the fourth abdominal segment. In water scorpion, *Laccotrephes maculatus* Fabr. the aorta is just a little longer than the heart.

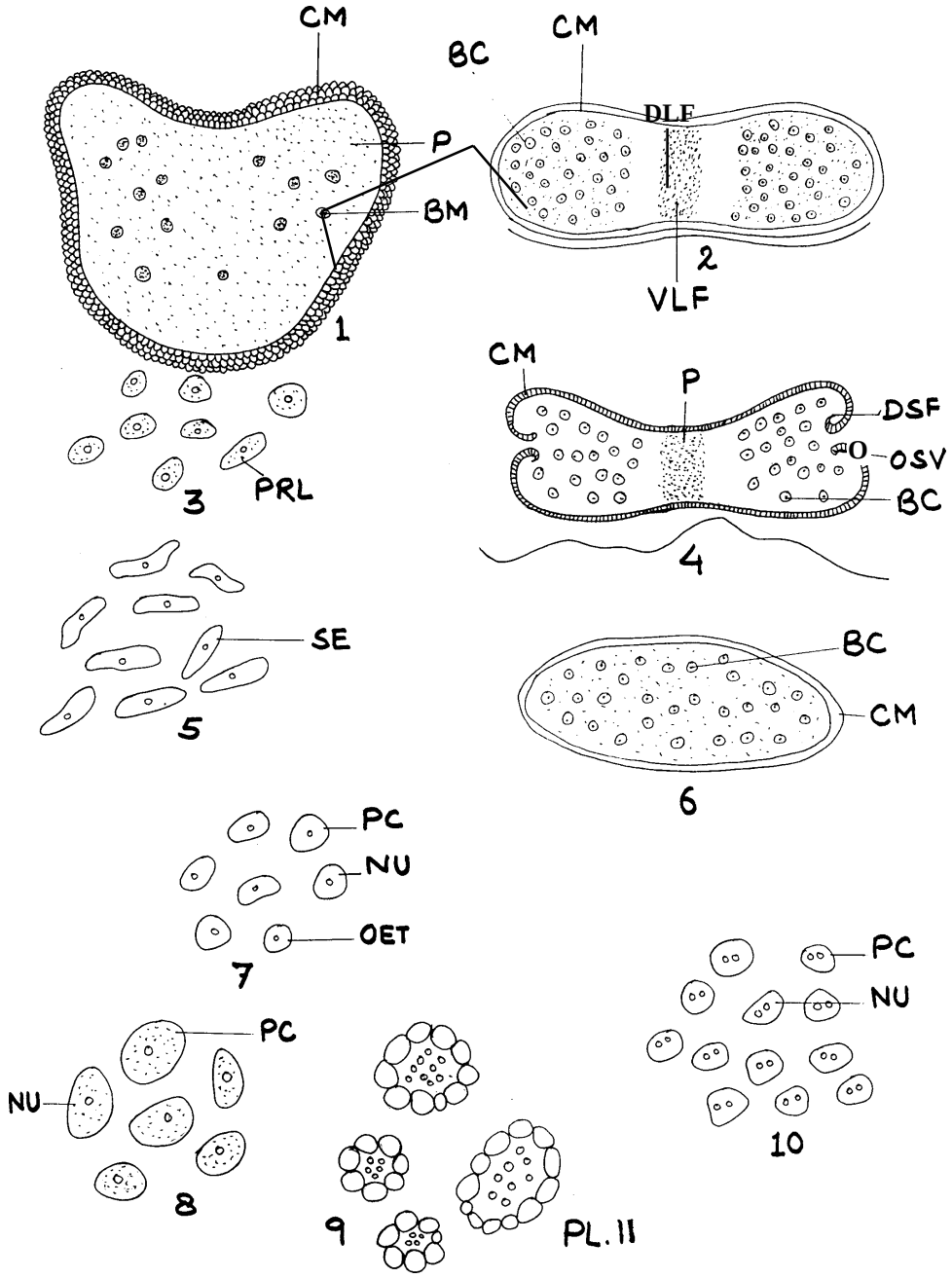
Histology : (Pl. II, Figs. 1, 2, 4 & 6)

The structure of the heart and aorta greatly resemble in histological details. The heart is dorso-ventrally flattened and consist of a thick layer of circular muscle fibre, outside which are found distantly separated longitudinally fibrillae. The lumen of the heart is filled with a large number of uninucleate blood corpuscles and granulated plasma.

The wall of the heart in *Dysdercus koenigii* (Khanna, 1964), *Belostoma indicum* (Hemilton, 1931) and *Leptocorisa trivittatus* (Wooley, 1951) is made up of single layer of cells, the cytoplasm of which is marked by longitudinal and circular fibrillae. Livingstone (1969) has reported the cardiac wall of *Tingis buddleiae* to be muscular.

The wall of the aorta is much thicker than that of the heart and is formed of relatively thick circular muscle fibres and some longitudinal fibrillae. The aorta is internally lined with a very thin syncytial layer having widely scattered nuclei. The lumen of the aorta is filled with uninucleate blood corpuscles which resemble those of the heart. Khanna (1964) has however reported the absence of muscular layer in the aorta of *Nepa cinerea* and *Dysdercus koenigii.*

The dorsal Diaphragm : The dorsal diaphragm is a horizontal muscular partition situated within the abdominal cavity and stratches in between the dorso lateral walls. It supports the heart and demarcates a narrow dorsal sinus or pericardial sinus from rest of the haemocoel of the body cavity. It assists the alary muscles in keeping the heart in the suspended position and separates the dorsal pericardial sinus from the perivisceral sinus. It consists of a delicate longitudinal and transverse fibrillae which are interwoven in the form of fenestrated gauze like sheath. In addition to these muscle fibres, the dorsal diaphragm also contains seven pairs of "alary muscles" or "dorsal transverse" muscles or the "wing musceles", the fibres of which are continuous with the fibres present on the sides. These alary muscles are to a great extent responsible for keeping the heart



Pt. II : 1. T.S. of anterior aorta; 2. T.S. of heart; 3. Proleucocyte; 4. T.S. of heart passing through ostia; 5. Seliniform cells; 6. T.S. of posterior region of aorta; 7. Oenocyte; 8. Pericardial cell; 9. Fat cells; 10. Pericardial cell.

BC = Blood corpuscles; BM = Basement membrane; CM = Circular muscles; DLF = Mid dorsal longitudinal furrow; NU = Nucleus; OET = Oenocytes; OSF = Ostial flaps; OSV = Ostia valve; P = Plasma; PC = Pericardial cell; PRL = Proleucocytes; SE = Seleniform cells; VLF = Mid ventral longitudinal furrow.

in suspended condition. The alary muscles originate from the lateral margin of the parasternite in the form of bundles fan out into 14-22 delicate fibrillae which get inserted on the ventro-lateral wall of the chambers of the heart.

In *Leptocorisa trivitttatus* (Wooley, 1951) and *Dysdercus keonigii* (Khanna, 1964) the diaphragm is present only in the posterior half of the abdomen. In *Nepa cinerea* (Hamilton, 1931) the diaphragm extends throughout the abdomen instead of keeping confined to the posterior region alone. In the water scorpion, *Laccotrephes maculatus* Fabr. the diaphragm extends from second to the eighth abdominal segment.

The blood : The blood (haemolymph of *Laccotrephes maculatus* Fabr.) is a viscous fluid medium or plasma in which various cellualr elements are found floating. Three different types of cells have been observed in its haemolymph. These are corpuscles or haemocytes, pericardial cells and fat cells. There has been considerable disagreement concerning their classification and their function. The most notable efforts to classify the insect haemocytes include those of Hallandle, Poisson and Yeager of these, Poisson has described the haemocytes of hemipteran insects and this system of classification of haemocytes is, therefore followed here.

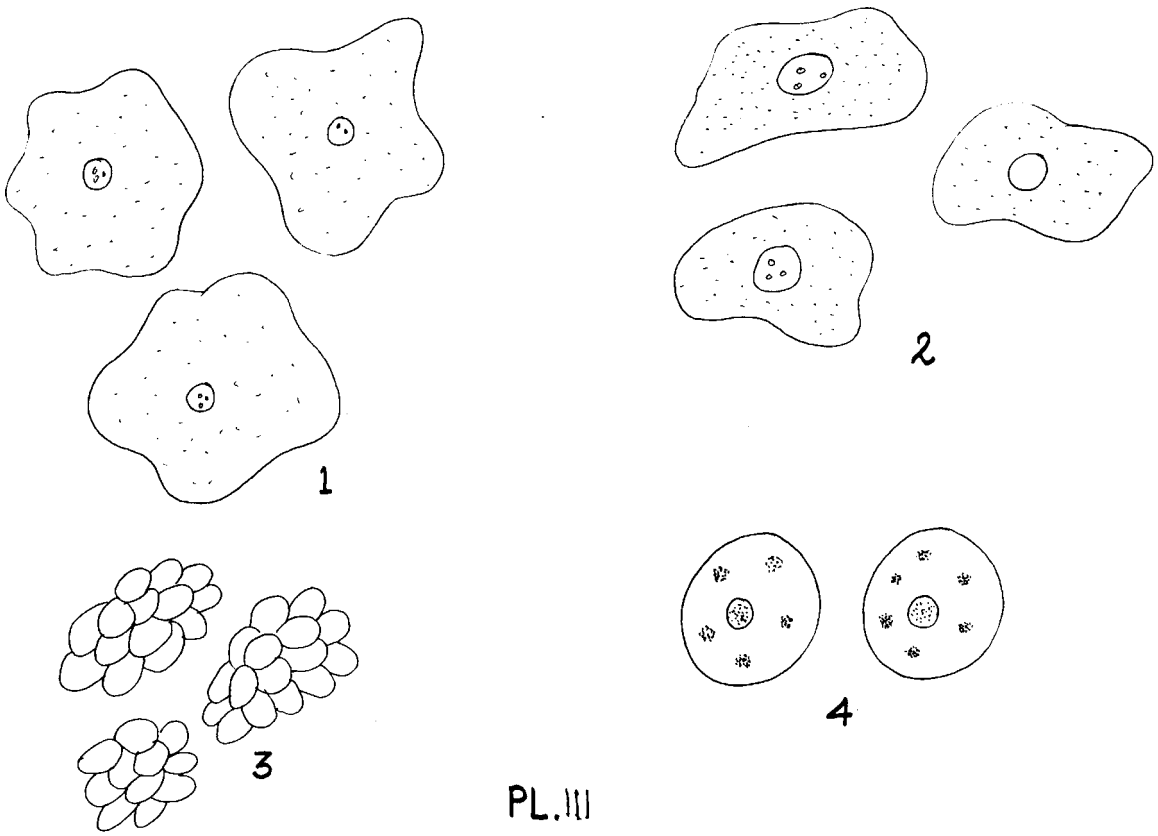
(a) Corpuscles (Haemocytes) (Pl. II, Figs. 1-10; Pl. III. Figs 1-4) : Several types of haemocytes have been reported in different insects by the various workers. Hamilton (1931) has reported four types of corpuscles in *Nepa cinerea*. Poisson and Tadeu (1928) described seven types of corpuscles in aquatic bugs. Khanna (1961) recorded seven types of corpuscles in *Dysdercus koenigii*. Kaushik (1971) described three types of corpuscles in the haemolymph of *Belostoma indicum*. The haemolymph of water scorpion, *Laccotrephes maculatus* Fabr. contains the following seven types of corpuscles.

(i) Proleucocytes (Pl. II, Fig. 3) : These are small round corpuscles, each with a large round nucleus and very little of cytoplasm.

(ii) Young leucocytes (Pl. III, Fig. 1): These are amoeboid, phagocytic cells and are larger in size than the proleucocytes. The nucleus of each of these corpuscles is, however, quite small and the cytoplasm is clear and hyaline in appearance cell of this type correspond to the micro-nucleocytes of wigglesworth.

(iii) Old leucocytes (Pl. III, Fig. 2) : These are also amoeboid and phagocytic cells, but they differ from the proceeding type in having large nuclei and finely granular cytoplasm.

(iv) Adipo leucocytes (Pl. III, Fig. 3) : These are large irregular shaped cells in which the cytoplasm is almost completely filled with the fat globules. They occur in great abundance in the haemolymph of *Halys dentatuo* Fabr. Similar cells have also been observed in the blood of *Pyrrhocoris apterus* (Hollando), and they are regarded as characteristic of the Heteoptera by Poisson.



Pt. III : 1. Young leucocytes; 2. Old leucocytes; 3. Adipo leucocytes; 4. Granular leucocytes.

(v) Granular leucocytes (Pl. III, Fig. 4) : These are similar to the adipo leucocyte in shape and size, but their cytoplasm is full to fairly large granules, which may be scattered throughout or arranged in groups. The nucleus in these cells is larger than in the adipo leucocytes. These cells are not so abundant as the adipo leucocytes.

(vi) Seleniform cells (Pl. II, Fig. 5) : These are elongated fusiform cells with small nuclei and finely granular cytoplasm. They are much less common in the adult than the other cells described above.

(vii) Oenocytoids (Pl. II, Fig. 7) : These are round or oval cells, slightly larger than the proleucocytes. Each contain a single small nucleus and finely granular cytoplasm. The nucleus is poor in chromatin.

(b) Pericardial cells (Pl. II, Fig. 8) : The pericardial cells or nephrocytes are

distinctly visible small oval, rounded or elliptical, single or binucleated cells with thickly granulated cytoplasm. These serve in excretion.

(c) Fat cells (Pl. II, Fig. 9) : These are present in the haemocoel of the thorax and abdomen on either side of the dorsal blood vessel and composed of masses or lobes of compactly arranged rounded cells. These are the largest cells of the haemolymph of *Laccotrephes maculatus* Fabr. These cells possess distinctly visible nuclei and contain numerous chromatin granules in the granulated cytoplasm.

Organs of Elimination

Malpighian Tubules (Pl. IV, Figs. 1-5) :

The malpighian tubules are the main organs of elimination and excretion of waste products of water scorpion, *Laccotrephes maculatus* Fabr. The pericardial cells and the fat cells found in the haemolymph also serve to some extent in removal of the wastes. There are six pairs of highly coiled, much elongated malpighian tubules which two pairs opened anteriorly and four pairs posteriorly into the Malpighian ampulla. Malpighian ampula is situated at the posterior end of the mid-gut. The openions differ as regards to the site of the opening of the Malpighian tubules in different Heteroptera. Saxena (1955) and Kurup (1961) have suggested the presence of the Malpighian tubule openings at the junction of mid-and hind-gut. Akbar (1958) has reported these openings to be at the anterior end of the ileum.

The Malpighian tubules in *Laccotrephes maculatus* Fabr. are highly convoluted elongated structures occupying the median and the dorso-lateral portion of the posterior region of the abdomen. The heart is found just above the Malpighian tubules. Each Malpighian tubule is devided into three main regions *viz.*, a proximal capillary region, middle region and a distal region. The proximal region is thin, transparant and capillary like. The middle region is the longest and tube like. The distal region is relatively short and open into the posterior end of Malpighian ampulla which in turn opens into the posterior end of the mid-gut. The free terminal end of the Malpighian tubule have united with each other and have, thus formed several distinct loops.

Histology : (Pl. IV, Figs. 2-5)

There is neither the muscular layer nor the intimal lining in the Malpighian tubules of *Laccotrephes maculatus* Fabr. The capillary region of the Malpighian tubule is thin walled, transparent and surrounded by a thick layer of connective tissue. The basement membrane is quite thick. The cells in this region are undifferentiated having oval or spherical nuclei with a distinct nuclear membrane. Each nucleus has a small darkly stained nucleus surrounded by fine granules. This region does not show the brush border. The Malpighian tubule in the middle region is relatively wider and consists of well differentiated cells which have large oval nuclei with distinctly visible nucleoli. The basement membrane is very thick. There are no muscular layers. This region is internally lined by a distinct

brush border. The epithelium of the distal end consists of large undifferentiated cells having thickly granulated dense cytoplasm. This region does not possess the brush border. The lumen of the distal region is wider than in the proximal or the middle regions.

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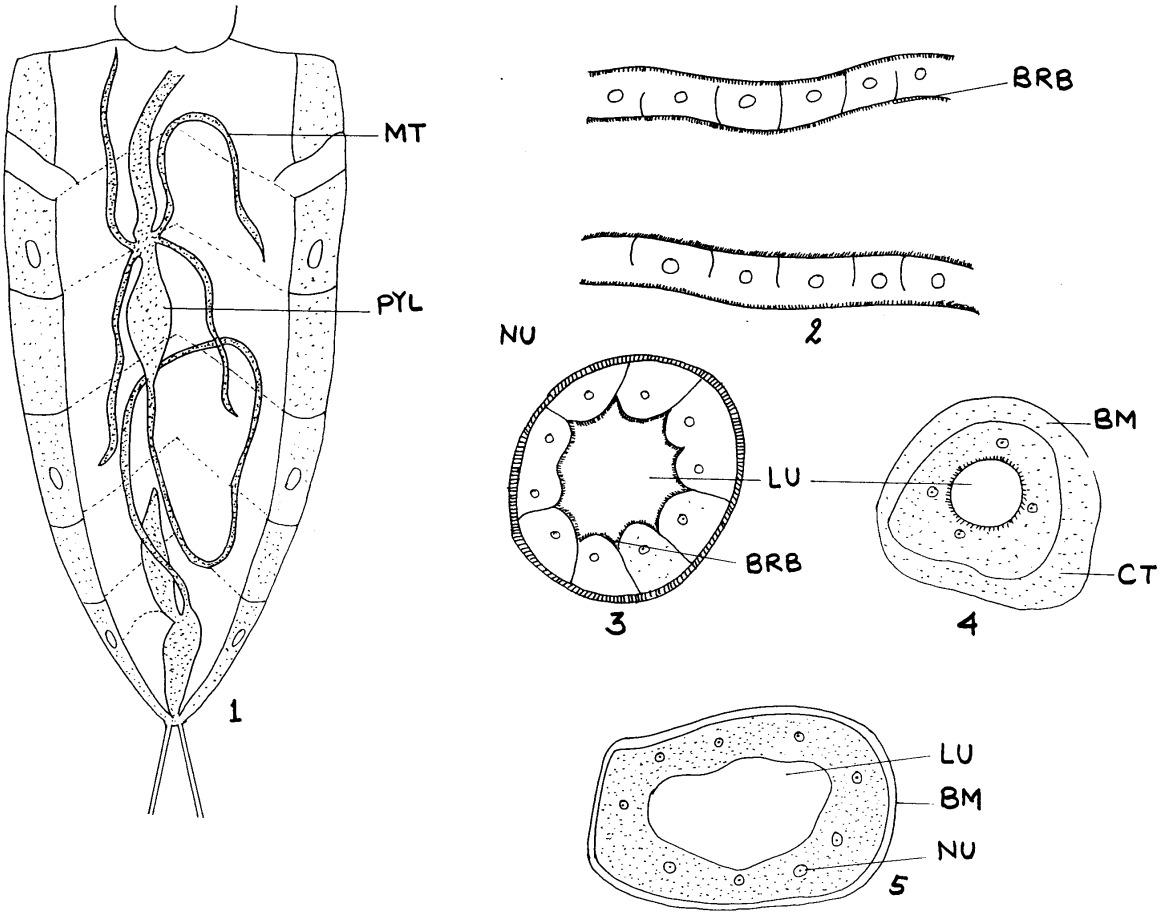

Pt. III : 1. Malpighian tubules *in situ*; 2. Transverse section of Malpighian tubule; 3. T.S. of middle region of Malpighian tubule; 4. T.S. of proximal region of Malpighian tubule; 5. T.S. of dorsal region of Malpighian tubule.

BM = Basement membrane; BRB = Brush border; CT = Connective tissue; LU = Lumen; MT = Malpighian tubule; NU = Nuclei; PYL = Pylorus.

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