Uttar Pradesh J. Zool. 15 (1) : 19-22, 1995 *ISSN 0256-971X*

HISTOLOGICAL OBSERVATIONS ON THE MIDGUT AND HINDGUT OF *MACROBRACHIUM MALCOLMSONII* (CRUSTACEA : DECAPODA)

M. LALITHA AND C. VIJAYA LAKSHMI

DEPARTMENT OF ZOOLOGY, ANDHRA UNIVERSITY, VISAKHAPATNAM-530003, INDIA.

The morphology and histology of the midgut and hindgut in the freshwater prawn *Macrobrachium malcolmsonii* are described. The functional significance of these structures is discussed.

INTRODUCTION

The crustacean alimentary canal is an itricate system in many cases taxonomically consists of the same parts. There are, however, certain variations in the histological organization. The order Macrura has attracted the attention of very few investigators as far as anatomy, feeding and digestion are concerned. Most of these investigators have been principally concerned with specific regions of the alimentary canal (Reddy, 1937; Pillai, 1960; Vonk, 1960; Dall, 1967; Phill & Pugh, 1973; Cooke, 1976).

Malaczynska & Klepke (1960) observed the cytological and cytochemical studies of the midgut epithelium in *Astacus*. Tyagi & Prakash (1967) reported the physiology of digestion in freshwater prawn, *Macrobrachium dayanum*. Talbot *et al.* (1972) described the fine structure of the midgut epithelium in the developing brown shrimp, *Penaeus cytecus*. The anatomy and histology of the digestive system of *Caridina weberi* was described by Chinnayya (1975).

The present study deals with the morphology and histology of the midgut and hindgut of the freshwater prawn, *M. malcolmsonii* (Milne Edwards) belonging to the family Palaemonidae.

MATERIAL AND METHODS

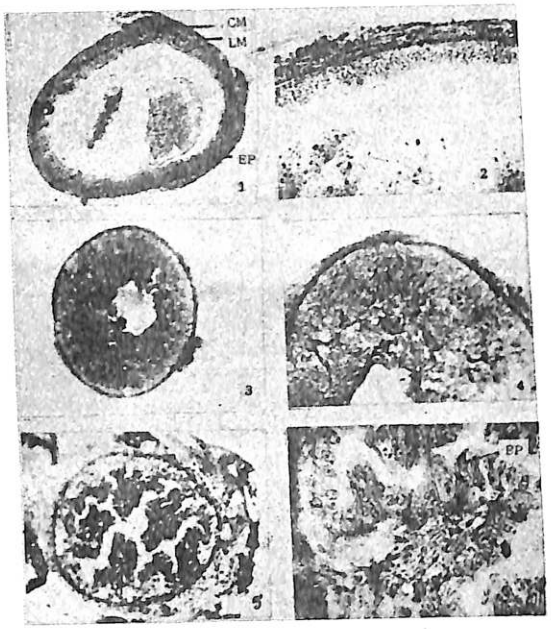
Specimens of *M. malcolmsonii* were collected from the freshwater pond near Madhuravada which is 16 km away from Visakhapatnam. The specimens were brought to the laboratory and maintained in a big covered glass troughs with clear aerated water. For histological observations of the digestive system, these specimens were starved for two days and they were made free of grit and then the digestive system was dissected out and fragments about 2 mm length were fixed in Bouin's, Zenker's, Susa and formol calcium fixing fluids. After the usual process of dehydration and embedding, sections of 8 μ thick were cut.

Heidenhain's Azan, Delafield's iron haematoxylin and Mallory's triple stain were used for routine histological studies.

RESULTS

The alimentary canal of *M. malcolmsonii* can be divided into three regions, namely the foregut, midgut and hindgut. The posterior side of the pyloric stomach passes into the midgut.

Midgut : The midgut is a long narrow tube with slender walls, which ascends gradually between the two lobes of hepatopancreas, continuing backwards along the median line above the mass of ventral abdominal muscles. It lies below the supra-intestinal artery all along its length, forming the longest portion of the alimentary canal. It extends through the greater part of the thorax and the whole length of the abdomen as far back as the sixth abdominal segment. Posteriorly it is demarcated by the club-shaped swelling of the hindgut.



Figs. 1-6. 1. T.S. of midgut (x 50); 2. Section showing the wall of the midgut (x 200); 3. T.S. of the rectal bulb (x 50); 4. Enlarged view of the rectal bulb (x 200); 5. T.S. of the hindgut (x 50); 6. Wall of the hindgut showing the intestinal mucosal folds (x 200) (CM = Circular muscles; EP = Epithelium; LM = Longitudinal muscles).

Histology : The wall of the midgut consists of an outer connective tissue layer, formed by palisade elastic fibres followed by a thick layer of longitudinal muscle fibres, containing a network of blood vessels. Below this is a thin layer of circular muscle fibres. A wavy undulating basal membrane is present beneath the circular muscles, then the internal epithelial lining consisting of epithelial cells. The epithelial cells are columnar, being interposed at regular intervals by a number of rounded basal of replacing cells, resting on the basal membrane. The nuclei of the midgut epithelial cells are elongated or oval with usually two nucleoli. Free ends of the cells exhibit fine striations. Chitinous lining of the epithelium is absent in thin region of the digestive tract. The lumen of the midgut is wide at its anterior end and it is invaded by a number of villi like longitudinal folds of the epithelial lining of the gut in the posterior region of the midgut (Figs. 1 & 2).

Hindgut : The hindgut is the shortest portion of digestive tract. It commences from the hind end of the midgut and extends to the anus. It consists of an anterior swollen thick muscular sac, the rectum and a narrow tubular structure and the two resembling a club and a long handle, respectively. As the hindgut is also ectodermal in origin it is lined with a chitinous layer consisting of collagen.

Between the ending of midgut and the starting of hindgut there is a short gap, which actually separates the two regions, where the basal membrane is exposed. The junction is not having any caecal-like out growth. It takes a narrow slope and opens to exterior by the anus on the ventral side of the base of the telson. At the commencement of the hindgut *i.e.* the beginning of the rectum the lumen is narrowed down by thick circular pads, formed by the elevation of the epithelial cells with a core of circular and radial muscle fibres inside. These elevations first of all, begin as fan-like out growths protruding into the lumen and subsequently fuse together forming a thick muscular wall narrowing the lumen into a small channel (Figs. 3 & 4).

Following the rectum is the narrow tubular portion of the hindgut (Figs. 5 & 6). The lumen is obliterated by several folds, the inner chitinous lining of which consists of collagen. The wall of the hindgut consists an outer connective tissue layer, followed by circular muscle fibres below which are the thin longitudinal muscle fibres. A thin basal membrane is present below the longitudinal muscle fibres. Bundles of longitudinal muscles are embedded in the connective tissue. These bundles extend as fan-like outgrowths into the lumen of the hindgut and later forming into a single unit. The epithelium is formed of elongated cells with large nuclei, which are centrally placed. The inner most layer overlying epithelium is collagenous. It is basophilic and does not display the two layered appearance as seen in the oesophagus. It stains weakly with alcian blue. The whole gut is surrounded by a layer of connective tissue with blood vessels and nerves.

The anus is a longitudinal slit with tumid lips situated on a raised papilla. It is provided with a sphincter muscle and radiating muscle fibres. Sphincter muscles aid in closing the anus and the others serve to open at the time of defection.

DISCUSSION

The midgut is subjected to considerable variations in different decapods. It has been described as shortest portion of digestive tract, especially in brachyurans (Reddy, 1937; Barker & Gibson, 1978). But in macrurans, the midgut is the longest portion, extending posteriorly upto the sixth abdominal segment. In *Homarus gammarus*, it accounts for 5% of post-gastric intestinal tract (Barker & Gibson, 1977). Similar condition has also been reported by Calman (1909), Patwardhan (1937), Gopalakrishnan (1957), Pillai (1960) and Rigdon & Mansik (1976). As for as the histology of the midgut of *M. malcolmsonii* is concerned, the intestinal epithelial cells has already been described, ultrastructurally by Cooke (1976), while comparing the intestinal epithelium of *M. rosenbergii* to that of a desert scorpion, *Hardurus arigonensis*. Histologically it resembles the description of the workers, cited above.

The hindgut which constitutes the smallest portion of the alimentary canal is located at the posterior half of the sixth abdominal segment, the proximal portion of which forms the rectum, whose mucosal folds are fan-like. These fan-like out growths fuse subsequently in the lumen to form a mass of connective tissue. These are the extensions of the longitudinal muscles into this connective tissue. Similar structure has also been reported by Patwardhan (1937) in *Palaemon malcolmsonii*. Rigdon & Mansik (1976) in *Penaeus azetecus* and Chakravarthy (1980) in *Macrobrachium rosenbergii*. Rigdon & Mansik (1976) considered the fan-like extension of mucosal epithelium in the anterior end of the hindgut as polyp-like projections in the lumen. Contrary to the earlier observations, mucous glands are absent in the hindgut of the *M. malcolmsonii*. Similar observations were reported by Chakravarthy (1980) in *M. rosenbergii*.

ACKNOWLEDGEMENTS

One of the authors (ML) is grateful to the Council of Scientific and Industrial Research, New Delhi for the award of a fellowship during the tenure of this work.

REFERENCES

BARKER, P. L. & GIBSON, R. 197. Observations on the feeding mechanism, structure of the gut, and digestive physiology of the European lobster, *Homarus gammarus* (L.) (Decapoda : Nephropidae). *J. Exp. Mar. Biol. Ecol.* **26** : 297-324.

1978. Observations on the structure of the mouth parts, histology of the alimentary tract, and digestive physiology of the mud crab, *Scylla serrata* (Forskal) (Decapoda : Portunidae). *Ibid.* **32** : 177-196.

CALMAN, W. T. 1909. *A treatise on zoology*, edited by Sir Ray Lankester, Part VII. Appendiculata-Crustacea. 251-318.

CHAKRAVARTHY, S. M. 1981. Studies on the prawn *Macrobrachium rosenbergii*. II. Schenkeli Johnson (Crustacea : Palaemonidae). *Ph. D. Thesis, Andhra University, Waltair.*

CHINNAYYA, R. 1975. Studies on the anatomy and histology of the digestive system of *Caridina weberi*. *Nat. Sci. J. Marath. Univ. Aur. Vol. XIV Sci,* **7** : 209-213.

COOKE, W. J. 1976. Comparative ultrastructure of intestinal epithelial from a freshwater prawn and a desert scorpion. *Pac. Sci.* **30** (3) : 213-214.

DALL, W. 1967. The functional anatomy of the digestive tract of a shrimp *Metapenaeus bennethae* Rocok and Dall (Crustacea : Decapoda : Penaeidae). *Aust. J. Zool.* **15** (4) : 699-714.

GOPALAKRISHNAN, V. 1957. Studies on the biology of penaeids. *Ph. D. Thesis, University of Madras, Madras.*

MALACZYNSKA, S. Z. & KLEPKE, A. 1960. Cytological and cytochemical studies of the midgut epithelium in *Astacus*. *Bull. Soc. Amis. Sci. Lett. Poznan, Ser.* D. **1** : 1-18.

PATWARDHAN, S. S. 1937. The Indian Zoological Memoirs on Indian animal types 6. *Palaemon* (The Indian river prawn). 2nd ed. XIV+102+XVIII, Illus. Zoological Society of India, Calcutta.

PHILL, R.W. & PUGH, J. E. 1973. Some preliminary histological observations of the hindgut of *Palaemonetes sp. Va. J. Sci.* **24** (3) : 128.

PILLAI, R. S. 1960. Studies on the shrimp *Caridina laevis* (Heller). I. The digestive system. *J. Mar. Biol. Assoc. India.* **2** (1) : 57-74.

RIGDON, R. H. & MANSIK, D. J. 1976. Gastro-intestinal tract of *Penaeus astacus* Iber, 1891 (Decapoda : Natantia). A histological study. *Crustaceana.* **30** : 164-168.

REDDY, A. R. 1937. The physiology of digestion and absorption in the crab *Paratelphusa hydrodromus* (Herbst). *Proc. Indian Acad. Sci.* **6** B : 170-193.

TALBOT PRUDENCE., WALLIS CLARK, H. & ADDISON, L. L. 1972. Fine structure of the midgut epithelium in the developing brown shrimp, *Penaeus eytecus*. *J. Morphol.* **138** (4) : 467-486.

TYAGI, A. P. & PRAKASH, A. 1967. A study on the physiology of digestion in freshwater prawn *Macrobrachium dayanum*. *J. Zool. Soc. India.* **19** (1/2) : 77-83.

VONK, H. J. 1960. Digestion and metabolism. In : *The Physiology of Crustacea* (Watermann, J.H. Ed). *Academic Press, New York,* **1** : 291-316.