J. Mar. biol. Ass. India, 1962, 4 (2) : 172-176

STUDIES ON THE SHRIMP *CARIDINA LAEVIS* (HELLER)

V. Excretory System

By R. SRIDHARAN PILLAI*

Department of Zoology, University College, Trivandrum

THIS paper forms the fifth part of the series dealing with the anatomy of *Caridina laevis*. The digestive system, reproductive system, respiratory system and neurosecretory system have already been published (Pillai, 1960a, 1960b, 1961a, 1961b).

METHODS

The antennal glands were studied mostly by the help of cut material. The coxal segment of the antenna with the antennal gland was removed and fixed in Bouin's fluid and Zenkerformol. Sections were stained in Heidenhain's Susa, Heidenhain's Azan, Heidenhain's iron haematoxylin and Mallory's connective tissue stain.

The principal organ of excretion in *Caridina* is the antennal gland, lodged inside the basal swollen coxal segment of the antenna. In the live animal the gland appears as a whitish mass seen through the thin ventral cuticular wall of the coxa. The gland is biconvex and the convexity is more on the ventral aspect, particularly when the urine content is little. In length it measures about 315 μ in an adult shrimp.

STRUCTURE

The antennal gland consists of the gland proper, the bladder and the ureter. The ureter opens to the exterior on the inner side of the coxa. The gland proper consists of a highly reticulate portion, the end sac and a coiled tubular portion, the renal tubule. The renal tubule forms a substratum for all the other parts of the gland. The end sac in an adult shrimp is 300 μ long and about 160 μ thick and more or less oval in shape. The wall develops a series of ridges which anastomose with the result that the lumen is reduced to a highly branching system of spaces. Both above and below the end sac are blood lacunae into which the renal artery given off from the antennary artery opens. These blood spaces extend into the meshes of the end sac and are not completely covered everywhere by the epithelium as has been observed by Weldon (1891) in *Pandalus* and Grobben (1880) in *Palaemon treillianus*. That no other part of the antennal gland has a direct blood supply has been shown by Parry (1955) in *Palaemonetes varians*. The end sac leads into the renal tubule on its antero-ventral aspect. No valve guarding this opening other than a constriction has been observed. The renal tubule is long and folded upon itself. After a tortuous course it opens into the thin-walled bladder at the

* Present Address : Zoological Survey of India, 34 Chittaranjan Avenue, Calcutta-12.

level of the posterior margin of the end sac. This opening is valvular since the wall of the bladder projects into the cavity of the renal tubule in the shape of a small conical chimney. The valve, judging from its disposition does not appear to facilitate the transmission of urine from the tubule into the bladder. A similar valve has been described where the renal tubule opens into the exit tube in the early stages of the development in *Hemimysis* (Manton, 1928). The anterior end of the bladder leads to the exterior on the median aspect of the coxal segment by a short duct, the ureter. The external opening is small and obscure.

Histology

End Sac

The wall of the end sac in the adult shrimp is one cell thick, though during development, it is more than one cell thick in many regions. In a cross section, the end sac appears to be made up of a series of tubules enclosing irregular spaces. Adjacent tubules are separated by intertubular spaces containing blood, inside which corpuscles are often noticed. The inner margin of the end sac presents faint striations, particularly in materials fixed in Heidenhain's Susa. But in those that are fixed in the more general type of fixatives, numerous small vacuoles with fine granular coagulum are seen projecting into the lumen. At places the lumen is minute and sometimes occluded where the striated margins come together and almost touch. The individual cells of the end sac are the largest in the whole of the antennal gland. The cytoplasm is uniformly granular and the boundary is obscure. The nuclei are large and round with usually one nucleolus and a few clumps of chromatin. The blood spaces in the intertubular spaces are, at places, lined by connective tissue. Nephrocytes undergoing disintegration have also been observed in the intertubular spaces (*vide* Respiratory system, Pillai 1961a).

Renal tubule

The wall of the renal tubule is not uniformly thick. The nuclei are either round or elongated, placed very near the lumen and have usually one prominent nucleolus each. The elongated nuclei are placed vertically in columnar regions and horizontally in the more squamous regions. The cytoplasm is clearly striated transversely and this is a very constant feature irrespective of fixatives used. The striae are strongly eosinophil and phloxinophil. The successive coils of the tubule are bound together at places by connective tissue which encloses blood spaces. The cells are vacuolated and the inner boundary is rugged unlike that of the end sac and without a conspicuous coagulum inside the lumen.

Bladder

The bladder has a very thin wall composed of a layer of epithelium with oval nuclei, the cytoplasm showing striations as the renal tubule. The inner margin of the epithelium of the bladder is better defined than that of the renal tubule. The nuclei are situated nearer to this margin and are still more scarce than in the renal tubule. The upper and lower layers of the epithelium of the bladder are quite alike in structure. The lumen of the bladder does not present any sort of coagulum. Physiological evidence indicates that the epithelium of the bladder in the cray fish (Maluf, 1941) is nonsecretory. Here, except in the most proximal portion, the wall of the bladder is not columnar.

A study of the post-embryonic general development of the antennal glands in *Caridina* reveals the following. In the newly hatched larva, the end sac is small (37

μ across) with an irregular cavity inside. The wall in some parts is more than one cell thick at this stage unlike in *Palaemonetes varians* (Allen, 1892). In *Hemimysis* (Manton, 1928) also it is single layered. At this stage a narrow renal tubule, Z-shaped when seen from the outer side, has established communication with the end sac on its anterior ventral side. The posterior limb of the tubule opens into a dorsal somewhat dilated chamber, the bladder. The lumen of the renal tubule is narrow and its wall is regular, made up of a single layer of cells with a diameter of 17 μ. No indication of striation is visible at this stage either in the renal tubule or in the bladder, unlike in the larva of *Palaemonetes*, where it is indistinctly seen (Allen, 1892). The bladder epithelium is narrow and the opening of the renal tubule into it is without a valve. In a still earlier stage of development viz. about 5 to 6 days

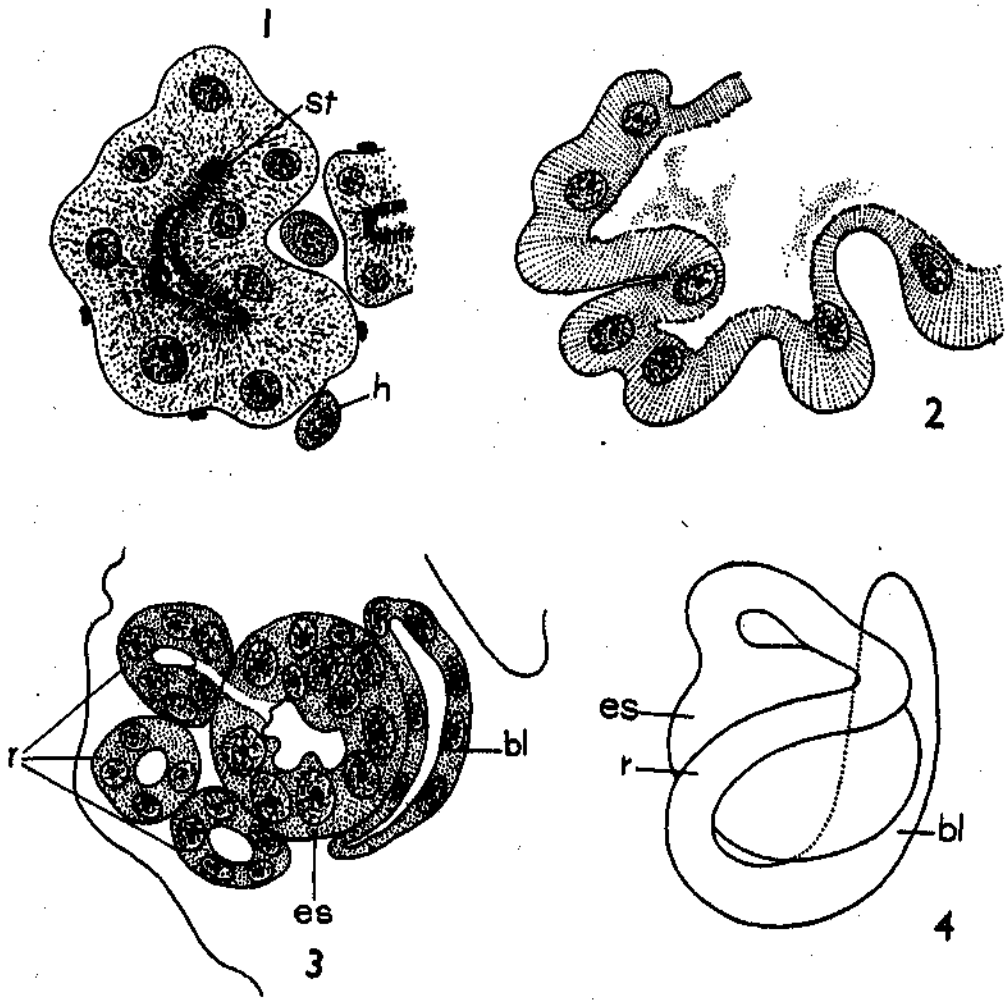

FIG. 1. A portion of the end sac epithelium. h. haemocyte, st. striated border.
FIG. 2. A portion of the renal tubule.
FIG. 3. Section through the larval antennal gland (just hatched). bl. bladder, es. end sac, r. renal tubule.
FIG. 4. Diagrammatic ventral aspect of the larval antennal gland (reconstruction). Lettering as above.

before hatching, the end sac and the renal tubule are two adjacent masses of cells which condition corresponds to that in the newly hatched larva of *Palaemonetes*. The end sac is the first to develop a cavity. The rudiment of the renal tubule develops a cavity later and gets connected to the end sac. Before getting connected with the ureter, it expands to form a bladder. In a larva aged 18 to 20 days, the end sac becomes elaborate with the characteristic infoldings and the renal tubule becomes much elongated and convoluted.

The excretory system in Decapoda offers a wide variety in structure. Even within a small group as Caridea, the excretory system varies a good deal as in *Crangon Pandalus, Virbius,* (Weldon 1891) and *Palaemonetes* (Allen, 1892). A comparison of the antennal glands of *Caridina* with the above forms would bring out the extent of its variation. The end sac epithelium is the only division which presents a uniformity of structure among the members of the group. The renal tubule presents a lot of variation in the group Caridea. In *Virbius* it is represented by a single short wide tube. In *Pandalus* and *Crangon* the larvae present a condition similar to that in the adult *Virbius*. In *Palaemon serratus* Marchal (1892) has confirmed the findings of Weldon that the ' glandular plexus ' is composed of several renal tubules. The renal tubule of *Palaemon squilla* and *Palaemonetes varians* is also essentially similar to that in *Palaemon serratus* (Weldon, 1891 and Allen, 1892). In the young ones of *Caridina* (newly hatched) the renal tubule is a short tube. The only difference between the gland of the adult and the young of *Caridina* is that in the former, the tubule is more elongated and coiled. At the same time it remains single and shows no tendency towards splitting. The degree of organisation of the antennal gland of the adult makes it possible to be placed between that of *Virbius* and *Palaemon*. The valve that is found in *Caridina* between the renal tubule and the bladder does not find its homologue in other Caridea, but is found only in embryonic stages of *Hemimysis*. The bladder has more or less the same histological properties in the different members of Caridea. A distinction has been drawn between the upper and lower layers of the bladder i.e., the one that is adjacent to the end sac epithelium and the other. No such distinction has been observed in the present form. The extent of the development of the bladder varies much, especially when the nephroperitoneal sac is looked upon as an outgrowth of the bladder. The nephroperitoneal sac is present in all the above forms (*Pandalus, Virbius, Crangon, Palaemonetes* and *Palaemon* spp.). It is noteworthy that in *Caridina* this is absent.

Summary

The antennal gland consists of a highly reticulate, glandular end sac, a coiled glandular renal tubule, a thin-walled bladder and a short ureter. A nephroperitoneal sac, represented in the other Caridea is absent. The histology of the various divisions is dealt with.

Acknowledgement

I wish to express my indebtedness to Dr. K. Bhaskaran Nair for the invaluable help and guidance. I thank the Government of India for the award of a Research Scholarship and the administration of the University College, Trivandrum for the facilities provided in the Department of Zoology.

REFERENCES

ALLEN, E. J. 1892. Nephridia and body cavity of some decapod Crustacea. *Quart. J. micr. Sci.* **34** : 403-426.

GROBBEN, C. 1880. *Die Antennandruse der Crustacean. *Arb. Inst. Wien*, **3** : 93-110.

MALUF, N. S. R. 1941. Micturition in the crayfish and further observations on the anatomy of the nephron of this animal. *Biol. Bull.*, **81** : 134-148.

MANTON, S. M. 1928. On the embryology of a Mysid Crustacean *Heteromysis lamornae*. *Phil. Trans. roy. Soc.* London, **216** : 363-463.

MARCHAL, P. 1892. Recherches anatomiques et physiologiques sur l'appareil excreteur des Crustaces Decapodes. *Arch. Zool. exp. gen.* Paris, **10** : 75-275.

PARRY, G. 1955. Urine production in the Antennal glands of *Palaemonetes varians*. *J. exp. Biol.*, **32** : 408-422.

PILLAI, R. S. 1960a. Studies on the shrimp *Caridina laevis* (Heller). 1. The Digestive System. *J. Mar. biol. Ass. India*, **2** : 57-74.

———, 1960b. Studies on the shrimp *Caridina laevis* (Heller). II. The Reproductive System. *Ibid.*, **2** : 226-236.

———, 1961a. Studies on the shrimp *Caridina laevis* (Heller). III. Respiratory system. *Ibid.*, **3** : 137-145.

———, 1961b. Studies on the shrimp *Caridina laevis* (Heller). IV. Neurosecretory system. *Ibid.*, **3** (1 & 2). 146-152.

WELDON, W. 1889. The coelom and nephridia of *Palaemon serratus*. *J. Mar. biol. Ass.* U.K., **1** : 162-168.

———, 1891. Renal organs of certain decapod Crustacea. *Quart. J. micr. Sci.*, **32** : 279-291.

* Not referred to in original.