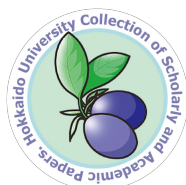




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Notes on the Morphology of an Apodous Holothurian, *Scoliodotella uchidai*^{1) 2)}

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The present study concerns the internal morphology and histology of an apodous holothurian, *Scoliodotella uchidai*. Although the followings are noticeable features in this species, the general organization is along the line of the other apodous species; unique combination of the alimentary canal and the mesenteries, non-winding small intestine, lack of outer connective tissue layer in the alimentary canal, and only one polian vesicle and stone canal.

In recent years works were only fragmental in the field of holothurian morphology (Filice, 1950; Millott, 1950, 1953; Smith, 1962), though considerable number of inclusive works were carried out on this subject several decades ago (cf. Hyman, 1955; Ludwig, 1889/1892). Recently the author described an apodous holothurian, *Scoliodotella uchidai*, as a new species belonging to a new genus in Chiridotinae, based mainly on endoskeletal ossicles and oral podia (Oguro, 1961). It seemed, however, that more detailed description on the species is desirable. Since that the author has had opportunities to collect the specimens enough to study. The following is a brief account of the morphological studies on *Scoliodotella uchidai*, done in order to give a supplementary information on this species.

MATERIAL AND METHODS

The material used in this study was collected at Cape Aikappu and Daikoku Island both in Akkesh Bay during 1956-1963. Some were fixed in 70% ethanol or 10% neutralized formol for observations by means of a binocular dissecting microscope. The others were fixed in Bouin's solution and cut into serial sections at 8-15 μ by routine paraffin method. They were stained with Ehrlich's hematoxylin-eosin or Heidenhain's azan stain and served for histological examination. Before the specimens were fixed, they had been kept in petri-dishes containing filtered sea-water to expel intestinal contents, mainly sand grains, and anesthetized by magnesium sulphate. All measuring were performed on fixed material.

OBSERVATIONS

Skeletal system The calcareous ring is composed of ten pieces, five radial and

- 1) This paper is dedicated to Professor Sajiyo Makino, Zoological Institute, Hokkaido University, Sapporo, in honor of his sixtieth birthday, June 21, 1966.
- 2) Contributions from the Akkeshi Marine Biological Station, No. 127.

five inter-radial pieces, each being arranged alternately (Fig. 1). The mid-ventral (A) radial piece is the largest and the mid-dorsal (CD) inter-radial piece is the smallest one among them. The other eight pieces are similar in size and form; somewhat twisted rectangular and concaved in inner side. Notches or holes, which often exist in the radial piece of the other apodous species (Clark, 1907), are missing either in the radial or inter-radial pieces. The mid-ventral radial piece is also rectangular but provided with two anterior projections. These pieces are firmly bound each other forming a ring encircling the esophagus. Each radial piece is provided with longitudinal muscle bands. Description on the endoskeletal ossicles was given in the preceding paper (Oguro, 1961).

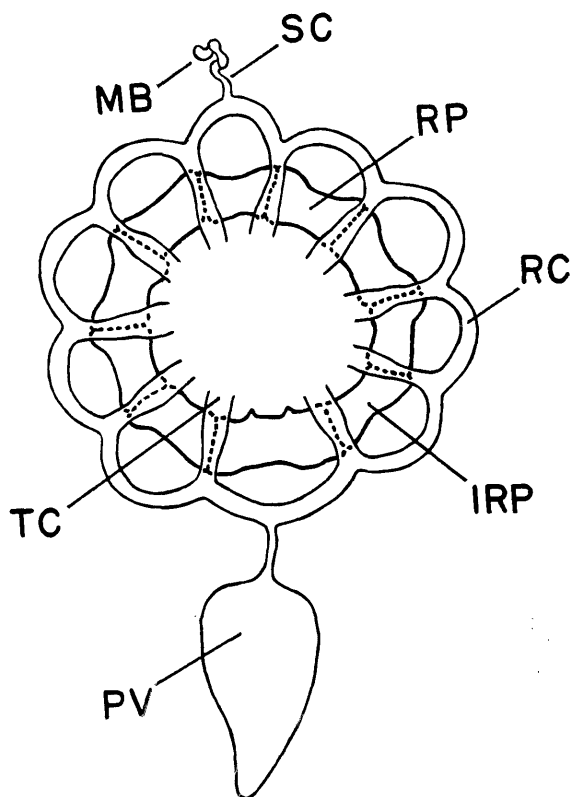


Fig. 1. Schematic illustration of water-vascular system with calcareous ring. View from posterior. IRP, inter-radial piece of calcareous ring; MB, madreporic body; PV, polian vesicle; RC, radial canal; RP, radial piece of calcareous ring; SC, stone canal; TC, tentacular canal.

Body wall Body wall is composed of five components (Fig. 2). The outermost is a very thin layer of homogeneous cuticle. Next is a thick layer known as epidermis which is mainly composed of tall columnar epithelial cells, being interspersed with gland cells. This layer tends to make clumps though not so markedly

as reported in *Synapta inhaerens* by Woodland (1907). It is from 15μ to 70μ in thickness according to absence or presence of clumps. The third layer of the body wall is the dermis, thick layer of connective tissue, in which endoskeletal ossicles are embedded. The tissue is considerably loose in outer part and tends to be rather dense toward the fourth layer, though there is no conspicuous boundary between the loose and the dense portions as shown in *Synapta inhaerens* (Woodland, 1907). Inner to the dermis is a thin layer of circular muscles, about 15μ in thickness. This circular muscle layer is not interrupted with longitudinal muscles of single strip which exists on ambulacra, unlike in the members of Molpadonia (Gerould, 1896). The inner-most surface of the body wall is lined with coelomic epithelium which is thin and uniform in thickness, about 9μ .

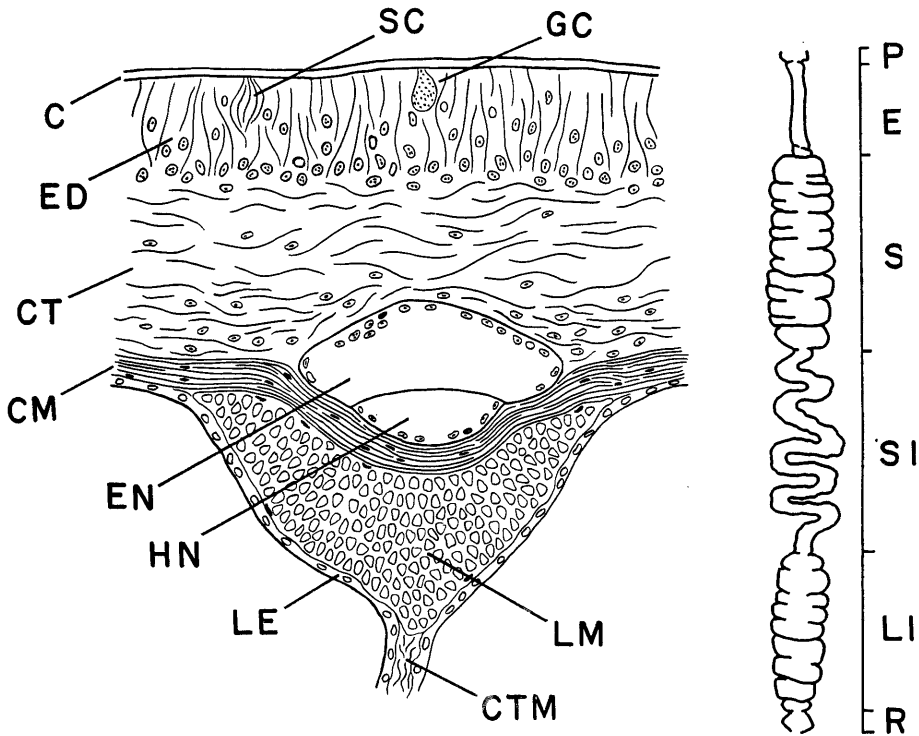


Fig. 2 (left). Schematic illustration of cross section of the body wall at the level of the large intestine. C, cuticle; CM, circular muscle; CT, connective tissue; CTM, connective tissue of mesentery; ED, epidermis; EN, ectoneural nerve; GC, gland cell; HN, hyponeural nerve; LE, lining epithelium; LM, longitudinal muscle; SC, sensory cell.

Fig. 3 (right). External view of the alimentary canal. E, esophagus; LI, large intestine; P, pharynx; R, rectum; S, stomach; SI, small intestine.

Water-vascular system As in the other apodous holothurians, the water-vascular system of this species is very simple, lacking in radial canal and their derivatives. It consists of a ring canal and ten tentacular canals which issue branches into digits (Fig. 1). Unlike the general tendency to multiplication in number of

the polian vesicle and stone canal in Apoda (Hyman, 1955), this species possesses one polian vesicle and a single stone canal. At the mid-ventral radius (A) the ring canal gives out the polian vesicle which is of cayenne-shape with a narrow and short neck. The size of the polian vesicle of this species shows wide variation. The stone canal is issued from the ring canal at the mid-dorsal inter-radius (CD), and supported by the mid-dorsal mesentery except the tip forming a madreporic body. No tentacular ampulla is found. The wall of the ring canal and polian vesicle is histologically composed of four layers; lining epithelium (ciliated in the ring canal),

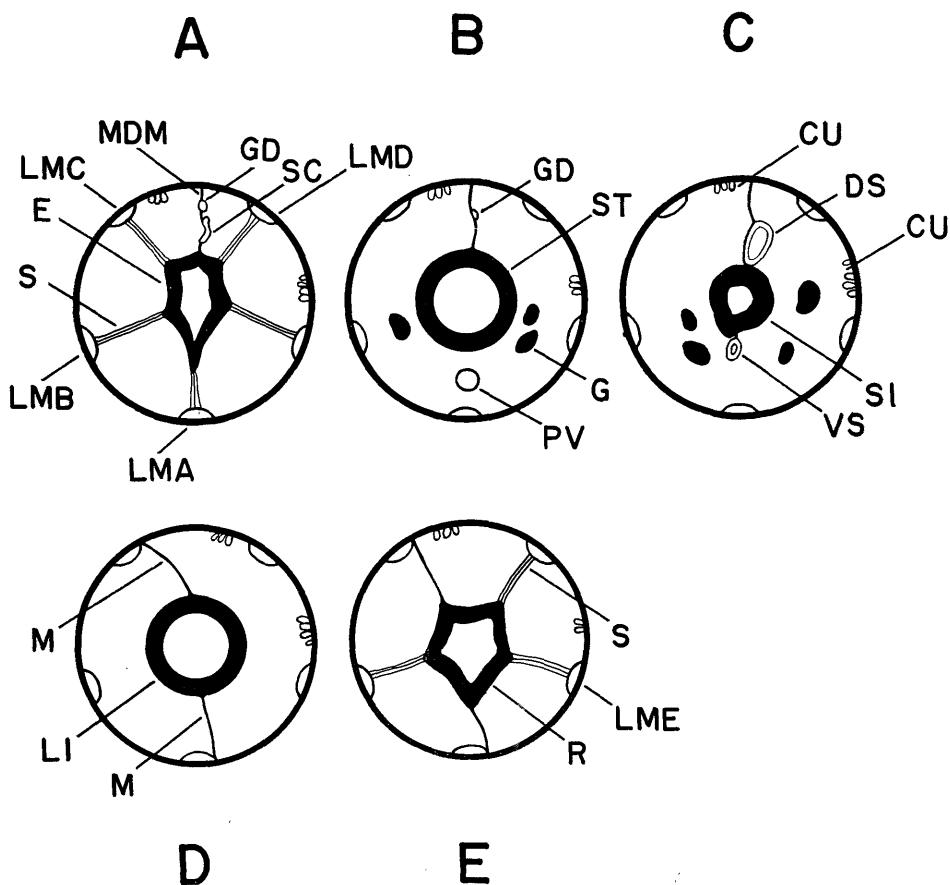


Fig. 4. Schematic illustrations of cross section of the body showing the arrangement of the organs. A, B, C, D, and E show sections at the level of the esophagus, stomach, small intestine, large intestine and the rectum, respectively. CU, ciliated urns; DS, dorsal sinus; E, esophagus; G, gonad; GD, gonoduct; LI, large intestine; LMA, longitudinal muscle on radius A; LMB, longitudinal muscle on radius B; LMC, longitudinal muscle on radius C; LMD, longitudinal muscle on radius D; LME, longitudinal muscle on radius E; M, mesentery; MDM, mid-dorsal mesentery; PV, polian vesicle; R, rectum; S, suspensor; SC, stone canal; SI, small intestine; ST, stomach; VS, ventral sinus.

circular muscle layer of connective tissue and coelomic epithelium. The wall is very thin, usually about 8μ in total thickness.

Alimentary canal Although the small intestine does not wind (Fig. 3), general organization of the digestive system is similar to that of the other apodous species hitherto studied. The mouth opens at the center of the oral disk without armature. A very short pharynx, which is of trumpet-shape and connected by tiny connective tissue strands with longitudinal muscle bands, follows the mouth. Posterior to the pharynx is the esophagus. At the border of the esophagus and the stomach there is a deep constriction. The stomach is traversed by small constrictions. Next to the stomach is the small intestine which runs merely undulantly and does not show winding. This is different from the usual manner found in holothurian small intestines. Following the small intestine, the large intestine is marked off. It is relatively large tube with small constrictions as seen in the stomach. At the end of the large intestine there is a small portion which may be called a rectum where the intestinal wall becomes thin. It ends as an anus situated at the center of the posterior end of the body.

The alimentary canal from the esophagus to the posterior end of the small intestine is suspended by a mid-dorsal mesentery on the inter-radius CD but the mesentery disappears abruptly at the end of the small intestine. The large intestine is connected to the body wall by two mesenteries, one on the radius A and the other on the radius C. Finally the rectum is supported by three suspensors in addition to the two mesenteries. At the very end, it is supported by numerous tiny connective tissue strands as seen in the pharynx (Fig. 4).

The wall of the alimentary canal consists of four layers; lining epithelium, connective tissue layer, muscle layer composed of both longitudinal and circular muscles, and covering epithelium (Hamann, 1883; Siviks and Domantay, 1928). Total and relative thickness of these layers vary in different parts of the canal (Fig. 5). As described before, the wall of the alimentary canal lacks outer layer of connective tissue that is present between covering epithelium and the muscle layer in the majority of holothurians (Hamann, 1883). At the mouth the longitudinal muscle layer is inner to the circular muscle, while the directional relation of the muscle layers is reversed in the other parts of the canal even in the anal portion. In the lining epithelium of the pharynx numerous gland cells are present but they are rare in the esophagus. They increase again in the small and large intestine. The esophagus and the pharynx are covered with cuticle. In the connective tissue layer of the small intestine there are lacunar spaces. The thickness of the covering epithelium and the muscle layers shows constant value everywhere of the canal, about 15μ . That of the connective tissue layer, however, shows a great variation in parts of the canal; $50-60\mu$ in the pharynx and esophagus, $15-50\mu$ in the stomach, $30-150\mu$ in the small intestine, $150-180\mu$ in the large intestine, and $30-50\mu$ in the rectum. The variation of the thickness is mainly due to the folding or invaginating of the lining epithelium.

Nervous system The nervous system mainly consists of a nerve ring, ten tentacular nerves and five radial nerves. The nerve ring lies latero-anterior to the calcareous ring encircling the pharynx. In cross section, it is elliptical in form and neurons are restricted in the anterior half of it. In cross section the tentacular nerve does

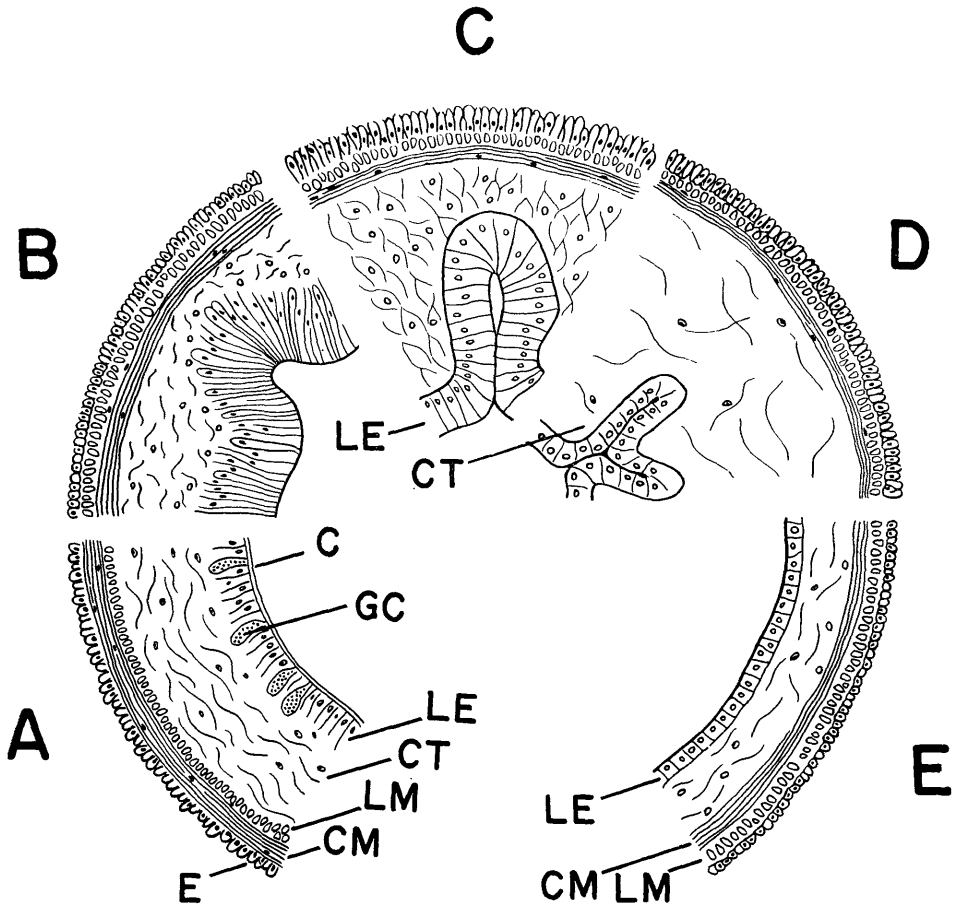


Fig. 5. Schematic illustration of cross section of the alimentary canal. A, B, C, D, and E show anterior portion of the pharynx, stomach, small intestine, large intestine, and the rectum, respectively. C, cuticle; CM, circular muscle; CT, connective tissue; E, epidermis; GC, gland cell; LE, lining epithelium; LM, longitudinal muscle.

not show a complete ring, as described in *Labdomoligus ruber* (Becher, 1906), but incomplete ring situating between the longitudinal muscle and the dermis. The radial nerve consists of two parts, outer ectoneural and inner hyponeural (Fig. 2).

Reproductive system This species is obviously dioecious but the both sexes are hardly distinguishable externally even in the breeding season. The gonad is of bi-lobed tube. The tubes are branched and suspended freely in the coelom, each lobe in either side of the mid-dorsal mesentery. Usually the ovarian lobes are thick, short and less branched than the testicular ones. Between the gonad and the genital opening is the gonoduct which is suspended by the mid-dorsal mesentery (Fig. 4). No difference in the structure of the gonoduct is found between the both sexes. The inner-most is ciliated epithelium. Next is loose connective tissue and the outer-most is peritoneum. The genital opening is situated at the mid-dorsal inter-radius

(CD) without special apparatus, near the base of the tentacles.

Coelomic organ *Scoliodotella uchidai* has ciliated urns which are known as a characteristic coelomic organ in Apoda (Hyman, 1955). The ciliated urns of this species are solitary, not mounted on common stems as seen in *Chiridota* (Semper, 1868¹⁾). Each urn is of cornucopia-shape, 50–70 μ high and 35–45 μ wide at the top, and the inner side of it is covered with cilia. The clumps of aggregated haemocytes are often found in the concaved parts of the urns (Cuénot, 1902). There are two rows of the urns on the coelomic side of the body wall, not mounted on the mesenteries, one on the inter-radius CD and the other on the inter-radius DE. The urns are many in the middle portion of the body and interspersed in the both extremities.

Remarks As described before, general organization of this species is along the line of the other apodous holothurians. The followings, however, are characteristic features of *Scoliodotella uchidai*.

The alimentary canal of holothurians including apodous species is in general suspended by three mesenteries; the esophagus and the stomach and the descending part of the small intestine, the ascending part of the small intestine, and the rest of the canal are suspended by the mid-dorsal mesentery, left mesentery and the ventral mesentery, respectively. In the present species, however, the alimentary canal from the esophagus to the posterior end of the small intestine is suspended by one mid-dorsal mesentery, and the rest of the canal, viz., large intestine and rectum, is suspended by two mesenteries. This may be due to non-winding nature of the alimentary canal of this species, which is another characteristic of the present species. Further, the alimentary canal of this species lacks outer connective tissue layer usually found between the epithelium and the muscle layer. Single polian vesicle and only one stone canal are also worth to notice among Apoda.

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