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"Morphological Adaptations of *Telescopium telescopium* in the Mangrove Ecosystem of Punnakayal, Thoothukudi District"

A. Jenivi[1], Dr. R.D. Thilaga[2]

1&2. PG & Research Department of Zoology, St. Mary's College (Autonomous), Tuticorin-628002, Affiliated to Manonmaniam Sundaranar University, Abishekapatti, Tirunelveli, Tamil Nadu, India

Corresponding Author Email: ajenivi@gmail.com

Abstract

This study presents a detailed morphological description of *Telescopium telescopium*(Linnaeus, 1758), a commercially valuable potamididae gastropod, based on specimens collected from the Punnakayal mangrove region . The research examines the shell characteristics, head-foot morphology, mantle organs, visceral mass, digestive system, reproductive system, and central nervous system of *T. telescopium* through dissections and histological analysis.. This comprehensive morphological study contributes to a better understanding of potamididae taxonomy and provides insights into the adaptations of *Telescopium telescopium* for its predatory lifestyle in tropical marine ecosystems.

Key words: *Telescopium telescopium*, Potamididae, Adaptation.

Introduction

One of the most conspicuous elements of the macrofauna in the vast mangrove swamps of the Indo – West Pacific province are the ubiquitous potamidid snails of the genera *Telescopium sp*. This species is a large prosobranch that occur in great numbers and frequently dominate the surface of the muddy substrates of mangrove forests (Richard Houbrick, 1991). On the basis of conchological characteristics *Telescopium telescopium* has been placed in the order mesogastropod. Thilaga (2005) and Jeyaprabha (2012) stated that a combination of factors such availability of food, temperature, oxygen content, salinity, humidity and population density might play an important role in shell morphology.

Although a number of ecological studies on migratory movements and vertical distribution in the mangrove habitat have been published, morphological studies on potamidids are very limited. Fretter (1952) made an observation on the functional morphology and life history of prosobranch molluscs. Graham (1956) on the reproductive tract, Risbec (1947) has given the gross morphology of the generative organs of few species of *Cerithidea.* Account on the structural and functional aspects of prosobranch anatomy has been given by Morton (1958). Hyman (1967) has given a complete and comparative account on the prosobranch reproductive systems. Richard Houbrick (1991) studied the systematic review and functional morphology of the potamidid prosobranchs. The morphology of several mesogastropods has been investigated by Sreenivasan and Natarajan (1991), Baskara Sanjeev (2001), Annadurai *et al.* (2006), Hodgson and Dickens (2012), Sitnikova *et al.* (2016) and Hofman (2021).

The above review reveals that there is only a little information is available on the morphology of *T. telescopium*. Hence in the present study an in depth work was carried out to describe the shell, operculum, animal removed from the shell genital and visceral complexes of *T. telescopium.*

2 Material and methods

For the present study the specimens of *T. telescopium* were collected from the Punnakayal mangroves by hand picking during low tide and brought to the laboratory alive. Adhering particles were removed and maintained under laboratory conditions for further studies. The animals were

obtained by making open the shell or by boiling the shell in water or in mild alkaline solutions. After removing the flesh part, the shells were also cleaned using brush with detergent powder. The morphology of the shell and ornamental pattern of the shell were studied. Dissections were carried out in living as well as in preserved animals for studying the different systems. About one hundred animals were used for these studies. Camera lucida drawings were made with the help of a stereozoom microscope and measurements were recorded using stage and ocular micrometers. Histological studies of various body parts were also carried out.

Results

1 Shell

T. telescopium has a large, rather thickand hefty shell. Spiral ridges and intricate carvings decorate the shell. A deep canal surrounds the columellar pillar at the base of the shell, and the cords radiate outward in all directions. The shell is black in juveniles and gray in adults. The outer lip of the aperture is flared and develops beyond the columellar base and thickens in older specimens; the aperture itself is narrowly oval, tangential to the shell axis, with twisted columella. The older specimens, the protoconches are small and the periostracum is colourless. In male *T. telescopium* the shells possess elongate spire and narrow aperture and the shell is also longer and narrower in males, but in females the shell is shorter and broader (Fig. 1).

2 Operculum

The operculum has an ovate shape, a nucleus in the middle, and radiating growth ridges which mostly has brown or dark tone. The final growth increment of the operculum always rests obliquely on the labial lip of the preceding whorl this characteristic is known as rigiclaudence. Since the operculum of most potamididae are flexicaudent, this species is most distinguished when compared to other species.

The snail carries its shell with the aperture facing forward when it moves, the aperture is seen as anterior and the apex as posterior. The shell measures 8 mm to 13 cm in length when fully grown. The aperture is about 16 mm in length to 20 mm in width (Fig. 2).

3 Animal removed from the shell

i) Head

T. telescopium has a distinct head, foot, and visceral mass. The head is big and symmetrical on both sides (Fig. 4, .5).

ii) Tentacles

The snout is joined to a pair of tentacles at its base; these tentacles are between 4 mm to 5 mm in length, depending on the size of the animal and are thicker at their bases and thinner at their tips. When the animal is moving, the tentacles are in continual motion. Except for the point of fusion with the main body, the tentacles are uniform and black with pigmentation. The tentacles have been discovered to have a tactile use (Fig. 6).

iii) Snout

T. telescopium has a black, fleshy, approximately triangular snout that measures about 4.5 mm in length, 7.5 mm at the base and 2.5 mm at the tip. The mouth is situated slightly ventral to the anterior edge of the snout, and it opens internally into the buccal cavity. The slit like opening of the mouth is semicircular in shape. It is located slightly ventral to the anterior border of the snout. In alive specimen the snout is extended to form a long proboscis (Fig. 4).

iv) Eyes

The eyes of *T. telescopium* are found at the base of the tentacles like small black spots. The eyes serve as photoreceptors (Fig. 6).

v) Foot

The foot of *T. telescopium* is a muscular organ on the side of the head with a wide ventral creeping sole. It may swell and shrink and has a dark, pigmented surface. The foot is divisible into anterior propodium a posterior metapodium and middle mesopodium. The propodium forms the flat creeping sole. During locomotion the metapodium is expanded externally. The mesopodium possess pedalglands which secrete slimy substances that help in locomotion (Fig. 4).

vi) Pallial complex

Pallial complex of *T. telescopium* comprising of pallial cavity which occupies the space between mantle and dorsal surface of the body of the animal. Pallial cavity contains ctenidium, osphradium, hypobranchial gland, heart, terminations of digestive, excretory and reproductive organs (Fig. 6).

a) Mantle

The mantle wall of *T. telescopium* extends from the ventral side of the pallial area to the dorsal side, and it is deep, wide in the anterior, and narrows in the posterior, housing the organs of the pallial complex. It acts like a collar and goes around the neck of the animal. The mantle dorsal and lateral margins are smooth and devoid of crenulations. Muscular folds form on the mantle edge only near the inhalant siphon, but there are no such folds near the exhalant siphon. The mantle margin also plays a role in the secretion of shell in additional to its other glandular and sensory roles. Through the transparent mantle the organs constituting the pallial complex are visible. The mantle protects the organs within it (Fig. 6).

b) Ctenidium

The left side of the mantle cavity is occupied by the ctenidium. It is made up of axis-attached triangular leaflets. The ctenidium spans the entire depth of the mantle cavity. The ctenidium of *T. telescopium* is monopectinate type (Fig. 6).

c) Osphradium

The osphradium is a large, black organ in *T. telescopium*. It is monopectinate found very close to the ctenidum. It extends from the base of the inhalant siphon into the mantle cavity. It is believed that the osphradium is a chemoreceptor organ that checks the purity of water entering the mantle cavity (Fig. 6).

d) Hypobranchial gland

Hypobranchial gland spreads over the roof of the mantle cavity, the gland is thick posteriorly, but it becomes thin in its anterior half. The intestine and rectum run along the right side of the hypobranchial gland. A colorless mucus is secreted, which binds the particles together before they are flushed out of the mantle cavity (Fig. 6).

e) Kidney

The kidney is a big, spongy and flat organ that ranges in color from grey to brown. It may be found on the left side of the visceral hump. The renal aperture, which resembles an oval slit, may be seen on the ventrolateral side of the ascending kidney, not far from the digestive system. The entrance is encircled by cilia (Fig. 9).

f) Heart

The pericardial cavity contains the two chambered heart. Below the surface of the pericardial sac, the anterior aorta extends onward. It extends dorsally to the left of the posterior region of the oesophagus and in the head and foot region, it terminates in a series of sinuses. Following its split from the anterior aorta, the posterior aorta proceeds distally from the visceral mass and enters the visceral sinuses to end. Sinuses and blood vessels are visible and vaguely defined (Fig. 10).

vii) The Nervous system

Streptoneurons make up the caenogastropod's nervous system. In *T. telescopium* central nervous system includes the cerebral, pleural and pedal ganglia, which are all located ventrally, are distinct from the nerve ring ganglia. There are little openings called commissures that connect the right and left ganglia to the pedal ganglia. From the ganglia, fine nerves protrude and reach to various locations. There is a tiny ganglion found in the inhalant siphon region of the mandle edge (Fig. 8).

viii) Genital complex

The testes, vasa efferentia, vas deferens, prostrate gland, seminal groove, male genital ridge, male genital flap and the prostrate gland all make up the pallial area of the male genital complex. The testis is unpaired and yellowish brown organ situated over the digestive gland. Vasa efferentia are small ducts connecting the testis with unpaired vasdeferens. The vas deferens starts from the testis and extends upto mantle cavity. Seminal groove arises near the opening of vasdeferens and extends upto the edge of the mantle in the anterior region closer to the rectum. The seminal groove is white in colour and covered by genital folds in living animals, serves as a temporary sperm tube. The prostrate gland is a white wavy strand of tissues extending from the mantle edge to the opening of vas deferens. Male genital ridge extends from the beginning of the mantle cavity to the edge of the mantle. The male genital flap extends as the genital ridge in the mantle cavity. It begins off wide but shrinks as it approaches the left side of the hypo branchial gland, where it joins with the mantle (Fig. 2, 11a, b).

The female reproductive system of *T. telescopium* includes the ovary, oviduct genital folds, resorptive folds, genital groove albumen gland and female genital foldings. The ovary is single and located in the apical region of the whorl and lies over the digestive gland. The oviduct arises from the apical whorl and is uniformly thick, except in the anterior extremity where it opens into the genital groove. There are two genital folds arising perpendiculary to the axis of the floor of the mantle to the end of the pallial cavity where the hypobranchial gland terminates.

The genital folds give a zig zag appearance. The fold near the hypobranchial gland is the right genital fold and other which is situated left to the former is the left genital fold which is shorter than the right. The area between the left genital fold and the albumen gland and extending to the end of the pallial cavity constitutes of five little plicated structures of varied heights known as resorptive folds. The female genital groove starts from the mantle cavity and continues all the way to the mantle edge. Wavy strand of tissues extends throughout the floor of the mantle in the antero-posterior direction and extends upto the pedal groove near mantle edge. There are about 5 female genital foldings. In the anterior region they unite to form a single fold tapering and becoming confluent with the genital groove near mantle edge. In the posterior region these foldings unite to form a short flap and terminate near genital groove (Fig. 3, 12a, b).

ix) Visceral Complex

The visceral mass takes up the fag end of the near part of the body. It includes the digestive and reproductive system. The visceral mass is primarily made up of the digestive gland. The gonad, which covers the stomach on the dorsal side, changes color over the course of its reproductive cycle. The whorls of the shell are a great fit for the visceral coil (Fig. 7).

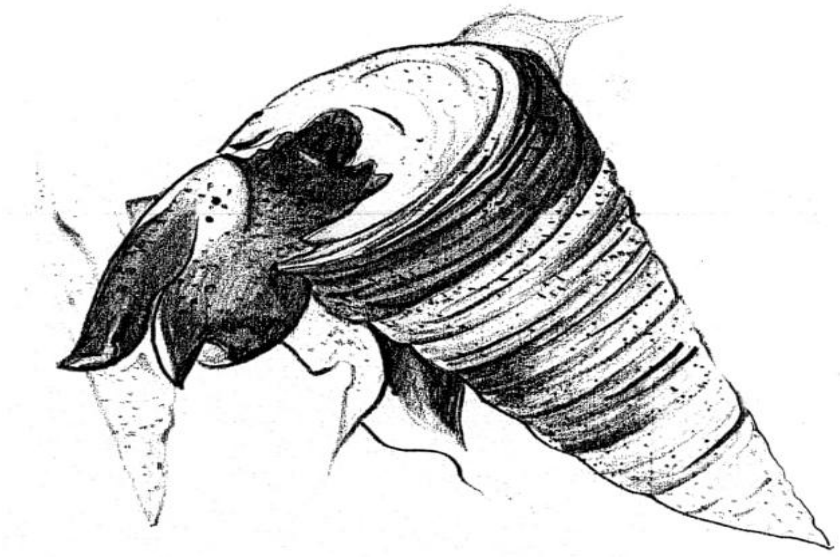

Fig. 1 : External morphology of *T. telescopium*

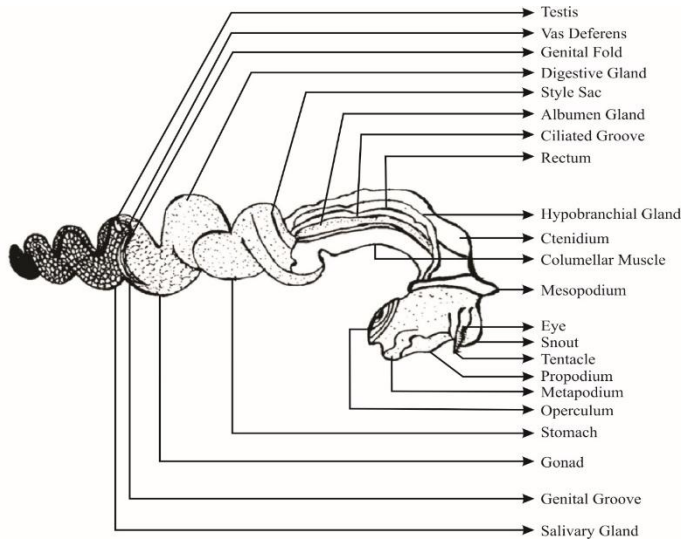

Fig. 2 : Internal morphology of male *T. telescopium*

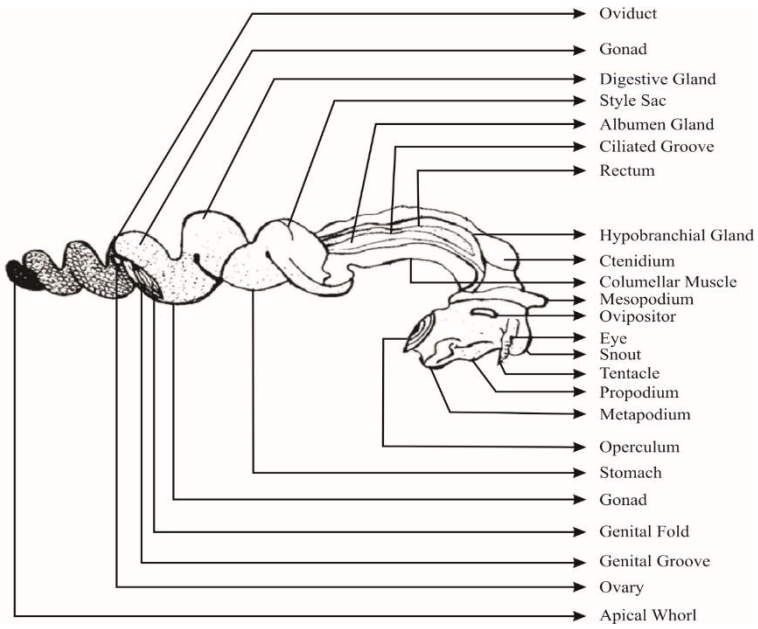

Fig. 3 : Internal morphology of female *T. telescopium*

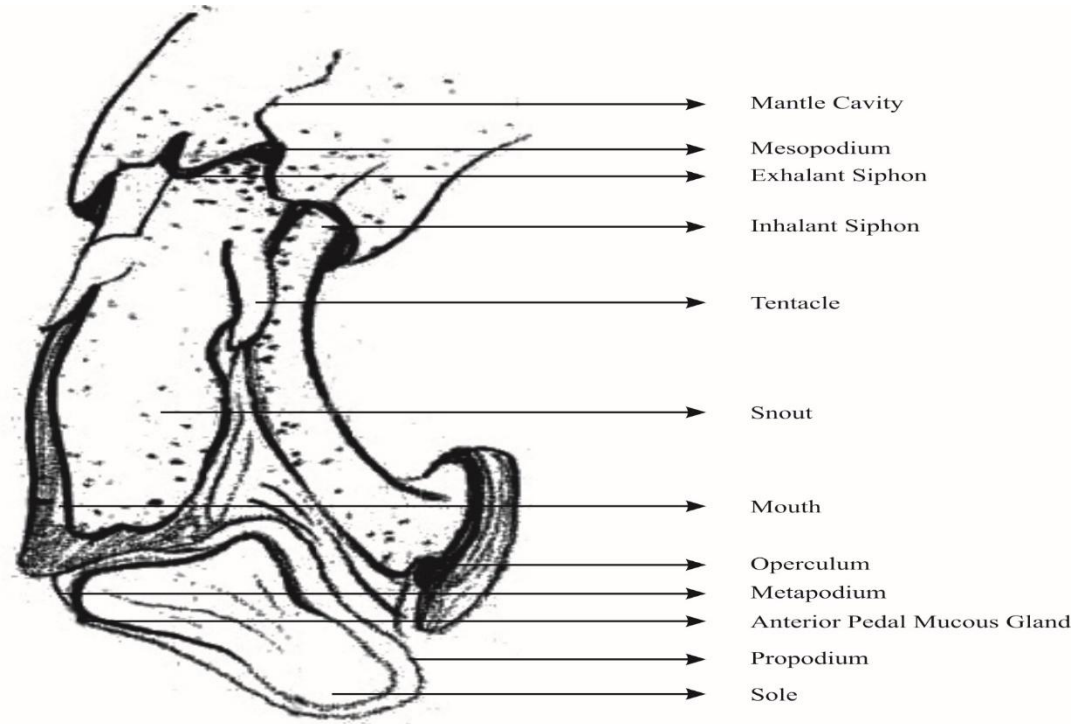

Fig. 4 : Head – foot complex of (male) *T. telescopium*

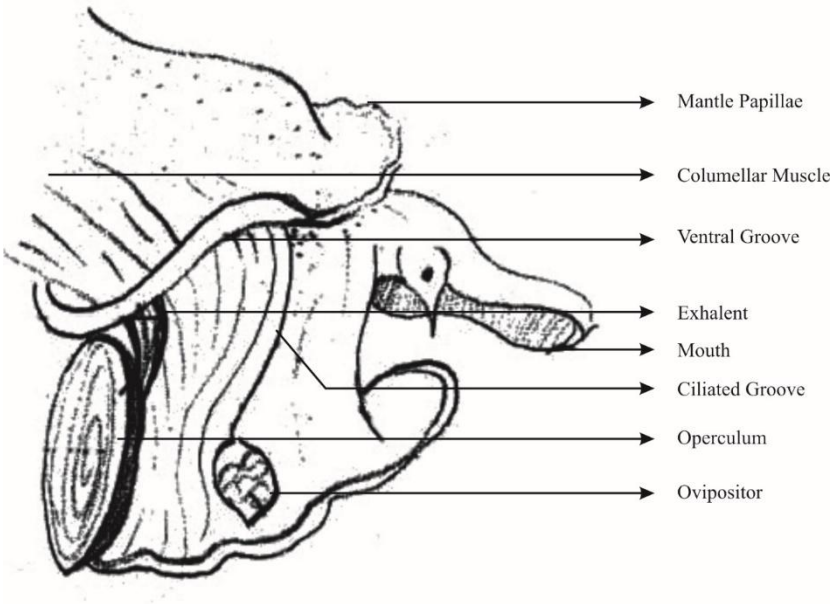

Fig. 5 : Head-Foot complex of (female) *T. telescopium*

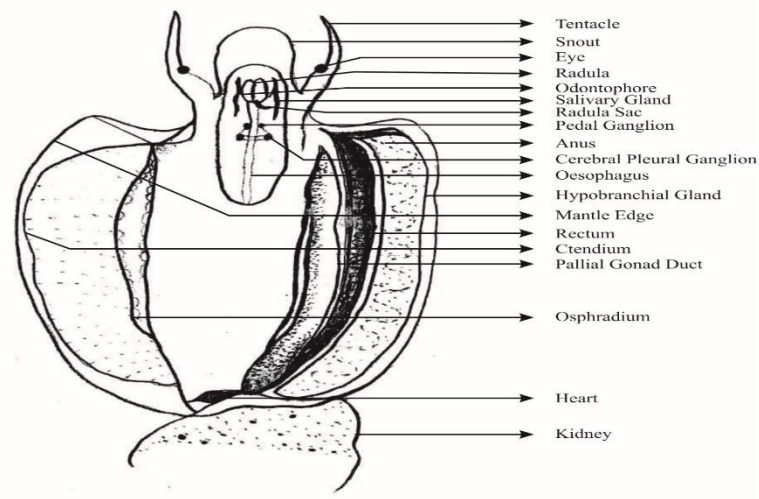

Fig. 6 : Ctenidium, Osphradium, Hypobranchial gland of *T. telescopium*

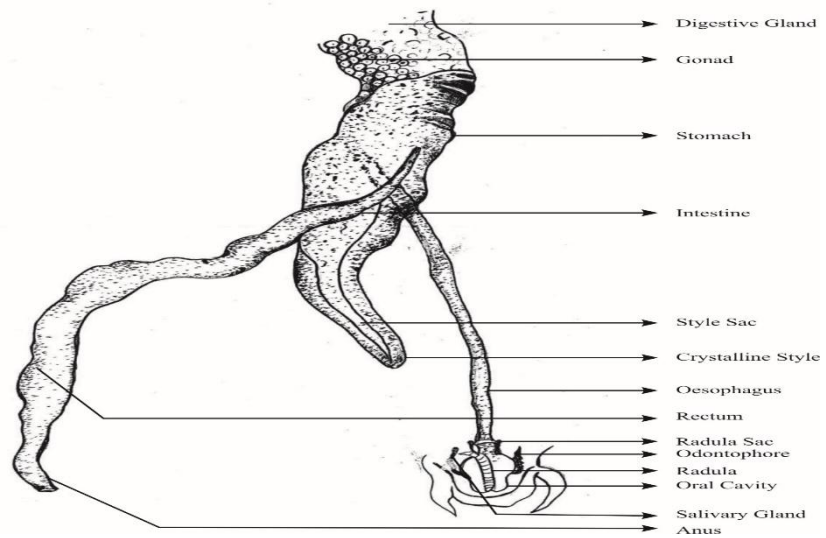

Fig. 7 : Inner view of radular apparatus

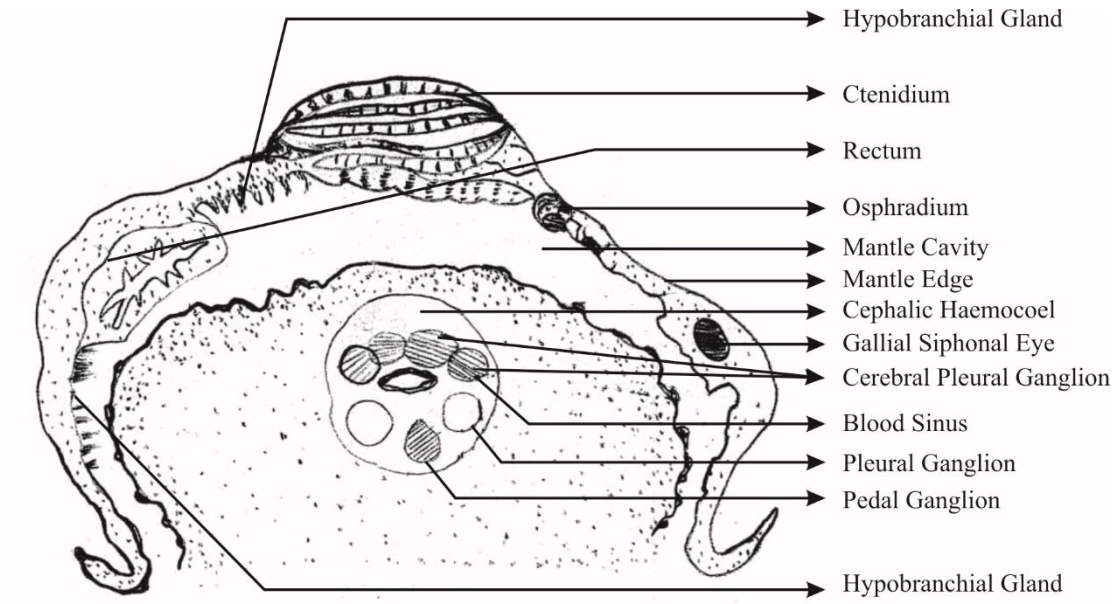

Fig. 8 : Nerve ring of *T. telescopium*

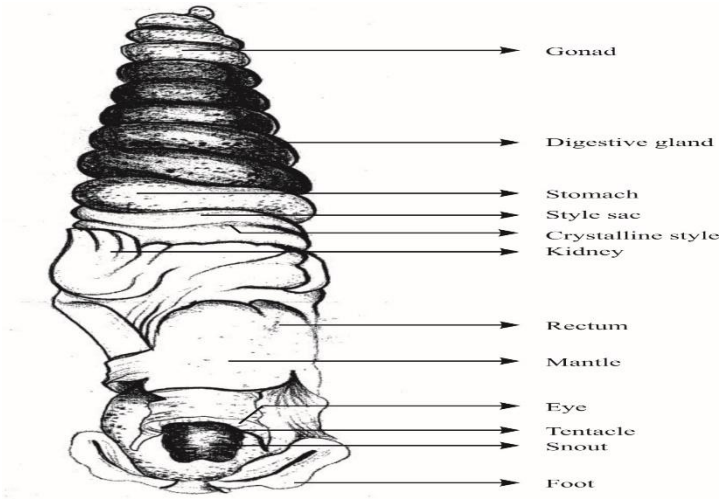

Fig..9 : Anterior part of the Digestive tract of *T. telescopium*

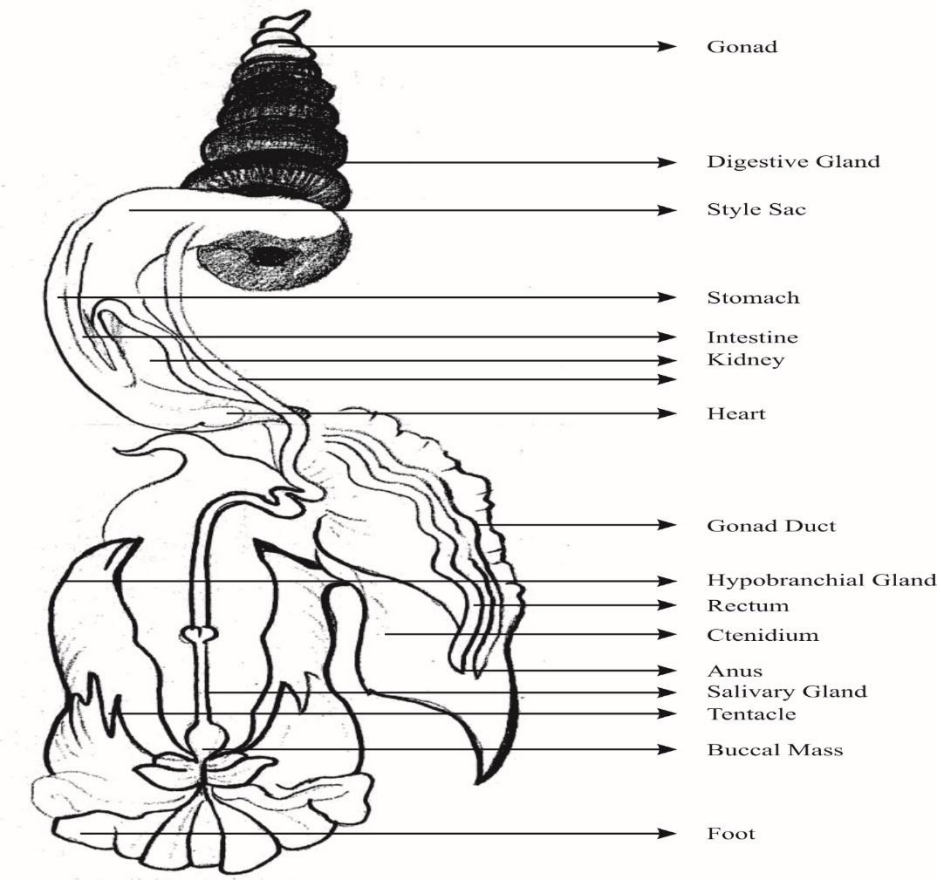

Fig. 10 : The alimentary system and other organs of a dissected specimen

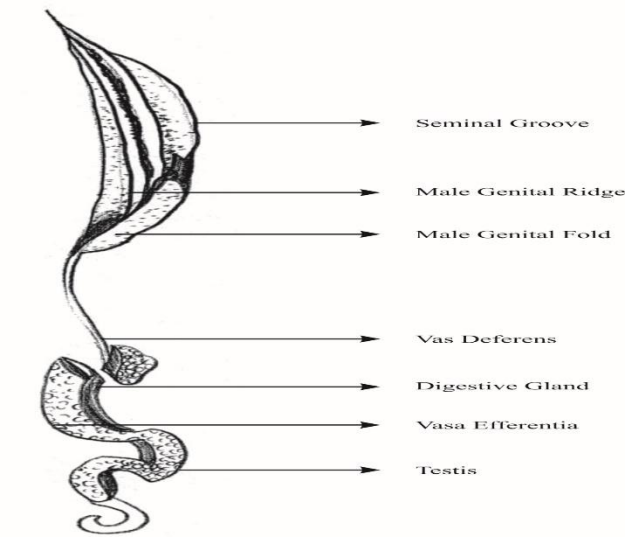

Fig. 11a : Male Reproductive system of *T. telescopium*

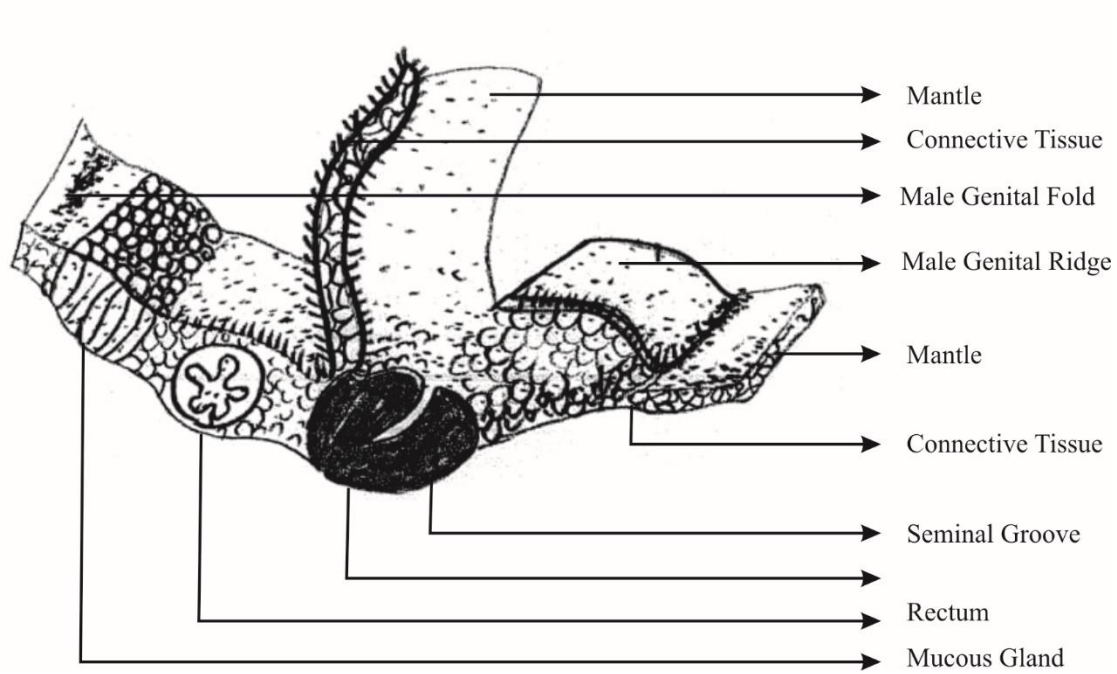

Fig. 11b : Anterior view of transverse section of Male reproductive tract of *T. telescopium*

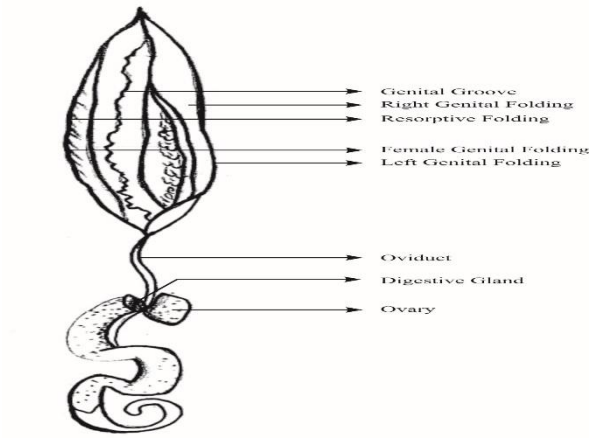

Fig. 12a : Female Reproductive system of *T. telescopium*

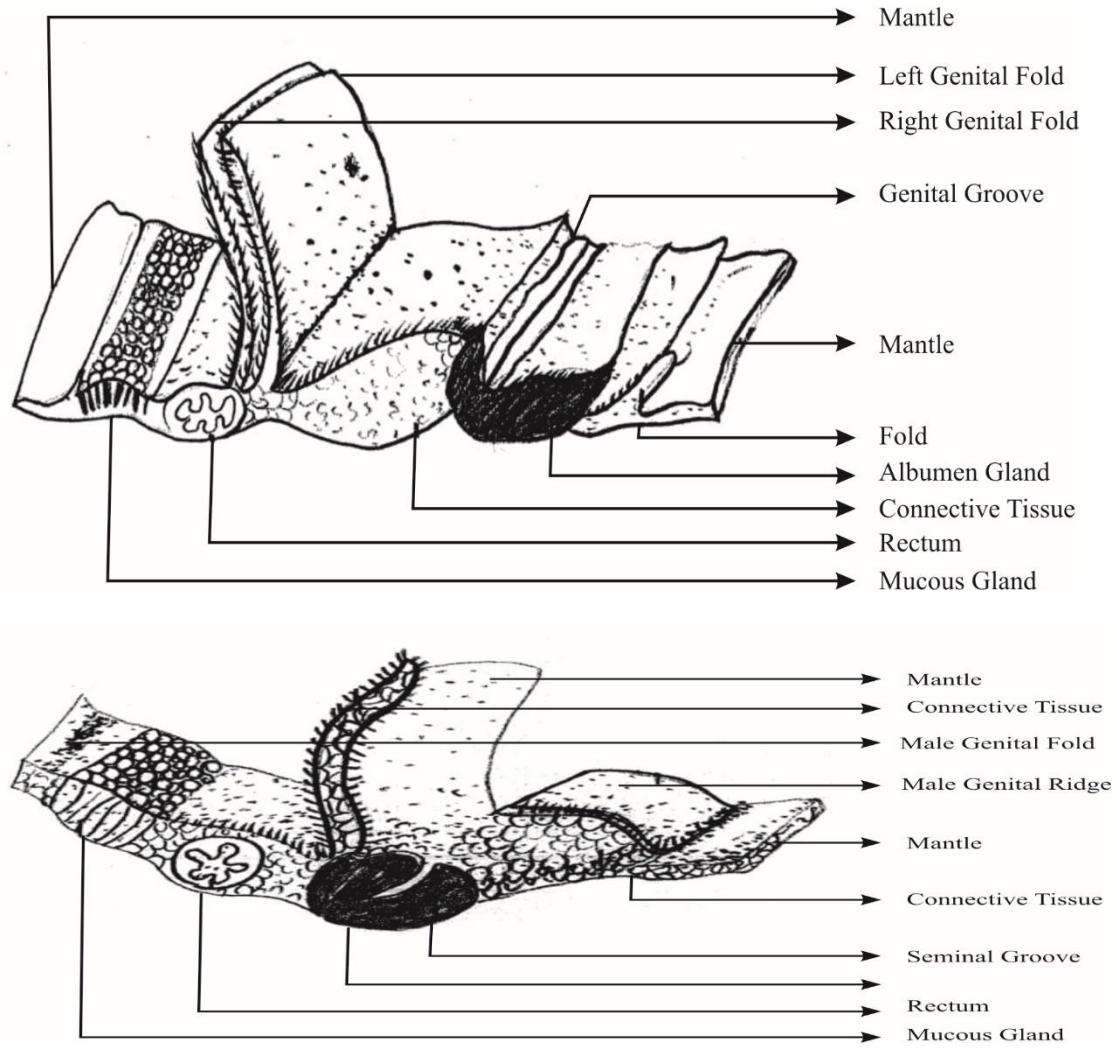

Fig. 12b : Anterior view of transverse section of Female reproductive tract of *T. telescopium*

4 Discussion

T. telescopium is one of the biggest mangrove horn snail. Richard Houbrick (1991) carried out a thorough examination and functional morphology study of mangrove prosobranch snails. The present study has established that the shell of *T. telescopium* is a massive solid conical structure, reaching up to 130 mm in length and 50 mm in breadth and including 12-16 whorls. The early whorls were sculpted with two smooth spiral cord and a beaded spiral coil near the suture. The adult whorls have axial striae and are sculpted with three spiral cords. Age and erosion may break down spiral cords to the point that they no longer operate. Concentric cords cover the base of the shell. Aperture is small, narrow and tangenital to the shell axis. The colour of the shell is uniform dark reddish brown to black, operculum is corneous, small circular with central nucleus.

T. telescopium is sexually dioecious, there is little to distinguish the sexes externally except the appeareance of shell (Fig. 11). In males the whorls of the shells are uniform, but in females the middle part of the shell exhibits slightly bulged condition (Fig. 12). In males the shell has more elongated spire with a narrow aperture and the pedal groove is absent in males but present only in females. Satyamoorthi (1960) noted that the degree of shell sculpture is a dietary trait. Growth of the shell is the result of new materials secreted by the mantle and was related with the weight of the body tissue and shell size (Hughes, 1986). The above descriptions are also in accordance with the present findings of the experimental animal.

The head is bilaterally symmetrical. The snout of *T. telescopium* is a thick, fleshy roughly triangular structure. In alive specimen the snout is extended to form a long proboscis that resembles other potamidids. The tentacles arise from the base of the snout. The animal's small radula, jaws, and buccal mass provide another stark contrast to its massive bulk and are indicative of the fine particle material eaten by the animal. The findings corroborate well with the findings of Beniazzamar and Sarwar Jahan, 2013; Richard Houbrick (1991) in other Potamididae.

The foot of *T. telescopium* is well developed and aids in locomotion. Pedal groove is present in the foot of females but not in males. Gills of *T. telescopium* are mono pectinate in organization bearing parallelly arranged lamellae. The morphology of the ctenidium resembles with other potomidids snails *Terebralia* and *Cerithium* (Richard Hourbrick, 1991); Richard Willan (2013).

The alimentary canal is notable in *T. telescopium* by having crystalline style but no oesophageal gland like pila (Prasad, 1925) which supports the idea of Graham (1956) that oesophagus gland and crystalline style do not occur together and all the prosobranch snails without oesophageal pouch have a crystalline style.

The gastric shield in the stomach of *T. telescopium* suggests that the structure is of considerable significance in gastropods having crystalline style sac, it is considered as a primitive feature in gastropods (Richard houbrick, 1991; Das and manna, 1993). The stomach in *T. telescopium* is voluminous one and provided with gastric shield. The absence of crops makes the voluminous giving space for storge of food materials.

The presence of hypobranchial gland is the characteristic feature of these prosobranchs. *T. telescopium* hypobranchial gland serves a function similar to the results given by Meenakshi (1954). In addition, Fretter and Graham (1962) theorized that the hypobranchial gland was responsible for secreting a viscous fluid that bonded particles as they were flushed out of the mantle cavity.

Asymmetry between the kidneys is already quite apparent in gastropods (Haszprunar, 1988; Ponder and Lindberg, 1997; Sasaki, 1998). *T. telescopium* excretory organ, an elliptical slit-like kidney, is situated on the ventro-lateral region of the ascending portion of the kidney, inclose proximity to the intestine. The pericardial cavity contains the two chambered heart (Fig. 2.9, 2.10). Heart and Kidney are similar to *Bithynia tentaculata* (Fretter and Graham, 1962) *Struthiolaria papulosa* (Graham, 1962). The nervous system is considered to be the most important in anatomical

studies. The nervous system of *T. telescopium* commonly correspond with that of other potamidids. Little of it resembles that of the general study made by Fretter and Graham (1962) in *Littornia* nervous system.

In highly evolved prosobranchs the males have a large penis which is folded back in the mantle cavity (Swaminathan, 1962), but in *T. telescopium* the penis is absent and the sperms are carried directly from the mantle cavity towards outside through the exhalent current of water. In *Littorina* (Linke, 1933) and *Cypraea* species (Rao, 1934) a sperm conducting tube is present which functions as a closed genital tube. *T. telescopium* is similar to *Cypraea* and *Littorina* where the male genital groove is broad. In *T. telescopium* only one type of prostrate gland is present, but Fretter (1941) has observed two types of the prostrates in *Assiminea grayana*. (Krull, 1935) *Trivia* and *Nucella*. The ciliiation in the prostate of the above species has also been observed in *T. telescopium*. Due to the absence of the penis, there is no duct communicating from the prostate to penis in *T. telescopium* (Fig. 11a,b).

In female reproductive system of *T. telescopium* there are features which show similarities with the reproductive system of the other prosobranchs. Although *T. telescopium* lacks an ovipositor, the ciliated groove that Fretter (1947) reported in species like *Bithynia tentaculata*, (Ankel, 1938) and *Trivia* and *Stenoglossa* (Fretter, 1941) is an interesting adaptation. In *T. telescopium* the receptaculum seminis (Spermatheca) is represented by a longitudinal slit in the pallium bound by genital folds which form a temporary tube. *T. telescopium* when compared with other mesogastropodans like *Bithium, Cerithiopses clathrus* and *Cerithium* possessing an open system seems to have more similarities in the reproductive system except the presence of pedal groove in female and definite tracts for various function. Comparing *T. telescopium* morphology to that of other gastropods, Hughes (1986) found that the sexes are physically distinct, with sexual dimorphism evident in the size of the shell. It is clearly understood that it resembles the other caenogastropods in its morphology.

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