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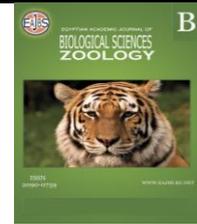
Studies on the Functional Morphology of the Digestive System of the Fresh Water Thiarid Snail, *Mieniplotia scabra* (MÜLLER, 1774), Family Thiaridae New to Egypt

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ABSTRACT

Detailed functional morphology of the digestive system of the thiarid snail *Mieniplotia scabra* is given in this study. The basic anatomical structure is consisting mainly of the mouth opening, the buccal mass, the salivary gland, the esophagus, the stomach, the style sac, the digestive gland, the intestine and the rectum. It confirms to that of any other style – bearing caenogastropods.

The muscular structure of the buccal mass of the present snail has been macro and micro anatomically studied. Their structure has been correlated with their function and with the mechanism of feeding. It has been compared with the corresponding constituents of other caenogastropods mainly in family Thiaridae.

The esophagus is an almost long tube and divided into three parts; pro - mid-, and post esophagus. The absence of the esophageal pouches and the crop of the alimentary canal of the present species reveal that the present snail is not adapted for cilliary feeding. The main structure of the stomach and the style sac resembles to those described in other thiarid snails. The detailed microanatomy and function of the epithelial lining of the digestive tubules of the digestive gland vary from one group to another thiarid snail according to the mode of feeding and digestion. Thus, in the present style - bearing microphagous herbivorous species the cells of the digestive tubule can be found in any one of the following three phases of activity; absorption, digestion and excretion. Therefore, they may be mainly adapted for intracellular digestion, absorption and excretion. The pro - intestine with its typhlosole, the post - intestine and the rectum have a simple histological structure; each being basically formed of a simple ciliated columnar epithelium with mucus-secreting cells and an outer muscular coat. The anal papilla characterized by the relatively thick muscular coat and long cilia of the epithelial lining.

INTRODUCTION

Thiaridae, Gill, 1871, is a family of class Gastropoda that includes species that have been intensely studied because of their reproductive, medical, veterinary importance and life history strategies, and their capacity for successful colonization of new habitats worldwide (Srong *et. al.,* 2011). Although understanding of Thiaridae has been increased in recent times (Glaubrecht, 1996, 1999 and 2006, Gomez *et. al.,* 2011 and Strong *et. al.* 2011), little is known about their internal structure, most of which were described based

solely on conchological features following the typological approaches of most 19th and 20th century (Reeve, 1860 and Ihering, 1902, 1909).

Mieniplotia scabra (MÜller, 1774) is a freshwater gastropod belonging to family Thiaridae (Troschel, 1857) a family that in Egypt includes another alien invasive two species *Cleopatra bulimoides* and *Melanoides tuberculatus. Mieniplotia scabra* is variable and includes many synonyms or infraspecific taxa of uncertain validity (Benthem - Jutting and Van, 1956; Brandt, 1974; StarmÜhlner, 1976, 1983, 1984; Clanfanelli *et al,* 2016). The systematic recognition at the genus level is controversial; the species is often attributed to *Thiara* Röding 1798, and even recently, some authors are continuing to consider valid the attribution to this genus (Roll et al., 2009; GBIF, 2014). Other author (Mienis, 2012; Mienis & Rittner, 2013; Nasarat *et al.*, 2014) place this species in the genus *Pseudoplotia*, Forcart, 1950; while Glaubrecht *et al.*, (2009), Glaubrecht & Podlaka (2010), Budha (2012) and Bogan (2012) place it in the genus *Plotia* (Röding 1798). The generic attribution has been recently reviewed by Low and Tan, (2014) that have established the new monospecific genus *Mieniplotia*, already adopted by Bouchet (2015). Considering that the genetic analysis confirms *Mieniplotia scabra* as rather distant from other Thiaridae (Glaubrecht*, et al* 2009), its inclusion in a monospecific genus is acceptable.

Mieniplotia scabra is recorded for the first time in Qena province, Egypt during 2017 by Moustafa & Hussien (2018a, b), where they describing its shell and soft pallial organs as *Thiara scabra*. According to Clanfanelli *et. al.* (2016), *Mieniplotia scabra* lives in Europa, Asia and Africa, giving a high propensity to invasiveness.

To the best of the author's knowledge, little is known about the structure of the different systems by StarmÜhlner (1974) as *Thiara scabra* and Low& Tan (2014) who describe briefly the shell. The detailed functional morphology of the digestive system of the invasive snail *Mieniplotia scabra* appears to be needed to fill a gap of knowledge about one of the family Thiaridae. Such a study may also add certain information of taxonomical and evolutionary importance.

MATERIALS AND METHODS

The present study was carried out in the faculty of Science, Qena, South Valley University, Upper Egypt throughout a period of one year (January - December 2017). The specimens of *Mieniplotia,* were regularly collected in great numbers, in the whole year round from the River Nile and some freshwater courses as Elkalabia drainage and irrigation canals in Qena province (26° 51´ N / 32 ° 43´ E) Upper Egypt. *Mieniplotia* snails were found most commonly crawling on the bottom of small ponds, slow running parts of the River Nile and its branches. Some specimens were also found embedded, either partially or completely, in mud along the bank of freshwater courses. In nature, the snails were found in common association with one or more other molluscan genera such as *Physa, Bellamya, Melanoides, Lanistes, Bulinus, Neritina, Cleopatra* sp*.* and rarely *Lymnaea.* The physical factors were recorded where; pH ranged from 6.8 to 7.8; dissolved oxygen ranged from 5.5 to 7.6 ppm; conductivity ranged from 0.22 to 0.98 mS; TDS ranged from 150 to 890 mg / L.

Full-grown specimens used in this investigation for dissection, examination and drawing, were 12.3 -18.3 mm. in the average shell height, and 0.75 - 0.9 mm width, respectively. For dissection of the soft parts, the body whorls of the shell were carefully broken, the columellar muscle was dislodged, and the soft parts were gently twisted out of the remaining nuclear whorls. It is worth mentioning in this regard that fresh *Mieniplotia* specimens were more suitable for the dissection and examination of the soft parts than preserved ones. For histological preparations, the fresh material was fixed in hot Bouin`s

or. Paraffin sections, 5-8μm, thick were stained with Harris haematoxylin & eosin or Mallory`s Triple stain According to Russel (1958) and quoted from Drury and Wallington (1980).

 Mieniplotia scabra belongs to the genus *Mieniplotia* (Röding, 1798); Family, Thiaridae; Superfamily: Cerithioidea; Order, Cerithiimorpha; Subclass, Caenogastropoda, Class: Gastropoda, Phylum: Mollusca.

RESULTS

The digestive system of *Mieniplotia scabra* consists mainly of the following parts, (Figs. 1- 4); the mouth opening, the buccal mass, the esophagus, the stomach, the style sac, the intestine and the rectum and the salivary and digestive glands.

1- The Mouth:

The mouth opening is the true entrance to the alimentary tract due to the absence of a proboscis. It appears at rest like a folded slit extending vertically on the most anterior surface of the snout. The margins of this slit take the form of thick plicate brown continuous lip or peristome. Their collar can be easily differentiated due to the dank pigments nature of the cephalic region surrounding them.

2- The Buccal Mass: (Figs: 1-12):

In *Mienoplatia scabra*, the buccal mass forms the anterior part of the digestive system is a conspicuous globular nearly pyriform muscular reddish mass. In the adult snail, it measures about 3.25 mm, in length, 1.85 mm in its posterior greatest width and 1.1 mm in its greatest length.

When the dorsal cephalic walls is cut open medially by a longitudinal incision, the buccal mass becomes exposed and appears occupying a median, relatively large part of the cephalic haemocoel. It is attached to the cephalic wall by a number of thin extrinsic muscle strands inserted into all sides of the mass. The cerebral ganglia can easily seem in the cephalic cavity, one on each other side of the posterodorsal edge of the mass. The cerebral commissure, extending between these two ganglia passes transversely over the posterior-most edge of the buccal mass, at the point of its connection with the esophagus.

The anterior part of the salivary glands and their two ducts can be seen, extending longitudinally on both dorsal sides of the posterior half of the buccal mass. The anterior parts of the two salivary gland ducts become embedded (Figs: 1&4).

The outer musculature of the buccal mass of the presented species will be described in the following manner:

2.1- The extrinsic muscles

2.2- Muscular coat of the buccal mass

2.3- Internal constituents of the buccal mass.

2.1- The Extrinsic Muscles:

There are some extrinsic muscles arising from the body wall and inserted into the buccal mass. These muscles can be discriminated according to their points of insertions into:

2.1.1- The Mid-Dorsal Extrinsic Muscles (Figs. 2 &5):

There are in the form of several pairs of narrow and dorsal cephalic at its median longitudinal line and extending to the external dorsal surface of the buccal mass to become inserted into its musculature on both sides of the middorsal line.

The mid-dorsal extrinsic muscles of the present species appear to be corresponding to the 6-8 pairs of the mid-dorsal protractors of the buccal mass of the snail *Marisa cornuarietis* (Demian, 1964) and to the one pair of such species of muscles designated by Scott (1957) as "protracta dorsla posterior medial" in the Argentinian ampullanids and to "musc.protector pharings dorsalis medius in *Cleopatra colbeaui* and *thiara amarula*

(StarmÜhlner, 1969) and mid-dorsal extrinsic muscles of the buccal mass of caengastropod *Bellamya unicollar* (Biddiny and Hamada, 1981).

2.1.2- The Ventral Extrinsic Muscles (Figs. 4-6):

Two long flattened, nearly, adjacent, muscular bands extending along the inner surface of the middle region of the cephalic wall. They converge gradually towards each other as they pass anteriorly close to the mid-ventral surface of the buccal mass and become inserted in the foot muscles. Each band is about 2.6 mm. long and 600µm. in maximum width. No corresponded muscles were recorded in *Cleopatra calbeaui*, *Thiara amarula* (Stramuhler, 1969). Moustafa and Hussien (2018a, b) recorded the presence of ventral muscle in the thiarid snail *Cleopatra bulimoides* in Egypt.

2.1.3- The Circumoral Dilators (Figs. 2, 4-6):

These muscles consist of a long number of small, short, slender muscle bands, originating from the inner surface of the anterior-most part of the cephalic wall and extending towards the extreme anterior part of the buccal mass, in a radial manner and finally become embedded inter its musculature.

The position and possible function of these muscles show that they correspond to those of the *Marisa cornuarietis* (Demian, 1964) and to the dorsal mandibular dilators of the basematophera *Planorbius correns* (Hemrow, 1973). Also, they correspond to some of the muscles of *Pila globosa*, reffered to by Prashad (1925), as the "ventral protractors" of the buccal mass and to Musc. Circumoralis of *Cleopatra colbeaui* and *Thiara amarula* (StarmÜhlner, 1969).

2.1.4 - Lateral Extrinsic Muscles (Figs. 4&5):

These muscles can be seen as anterior and posterior groups. They are increasing gradually in thickness as they extend towards their point of insertion in cephalic haemocoel, originates as a single band from the inner surface of the posterolateral part of the cephalic wall, at a point opposite the pro-esophagus. It extends within the cephalic haemocoel in an anterior direction towards the posterolateral part of the buccal mass.

These muscles appear to correspond ventrolateral extrinsic muscles of the buccal mass of the viviparid snail *Bellamya unicola* (Beddiny and Hamada, 1981), to lateral muscles of the buccal mass of *Cleopatra bulimoides* (Moustafa, 1987 and Moustafa & Hussien, 2018a, b). No corresponding muscles were recorded in both thiarid snail *Cleopatra colbeani* and *Thiara amarula* (StarmÜhlner, 1969).

2.1.5- Ventrolateral Extrinsic Muscles (Figs. 3 &4 &5):

These muscles are in the form of two short broad bands. Each band originates from ventrolateral part of the inner surface of the cephalic wall and extends toward the opposite ventrolateral part of the anterior edge of the buccal mass where it becomes inserted. These muscles attach the buccal mass to the cephalic wall. Their contraction and relaxation apparently cause the successive projection and retraction of the mouth opening during feeding. No corresponding muscles were detected in *Cleopatra bulimoides* (Moustafa, 1987), *Cleopatra colbeani* and *Thiara amarula* (StarmÜhlner, 1969).

2.2 - Muscular Coat of the Buccal Mass (Figs. 5 & 6):

The buccal mass of the present snail is characterized by an outer thin muscular sheath, composed of smooth muscle fibres extending mainly in a circular direction, with extrinsic muscles and the intrinsic coat of the odontopheral mass.

2.3- Internal Constituents of the Buccal Mass:

Macro and microanatomical investigation of the buccal mass of the present species reveals that the internal structure of the buccal mass consists mainly of; The jaws dorsal buccal ridge, the postradular ridge, the odontopheral mass, the radula and radula sac and the subradula organ.

2.3.1- The Jaws (Figs. 5 & 6):

There are two small chitinous jaws hanging from the roof of the buccal cavity, one on each side, a little behind the oral aperture. Each jaw has a more or less cone-shaped outline, with a relatively broad thin base of attachment and narrow thick free cutting serrated edge.

2.3.2-The Dorsal Buccal Ridges (Figs. 5 & 6):

When the buccal cavity is cut open by a median longitudinal incision within the dorsal wall, two pads, like somewhat semi lunar ridges are seem projecting down from its roof, one on each side of the median plan. Both ridges form the lateral borders of the dorsal feed channel, which runs between them from the position of the jaw to the esophageal opening.

2.3.3- The Post-Radular Ledge (Figs. 5 & 6):

On the floor of the buccal cavity, there is a distinct transverse, creamish soft fold. It extends as a ledge in front of the oesophegal opening and passes anteriorly for a short distance above the lateral odontopheral cartilage to the end at posterior end of the exposed radular ribbon. This fold can be termed the post radular ledge as it is in the case in *Marisa cornuarietis* (Demian, 1964).

2.3.4-The Odontopheral Mass (Figs. 5 & 6):

Macro-micro anatomical study snail's anatomy of the buccal mass of the present species has shown the presence of an odontopheral mass below the floor of the buccal cavity, on both sides of the radular ribbon and sac. This mass comprises two elongated cone-shaped cartilages and each one has its own muscular coat. The two odontopheral cartilages have oblique dorsoventral natural positions on both sides of the buccal mass with their tapering end lying close together anterodorsally and the two broad ends lying postero-ventrally.

It is noticeable that the two tapering anterodorsal end of the right and left cartilage connected together by a thin muscles band. The two cartilages diverge from each other as they pass postero-ventrally to become opposite to each other on both sides of the radular ribbon and sac. In a dorsal view it has a triangular outline with a convex inner side and a concave outer one.

The muscular coat of the odontopheral cartilage is not regular in thickness and consists of circular muscle fibers in close contact with the periphery of the cartilaginous plate and covering it completely. It is noticeable that there is a connective tissue area between the muscular coat and the cartilage at its ventrolateral angle.There are four pairs of muscular bands connecting the muscular coat of the odontopheral mass with the radular sac at different locations. The first of these is a pair of distinct bands that can be easily exposed by macro anatomy. Each one arises from a mid-dorsal posterior part on the coat of the lateral cartilage in curved course to become inserted into a point on the ventral edge of the same side of the radular sac wall. They may be used for the retraction of the radular sac and radular ribbon during backward stroke of the radula. They can be referred to as the posterior radular tensors and corresponding in function to "Musc. Tensor radularis" in *Cleopatra colbeani* and *Thiara amarula* (StarmÜhlner, 1969), the supra median radular tensors in caenogastropod *Marise cornuaietis* (Demian, 1964), the posteroventral radular tensors in *Bellamya unicolar* (Beddiny and Hamada, 1982). The location of the "Musc. Tensor radular" in *Cleopatra colbeaui* (Starmulher, 1969) slightly differ from these of the present species in the fact that the former emanates from the posterolateral region of the odontopheral cartilage and extend dorsally and slightly backward to become attached to the posterior part of the floor of the buccal cavity and the ventral anterior part of the radular sac. On the other hand, this muscle was completely similar to Musc. Tensor radula described by (StarmÜhlner, 1969) in *Thiara amarula*.

The second pair of the muscular bands connecting the odontopheral mass with the radular sac can be designated as the post ventral muscle, originating from the median postventral part of the muscular coat of the lateral cartilage of one side and possess inwards and forwards along the posterior and inner margins of this coat to become in contact with the ventral margin of the same side of the radular sac wall. According to the position of these muscles, it is likely to assume that they apparently tend to pull the subradular epithelium backward and outwards to cause the stretching and spreading of the radula over the lateral cartilage. These muscles may correspond in function to the "Musc. Tensor radular lateralis" of *Cleopatra colbaui* and *Thiara amarula* (StarmÜhlner, 1969 P 189 fig 249) and the ventrolateral radular tensor of *Bellamya unicolor* (Beddiny and Hamada, 1982).

The third pair of these muscles can be named the dorsal muscles of the radular sac. Each of these muscles originates from the dorsal surface of the muscular coat of one of the lateral cartilage at a posterolateral point which is near the margin of the same side of the roof of the radular sac. Similar muscles have been described as "the super tensor of the radular sac" by Beddiny and Hamada (1982) in *Bellamya unicolon*.

The fourth pair of muscles connecting the odontopheral mass to the radular sac and radular ribbon consists of two twin bands arising from the anterior part of the coat of the two lateral cartilages. Each band possess backwards to become embedded in the ventral wall of the radular sac at a point near its closed end on the same side of the odontopheral mass from which it originates and can be termed anteroventral radular muscles. No corresponding muscles in the location have been maintained by StarmÜhlner (1969) in *Cleopatra calbeaui* and *Thiara amarula*.

2.3.5- The Radular Sac and the Radula (Figs. 7-12):

The radular sac of the present species arises as a ventral evagination of the floor of the buccal cavity at a median point between the anterior tip of the two odontopheral cartilages and extents posteroventrally to end below the poroesophagus. In the freshly dissected snail, it has almost pale yellow colour. It is an elongated dorsoventrally compossed sac of about 600 Mm in length. It is avoided in cross-section with a regular short axis of 200 Mm and a long axis which increases slightly towards its posterior end being about 170 µm. and 60 µm. at its anterior and posterior end, respectively within the cavity of this sac, extends the radular ribbon from its posterior blind end till it emerges from its anterior opening into the buccal cavity.

The redular ribbon of the present species appears in feeding snails, as an elongated colourless band about 2.1 mm long. It has an upper concave surface at its anterior functional part due to the slight elevation of its two lateral edges and a posteriors or nonfunctional convex one about 0.98mm long.

The former part emerges from the radular sac and extends forwards on the floor of the buccal cavity with its sides passing over the odontopheral mass. On the other hand, the latter part lies within the radular sac. The teeth are firmly fixed at their bases into the radular membrane on which they are arranged in successive transverse raws.

The longitudinal part of the radula can be differentiated into a median denticulate ribbon forming the radula proper, and two lateral edentate smooth plates lying on the odontopheral cartilages on both sides. These two lateral plates correspond to the long process of the radular membrane mentioned by Scott (1957). The along processes are semicircular in outline, with an average length and width of 0.7 and 0.85 mm, respectively. Each process is formed of a somewhat thick layer of chitinous material.

Sections of the functional part of the radular ribbon show that it consists of the teeth, the radular membrane and subraradular epithelium. The subraradular membrane is formed

only in the radular proper. It consists of a large number of thin lamellae of chitinous nature about 55 Mm in thickness. In longitudinal sections it shows alternating thick and thin regions.

Inside the radular sac, the newly formed radular teeth lie close to the radular membrane and their apices are surrounded lay. Peripheral caves secreted by the supra-radular epithelium.

The fully formed is thus composed of a central core and a peripheral cover. According to the form of the radular ribbon, the radular ribbon of the present snail is of the taenioglassate type. It has the formula 1:1:1:0:1:1:1/ 100-110, indicating the existence of seven teeth in each transverse row, and the number of the whole transverse rows ranges from, is somewhat triangular in outline and has a tapering base of attachment with an obtuse angle. It -is much wider than long, being 50-30 Mm. in width and length negatively. The free upper broad margin of the tooth is reflected backward and carries at its free margin a relatively broad central cusp and four lateral or accessory small cusps on each side. The central cusp is almost triangular in outline in a top view with a tapering blunt apex extending over about one-third of the length of the base of attachment. The lateral cusps are also conical in outline with somewhat tapering and pointed free ends, slightly curved toward the central cusps and their size decrease gradually towards the lateral edge of the tooth. The lateral tooth has a curved thin base of the attachment with an oblique wide-shaped shaft tapering greatly towards the embedded fine end. The transversely located root of the base of attachment is about 65 Mm. long and carries eight tapering cone-shaped cusps on the free edge of its backward reflecting part. The three cusps close to the central tooth are relatively larger than the remaining cusps, sharply pointed and directed inward towards the central tooth. The intermediate tooth is somewhat semicircular in outline with a fine shaft nearly perpendicular on the radular membrane, in which it's tapering and is inserted. The shaft is connected with a transversely located part about 70 µm. in length partially overlaying the adjacent lateral tooth and attached to a backward reflected earing nine small tapering cusps. The marginal tooth has an outline and the number of cusps greatly similar to those of the intermediate ones.

2.3.6- The Subradular Organ (Fig. 12):

Below the anterior part of the radular ribbon, these are a highly folded area of the floor of the buccal cavity. This area can be formed" the subradular organ" as proposed by prashad (1925). It is likely to assume that this organ probably helps in lubricating the lining of the buccal cavity.

2.3.7- The Salivary Gland (Figs. 1 & 4):

The salivary glands appear in macro anatomy as two elongated masses on the postero-ventral sides of the cephalic haemocoel beginning at a level nearly opposite to the posterior end of the proesophagus. Each gland extends anteriorly and upwards along one of the dorsal sides of the proesophagus and it becomes thin enclosing the tubular salivary gland duct before passing below the cerebral commissure to reach the postero-dorsal side of the buccal mass. Microanatomy shows that each salivary gland consists of a number of branched tubules with their lumina connected together. These tubules are concentrated at the posterior part of the gland which is nearly globular.

3 -The Esophagus (Figs. 1 & 13 & 16-19):

The esophagus of the fresh specimens is a yellowish-white long dorsoventrally compressed simple tube, starting from the postero-dorsal end of the buccal mass and passing downwards to join the stomach. Its average length is 6.4 mm. but its breadth shows a distinct enlargement at is anterior part and then it decreases gradually in breadth towards its distal end. Therefore, the esophagus can be hardly differentiated externally into three regions: a short and relatively wide anterior, a moderately dilated middle and a narrowly rounded post esophagus which leads into the stomach (Fig. 1). Examination of

serial transverse sections showed the average thickness of wall   of the esophagus ranged from 25 - 40 μm., being consists mainly of: the mucosal lining composed mainly of simple, almost ciliated, columnar cells ranged from 5 - 30 μm, outside the mucosa there is a coat of connective tissue richly supplied with circular, longitudinal and oblique muscle fibers, about 15 μm. in thickness (Figs., 16-19).

4 - The Stomach:

In its normal position, the stomach is an elongated oval sac-like structure about 3.5 – 3.8 mm. long. It is transversely located within the penultimate whorl of the visceral mass and its whole outer surface is covered by the digestive gland follicles, except the dorsal part. It is noticeable that its dorsal surface appears pale bluish in color indicating the presence of haemolymph spaces within the connective tissue covering it. In a dorsal view, the stomach has a relatively broad or posterior part 0.8 mm. in greatest width, and it narrows gradually towards the relatively narrow and short proximal or anterior part about 0.35 mm, in width. The former part which is far from the buccal mass is about 2.1 mm long and the latter is about 0.9 mm long. The esophagus opens into the distal or cardiac part of the stomach at a point near the left side of its anteroventral surface. Also, careful examination of the ventral aspect of the stomach shows the existence of a small ventral protrusion or vestibule arising from its distal or cardiac part close to its point of connection with the esophagus. These vestibules nearly rounded in top view being about 3.5 mm. in diameter and it receives, at its posterior edge, two adjacent common ducts emerging from the follicles of the digestive gland. The antero-median border of the proximal or pyloric part of the stomach is connected dorsally to the style sac and ventrally to the intestine, (Figs. 13-14).

A mid-longitudinal incision is made along the roof of the stomach, a system of elevations and grooves can be seen on the lining of its cardiac and pyloric parts, (Figs. 13-14).Examination of histological sections of the stomach revealed that these elevations are folds of the epithelial lining. On the floor of the cardiac portion of the stomach, three relatively large folds can be easily discerned. The first of these is mid-ventral somewhat conical fold which is the largest one: being about 1.00 mm long. It has a distal or posterior relatively broad part about 0.75 mm. in greatest width and narrows gradually towards its proximal end to become about 0.35 mm. wide. The second fold is intermediate in size and semicircular in outline extending on the periphery of the postero-lateral part of the floor of the cardiac stomach. It encircles the broadest posterior part of the mid-ventral fold and its left part is longer than the right one. It is moderately protruding into the lumen; being about 175 μm., in height and about 300 μm in width. These two folds enclose in between a semicircular relatively deep groove which is usually filled with food and the secretion of the digestive gland and it corresponds to the groove termed "the gutter" in the snail *Paludomus tanschaurica* (Seshaiya, 1929). The third fold is the smallest one, and it runs as a narrow elevation along the left margin of the floor of the cardiac part from its posterior end forwards to a point about 0.45 mm. before its anterior border. It is differentiated into an outer long limb about 2.0 mm in length and an inner anterior adjacent short limb about 0.3 mm. in length and 0.13 mm in width. The anterior region of fusion of the limbs is about 0.15 mm. long and about 75 μm wide, and the outer limb narrows gradually and slightly towards its posterior end which is 0.25 mm wide. The position of this fold in the closed stomach gives the impression that it may likely act as a barrier to prevent the contents of the previously mentioned groove from flowing interiorly into the pyloric stomach which lies at a relatively low level, (Figs. 20-23).

The interior of the pyloric part of the stomach is characterized by a nearly smooth deep floor and a slightly ridged roof. The low level of the floor of this part, in comparison with that of the cardiac stomach, facilitates the flow of the partially digested food from the

latter into the former, (Fig. 4).

The wall of the cardiac part of the stomach has a simple columnar epithelial lining which is almost ciliated in all parts except that covered by the gastric shield. The latter part is distinguished by relatively short columnar cells ranging from 20 to 40 µm. in height, in comparison with the rest of the endothelium which is ranging from 30 to 50 µm in height. It is noticeable that the whole endothelium is formed of granulated narrow cells with almost central nuclei nearly alternatively with vacuolated relatively broad ones with mostly basal nuclei. This indicates the secretory nature of this endothelium. Outside this endothelium, there is a clear basement membrane followed by a coat of a highly vacuolated connective tissue supported by irregularly scattered circular muscle fibers. This coat connects the cardiac stomach with the digestive gland or the mantle wall, (Figs. 20-22).The basic histological structure of the wall of the pyloric stomach is similar to that of the cardiac stomach. The noticeable difference between them is mainly confined to the ciliation and high of the endothelial columnar cells which are continuously ciliated in the former and generally shorter (about 15 µm. high) than in the latter, (Fig. 20).

5 - The Digestive Gland (Figs. 1 & 24-26):

The digestive gland of the present species is a large mass, occupying the first three apical whorls of the visceral mass. It has a deep yellowish-brown color, and appears in macroanatomy to be divided by septa into small oval or rounded lobules. It measures about 12.0 mm in maximum length, whereas its width ranging from 0.5 mm to 5.1 mm. The integument, covering the digestive gland can be microscopically differentiated into an outer simple thin epithelium followed internally by a compact thin layer of circular muscle fibers and wide area of vacuolated connective tissue. The outer epithelial layer which rests on a distinct basement membrane is mainly made up of flattened cells, except a dorsolateral area formed of cuboidal cells.

Sections show that the digestive gland is of the compound branched tubular type (Fig., 24). Each is formed of a highly complicated system of branching blind tubules which open into a relatively small number of fine tubules that collect into a main digestive gland duct (Fig., 26). The digestive gland tubules open directly into the ductules without the intervention of clear non-secretory necks, and this case is similar to that found in *Bellamya unicolor* (Beddiny and Hamada, 1982). The main digestive duct opens into small depression in the bottom of the cardiac part of the stomach near the opening of the esophagus, (Figs., 1&14 & 24 & 25). This depression may correspond to the hepatic vestibule of *Marisa cornuarietis* (Damian, 1964 & Lutfy & Demian, 1967) and the small hepatic depression of *Bellamya unicolor* (Beddiny and Hamada, 1982). The hepatic tubules are backed together by a vacuolated connective tissue that is rich in haemolymph spaces. The main digestive gland duct consists mainly of an outer thin coat of circular muscle fibers, surrounding an epithelial lining of columnar cells. Some of these cells are glandular showing clear vacuoles. The wall of hepatic tubule has an outer very thin layer of circular muscle fibers; about 7 µm, thick, surrounding a simple epithelial lining of relatively tall columnar cells, about 40 µm high. This wall encloses an irregular, variable and narrow lumen. The digestive cells correspond to the gland cells of Graham (1932), the digestive cells of Carriker & Bilstad (1946) and Cleland (1954), the hepatic cells of Michelson (1955). The digestive cells of Pan (1958), Fretter & Graham (1962) and the secretory and digestive cells of Andrews (1956) in a number of gastropods. The digestive cells of the digestive gland of the present species are tall and broad or club-shaped, with domed distal apices and flat bases. They are most abundant and largest elements in the epithelial lining of the digestive gland tubules and vary in length within one and the same tubule ranging from 25 - 37 µm in height. They usually have oval, spheroidal or cone-shaped nuclei. In some digestive cells, especially when they are highly charged with the

products of the digestion, the nuclei become irregular in shape due to the depression and indentations of their membrane. The cytoplasm show different degrees of vacuolation and its contents take different forms, sizes, and colors according to activity phases, (Figs. 24 & 25). For these reasons, the activity of the digestive cells can be ordered into three phases: absorption, digestion and excretion. It is noticeable that there are intermediate stages between them. In the case of the phase of absorption, the digestive cells appear tall columnar with their apical two-third occupied by vacuoles. In case of digestion, become cone-shaped and distended because they are packed with vacuoles. In the third or excretory phase, the digestive cells appear cone-shaped and characterized by reduction of vacuoles and the distinct large vacuole contains a characteristic big yellow body, (Fig., 14). This histological structure of the basic unit of the digestive gland tubules shows that in the prosobranch snail as in other style bearing prosobranchs (Graham 1939), there is mainly intracellular digestion.

6 - The Style Sac (Figs. 14 & 15 & 28):

As it is the case of another style - bearing prosobranchs (Graham, 1939), *Thiara scabra* has somewhat large, oval blind whitish style sac, connected with the proximal or anterior wall of the stomach. It passes from its point of connection with the pyloric stomach forwards for about 2.1 mm before its blind end reaches a point nearly opposite to the anterior edge of the kidney. It is about 0.23 mm wide at its connection with the stomach and it increases clearly in width to reach a maximum width of 0.75 mm at the middle, then its width decreases to be 0.39 mm at the blind end, (Fig. 14). The style sac has a thin wall that is internally brownish in color and encloses a wide lumen including the crystalline style. It opens by a nearly circular opening about 0.40 mm. in diameter into the pyloric stomach (Fig., 13 & 14).

Examination of a serial transverse section of the style sac revealed that the style sac of the present species gives a small protrusion along the left side of its ventral wall. It is small at the anterior blind part of the style sac and increases gradually in length as it passes posteriorly towards the intestine, and finally it opens into the intestinal lumen near the connection of the two with the pyloric stomach, (Fig. 25).

In macro-anatomy, the crystalline rod takes the form of a straight cone-shaped soft, pale grey translucent rod of 3.1 and 0.9 mm in the average length and width, respectively. It tapers gradually from its broad base at the blind end of the style sac, till its apex which is 0.20 mm in width, (Fig. 15). Transverse microscopical sections of the style sac revealed that the wall of the style sac consists of a simple epithelial lining and an outer very thin layer of circular muscle fibers about 10 μm. thick. The epithelial lining is formed of a layer of tall ciliated columnar cells about 40 μm high. Most of these cells are vacuolated with basal nuclei such structure shows the secretory function of this epithelial lining. It is noticeable that the cilia are dense and nearly equal length of about 18 μm forming an even brush-like inner border, (Fig. 28).

7 - The Intestine (Figs. 1 & 13 & 29 & 31):

The intestine of *Mieniplotia scabra* is a yellowish-white smooth and convoluted tube of about 7.1 mm in the average length. It is slightly dorsoventrally compressed to become oval in cross-sections. Its width decreases slightly and gradually as it passes from its point of connection with the stomach where it is about 0.5 mm wide till it joins the rectum where it becomes about 0.35 mm. The intestine leaves the anterior end of the pyloric stomach at a point lying dorsal to the left side of the region of junction of the latter with the style sac. Then the intestine passes anteriorly, in a curved manner, on the left side of the style sac, and turns to the right side and backward to form a loop below the style sac before it returns to the left side again and finally passes anteriorly for a short distance to join the rectum. Careful examination of the internal surface in both macroanatomy and

microscopical cross-sections revealed that the intestine can be discerned into two parts; namely the anterior and posterior intestine. The anterior intestine is marked by a prominent internal ventral fold or typhlosole running along its whole length of about 3.4 mm. The size of this fold decreases gradually as the anterior intestine passes towards the post-intestine until it disappears as the latter begins. The typhlosole leads to the formation of two grooves on both sides along the interior of the ventral wall of the anterior intestine. The posterior intestine is a relatively narrow duct about 2.8 mm. long, extending from the end of the posterior intestine to the beginning of the rectum. It is some oval in cross-sections, with the longest axis ranging from about 200 to 225 μm. along its whole length, but the shortest axis is about 170 μm.

Histologically, the wall of each of the two regions of the intestine is basically composed of simple ciliated columnar epithelial lining followed by a thin circular muscle layer and an external thick coat of vacuolated connective tissue. It is remarkable that the columnar cells of the mucosa of the anterior intestine are generally shorter than those of the post-intestine; having an average height of about 27 μm. and 35 μm., respectively. It is also noticeable that the number of the vacuolated cells of the anterior intestine appears opening in the lumen, (Figs. 29 -31).

8 - The Rectum (Figs. 1 & 13 & 14 & 32):

The rectum extends from its point of connection with the post intestine anteriorly along the inner surface of the right side of the roof of the mantle cavity within a relatively wide rectal sinus, lying nearby the ctenidium. It terminates, a little behind the free anterior mantle edge, in a short projecting anal papilla, that carries the anal opening at its free end. The rectum is a dorsoventrally compressed ovoid yellowish tube which is externally distinguished by regular transverse wrinkles. It measures about 8.3 mm in length and 0.8 in its greatest width. The anal papilla is about 1.0 mm. long and 0.4 mm. in its maximal width.

In longitudinal sections, the rectum has an ovoid outline, a relatively wide lumen and a thin wall about 22 μm. Its wall consists of a simple ciliated columnar epithelial lining, about 12 μm., followed by a thin layer of circular muscle fibers of about 9 μm. thick. The epithelial lining together with the muscular coat, are thrown into a number of folds which vary greatly in size and lead to the division of the rectal lumen into a number of variable longitudinal grooves. Most of cells of the epithelial lining have central vacuoles indicating its mucous nature.

The histological structure of the wall of the anal papilla is basically similar to that of the rectum. But it is, however, distinguished by the increase in the thickness of the circular muscle fibers, (Fig. 32). According to the histological structure of the rectum, it is likely to assume that its epithelial lining may have an absorptive function. Also, the circular muscle layer and the folded mucosal lining, with its mucous secretion, may be used for dividing the fecal particles into compact rod-like fine fragments to be ejected to the outside via the anal opening.
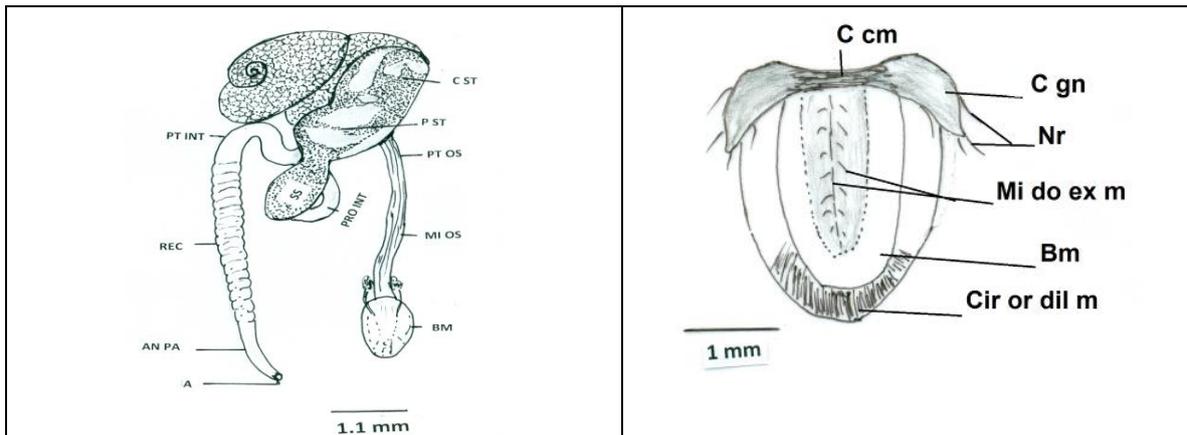
Fig.1: A camera Lucida drawing of the digestive system to show the stomach, style sac and the intestine.

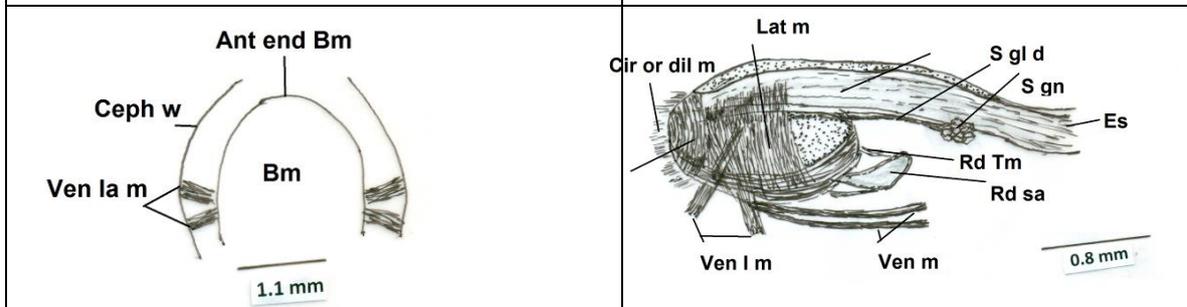**Fig.2**: Dorsal view of the buccal mass as seen in situ.

Fig.3: Drawing of the ventero- lateral aspect of the buccal mass.
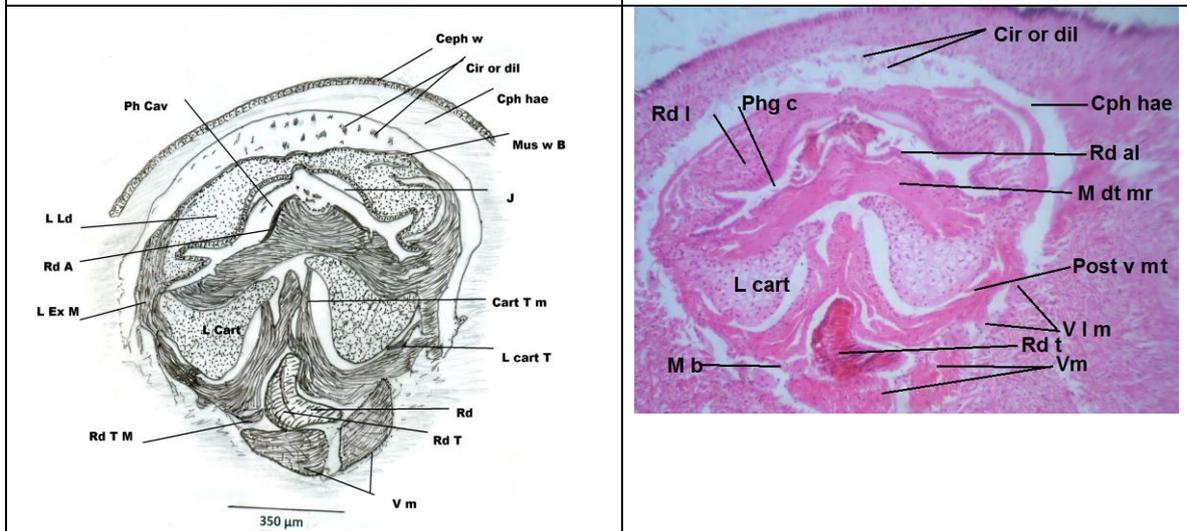
Fig.4: Lateral view of the buccal mass.

Fig.5: Hand transverse section of the buccal mass shows its interior structure.

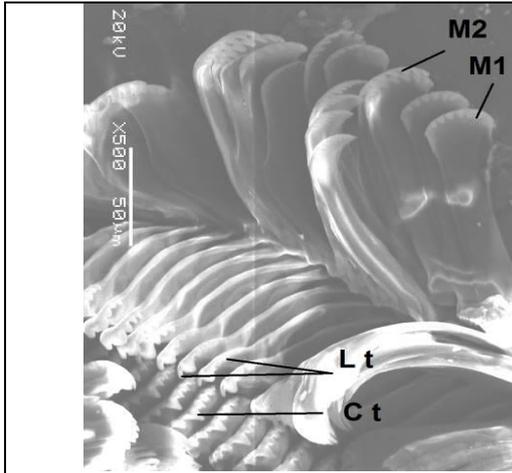**Fig.6**: T. S of the mid-region of the buccal mass showing its structure
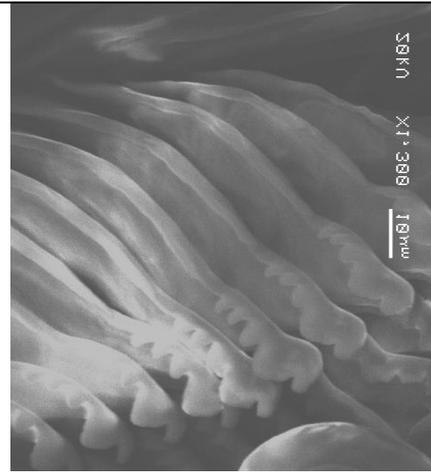
Fig.7: SEM of the radula showing its structure

Fig.8: SEM of the radula showing the structure of the lateral teeth
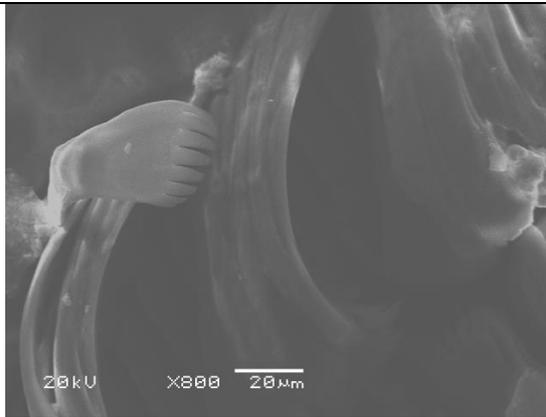
Fig.9: SEM of the radula showing the structure of marginal teeth.
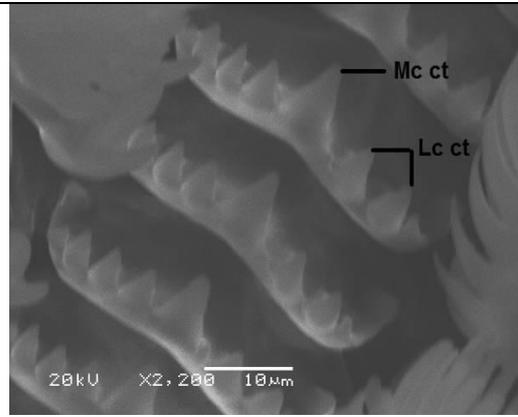
Fig.10: SEM of the radula showing the structure of rachidian teeth.
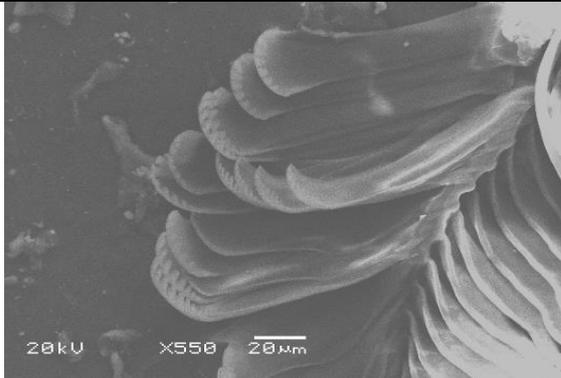
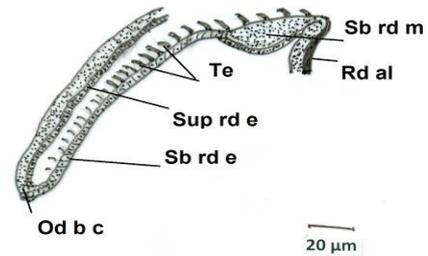**Fig.11:** SEM of the radula showing the marginal teeth.

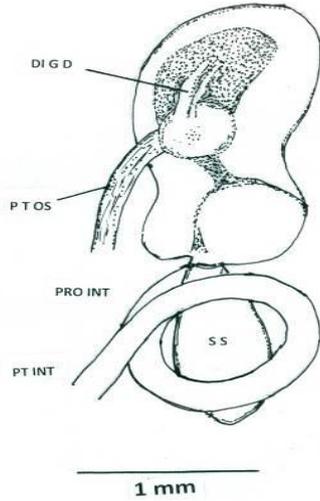**Fig.12**: diagrammatic drawing of L. S. of the radula and radular sac.

Fig.13: A camera Lucida drawing of the ventral aspect of the stomach and the associated structure
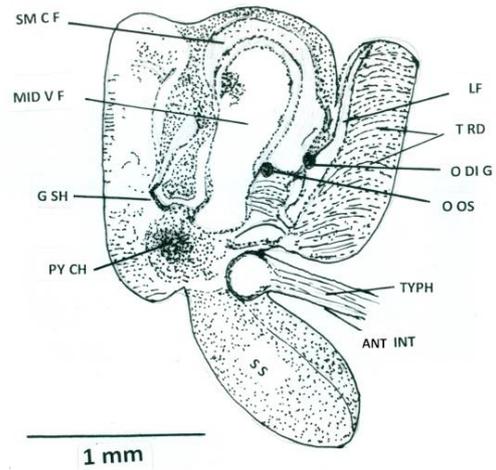

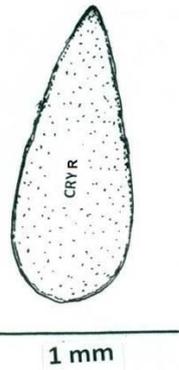**Fig.14**: A camera Lucida drawing of the interior of the stomach after making a mid - dorsal incision.

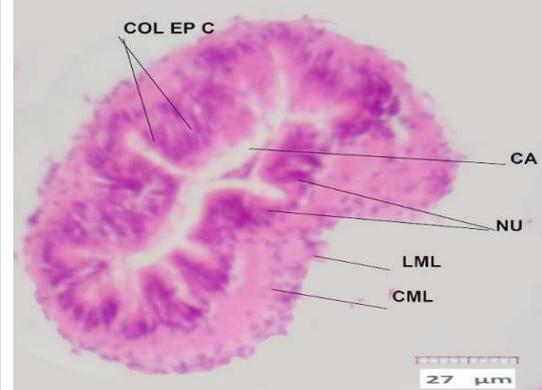**Fig.15**; A camera Lucida drawing of the dorsal aspect of the crystalline rod.

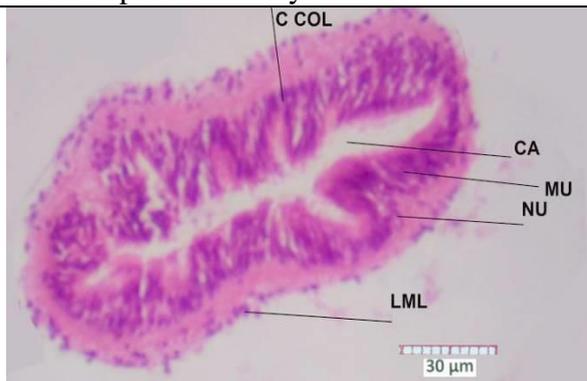**Fig.16**: T.S. of the anterior esophagus

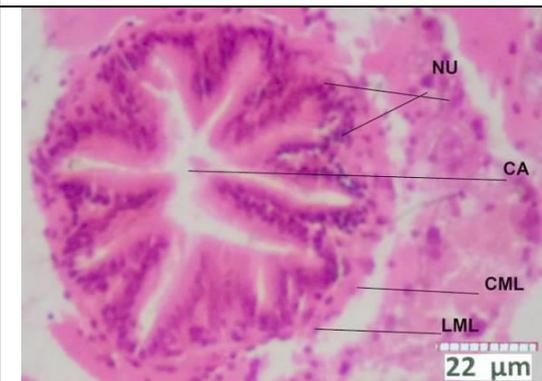**Fig,17**: T. S. of middle esophagus

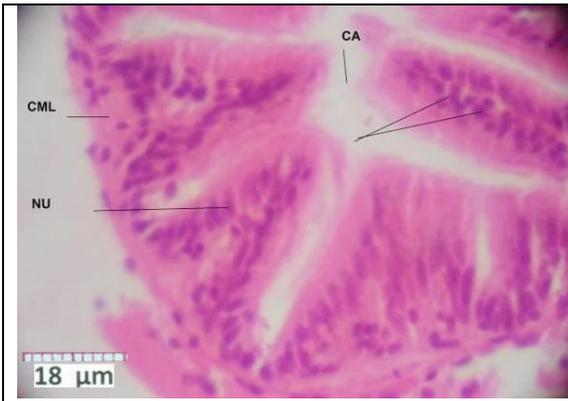**Fig.18**: T. S. of posterior esophagus

Fig.19: A magnified part of a T. S. of post-esophagus

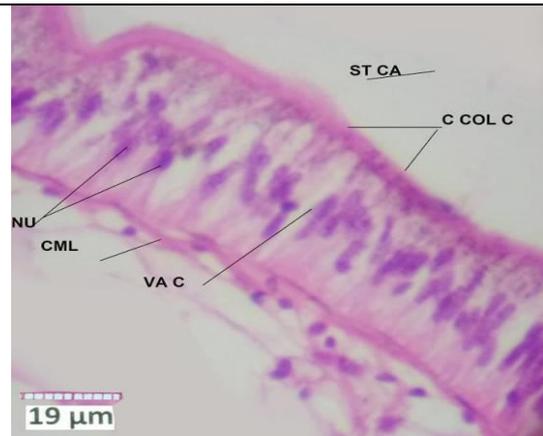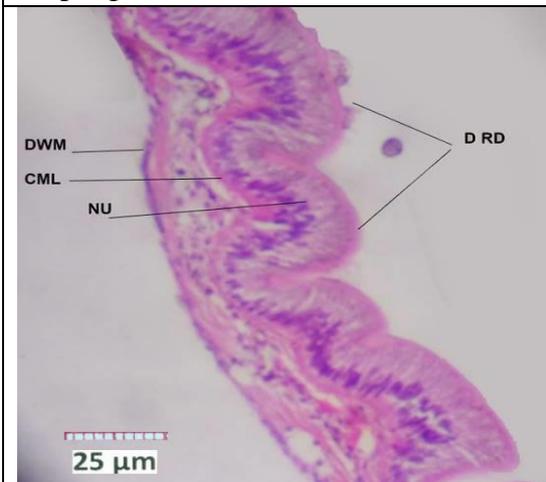**Fig.20**: T. S. of a part of the pyloric chamber of the stomach.

Fig.21: T. S. of the dorsal surface of the stomach to show the transverse ridges

Fig.22: T. S. of the mid - ventral fold of the stomach showing the gastric shield
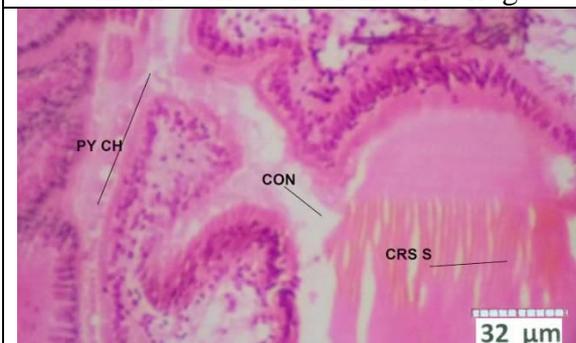
Fig.23: T. S. showing the connection between the style sac and the pyloric portion of the stomach
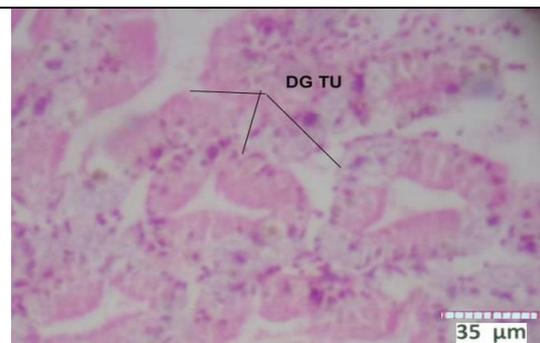
Fig.24: Section through the digestive gland tubules

Fig.25: magnified part of the digestive gland tubule showing its activity

Fig.26: Section of the digestive gland showing the connection between the main digestive gland duct with the two lateral ductules
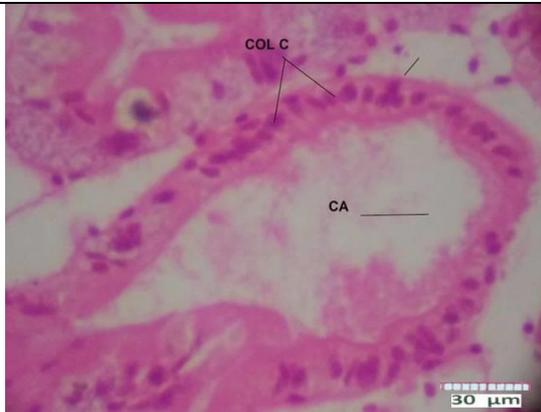
Fig.27: T. S. through the main digestive gland duct
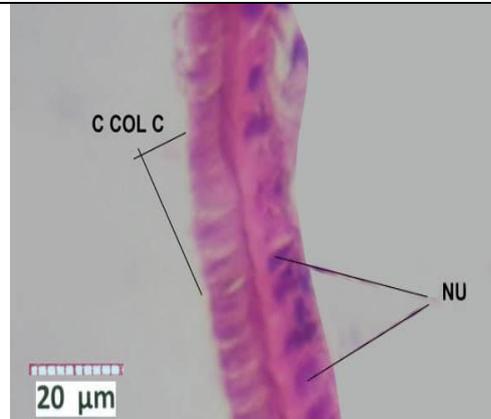
Fig.28: A magnified part of the wall of the style sac

Fig.29: T. S. of the anterior intestine shows the typhlosole

Fig.30: T. S. through the posterior intestine

Fig,31: A magnified part of figure (19)

Fig.32: L. S. showing a part of the rectum, anal papilla and the opening of the anus

DISCUSSION

The basic anatomical structure of the digestive system of the thiarid snail *Mieniplotia scabra* conforms to that of any other style bearing gastropods. It consists mainly of the mouth, the muscular buccal mass, the esophagus, the stomach, the style sac, the intestine, the rectum which ends by the anal papillae and th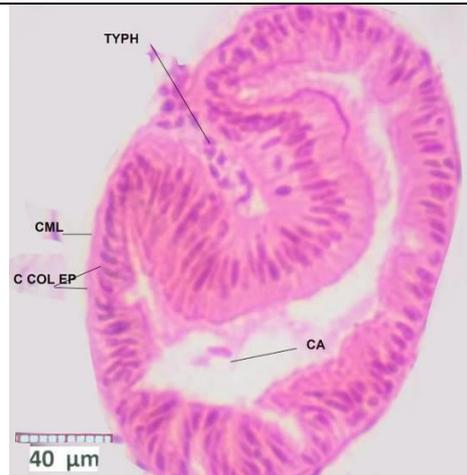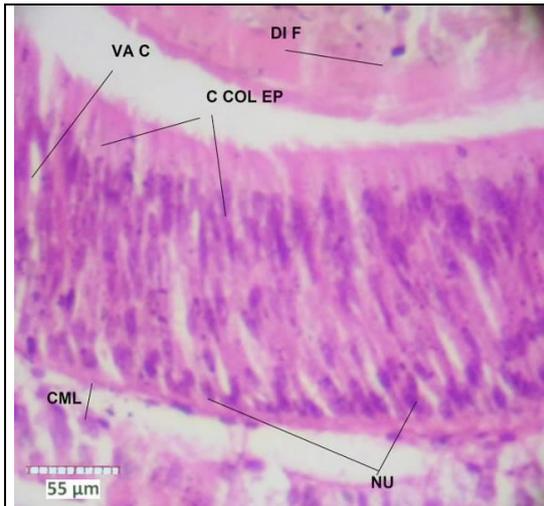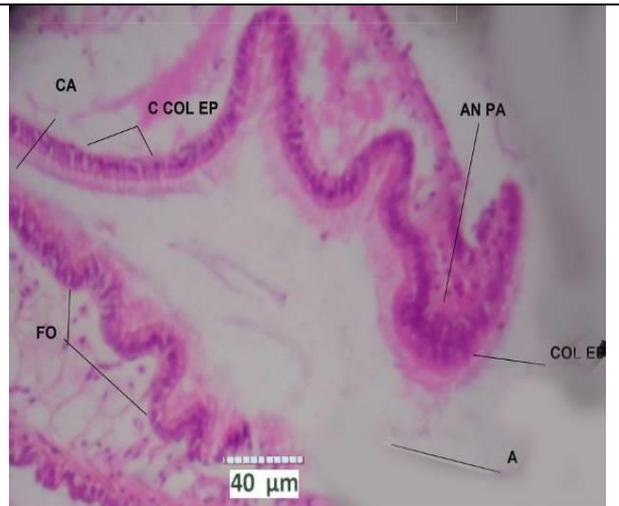e glandular structures which are the salivary and digestive glands. The present species, like some other caenogastropoda, lives in habitats where continuous feeding is possible and consequently, characterized by the presence of the crystalline style and the absence of esophageal pouch (Graham, 1939). Also, the present species is devoide of the cephalic folds and the food groove of the floor of the mantle cavity, while these features are found in partially or totally ciliary feeding. Thus it can be deduced that the thiarid snail *Mieniplotia scabra* is not adapted for ciliary feeding. The present results agree with the finding of Moustafa (1987).

The buccal mass of the present species, as that of the other caenogastropoda (Thiarid snails) is mainly formed of a basic muscular organization, the odontopheral apparatus, the radular sac and the radular ribbon. It is obvious from the present investigation that there is a number of muscle strands fixing the buccal mass of the cephalic wall within the haemocoelic cephalic cavity. These muscle strands can be differentiated according to the location of their attachment to the buccal mass into the mid-dorsal, lateral, circum oral, ventero-lateral and ventral muscles. These extrinsic muscles; although differ in the exact location of their origins from the cephalic wall and their insertions into the buccal mass from one gastropod to the other; *Marisa cornuarietis* (Demian, 1964), e.g. *Cleopatra colbeaui* and *Thiara amarula* (StarmÜhlner, 1969), *Bellamya unicolor* (Beddiny and Hamada, 1981), *Afropomus balanoideus* (Berthold, 1988), and *Cleopatra bulimoides* (Moustafa & Hussein, 2018a, b) yet in each of these caengastropod they commonly share the following function: (1) - the fixation of the buccal mass within the cephalic cavity, (2) - the anterior extension and posterior retraction of the buccal mass and the floor of the buccal cavity; (3) - the widening and narrowing of the oral aperture during feeding. it is worth mentioning in this regard that Seshaiya (1934) has briefly referred to corresponding muscles in the melaniid snail *Paludomus tanschaurica* and Yousif,(1975) has completely neglected the reference to corresponding muscles in *Melanoides tuberculatus* in Egypt. The existence of two lateral

cartilage in *Mieniplotia scabra* supporting the odontophore in the buccal mass of *Mieniplotia scabra*, as it is the case in other members of thiarida such as *C. colbeaui* and *Thiara amarula* (StarmÜhlner, 1969) or of family Thiaridae such as *Paludomus tanscharica* (Seshaiya, 1934) and *Melanoides tuberculatus* (Yousif, 1975) , adds a further evidence to Graham's (1939) statement that the odontopheral cartilages decrease in number as one ascends the caenogastropda series and in monotocardians fusion between these cartilages on each side is completely leading to only two cartilages in all. But it has been reported by some authors as prashad (1925) working on *Pila globosa*, Demian (1964) on *Marisa cornuarietis* and Beddiny and Hamada (1982) on *Bellamya unicolar* that each of these monotocardians has two pairs of odontopheral cartilages; one lateral and the other superior.

The typically taenioglossate radula of *M. scabra* shows the character of the family Thiaridae mentioned by Connoly (1939) and focused on the central tooth which is short, usually without basal denticles, and median and with the outer angle of the base obliquely elongated. Also, it coincides with Connolly's (1939) description of the radula in genus *Cleopatra* type *Cyclostoma bulimoides* Oliv. (Zanguebaria, Fischer 1881). This description elucidates that the radula is minute, the central tooth has numerous denticles and plain body, and each of the remaining teeth has about 7-9 denticles. The present study supports Strmuhlner's (1969) statement that the basal median process of the rachidian tooth in all forms of *Cleopatra* and *Thiara* of Madagscar is much shorter than that found in the African species of *Cleopatra* and *Thiara*. On the other hand the present results disagree with the findings of Surbakti and Ngili (2017) who stated that the variation of the habitat had affected the type of radula where *Mieniplotia scabra* were collected from different habitat in Upper Egypt with no differences in the structure of their radulae.

The present study agrees with the finding of other studies; Kohler *et. al.* (2008); Vogler (2013); Gayathri *et. al* (2016); Surbakti and Ngili (2017) that the Cerithoidea and family Thiaridae had differences in the radular formula and dentation of teeth of the different genus and species of this family

It is noticeable that the basic histological structure of the constituents of the buccal mass is similar to that of the corresponding elements described in other gastropods, e.g. *Marisa cornuarietis* (Lutfy and Demian, 1964a, b and 1967) and *Bellamya unicolor* (Beddiny and Hamada, 1982b). Binder (1959) had only recorded the position and size of the buccal mass of the thiarid *Cleopatra bulimoides* in Ocidental Africa and that the radula was described by Pilsbry & Bequaert (1927), Moustafa (1987) and Moustafa & Hussein (2108a, b).

It is worth mentioning in this regard that StarmÜhlner (1969) in his comprehensive study of the freshwater gastropods of Madagascar had briefly described the anatomy of the alimentary canal of *Thiara scabra and Cleopatra* sp. It is noticeable that he had considered the anterior part of the alimentary canal lying in front of the odontopheral cartilages as the buccal cavity which leads to the pharynx located above the odontophoral cartilages and passing backward to open into the esophagus. Also in the pharyngeal region, he had only briefly referred to the muscular strands, two lateral cartilages, the radula and the radular sac.

The basic anatomical structure of the digestive system of the Egyptian thiarid snail *Mieniplotia scabra* conforms to that of any other style bearing snails (Graham, 1939; Moustafa (1987); Strong & Glaubrecht , (2003); Vogler et al , (2014); Bocxlaer and Strong (2016); Khalil & Aly (1997). It consists mainly of the mouth, which leads to the pgayngeal cavity (StarmÜhlner, 1969), the muscular buccal mass, the esophagus, the stomach, the style sac, the intestine, the rectum which ends with the anal papilla and the

glandular structures which are the digestive and salivary glands. The present species, like some other prosobranchs, lives in habitats where continuous feeding is possible and consequently, it is characterized by the presence of the crystalline style and the absence of esophageal pouches as it was recorded by Graham (1939). Also, the present snail is devoid of the cephalic fold and the food groove of the floor of mantle cavity, while these features are found in partially or totally cilliary feeding gastropods e. g. *Bellamya unicolar* (Beddiny and Hamada, 1882c) and *Turritella communis* R (Graham, 1938). Thus it can be deduced that *Mieniplotia scabra* is not adapted for ciliary feeding and it depends on rasping soft food, consisting mainly of algae and plant leaves, by the radular teeth and taking up the fine food fragments.

The present study agrees with the findings of Binder (1959), StarmÜhlner (1969), Beddiny & Hamada (1982 & 1983) that most of Cerithoideans, the esophagus is an almost long tube which can be differentiated due to variation in width, outline of cross-sections and thickness of the wall into, anterior, middle and posterior esophagus. Each of these parts has the same basic histological structure of mucous-secreting, almost ciliated columnar epithelial lining and connective tissue coat richly supplied with circular, longitudinal and oblique muscle fibers.

The absence of the crop in the alimentary canal of the snail *Mieniplotia scabra* coincides with what had been found in the snails in other thiarid species, e. g. *Thiara granifera* (Abbott, 1952), *Cleopatra colbeaui & C. madagascariensis* (StarmÜhlner, 1969) and *Cleopatra bulimoides* (Moustafa, 1987) . This character appears to be correlated with the adaptation of these snails to feeding on fine food particles as it is the case in similar Cerithoideans, e. g. the viviparid snail *Bellamya unicolar* (Beddiny and Hamada, 1982).

The structure of the digestive gland of the present species is similar to that described by Lutfy & Demian (1967) in *Marisa cornuarietis*; Beddiny and Hamada (1982) in *Bellamya unicolar* and *Cleopatra bulimoides* (Moustafa, 1987). The digestive gland of the present species as in all forms with a crystalline style (e.g. Yong, 1926 b and Graham, 1939) may assume the form of digestive diverticula organs not for secretion but for the ingestion of minute's particles and for their intracellular digestion.

The macro and microanatomy of the stomach of *Mieniplotia scabra* under investigation is almost similar to that of the mesogastropod species in occidental Africa drawn by Binder (1959). StarmÜhlner (1969) neither described nor illustrated the interior of the stomach or the digestive gland in his study of the digestive system of the freshwater style bearing gastropods of Madagascar, including certain thiarid species, e.g. *Cleopatra colbeaui, C. madagascariensis, Thiara amarula* and *Melanoides tuberculatus.* The microanatomy of the latter species was studied by Yousif (1975) who described and illustrated the interior of its stomach; showing its similarity to that of the present species in the fundamental folds, ridges and grooves. Also, the interior structure of the stomach of the present species agrees with the findings of some Cerithoidan species recorded by Khalil & Ali (1997) and as a midgut recorded by, Glaubrecht (1996&1999), Michel, (2004, Strong, (2003&2005), Michel (2004), Strong and Glaubrecht, (2007), Strong *et al.* (2011), Vogler *et al.* (2014) and Bouchet (2015).

The structure and position of the anterior intestine with its typhlosole, the posterior intestine and the rectum show the same similarities in structure, a position as hindgut to those described by the abovementioned authors. On the other hand, Strong & Glaubrecht (2003); Strong, (2005) and Strong & Frest (2007) divided the digestive system into three region; forgut which include mouth, buccal mass and esophagus; the midgut which include the stomach and the style sac; and the hindgut which include the intestine, rectum

and anal papilla which ends by anus. The present authors prefer to use the classical nomenclature of the different regions of the digestive system.

LIST OF ABBREVIATIONS

A	Anus	MD VF	Mid - ventral fold
AN PA	Anal Papilla	Mi do ex m	Mid-dorsal extrinsic muscle
Ant end Bm	Anterior end of buccal mass	MI OS	Middle esophagus
ANT INT	Anterior Intestine	Mu	Mucosa
BM	Buccal Mass	Mus wB	Muscular wall of buccal mass
C cm	Cerebral commisure	Nr	Nerve
C gn	Cerebral ganglion	Nu	Nucleus
C M L	Circular Muscle Layer	O DI G	Opening of digestive gland
C SH	Cardiac Stomach	O OS	Opening of eesophagus
C St	Cardiac Stomach	Od b c	Odontoblastic cushion
Cart t m	Cartilage tensor muscle	P St	Pyloric Stomach
Ceph w	Cephalic wall	Ph cav	Pharyngeal cavity
Cir or di	Circum oral dilaters	Post v.m	Postventral muscle
Cir or dil m	Circum oral dilator	PT INT	Posterior Intestine
Co Di GD	Common Digestive Gland Duct	PT OS	Posterior eesophagus
Co E C	Columnar Epithelium Ciliated	PY CH	pyloric chamber
Con	Connective tissue	Rd	Radular
Cph hae	Cephalic Haemocoel	Rd al	Radial allery
CRY S	Crystalline rod	Rd sa	Radular sac
Ct	Central tooth	Rd t	Radular teeth
D W M	External Dorsal Wall	Rd T	Radular tensor
D. MBM	Dorsal muscle of buccal mass	Rd T M	Radular tensor muscle
DG Tu	Digestive Gland Tubule	Rdt	Radular teeth
Di G D	digestive gland duct	Rec.	Rectum
Di G Du	Digestive Gland Duct	S gl d	Salivary gland duct
D-rd	Dorsal ridges	S gn	Salivary gland
Es	esophagus	Sb rd e	Subradular epithelium
G SH	gastric shield	Sb rd m	Subraradular muscle
J	Jaw	SM C F	Semi-circular fold
L cart	Lateral cartild	SS	Style Sac
L cart T	Lateral Cartilage tensor	St Ca	Stomach cavity
L Ex M	Lateral extrinsic muscle	Sub Rd ep	Subradular ep
L F	lateral fold	Sup rd e	Super radular epithelium
L ld	Lateral ledge	T RD	transverse ridges
L M L	Longitudinal Muscle Layer	Te	Teeth
Lat m	Lateral muscle	TYPH	Typhlosole
Lc ct	Lateral Cusp of central tooth	V m	Ventral muscle
Lt	Lateral teeth	V tcart	Ventral tensor of lateral cartilge
Lt rd	Lateral tensor of radula	Va C	Vacuolated cell
M1	Firist marginal teeth	Ven l m	Venterolateral muscle
M2	Second marginal teeth	Ven m	Ventero muscle
Ma Tmr	Main dorsal tensor muscle of Radula	VLm	Ventro lateral muscle
Mb	Muscle band	Vm	Ventral teeth
Mc ct	Median cusp of central tooth		

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ARABIC SUMMARY

دراسات على التشريح الوظيفي للجهاز الهضمي لأحد قواقع المياه العذبة من فصيلة ثياريدي   *Mieniplotia scabra* (ميلر 1974) نوع جديد بالنسبة لمصر

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في هذا البحث تم لأول مرة دراسة التشريح الوظيفي للجهاز الهضمي لقوقع المياه العذبة *Mieniplotia scabra* (ميلر 1974) ، والذي سجل لأول مرة في جنوب مصر خلال عام 2017.

وقد أثبتت الدراسة أن الجهاز الهضمي يتكون من الفم ، الكتلة الفمية ، المريء ، المعدة ، الأمعاء ، المستقيم ، فتحة الشرج ، الغدد الملحقة (الغدة اللعابية – الغدة الهاضمة).

تم دراسة التركيب العضلي للكتلة الفمية ومقارنتها بمثيلاتها في الفصيلة وتحت الطائفة ، وقد أوضح التشريح المورفولوجي والنسيجي ارتباط ذلك التركيب العضلي بوظيفته الأساسية وهي عملية الاغتذاء.

المريء عبارة عن أنبوب طويل يلي الكتله الفمية ، وينقسم إلي ثلاثة أجزاء (أمامي – وسط – خلفي) ، ونظرا لغياب الجيوب المريئية يصبح نوع *Mieniplotia scabra* غير مهيأ للاغتذاء الهدبي وذلك لوجود السفن.

المعدة اتقسم الي جزأين رئيسيين وهما الجزء الفؤادي والجزء القلبي ، ويتصل الجزء الفؤادي بالكيس البللوري والذي يحتوي علي العمود البللوري ، والذي تساهم حركته في توزيع الغذاء في المعدة.

أوضحت الدراسة الاختلاف النسيجي لأنيبيبات الغدة الهاضمة ، مما يثبت أن الهضم داخل خلايا الغدة الهاضمة ، وكذلك وجود التيفلوسول في المعي الأمامي يظهر إحدي الصفات المميزة لهذه الفصيلة ، كما أوضحت الدراسة التشابه النسيجي للأمعاء وكذلك وجود الحلمة الشرجية.