

First record of an intermediate thiarid snail host; *Tarebia granifera* (Lamarck, 1822) of the lung trematod (*Paragonimus westermani* Kerbert) in Qena Province, Upper Egypt

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ABSTRACT

In a one-year study, a new record of the freshwater thiarid snail, *Tarebia granifera*, was collected in huge amounts from the River Nile in Qena province, Upper Egypt. *Tarebia granifera* is a highly invasive species that has spread throughout the tropical world and can displace native gastropods as well as cause damage to water systems by clogging pipes and machinery. The shell is extremely variable in size, shape, and sculpture: obtusely to elongate conical, elevated spire up to 8 – 13 whorls, the ultimate whorl large; coarsely sculptured by elevated ridges in a vertical and spiral direction, causing a pattern of strong and blunt nodules. It was noticed that the apex is always eroded and the umbilicus is closed. Aperture is almost vertical, oval, pointed above, and rounded below. The operculum is corneous, opaque, dark reddish-brown. The type of operculum of the investigated snail is paucispiral with the nucleus placed in the far bottom right corner. Growth lines are coarse and irregular. The soft parts show the typical parts of the gastropod body, which are; the head, foot, and visceral mass. The head and foot of the active snail can be seen protruding out of the shell. The pallial organs are typically like thiarid in both form and position. The mantle is the most important and specialized organ of the Gastropoda, for it not only bears the glands that secrete the shell but it also serves as a base to which the ctenidium, osphradium, and several excretory and reproductive outlets are attached. The mantle of the present species is a thin, fleshy, cone-shaped cap and hangs over the body. It is appressed closely to the interior of the last half of the last whorl and thus creates an open cavity into which water may enter freely to bathe the gills. The anterior border bears a series of 4– 5 large, projecting, fleshy papillae; the farthest to the left being the largest. The four papillae, the farthest to the left, are bulbous at their basal attachment to the mantle and are pointed at their distal ends, which may be seen projecting well beyond the edge of the shell. While, to the right, there are 6 to 8 progressively smaller papillae that are not bulbous at their base and act as the accessory respiratory systems and as chemoreceptors.

INTRODUCTION

Recently, an increasing interest has been directed to the Thiaridae, or "melaniid" snails, not only among malacologists but also among parasitologists. Notably, numerous species in Thiaridae family serve as intermediate hosts of human Trematodes diseases. A

few years ago, *Tarebia granifera* (Lamnrck, 1822) has been determined as an important intermediate snail host of the oriental lung fluke (*Paragonimus westermani* Kerbert).

A review of the available literature of the freshwater snail fauna in Egypt has shown that, genus *Tarebia* (Adams & Adams, 1854) was not represented in the molluscan fauna of Egypt (Starmühlner, 1982, van Damme, 1986; Neubert, 1998; Brown, 2005; Ibrahim *et al.*, 2006; Thompson *et al.*, 2009; Hussein *et al.*, 2011; Abd Elwakeil *et al.*, 2013; Choubisa & Sheikh, 2013; Abdel - Gawad & Mola, 2014; Lotfy & Lotfy, 2015; Moustafa & Hussien, 2018a, b). This was also indicated by Davis and Yannmaguchi (1969), Pace (1973), Brandt (1974), Starmühlner (1976, 1984), Burch (1980), Subba Rao (1989), Appleton and Nadasan (2002), Glaubrecht *et al.* (2009), Dunga *et al.* (2010), Budha (2012), Gloer and Pesic (2012), GBIF (2014), Isnaningsih *et al.* (2017), Nuanpan *et al.* (2018) and Ponder, *et al.*, 2020.

To the best of the previous authors' knowledge, it is the first time to record this genus in Upper Egypt, mainly in Qena city. It may have reached Egypt by the Nile stream or it may be introduced by any other way, but the date of its introduction is still unknown. It is initially represented with only one species.

The original distribution of *Tarebia granifera* includes a large area of the Indo - Pacific coasts and its adjacent islands from Central East Africa to South Asia and North-East Australia (Davis & Yannmaguchi, 1969; Pace, 1973; Brandt, 1974; Starmühlner, 1976, 1984; Burch, 1980; Subba Rao, 1989; Nasmann *et al.*, 2007; Glaubrecht *et al.*, 2009; Dunga *et al.*, 2010; Budha, 2012; Gloer & Pesic, 2012; GBIF, 2014; Isnaningsih *et al.*, 2017).

In Egypt, according to previous researches, this species was collected for the first time in great numbers from River Nile in 2018 at Qena province, mainly Qena city. Due to its medical and veterinary importance, the present paper was conducted to primarily address the anatomy of the fresh-water snail *Tarebia granifera*.

MATERIALS AND METHODS

The present study was carried out in the Faculty of Science at Qena City, South Valley University, Upper Egypt. The snail under investigation was collected throughout a period of one year (January - December 2020). It was regularly collected in great numbers the whole year round from the Nile River at Qena City 26.170 N, 32.70 E, Upper Egypt. *Tarebia* snails were most commonly found embedded on the bottom of the slow running parts of the River Nile.

In nature, the snails were found in common association with one or more other molluscan genera such as *Physa*, *Bellamya*, *Melanoides*, *Lanistes*, *Bulinus*, *Neritina*, *Mutela*, *Cleopatra* sp. and rarely *Lymnaea*. Some physical factors were recorded at the collecting sites; among which is pH value that ranged between 6.75 and 7.8, the dissolved oxygen that ranged from 5.5 to 7.6 ppm, the conductivity that varied from 0.22 to 0.98 mS, and finally, the TDS with ranges between 220 and 900 mg /l.

Collected specimens were taken to the laboratory in separate containers with labels indicating the locality and date. The snails of *Tarebia* were sorted out, cleaned and reared in large plastic aquaria provided with dechlorinated tap water and some water plants as *Ceratophyllum demersum*. The snails were fed on fresh lettuce leaves which were added to the aquaria after the removal of excess food and feces during water change at the end of the suitable intervals of four or seven days. The snails were observed daily and the dead specimens were removed. This technique was found to be adequate in avoiding water pollution, which may cause death of snails. Full grown specimens used in this investigation for dissection, examination and drawings, ranged between 27 – 40 mm long in the average shell height, and width of 7.5 - 10.3 mm. All measurements given in the following description comply to those sizes and were taken by an eyepiece micrometer. Drawings of the shell and the soft parts of the snails were done with the help of camera Lucida. The terms 'proximal' and 'distal' used in this text designate the relative position of the part concerned with the head region of the snail, i.e. the proximal part is the nearest one to the latter region.

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 that fresh *Tarebia* specimens were more suitable for the dissection and examination of the soft parts than the preserved ones. This is because preservation in 70% alcohol or 10% formalin solutions turns the color of the soft parts pale leading to their rigidity.

RESULTS AND DISCUSSION

The thiarid snail *Tarebia granifera* (Lamarck, 1822) belongs to benthic fauna and lives attached to different kinds of substrate but mainly embedded in mud, and occurs in freshwater bodies, in lotic as well as lentic habitats. This species is able to live in temperatures ranging between 15 and 35°C and can resist turbidity (**Bentham-Jutting, 1956; Kartyev et al., 2009**).

Tarebia granifera (Lamarck, 1816), common name Quilted melania, belongs to genus: *Tarebia* (Adams & Adams, 1854) (Type species: *Melania granifera* Lamarck, 1816); Family: Thiariidae; Superfamily: Cerithioidea; Order: Cerithiida; Megaorder: Cerithiimorpha; Infraclass: Caenogastropoda; Class: Gastropoda; Phylum: Mollusca.

Original name: *Melania granifera* Lamarck 1816

Type locality: Timor, Indonesia, Asia.

According to Cowie (1995), the first figure of *Tarebia granifera* was published by Lamarck (1816) with the name *Melania granifera* without any description or location (**Cowie, 1995**). Later Lamarck (1822) published the following description: "M. testa ouato – acuta, striis Iransuersis crasslusculis granosis cincta, luteo, virescente ullino unfractu pentricosa; spirce anfractibus planis; aperlura Alba". **Adams and Adams (1854)** reassigned *granifera* to genus *Tarebia*. A number of authors referred to Lamarck (

1819) and used the name *Melania granifera* (Brot, 1874; Rensch, 1934), while others used the name *Thiara granifera* according to Adams and Adams (1854) as **Benthem-Jutting (1937, 1941)**. Beside those two names, some other authors used the name *Melania lineata* due to the distinguishable dark lines coinciding with spiral ridges (Mousson, 1848; Martens, 1897). Based on this distinct character, **Rensch (1934)** divided *Melania granifera* into two subspecies: *M. granifera granifera* and *M. granifera lineata*. **Benthem-Jutting (1956)** incorporated this species to *Melanoides granifera* and recorded 19 synonyms. Furthermore, Glaubrecht (1996) returned the name to *Tarebia granifera*.

(A) - The Shell (Figs. 1- 3)

Shells of the present species are highly polymorphic; extremely variable in size, shape and sculpture: obtusely to elongated conical, elevated spire up to 8 – 13 whorls, the ultimate whorl is large; coarsely sculptured by elevated ridges in vertical and spiral direction, causing a pattern of strong blunt nodules. It possesses fine dark lines coinciding with spiral ridges; on the last whorl, there are 5 – 8 spiral ridges, sometimes they predominate the spiral, and some other times prevail the axial ribs. Apex is pointed and often eroded. The shell color ranges from light to dark brown. The umbilicus is enclosed. Aperture is oval with sinuous outer margin and somewhat channeled.

Operculum is corneous, opaque, dark reddish brown. The type of operculum of the investigated snail is paucispiral with nucleus placed in the far bottom right corner (Simone, 2019, 2020). Growth lines are coarse and irregular. The inner side of the operculum is glossy and smooth with a large elongate, depressed scar from the muscle of attachment.

The characters of the shell and its operculum coincide with those of genus *T. granifera* (Lamarck, 1816) studied by Morrison (1954), Starmühlner (1974), Thompson *et al.* (2009), Nasarat and Neubert (2014), Isnaningsih *et al.* (2017) and Ricardo and Simon (2020). In addition to the shell characters of genus *Tarebia*, the results concur with the findings of Starmühlner (1969, 1974), Thompson *et al.* (2009) and Nasarat and Neubert (2014) and Isnaningsih *et al.* (2017) in the number of whorls and the eroded apical whorls.

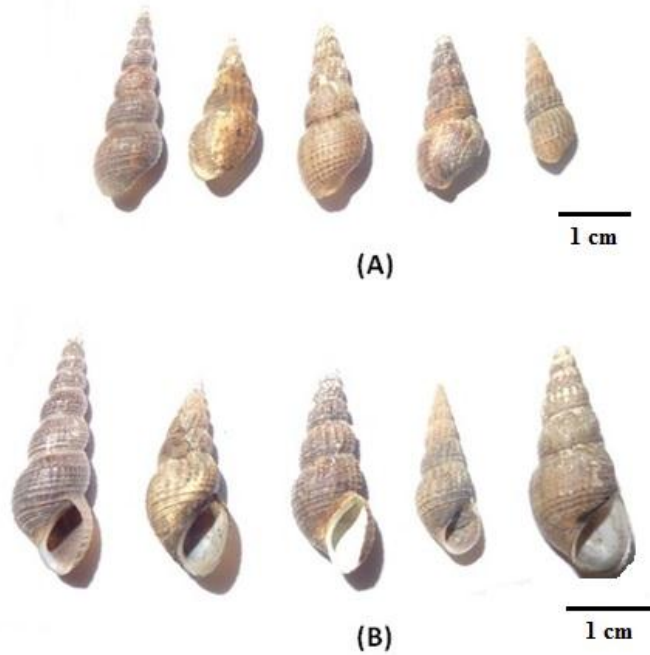


Fig. 1: A photograph of the shells of *Tarebia granifera*, showing the variation of shell shapes.
 (A) – Dorsal view (B) – ventral view

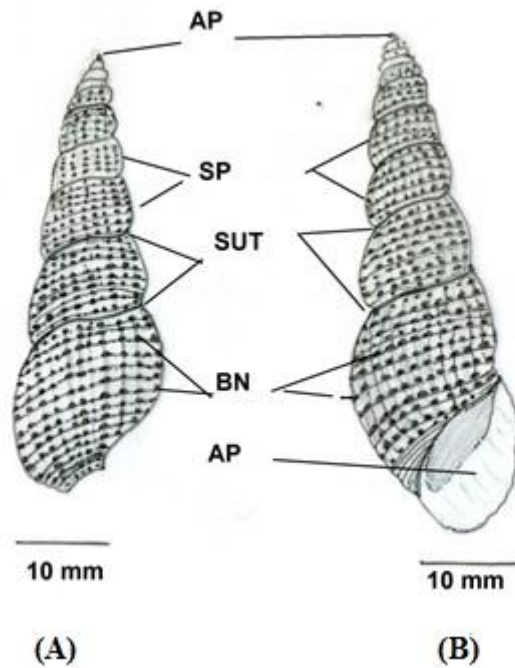


Fig. 2: A camera Lucida drawings of shell shapes similar to those in Figs. (1A, B).
 AP: Apex, SP: Spires, SUT: Sutures, BN: Blunt Nodules, AP: Aperture.
 (A) – Dorsal view (B) – ventral view

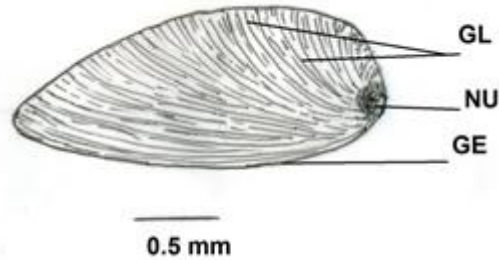


Fig. 3: A camera Lucida drawing of the upper surface of the operculum.
GL: Growth Lines, Nu: nucleus, GE: Growth Edge.

(B) - The soft parts (Figs. 4 - 8)

Animal is coiling in 3– 4 whorls, the head foot is deep brown, while the mantle is white covered with green pigment. The soft parts of the investigated species show the usual parts of the gastropod body; including the head, foot and the visceral mass. The head and foot of the active snail can be seen protruding out of the shell. The head is an elongated dorsally convex, oval mass lying anteriorly and dorsal to the foot, it is 1.8 and 0.5 mm in the long and short axis, respectively. During life, it may become prolonged anteriorly into a contractile, dorsoventrally compressed snout. The oral aperture takes the shape of a vertical slit and is situated at the anterior end of the snout. The head has a deep brownish basal color with minute yellow mottling scattered all over its dorsal side. A pair of moderately long triangular tentacles is carried dorsally on both sides of the head region. These are relatively thick at their basal ends and gradually taper toward their distal ends. They are brown in color with dark brownish transverse or longitudinal bands. Along the outer margin of the dorsal side of the basal broad part of each tentacle, there is a distinct black oval sessile eye.

The foot forms the greatest soft part that protrudes outside the shell of the fully expanded snail. It is a highly muscular organ which is more or less triangular in the outline in the dorsal view, with a broad and convex anterior margin of 1.0 mm in the average width. It gradually tapers towards its posterior end with width measure of 0.65 mm.

The mantle is the most important and specialized organ of the gastropoda, for it not only bears the glands that secrete the shell but it also serves as a base to which the ctenidium, osphradium, and several excretory and reproductive outlets are attached. The mantle of the present species is a thin, fleshy, cone – shaped cap that hangs over the body. It is appressed closely to the interior of the last half of the last whorl, and thus creates an open cavity into which water may enter freely to bathe the gills. The anterior border bears a series of large, projecting, fleshy papillae, the farthest to the left being the largest. The four papillae, the farthest to the left, are bulbous at their basal attachment to the mantle and pointed at their distal ends, which may be seen projecting well beyond the edge of the shell. To the right of those are 6 to 8 progressively smaller papillae that are

not bulbous at their base. The present findings agree with those of **Seshaiya (1934)** and **Abbott (1952)** stating that those papillae act as accessory respiratory system and a chemoreceptors as well.

The visceral mass is spiral, bulky, coiled and cone-shaped. It is covered with a thin and almost transparent integument, or mantle wall, which is supplied with dark green pigments. Through this pigmented mantle, most of the internal organs can be seen by the naked eye.

Mature and immature males were not detected in the present study. In mature female specimens, the dorsal and right aspect of the first and second whorls of the visceral mass have a brown color due to the presence of a digestive gland which can be easily seen beneath the mantle wall.

The kidney appears under the dissecting binocular microscope as a flattened quadrate creamish- white organ on the left dorsal side of the penultimate whorl of the visceral mass. When making an oblique longitudinal incision in the roof of the mantle cavity, which then shows a side of the mantle flap, the mantle cavity and its pallial organs are exposed. The pallial organs consist of the ctenidium, osphradium and rectum.

The ctenidium of the present species is elongated, being about 5 mm long and it is monopectinate. The ctenidial axis is attached to the inner surface of the roof of the pallial cavity in an oblique manner starting from a point at the posterior left side and ending at a point on its anterior right one. The ctenidial axis is attached to 90 - 100 thin and roughly triangular leaflets. They attain the maximal width and length at the median region of the ctenidial axis and their dimension decreases gradually towards its two terminal ends.

The osphradium is projected along the inner surface of the mantle as an elongated finger - like structure of about 2.5 mm long. It runs more or less parallel to the left margin of the ctenidial axis, ending anteriorly at a point of about 1.3 mm behind the mantle collar.

The rectum exists as an oblique creamish white cylindrical duct and closes the right margin of the ctenidial axis. It is attached to the inner surface of the mantle and leads to the anal papilla, which opens into the mantle cavity at a point a little behind the right side of the mantle collar. On comparing the characteristic features of the soft part of pallial organs of the present species with those of genus *Tarebia* described by **Rirch (1937)**, **Abbot (1948)**, **Brandt (1974)** and **Starmühlner (1974, 1976, 1984)**, the results revealed that the pallial organs are in the same position described by the previous authors.

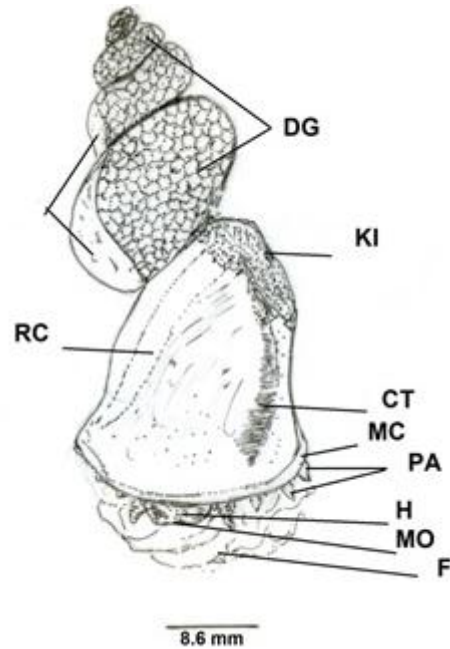


Fig. 4: A camera Lucida drawing of the dorsal aspect of the soft part of an adult specimen. DG: Digestive Gland, KI: Kidney, CT: Ctenidium, MC: Mantle Collar, PA: papillae, H: Head, MO: Mouth, F: Foot, RE: Rectum.

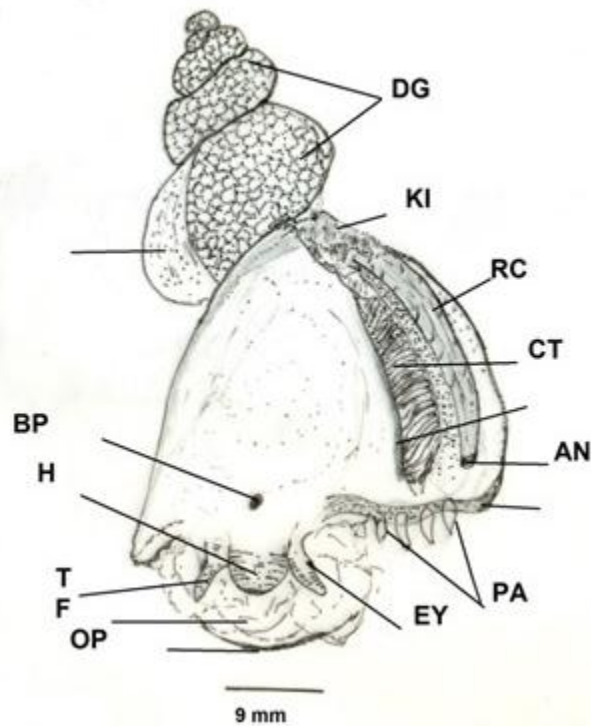


Fig. 5: A camera Lucida drawing of the dorsal aspect of the soft part of an adult specimen with the roof of the pallial cavity cut and opened to expose the pallial organs. DG: digestive gland, KI: kidney, RC: Rectum, CT: Ctenidium, AN: Anus, PA: Papillae, EY: Eye, OP: Operculum, F: Foot, T: Tentacle, H: Head, BP: Birth pore.

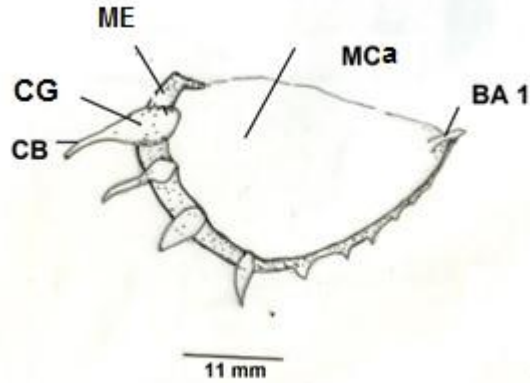


Fig. 6: A camera Lucida drawing of the edge of the ventral aspect of the mantle collar showing the sensory papillae.

CB: Black Color, CG: Color Granule, ME: Mantle Edge, MCa: Mantle Cavity, BA1: Anal papilla.

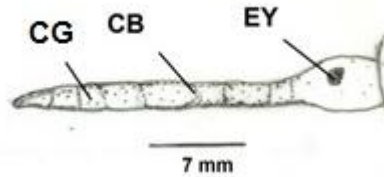


Fig. 7: A camera Lucida drawing of the edge of the right tentacle.

CG: Color Granule. CB – Black Color, EY – Eye.

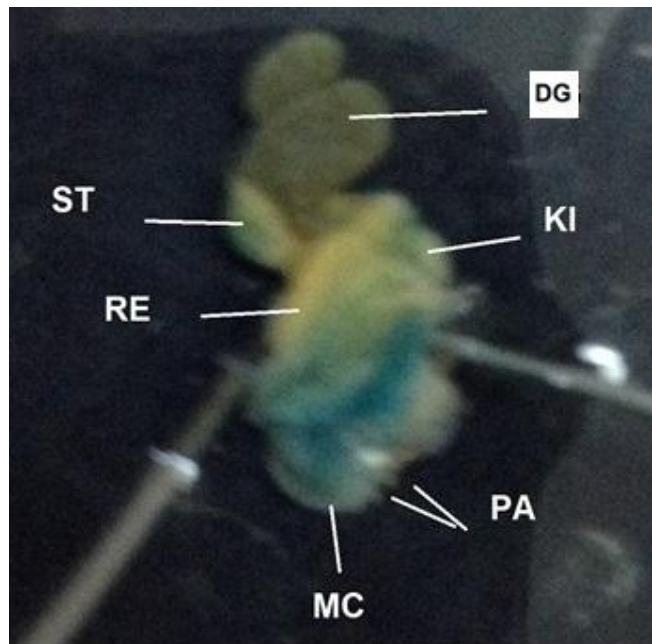


Fig. 8: A photograph of the dorsal aspect of the soft organs of *Tarebia granifera* after removing the shell.

DG: Digestive Gland, KI: Kidney, MC: Mantle Collar, PA: Papillae, RE: Rectum, ST: Stomach.

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