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SYNOPSIS OF THE EGYPTIAN FRESHWATER SNAIL FAUNA

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ABSTRACT: Egypt harbours many species of freshwater snails that transmit parasites causing serious diseases in humans and animals. Due to their significance, it is important to up-date the faunal list regularly. Our objective was to present such an up-date. The twenty eight species known to exist in the country are reviewed, including their synonymy, type localities, diagnostic features and parasitological importance; the shell morphology is illustrated. Besides, snail species thought to be extinct in the country are noted. This review can be used as a field guide for identification of the various species of snails colonising freshwater habitats in Egypt.

KEYWORDS: snail, freshwater, Egypt, field guide

INTRODUCTION

Freshwater snails play an important role in their ecosystems and many of them have great medical and veterinary importance. Worldwide, about 350 snail species are estimated to be possible hosts of parasites which cause human and animal diseases (ROZENDAAL 1997). The Egyptian freshwater snail fauna includes many species that transmit serious parasitic diseases such as schistosomiasis and fascioliasis. Though the fauna has been studied for a long time (FRIEDRICH 1874, LEIPER 1916a, SATTMANN & KINZELBACH 1988, IBRAHIM et al. 1999), considering the new data and the taxonomic changes, it is important to up-date the information regularly. The present work was carried out with the aim to present an up-to-date review of freshwater snails of Egypt and their distribution (Fig. 1). All species known to exist in the country are covered, regardless of their medical and veterinary importance.

The taxonomy of class Gastropoda, snails and slugs, is changing rapidly and it will be some time before a classification system for higher taxa becomes generally accepted (HASZPRUNAR 1988, PONDER & LINDBERG 1997, BOUCHET & ROCROI 2005). The simplified, now informal system based on the respiratory organs (THIELE 1931) is used here. It includes three major groups: prosobranchs (gills anterior to the heart), opisthobranchs (gills posterior and right to the heart) and pulmonates (pallial lung instead of gills). The freshwater snails found in Africa, including Egypt, are either prosobranchs or pulmonates (BROWN 1994).

PROSOBRANCHS

Prosobranch snails have thick-walled shells equipped with opercula. They have pectinate gills, called branchia or ctenidia, situated within the mantle cavity. Most prosobranchs are dioecious (BROWN 1994). In the Egyptian freshwater fauna they are represented by nine families.

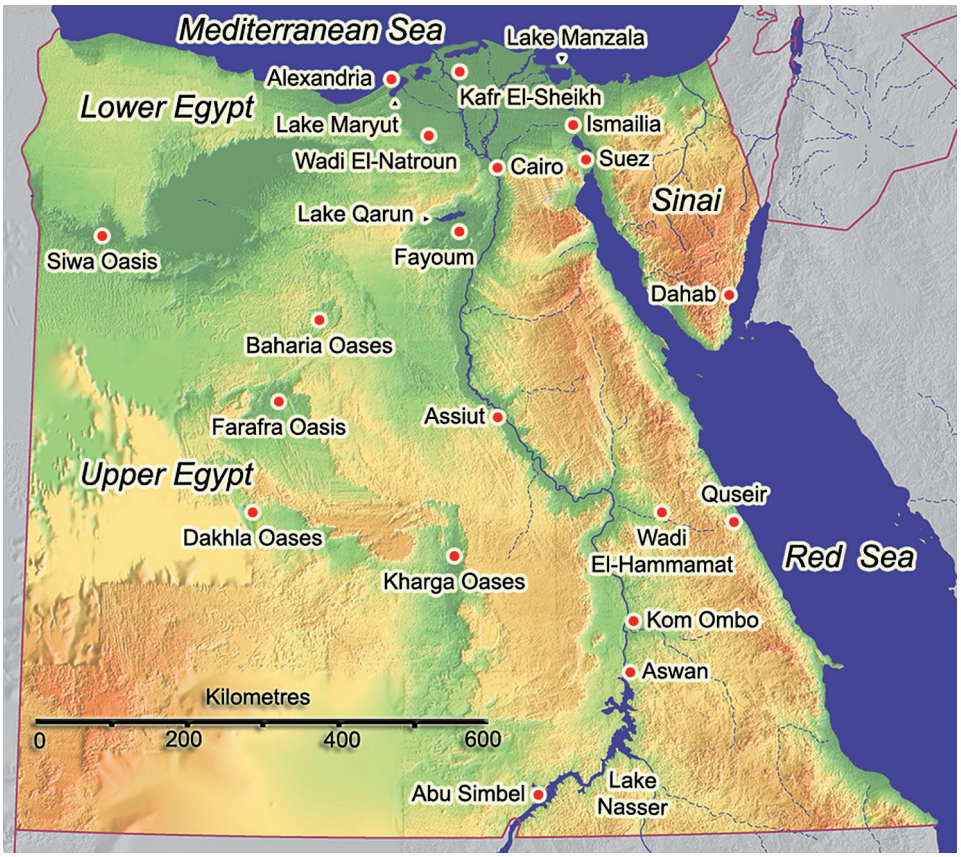

Fig. 1. Map of Egypt

FAMILY NERITIDAE RAFINESQUE, 1815

Neritids are small to medium-sized snails, sometimes exceeding 20 mm in length, which inhabit saltwater and freshwater. They have cap-like (hemispherical) shells with few whorls and greatly expanded body whorl. The aperture is D-shaped, and the operculum is strongly calcified, with one or two internal apophyses. The family is represented in Egypt by only one species (BROWN 1994): *Theodoxus niloticus* (Reeve, 1856). *Theodoxus anatolicus* (Récluz, 1841) was reported from Fayoum (GRABNER et al. 2014), but the record needs to be confirmed as the species had not been reported from Africa before (BROWN 1994).

1. ***Theodoxus niloticus*** (Reeve, 1856)

Neritina nilotica Reeve, 1856

Type locality: Egypt, Nile Delta.
Distinctive characters (Fig. 2): When fully grown, the shell is 9 × 8 mm in size. Its colour and pattern are highly variable, but commonly with purplish-brown zigzag bands. The operculum is equipped with two apophyses (GARDNER 1932, BROWN 1994, IBRAHIM et al. 1999).
Distribution (Fig. 1): The species is tolerant to some degree of salinity and is thus usually found in fresh and brackish waters. It is more common in the coastal areas of Lower Egypt (SATTMANN & KINZELBACH 1988, BROWN 1994), but was also found in Upper Egypt and Lake Nasser (SATTMANN & KINZELBACH 1988, IBRAHIM et al. 1999, ABD EL-WAKEIL et al. 2013). It was also reported in Sinai (EL-KADY et al. 2000, IBRAHIM et al. 2006). Besides, it was abundant in the extinct fauna of aquatic molluscs in the Fayoum Depression (GARDNER 1932).
Parasitological importance: Unknown.

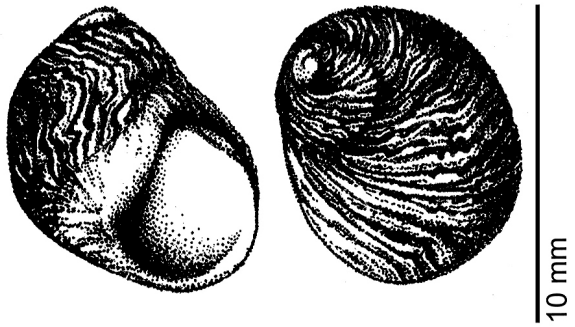

Fig. 2. *Theodoxus niloticus*

FAMILY VIVIPARIDAE GRAY, 1847

Viviparids are freshwater snails. Their dextral shells are more than 10 mm high. The whorls are

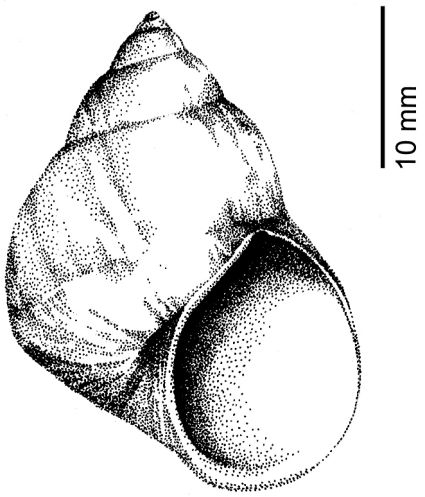

Fig. 3. *Bellamya unicolor*

generally more numerous than in the neritids. Also, the spire is higher and more conical. The operculum is entirely corneous and concentric. The animal is viviparous and the embryos develop in the lower oviduct. The right tentacle in males is modified as a copulatory organ. The radula is taenioglossate. The central tooth is wide and without basal denticles (BROWN 1994). Only one species occurs in Egypt: *Bellamya unicolor* (Olivier, 1804).

2. ***Bellamya unicolor*** (Olivier, 1804)

Cyclostoma unicolor Olivier, 1804
Vivipara unicolor (Olivier, 1804)

Type locality: Egypt, Alexandria.
Distinctive characters (Fig. 3): Fully grown shells are 30 × 20 mm, with the aperture usually occupying about half of the total shell height. The body whorl is slightly flattened at the periphery producing a keel. The umbilicus is either narrow or closed. Spiral rows of small bristles may occur on the shell surface (MANDAHL-BARTH 1973a, BROWN 1994).
Distribution (Fig. 1): This species is widely distributed in the Nile Valley and Delta (SATTMANN & KINZELBACH 1988, BROWN 1994, EL-SHAZLY et al. 2012, ABD EL-WAKEIL et al. 2013). It was found in Lake Nasser (IBRAHIM et al. 1999). Besides, it was recorded from Sinai (EL-KADY et al. 2000, IBRAHIM et al. 2006).
Parasitological importance: Unknown.

FAMILY AMPULLARIIDAE GRAY, 1824 (PILIDAE PRESTON, 1915)

Ampullariids are medium to large snails. Fully grown shells exceed 15 mm in height. The shell is depressed to ovate, and externally may appear either dextral or sinistral. The whorls are strongly rounded, either angular or carinate. The operculum is concentric, either entirely corneous or with calcareous inner layer. In addition to the tentacles, there is a tentacle-like process (pseudopodium) on each side of the snout. Near each tentacle there is an epipodial lobe: the left lobe forms an inhalent siphon and the right one forms an exhalent siphon. The snails are oviparous. The male copulatory organ is formed by a modified part of the mantle edge. The central tooth is broad and without basal denticles. Some species live in seasonal waterbodies which dry out for long periods (BROWN 1994). This family is represented in Egypt by only two species: *Lanistes carinatus* (Olivier, 1804) and *Pila ovata* (Olivier, 1804). Two other species: *Lanistes varicus* (O. F. Müller, 1774) and *Pila wernei* (Philippi, 1851) were mentioned among the snails rarely found in Egypt (IBRAHIM et al. 1999) and reported from Assiut (ABD EL-WAKEIL et al. 2013). However, none of the two was mentioned among the Egyptian freshwater snails (BROWN 1994). Based on the data accumulated during our previous malacological survey in Egypt (LOTFY et al. 2005), and after a comprehensive literature review we conclude that the presence of the two species in the country needs to be confirmed by further studies.

3. ***Lanistes carinatus*** (Olivier, 1804)

Lanistes bolteni (Chemnitz, 1786)
Lanistes boltenianus (Röding, 1798)
Ampullaria carinata Oliver, 1804

Type locality: Egypt, Alexandria.
Distinctive characters (Fig. 4): The shell appears sinistral and is 25 × 35 mm in size. It is depressed to ovately conic. The whorls vary from evenly curved to angular and carinate. The umbilicus may be widely open or closed. The operculum is entirely corneous. The eggs are deposited on aquatic vegetation as gelatinous clusters (BROWN 1994, IBRAHIM et al. 1999).
Distribution (Fig. 1): The species is widely distributed in the Nile Valley and Delta (SATTMANN & KINZELBACH 1988, BROWN 1994, EL-SHAZLY et al. 2012, ABD EL-WAKEIL et al. 2013). It was also found in Sinai (EL-KADY et al. 2000, IBRAHIM et al. 2006).

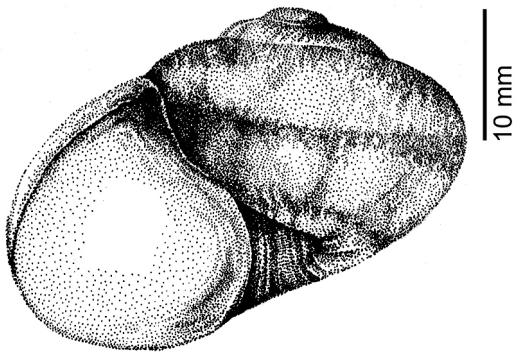

Fig. 4. *Lanistes carinatus*

Parasitological importance: The snail was reported to transmit the rat lung-worm *Parastrongylus cantonensis* in Egypt (YOUSIF & IBRAHIM 1978, EL-SHAZLY et al. 2002a, IBRAHIM 2007). Experimental infection with the parasite was successful, and the first stage larvae reached the infective third stage in the snail (YOUSIF & LAMMLER 1975).
Remarks: *Lanistes carinatus* (Oliver) and *L. bolteianus* (Röding) were previously regarded as distinct species. However, according to BROWN (1994) and ABDELMORDY et al. (1997) they are conspecific.

4. ***Pila ovata*** (Olivier, 1804)

Ampullaria ovata Olivier, 1804

Type locality: Egypt, Alexandria.
Distinctive characters (Fig. 5): The shell is dextral, when fully grown 115 × 108 mm in size. The whorls are more or less regularly convex. The operculum has a calcareous inner layer. Females deposit clusters of eggs, with calcareous capsules, just above the water surface amongst stones or in crevices in the soil. The male copulatory organ is comparatively elaborate (BERTHOLD 1989, BROWN 1994).
Distribution (Fig. 1): Besides the Nile Valley in Upper Egypt (ABD EL-WAKEIL et al. 2013) and Lake Nasser (IBRAHIM et al. 1999), isolated populations were reported in Fayoum (IBRAHIM et al. 1999) and Siwa Oasis (CRAWFORD 1949, IBRAHIM 1975, SATTMANN & KINZELBACH 1988).
Parasitological importance: Unknown.

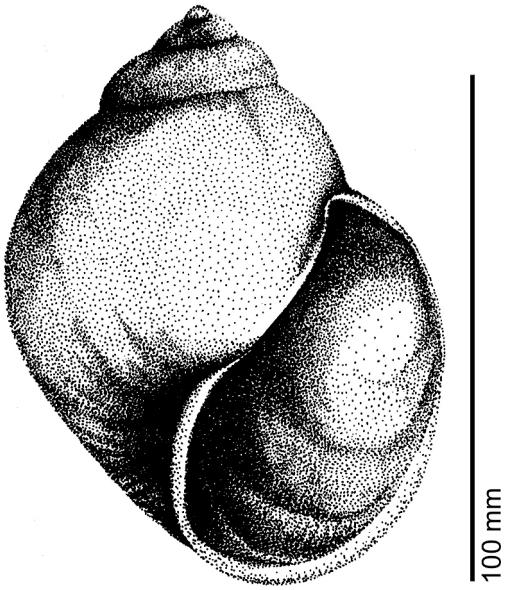

Fig. 5. *Pila ovata*

FAMILY VALVATIDAE GRAY, 1840

Valvatids have dextral discoid to ovate smooth shells. Their fully grown shell is less than 10 mm in height and has a large umbilicus. The aperture is circular and the operculum is multispiral. Valvatids are hermaphroditic and oviparous. They have a feather-like gill and a tentacle-like appendage on the mantle edge, on the right side. The central tooth has no basal denticles (BROWN 1994).

5. ***Valvata nilotica*** Jickeli, 1874

Valvata saulcyi Bourguignat, 1853

Type locality: Egypt, Alexandria.
Distinctive characters (Fig. 6): The shell, of 3.3 × 5.0 mm, is colourless or pale brown, depressed with very fine ribs and spiral sculpture. The spire height and umbilicus size are highly variable (INNES 1884, BROWN 1994).

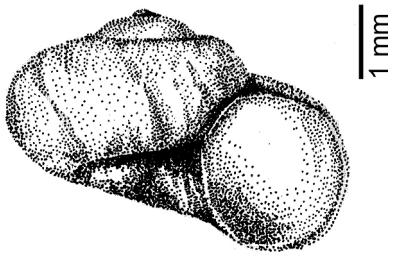

Fig. 6. *Valvata nilotica*

Distribution (Fig. 1): The species was reported in the Nile Valley and Delta (SATTMANN & KINZELBACH 1988, BROWN 1994, ABD EL-WAKEIL et al. 2013). It was found also in Lake Nasser (SATTMANN & KINZELBACH 1988, IBRAHIM et al. 1999) and Sinai (TCHERNOV 1971, EL-KADY et al. 2000).
Parasitological importance: Unknown.

FAMILY HYDROBIIDAE TROSCHEL, 1857

Hydrobiids have smooth colourless shells, less than 10 mm in height, and higher than wide. The operculum is ovate, entirely corneous and paucispiral. The radula has no accessory plate. This family is represented in Egypt by *Hydrobia musaensis* Frauenfeld, 1855 and *Ecrobia ventrosa* (Montagu, 1803) (BROWN 1994). A third species, *Hydrobia aponensis* Martens, 1858, was reported from Fayoum and Upper Egypt (GARDNER 1932, GAUTHIER 1980). Most probably it is now extinct in the country (IBRAHIM et al. 1999). Recently this species was reported from Assiut (ABD EL-WAKEIL et al. 2013), but as mentioned before the results of this survey need to be confirmed by further studies.

6. *Hydrobia musaensis* Frauenfeld, 1855

Type locality: North Africa.
Distinctive characters (Fig. 7): Compared with other species of the genus this snail has a small, relatively broad shell, consisting of six whorls. The whorls are rather flat and the sutures are shallow (Brown 1994, Ibrahim et al. 1999). The shell length is 3 mm, while the width of the body whorl reaches 1 mm. The aperture is oval but asymmetrical, the outer lip being more rounded than the inner one (Tchernov 1971).
Distribution (Fig. 1): It was originally described by Frauenfeld in 1855 from Suez. It inhabits fresh and brackish waters in the Nile Delta, Fayoum, Sinai (Crawford 1949, Tchernov 1971, Van Damme 1984, Abo-Madyan et al. 2005), Quseir, and Siwa Oasis (Crawford 1949, Sattmann & Kinzelbach 1988).

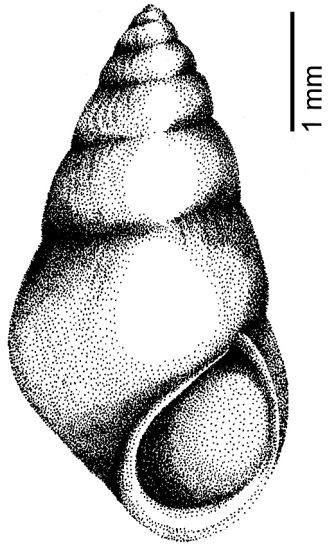

Fig. 7. *Hydrobia musaensis*

Parasitological importance: Unknown.

7. *Ecrobia ventrosa* (Montagu, 1803)

Turbo ventrosus Montagu, 1803
Hydrobia ventrosa (Montagu, 1803)
Ventrosia ventrosa (Montagu, 1803)

Type locality: Europe.
Distinctive characters (Fig. 8): The shell is 3–4 × 1.5–2 mm in size. It has 5–7 convex whorls. It is slender, with deep and distinctly oblique suture. The aperture is rounded above (or only slightly pointed). The lip is weakly developed. The shell is very finely striated and translucent, glossy yellow-brown, the colour being usually hidden by a matt deposit (Brown 1994, Ibrahim et al. 1999).
Distribution (Fig. 1): The species inhabits brackish waters of the northern lakes of the Delta (Ibrahim et al. 1999), Lake Qarun in Fayoum (Van Damme 1984), and Siwa Oasis (Crawford 1949, Ibrahim 1975, Sattmann & Kinzelbach 1988).
Parasitological importance: Unknown.

Fig. 8. *Ecrobia ventrosa*

FAMILY BITHYNIIDAE TROSCHEL, 1857

The bithyniid shell is small to medium-sized (less than 15 mm in height). It is dextral and depressed to ovately conical. The aperture is fairly large, with a continuous thickened and often dark peristome. The operculum is thick and calcareous with outer concentric area and usually a spiral nucleus. In fully grown specimens the operculum fits into the peristome. The exhalent siphon (epitaenial fold) is usually present on the right side, in connection with the ciliary feeding mechanism. The snails are oviparous. The penis is equipped with an accessory appendage and duct (hold-fast organ). Egg capsules have exit holes closed by plugs. The central radular tooth is usually provided with basal denticles (Brown 1994). According to Brown (1994), there is no species of *Bithynia* known to occur in Egypt, and the family is represented by only one species, *Gabbiella senaariensis* (Küster, 1852) (Brown 1994). However, there are some reports of the genus *Bithynia* from Egypt (Gardner 1932, Tohamy & Mohamed 2006, Abd El-Wakeil et al. 2013). Such reports need to be confirmed by more detailed taxonomic studies.

8. *Gabbiella senaariensis* (Küster, 1852)

Paludina senaariensis Küster, 1852

Type locality: Sudan, Senaar.
Distinctive characters (Fig. 9): The shell is 8.5 × 5.5 mm in size. The spire is distinctly higher than the aperture, and is often decollate. In the fully grown shell the total of four whorls are completed at about 5 mm height (Brown 1994, Ibrahim et al. 1999).
Distribution (Fig. 1): The species was reported from the Nile Valley and Delta (Sattmann & Kinzelbach

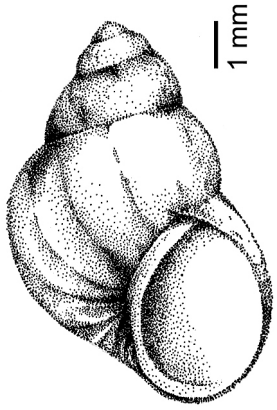

Fig. 9. *Gabbiella senaariensis*

1988, Brown 1994, Abd El-Wakeil et al. 2013), Lake Nasser (Ibrahim et al. 1999), Fayoum (Gardner 1932), and Sinai (El-Kady et al. 2000).
Parasitological importance: Unknown.

FAMILY THIARIDAE TROSCHEL, 1857

The thiarid shell is small to large, dextral, ovately to narrowly conical. The fully grown shell is more than 10 mm in height. It is commonly thick-walled and strongly sculptured. The basal margin of aperture is entire. The operculum is entirely corneous, and is either paucispiral or concentric with spiral nucleus. The mantle edge is either with or without papillae. The snails are commonly ovoviviparous; species of some genera are parthenogenic. The offspring develops in a brood pouch. The males lack penis, except in *Tiphobia*, and are rare or unknown for some species. Thiarids inhabit fresh and brackish waters (Brown 1994). Results of molecular studies have shown the family to be polyphyletic (Lydeard et al. 2002).

9. ***Cleopatra bulimoides*** (Olivier, 1804)

Cyclostoma bulimoides Olivier, 1804
Cleopatra cyclostomoides (Küster, 1852)

Type locality: Egypt, Alexandria.
Distinctive characters (Fig. 10): It is a very variable, polytypic species including many named forms whose conspecificity needs to be tested by further evidence, especially genetic. The typical form measures 16 × 9 mm, while the slender form measures 22 × 9 mm. The typical form has lower whorls, evenly curved and smooth, carinations are confined to the apical whorls; usually with one or more dark brown bands (Brown 1994).
Distribution (Fig. 1): The species was reported from the Nile Valley and Delta, Lake Nasser, Fayoum, and Sinai (Schutt 1986, Sattmann & Kinzelbach

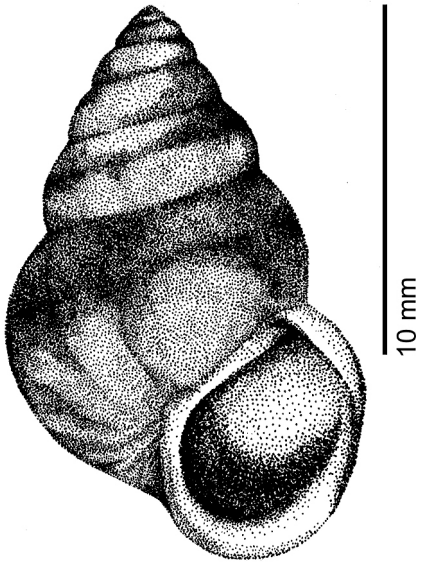

Fig. 10. *Cleopatra bulimoides*

1988, Brown 1994, Ibrahim et al. 1999, El-Kady et al. 2000, Ibrahim et al. 2006, Abd El-Wakeil et al. 2013).
Parasitological importance: It is the first intermediate host of the digenean *Prohemistomum vivax* which parasitises the Egyptian kite (Abdel-Azim 1933) and may infect humans (Nasr 1941, Witenberg 1964). It also transmits the paramphistome *Gastrodiscus aegyptiacus* – an intestinal parasite of African equines (Malek 1971, Fahmy et al. 1977). In addition, the snail was found to be naturally infected with larvae of *P. cantonensis* in Egypt (El-Shazly et al. 2002a, Ibrahim 2007).
Remarks: Some Egyptian authors still treat *C. bulimoides* and *C. cyclostomoides* as distinct species (Ibrahim et al. 2006, Ibrahim 2007). According to Brown (1994) they are synonyms.

10. ***Melanoides tuberculata*** (O. F. Müller, 1774)

Melania tuberculata O. F. Müller, 1774

Type locality: India, Coromandel Coast.
Distinctive characters (Fig. 11): The shell measures 27 × 9 mm (complete shell with 11 whorls). However, some morphs are smaller (less than 20 mm high) or larger (nearly 50 mm high). The shell is narrowly conical, and the whorls are regularly increasing, moderately convex, with ribs and spiral ridges forming a highly varied sculpture, though commonly tuberculate. The shell colour is often pale with reddish-brown patches aligned with the ribs (making flame-like markings), sometimes uniformly brownish. The central tooth has 7–12 cusps (Brown 1994). Conchological variations could be due partly to parthenogenic propagation of clones, as some populations are predominantly or perhaps entirely females.

Fig. 11. *Melanoides tuberculata*

However, males occur quite commonly in some localities, for example in Israel and Sinai (LIVSHITS et al. 1984, HELLER & FARSTEY 1990). It is noteworthy that males can be recognised by their reddish testis showing as a dark area in the upper whorls (HELLER & FARSTEY 1989).

Distribution (Fig. 1): The snail is tolerant of moderate brackishness in coastal localities and abundant in shell deposits representing the last molluscan faunas where inland lakes have entirely evaporated or have become too saline for freshwater organisms (BROWN 1994). It is widely distributed in the Nile Valley and Delta (YOUSIF et al. 2009, ABD EL-WAKEIL et al. 2013). Also, it was reported from Lake Manzala, Wadi El-Natroun, Wadi El-Hammamad (El-Hammamat), Quseir, and Baharia, Dakhla, Farafra, Kharga, and Siwa Oases (SATTMANN & KINZELBACH 1988). Besides, it was reported from Sinai (TCHERNOV 1971, EL-KADY et al. 2000, IBRAHIM et al. 2006, YOUSIF et al. 2009).

Parasitological importance: At least 37 species of digeneans are known to be transmitted by *M. tuberculata* worldwide. Eleven of those parasites may affect human health (PINTO & DE MELO 2011). Besides, it was reported to transmit the nematode *P. cantonensis* in Egypt (IBRAHIM 2007).

FAMILY MELANOPSIDAE H. ADAMS ET A. ADAMS, 1854

Melanopsids are medium to large snails with fully grown shells more than 10 mm in height. The shell is ovately or more narrowly conical, smooth or strongly sculptured. The operculum is paucispiral with basal nucleus. The mantle edge is smooth. Both sexes are present. The snails are oviparous (MORRISON 1954, HOUBRICK 1988, BROWN 1994).

11. *Melanopsis praemorsa* (Linnaeus, 1758)

Buccinum praemorsum Linnaeus, 1758

Type locality: South Europe.

Distinctive characters (Fig. 12): The shell measures 20 × 11 mm. It is ovate, with a short spire, and a large elongated body whorl. The outer lip of the aperture is thin, but the inner lip has a smooth parietal callus, thickened into a pad over the parietal wall. It is either smooth or with strong spiral ridges or ribs. Four species of *Melanopsis* were distinguished in Northwest Africa based on shell characters by CHEVALLIER (1969), and two by DUPOUY et al. (1980). There is no direct evidence of genetic differences between these different shell morphs and they all seem to belong to a single, circum-Mediterranean superspecies (GLAUBRECHT 1992, 1993).

Distribution (Fig. 1): The snail inhabits various waterbodies; it can tolerate high temperature, desiccation and high content of dissolved chemicals (DUPOUY 1979, DUPOUY et al. 1980, MEIER-BROOK et al. 1987). In Egypt, it was found only in Sinai (TCHERNOV 1971).

Parasitological importance: Unknown.

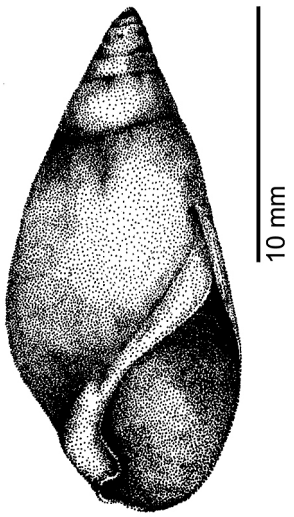

Fig. 12. *Melanopsis praemorsa*

FAMILY POTAMIDIDAE H. ADAMS ET A. ADAMS, 1854

Potamidids are medium to large snails with fully grown shells more than 10 mm in height. The shell is dextral, narrowly conical, and sculptured. A notch is present at the basal margin of the aperture. The operculum is multispiral. The family is restricted to brackish waters, usually at the coast (BROWN 1994). Early studies suggested that the family was polyphyl-

etic (Houbrick 1988, 1991), but more recent studies showed it to be monophyletic (Lydeard et al. 2002, Strong et al. 2011).

12. ***Potamides conicus*** (de Blainville, 1829)

Cerithium conicum de Blainville, 1829
Pirenella conica (de Blainville, 1829)

Type locality: Mediterranean region.
Distinctive characters (Fig. 13): The shell is medium-sized, of 20 × 17 mm. It has 2–4 spiral rows of nodules. It is variously coloured with white, grey and brown. The mantle edge with papillae (Demian et al. 1966, Brown 1994).
Distribution: The species occurs patchily along coastal habitats in the eastern and southern Mediterranean, the Red Sea and the Persian Gulf, as well as in Libya, Sardinia and Malta (Taraschewski & Paperna 1981). In Egypt (Fig. 1), it is common in the brackish lakes of the Nile Delta (Martin 1959), and in inland saline lakes of the Siwa Depression (Crawford 1949, Ibrahim 1975) and Lake Qarun in Fayoum (Demian et al. 1963, Sattmann & Kinzelbach 1988). In Sinai, *P. conicus* has been reported from the Bardawil lagoon, the Bitter Lakes and Lake Timsah in the Suez region (Tillier & Bavay 1905, Martin 1959, Demian et al. 1963, Barash & Danin 1971, 1972/1973, Por 1971), and from the mangrove lagoons and the pool of Dahab on the coast of the Gulf of Aqaba (Por & Dor 1975, Por et al. 1977).

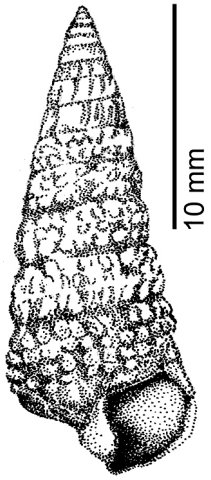

Fig. 13. *Potamides conicus*

Parasitological importance: Worldwide, this snail acts as the first intermediate host of many species of the digenean families Heterophyidae, Echinostomatidae, Microphallidae, Notocotylidae, Haploporidae, Haplosplanchnidae, Cyathocotylidae, and Strigeidae (Taraschewski & Paperna 1981). In Egypt, the most important parasite transmitted by the snail is *H. heterophyes* (El-Gindy & Hanna 1963, Taraschewski & Paperna 1982).

PULMONATES

They are non-operculate snails with thin-walled shells. They lack gills, and the mantle cavity serves as an air-breathing organ (Brown 1994).

FAMILY PHYSIDAE FITZINGER, 1833

Physids are medium-sized sinistral snails with sharply pointed spire and smooth whorls. The tentacles are long and slender. The foot is pointed. The pseudobranch is absent. The mantle is expanded to varying extent, and its margin ranges from smooth to scalloped and digitate. The physid shells are like those of some species of *Bulinus*, but distinguishable by the generally more pointed spire, shallower suture and smoother surface. In addition, they could be distinguished from *Bulinus* by the expanded mantle fringe, simple penis, oblique rows of radular teeth, and the lack of both pseudobranch and blood haemoglobin. Their eggs are deposited in soft elongate masses unlike the capsules of *Bulinus* which are flatter, firm and circular in outline (Brown 1994). The classification of the family at any level is far from stability (Te 1980, Taylor 1988, Brown 1994).

13. ***Haitia acuta*** (Draparnaud, 1805)

Physa acuta Draparnaud, 1805
Physella acuta (Draparnaud, 1805)
Physa heterostropha (Say, 1817)
Physa subopaca (Lamarck, 1822)

Type locality: France, River Garonne.
Distinctive characters (Fig. 14): The shell measures 15 × 9 mm, and resembles that of *Bulinus truncatus* (Ibrahim et al. 1999). For quick identification it could be distinguished from *B. truncatus* by the following characters: the shell is stronger, more conical and pointed at the spire, whorls without shoulder angle, twisted columella; the body whorl has no umbilicus, and upon crushing a living *H. acuta* a bluish blood oozes out, instead of the reddish coloured blood that comes out of *B. truncatus* (Brown 1994).
Distribution (Fig. 1): The snail is widely distributed in the freshwater habitats of the Nile Valley and Delta (Sattmann & Kinzelbach 1988, Abd El-Wakeil et al. 2013), Lake Nasser (Sattmann & Kinzelbach 1988, Ibrahim et al. 1999), Fayoum (Grabner et al. 2014), and Sinai (Tchernov 1971, El-Kady et al. 2000, Ibrahim et al. 2006).

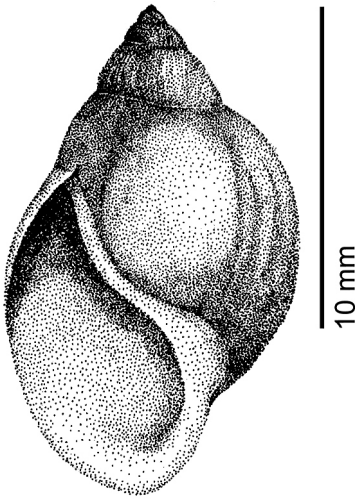

Fig. 14. *Haitia acuta*

Parasitological importance: *Haitia acuta* serves as intermediate host of several species of bird trematodes including schistosomes. An unconfirmed experimental infection with *Schistosoma haematobium* was reported (MAGZOUB & KASIM 1980), but there is no other evidence that it could be a host. The Egyptian strain of *H. acuta* was highly susceptible to infection with the digenean *Echinostoma liei* (CHRISTENSEN et al. 1980). *Haitia acuta* proved to be susceptible to infection with the nematode *P. cantonensis,* and the first stage larvae reached the infective third stage (YOUSIF & LAMMLER 1975). Also, *H. acuta* naturally infected with *P. cantonensis* was reported in Egypt (ABO-MADYAN et al. 2005).

FAMILY LYMNAEIDAE RAFINESQUE, 1815

Lymnaeids are small to large snails with dextral shells and pointed spires which vary widely in height. Their tentacles are flat and triangular. They lack both pseudobranch and blood haemoglobin. The two genital orifices are situated on the right side. The eggs are deposited in elongated gelatinous capsules. HUBENDICK (1951) considered many genera as synonyms of *Lymnaea*, but it seems justifiable to retain some of these groups, at least as subgenera (BROWN 1994, BARGUES & MAS-COMA 2005). Nowadays, five species of lymnaeids are present in Egypt: *Galba truncatula* (O. F. Müller, 1774); *Galba schirazensis* (Küster, 1863); *Lymnaea stagnalis* (Linnaeus, 1758); *Pseudosuccinea columella* (Say, 1817); and *Radix natalensis* (Krauss, 1848). Although *Lymnaea alexandrina* (Bourguignat, 1883) is synonymous (KENDALL 1974) with *Radix natalensis*, some Egyptian authors still report *Lymnaea alexandrina* as a separate species (EL-BAHY 1997, EL-SHAZLY et al. 2002a). Some fossilised shells of *Radix peregra* (O. F. Müller, 1774) were collected from Kom Ombo in Upper Egypt (LEIGH & BUTZER 1968). VAN DAMME (1988) claimed that this species was not present in the country. *Radix auricularia* (Linnaeus, 1758) was recorded from Fayoum (GARDNER 1932) and Kom Ombo (LEIGH & BUTZER 1968), but the lack of recent records may indicate that it is now extinct in Egypt (IBRAHIM et al. 1999). Similarly, fossilised shells of *Stagnicola palustris* (O. F. Müller, 1774) were reported in Fayoum (BLANCKENHORN 1901) and Kom Ombo (LEIGH & BUTZER 1968), but currently the snail is extinct in the country (IBRAHIM et al. 1999). On the other hand, snails identified as *Stagnicola* sp. were collected from different sites in Upper Egypt and Lake Nasser by Kinzelbach in 1985 (SATTMANN & KINZELBACH 1988).

14. ***Galba truncatula*** (O. F. Müller, 1774)

Lymnaea truncatula O. F. Müller, 1774

Type locality: Germany, Thangelstedt in Thuringia (near Weimar).

Distinctive characters (Fig. 15): The species is the smallest African lymnaeid (up to 11 × 6 mm), characterised by a spire equal in height to the aperture. The shell consists of 5–6 convex whorls. The columellar margin is straighter and more broadly reflected than in *Radix natalensis* (BROWN 1994, IBRAHIM et al. 1999).

Distribution (Fig. 1): The snail inhabits small streams, seepages and temporary pools of rainwater (BROWN 1994). It was recorded from the Nile Valley and Delta (LEIPER 1916a, PALLARY 1924, EL-SHAZLY et al. 2002b, 2012); Baharia, Dakhla, and Kharga Oases (NAGATY et al. 1959, FRANDSEN 1983, BROWN 1994); the New Valley (ABDEL-GHANI 1965, 1976); and Sinai (EL-KADY et al. 2000).

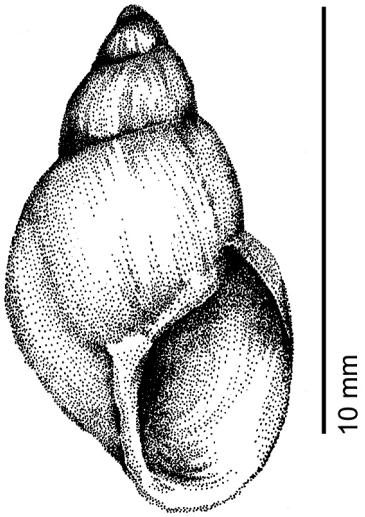

Fig. 15. *Galba truncatula*

Parasitological importance: It is the most common intermediate host of *Fasciola hepatica* worldwide (BARGUES et al. 2012). Egyptian populations of this snail were found to be naturally infected with *Fasciola* sp. (EL-SHAZLY et al. 2002b, 2012). Successful experimental infections with *F. hepatica* and *F. gigantica* were obtained under laboratory conditions (DAR et al. 2003a, b, 2004). The snail also serves as an intermediate host of *Paramphistomum daubneyi* in some African countries (DINNIK 1962). However, this paramphistome was not reported to be present in Egypt (SEY 1977).

15. ***Galba schirazensis*** (Küster, 1863)

Lymnaea schirazensis Küster, 1863

Type locality: Iran, Shiraz.
Distinctive characters (Fig. 16): The species is phenotypically very close to *G. truncatula* and has always been confused with it (BARGUES et al. 2011). Although many phenotypic characteristics may be helpful in preliminary identification, specimens can only be determined by sequencing of at least one of the molecular markers used, for example ribosomal DNA markers ITS-2 and ITS-1; mitochondrial DNA markers: 16SrDNA and COX1 (BARGUES et al. 2012). However, some characteristics may be useful in identification of *G. schirazensis*: maximum shell height of 8.06 mm, regularly convex whorls, straight columella. The first bilateral teeth are mostly bicuspid. The praeputium/penis sheath length ratio is 1.20–2.23 (mean 1.60) (BARGUES et al. 2011, 2012).
Distribution (Fig. 1): The snail is often amphibious. Mixed populations of *G. truncatula* and *G. schirazensis* have already been described (BARGUES et al. 2012). The presence of this species in the Nile Delta has been confirmed (BARGUES et al. 2011, AGRAMUNT 2013).

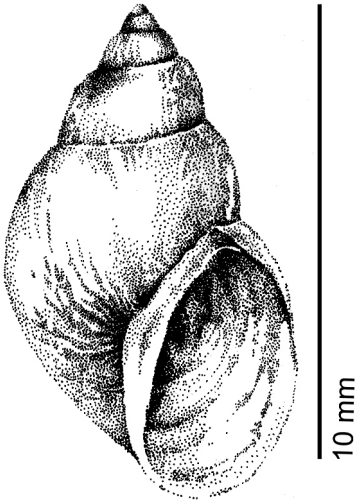

Fig. 16. *Galba schirazensis*

Parasitological importance: Unlike the morphologically similar *G. truncatula*, this species does not transmit *F. hepatica* (BARGUES et al. 2011, 2012).

16. ***Lymnaea stagnalis*** (Linnaeus, 1758)

Helix stagnalis Linnaeus, 1758

Type locality: Europe.
Distinctive characters (Fig. 17): The species is commonly called the great pond snail. It has a large shell (45 × 25 mm) with slender and sharply pointed spire (BROWN 1994). The shell consists of 6–8 whorls, with large, expanded body whorl. Aperture large, ovate, usually equal to half of the shell height. The umbilicus usually covered. Shell colour variable, the initial whorls usually darker.

Fig. 17. *Lymnaea stagnalis*

Distribution (Fig. 1): The species was reported in the Nile Delta (EL-SHAZLY et al. 2012), Kom Ombo (LEIGH & BUTZER 1968), Wadi El-Natroun (ABDEL-GHANI 1953, SATTMANN & KINZELBACH 1988), and Fayoum (GARDNER 1932).
Parasitological importance: This species acts as an intermediate host of *F. hepatica* (KENDALL 1949). It may transmit a range of digeneans in Europe and Russia, such as *Moliniella anceps* (YURLOVA et al. 2006, KUDLAI 2009), *Echinoparyphium recurvatum*, *Opisthioglyphe ranae*, *Plagiorchis elegans*, *Diplostomum pseudospathaceum*, *Echinostoma revolutum*, *Trichobilharzia szidati* (SOLDANOVA et al. 2010), and *Elaphostrongylus rangiferi* (SKORPING 1985). In Egypt, *L. stagnalis* was found to be naturally infected with *Fasciola* sp. (EL-SHAZLY et al. 2012). Experimental infection of the snail with *P. cantonensis* was possible, and the first stage larvae reached the infective third stage in the snail (YOUSIF & LAMMLER 1975).

17. ***Pseudosuccinea columella*** (Say, 1817)

Lymnaea columella Say, 1817

Type locality: North America (probably near Philadelphia).
Distinctive characters (Fig. 18): The shell (up to 17 × 9 mm) is narrower than that of *L. natalensis*, and is easily distinguished from it by the close-set spiral lines, which result in a reticulated pattern. The shell consists of 6–8 whorls, with large, expanded body whorl. Aperture large, ovate, usually equal to half of the shell height. Umbilicus usually covered. Shell colour variable, the initial whorls usually darker.

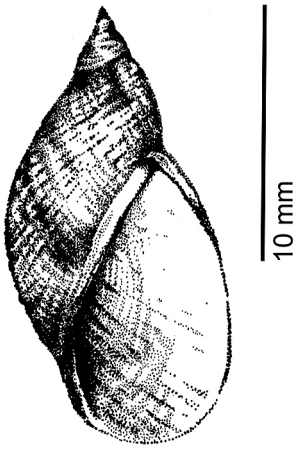

Fig. 18. *Pseudosuccinea columella*

Distribution (Fig. 1): This American species is now well-established in Africa. It was reported from the Nile Valley and Delta, Fayoum, and Sinai (Nagaty et al. 1959, Ahmed & Ramzy 1999, El-Kady et al. 2000, El-Shazly et al. 2012, Abd El-Wakeil et al. 2013, Grabner et al. 2014).
Parasitological importance: This species is a major host of *F. hepatica* in North America and the Caribbeans (Torgerson & Claxton 1999, Gutierrez et al. 2011). It also serves as a host for *Fascioloides magna* (Krull 1933), and *Telorchis* spp. (Echaubard et al. 2010). In Egypt, it was found to be naturally infected with *F. gigantica* (Nagaty et al. 1959, Ahmed & Ramzy 1999, Grabner et al. 2014). It serves also as an intermediate host of some echinostomes including *Echinostoma caproni* (Grabner et al. 2014).

18. ***Radix natalensis*** (Krauss, 1848)

Limnaeus natalensis Krauss, 1848
Lymnaea natalensis (Krauss, 1848)
Limnaea alexandrina Bourguignat, 1883
Lymnaea alexandrina (Bourguignat, 1883)
Limnaea cailliaudi Bourguignat, 1883

Type locality: South Africa, Natal.

Distinctive characters (Fig. 19): Placement of this species in the genus *Radix* was confirmed by Correa et al. (2010). It is a relatively large lymnaeid (up to 23 × 15 mm). The shell shape varies widely. The spire is much shorter than the aperture, and consisting of 4–4.4 whorls. The surface often bears spiral rows of short transverse grooves, and lacks the spiral ridges which characterise *Pseudosuccinea columella* (Brown 1994, Ibrahim et al. 1999).
Distribution (Fig. 1): This species is most frequent in permanent streams and impoundments such as small dams (Hubendick 1951, Brown 1994). It was reported from the Nile Valley and Delta, Lake Nasser, and Wadi El-Natroun (Sattmann & Kinzelbach 1988, El-Shazly et al. 2002b, 2012, Abd El-Wakeil et al. 2013). Also, it was found in Al-Salam Irrigation Canal, North Sinai (Ibrahim et al. 2006).
Parasitological importance: The snail is a major intermediate host for *F. gigantica* in Egypt (Brown 1994, Lotfy et al. 2001). Experimental infection of *R. natalensis* with *F. hepatica* was successful. Thus, *R. natalensis* can be considered a potential intermediate host of *F. hepatica* in Egypt (Lotfy et al. 2001, Dar et al. 2010). In addition, this species was found to be naturally infected with the larvae of *P. cantonensis* in Egypt (El-Shazly et al. 2002a, Ibrahim 2007). In addition, experimental infection with the parasite was possible, and the first stage larvae reached the infective third stage in the snail (Yousif & Lammler 1975).

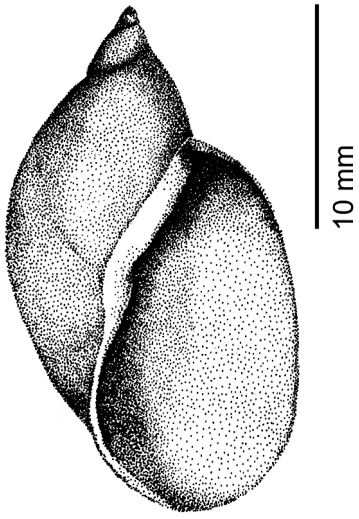

Fig. 19. *Radix natalensis*

FAMILY PLANORBIDAE RAFINESQUE, 1815

Planorbids are small to medium-sized snails with long slender tentacles and reddish blood containing haemaglobin. The pseudobranch is present. The shell and anatomy are diverse, especially the male copulatory organ and prostate gland (BROWN 1994).

SUBFAMILY PLANORBINAE RAFINESQUE, 1815

Members of this subfamily usually have pseudodextral discoid or lenticular shell. The shell appears dextral, because it is carried inverted so that the side corresponding to the apical side in other snails is the lower side of the planorbine shell. Also, it is considered by some authors as dextral shell but with sinistral animal. The pseudobranch has the form of a simple lobe. One or more prostatic tubules open either directly into the sperm duct or into a separate prostatic duct. The structure of the copulatory organ varies, though it has no 'ultrapenis' of the Bulininae (BROWN 1994). Eight species of planorbines have been confirmed to be present in Egypt: *Africanogyrus coretus* (de Blainville, 1826), *Biomphalaria alexandrina* (Ehrenberg, 1831), *Biomphalaria glabrata* (Say, 1818), *Gyraulus costulatus* (Krauss, 1848), *Gyraulus ehrenbergi* (Beck, 1837), *Planorbella duryi* (Wetherby, 1879), *Planorbis planorbis* (Linnaeus, 1758) and *Segmentorbis angustus* (Jickeli, 1874). IBRAHIM et al. (1999) treated *Afrogyrus coretus* (de Blainville, 1826) and *Afrogyrus oasiensis* (Demian, 1962) as distinct species, but BROWN (1994) synonymised the two names. *Biomphalaria pfeifferi* (Krauss, 1848) was reported from Fayoum (GARDNER 1932, IBRAHIM et al. 1999, ABO-MADYAN et al. 2005), and some sites in Lower Egypt (IBRAHIM et al. 1999). However, the snail was not found during our previous malacological survey in Egypt (LOTFY et al. 2005). In addition, it was not mentioned by BROWN (1994) to be present in Egypt. Its occurrence in the country needs to be confirmed by a taxonomical study. *Segmentorbis eussoensis* (Preston, 1912) was reported once to occur in Egypt (MANDAHL-BARTH 1973b), but further studies are needed to confirm that it is not synonymous with *Segmentorbis angustus* (BROWN 1994).

19. ***Africanogyrus coretus*** (de Blainville, 1826)

Planorbis coretus de Blainville 1826
Afrogyrus coretus (de Blainville, 1826)
Anisus oasiensis Demian, 1962
Afrogyrus oasiensis (Demian, 1962)

Type locality: Senegal, Podor.
Distinctive characters (Fig. 20): The shell is very small, brownish yellow, discoid, flat on both sides; when fully grown it is 0.7 × 2.1–2.5 mm, with 4–5 slowly increasing whorls. The aperture is small, slightly broader than high and not modified by any conspicuous carina. The peristome is simple and very thin. The sculpture consists of fine, close-set, curved growth lines. The umbilicus diameter equals about half of the total shell diameter. The penis has a subterminal orifice and a cup-like stylet (BROWN 1994, IBRAHIM et al. 1999).
Distribution (Fig. 1): This snail was reported from Lower Nile (IBRAHIM et al. 1999), Dakhla and Kharga Oases (DEMIAN 1962, VAN DAMME 1988).
Parasitological importance: Unknown.

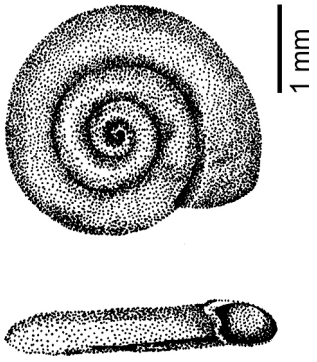

Fig. 20. *Africanogyrus coretus*

20. ***Biomphalaria alexandrina*** (Ehrenberg, 1831)

Planorbis alexandrinus Ehrenberg, 1831
Planorbis boissyi Potiez et Michaud, 1838

Type locality: Nile Delta between Alexandria and Rosetta.

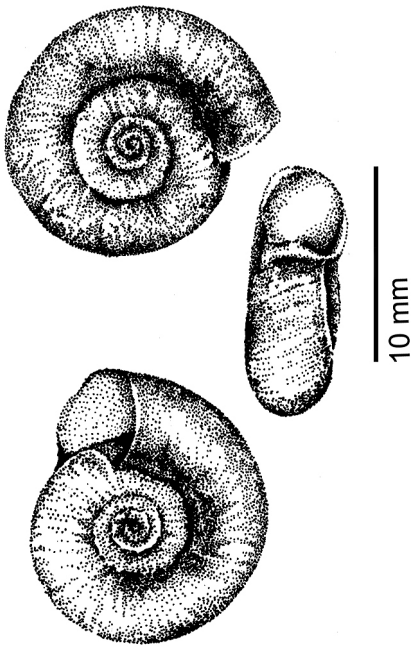

Fig. 21. *Biomphalaria alexandrina*

Distinctive characters (Fig. 21): The shell measures 4.8 × 14.2 mm. It is thin to rather thick and sometimes fragile; it has about 5 spirally coiled whorls. It is umbilicated on the left side and has a more depressed spire with a deep suture on the right side. The sculpture includes slightly curved regular growth lines. The aperture is suboval, distinctly wider than high. The inner lip is closely applied to the columella. The umbilicus is open and wide. The prostatic duct and preputial gland are absent (BROWN 1994, IBRAHIM et al. 1999).
Distribution (Fig. 1): Originally, this snail was restricted to the Nile Delta. Starting from the late 1970s, this snail was found at increasing distances upstream as far as Lake Nasser at Aswan and Abu Simbel (SATTMANN & KINZELBACH 1988, VRIJENHOEK & GRAVEN 1992, LOTFY et al. 2005). The changes in the hydrology of the Nile Valley and Delta, the controlled water flow, and the new irrigation networks following construction of the Low and High Dams at Aswan, in 1902 and 1968, respectively, have resulted in providing the snail with an increasing number of appropriate habitats (EL-GINDY 1957, VRIJENHOEK & GRAVEN 1992). Nowadays, the species is widely distributed in the Nile Valley and Delta. Also, it was found in Lake Nasser, Wadi El-Natroun (SATTMANN & KINZELBACH 1988), and Sinai (EL-KADY et al. 2000, IBRAHIM et al. 2006).
Parasitological importance: This species serves as the intermediate host of *Schistosoma mansoni* in Egypt (LEIPER 1916b, EL-GINDY 1957, LOTFY 2009, ABOU-EL-NAGA 2013). *Biomphalaria alexandrina* was reported to be naturally infected with *F. gigantica* (FARAG & EL SAYAD 1995) and *Fasciola* sp. (EL-SHAZLY et al. 2002b). However, the snail was not susceptible to infection with *F. gigantica* under experimental conditions (MOHAMED et al. 1998). Also, it was found to be naturally infected with *Echinostoma liei* (JEYARASASINGAM et al. 1972). The species was found to be naturally infected with larvae of *P. cantonensis* in Egypt (EL-SHAZLY et al. 2002a, IBRAHIM 2007). Besides, experimental infection with the parasite was successful, and the first stage larvae reached the infective third stage in the snail (YOUSIF & LAMMLER 1975).

21. ***Biomphalaria glabrata*** (Say, 1818)

Planorbis glabratus Say, 1818

Type locality: South America.
Distinctive characters (Fig. 22): The shell (5–8 × 20–27 mm) is widely umbilicate and larger than that of *B. alexandrina*. The number of whorls increases more rapidly in *B. alexandrina* than in *B. glabrata*. Unlike *B. alexandrina*, *B. glabrata* has a renal ridge which is not observed in any African *Biomphalaria* species (BROWN 1994, IBRAHIM et al. 1999).

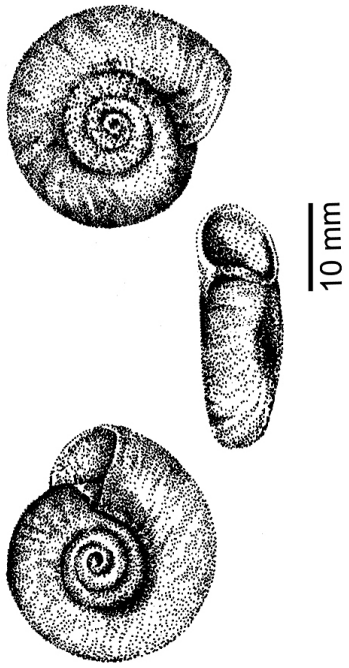

Fig. 22. *Biomphalaria glabrata*

Distribution (Fig. 1): In the early 1980s, *B. glabrata* was reported to be introduced into the Egyptian freshwater habitats in the Nile Delta (PFLUGER 1982, YOUSIF et al. 1996, 1998a, b, KRISTENSEN et al. 1999, CAMPBELL et al. 2000).
Parasitological importance: This species is the major intermediate host for *S. mansoni* in the Neotropics (POINTIER et al. 2005). Experimentally, *B. glabrata* was found to be susceptible to the Egyptian strains of *S. mansoni* but showed lower susceptibility than *B. alexandrina*. Unfortunately, the duration of cercarial shedding was longer and the numbers of cercariae shed per snail were higher in *B. glabrata* than in *B. alexandrina* (YOUSIF et al. 1998b). The snail was reported to be infected with the larvae of *P. cantonensis* under natural conditions (EL-SHAZLY et al. 2002a). Also, experimental infection with the parasite was successful, and the first stage larvae reached the infective third stage in the snail (YOUSIF & LAMMLER 1975). The NIH strain of *B. glabrata* could easily be infected with the Egyptian strain of *Echinostoma liei* in the laboratory (JEYARASASINGAM et al. 1972). The presence of snails naturally infected with this echinostome needs to be confirmed.

22. ***Gyraulus ehrenbergi*** (Beck, 1837)

Planorbis ehrenbergi Beck, 1837

Type locality: Egypt.
Distinctive characters (Fig. 23): The shell is discoid, flat on both sides; when fully grown it is 1.7 × 6.8 mm in size, in most cases composed of 3–4 rapidly increasing whorls. The shell often has an angled periphery (BROWN 1994, IBRAHIM et al. 1999).

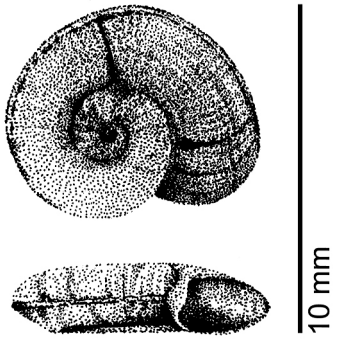

Fig. 23. *Gyraulus ehrenbergi*

Distribution (Fig. 1): The snail is found mainly in the Nile Valley and Delta (SATTMANN & KINZELBACH 1988, BROWN 1994, ABD EL-WAKEIL et al. 2013).
Parasitological importance: Unknown.

23. *Gyraulus costulatus* (Krauss, 1848)

Planorbis costulatus Krauss, 1848

Type locality: South Africa, Natal, Umgeni River.
Distinctive characters (Fig. 24): The shell measures 1.5 × 6.6 mm. The typical form is depressed, with rapidly increasing whorls and strong, regularly-spaced ribs. The periphery bears a carina with a periosotracal fringe. The shape of the whorls varies widely (BROWN 1994).

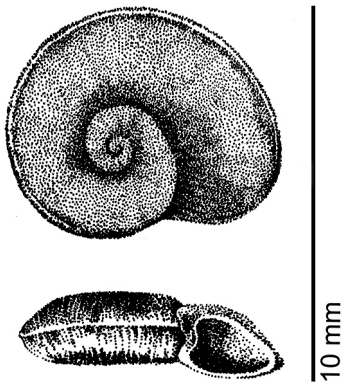

Fig. 24. *Gyraulus costulatus*

Distribution (Fig. 1): The species is widespread in the tropical region of Africa. In Egypt, it was reported in the Nile Valley in Assiut and a few localities further south. It was found also in Lake Nasser (SATTMANN & KINZELBACH 1988).
Parasitological importance: Unknown.

24. *Planorbella duryi* (Wetherby, 1879)

Planorbis duryi Wetherby, 1879
Helisoma duryi (Wetherby, 1879)

Type locality: North America.
Distinctive characters (Fig. 25): During the earlier fieldwork, it was noticed that some Egyptian field workers misidentified *P. duryi* as *B. glabrata* (LOTFY et al. 2005). There were similar reports of misidentification of *P. duryi* as *Biomphalaria* in other parts of the world. The typical form of *P. duryi* can be distinguished from *Biomphalaria* spp. by the presence of prostatic duct and preputial gland, higher shell (7 × 18 mm), more regular whorls, flat surface within the umbilicus, and deeply concave upper side (VAN BRUGGEN 1974, APPLETON 1977, IBRAHIM et al. 1999).

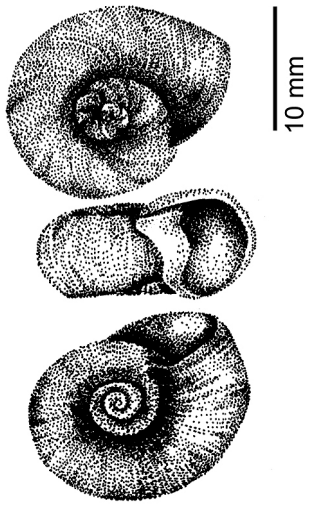

Fig. 25. *Planorbella duryi*

Distribution (Fig. 1): The species was introduced into Egypt (PFLUGER & ROUSHDY 1980). It was studied in field trials as a competitor of intermediate hosts of schistosomes in Egypt (FRANDSEN & MADSEN 1979). It was first recorded in Egypt in 1980 and 1981, a few kilometres north of Cairo (PFLUGER & ROUSHDY 1980, ROUSHDY & EL-EMAM 1981). In the early 1990s, the snail was reported to be present further north into the Nile Delta (YOUSIF et al. 1993). The distribution of *P. duryi* was reported to be further extended as it was found in Kafr El-Sheikh (North-Central Delta), Ismailia (Eastern Delta), Aswan (LOTFY et al. 2005), and Lake Nasser (IBRAHIM et al. 1999). Nowadays, the species is widely distributed in the Nile Valley and Delta. Also, it was found in Al-Salam Irrigation Canal, North Sinai (IBRAHIM et al. 2006).
Parasitological importance: Experimental infection of *Planorbella* sp. with *P. cantonensis* was successful, and the first stage larvae reached the infective third stage in the snail (YOUSIF & LAMMLER 1975).

25. ***Planorbis planorbis*** (Linnaeus, 1758)

Helix planorbis Linnaeus, 1758
Planorbis umbilicatus O. F. Müler, 1774
Planorbis marginatus Draparnaud, 1805
Planorbis submarginatus de Cristofori et Jan, 1832
Planorbis subcarinatus Pfeiffer, 1894
Planorbis philippii Germain, 1908

Type locality: Europe.
Distinctive characters (Fig. 26): The shell is more than 2 mm in height (2.5 × 10 mm), characterised by a distinct angle below the periphery. The whorls at the apex form a depression that is almost as deep as the suture. Thus the suture on the right side appears more deeply impressed than on the left, showing a shallow umbilicus (Brown 1994, Ibrahim et al. 1999).

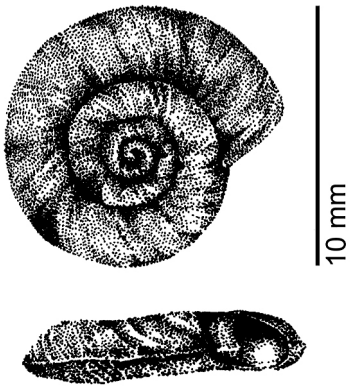

Fig. 26. *Planorbis planorbis*

Distribution (Fig. 1): This is the only species of *Planorbis* found in Egypt (Brown 1994). Other species recorded by Egyptian workers (Hiekal & El-Sokkary 1987, El-Bahy 1997, El-Khayat et al. 2011) are either synonymous or misidentified. It was reported from the Nile Valley and Delta, Lake Manzala, Wadi El-Natroun, and Siwa Oasis (Crawford 1949, Hiekal & El-Sokkary 1987, Sattmann & Kinzelbach 1988, El-Bahy 1997, El-Khayat et al. 2011).
Parasitological importance: Experimental infection of the snail with *P. cantonensis* was successful, and the first stage larvae reached the infective third stage in the snail (Yousif & Lammler 1975).

26. ***Segmentorbis angustus*** (Jickeli, 1874)

Segmentina angustus Jickeli, 1874

Type locality: Ethiopia, Hamasen Province, Toquor River at Mekerka (west of Asmara).
Distinctive characters (Fig. 27): The shell is lenticular, with convex upper side and flat underside; its size is 2 × 5.5 mm. When fully grown it is about 3 times broader than high, with usually no more than 3 sets of internal septa (Brown 1994).

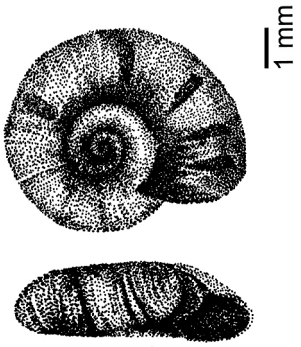

Fig. 27. *Segmentorbis angustus*

Distribution (Fig. 1): Egypt is not a typical area for this species, and its major distribution is further south in Africa (Brown 1994). It was recorded from Lower and Upper Nile in Egypt. It was found also in Lake Nasser, Lake Qarun, the edge of Lake Maryut, and west of Alexandria, but it is rare in these sites (Van Damme 1984, Sattmann & Kinzelbach 1988, Ibrahim et al. 1999).
Parasitological importance: Unknown.

SUBFAMILY BULININAE FISCHER ET CROSSE, 1880

Bulinines have small to medium-sized sinistral shells, reaching 25 mm in height or diameter. The shell is either spired (*Bulinus*) or discoid (*Indoplanorbis*). The pseudobranch is large, deeply folded, and highly vascularised. The penis does not project freely into the penis sheath, but is a long and coiled eversible tube called "ultra-penis", attached at both upper and lower ends of the sheath. Numerous prostatic tubules are concentrated into a compact organ. Only two genera are known; *Bulinus* found mainly in Africa and *Indoplanorbis* in Asia. However, *Indoplanorbis* was reported, probably introduced, in Africa (Brown 1994).

Only two species: *Bulinus forskalii* (Ehrenberg, 1831) and *Bulinus truncatus* (Audouin, 1827), are known to exist in Egypt (El-Gindy & Rushdi 1962, Brown 1994). Another two species were mentioned by Ibrahim et al. (1999): *Bulinus guernei* (Dautzenberg, 1890) and *Bulinus natalensis* (Küster, 1841). Analyses of morphology and enzymes indicated that *B. guernei* was conspecific with and indistinguishable from *B. truncatus* (Brown et al. 1986, Jelnes 1986). *Bulinus natalensis* was not mentioned among the Egyptian freshwater snails (Brown 1994). The species is distributed mainly in eastern Africa from Ethiopia to the coastal region of Natal (Brown 1994). Based on the data accumulated during our previous malacological survey in Egypt (Lotfy et al. 2005), and after a comprehensive literature review we concluded that the presence of *B. natalensis* in the country needed to be confirmed by more studies.

27. *Bulinus forskalii (Ehrenberg, 1831)*

Isidora forskalii Ehrenberg, 1831
Pyrgophysa forskalii (Ehrenberg, 1831)
Physa micropleura Bourguignat, 1876

Type locality: Egypt, Damietta.
Distinctive characters (Fig. 28): The shell measures 17 × 5.4 mm (smaller in many localities). The spire is high and slender in fully grown specimens. The whorls are shouldered to some degree and sometimes carinate. Strong ribs are commonly present and may bear fringes of periostracum. The copulatory organ with penis sheath is almost equal in length to the preputium (BROWN 1994).
Distribution (Fig. 1): The snail is essentially Afrotropical, reaching the Mediterranean only in Lower Egypt (VAN DAMME 1984). It was reported from the Nile Valley and Delta, Lake Nasser, Fayoum, and Kharga Oases (SATTMANN & KINZELBACH 1988, IBRAHIM et al. 1999, ABO-MADYAN et al. 2005).
Parasitological importance: Despite some inconclusive reports, there is no confirmed locality for transmission of *S. haematobium* by *B. forskalii* worldwide (BROWN 1994). However, the snail can serve as an intermediate host for other schistosomes, like *Schistosoma bovis* (KINOTI 1964), *Schistosoma guineensis* (GOW et al. 2004), and *Schistosoma margrebowiei* (WRIGHT et al. 1979a). It also serves as an intermediate host for many species of paramphistomes, including *Calicophoron microbothrium* (GRABER & DAYNES 1974), *Carmyerius* sp. (WRIGHT et al. 1979b), *Gastrodiscus aegyptiacus* (DE KOCK & WOLMARANS 2005), *Paramphistomum phillerouxi* (DINNIK 1961), and *P. togolense* (ALBARET et al. 1978). In Egypt, the parasites transmitted by this snail need to be confirmed.

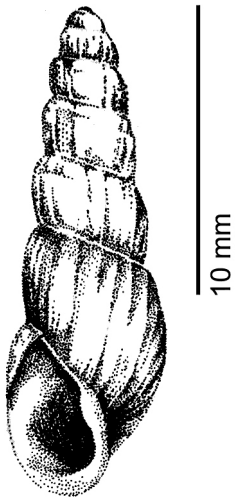

Fig. 28. *Bulinus forskalii*

28. *Bulinus truncatus* (Audouin, 1827)

Physa truncata Audouin, 1827
Physa alexandrina Bourguignat, 1876

Type locality: Egypt.
Distinctive characters (Fig. 29): The shell measures 9.5 × 6 mm (slender form), 9.5 × 7.5 (broad form), and sometimes is almost 20 mm high (BROWN 1994). The type specimen is small (only 5 mm high), with a depressed spire (BOUCHET & DANRIGAL 1982). This species is characterised by a combination of characters which is not easy to define: the uneven curvature of the whorls tends to produce a blunt shoulder, the columellar margin is usually narrow and more or less twisted, and the shell colour is pale. The spire height, shape of columellar margin and umbilicus size vary widely. The spire is shorter than the aperture and the apex ranges from obtuse to rather elevated. The umbilicus varies from small to rather big. The aperture varies from elongate ovate to ovoid and almost round (BROWN 1994, IBRAHIM et al. 1999).
Distribution (Fig. 1): The species is widely distributed in the Nile Valley and Delta, and Lake Nasser (SATTMANN & KINZELBACH 1988, IBRAHIM et al. 1999, ABD EL-WAKEIL et al. 2013). It was also found in Sinai (EL-KADY et al. 2000, IBRAHIM et al. 2006).
Parasitological importance: It serves as the intermediate host of *S. haematobium* (LEIPER 1915). It was reported to serve as an intermediate host of *F. hepatica* in Tunisia (HAMED et al. 2009, 2014). This species is the main intermediate host of the paramphistome *Calicophoron microbothrium* in North Africa including Egypt (DINNIK 1965, RYSAVY et al. 1974). This parasite is the most widely reported species causing harm to domestic livestock in Africa (EDUARDO 1983). *Bulinus truncatus* was found to be naturally infected with larvae of *P. cantonensis* in Egypt (EL-SHAZLY et al. 2002a). Experimental infection with this nematode was successful, and the first stage larvae reached the infective third stage in the snail (YOUSIF & LAMMLER 1975).

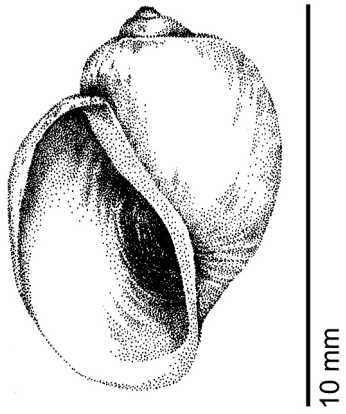

Fig. 29. *Bulinus truncatus*

CONCLUDING REMARKS

This review covers a total of 28 snail species currently present in freshwater habitats of Egypt. These species include two which were introduced during the last few decades. The presence of other snail species in the country is questionable and needs to be confirmed by detailed taxonomic studies. The Egyptian freshwater snail fauna and its geographical distribution are changing over time, some snails are now extinct in the country, and therefore it is crucial to update the available information regarding the surviving species and their biogeography.

Of 28 snail species found in Egypt, 15 can transmit human and animal parasites. The nematode *P. cantonensis* is transmitted by *L. carinatus*, *C. bulimoides*, *M. tuberculata, H. acuta, L. stagnalis*, *R. natalensis, B. alexandrina*, *B. glabrata*, *P. duryi*, *P. planorbis* and *B. truncatus*; echinostomes by *P. conicus*, *H. acuta*, *L. stagnalis*, *P. columella*, *B. alexandrina* and *B. glabrata*; fasciolids by *G. truncatula, L. stagnalis*, *P. columella*, *R. natalensis* and *B. alexandrina*. *H. heterophyes* is transmitted by *P. conicus*. Paramphistomes are transmitted by *C. bulimoides*, *B. forskalii* and *B. truncatus*; schistosomes by *L. stagnalis*, *B. alexandrina*, *B. glabrata*, *B. forskalii* and *B. truncatus*.

REFERENCES

Abd El-Wakeil K. F., Obuid-Allah A. H., Mohamed A. H., Abd El-Aziz F. E. A. 2013. Community structure of molluscans in River Nile and its branches in Assiut Governorate, Egypt. Egypt. J. Aquatic Res. 39: 193–198. http://dx.doi.org/10.1016/j.ejar.2013.09.002

Abdel-Azim M. 1933. On *Prohemistomum vivax* (Sonsino, 1892) and its development from *Cercaria vivax* Sonsino, 1892. Z. Parasitenkd. 5: 432–436. http://dx.doi.org/10.1007/BF02121886

Abdel-Ghani A. F. 1953. *Lymnaea stagnalis* in Egypt. Nautilus 67: 44–45.

Abdel-Ghani A. F. 1965. *Lymnaea truncatula* in the Nile Valley in Egypt. Proceeding of the 6th Annual Veterinary Congress, Cairo, Egypt: 93–100.

Abdel-Ghani A. F. 1976. The present situation of *Lymnaea* snails in the New Valley. Proceeding of the 13th Arab Veterinary Congress, Cairo, Egypt: 556–567.

Abdelmordy M. B., Sleem S. H., Tantawi T. A. 1997. Isozyme polymorphism of esterases in the genus *Lanistes* (Mollusca: Prosobranchiata) and genetic analysis of populations. Biochem. Genet. 35: 77–89. http://dx.doi.org/10.1023/A:1022204123584

Abo-Madyan A. A., Morsy T. A., Motawea S. M., El Garhy M. F., Massoud A. M. 2005. Spot light survey on fresh-water snails of medical importance in Al Fayoum Governorate, Egypt. J. Egypt. Soc. Parasitol. 35: 49–58.

Abou-El-Naga I. F. 2013. *Biomphalaria alexandrina* in Egypt: Past, present and future. J. Biosci. 38: 1–8. http://dx.doi.org/10.1007/s12038-013-9329-4

Agramunt V. H. 2013. Human and animal fascioliasis, with emphasis on Egypt. Ph.D. Thesis, Department of Cell Biology and Parasitology, Faculty of Pharmacy. University of Valencia, Valencia, Spain.

Ahmed A. H., Ramzy R. M. 1999. Infection of two lymnaeid snails with *Fasciola gigantica* in Giza, a field study. J. Egypt. Soc. Parasitol. 29: 687–696.

Albaret J. L., Bayssade-Dufour C., Guilhon J., Kulo S. D., Picot H. 1978. Life cycle of *Paramphistomum togolense* n. sp. (Trematoda, Paramphistomidae). Ann. Parasitol. Hum. Comp. 53: 495–510.

Appleton C. C. 1977. The exotic freshwater snail *Helisoma duryi* (Wetherby, 1879) in southern Africa. Zool. Med. Leiden 52: 125–135.

Barash A., Danin Z. 1971. Mollusca from the stomach of *Sparus auratus* fished in the Lagoon of Bardawil. Argamon Isr. J. Malacol. 2: 79–104.

Barash A., Danin Z. 1972/1973. The Indo-Pacific species of Mollusca in the Mediterranean and notes on a collection from the Suez Canal. Isr. J. Zool. 21: 301–374.

Bargues M. D., Artigas P., Khoubbane M., Flores R., Gloer P., Rojas-Garcia R., Ashrafi K., Falkner G., Mas-Coma S. 2011. *Lymnaea schirazensis*, an overlooked snail distorting fascioliasis data: genotype, phenotype, ecology, worldwide spread, susceptibility, applicability. PLoS ONE 6: e24567. http://dx.doi.org/10.1371/journal.pone.0024567

Bargues M. D., Artigas P., Khoubbane M., Ortiz P., Naquira C., Mas-Coma S. 2012. Molecular characterisation of *Galba truncatula*, *Lymnaea neotropica* and *L. schirazensis* from Cajamarca, Peru and their potential role in transmission of human and animal fascioliasis. Parasite. Vector. 5: 174. http://dx.doi.org/10.1186/1756-3305-5-174

Bargues M. D., Mas-Coma S. 2005. Reviewing lymnaeid vectors of fascioliasis by ribosomal DNA sequence analyses. J. Helminthol. 79: 257–267. http://dx.doi.org/10.1079/JOH2005297

Berthold T. 1989. Comparative conchology and functional morphology of the copulatory organ of the Ampullariidae and their bearing upon phylogeny and palaeontology. Abh. Naturwissensch. Ver. Hamburg, NF 28: 141–164.

Blanckenhorn M. 1901. Neues zur Geologie und Paläontologie Ägyptens. IV. Das Pliocan und Quartarzeitalter in Ägypten ausschliesslich des Rothen Meergebietes. Z. Dtsch. Geol. Ges. 53: 307–502.

BOUCHET P., DANRIGAL F. 1982. Napoleon's Egyptian campaign (1798–1801) and the Savigny collection of shells. Nautilus 96: 9–24.

BOUCHET P., ROCROI J. 2005. Classification and nomenclator of gastropod families. Malacologia 47: 1–397.

BROWN D. S. 1994. Freshwater snails of Africa and their medical importance. 2nd ed. Taylor and Francis Ltd., London, UK.

BROWN D. S., SHAW K. M., SOUTHGATE V. R., ROLLINSON D. 1986. *Bulinus guernei* (Mollusca: Gastropoda) of West Africa: taxonomic status and role as host for schistosomes. Zool. J. Linn. Soc. 88: 59–90. http://dx.doi.org/10.1111/j.1096-3642.1986.tb00877.x

CAMPBELL G., JONES C. S., LOCKYER A. E., HUGHES S., BROWN D., NOBLE L. R., ROLLINSON D. 2000. Molecular evidence supports an African affinity of the neotropical freshwater gastropod, *Biomphalaria glabrata* Say, 1818, an intermediate host for *Schistosoma mansoni*. Proc. R. Soc. Lond. B Biol. Sci. 267: 2351–2358. http://dx.doi.org/10.1098/rspb.2000.1291

CHEVALLIER H. 1969. Mollusques subfossiles récoltées par M. Henri L'Hote dans le sud Oranais et la Sahara. Bull. Mus. Natl. Hist. Nat. 41: 266–294.

CHRISTENSEN N. O., FRANDSEN F., ROUSHDY M. Z. 1980. The influence of environmental conditions and parasite-intermediate host-related factors on the transmission of *Echinostoma liei*. Z. Parasitenkd. 64: 47–63. http://dx.doi.org/10.1007/BF00927056

CORREA A. C., ESCOBAR J. S., DURAND P., RENAUD F., DAVID P., JARNE P., POINTIER J.P., HURTREZ-BOUSSES S. 2010. Bridging gaps in the molecular phylogeny of the Lymnaeidae (Gastropoda: Pulmonata), vectors of fascioliasis. BMC Evol. Biol. 10: 381. http://dx.doi.org/10.1186/1471-2148-10-381

CRAWFORD G. I. 1949. The Armstrong College Zoological Expedition to Siwa Oasis (Libyan Desert) 1935. Mollusca. Proc. Egypt. Acad. Sci. 4: 45–58.

DAR Y., DJUIKWO T. F., VIGNOLES P., DREYFUSS G., RONDELAUD D. 2010. *Radix natalensis* (Gastropoda: Lymnaeidae), a potential intermediate host of *Fasciola hepatica* in Egypt. Parasite 17: 251–256. http://dx.doi.org/10.1051/parasite/2010173251

DAR Y., VIGNOLES P., DREYFUSS G., RONDELAUD D. 2003a. *Fasciola hepatica* and *Fasciola gigantica*: comparative morphometric studies on the redial stage of both species. Parasitol. Res. 91: 369–373. http://dx.doi.org/10.1007/s00436-003-0966-7

DAR Y., VIGNOLES P., RONDELAUD D., DREYFUSS G. 2003b. *Fasciola gigantica*: larval productivity of three different miracidial isolates in the snail *Lymnaea truncatula*. J. Helminthol. 77: 11–14. http://dx.doi.org/10.1079/JOH2002145

DAR Y., VIGNOLES P., RONDELAUD D., DREYFUSS G. 2004. Larval productivity of *Fasciola gigantica* in two lymnaeid snails. J. Helminthol. 78: 215–218. http://dx.doi.org/10.1079/JOH2003224

DEMIAN E. S. 1962. *Anisus oasiensis* sp. n. a new planorbid species from Egypt. Arkiv Zool. 15: 149–162.

DEMIAN E. S., YOUSIF F., RIFAAT M. A. 1963. Contributions to the study of the larval trematodes found in the brackish-water snail *Pirenella conica*. Bull. Zool. Soc. Egypt 18: 31–41.

DEMIAN E. S., YOUSIF F., RIFAAT M. A. 1966. Morphological studies on *Pirenella conica* (Blainville), the snail vector of heterophyiasis. Ain Shams Sci. Bull. 9: 273–343.

DINNIK J. A. 1961. *Paramphistomum phillerouxi* sp. nov. and its development in *Bulinus forskali*. J. Helminthol. 35: 69–90. http://dx.doi.org/10.1017/S0022149X00024792

DINNIK J. A. 1962. *Paramphistomum daubneyi* sp. nov. from cattle and its snail host in the Kenya highlands. Parasitology 52: 143–151. http://dx.doi.org/10.1017/S0031182000024070

DINNIK J. A. 1965. The snail hosts of certain Paramphistomatidae and Gastrothylacidae (Trematoda) discovered by the late Dr. P. L. Le Roux in Africa. J. Helminthol. 39: 141–150. http://dx.doi.org/10.1017/S0022149X00020551

DUPOUY J. 1979. Compétition entre Melanopsis et basommatophores en Algérie: l'élimination de *Bulinus truncatus*. Malacologia 18: 233–236.

DUPOUY J., ABDELHAK F., YAZID F. 1980. Compétition interspècifique entre *Melanopsis praemorsa* L. (Prosobranchia: Thiaridae) et certains basommatophores en Oranie et au Sahara nord-occidentale. J. Mollus. Stud. 46: 1–12.

ECHAUBARD P., LITTLE K., PAULI B., LESBARRERES D. 2010. Context-dependent effects of ranaviral infection on northern leopard frog life history traits. PLoS ONE 5: e13723. http://dx.doi.org/10.1371/journal.pone.0013723

EDUARDO S. L. 1983. The taxonomy of the family Paramphistomatidae Fischoeder, 1901 with special reference to the morphology of the species occurring in ruminants: 3. Revision of the genus *Calicophoron* Näsmark, 1937. Syst. Parasitol. 5: 25–79. http://dx.doi.org/10.1007/BF00010983

EL-BAHY M. M. 1997. Fascioliasis among animal, snail and human hosts in Kafr El-Sheikh Governorate with special reference to species infecting humans. Vet. Med. J. 45: 187–209.

EL-GINDY M. S. 1957. Distribution and ecology of the snail vectors of schistosomiasis in Egypt. J. Egypt. Med. Assoc. 40: 192–204.

EL-GINDY M. S., HANNA F. Y. 1963. Larval trematodes from snails *Pirenella conica* and *Melania tuberculata* with special reference to heterophyiasis. Bull. Endem. Dis. (Baghdad) 5: 33–58.

EL-GINDY M. S., RUSHDI M. S. 1962. The variability in morphology and anatomy of the bulinid snails in Egypt, with special reference to their transmission of *Schistosoma haematobium*. Ciba Foundation Symposium on Bilharziasis, Cairo, Egypt: 81–102. http://dx.doi.org/10.1002/9780470719312.ch5

EL-KADY G. A., SHOUKRY A., REDA L. A., EL-BADRI Y. S. 2000. Survey and population dynamics of freshwater snails in newly settled areas of the Sinai Peninsula. Egypt. J. Biol. 2: 42–48.

EL-KHAYAT H. M., ISMAIL N. M., MAHMOUD K. M., RAGB F. M., EL-SAID K. M., MOSTAFA B. B., EL- DEEB F. A., TANTAWY A. A. 2011. Evaluation of some chemical parameters as potential determinants of freshwater snails

with special reference to medically important snails in Egypt. Int. J. Biol. Life Sci. Eng. 5: 56–69.

EL-SHAZLY A. M., EL-HAMSHARY E. M., EL-SHEWY K. M., RIFAAT M. M., EL-SHARKAWY I. M. 2002a. Incidence of *Parastrongylus cantonensis* larvae in different fresh water snails in Dakahlia Governorate. J. Egypt. Soc. Parasitol. 32: 579–588.

EL-SHAZLY A. M., HELMY M. M., HARIDY F. M., EL-SHARKAWY E. M., MORSY T. A. 2002b. *Fasciola* immature stages sought in *Lymnaea* species and *Biomphalaria* species in the water bodies of Dakahlia Governorate. J. Egypt. Soc. Parasitol. 32: 109–118.

EL-SHAZLY A. M., NABIH N., SALEM D. A., MOHAMED M. Z. 2012. Snail populations in Dakahlia Governorate, Egypt, with special reference to lymnaeids. Egypt. J. Biol. 14: 45–49.

FAHMY M. A. M., MANDOUR A. M., ARAFA M. S., OMRAN L. A. M. 1977. On the larval trematodes recovered from *Cleopatra bulimoides* in Assiut Governorate. Assiut Vet. Med. J. 4: 91–98.

FARAG H. F., SAYAD M. H. EL 1995. *Biomphalaria alexandrina* naturally infected with *Fasciola gigantica* in Egypt. Trans. R. Soc. Trop. Med. Hyg. 89: 36. http://dx.doi.org/10.1016/0035-9203(95)90648-7

FRANDSEN F. 1983. A field guide to freshwater snails in countries of the WHO Eastern Mediterranean region. Danish Bilharziasis Laboratory, Copenhagen, Denmark.

FRANDSEN F., MADSEN H. 1979. A review of *Helisoma duryi* in biological control. Acta Trop. 36: 67–84.

FRAUENFELD G. VON 1855. Naturhistorische Fragmente: gesammelt auf einer Reise am Rothen Meere im Frühjahre 1855. Sitzungsber. Mathematisch-Naturwissensch. Cl. Kaiserl. Akad. Wissenschaft. (Wien) 18: 66–87.

FRIEDRICH J. C. 1874. Fauna der Land-und Süsswasser-Mollusken Nord-Ost-Afrika's. Druck von E. Blochmann & Sohn, Dresden, Germany.

GARDNER E. W. 1932. Some lacustrine Mollusca from the Faiyum Depression. A study in variation. Mém. Inst. Égypt. 18: 1–123.

GAUTHIER A. 1980. Contributions to the archaeozoology of Egypt. In: WENDORF F., SCHILD R. (eds). Prehistory of the Eastern Sahara. Academic Press, New York, pp. 317–344.

GLAUBRECHT M. 1992. Temporal and spatial distribution of Melanopsidae at the northern Tethys margin since the Cretaceous. In: GIUSTI F., MANGANELLI G. (eds). The 11th International Malacological Congress. Unitas Malacologica, Siena, Italy, pp. 426–427.

GLAUBRECHT M. 1993. Mapping the diversity: Geographical distribution of the freshwater snail *Melanopsis* (Gastropoda: ?Cerithioidea: Melanopsidae) with focus on its systematics in the Mediterranean Basin. Mitt. Hamb. Zool. Mus. Inst. 90: 41–97.

GOW J. L., NOBLE L. R., ROLLINSON D., MIMPFOUNDI R., JONES C. S. 2004. Breeding system and demography shape population genetic structure across ecological and climatic zones in the African freshwater snail, *Bulinus forskalii* (Gastropoda, Pulmonata), intermediate host for schistosomes. Mol. Ecol. 13: 3561–3573. http://dx.doi.org/10.1111/j.1365-294X.2004.02339.x

GRABER M., DAYNES P. 1974. Mollusques vecteurs de trématodoses humaines et animales en Ethiopie. Rev. Elev. Med. Vet. Pays Trop. 27: 307–322.

GRABNER D. S., MOHAMED F. A. M. M., NACHEV M., MEABED E. M. H., SABRY A. H. A., SURES B. 2014. Invasion biology meets parasitology: A case study of parasite spill-back with Egyptian *Fasciola gigantica* in the invasive snail *Pseudosuccinea columella*. PLoS ONE 9: e88537. http://dx.doi.org/10.1371/journal.pone.0088537

GUTIERREZ A., VAZQUEZ A.A., HEVIA Y., SANCHEZ J., CORREA A. C., HURTREZ-BOUSSES S., POINTIER J. P., THERON A. 2011. First report of larval stages of *Fasciola hepatica* in a wild population of *Pseudosuccinea columella* from Cuba and the Caribbean. J. Helminthol. 85: 109–111. http://dx.doi.org/10.1017/S0022149X10000350

HAMED N., AYADI A., HAMMAMI H. 2014. Epidemiological studies on fasciolosis in northern Tunisia. Revue Méd. Vét. 165: 49–56.

HAMED N., HAMMAMI H., KHALED S., RONDELAUD D., AYADI A. 2009. Natural infection of *Fasciola hepatica* (Trematoda: Fasciolidae) in *Bulinus truncatus* (Gastropoda: Planorbidae) in northern Tunisia. J. Helminthol. 83: 271–273. http://dx.doi.org/10.1017/S0022149X08207947

HASZPRUNAR G. 1988. On the origin and evolution of major gastropod groups, with special reference to the Streptoneura. J. Mollus. Stud. 54: 367–441. http://dx.doi.org/10.1093/mollus/54.4.367

HELLER J., FARSTEY V. 1989. A field method to separate males and females of the freshwater snail *Melanoides tuberculata*. J. Mollus. Stud. 55: 427–429. http://dx.doi.org/10.1093/mollus/55.3.427

HELLER J., FARSTEY V. 1990. Sexual and parthenogenetic populations of the freshwater snail *Melanoides tuberculata* in Israel. Isr. J. Zool. 37: 75–87.

HIEKAL F. A., EL-SOKKARY H. Y. 1987. Survey on the larval trematodes found in the freshwater snails in Edfina Behera Governorate, Egypt. Alex. J. Vet. Sci. 3: 127–140.

HOUBRICK R. S. 1988. Cerithioidean phylogeny. Malacol. Rev. Suppl. 4: 88–128.

HOUBRICK R. S. 1991. Systematic review and functional morphology of the mangrove snails *Terebralia* and *Telescopium* (Potamididae). Malacologia 33: 289–338.

HUBENDICK B. 1951. Recent Lymnaeidae. Kungliga Svenska Vetenskaps-Akademiens Handlingar 3: 1–222.

IBRAHIM A. M. 1975. On the molluscan fauna of the Siwa Oasis. Bull. Zool. Soc. Egypt 27: 71–77.

IBRAHIM A. M., BISHAI H. M., KHALIL M. T. 1999. Freshwater molluscs of Egypt. Publication of National Biodiversity Unit. Egyptian Environmental Affairs Agency, Cairo, Egypt.

IBRAHIM M. M. 2007. Prevalence and intensity of *Angiostrongylus cantonensis* in freshwater snails in relation to some ecological and biological factors. Parasite 14: 61–70. http://dx.doi.org/10.1051/parasite/2007141061

IBRAHIM M. M. I., SHALABY I. M. I., SALEM M. A. M. 2006. Freshwater snails and larval trematode communities in Al-Salam Irrigation Canal. Egypt. J. Zool. 47 65–81.

INNES W. 1884. Récensement des Planorbes et des Valvées de l'Egypte. Bull. Soc. Malacol. Fr. 1: 329–352.

JELNES J. E. 1986. Experimental taxonomy of *Bulinus*: the West and North African species reconsidered, based upon an electrophoretic study of several enzymes per individual. Zool. J. Linn. Soc. 87: 1–26. http://dx.doi.org/10.1111/j.1096-3642.1986.tb01327.x

JEYARASASINGAM U., HEYNEMAN D., LIM H., MANSOUR N. 1972. Life cycle of a new echinostome from Egypt, *Echinostoma liei* sp.nov. (Trematoda: Echinostomatidae). Parasitology 65: 203–222. http://dx.doi.org/10.1017/S0031182000044991

KENDALL S. B. 1949. *Lymnaea stagnalis* as an intermediate host of *Fasciola hepatica*. Nature 163: 880–881. http://dx.doi.org/10.1038/163880a0

KENDALL S. B. 1974. Some parasites of domestic animals in the Aswan Governorate – Arab Republic of Egypt. Trop. Anim. Health Prod. 6: 128–130. http://dx.doi.org/10.1007/BF02380704

KINOTI G. K. 1964. A note on the susceptibility of some gastropod molluscs to *Schistosoma bovis* and *S. mattheei*. Ann. Trop. Med. Parasitol. 58: 270–279.

KRISTENSEN T. K., YOUSIF F., RAAHAUGE P. 1999. Molecular characterisation of *Biomphalaria* spp. in Egypt. J. Mollus. Stud. 65: 133–136. http://dx.doi.org/10.1093/mollus/65.1.133

KOCK K. N. DE, WOLMARANS C. T. 2005. Distribution, habitats and role as intermediate host of the freshwater snail, *Bulinus forskalii*, in South Africa. Onderstepoort J. Vet. Res. 72: 165–174. http://dx.doi.org/10.4102/ojvr.v72i2.214

KRULL W. H. 1933. New snail hosts for *Fasciola magna* (Bassi, 1875) Stiles, 1894. J. Parasitol. 20: 107–108.

KUDLAI O. 2009. The discovery of the intermediate host for the trematode *Moliniella anceps* (Trematoda, Echinostomatidae) in Ukraine. Vestn. Zool. 43: e11–e13.

LEIGH E. G., BUTZER K. W. 1968. Fossil molluscs from the Kom Ombo Plain. In: BUTZER K. W., HANSEN C. L. (eds). Desert and river in Nubia: Geomorphology and prehistoric environments at the Aswan Reservoir. University of Wisconsin Press, Madison, Wisconsin, pp. 509–512.

LEIPER R. T. 1915. Report on the results of the bilharzia mission in Egypt, 1915. J. Roy. Army Med. Corps 25: 1–55, 147–192, 253–267.

LEIPER R. T. 1916a. Report on the results of the bilharzia mission in Egypt, 1915, Part IV. Egyptian Mollusca. J. Roy. Army Med. Corps 27: 171–190.

LEIPER R. T. 1916b. On the relation between the terminal-spined and lateral-spined eggs of bilharzia. Br. Med. J. 1: 411. http://dx.doi.org/10.1136/bmj.1.2881.411

LIVSHITS G., FISHELSON L., WISE G. S. 1984. Genetic similarity and diversity of parthenogenetic and bisexual populations of the freshwater snail *Melanoides tuberculata*. Biol. J. Linn. Soc. Lond. 23: 41–54. http://dx.doi.org/10.1111/j.1095-8312.1984.tb00805.x

LOTFY W. M. 2009. Human schistosomiasis in Egypt: historical review, assessment of the current picture and prediction of the future trends. J. Med. Res. Inst. 30: 1–7.

LOTFY W. M., DEJONG R. J., ABDEL-KADER A., LOKER E. S. 2005. A molecular survey of *Biomphalaria* in Egypt: is *B. glabrata* present? Am. J. Trop. Med. Hyg. 73: 131–139.

LOTFY W. M., EL-MORSHEDY H. N., ABOU EL-HODA M. 2001. Studies on *Fasciola* egg size and infectivity to *Lymnaea cailliaudi* in Egypt. Bull. High Inst. Publ. Health 31: 705–714.

LYDEARD C., HOLZNAGEL W. E., GLAUBRECHT M., PONDER W. F. 2002. Molecular phylogeny of a circum-global, diverse gastropod superfamily (Cerithioidea: Mollusca: Caenogastropoda): pushing the deepest phylogenetic limits of mitochondrial LSU rDNA sequences. Mol. Phylogenet. Evol. 22: 399–406. http://dx.doi.org/10.1006/mpev.2001.1072

MAGZOUB M., KASIM A. A. 1980. Schistosomiasis in Saudi Arabia. Ann. Trop. Med. Parasitol. 74: 511–513.

MALEK E. A. 1971. The life cycle of *Gastrodiscus aegyptiacus* (Cobbold, 1876) Looss, 1896 (Trematoda: Paramphistomatidae: Gastrodiscinae). J. Parasitol. 57: 975–979. http://dx.doi.org/10.2307/3277847

MANDAHL-BARTH G. 1973a. A field guide to African freshwater snails. 2. East African species. Danish Bilharziasis Laboratory, Charlottenlund, Denmark.

MANDAHL-BARTH G. 1973b. Description of new species of African freshwater molluscs. Proc. Malac. Soc. London 40: 227–286.

MARTIN W. E. 1959. Egyptian heterophyid trematodes. Trans. Am. Microsc. Soc. 78: 172–181. http://dx.doi.org/10.2307/3224026

MEIER-BROOK C., HAAS D., WINTER G., ZELLER T. 1987. Hydrochemical factors limiting the distribution of *Bulinus truncatus*. Am. Malacol. Bull. 5: 85–90.

MOHAMED S. H., MOSTAFA O. M., MOHAMMAD A. H. 1998. Susceptibility of some pulmonate snails to the infection with *Fasciola* sp. from various mammalian hosts. J. Uni. Arab Biol. 10: 29–44.

MORRISON J. P. 1954. The relationships of old and new world melanians. Proc. U.S. Nat. Mus. 103: 357–394.

NAGATY H. F., EL-GINDY M. S., ABDEL MAGEED S. M. 1959. On the morphology, anatomy and trematodes infection of some lymnaeid snails from Egypt with special references to fascioliasis. J. Egypt. Med. Assoc. 19: 51–77.

NASR M. 1941. The occurrence of *Prohemistomum vivax* (Sonsino, 1892) Azim 1933 infection in man, with a redescription of the parasite. Lab. Med. Prog. 2: 135–149.

PALLARY P. 1924. Supplément à la faune malacologique terrestre et fluviale de l'Égypte. Mém. Inst. Égypt. 7: 23–24 & 46–49.

PFLUGER W. 1982. Introduction of *Biomphalaria glabrata* to Egypt and other African countries. Trans. R. Soc. Trop. Med. Hyg. 76: 567. http://dx.doi.org/10.1016/0035-9203(82)90167-5

PFLUGER W., ROUSHDY M. Z. 1980. Record of *Helisoma* snails from the field in Egypt. Z. Parasitenkd. 63: 287–288. http://dx.doi.org/10.1007/BF00931991

PINTO H. A., MELO A. L. DE 2011. A checklist of trematodes (Platyhelminthes) transmitted by *Melanoides tuberculata* (Mollusca: Thiaridae). Zootaxa 2799: 15–28.

POINTIER J. P., DAVID P., JARNE P. 2005. Biological invasions: the case of planorbid snails. J. Helminthol. 79: 249–256. http://dx.doi.org/10.1079/JOH2005292

PONDER W. F., LINDBERG D. R. 1997. Towards a phylogeny of gastropod molluscs: an analysis using morphological characters. Zool. J. Linn. Soc. 119: 83–265. http://dx.doi.org/10.1111/j.1096-3642.1997.tb00137.x

POR F. D. 1971. The zoobenthos of the Sirbonian lagoons. Rapports et Procès-Verbaux des Réunions de la Commission Internationale pour l'Exploration Scientifique de la Mer Mediterranée 20: 247–249.

POR F. D., DOR I. 1975. Ecology of the metahaline pool of Di Zahav, Gulf of Elat, with notes on the Siphonocladacea and the typology of near-shore marine pools. Mar. Biol. 29: 37–44. http://dx.doi.org/10.1007/BF00395525

POR F. D., DOR I., AMIR A. 1977. The mangal of Sinai: limits of an ecosystem. Helgol. Wiss. Meeresunters. 30: 295–314. http://dx.doi.org/10.1007/BF02207843

ROUSHDY M. Z., EL-EMAM M. 1981. A natural population of *Helisoma duryi* in the River Nile in Egypt. Egypt. J. Bilharz. 8: 87–89.

ROZENDAAL J. A. 1997. Freshwater snails, vector control: methods for use by individuals and communities. WHO, Geneva, Switzerland, pp. 337–356.

RYSAVY B., BARUS V., MORAVEC F., YOUSIF F. 1974. On some problems of the biological control of human schistosomiasis in Egypt. Folia Parasitol. (Praha) 21: 161–168.

SATTMANN H., KINZELBACH R. 1988. Notes on inland water molluscs from Egypt (Mollusca: Gastropoda, Bivalvia). Zool. Middle East 2: 72–78. http://dx.doi.org/10.1080/09397140.1988.10637562

SCHUTT C. H. J. 1986. Der ägyptische Nil und seine Weichtiere. De Kreukel 22: 169–183.

SEY O. 1977. Examination of amphistomes (Trematoda: Paramphistomata) parasitizing in Egyptian ruminants. Parasitol. Hung. 10: 47–50.

SKORPING A. 1985. *Lymnaea stagnalis* as experimental intermediate host for *Elaphostrongylus rangiferi*. Z. Parasitenkd. 71: 265–270. http://dx.doi.org/10.1007/BF00926277

SOLDANOVA M., SELBACH C., SURES B., KOSTADINOVA A., PEREZ-DEL-OLMO A. 2010. Larval trematode communities in *Radix auricularia* and *Lymnaea stagnalis* in a reservoir system of the Ruhr River. Parasite. Vector. 3: 56. http://dx.doi.org/10.1186/1756-3305-3-56

STRONG E. E., COLGAN D. J., HEALY J. M., LYDEARD C., PONDER W. F., GLAUBRECHT M. 2011. Phylogeny of the gastropod superfamily Cerithioidea using morphology and molecules. Zool. J. Linn. Soc. 162: 43–89. http://dx.doi.org/10.1111/j.1096-3642.2010.00670.x

TARASCHEWSKI H., PAPERNA I. 1981. Distribution of the snail *Pirenella conica* in Sinai and Israel and its infection by Heterophydae and other trematodes. Mar. Ecol. Prog. Ser. 5: 193–205. http://dx.doi.org/10.3354/meps005193

TARASCHEWSKI, H., PAPERNA I. 1982. Trematode infections in *Pirenella conica* in three sites of a mangrove lagoon in Sinai. Z. Parasitenkd. 67: 165–173. http://dx.doi.org/10.1007/BF00928112

TAYLOR D. W. 1988. New species of *Physa* (Gastropoda: Hygrophila) from the western United States. Malacol. Rev. 21: 43–79.

TCHERNOV E. 1971. Freshwater molluscs of the Sinai peninsula. Isr. J. Zool. 20: 209–221.

TE G. A. 1980. New classification system for the family Physidae. Arch. Moll. 110: 179–184.

THIELE J. 1931. Handbuch der systematischen Weichtierkunde, II. Verlag von Gustav Fischer, Jena, Germany.

TILLIER L., BAVAY A. 1905. Les mollusques testacés du Canal de Suez. Bull. Soc. Zool. Fr. 30: 170–181.

TOHAMY A. A., MOHAMED S. M. 2006. Chromosomal studies on two Egyptian freshwater snails, *Cleopatra* and *Bithynia* (Mollusca-Prosobranchiata). Arab J. Biotech. 9: 17–26.

TORGERSON P., CLAXTON J. 1999. Epidemiology and control. In: DALTON J. P. (ed.). Fasciolosis. CABI Publishing, New York, pp. 113–149.

VAN BRUGGEN A. C. 1974. Alien planorbid from South West Africa erroneously recorded as *Biomphalaria pfeifferi*. Zool. Med. Leiden 48: 11–18.

VAN DAMME D. 1984. The freshwater mollusca of Northern Africa: distribution, biogeography and palaeoecology. Dr. W. Junk Publishers, Dordrecht, The Netherlands.

VAN DAMME D. 1988. Biogeography, palaeoecology en evolution of the North African freshwater molluscs during the Quaternary. D.Sc. Thesis, Faculty Exact Sciences, Gent University, Gent, Belgium.

VRIJENHOEK R. C., GRAVEN M. A. 1992. Population genetics of Egyptian *Biomphalaria alexandrina* (Gastropoda, Planorbidae). J. Hered. 83: 255–261.

WITENBERG G. 1964. Zooparasitic diseases. A. Helminthozoonoses. In: VAN HOEDEN J. (ed.). Zoonoses. Elsevier Publishing Company, New York, pp. 529–719.

WRIGHT C. A., SOUTHGATE V. R., HOWARD G. W. 1979a. Observations on the life-cycle of *Schistosoma margrebowiei* and its possible interactions with *S. leiperi* in Zambia. J. Nat. Hist. 13: 499–506. http://dx.doi.org/10.1080/00222937900770381

WRIGHT C. A., SOUTHGATE V. R., HOWARD G. W. 1979b. A note on the life-cycles of some amphistome flukes in Zambia. J. Helminthol. 53: 251–252. http://dx.doi.org/10.1017/S0022149X00006039

YOUSIF F., EL-EMAM M., ROUSHDY M. Z. 1993. *Helisoma duryi*: its present range of distribution and implications with schistosomiasis snails in Egypt. J. Egypt. Soc. Parasitol. 23: 195–211.

YOUSIF F., HAROUN N., IBRAHIM A., EL-BARDICY S. 1996. *Biomphalaria glabrata*: A new threat for schistosomiasis transmission in Egypt. J. Egypt. Soc. Parasitol. 26: 191–205.

YOUSIF F., IBRAHIM A. 1978. The first record of *Angiostrongylus cantonensis* from Egypt. Z. Parasitenkd. 56: 73–80. http://dx.doi.org/10.1007/BF00925940

YOUSIF F., IBRAHIM A., ABDEL-KADER A., EL-BARDICY S. 1998a. Invasion of the Nile Valley in Egypt by a hybrid of *Biomphalaria glabrata* and *Biomphalaria alexandrina*, snail vectors of *Schistosoma mansoni*. J. Egypt. Soc. Parasitol. 28: 569–582.

YOUSIF F., IBRAHIM A., EL-BARDICY S. N. 1998b. Compatibility of *Biomphalaria alexandrina*, *Biomphalaria glabrata* and a hybrid of both to seven strains of *Schistosoma mansoni* from Egypt. J. Egypt. Soc. Parasitol. 28: 863–881.

YOUSIF F., IBRAHIM A., SLEEM S., EL-BARDICY S., AYOUB M. 2009. Morphological and genetic analyses of *Melanoides tuberculata* populations in Egypt. Glob. J. Mol. Sci. 4: 112–117.

YOUSIF F., LAMMLER G. 1975. The suitability of several aquatic snails as intermediate hosts for *Angiostrongylus cantonensis*. Z. Parasitenkd. 47: 203–210. http://dx.doi.org/10.1007/BF00418203

YURLOVA N. I., VODYANITSKAYA S. N., SERBINA E. A., BISERKOV V. Y., GEORGIEV B. B., CHIPEV N. H. 2006. Temporal variation in prevalence and abundance of metacercariae in the pulmonate snail *Lymnaea stagnalis* in Chany Lake, West Siberia, Russia: long-term patterns and environmental covariates. J. Parasitol. 92: 249–259. http://dx.doi.org/10.1645/GE-544R2.1

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