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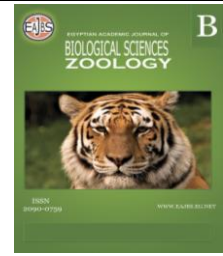


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**Taxonomic Key as A Simple Tool for Identifying and Determining the Abundant Terrestrial Snails in Egyptian Fields
(Gastropoda, Pulmonata: Succineidae, Geomitridae, Helicidae, Hygromiidae)**

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ABSTRACT

Terrestrial snail collection that had been recorded in Egyptian fields, gardens and nurseries are reviewed and described with a clear description, pictures, and taxonomic data in addition to shell morphological characters that provided for every species.

This study includes six terrestrial snails, *Succinea (Amphibina) cleopatra* (Pallary, 1909) (Succineidae), *Cochlicella acuta* (O. F. Müller, 1774), *Xeropicta krynickii* (Krynicky, 1833) (Geomitridae), *Massylaea vermiculata* (O.F. Müller 1774), *Theba pisana* (O. F. Müller, 1774) (Helicidae) and *Monacha obstructa* (L. Pfeiffer, 1842) (Hygromiidae) that are common to be observed in the Egyptian Agricultural fields. This report of land snail's identification is based on the specimen's shell morphology and their distribution through their activity season in multiple surveys whether through our research studies or previous research. This report is an attempt to deliver a comprehensive shell description and survey data of land snails as agricultural pests providing a well-defined taxonomic key to the species level. The taxonomical key can provide the growers with the essential data of identifying the land snail species that could be noticed in the crop fields, gardens, or ornamental plant nurseries.

INTRODUCTION

Some land snail and slug species have been extent by human far beyond their natural range (Cowie, 2001; Herbert, 2010). The spread of terrestrial mollusc species has intensified following the emergence of modialization, including through trade-in plant material and other goods (Barker, 2002).

Terrestrial gastropods considered recently as one of the important economic pests in all over world and Egypt as well, infesting almost all the growth vegetation stages of the plant causing yield reduction and severe damage to the economic edible parts of the field

crops, fruits, and vegetables (Baur and Baur, 1993). The population density of land snails could be observed on the soil surface, stems, leaves and fruits as well (Awad, 2013). Different species of terrestrial gastropods infested diverse of host plants in the north region of delta governorates such as Beheira (Hashem *et al.*, 1993); Gharbia (Metwally *et al.*, 2002; Arafa, 2006); Dakahlia (Daoud, 2004; Arafa, 2006); Damietta (Mahmoud and Awad 2008); Ismailia (El-Okda, 1984; Mahrous *et al.*, 2002; Mohammed, 2015); Kafer El-Sheikh (El-Deeb *et al.*, 2004); Qalyubia (Arafa, 2006); Monufia (Arafa, 2006, Heikal, 2015; Mohammed, 2015); Sharkia (Ismail, 1997; Mahrous *et al.*, 2002); and Port Saied governorate (Awad and Abd El-Galil, 2020) in Egypt.

Terrestrial gastropod surveys had been recorded around Egypt (Hashem *et al.*, 1992; El-Deeb *et al.*, 1996; Abd El-Aal, 2001; Mortada, 2002; Idress, 2003; Sallam and El-Wakeil, 2012; Mohammed, 2015). The species varied in level of infestation according to locality weather and environment and host type (Gazzy *et al.*, 2019). The habitat characteristics such as vegetation, organic matter and soil structure can be important for species abundance.

Generally, in the previous surveys, *M. vermiculata*, *T. pisana* and *Monacha* sp. were the most dominant and widespread land snails in many governorates (Idress, 2003; Eshra, 2013; Mohammed, 2015).

This present work is to report taxonomic information and shell description about the most invasive common recorded species at Egyptian fields and their full identification.

MATERIALS AND METHODS

This work summarizes the taxonomic data of the six species of snails *Succinea (Amphibina) cleopatra* (Pallary, 1909) (Succineidae), *Cochlicella acuta* (O. F. Müller, 1774), *Xeropicta krynickii* (Krynicky, 1833) (Geomitridae), *Massylaea vermiculata* (O.F. Müller 1774), *Theba pisana* (O.F. Müller, 1774) (Helicidae) and *Monacha obstructa* (L. Pfeiffer, 1842) (Hygromiidae) had been clarified in this work. The species had been recorded during field surveys and collecting living samples in various habitats, agricultural fields and gardens over the past five years in addition to the previous data in previous research and survey literatures. The collected samples represent common land snails in Egypt as agricultural pests.

The shell description counts on the differences in shell diameter, thickness, height, and color whether background color, bands and blotches color. The species have been identified based on conchological criteria with reference to Kerney and Cameron (1979), Godan (1983), Cameron (2003), and Yildirim *et al.* (2004). The empty shells were photographed in the laboratory, and the living samples were photographed in the field to document the shell morphology and the gastropod's infestation in the field. The Geographic coordinates of some collecting spots were recorded using a GPS. Finally, living specimens were transferred and preserved in Malacology Laboratory of Zoology and Agricultural Nematology Department, Faculty of Agriculture, Cairo University.

RESULTS

Six species of land snails, belonging to four different families are economically important as agricultural pests. Their taxonomic key had been designated and designs in detail according to the adult shell morphology and its characters. *Succinea (Amphibina) Cleopatra* (Pallary, 1909) (Succineidae), *Cochlicella acuta* (O. F. Müller, 1774), *Xeropicta krynickii* (Krynicky, 1833) (Geomitridae), *Massylaea vermiculata* (O. F. Müller 1774), *Theba pisana* (O. F. Müller, 1774) (Helicidae) and *Monacha obstructa* (L. Pfeiffer, 1842) (Hygromiidae) are identified in the following key according to Kerney and Cameron (1979);

Godan (1983); Cameron (2003) and Yildirim *et al.*, (2004).

- 1.a. Shell clearly higher than wide; shell high ($H < 7$ mm) **Succineidae, Geomitridae**
 b. Shell wide as a high, [large shell ($H < 7$ mm)]..... **Helicidae, Hygromiidae**
- 2.a. Sinistral shell (the shell of a gastropod is left-handed or coiled in an anti-clockwise direction)..... **3**
 b. Dextral shell (the shell of a gastropod is right-handed or coiled in a clockwise direction) **4**
3. No records of the sinistral shell of terrestrial snail species in Egyptian fields yet or it could be a freshwater snail such as *Lanistes* sp., *Haitia* sp., *Bulinus* sp. (Lotfy and Lotfy, 2015)
- 4.a. Adult shell less than 3 mm high..... **5**
 b. Adult shell more than 3 mm high **6**
5. Not included in this study.
- 6.a. Height of the aperture is nearly or more than half height of shell **7**
 b. Height of the aperture is 0.4 x shell height or less..... **8**
7. Adult shell high more than 12 mm, shell with rounded and rapidly expanding whorls, translucent, always less than 5 whorls, and with a simple, unthickened aperture..... **Succinea** sp.
- 8.a. Shell with few, very rapidly expanding whorls and shallow suture, bright shell and shell height up to 20 mm..... **Succinea (Amphibina) Cleopatra**
9. Shell is a nearly perfect cone, with a small, simple and thickened aperture, shell opaque and whitish, often with dark bands and/or blotches..... **Geomitridae, Cochlicella**
- 10.a. shell very elongate, with height more than 2x width, when shell is 7 mm or more high, whorls relatively convex, with moderate sutures **Cochlicella acuta**
 b. Shell height less than 2x width, whorls more flattened, and sutures shallow..... **Cochlicella barbara**
- c. Shell conical, whorls convex and shallow sutures..... **Cochlicella conoidea**
- 11.a. adult shell with more than 3 whorls, globular (height roughly equal to the width), shell very large reach to 25 mm or more in wide, with very rapidly expanding whorls **12**
 b. Adult shell less than 25 mm wide, shapes of shell varied including globular..... **13**
- 12- Shell with a light creamy background with dark brown bands around 5 to 6 bands, no umbilicus, the aperture is compressed, and the edge of the lip is thick and reflected lip. Diameter around 25 – 30 mm, spiral low **Massylaea vermiculata**
- 13.a. Shell creamy white to light brown in the background, diameter around 20 mm, umbilicus completely sealed by a lip, the lip with thin, not strong edge with the variable pattern often with bands or blotches **Theba pisana**
 b. Shell creamy white to light brown in background diameter around 17 mm, 3.5 whorls the pattern in bands darker almost brown to dark brown **14**
- 14.a. Shell diameter around 12 – 17 mm white in the background with 5 to 6 whorls varying shades of brown spots and band with open umbilicus, white or brown spiral bands **Xeropicta krynickii**
 b. Shell diameter around 12 – 16 mm in diameter, aperture thick white umbilicus is closed with almost like crescent shape, flattened shell with thickened rib behind the lip with an almost pinkish line behind the aperture **Monacha obstructa**
 c. Shell diameter around 9 – 17 mm in diameter, umbilicus is minute, partly obscured by reflected columnar lip depressed globular shell with aperture is elliptical with thickened internal lip **Monacha cartusiana**
 d. Shell diameter around 16 – 20 mm in diameter, the aperture is nearly circular with a white internal lip, the umbilicus is small slightly obscured by a reflected columnar lip, globular shell slightly depressed **Monacha cantiana**

List of Land Snails:

Phylum.....Mollusca Linnaeus, 1758
 Class.....Gastropoda Cuvier, 1795
 Order.....Stylommatophora Schmidt, 1855
 Superfamily.....Succineoidea Beck, 1837
 Family.....Succineidae Beck, 1837
 Subfamily.....Succineinae Beck, 1837
 Genus.....*Succinea* Draparnaud, 1801

***Succinea (Amphibina) Cleopatra (Pallary, 1909)* (Fig. 1)**

Distribution in Egypt:

This species had been verified in multiple spots in Egyptian governorates such as Alexandria and Damietta (Pallary, 1909). *Succinea cleopatra* recorded in River Nile and its branches in Assiut governorate (Abd El-Wakeil *et al.*, 2013). El-Khayat *et al.* (2017) recorded the same species at the River Nile banks including Damietta and Rosetta Branches, including Minya, Giza, Qalyubia, Beheira, and Ismailia canals. It was the most abundant species in the River Nile by 33.6% among the other snail species (El-Khayat *et al.*, 2017). It was identified in the sites of Minya, Giza and Damietta governorates as well (Mahmoud and Sayed, 2018).

During this study, this species had been documented in El Qanater El Khayreya, Qalyubia governorate (coordinates 30°11.601' N 31°06.693' E) and surrounding area found on chicory, wild weeds and around plant pots where more humid and shade.

Generally, the species *Succinea* sp. documented in South district of Port Saied, Port Saied governorate (Awad, 2013), Ismailia and Sharkia (Rady, 2014), Qalyubia, Monufia, Sharkia, Damietta, and Dakahlia (Mohammed, 2015), and Kafr El-Sheikh governorate (Gazzy *et al.* 2019).

Distribution Around the World:

Holarctic species, that a species presents in the Northern Hemisphere, especially in the north of the Tropic of Cancer and in particular in the Nearctic and Palearctic regions, thus considering Europe, North America, Africa to the north (l 'atlas) and Eurasia north of the Himalayas, it is wide distribution species found in North West of Europe (Kerney and Cameron, 1979). In addition, the Czech Republic (Juříčková *et al.* 2001), Ukraine (Balashov and Gural-Sverlova, 2012) and Bulgaria (Georgiev, 2006).

Shell Description:

Shell with three rapidly widening whorls, the last whorl occupying about 2/3 of the total height. The shell usually is pale brown, thin, glossy, fragile and translucent, with a short spire and very large last body whorl and aperture and no umbilicus (Kerney and Cameron, 1979). Elongate amber shell, whorls rounded, suture shallow with numerous irregular growth-lines. The visible soft parts of the body are pale yellowish-brown or yellow with a reddish hue, which becomes lighter downwards to the sides (Kerney and Cameron, 1979). Succineidae group has variable shells that often can be difficult to identify the species correctly without dissecting.

Shell Dimensions:

Shell diameter around 10 to 17 mm till 20 mm.

Host Range and Habitat:

Generally, family Succineidae prefer wet and humid environment such as margins of lakes and rivers that almost found on muddy surfaces (Kerney and Cameron, 1979).

Succineidae gastropods usually were found on plants close to the banks of small rivers or in the shade of plant pots in nurseries and gardens where more humid. This species had been reported that these species play important role in the public health distributed in the River

Nile branches, main canals and some drains in Egyptian governorates (Hussein *et al.*, 2011; El-Khayat *et al.*, 2017).

Succinea sp. had been recorded on lettuce, Egyptian clover, rice, broad bean, pea and cabbage (Mohammed, 2015; Heiba *et al.*, 2018; Gazzy *et al.*, 2019) and also recorded mainly on field and vegetables, and not had recorded on ornamental plants or wood trees in Kafr El sheikh governorate (Heiba *et al.*, 2018). In this study, *Succinea* (*Amphibina*) *Cleopatra* found on Chicory *Cichorium pumilum* and Egyptian clover *Trifolium alexandrinum* at El Qanater El Khayreya (coordinates 30°11.601' N 31°06.693' E) (Fig. 2).

Phylum.....Mollusca Linnaeus, 1758
 Class.....Gastropoda Cuvier, 1795
 Order:.....Stylommatophora Schmidt, 1855
 Superfamily.....Helicoidea Rafinesque, 1815
 Family.....Geomitridae Boettger, 1909
 Subfamily.....Geomitrinae Boettger, 1909
 Genus.....*Cochlicella* Férussac, 1821

***Cochlicella acuta* (O. F. Müller, 1774) (Fig. 3, A)**

Distribution in Egypt:

The species is recorded in Qalyubia, Gharbia, Monufia, Damietta, Ismailia and Kafr El Sheikh governorate (Kassab and Daoud 1964; Mohammed, 2015; Heiba *et al.*, 2018; Gazzy *et al.*, 2019; Mostafa, 2020), Cairo (Mohamed and Ali, 2011), Beheria governorate (Eshra, 2013), and recorded in some desert spots in King Mariout and Borg El Arab, Alexandria (Ali, 2017).

C. acuta recorded in this study in a farm in Sharkia governorate (30°25'11" N 31°38'21" E), 110 ft elevation under leaf litter, on tree trunk of windbreaker and ornamental plants.

Distribution Around the World:

The species lives in the north and the west of the Mediterranean region, on the Atlantic coasts of Belgium and South England. It is introduced to the Eastern Mediterranean (Greece, Turkey). It also occurs in Northern Africa. In Spain (Salamanca, Zaragoza, Huesca) and south of Ireland, it also occurs far from the coast. This snail may have entered the British Isles in the late prehistoric period (Lewis, 1977; Kerney and Cameron, 1979; Welter-Schultes, 2012).

Shell Description:

Shell with 8 to 10 slightly convex whorl. It is a somewhat delicate and elongated cone; umbilicus is minute, obscured by reflected columellar lip. The aperture is elliptical, higher than wide and with no evidence of an internal rib (Ali, 2011). The shell is very variable in color and background, often having a cream or off-white background with many pale brown blotches or thin lines, which are sometimes organized into spiral bands. The shell in general is taller and thinner compare to *C. barbara* and *C. conoidea*.

Shell Dimensions:

The shell height ranged from 10 – 20 mm, while the diameter ranged from 4 - 7 mm (Kerney and Cameron, 1979).

Host Range and Habitat:

The species had been recorded on grapes, mango and date palm in Qalyubia, Gharbia, Monufia, Damietta, and Ismailia (Mohammed, 2015) on lettuce, Egyptian clover, cabbage and broad bean in different governorates (Heiba *et al.*, 2018; Gazzy *et al.*, 2019) and on guava trees orchards in Kafr El Sheikh governorate (Mostafa, 2020).

***Cochlicella barbara* (Linnaeus, 1758)** (Fig. 3, B)

It had been noticed during our survey that some **individuals of *Cochlicella*** are closer in shape and description to *C. barbara* that can give an initial indication that some spots in Egyptian fields had been infested with this species such as in Sharkia governorate (30°25'11" N 31°38'21" E), 110 ft elevation.

Distribution in Egypt:

Pallary (1909) had been recorded that *C. barbara* in Sidi Gaber and Mariout in Alexandria, for this point it maybe needs further study for verification.

Distribution Around the World:

This species lives in the European coastal regions from the north of Portugal to the northwestern part of the Mediterranean; it is introduced in Belgium, Britain i.e. Cornwall and Wales, and spread throughout the Mediterranean region (Bank and Neubert, 2017); also in Algeria (Bouaziz-Yahiatene and Medjdoub-Bensaad, 2016).

Shell Description:

With cone shell shape of 7 – 8 very slightly convex whorls with shallow sutures. In general, the shell is shorter and wider in the last whorl compare to *C. acuta*. The shell is elongated. Umbilicus is minute and partly obscured by collumellar lip. No internal lip in the aperture. Shell thick and white background with some variations in banding.

Shell Dimensions:

The shell height ranged from 8 – 12 mm, while the diameter ranged from 5 - 8 mm (Kerney and Cameron, 1979).

***Cochlicella conoidea* (Draparnaud, 1801)** (Figs. 3, C and D)**Distribution in Egypt:**

It is not recorded in Egypt, however the species here for full comparison among the three species that are widespread in Mediterranean region (Figs. 4, A, B and C).

Distribution Around the World:

The species lives in the Mediterranean region. It is rare in Cyprus and does not occur in the north of Italy (Bank and Neubert, 2017), however it recorded in Mount Circeo (Latium, Italy), on the southwestern coast of Italy on the Tyrrhenian Sea. Godan (1983) states that *C. conoidea* had been found in the United States in ship storerooms and containers as pest and intercepted in USA on *Lens culinaris* (lentils) as well as other plants and seeds.

Shell Description:

Shell is light grey or light horny brown, coloured with brown blotches and / or brown band at the base of the last whorl; aperture simple and sharp, umbilicus open and slightly covered by columellar margin of the aperture.

The shell is shorter compare to the two previous *Cochlicella* species. Shorter than *Cochlicella acuta* and with a larger diameter and a slightly more profound suture than *C. barbara*.

Shell Dimensions:

The shell height ranged from 6 to 9 mm, while the diameter ranged from 5 to 6 mm; the whorls around 4.5 to 6 whorls.

In this study, the species *C. acuta* and *C. barbara* had been observed on windbreaker trees in Sharkia governorate (coordinates: 30°25'11" N 31°38'21" E), during their aestivation time in October 2019 showing the feeding symptoms on the tree trunk (Figs. 5 and 6).

Phylum Mollusca Linnaeus, 1758
 Class Gastropoda Cuvier, 1795
 Order: Stylommatophora Schmidt, 1855
 Superfamily Helicoidea Rafinesque, 1815
 Family Geomitridae Boettger, 1909

Subfamily.....Helicellinae Ihering, 1909
 Genus*Xeropicta* Monterosato, 1892

***Xeropicta krynickii* (Krynicky, 1833)** (Figs. 7 and 8)

Distribution in Egypt:

Xeropicta krynickii is the accepted name of the old synonym *Helix (Xerophila) vestalis* Pfeiffer, 1841 and recorded in previous literature in Egypt as *Helicella vestalis*. This species recorded in Sharkia (Abd El Rahman and Al Akra, 2012; Mohammed, 2015), Qalyubia, Monufia, Damietta, Ismailia and Dakahlia governorate (Mohammed, 2015). *X. krynickii* was abundant on the border of King Mariout till Borg El Arab, Alexandria in addition to the south of El Alamein, El Alamein North coast of Egypt (Ali, 2017).

Distribution Around the World:

Xeropicta krynickii has a peri-Black sea distribution. Extending its range as far as the Middle East. It was recorded from Podgorica (Montenegro), Italy, Azerbaidzhan, Iran, Syria, Lebanon, Jordan, Israel and Egypt (De Mattia and Pešić, 2014), and also distributed in the East Mediterranean region, central the Middle East and Jordan (Neubert *et al.*, 2015). It was probably introduced also to Cyprus and Crete (Schütt 2001; Welter-Schultes, 2012). This species suggested as national quarantine significant pest in USA (Cowie *et al.*, 2009).

Shell Description:

The shell is medium-sized to small low conic above, with a sub depressed to subconoidal spire and slightly elevated, glossy, basic color cream-whitish, purely white or with distinct brown spiral bands or rows of brown dots; aperture broadly oval with a sharp peristome, lip weak to strong. The umbilicus is perspective, widely open. The color varied from creamy or white to brown-banded with light background; the bands were either continuous or broken into squares or dots (Ali, 2017; De Mattia and Pešić, 2014).

According to (Neubert *et al.*, 2015), the shell is depressed, glossy, with well-marked dark brown spiral bands and rarely all white, the spiral bands can be broken up into a checked pattern especially on the umbilical side. The teleoconch covered with fine axial ribs, the aperture is slightly elliptical.

Shell Dimensions:

Shell diameter of *X. krynickii* averaged 15.25 ± 1.09 mm and the mean shell height was 10.01 ± 0.69 mm that found in some spots between Borg El Arab, Alexandria to Marsa Matrouh. It could reach to 12.50 ± 0.53 mm in diameter and the mean shell height was 8.27 ± 0.49 mm that found in King Mariout (Ali, 2017), around 5 to 6 well rounded whorls with distinct deep sutures.

Host Range and Habitat:

The species found on sandy soil, big rocks, and moderately dense vegetation with wild vegetation such as *Thymelaea hirsute* (L.) Endl. (Thymelaeaceae), *Centaurea calcitrapa* L. (Compositae) and *Dicanthium annulatum* (Forssk) Stapf (Gramineae) (Figs. 9 and 10) in the road lead to Borg El Arab, Alexandria (coordinates: 30°56.723' N 29°40.110' E) 190 ft elevation. It is common to find the species on thorny or pointed leaves plants in arid spots. The species was found on navel orange, wheat and grapes as an agricultural pest (Mohammed, 2015).

Phylum.....Mollusca Linnaeus, 1758
 Class.....Gastropoda Cuvier, 1795
 Order.....Stylommatophora Schmidt, 1855
 Superfamily.....Helicoidea Rafinesque, 1815
 Family.....Helicidae Rafinesque, 1815
 Subfamily.....Helicinae Rafinesque, 1815
 Genus *Massylaea* O.F. Müller, 1774

***Massylaea vermiculata* (O.F. Müller 1774)** (Figs. 11 and 12)

Massylaea vermiculata, a common wide distributed helicid land snail in Egypt that formerly known as *Eobania vermiculata* and re-identified to genus *Massylaea* (Bouaziz-Yahiatene *et al.*, 2017).

Distribution in Egypt:

Pallary (1909) reported the species from many localities in the northern part of Egypt such as Alexandria and Damietta. The species recorded also in Kafr El-Sheikh (Heiba *et al.*, 2018), Sharkia (Hegab *et al.*, 1999; Mohammed, 2015; Ismail *et al.*, 2017; Khidr *et al.* 2020), Beheira, and Alexandria (Eshra, 2013; 2014), Monufia (Heikal, 2015) Gharbia, Damietta, Ismailia, Dakahlia (Mohammed, 2015), and Qalyubia governorate (Mohammed, 2015; Khidr *et al.* 2020).

Distribution Around the World:

The species is the most common and widespread in the Mediterranean region (Kerney and Cameron, 1979) having a cosmopolitan distribution and is meanwhile introduced in proper habitat in multiple parts of the world (Neubert *et al.*, 2015). It is recorded also in Croatia (Rađa *et al.*, 2012), Hungary and Slovenia (Páll-Gergely *et al.* 2020).

Shell Description:

Shell thick-walled large, globose, bright cream-whitish in the background, dense and irregular pattern of white dots, with mostly with 5 reddish to dark brown spiral bands, first two often merged, 3rd widest just above the periphery line, and the 4th and 5th below this. Bands are regularly continuous and wide; the umbilicus is totally covered. The aperture broad and oblique; moderately strong lip that reinforced to form an oblique lamella.

Shell Dimensions:

The shell is moderate; the diameter ranged 26 ± 4 mm and can reach 35 mm, while shell height ranged from 14 to 24 mm, with 5 to 6 well-rounded whorls with low sutures.

Host Range and Habitat:

The species are found in the fields, countryside, gardens, vineyards, hedges and dunes. It crawls the tree trunk such as citrus (Hashem *et al.*, 1993; Mahrous *et al.*, 2002, Heiba *et al.*, 2018), palms, bushes and fences on hot daytime. It was found mainly on fruit, wood trees and ornamental plants. Figures (13, 14, 15, 16, 17, 18, 19 and 20) showed different habitats i.e. in aestivation period hidden under leaf litter and plant debris where more shade and humid. The species documented in multiple locations such as Botanical garden belong to Heliopolis University, Al Salam City, Cairo Governorate (coordinates: 30°9'13" N 31°25'56" E), Gilvena village, Sharkia governorate (coordinates: 30°25'31.8" N 31°37'12.5" E), farm in Tahaweyah, Bilbeis (coordinates: 30°25'11" N 31°38'21" E), three spots at Peach orchard and mango seedling nursery at El Tahady entrance El Khereigen village on the desert road from Cairo to Alexandria at 113 km² (coordinates: 30°29.545' N 30°19.542' E, 112 ft elevation - 30°29.550' N 30°19.514' E, 129 ft elevation - 30°29.557' 30°19.490' E, 127 ft elevation), El Nagah district, Beheira and Ismailia governorate.

The populations of this snail recorded in Palestine and Jordan (Mienis, 1973; Neubert *et al.*, 2015) and introduced to the area by ornamental plants, which were imported from other Mediterranean countries (Mienis, 1973). The species were recorded on navel orange, Egyptian clover and wheat (Mohammed, 2015).

Phylum	Mollusca Linnaeus, 1758
Class	Gastropoda Cuvier, 1795
Order	Stylommatophora Schmidt, 185
Superfamily	Helicoidea Rafinesque, 1815
Family	Helicidae Rafinesque, 1815
Subfamily	Helicinae Rafinesque, 1815

Genus *Theba* Risso, 1826

***Theba pisana* (O. F. Müller 1774)** (Figs. 21, 22, 23 and 24)

Distribution in Egypt:

Beheira (Eshra, 2013), Kafr El-Sheikh governorate (Heiba *et al.* 2018), Monufia (Heikal, 2015), El-Maamoura region, Alexandria (Eshra, 2014), Qalyubia, Sharkia, Gharbia, Damietta, and Ismailia (Mohammed, 2015) and Borg El Arab and King Mariout Alexandria (Ali, 2017).

Distribution Around the World:

Distribution is in the whole Mediterranean region and on the Atlantic coast from Morocco to England (Yildirim *et al.*, 2004). The species spread throughout Australia, South Africa, Brazil, Argentina and San Diego, Los Angeles and California in USA.

Shell Description:

The shell is white in the background almost rarely pink, compressed and spherical with narrow umbilicus and partly obscured by the reflected columnar lip. The aperture is elliptical with an internal rib and often with pinkish light colour or rosy red lip. The shell has a varied pattern of dark spiral bands, lines, or spots; some individuals have no dark bands (Kerney and Cameron, 1979).

Shell Dimensions:

Shell diameter reached to 25 mm as maximum diameter, while height reaches to 20 mm, with 5.5 to 6 slightly convex whorls with shallow sutures. In juveniles, all whorls sharply keeled then disappear gradually when the individual becomes mature.

Host Range and Habitat:

The specimens may be observed in clusters on grasses or accumulated on tree trunks or fences on which they climb for cooling and moist conditions (Yildirim *et al.*, 2004). The species had been recorded on navel orange, mango, wheat, grapes (Mohammed, 2015), lettuce, Egyptian clover, cabbage (Gazzy *et al.*, 2019), on fruit, wood trees and ornamental plants (Heiba *et al.*, 2018). The figures 25, 26 and 27 showing the different habitat and host range of this species during this study.

Phylum Mollusca Linnaeus, 1758

Class Gastropoda Cuvier, 1795

Superfamily Helicoidea Rafinesque 1815

Family Hygromiidae Tryon, 1866

Subfamily Trochulininae Lindholm, 1927

Genus *Monacha* Fitzinger, 1833

***Monacha obstructa* (L. Pfeiffer, 1842)** (Fig. 28)

Distribution in Egypt:

Fayoum (Abd El-Haleim, 2007), Giza (Ali, 2006), Alexandria and Beheira (Eshra, 2013), Port Saied (Awad, 2013), Monufia (Heikal, 2015), Qalyubia, Gharbia (Mohammed, 2015), Kafr El-Sheikh (Heiba *et al.*, 2018), and Sharkia governorate (Abdel-Rahman *et al.* 2019).

Distribution Around the World:

Southern Turkey, Iran (Hausdorf, 2000a), Syria, Lebanon (Neubert and Bariche, 2013), Jordan (Neubert *et al.*, 2015), Saudi Arabia (Neubert, 1998), and Iraq (Abdul-Sahib, 2006).

Shell Description:

The shell is strongly depressed conical-globular; aperture is elliptical or broadly oval. Peristome is sharp and expanded often reddish with a strong white internal rib, umbilicus prick-like in juveniles and distinctly expanded by the last whorl of the adult (Hausdorf, 2000a).

Neubert and Bariche (2013) described the umbilicus as funnel-shaped “pseudoumbilicus”. The last whorl is slightly bending towards the aperture.

Shell Dimensions:

The shell diameter ranged from 10 – 14.9 mm as maximum diameter, while the height reached 8.5 mm with 4.5 to 5 convex whorls; body whorls are rounded. According to Neubert and Bariche (2013), the shell height averaged 6.58 mm, while the diameter averaged 11.83 mm.

Host Range and Habitat:

This species is a serious pest of Egyptian clover *Trifolium alexandrinum* (Mohamed and Ali, 2009) as well as Citrus (Hashem and El-Halawany, 1996). Previous research work recorded that the glassy clover snail *Monacha* sp. infested a wide range of plant hosts, field crops, vegetables and fruit (Heiba *et al.*, 2018). *Monacha* species were found on navel orange, tomato, cabbage (Mohammed, 2015), Egyptian clover, broad bean, wheat, sugar beet and Maize (Heiba *et al.*, 2018) in addition to cabbage, potatoes, carrot, pea and lettuce as vegetables were infested with *Monacha* sp. species. Its distribution ranges from Egypt to Pakistan, and Turkey to Saudi Arabia (Neubert, 1998), possibly because it can distribute by human activities (Neubert and Bariche, 2013).

The other two confusing species belong to the genus *Monacha* (*M. cartusiana* and *M. cantiana*) are common in the Mediterranean region and recorded in some European countries such as France, Switzerland, England and Germany (Kerney and Cameron, 1979). Figures 29, 30, 31, 32 and 33 show the habitat of *M. obstructa* on different plants and in different governorates i.e., Fayoum, Sharkia, Giza and Monufia governorate.

***Monacha cartusiana* (O.F. Müller 1774) (Fig. 34)**

Monacha cartusiana is widespread in Southern and Central Europe from the Iberian Peninsula, France, Switzerland, Germany and England in the west and the Netherlands in the north to the Balkan Peninsula and the western Caucasus region in the east (Kerney and Cameron, 1979). It is recorded also in Poland (Lesicki and Koralewska-Batura, 2007) and Czech Republic (Kolouch, 2005; Novák and Novák, 2009; Pech and Pechová, 2009). Its south-eastern distributional limit is insufficiently known because of confusion with *M. clausstralis*. *Monacha cartusiana* especially occurs synanthropically. It has probably been introduced by man in the Caucasus region (Hausdorf, 2000b).

Shell Description:

Shell depressed conical globular, umbilicus is minute, partly obscured by the reflected columnar lip. The aperture is elliptical with a thickened internal lip. The shell color is white creamy in the background, also has an internal white lip to a reddish line near the aperture, and often with traces of transparent pale brown spiral bands (Kerney and Cameron, 1979), the red aperture band gives an indication that snail shell is adult. Their black and white marbled mantle can be shown through the translucent and dull shell. The peristome sharp, hardly expanded, often brownish and with a strong whitish internal lip (Hausdorf, 2000b). The same author described the umbilicus that it is very narrow at the beginning, but distinctly enlarged by the last whorl and slightly obscured by the reflected columnar edge.

Shell Dimensions:

The diameter of the shell varied from 9 to 17 mm (Kerney and Cameron, 1979). For Hlaváč and Peltanová (2010), this measurement is extremely variable, starting from 6 to 18 mm. While the height varied from 6 to 10 mm with 5.5 to 6.5 convex whorls rising in a flattened cone.

***Monacha cantiana* (Montagu, 1803) (Fig. 35).**

This species is larger in diameter and less depressed with a rounded aperture and larger umbilicus compares to the last two *Monacha* species. *M. cantiana* is common to be found in the western Mediterranean region and North West of Europe distribution and common in England (Kerney and Cameron, 1979). The species originally inhabits Italy and southern France (Manganelli *et al.*, 1995) and found in the surroundings of Vienna, Austria (Fischer

and Duda, 2004). It is also recorded as the first occurrence in Czech Republic during autumn 2009 on grassy vegetation cover (Hlaváč and Peltanová, 2010).

Shell Description:

The shell is creamy to white-colour, globular and slightly depressed with a small umbilicus that is slightly obscured by reflected columnar lip. Aperture is almost elliptical with an internal white rib or reddish to a brown line near the aperture with much less contrast than the shell of *M. cartusiana*, which has a “white strip” on the external shell side (Hlaváč and Peltanová, 2010). With wide, reddish spiral bands noticeable near to aperture (Kerney and Cameron, 1979).

One of the distinct characters as well between the shell of *M. cantiana* and *M. cartusiana* is the shape of the umbilicus, which is wider and more open in *M. cantiana* than the umbilicus of *M. cartusiana* that is narrow and for two-thirds obscured (Hlaváč and Peltanová, 2010). *Monacha cantiana* is very similar to that of *M. cartusiana* in habitat, which is successfully spreading over the warm and intermediate climate regions and all types of Mediterranean habitats as general.

Shell Dimensions:

The shell diameter ranged from 16 to 20 mm, sometimes variable in width starting from 11 to 20 mm (Hlaváč and Peltanová, 2010), while the height ranging from 11 to 14 mm (Kerney and Cameron, 1979); with 5.5 to 6 slightly convex whorls in low conical spire.

Table 1: The list of the six terrestrial snails species that are common in Egyptian Agricultural fields in different governorates that had been recorded in Egypt.

Terrestrial gastropod	Location name
<i>Succinea (Amphibina) Cleopatra</i> (Pallary, 1909)	South district of Port Saied, Port Saied (Awad, 2013), Ismailia and Sharkia (Rady, 2014), Qalyubia, Monufia, Sharkia, Damietta, and Dakahlia (Mohammed, 2015), and Kafr El-Sheikh governorate (Gazzy <i>et al.</i> 2019).
<i>Cochlicella acuta</i> (O. F. Müller, 1774)	Qalyubia, Gharbia, Monufia, Damietta, Ismailia and Kafr El-Sheikh governorate (Kassab and Daoud 1964; Mohammed, 2015; Heiba <i>et al.</i> , 2018; Gazzy <i>et al.</i> , 2019; Mostafa, 2020), Cairo (Mohamed and Ali, 2011), Beheira governorate (Eshra, 2013), and recorded in some desert spots in King Mariout and Borg El Arab, Alexandria (Ali, 2017).
<i>Xeropicta krynickii</i> (Krynicky, 1833)	Sharkia (Abd El Rahman and Al Akra, 2012; Mohammed, 2015), Qalyubia, Monufia, Damietta, Ismailia, Dakahlia governorate (Mohammed, 2015), the border of King Mariout till Borg El Arab, Alexandria, South of El Alamein, El Alamein North Coast of Egypt (Ali, 2017).
<i>Massylaea vermiculata</i> (O.F. Müller 1774)	Northern part of Egypt i. e. Alexandria and Damietta Pallary (1909), Kafr El-Sheikh (Heiba <i>et al.</i> , 2018), Sharkia (Hegab <i>et al.</i> , 1999; Mohammed, 2015; Ismail <i>et al.</i> , 2017; Khidr <i>et al.</i> 2020), Beheira, and Alexandria (Eshra, 2013; 2014), Monufia (Heikal, 2015) Gharbia, Damietta, Ismailia, Dakahlia (Mohammed, 2015), and Qalyubia governorate (Mohammed, 2015; Khidr <i>et al.</i> 2020).
<i>Theba pisana</i> (O.F. Müller, 1774)	Beheira (Eshra, 2013), Kafr El-Sheikh governorate (Heiba <i>et al.</i> 2018), Monufia (Heikal, 2015), El-Maamoura region, Alexandria (Eshra, 2014), Qalyubia, Sharkia, Gharbia, Damietta, Ismailia (Mohammed, 2015) Borg El Arab and King Mariout, Alexandria (Ali, 2017).
<i>Monacha obstructa</i> (L. Pfeiffer, 1842)	Fayoum (Abd El-Haleim, 2007), Giza (Ali, 2006), Alexandria and Beheira governorates (Eshra, 2013), Port Saied (Awad, 2013), Monufia (Heikal, 2015), Qalyubia, Gharbia (Mohammed, 2015), Kafr El-Sheikh (Heiba <i>et al.</i> , 2018), and Sharkia Governorate (Abdel-Rahman <i>et al.</i> 2019).

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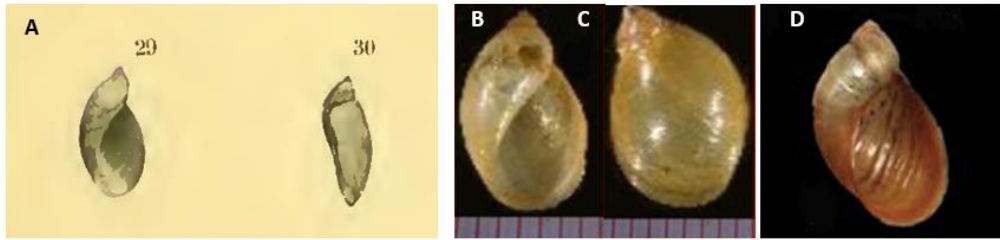


Fig. 1. *Succinea (Amphibina) cleopatra* (Pallary, 1909), [cited from: **A:** Pallary, 1909], **B:** ventral view of the shell, **C:** dorsal view of the shell [cited from: Abd El-Wakeil *et al.* 2013], **D:** [cited from: Orabi and Osman, 2015].



Fig. 2. The species *Succinea (Amphibina) Cleopatra* (Pallary, 1909) recorded on Chicory *Cichorium pumilum*, location: El Qanater El Khayreya (coordinates 30°11.601' N 31°06.693' E) [Photo by: Reham F. Ali].

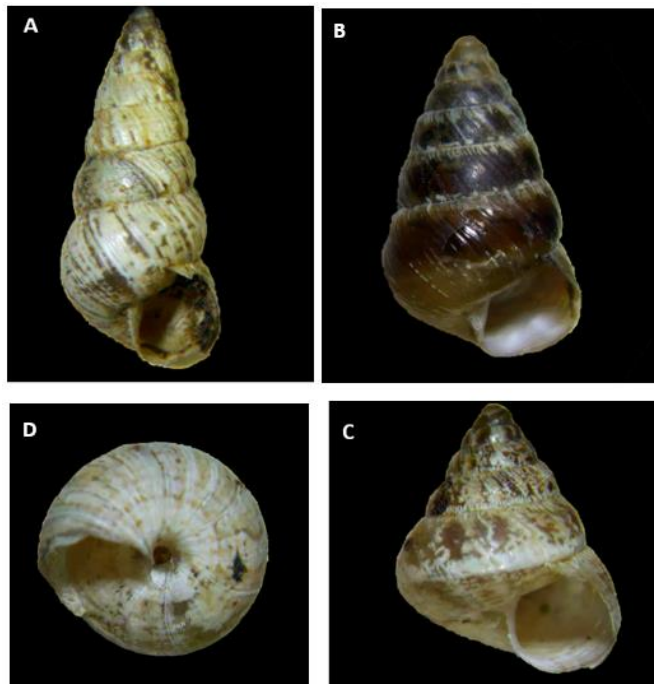


Fig. 3. *Cochlicella* species. **A:** *Cochlicella acuta* (O. F. Müller, 1774), **B:** *Cochlicella barbara* (Linnaeus, 1758), **C:** The lateral view of *Cochlicella conoidea* (Draparnaud, 1801), **D:** Dorsal side of the last species, [Photos by: Ramdini Ramdane].

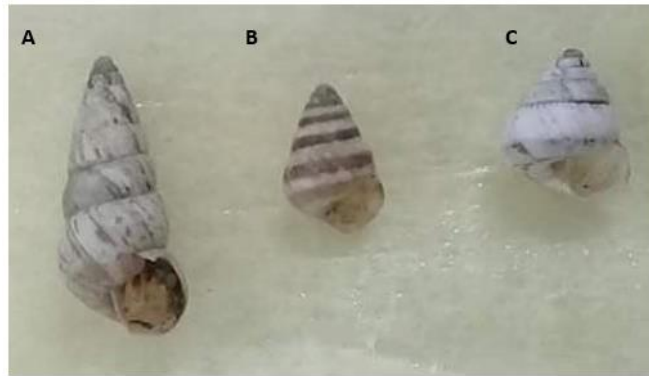


Fig. 4. The three species of genus *Cochlicella* showing the difference in length and diameter of the shells, **A:** *Cochlicella acuta* (O. F. Müller, 1774), **B:** *Cochlicella barbara* (Linnaeus, 1758), **C:** *Cochlicella conoidea* (Draparnaud, 1801), [Photos by: Ramdini Ramdane].



Fig. 5. *Cochlicella acuta* (O. F. Müller, 1774), found on windbreaker tree in crop field farm that probably could be mixed with *Cochlicella barbara* (Linnaeus, 1758), on the same tree trunk, location: Sharkia governorate (coordinates: 30°25'11" N 31°38'21" E), 110 ft elevation [Photos by: Reham F. Ali].



Fig. 6. The pictures show the feeding symptoms of *Cochlicella* sp. found on the trunk of the windbreaker tree in crop field farm, location: Sharkia governorate (coordinates: 30°25'11" N 31°38'21" E), 110 ft elevation [Photos by: Reham F. Ali].



Fig. 7. Shell of *Xeropicta krynickii* (Krynicky, 1833), King Mariout, Alexandria, [cited from: Ali, 2017].



Fig. 8. The species *Xeropicta krynickii* (Krynicky, 1833) with the ventral and the dorsal view of the shell showing the perspective widely open umbilicus and the aperture is slightly elliptical [Photo by: Reham F. Ali].



Fig. 9. The species *Xeropicta krynickii* (Krynicky, 1833) observed in the road lead to Borg El Arab, Alexandria (coordinates: 30°56.723' N 29°40.110' E) 190 ft elevation, **A:** the species found on *Dicanthium annulatum* (Forssk) Stapf (Gramineae), **B, C:** the species found on *Centaurea calcitrapa* L. (Compositae) [Photos by: Reham F. Ali].



Fig. 10. The species *Xeropicta krynickii* (Krynicky, 1833) documented on the border of King Mariout region, Alexandria (coordinates: 30°58'39.65"N 29°39'59.32"E) found on *Centaurea calcitrapa* L. (Compositae) and *Thymelaea hirsute* (L.) Endl.(Thymelaeaceae) [Photos by: Reham F. Ali].



Fig. 11. The species *Massylaea vermiculata* (O. F. Müller 1774) [cited from: Mienis *et al.* 2016].



Fig. 12. The species *Massylaea vermiculata* (O. F. Müller 1774) found on some leaves of ornamental plants in Giza governorate [Photo by: Reham F. Ali].



Fig. 13. The spread of the species *Massylaea vermiculata* (O. F. Müller 1774), location: Peach orchard and mango seedling nursery at El Tahady entrance El Khereigen village on the desert road from Cairo to Alexandria at 113 km² (coordinates: 30°29.545' N 30°19.542' E) 112 ft elevation, the pictures show the infestation of this species on different plants in multiple spots [Photos by: Reham F. Ali].



Fig. 14. The species *Massylaea vermiculata* (O. F. Müller 1774) hidden under leaf litter and plant debris where more shade and humid, location: Botanical garden belong to Heliopolis University, Al Salam City, Cairo Governorate (coordinates: 30°9'13" N 31°25'56" E) 190 ft elevation [Photos by: Reham F. Ali].



Fig. 15. The species *Massylaea vermiculata* (O. F. Müller 1774) on Casuarina tree located in Gilvena village, Sharkia governorate (coordinates: 30°25'31.8" N 31°37'12.5" E) [Photo by: Reham F. Ali].



Fig. 16. *Massylaea vermiculata* (O.F. Müller 1774) on citrus tree located in El Ma'araka village in El Nagah district, Beheira governorate [Photos by: Reham F. Ali].



Fig. 17. *Massylaea vermiculata* (O. F. Müller 1774) in gardens of citrus orchards in Ismailia governorate, the species almost cover the tree trunk and the symptom of snails feeding is obvious on the leaves [Photos by: Reham F. Ali].



Fig. 18. *Massylaea vermiculata* (O. F. Müller 1774), under plant debris while aestivation period in October 2019 in farm at Tahaweyah, Bilbeis, Sharkia governorate (coordinates: 30°25'11" N 31°38'21" E) [Photo by: Reham F. Ali].



Fig. 19. The species *Massylaea vermiculata* (O. F. Müller 1774), on ornamental plants garden and green grass, location: Botanical garden belong to Heliopolis University, Al Salam City, Cairo Governorate (coordinates: 30°9'13" N 31°25'56" E) 190 ft elevation [Photos by: Reham F. Ali].



Fig. 20. In this spot the species *Massylaea vermiculata* (O.F. Müller 1774), and the species *Theba pisana* (O.F. Müller 1774), are found together in the same garden of citrus orchards that are covered the tree trunk [Photos by: Reham F. Ali].



Fig. 21. Shell of *Theba pisana* (O. F. Müller 1774), King Mariout, Alexandria, [cited from: Ali, 2017].



Fig. 22. The two morphs of the species *Theba pisana* (O. F. Müller 1774) show the first shell has varied pattern of dark spiral bands, lines and spots with light background, the second picture has no dark bands [Photos by: Reham F. Ali].



Fig. 23. The species *Theba pisana* (O. F. Müller 1774) as living specimen, the sample found in garden in the desert road to Alexandria [Photo by: Reham F. Ali].



Fig. 24. The species *Theba pisana* (O. F. Müller 1774) with the ventral and the dorsal view of the shell; note the narrow umbilicus that partly obscured by reflected columnar lip, which is a distinguished characteristic feature of this species, the samples were collected from Alexandria [Photo by: Reham F. Ali].



Fig. 25. The species *Theba pisana* (O. F. Müller, 1774) on bushes trunk mixed with *Cochlicella acuta* (O. F. Müller, 1774) at the same spot, location: King Mariout, Alexandria, (coordinates: 30°58'49.22"N 29°40'24.28"E) [Photo by: Reham F. Ali].



Fig. 26. The species *Theba pisana* (O. F. Müller, 1774) recorded in King Mariout, Alexandria, **A, B:** The species *Theba pisana* on *Thymelaea hirsute* (L.) Endl. (Thymelaeaceae), the coordinates of the location is 30°58'49.22"N 29°40'24.28"E. **C, D:** the species found on other host plant (coordinates: 30°59'44.09"N 29°42'17.08"E) [Photos by: Reham F. Ali].



Fig. 27. The species *Theba pisana* (O. F. Müller, 1774) recorded on King Mariout, Alexandria on different vegetation [Photos by: Reham F. Ali].



Fig. 28. The species *Monacha obstructa* (L. Pfeiffer, 1842), Diameter = 11.45 mm, location: Birecik town, Turkey, [Photos by: Neubert, Eike, cited by: WoRMS taxa, 2018]. <http://www.marinespecies.org/photogallery.php?album=702&pic=132305>



Fig. 29. The species *Monacha obstructa* (L. Pfeiffer, 1842) recorded on Egyptian clover *Trifolium alexandrinum* L. (Fabaceae) as a common host plant for this species in Forkous village at Tamiya district, Fayoum governorate (coordinates: 29°26.49' N 30°58.53' E), **A:** the species is in aestivation period showing as empty shells beside the wild weeds in the field. **B, C, D:** closer view to the *Monacha obstructa* as empty shells in the fields under old leaf litter and wild weeds, where it appears in the picture that some shells have fractures, that may be due to the effect of climatic conditions in the field or heavy irrigation [Photos by: Reham F. Ali].



Fig. 30. The species *Monacha obstructa* (L. Pfeiffer, 1842) found under leaf litter in aestivation period while summer months at crop field farm, location: Sharkia governorate (coordinates: 30°25'11" N 31°38'21" E), 110 ft elevation [Photo by: Reham F. Ali].



Fig. 31. The species *Monacha obstructa* (L. Pfeiffer, 1842) recorded on the leaves of chicory *Cichorium pumilum* Jacq. (Asteraceae) as host plant, location: in Forkous village at Tamiya district, Fayoum governorate (coordinates: 29°26.49' N 30°58.53' E) [Photos by: Reham F. Ali].



Fig. 32. The species *Monacha obstructa* (L. Pfeiffer, 1842) recorded in nursery of ornamental plants in Monufia Governorate, **A:** the species is attached by mucus to the ornamental plant pots, where more moisture and shade, **B:** *Monacha obstructa* on the soil ground of the nursery, which clear to notice the mucus trail on the surface of the soil [Photos by: Reham F. Ali].



Fig. 33. The species *Monacha obstructa* recorded in Manshiet Dahshour, Giza (coordinates: 29°47.734' N 31°15.268' E). **A:** in field crop of Egyptian clover *Trifolium alexandrinum* L. (Fabaceae) and on the soil ground, which is close to moisture, humid and shade. **B:** closer look to *Monacha obstructa* on Chard *Beta vulgaris* subsp. *Vulgaris* (Amaranthaceae), where the body of the snail is clear with the optic tentacle, with a juvenile of the same species [Photos by: Reham F. Ali].



Fig. 34. The species *Monacha cartusiana* (O. F. Müller 1774), [Photos by: Olivier Gargominy, Muséum National d'Histoire Naturelle - Service du Patrimoine Naturel 36 rue Geoffroy Saint-Hilaire 75 231 PARIS]. https://inpn.mnhn.fr/espece/cd_nom/163256?lg=en

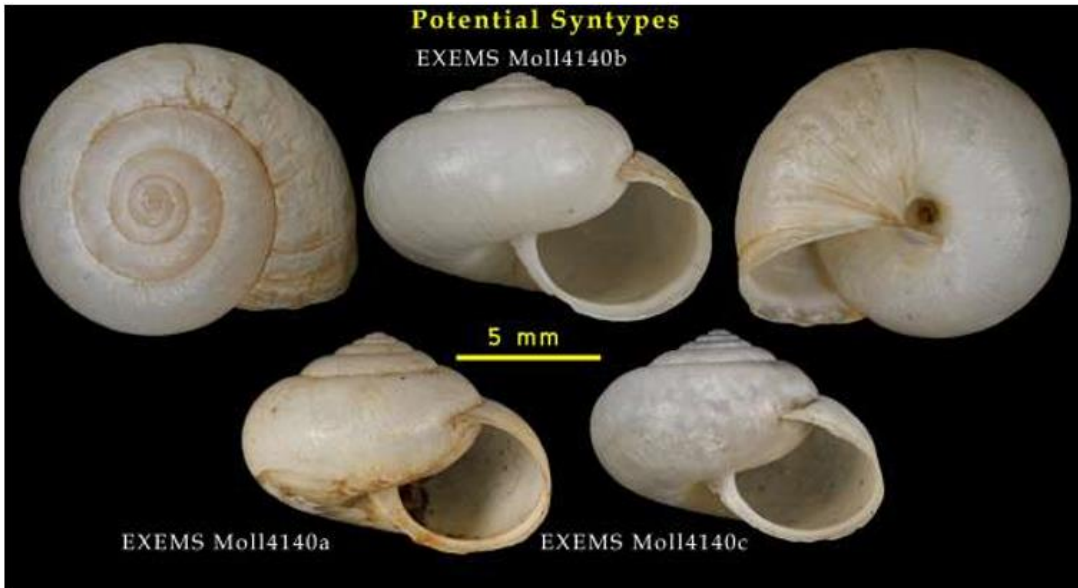


Fig. 35. The species *Monacha cantiana* (Montagu, 1803), [Shells from George Montagu’s collection, described by Col. George Montagu in the Royal Albert Memorial Museum and Art Gallery, Exeter and The Natural History Museum, London. Zoosystematics and Evolution 2018]. <https://rammcollections.org.uk/object/moll4140/>

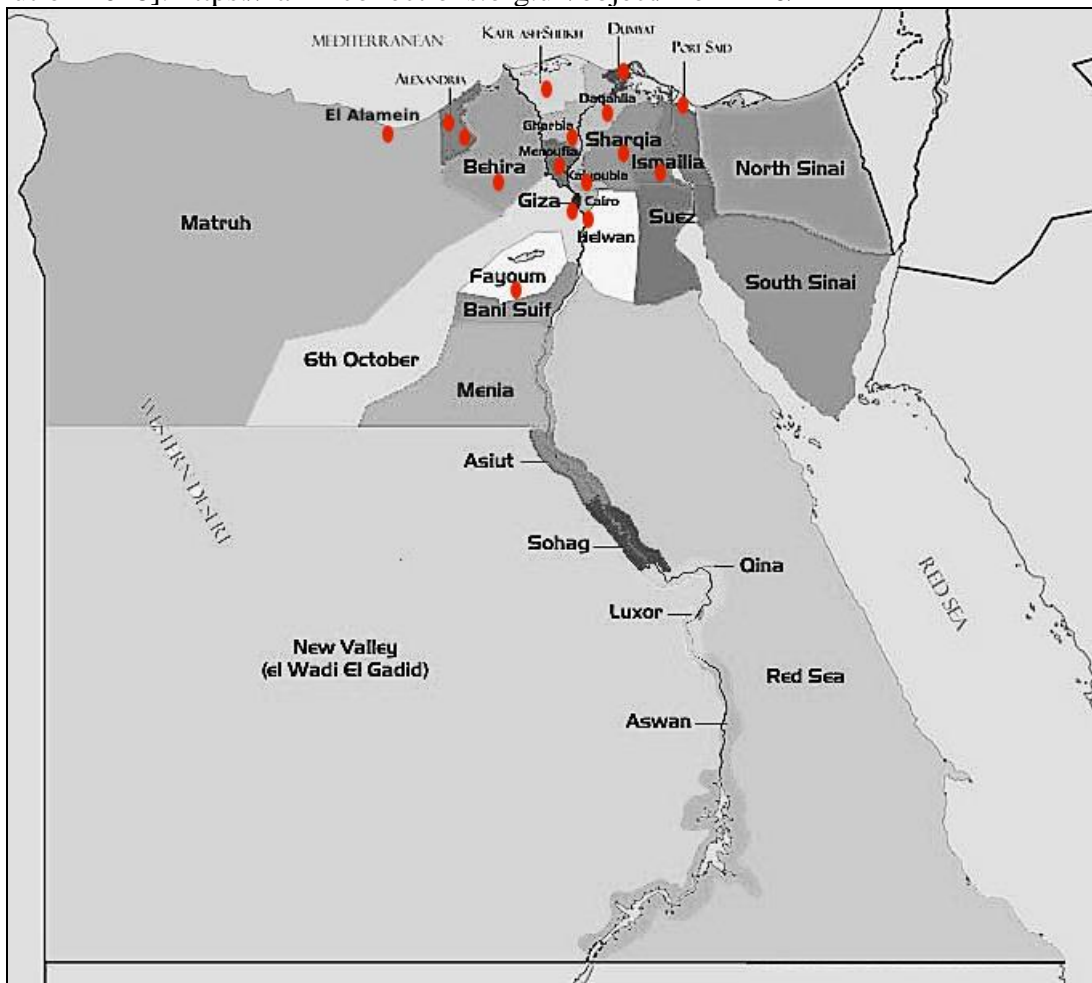


Fig. 36. Egypt map show the main governorates that had been infested by the six terrestrialsnail species under this current study and the previous bibliographic work.

DISCUSSION

The number of invasive land snail species reports are significantly increasing, the boundaries of original species ranges are expanding and leading to change the invertebrate fauna structure, which are becoming different whether in Egypt or around the world.

Many malacological investigations have been carried out in different governorates in Egypt during the last 25 years. Table (1) and figure (36) summarizes the governorates that had been infested by the six terrestrial snail species under the current study and previous bibliographic work.

The results of our prospection bring out a list of six species of terrestrial gastropods, without counting the slugs and semi-slugs, which we consider common in the fields in Egypt. El-Deeb *et al.* (1996) recorded the two species *Succinea putris* and *Massylaea vermiculata* in fields and orchards of Kafr El-Sheikh governorate. While Idress (2003) surveyed more species in more districts such as *Monacha* sp., *Massylaea vermiculata*, *Theba pisana*, *Cochlicella acuta*, *Succinea* sp. infesting field and vegetable crops, orchards and ornamental plants at El-Hamol, Balteem, Sakha and Kafr El-Sheikh districts of the same governorate.

Abd El-Aal (2001) stated that *M. cartusiana*, *X. krynickii*, *C. acuta*, *M. vermiculata* and *Succinea* sp. infested major economic crops in Sharkia governorate.

Mortada (2002) recorded 13 species of terrestrial snails and slugs belonging to five families Helicidae, Succinedae, Achatinidea, Zonitidae and Limacidae that were detected on different crops in 25 localities representing five districts of Dakahlia Governorate. While Al-Akra (2001) and Heikal (2015) recorded that *M. cartusiana*, *M. vermiculata*, *C. acuta*, *Oxychilus alliarius*, *Deroceras reticulatum* and *Limacus flavus* were found in Gharbia and Monufia governorate.

Massylaea vermiculata, *Theba pisana*, *Helicella vestalis*, *Cochicella acuta*, *Monacha cartusiana*, *Monacha obstructa*, *Succinea putris*, *Succinea oblonga*; *Rumina decollata*; *Oxychilus alliarius* were reported in different governorates such as Qalyubia, Sharkia, Gharbia, Monufia, Dakahlia, Damietta and Ismailia in Egypt (Mohammed, 2015).

Awad and Abd El-Galil (2020) revealed that land snails *Monacha cantiana*, *Monacha cartusiana*, and *Succinea putris* species, were observed on Egyptian clover *Trifolium alexandrinum*, wheat *Triticum vulgare*, and sugar beet *Beta vulgaris* at the Southern Part of Port Saied governorate.

REFERENCES

- Abd El Rahman, A. H. E. and Al Akra, T. M. M. (2012) Integrated control using different methods against two land snail species *Theba pisana* (Muller) and *Helicella vestalis* (Pfeiffer) infesting *Citrus nobilis* trees at Sharkia governorate. *Journal of Plant Protection and Pathology, Mansoura University*, 3(6): 571-581.
- Abdel-Rahman, A. H. E.; El-Massry, S. A. A.; Rizk, A. M. (2019) Laboratory and field evaluation of certain chemicals comparing with methomyl against land snail *Monacha* sp. (Stylommatophora: Hygromiidae) infesting Egyptian clover plant. *Egyptian Journal of Plant Protection Research Institute*, 2 (2): 398-404.
- Abd El-Aal, S. M. (2001) Studies on certain land snails at Sharkia Governorate. *Master of Science Thesis, Faculty of Agriculture, Zagazig University*, 137pp.
- Abd El-Haleim, S. M. (2007) Ecological and toxicological studies on some land snails infesting cotton and clover crops. *Master of Science Thesis, Faculty of Agriculture, Cairo University*, 122pp.
- Abd El-Wakeil, K. F.; Obuid-Allah, A. H.; Mohamed, A. H. and Abd El-Aziz, F. A. (2013) Community structure of molluscans in River Nile and its branches in Assiut

- governorate, Egypt. *Egyptian Journal of Aquatic Research*, 39: 193–198.
- Abdul-Sahib, I. M. (2006) A new record of white terrestrial snail *Monacha obstructa* (Pfeiffer, 1842), (Gastropoda: Pulmonata) from the Iraq marches. *Journal of Basrah Researches (Sciences)*, 32(3): 70-73.
- Al-Akra, T. M. (2001) Ecological, biological and toxicological studies on some Mollusca species at Monufia and Garbia Governorate. *Master of Science Thesis, Faculty of Agriculture, Al-Azhar University*, 189pp.
- Ali, R. F. (2006) Studies on some snails associated with different crops. *Master of Science Thesis, Faculty of Agriculture, Cairo University*, 153pp.
- Ali, R. F. (2011) Studies on some gastropods. *Doctor of Philosophy Thesis, Faculty of Agriculture, Cairo University*, 133pp.
- Ali, R. F. (2017) Contribution to the Malacofauna of the North coast of Egypt. *Folia Malacologica*, 25(2): 125-142.
- Arafa, A. A. I. (2006) Studies on terrestrial mollusks in some Delta governorates. *Doctor of Philosophy Thesis, Faculty of Agriculture, Al-Azhar University*, 167pp.
- Awad, M. H. M. (2013) Logical control and population density studies on land snails in South district of Port Saied, Port Saied governorate. *Egyptian Academic Journal of Biological Sciences, (B. Zoology)*, 5(2): 47- 63.
- Awad, M. H. M. and Abd El-Galil, Y. M. A. (2020) Field and laboratory studies on some land snails in the Southern Part of Port Saied governorate. *Egyptian Academic Journal of Biological Sciences, (B. Zoology)*, 12(2): 141-147.
- Balashov, I. and Gural-Sverlova, N. (2012) An annotated checklist of the terrestrial molluscs of Ukraine. *Journal of Conchology*, 41(1): 91-109.
- Bank, R. A. and Neubert, N. (2017) Checklist of the Land and Freshwater Gastropoda of Europe, MolluscaBase, Source ID: 279050. Last update: July 16th, 170p.
- Barker, G. M. (2002) Molluscs as Crop Pests. CABI Publishing, Wallingford, U.K. pp.1-468.
- Baur, B. and Baur, A. (1993) Climatic warning due to thermal radiation from an urban as possible cause for the local extension of land snails. *Journal of Applied Ecology*, 30: 333-340.
- Bouaziz-Yahiatene, H. and Medjdoub-Bensaad, F. (2016) Malacofauna Diversity in Kabylia Region (Algeria). *Advances in Environmental Biology*, 10(7): 99-106.
- Bouaziz-Yahiatene, H.; Pfarrer, B.; Medjdoub-Bensaad, F. and Neubert, E. (2017) Revision of *Massylaea* Möllendorff, 1898 (Stylommatophora, Helicidae). *ZooKeys*, 694: 109-133.
- Cameron, R. A. D. (2003) Land Snails in the British Isles. Published By: Field Studies Council, 82p.
- Cowie, R. H. (2001) Invertebrate invasions on Pacific islands and the replacement of unique native faunas: a synthesis of the land and freshwater snails. *Biological Invasions*, 3: 119-136.
- Cowie, R. H.; Dillon, R. T.; Robinson, D. G. and Smith, J. W. (2009) Alien non-marine snails and slugs of priority quarantine importance in the United States: A preliminary risk assessment. *American Malacological Bulletin*, 27: 113-132.
- Daoud, M. I. A. (2004) Ecological and morphological studies on some terrestrial snails in Dakahlia governorate. *Master of Science Thesis, Faculty of Agriculture, Al-Azhar University*, 177pp.
- De Mattia, W. and Pešić, V. (2014) *Xeropicta* (Gastropoda, Hygromiidae) goes west: the first record of *X. krynickii* (Krynicky, 1833) for Montenegro, with a description of its shell and genital morphology, and an additional record of *X. derbentina* (Krynicky, 1836) for Italy. *Ecologica Montenegrina*, 1(4): 193-200.
- El-Deeb, H. I.; Abdel-Halim, A.; Koutb, I.; Khidr, F. K. and Edress, N. M. (2004) Studying

- some ecological aspects associated with the prevalent land snails at Kafr El Sheikh governorate. *Journal of Agricultural Science Mansoura University*, 29: 2847-2853.
- El-Deeb, H. I.; Ghamry, E. M.; El-Hwashy, N. and Essa, N. (1996) Relative abundance of some land snails in certain Governorate of Egypt. *Journal of Agricultural Science Mansoura University*, 21(8): 2977-2982.
- El-Khayat, H. M. M.; Mahmoud, K. M. A.; and Sayed, S. S. M. (2017) Distribution and seasonal abundance of freshwater snails in some Egyptian water courses. *Journal of the Egyptian Society of Parasitology*, 47(3): 541-548.
- El-Okda, M. M. K. (1984) Land mollusca infestation and chemical control in El-Ismaelia governorate. *Agricultural Research Review Egypt*, 62: 87-92.
- Eshra, E. H. (2013) Survey and distribution of terrestrial snails in fruit orchards and ornamental plants at Alexandria and El-Beheira governorates, Egypt. *Alexandria Science Exchange Journal*, 34(2): 242-248.
- Eshra, E. H. (2014) Toxicity of methomyl, copper hydroxide and urea fertilizer on some land snails. *Annals of Agricultural Science*, 59(2): 281-284
- Fischer, W. and Duda, M. (2004) Beiträge zur Kenntnis der Molluskenfauna Österreichs VII. *Cerņuella virgata* (da Costa 1778), neu für die Molluskenfauna Wiens, sowie Bemerkungen zur Ausbreitung von *Monacha cantiana* (Montagu 1803), *Cerņuella neglecta* (Draparnaud 1805), *Hygromia cinctella* (Draparnaud 1801) und *Cornu aspersus* (O.F. Müller 1774) in Niederösterreich und Wien (Mollusca: Gastropoda). *Nachrichtenblatt der Ersten Vorarlberger Malakologischen Gesellschaft*, 12: 10-14.
- Gazzy, A. A.; Mostafa, N. M. and Shahawey, W. A. (2019) Survey, Population Dynamics and Estimation of Damage of Common Land Snail Species on Some Vegetable Plants and Egyptian Clover at Some Regions at Kafr El-Sheikh Governorate. *Journal of Plant Protection and Pathology, Mansoura University*, 10(1): 13-18.
- Georgiev, D. G. (2006) Two new species from the family Succineidae (Beck, 1837) (Gastropoda: Pulmonata) to the fauna of Bulgaria. *Scientific Studies of the University of Plovdiv, Biology, Animalia*, 41: 7-11.
- Godan, D. (1983) Pest slugs and snails, Biology and control. Springer Verlag, Berlin 424 PP.
- Hallgass, A. and Vannozi, A. (2014) The continental molluscs from Mount Circeo (Latium, Italy). *Biodiversity Journal*, 5(2): 151-164.
- Hashem, A. G. and El-Halawany, M. E. (1996) Egypt. In: Morse, J. G., Luck, R. F. and Gumpf, D. J. (eds). Citrus pest problems and their control in the Near East. *FAO Plant Production and Protection Paper*, 135: 25-42.
- Hashem, A. G.; Nakhla, J. M. and Tadros, A. W. (1992) Seasonal fluctuation in population of the land snails on citrus tree in the northern reclaimed lands. *Al-Azhar Journal of Agricultural Research*, 16: 325-340.
- Hashem, A. G.; Nakhla, J. M.; Tadros, A. W. and Korashy, M. A. (1993) Monitoring land snails on sweet orange trees in Behera governorate (Egypt). *Zagazig Journal of Agricultural Research*, 20(2A): 691-698.
- Hausdorf, B. (2000a) The genus *Monacha* in Turkey (Gastropoda: Pulmonata: Hygromiidae). *Archiv für Molluskenkunde*, 128(1/2): 61-151.
- Hausdorf, B. (2000b). The genus *Monacha* in the Western Caucasus (Gastropoda: Hygromiidae). *Journal of Natural History*, 34: 1575-1594.
- Hegab, A. M. I.; Ghamry, E. M.; El-Massry, S. A. A. and Hassan, A. I. (1999) Ecological studies on certain land snails in some localities at Sharkia governorate. *Zagazig Journal of Agricultural Research*, 26(3B): 787-795.
- Heiba; F. N.; Mortada, M. M.; Geassa, S. N.; Atlam, A. I. and Abd El-Wahed, S. I. (2018) Terrestrial gastropods: Survey and relationships between land snail assemblage and soil properties. *Journal of Plant Protection and Pathology, Mansoura University*,

- 9(3): 219-224.
- Heikal, H. M. (2015) Biological aspects and population dynamics of three terrestrial snails infesting fruit trees in Egypt. *International Journal of Advanced Research Biological Sciences*, 2(1): 169-180.
- Herbert, D. G. (2010) The introduced terrestrial mollusca of South Africa. Pretoria, South Africa: *South African National Biodiversity Institute*, 108p.
- Hlaváč, J. Č. and Peltanová, A. (2010) First occurrence of the Kentish Snail *Monacha cantiana* (Mollusca: Gastropoda: Hygromiidae) in the Czech Republic. *Malacologica Bohemoslovaca*, 9: 11–15.
- Hussein, M. A.; Obuid-Allah, A. H.; Mahmoud, A. A. and Fangary, H. M. (2011) Population dynamics of freshwater snails (Mollusca: Gastropoda) at Qena Governorate, Upper Egypt. *Egyptian Academic Journal of Biological Sciences, (B. Zoology)*, 3(1): 11-22.
- Idress, N. M. M. (2003) Application of some environmental safe methods for population management of common land snails in the newly reclaimed land in Egypt. *Master of Science Thesis, Environmental Studies and Research Institute, Ain shams University*, 150pp.
- Ismail, S. A. (1997) Ecology, biology and control of certain terrestrial snails infesting some vegetables and field crops in Sharkia Governorate. *Doctor of Philosophy Thesis, Faculty of Agriculture, Zagazig University*, 130pp.
- Ismail, S. A. A.; Issa, M. A.; Shettaia, S. Z. S. and Khattab, M. M. (2017) Dispersal of the land snail *Eobania vermiculata* in citrus orchards in Sharkia governorate. *Journal of Plant Protection and Pathology, Mansoura University*, 8(4): 177-180.
- Juříčková, L., Horsák M. and Beran L. (2001) Check-list of the molluscs (Mollusca) of the Czech Republic. *Acta Societatis Zoologicae Bohemicae*, 65: 25-40.
- Kassab, A., and Daoud, H. (1964) Notes on the biology and control of land snails of economic importance in the U. A. R. *The Agricultural Research Review* 42: 77-98.
- Kerney, M. P. and Cameron, R. A. D. (1979) A field guide of the land snails of Britain and north-west Europe. Wm. Collings & Sons, Glasgow, 288pp.
- Khidr, E. K.; Mahmoud, K. W.; Abd El- Rahman, A. H. E. (2020) Movement and seasonal activity of land snails *Theba pisana* and *Eobania vermiculata* (Gastropoda: Helicidae) on citrus orchards at Qalubiyah and Sharkia governorates. *Egyptian Journal of Plant Protection Research Institute*, 3 (2): 724-730.
- Kolouch, L. R. (2005) Další lokality tmavoretky bělavé [New evidence of the occurrence of the Carthusian snail]. *Živa*, 53(3): 123pp. (in Czech).
- Lesicki, A. and Koralewska-Batura, E. (2007) *Monacha cartusiana* (O. F. Müller, 1774) (Gastropoda: Pulmonata: Hygromiidae) becomes more frequent in Poland. *Folia Malacologica*, 15(4): 181-184.
- Lewis, G. (1977) Polymorphism and Selection in *Cochlicella acuta*. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 276(949): 399-451. <https://doi.org/10.1098/rstb.1977.0004>.
- Lotfy, W. M. and Lotfy, L. M. (2015) Synopsis of the Egyptian freshwater snail fauna. *Folia Malacologica*, 23(1): 19-40.
- Mahmoud, M. F. and Awad, M. H. M. (2008) Population density of certain land snail and slug species and their damage to some fields and vegetable crops. *Egyptian Journal of Agricultural Research*, 86(5): 1763-1772.
- Mahmoud, K. M. A. and Sayed, S. S. M. (2018) Association pattern among different snails and other macroinvertebrate species at certain freshwater courses in Egypt. *Egyptian Journal of Aquatic Biology & Fisheries*, 22(3): 99-110.
- Mahrous, M. E.; Ibrahim, M. H. and Abd El-Aal, E. M. (2002) Occurrence, population

- density and importance value of land snails infesting different crops in Sharkia Governorate. *Zagazig Journal of Agricultural Research*, 29(2): 613-629.
- Manganelli, G.; Bodon, M.; Favilli, L. and Giusti, F. (1995) Fascicolo 16. Gastropoda Pulmonata. – In: Checklist delle specie della fauna italiana, Minelli A., Ruffo S. and La Posta S. (eds), pp. 1-60.
- Metwally, A. M.; Zedan, H. A.; El-Saeid, A. B. and El-Akra, T. M. M. (2002) Ecological studies on certain land snails in Monofia and Gharbia governorate. *Proceedings of 2nd International Conference, Plant Protection Research Institute, Cairo, Egypt*, 65-79.
- Mienis, H. K. (1973) *Eobania vermiculata* (Müller) in Israel (Gastropoda: Helicidae). *Argamon, Israel Journal of Malacology*, 4: 9-10.
- Mienis, H. K.; Rittner, O. and Vaisman, S. (2016) Information concerning *Eobania vermiculata*, I. On the presence of this exotic species in Israel (Mollusca, Gastropoda, Helicidae). *Triton*, 34: 29-36.
- Mohamed, M. I. and Ali, R. F. (2009) Reproduction and life history in the two land snails *Monacha cartusiana* (Müller) and *Eobania vermiculata* (Müller) (Helicidae: Mollusca) in the laboratory. *Animal Biology Journal*, 1(2): 99-107.
- Mohamed, M. I. and Ali, R. F. (2011) Life cycle and growth rates of the conical snail *Cochlicella acuta* (Müller, 1774) (Gastropoda: Cochlicellidae). *Animal Biology Journal*, 2(4): 171-180.
- Mohammed, G. R. (2015) Incidence of land snails inhabiting different vegetation at some governorates in North-East of Delta Egypt. *Journal of Plant Protection and Pathology, Mansoura University*, 6(6): 899-907.
- Mortada, M. M. (2002) Ecological and biological studies on certain terrestrial Gastropods in Dakahlia governorate. *Doctor of Philosophy Thesis, Faculty of Agriculture, Zagazig University*, 185pp.
- Mostafa, N. M. (2020) Evaluation of some environmentally safe methods for controlling common land snail species at Kafr El-Sheikh governorate. *Egyptian Journal of Plant Protection Research Institute*, 3(2): 648-653.
- Neubert, E. (1998) Annotated checklist of the terrestrial and freshwater molluscs of the Arabian Peninsula with descriptions of new species. *Fauna of Arabia*, 17: 333-461.
- Neubert, E. and Bariche, M. (2013) On the *Monacha* species of Lebanon (Gastropoda, Hygromiidae). *ZooKeys*, 311: 1-18.
- Neubert, E.; Amr, Z. S.; Waitzbauer, W. and Al Talafha, H. (2015) Annotated checklist of the terrestrial gastropods of Jordan (Mollusca: Gastropoda). *Archiv für Molluskenkunde*, 144(2): 169-238.
- Novák J. and Novák M. (2009) Dvě nové lokality tmavoretky bělavé *Monacha cartusiana* (O.F. Müller, 1774) na Moravě [Two new localities of *Monacha cartusiana* (O.F. Müller, 1774) in Moravia, Czech Republic]. *Malacologica Bohemoslovaca*, 8: 29-30 (in Czech).
- Orabi, O. H. and Osman, M. F. (2015) Evaluation of some pollution at Manzala Lagoon: special reference to medical importance of Mollusca in Egypt. *Journal of Environmental and Analytical Toxicology*, 5(5) : 1. DOI: 10.4172/2161-0525.1000311.
- Pallary, P. (1909) Catalogue de la faune malacologique de l'Égypte. *Mémoires de l'Institut d'Égypte* 6. 92 pp., 5 pls.
- Páll-Gergely, B.; Fehér, Z. and Čejka, T. (2020) New records of the Mediterranean land snail *Massylaea vermiculata* (O. F. Müller, 1774) in Hungary and Slovakia. *Folia Malacologica*, 28(4): 337-341.
- Pech, P. and Pechová, H. (2009) *Monacha cartusiana* (Gastropoda: Hygromiidae) in South

- Bohemia. *Malacologica Bohemoslovaca*, 8: 28.
- Rađa, B.; Rađa, T.; Puizina, J.; Šamanić, I. and Šantć, M. (2012) Shell characteristics of land snail *Eobania vermiculata* (Müller, 1774) (Helicidae) from Croatia. *American Malacological Bulletin*, 30(2): 299–307.
- Rady, G. H.; Abd-El Gawad, A. A.; Ismail, S. A. A. and Lokma, M. H. (2014) Ecology of some terrestrial molluscs in Sharkia and Ismailia governorate. *Egyptian Journal of Agricultural Research*, 92 (3): 907-920.
- Sallam, A. and El-Wakeil, N. (2012) Biological and ecological studies on land snails and their control “Integrated Pest Management and Pest Control - Current and Future Tactics” Chapter, 18: 413-444.
- Schütt, H. (2001) Die türkischen Landschnecken 1758– 2000. *Acta biologica Benrodis: Supplement*, 4: 1–548.
- Yildirim, M. Z. and Gumus, U. K. (2004) Edible snails (Terrestrial) of Turkey. *Turkish Journal of Zoology*, 28: 329 – 335.
- Welter-Schultes F. W. (2012) European non-marine mol-luscs, a guide for species identification. Planet Poster Editions, Göttingen. 662P.

ARABIC SUMMARY

مفتاح التصنيف كأداة بسيطة لتحديد وتعريف القواقع الأرضية الشائعة في الحقول المصرية

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تمت مراجعة مجموعة القواقع الأرضية التي تم حصرها في الحقول والحدائق والمشاتل المصرية مع وصف واضح للخصائص المورفولوجية التي تخص كل نوع من أنواع القواقع الأرضية هذا بالإضافة إلي دعم البحث بالصور التوضيحية والملاحظات والسجلات التصنيفية لكل منها.

تتضمن هذه الدراسة ستة قواقع أرضية

Succinea (Amphibina) cleopatra (Pallary, 1909) (Succineidae), *Cochlicella acuta* (O. F. Müller, 1774), *Xeropicta krynickii* (Krynicky, 1833) (Geomitridae), *Massylaea vermiculata* (O. F. Müller, 1774), *Theba pisana* (O. F. Müller, 1774) (Helicidae) and *Monacha obstructa* (L. Pfeiffer, 1842) (Hygromiidae).

وتعتمد هذه الدراسة على تصنيف وتعريف كل نوع علي حسب شكل الصدفة وتحديد أماكن إنتشارها في المحافظات المصرية المختلفة، والذي تم تجميع هذه البيانات المختلفة خلال موسم النشاط في دراستنا الحالية وما تم التوصل إليه في العديد من الدراسات السابقة.

هذه الدراسة توفر مفتاح تصنيفي واضح ومعلومات أساسية للمزارعين لتعريف نوع القواقع الأرضية في البيئات الزراعية المصرية المختلفة.