

NOTES ON THE CURRENT STATUS OF FRESHWATER SNAILS FAUNA OF THE PALESTINIAN TERRITORIES (WEST BANK)

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ABSTRACT: A total of 14 species of freshwater snails are recorded from the Palestinian Territories (West Bank). They belong to seven families (Cochliopidae, Melanopsidae, Neritidae, Lymnaeidae, Physidae, Planorbidae, and Thiariidae) in eleven genera (*Bulinus*, *Eupaludestrina*, *Heleobia*, *Galba*, *Melanoides*, *Melanopsis*, *Mieniplotia*, *Physella*, *Planorbella*, *Radix*, and *Theodoxus*). *Planorbella duryi* (Wetherby, 1879) is an invasive alien species recorded for the first time in the West Bank. The most common species were *Physella acuta*, *Melanopsis buccinoidea* and *Theodoxus jordani*. All previous records of *Theodoxus macri* are now considered as *T. jordani*. *Bulinus truncatus*, the intermediate host for schistosomiasis, was found in three localities within the West Bank, representing the first records for this species within the Palestinian Territories.

KEY WORDS: freshwater gastropods; invasive; Mollusca; Palestine; West Bank

INTRODUCTION

Our knowledge on the malacofauna of historic Palestine is based on old literature (TRISTRAM 1865, GERMAIN 1921–1922, BODENHEIMER 1935, ABDEL AZIM & GISMANN 1956). TRISTRAM (1865) recorded several species of the freshwater and land snails from Palestine, Jordan, Lebanon and Syria. Little is known on the diversity of freshwater snail fauna in the Palestinian Territories (West Bank). So far, a total of 10 species belonging to five families have been

recorded (HELLER et al. 2005, BDIR & ADWAN 2012, HANDAL et al. 2015).

The Palestine Museum of Natural History (PMNH) and Palestine Institute for Biodiversity and Sustainability (PIBS) were established to promote biodiversity research in Palestine (QUMSIYEH et al. 2017). The aim of the current study is to provide new information regarding the freshwater gastropod species diversity in Palestine (West Bank) and expand the knowledge about their distribution.

MATERIAL AND METHODS

Freshwater snails were collected from 35 localities (Table 1, Fig. 1) from the Territories through several field visits to freshwater bodies during 2015–2021. Collected materials were deposited at the Palestine Museum of Natural History collection (PMNH). Freshwater habitats visited include springs, pools, temporary rain pools, water tanks, ponds, irrigation

canals and rivers. Samples were collected by hand from underneath rocks, floating vegetation, around the edges or by means of a 2 mm pore size sieve for small-size and mud-dwelling species, since they are larger than 2 mm. All living specimens were preserved in 70% alcohol, while the dry shells were kept in plastic containers.

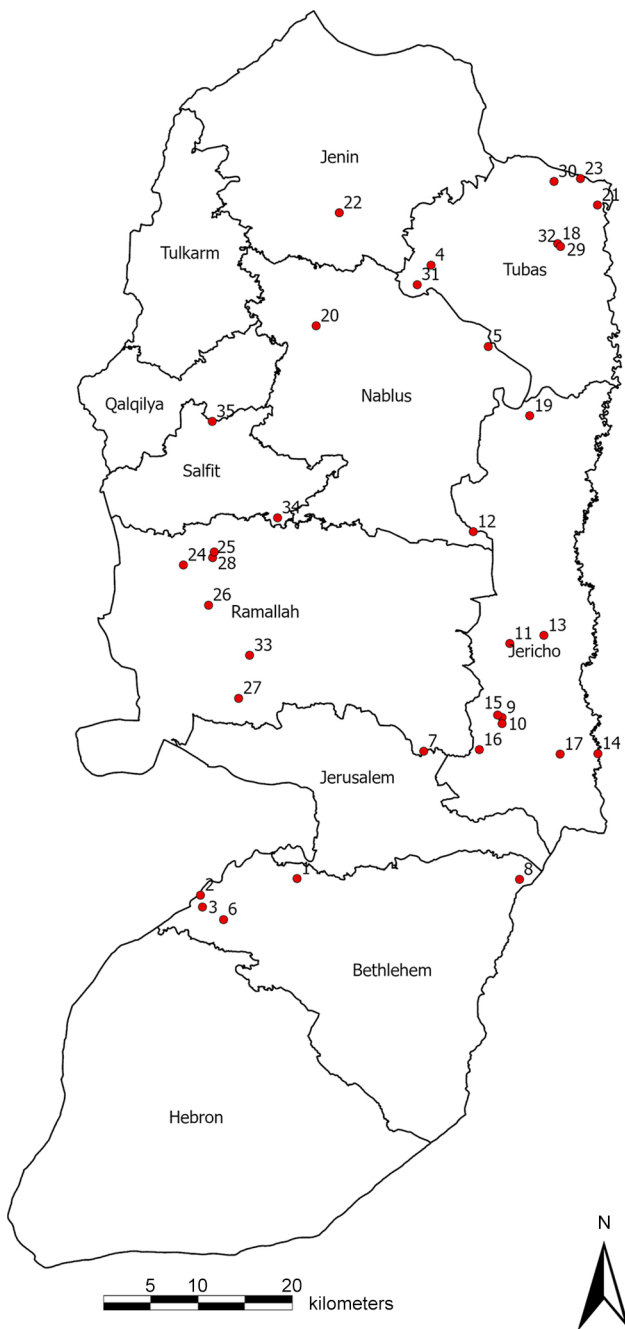


Fig. 1. Map of the Palestinian Territories showing collecting sites

Table 1. List of sampling sites

Site no.	Site name	N	E
1	Mar Andrya	31°43'03.10"	35°12'19.80"
2	Wadi Fukeen	31°42'05.40"	35°05'48.20"
3	Nahleen-Ein Fares	31°41'24.01"	35°05'55.37"
4	Kishda	32°18'27.60"	35°21'26.90"
5	Ain Shible	32°13'45.80"	35°25'21.40"
6	Nabe' Al-Farsi	31°40'41.10"	35°07'22.10"
7	Ain Al Fawar	31°50'23.20"	35°20'54.50"
8	Ain Feshkha	31°42'59.00"	35°27'22.70"
9	Ain Dyuk	31°52'19.50"	35°26'13.90"
10	Tal Al Smerrat	31°51'58.50"	35°26'13.60"
11	Ain Al-Ogga	31°56'36.23"	35°26'46.16"
12	Ain Fassayil	32°03'03.90"	35°24'18.00"
13	Al Ogga (Palm Farm)	31°57'03.70"	35°29'04.20"
14	Jordan River	32°46'57.17"	35°56'33.62"
15	Deir Krontol	31°52'29.00"	35°25'56.00"
16	Wadi Qelt	31°50'29.00"	35°24'40.50"
17	Jericho-Aquaponic	31°50'12.80"	35°30'09.70"
18	Em Al Jemal	32°19'40.71"	35°30'04.87"
19	Jiftlik	32°09'45.27"	35°28'09.55"
20	Nabe' Zawata	32°14'57.39"	35°13'38.00"
21	Ain Al Sakout	32°36'54.23"	35°54'17.87"
22	Marj Sanour	32°21'29.26"	35°15'12.20"
23	Ras Nakura	32°23'26.10"	35°31'38.20"
24	Aboud-Wadi Al-Hakeem	32°01'08.40"	35°04'36.20"
25	Nabe' Al-Hima	32°41'10.00"	35°39'51.00"
26	Mahmya Beit-Elo	31°58'50.10"	35°06'19.10"
27	Ein Al-Salhoud	31°53'27.50"	35°08'22.60"
28	Wadi Al Lemun – Beit Rima	32°01'54.70"	35°06'42.30"
29	Nabe' Al-Hilwa	32°19'31.60"	35°30'17.62"
30	Bardale	32°23'16.05"	35°29'51.17"
31	Al-Fara'a	32°17'20.30"	35°20'30.30"
32	Ain Al Beda	32°19'31.48"	35°30'17.20"
33	Ain Kenya	31°55'55.90"	35°09'07.20"
34	Salfit	32°03'52.80"	35°11'00.90"
35	Wadi Qana	32°09'26.10"	35°06'33.30"

RESULTS

A total of 14 species of freshwater snails belonging to eight families (Cochliopidae, Melanopsidae, Neritidae, Lymnaeidae, Physidae, Planorbidae, and Thiariidae) in eleven genera (*Bulinus*, *Eupaludestrina*, *Heleobia*, *Galba*, *Melanoides*, *Melanopsis*, *Mieniplotia*, *Physella*, *Planorbella*, *Radix*, and *Theodoxus*) were collected from freshwater habitats in the Palestinian Territories.

Family Neritidae Rafinesque, 1815

Theodoxus jordani (Sowerby, 1844)

Figs 2–3

Materials examined:

- Ras Nakura (PMNH-M52, 05.11.2013; PMNH-M57, PMNH-M73, 05.11.2013);
- Jiftlik (PMNH-M1, 21.03.2016);

- Aboud-Wadi Al-Hakeem (PMNH-M65, 27.07.2015);
- Ain Al Sultan (PMNH-M25, 21.12.2015; PMNH-M2433, 05.02.2019);
- Ain Al Ogga (PMNH-M3, 21.12.2015);
- Ain Dyuk (PMNH-M31, 21.12.2015; PMNH-M2431, 05.02.2019);
- Tal Al Smerrat (PMNH-M58, 21.12.2015);
- Nabe' Al-Hima (PMNH-M2382, 05.06.2021);
- Mahmya Beit-Elo (PMNH-M2384, 01.08.2016);
- Ein Al-Salhoud (PMNH-M2385, 10.10.2016);
- Nabe' Al-Hilwa (PMNH-M2404, 06.01.2021);
- Bardale (PMNH-M2411, 06.01.2021);
- Al-Fara'a (PMNH-M2420, 01.03.2021);
- Wadi Al Lemun – Beit Rima (PMNH-M2474, 20.08.2021).

Distribution. *Theodoxus jordani* has a wide range of distribution extending from southern Anatolia, Syria, Lebanon, Jordan, Palestine, into Mesopotamia and southern Iran (SANDS et al. 2020).

Remarks. DAGAN (1971) considered that *T. jordani* and *T. macri* are the same species based on that both species have central tooth of common structure and the operculum articulation is identical. However, ROTH (1987) reaffirmed the difference between the two species based on morphological evidences. SCHÜTT & ORTAL (1993) listed five subspecies of *T. jordani* recovered from plio-pleistocene sediments in the Jordan Valley; *Theodoxus jordani jordani*, *Theodoxus jordani pliocostulcaus*, *Theodoxus jordani uncarinatus*, *Theodoxus jordani bicarinatus* and *Theodoxus jordani tricarinatus*. DAGAN (1971) and BANDEL (2001) concluded that *T. macri* is a junior synonym of *T. jordani*. SANDS et al. (2020) recognized *T. jordani* as a full species with a wide distribution across southern Turkey to southern Iran, and that the genus *Theodoxus* in Jordan and Palestine is represented by a single species, *T. jordani*, based on molecular analyses.

According to the map depicted by SANDS et al. (2020), the distribution of *Theodoxus macri* is confined to southwestern Turkey and northwestern Syria. Thus, all previous records for *T. macri* from Palestine should be considered as *T. jordani*.

This species prefers clear and fast running water and was found attached to stones (AMR et al. 2014).

Family Cochliopidae Tryon, 1866

Eupaludestrina contempta (Dautzenberg, 1894)

Fig. 4

Materials examined:

- Ein Dyuk (PMNH-M2440, 01.02.2016; PMNH-M2436, 05.02.2019).

Distribution. Jordan, Lebanon, Palestine, and Syria.

Remarks. SCHÜTT (1991) reported this species from four localities in the Dead Sea area (Ein Turabe, En Hakikar, Enot Zuqim, and Enot Qane). This species is associated with springs and wetlands which has slightly saline muddy sediment. They are found attached to roots of aquatic submerged vegetation (AMR et al. 2014). In Jordan, two species are known, *Eupaludestrina contempta* (Dautzenberg, 1894) and *Eupaludestrina longiscata* (Bourguignat, 1856).

Heleobia sp.

Fig. 5

Materials examined:

- Nablus-Nabe' Zawata (PMNH-M2459, 15.07.2021, PMNH-M2460, 03.07.2021).

Distribution.: Species of this genus are known from Jordan, Palestine, Syria and Lebanon.

Remarks. Originally, this genus was placed as *Semisalsa*. Molecular data suggests that species of the genus *Semisalsa* should be reassigned under the genus *Heleobia* (WILKE et al. 2001). MILSTEIN et al. (2012) stated that *H. phaeniciaca* (Pallary, 1939) distributed in humid areas of Palestine is very common. The specimen collected from Nablus- Nabe' Zawata is similar to *Heleobia* sp. described by MILSTEIN et al. (2012) by having small and smooth shell.

Family Melanopsidae Adams et Adams, 1854

Melanopsis buccinoidea (Olivier, 1801)

Fig. 6

Materials examined:

- Aboud-Wadi Al-Hakeem (PMNH-M53, 27.07.2015);
- Ain Al Beda (PMNH-M8, 16.09.2015; PMNH-M2376, 05.06.2021; PMNH-M2377, 05.06.2021);
- Ain Kenya (PMNH-M27, 03.08.2015);
- Ain Feshkha (PMNH-M19, 05.11.2013; PMNH-M76, 05.11.2013);
- Ain Al Ogga (PMNH-M39, 04.12.2014; PMNH-M34, 21.12.2015);
- Al Ogga (Palm Farm) (PMNH-M56, 21.12.2015);
- Ras Nakura (PMNH-M14, 01.02.2014; PMNH-M2448, 05.11.2013);
- Salfit (PMNH-M2449, 2010);
- Wadi Fukeen (PMNH-M18, 29.07.2015; PMNH-M2444, 16.06.2021; PMNH-M2445, 16.06.2021);
- Wadi Qana (PMNH-M15, 01.02.2014; PMNH-M55, 01.02.2014);
- Wadi Qelt (PMNH-M36, 05.11.2013);
- Ain Al Sultan (PMNH-M46, 21.12.2015; PMNH-M2438, 05.02.2019);
- Ain Dyuk (PMNH-M16, 21.12.2015; PMNH-M2430, 05.02.2019);

- Tal Al Smerrat (PMNH-M48, 21.12.2015; PMNH-M2429, 05.02.2019);
- Jiftlik (PMNH-M40, 21.03.2016);
- Mahmya Beit-Elo (PMNH-M2383, 01.08.2016);
- Nabe' Al-Hilwa (PMNH-M2398, 06.01.2021; PMNH-M2400, 13.02.2021; PMNH-M2401, 13.02.2021);
- Al-Fara'a (PMNH-M2422, 01.03.2021);
- Ain Al Fawar (PMNH-M2426, 05.02.2019);
- Nahleen-Ein Fares (PMNH-M2442, 16.06.2021; PMNH-M2443, 16.06.2021);
- Wadi Al Lemun – Beit Rima (PMNH-M2475, 20.08.2021).

Distribution. Jordan, Palestine, Lebanon, Syria, Greece, Cyprus and southern Turkey.

Habitat. Clear freshwater springs and pools. This species is mostly associated with *Theodoxus jordani* (AMR et al. 2014).

Remarks. GLAUBRECHT (1993) gave a very comprehensive treatment for the species of the genus *Melanopsis* in the Mediterranean Basin based on morphometric features. He referred to populations of this genus in Jordan and Palestine as *Melanopsis praemorsa*

buccinoidea and *Melanopsis praemorsa costata*. HELLER et al. (2005), also based on morphological features, recognized *M. buccinoidea* as the species occurring in Palestine with variations. According to AMR et al. (2014) there are two forms of this freshwater snail; the Levant form (elongated) and the Jordan Valley form.

Melanopsis costata costata (Olivier, 1804)

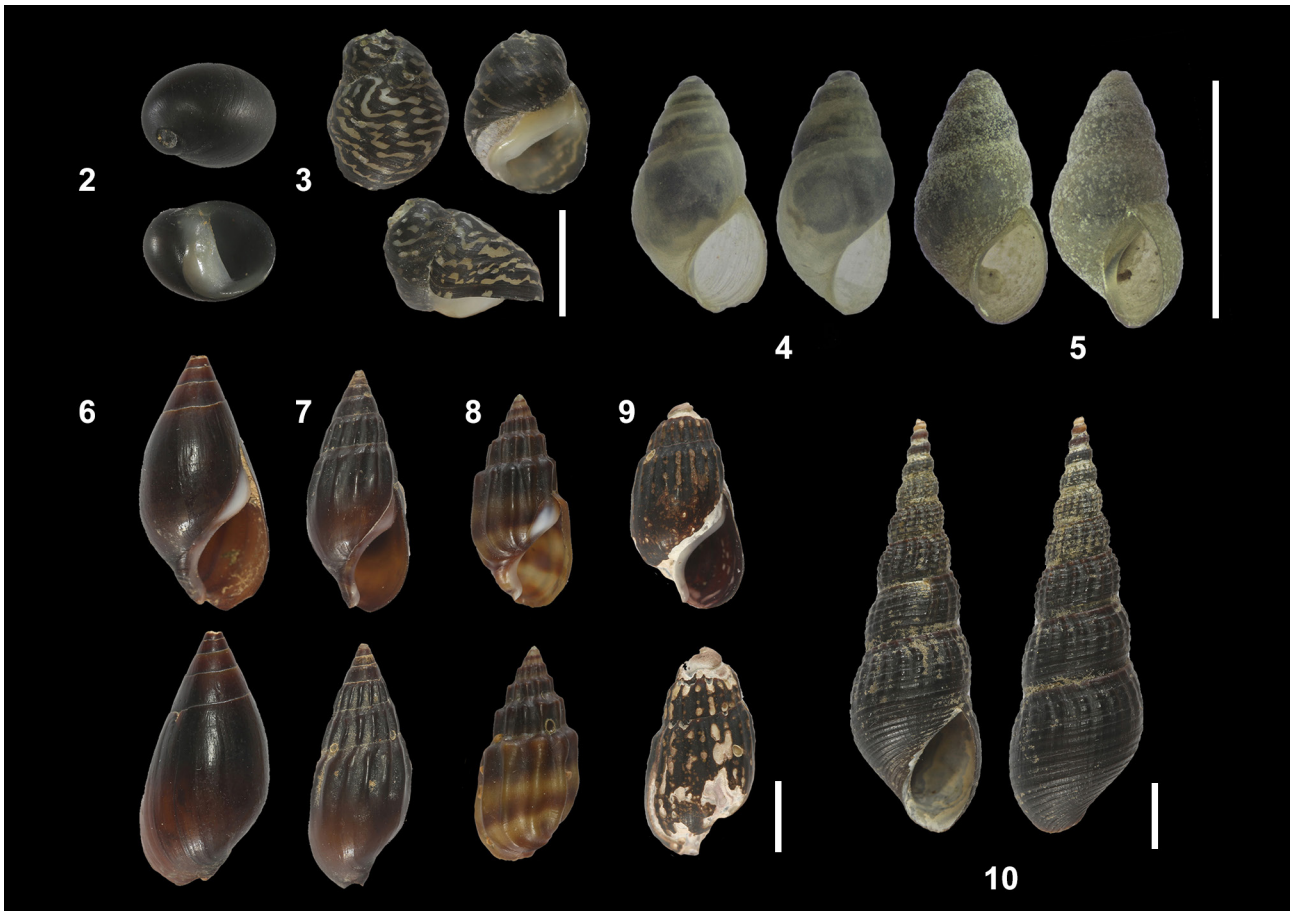
Fig. 7

Materials examined:

- Ras Nakura (PMNH-M2, 05.09.2013; PMNH-M2450, 05.09.2013);
- Jiftlik (PMNH-M22, 21.03.2016).

Distribution. Levant and Iran.

Remarks. HELLER et al. (2005) stated that four subspecies for this species are known in the Levant; namely *M. c. costata*, *M. c. lampra*, *M. c. jordani*, and *M. c. obliqua* whereas *M. c. obliqua* and *M. c. jordani* are common along the lower and upper Jordan River, respectively. This species is usually found submerged in mud in springs and swamps.



Figs 2–10. Shells of: 2 – black form of *Theodoxus jordani*; 3 – straited form of *Theodoxus jordani*; 4 – *Eupaludestrina contempta*; 5 – *Heleobia* sp.; 6 – *Melanopsis buccinoidea*; 7 – *Melanopsis costata costata*; 8 – *Melanopsis saulcyi*; 9 – *Melanopsis cerithiopsis*; 10 – *Melanoides tuberculata*. Scale bars – 5 mm (2–3), 3 mm (4–5), 5 mm (6–9), 5 mm (10)

***Melanopsis saulcyi* (Bourguignat, 1853)**

Fig. 8

Materials examined:

- Ras Nakura (PMNH-M2451, 06.09.2015);
- Ain Al Sultan (PMNH-M24, 21.12.2015; PMNH-M2434, 05.02.2019);
- Jiftlik (PMNH-M51, 21.03.2016);
- Jordan River (PMNH-M45, 05.11.2013);
- Nabe' Al-Hima (PMNH-M2381, 05.06.2021);
- Nabe' Al-Hilwa (PMNH-M2393, 13.02.2021; PMNH-M2394, 06.01.2021; PMNH-M2399, 06.01.2021; PMNH-M2396, 13.02.2021; PMNH-M2403, 13.02.2021; PMNH-M2397, 06.01.2021; PMNH-M2395, 05.06.2021);
- Al-Fara'a (PMNH-M2417, 01.03.2021; PMNH-M2419, 01.03.2021; PMNH-M2418, 01.03.2021; PMNH-M2416, 01.03.2021);
- Bardale (PMNH-M2410, 06.01.2021);
- Em Al Jemal-Northern Valleys (Al-Agouar) (PMNH-M2389, 10.04.2021).

Distribution. Jordan, Palestine and Syria.**Remarks.** This species differs from other ribbed species (i.e. *M. costata*) by having more ribs that are bumpy in appearance (HELLER et al. 2005). This species is mostly associated with slow running water, usually close to aquatic plants (AMR et al. 2014).***Melanopsis cerithiopsis* Bourguignat, 1884**

Fig. 9

Materials examined:

- Ein Al Sakout (PMNH-M2386, 10.10.2016; PMNH-M2425, 2020)

Remarks. This species was recovered from archaeological sites in Tell Jenin and Jericho (BIGGS 1963, EZZUGHAYYAR & SWAILEH 2014). It was found in sympatry with *M. buccinoidea* in the lower Jordan Valley. SCHÜTT (1987) considered this species as a relict form of *Melanopsis* that was common between Euphrates and the Jordan Valley. HELLER et al. (2005) considered *M. cerithiopsis* as a synonym of *M. saulcyi*.**Family Thiariidae Gill, 1871*****Melanoides tuberculata* (O. F. Müller, 1774)**

Fig. 10

Materials examined:

- Ain Feshkha (PMNH-M4, 05.09.2015);
- Ras Nakura (PMNH-M2452, 05.09.2013);
- Al Ogga (Palm Farm) (PMNH-M21, 21.12.2015);
- Ain Dyuk (PMNH-M54, 21.12.2015; PMNH-M7, 01.02.2016; PMNH-M2432, 05.02.2019; PMNH-M2435, 05.02.2019);
- Tal Al Smerrat (PMNH-M41, 21.12.2015; PMNH-M2428, 05.02.2019);
- Ain Al Ogga (PMNH-M2453, 21.12.2015);
- Deir Krontol (PMNH-M26, 01.02.2016);

- Jericho-Aquaponic (PMNH-M44, 14.02.2016);
- Jiftlik (PMNH-M2390, 02.02.2021; PMNH-M2392, 02.02.2021).

Distribution. Worldwide all over most of Africa, Asia and Australia.**Remarks.** *Melanoides tuberculata* is associated with freshwater bodies (i.e. springs, streams and swamps) that are considered slightly saline. It is considered as a common species within the West Bank, as it is spread alongside the Jordan River Valley, especially around the Dead Sea basin and Jericho district.***Mieniplotia scabra* (O. F. Müller, 1774)**

Fig. 11

Materials examined:

- Ras Nakura (PMNH-M2454, 05.09.2013).

Distribution. South and Southeast Asia, and the Indo-Australian Archipelago extending eastwards to the western Pacific Islands. It is considered as introduced to the Middle East.**Remarks.** This is considered as an invasive freshwater snail to the Palestinian Territories. HELLER et al. (2014) found that this was the most common freshwater snail in Lake Tiberias accounting for > 95% of the snails' populations, affecting native species (i.e. *Melanopsis costata*, *Melanoides tuberculata*, *Theodoxus jordani* and *Bithynia phialensis*). It was reported from the Jordan River (NASARAT et al. 2014).**Family Lymnaeidae Rafinesque, 1815*****Radix natalensis* (Krauss, 1848)**

Fig. 12

Materials examined:

- Kishda (PMNH-M2457, 16.12.2015).

Distribution. Tropical Africa, Yemen, Oman and Saudi Arabia.**Remarks.** This snail is found in marshes, swamps and other different types of steady water bodies (AMR et al. 2014). It is also implicated in the transmission of fasciolosis in different countries in Africa (BROWN 1994).***Galba truncatula* (O. F. Müller, 1774)**

Fig. 13

Materials examined:

- Bethlehem (PMNH-M2455, 04.12.2015);
- Tal Al Smerrat (PMNH-M2456, 21.12.2015);
- Ein Dyuk (PMNH-M2441, 01.02.2016);
- Al-Fara'a (PMNH-M2415, 02.02.2021).

Distribution. Wide distribution range across Europe and east and south Africa and the Middle East.**Remarks.** *Galba truncatula* is considered as the main intermediate host for several species of the genus *Fasciola*. It is mostly found in irrigation canals and

swamps. It has the tendency to adhere to muddy edges of rivers and springs (AMR et al. 2014).

Family Physidae Fitzinger, 1833

Physella acuta (Draparnaud, 1805)

Fig. 14

Materials examined:

- Bethlehem (PMNH-M2458, 22.10.2015);
- Ain Shible (PMNH-M9, 16.12.2015);
- Tal Al Smerrat (PMNH-M38, 21.12.2015);
- Al Ogga (Palm Farm) (PMNH-M33, 21.12.2015; PMNH-M32, 21.03.2016);
- Ein Dyuk (PMNH-M23, 01.02.2016; PMNH-M59, 01.02.2016; PMNH-M2437, 05.02.2019);
- Deir Krontol (PMNH-M30, 01.02.2016; PMNH-M2439, 01.02.2016);
- Ain Al Beda (PMNH-M2378, 05.06.2021; PMNH-M2379, 05.06.2021; PMNH-M2380, 13.02.2021);
- Nabe' Al-Farsi (PMNH-M2388, 05.06.2021);
- Jiftlik (PMNH-M2391, 02.02.2021; PMNH-M2463, 31.07.2021);
- Nabe' Al-Hilwa (PMNH-M2402, 06.01.2021);

- Bardale (PMNH-M2405, 06.01.2021; PMNH-M2406, 13.02.2021; PMNH-M2407, 06.01.2021; PMNH-M2409, 06.01.2021; PMNH-M2412, 06.01.2021; PMNH-M2413, 06.01.2021; PMNH-M2414, 06.01.2021);
- Ain Al Ogga (PMNH-M2423, 1.09.2021; PMNH-M2424, 22.12.2020);
- Tal Al Smerrat (PMNH-M2427, 05.02.2019);
- Al-Fara'a (PMNH-M2415, 02.02.2021).

Distribution. This is a widespread species in northern America, Europe, Eurasia, and Africa.

Remarks. *Physella acuta* is one of the most common species found in steady water bodies in the West Bank including temporary irrigation ponds with plastic cover and swamps.

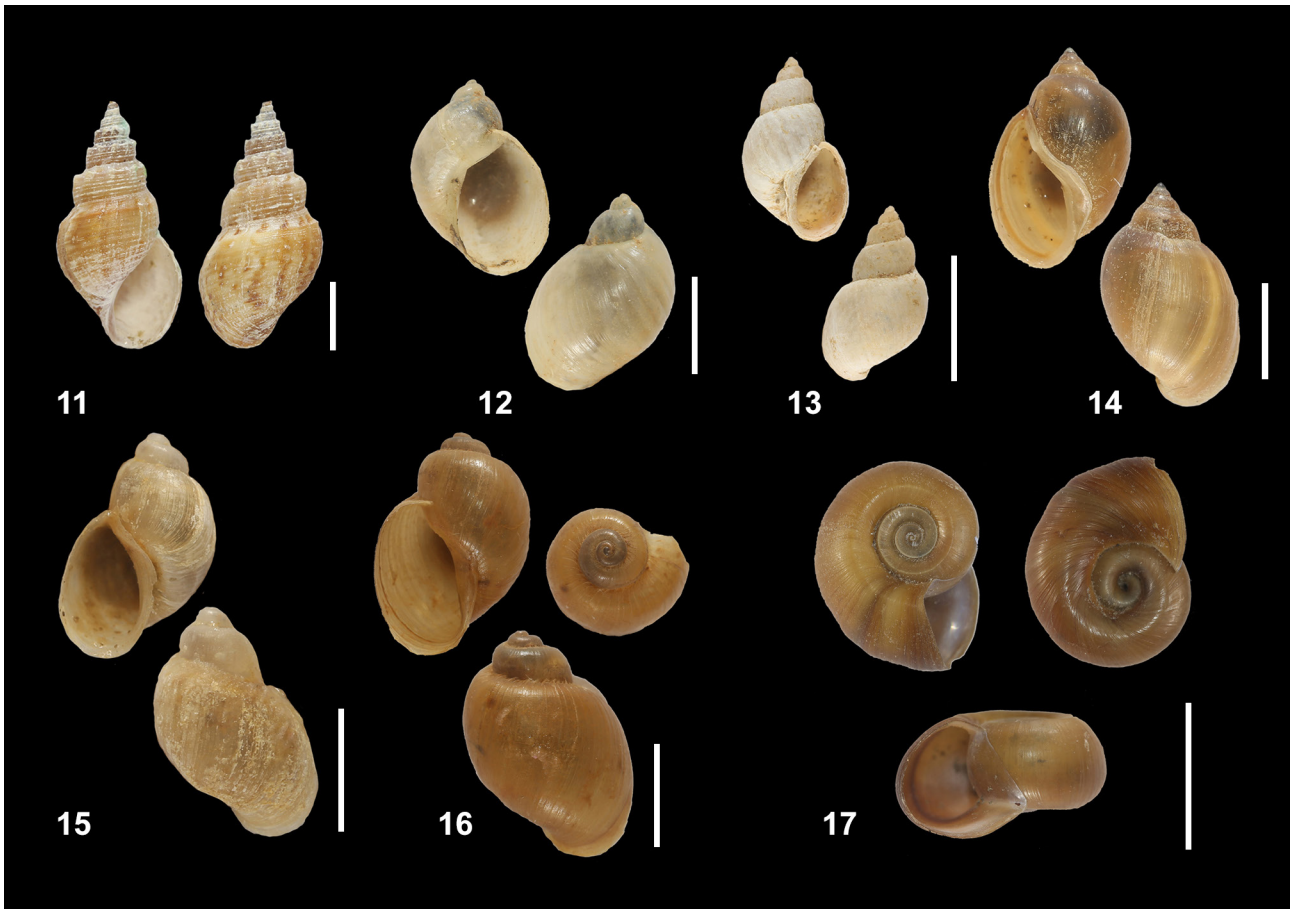
Family Planorbidae Rafinesque, 1815

Bulinus truncatus (Audouin, 1827)

Figs 15–16

Materials examined:

- Marj Sanour (PMNH-M2462, 15.12.2021);
- Ain Al Ogga (PMNH-M2424, 22.12.2020);
- Al-Fara'a (PMNH-M2421, 01.03.2021).



Figs 11–17. Shells of: 11 – *Mieniplotia scabra*; 12 – *Radix natalensis*; 13 – *Galba truncatula*; 14 – *Physella acuta*; 15–16 – *Bulinus truncatus*; 17 – *Planorbella duryi*. Scale bars – 5 mm (11–16), 10 mm (17)

Distribution. Africa, southwest Asia and Portugal, Sardinia and Corsica.

Remarks. This species was reported in Palestine (ABDEL AZIM & GISMANN 1956, SALITERNIK & WITENBERG 1959). The snails were found in three sites in three different districts. It prefers still waters such as reservoirs, ponds, slow running waters, and irrigation canals. In the Middle East and Africa, this species acts as intermediate hosts for *Schistosoma haematobium* (BROWN 1994).

Planorbella duryi (Wetherby, 1879)

Fig. 17

DISCUSSION

In an earlier study, HANDAL et al. (2015) reported 10 species of freshwater snails from the West Bank. We added four additional species: *Bulinus truncatus*, *Melanopsis cerithiopsis*, *Planorbella duryi*, and *Heleobia* sp. The status of *Theodoxus jordani* and *Theodoxus macri* is clarified based on recent revisions (SANDS et al. 2020); all previous records of *T. macri* are now considered as *T. jordani*.

Most species recorded are considered endemic to the Levant, including all species of the genus *Melanopsis*, *T. jordani* and *E. contempta*, while the species *B. truncatus*, *G. truncatula*, *P. acuta*, *R. natalensis* and *M. tuberculata* have a wide distribution. A total of at least 33 species of freshwater snails were reported from historic Palestine (MILSTEIN et al. 2012), while 22 species were reported from the Jordan River (AMR et al. 2014).

Nineteen species of invasive freshwater snails were reported as introduced species to Palestine (ROLL et al. 2009). *Mieniplotia scabra*, an invasive species that became well established in Lake Tiberias,

Materials examined:

- Bethlehem – Botanical Garden Pond at PMNH (PMNH-M2461, 10.08.2017).

Distribution. This species is endemic to Florida, USA, and now introduced to several countries through aquatic plants used in aquaria.

Remarks. *Planorbella duryi* is an invasive species which was introduced to our area (ROLL et al. 2009). This species was found at the Palestine Museum of Natural History pond, that may have been imported along with an aquatic plant from Jerusalem botanical garden to the museum in Bethlehem.

caused almost the eradication of four native species (HELLER et al. 2014). It is now common in waterbodies in the Jordan Valley within the Jordanian territories (NASARAT et al. 2014). *Planorbella duryi* was also introduced and is expanding its range within the historic Palestine as well as the West Bank (ROLL et al. 2009, MILSTEIN et al. 2012). Although not reported in the current study, *Pyrgophorus* sp., which is another invasive species, was reported from several localities near the Jordan Valley (MILSTEIN et al. 2012).

ACKNOWLEDGMENTS

A great appreciation for the help provided by the Palestine Institute for biodiversity and Sustainability team in this study. This study was partially funded by the European Union (ENI/2019/412-148: Unity and Diversity in Nature and Society) under the Biodiversity Center and the Ministry of Education of Palestine (for the Medical Zoology Unit).

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Received: December 27th, 2022

Revised: February 4th, 2023

Accepted: February 27th, 2023

Published on-line: March 25th, 2023

