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RESEARCH PAPER

Morphological Identification and Distribution of Freshwater Snails (Gastropods: Mollusca) in Greater Zab River, Kurdistan Region, Iraq

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A B S T R A C T:

A total of 4754 snails were collected from four sites (Qandil, Kawergosk, Khabat, and Sufaia) on Greater Zab River, Kurdistan Region, Iraq, identified morphologically and the distribution results made up of 2764 (58.14%) of *Physella acuta*, 919 (19.33%) of *Radix auricularia*, 416 (8.75%) of *Radix euphratica*, 180 (3.79%) of *Radix* sp., 255 (5.36) of *Melanopsis praemorsa* and 220 (4.63%) of *Gyraulus huwaizahensis*. Statistical analysis of species distribution showed significant ($p<0.05$) differences with study sites. All species (except *Physella acuta*) recorded for the first time in Greater Zab River.

KEY WORDS: Freshwater snail; Morphology; Greater Zab River; Iraq.
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1. INTRODUCTION:

Snails are one of the most diverse groups of freshwater invertebrates and are definitely among the public's easiest to identify these soft-bodied, unsegmented, univalve, calcareous shell, that consist of a head, foot, visceral mass and mantle (Pyron and Brown, 2015). The most widespread species on the margins of lakes and streams and possess a file such as radula which feed on detritus, graze on macrophyte or cobble periphyton, or even float upside down on the surface of the water assisted by surface tension (Dey, 2007; Brown and Lydeard, 2009). The first investigation on the distribution of some mollusks was done in Iraq by Najim (1959), who collected various species of freshwater mollusks from different parts that gave an important note on the distribution of mollusks, after that various species were recorded in different geographical regions in Iraq by several researchers (Harris, 1965; Shamsuddin and Al-Adhami, 1969; Ali, 1979; Radawy, 1979; Mohammad, 1983; Al-Dabbagh and Daoud, 1985; Al-Dabbagh and Luka, 1986; Al-Ali, 2002; Al-Qarooni, 2005; Plaziat and Younis, 2005; Al-Daoody, 2006; Ali et al., 2007; Glöer and Naser, 2007; Ali et al., 2008; Farid et al., 2008; Al-Waaly et al., 2014; Al-Shammari, 2015; Mohammad, 2015; Jaweir and Abid-Ali, 2015; Ghulam and Abdul-Sahib, 2015; Hashim and Al-Taee, 2015; Al-Abbad et al., 2015; Al-Waaly et al., 2015). In contrast, the information about freshwater snails in Kurdistan Region is very scarce, only there are three reports on freshwater snails were conducted in Greater Zab River (Abdullah and Abbas, 1989; Ali, 2007; Ali and Jiwar, 2007).

Snails can be identified using taxonomic morphological features and reproductive structures (Dey, 2007; Barco et al., 2010). On the light of above reasons, this research was conducted to investigate the identification and distribution of freshwater snails collected from Greater Zab River in Kurdistan Region, in order to add them to the reported Iraqi fauna.

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2. MATERIALS AND METHODS

2.1. Study Area

Greater Zab River is located to the east Tigris River in the northern part of Iraq (Kurdistan Region) (Fig. 1). The freshwater snails monthly collected and identify from various selected areas (Qandil, Kawergosk, Khabat and Sufaia), during October 2016 until September 2017. Samples were brought to the laboratory and kept in glass aquaria constantly aerated, aquatic vegetation was placed to keep the water clean for a longer period.

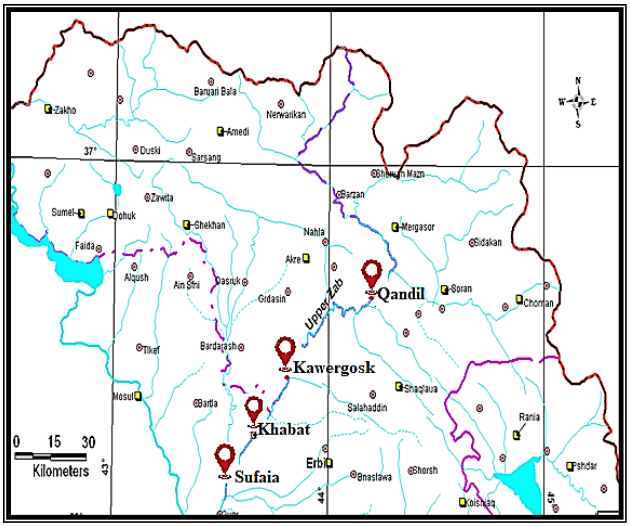

Figure 1: Map of Kurdistan Region, showing sampling sites on the Greater Zab River

2.2. Diagnosis of Snails

The detected snails were identified according to their morphology, the shell offers a great number of characters important for taxonomy, the general shape, presence or absence of operculum, the number and the nature of coiling may be dextral or sinistral, shape of whorls, sculpture, the nature of umbilicus, columella and the size and shape of the aperture of shell, radula, reproductive structures and specific life stages are very important traits for identifying freshwater snails (Dey, 2007; Barco et al., 2010). The following keys were used for identification Brown (1994); Plaziat and Younis (2005); Glöer and Naser (2007); Glöer and Pešić (2012).

2.3. Statistical analysis

Statistical analysis was performed for the data using software program Statistical Package for Social Science (SPSS version 25). Post hoc test (Duncan) was applied to determine significant differences between spatial and temporal variation. All data are expressed as mean. A P value of 0.05 was considered as the limit for statistical significance. Pearson correlation was calculated.

3. RESULTS AND DISCUSSION

In current study, six species of freshwater snails were identified from the studied sites, five of them recorded as new in Greater Zab River (Table 1).

Table 1: List of freshwater snails recorded during the study period in various sites

Taxonomy	Qandil	Kawergosk	Khabat	Sufaia
***Physella acuta* (Draparnaud,1805)**		+	+	+
***Radix auricularia* (Linnaeus, 1758)**		+	+	+
***Radix euphratica* (Mousson, 1874)**		+	+	+
***Radix* sp.**		+	+	+
***Gyraulus huwaizahensis* Glöer and Naser, 2007**	+			+
***Melanopsis praemorsa* (L. 1758, Buccinum)**	+			

3.1. Morphological Descriptions

3.1.1. *Physella acuta* (Draparnaud,1805)

This species has a thin shell with spire elongates, but short, with five whorls has a sinistral shell, extended mantle margin, or edge, that partially covers the shell. The shell is a light “fawn” color, with the body being gray and covered in fleck spots on the top mantle under the shell. The aperture or shell opening is ear-shaped and the suture slightly impressed the height of up to 12-17 mm and the width 6-8 mm (Figure 2). The description and measurements of the present specimens were similar to those reported by Paraense and Pointier (2003).

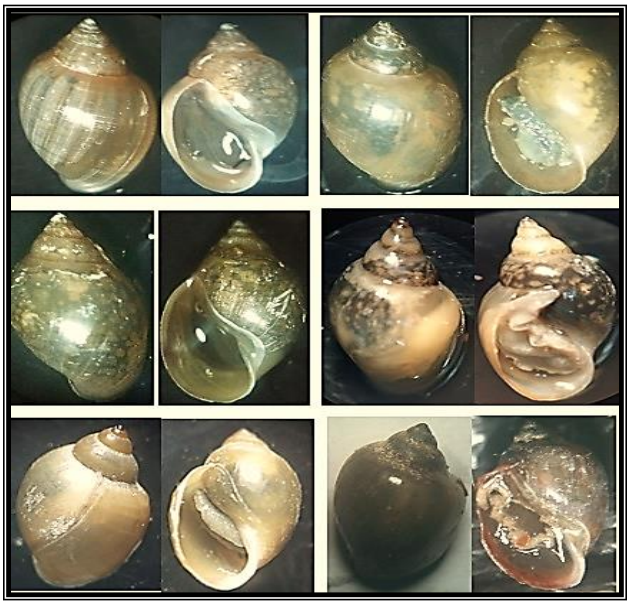

Figure 2: *Physella acuta* (20X)

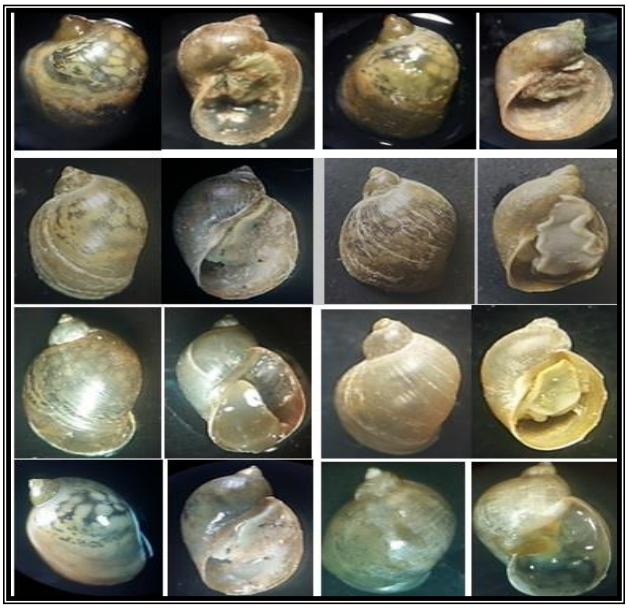

Figure 3: *Radix auricularia* (20X)

3.1.2. *Radix auricularia* (Linnaeus, 1758)

The shell slightly variable; it is ovate or spherically ovate in shape, relatively thin-walled and fragile. The whorls 4 – 4.5 weakly convex. Spire low, conical and sharply terminated, with the body whorl greatly expanded. Aperture ear-shaped very large which contains no operculum. Umbilicus narrow, fissured and often covered. Shell color from whitish-yellow to brown (Figure 3). Shell height, usually the same or almost the same as its width, reaches 14-24 mm, the width of the shell is from 12-18 mm. The description and measurements of the present specimens were similar to those recorded by Aksenova et al. (2018). The genus *Radix* Montfort 1810, formerly included in *Lymnaea*, is member of the Lymnaeidae family (Pfenninger et al., 2006; Mhaisen et al., 2013).

3.1.3. *Radix euphratica* (Mousson, 1874)

Shell egg-shaped, thin, shiny, and light ivory. Spire height half of aperture height. 4-4.5 slightly convex whorls. The shell 15 mm high and 9 mm broad (Figure 4). Mantle pigmentation is unicolored black without any spots. Head and foot without speckles. The dark preputium and the black mantle pigmentation and the missing speckles on head and foot show the distinctness from Radix auricularia. The present snail shows a great similarity with the specimens of Aksenova et al. (2018).

Figure 4: *Radix euphratica* (20X)

3.1.3. *Radix* sp.

The body is protected by a thin shell (Figure 5). Spiral form, not very much pointed and less acuminate, more ovate with a narrow ovate aperture; the outer lip not very much expanded and almost straight in outline, The shell 22 mm high and 8 mm broad. The description and measurements of the present specimens were similar to those reported Tigga et al. (2014).

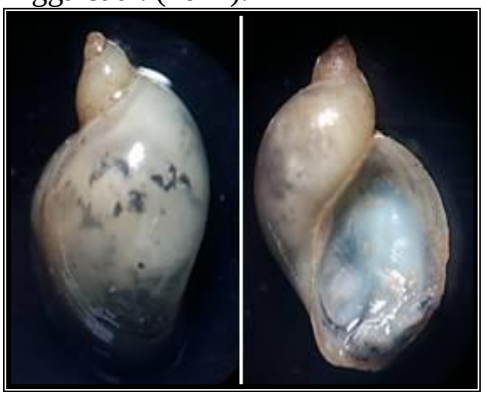

Figure 5: *Radix* sp. (20X)

3.1.4. *Gyraulus huwaizahensis* Glöer and Naser, 2007

The shell is small to medium-size, 3.0–3.5 mm in diameter and 1.0 mm in height. The animal is light grey with one row of distinct small black spots. Light-corneus shell is glossy and transparent with fine growth lines. Three and three quarter regular convex whorls with a clear suture increase very rapidly from 2nd to 3rd whorl. The last whorl is not deflected. Both sides of the shell are slightly convex (Figure 6). It is lives on submerged aquatic plants, synoptically with Bithynia sp., Radix spp. and Physella acuta. The description and measurements of the present specimens were similar to those reported by Glöer and Naser (2007).

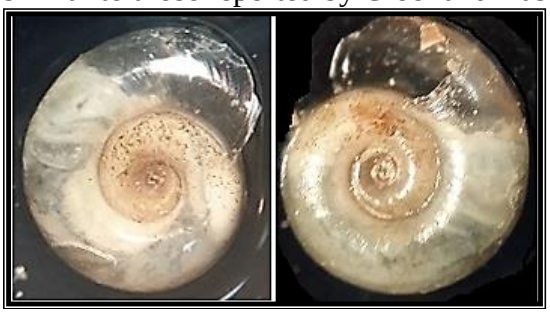

Figure 6: *Gyraulus huwaizahensis* (40X)

3.1.5. *Melanopsis praemorsa* (Linnaeus, 1758)

Highly polymorphic within the same population. The shell is fusiform, the spire consists of 5 to 6 rounds separated by deep sutures, medium in size, dark-brown to black which may exceed 2 cm in length. The sculpture of the shell is highly varied, being either smooth or ribbed to a greater or lesser extent (Figure 7). The description t of the present specimen are similar to those reported by Mouahid et al. (1996); Elkarmi and Ismail (2006); Nechad et al. (2016).

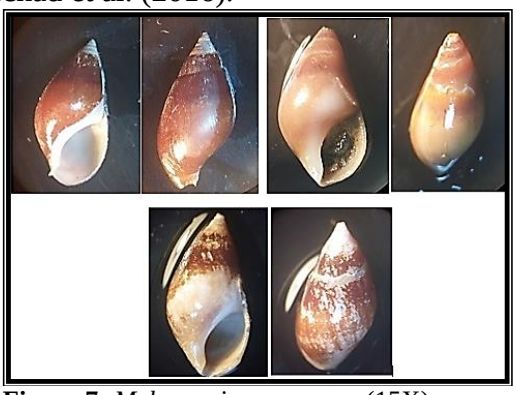

Figure 7: *Melanopsis praemorsa* (15X)

3.2. Freshwater Snails' Distribution

Concerning freshwater snails' community, abundance, and distribution of the results showed a high variation during the studied period in the studied sites. In this study recorded six species of freshwater snails were recorded in four studied sites. A total of 4754 snails were collected made up of 2764 (58.14%) of *Physella acuta*, 919 (19.33%) of *Radix auricularia*, 416 (8.75%) of *Radix euphratica*, 180 (3.79%) of *Radix* sp., 255 (5.36) of *Melanopsis praemorsa* and 220 (4.63%) of *Gyraulus huwaizahensis* (Figure 8).

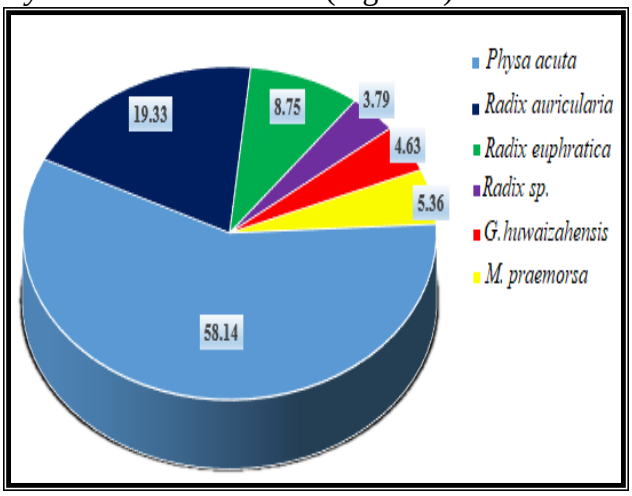

Figure 8: Percentage of Snail's distribution in Greater Zab River

Table 2: Sites variation of freshwater *S*nail species in Greater Zab River (S1=Qandil, S2= Kawergosk, S3= Khabat, S4= Sufaia).

Sites	*Physella acuta*	*Radix auricularia*	*Radix euphratica*	*Radix sp.*	*Gyraulus huwaizahensis*	*Melanopsis praemorsa*
S1	0	0	0	0	9.25 [a]	21.25
S3	84.08 [a]	25.41 [b]	8.75 [c]	3.42 [c]	0	0
S3	78.58 [b]	25.58 [a]	11.08 [b]	4.17 [b]	0	0
S4	67.67 [c]	25.58 [a]	14.83 [a]	7.42 [a]	9.1 [b]	0

The letters ([a, b, c] …. etc.) represents the significance among variations in Duncan test.

In Figure (8) showed that *Physella acuta* distributed (58.14%) and present in three sites except in Qandil site (Table 1), because this snail is Mediterranean origin, common gastropod species in Iraq invades all fresh waters in the world and present in a moderate amount of aquatic vegetation and organic debris (Smith, 2001; Wethington and Lydeard, 2007; Al-Waaly, 2014). Another reason, it is hermaphrodite and its ability to self-fertilization can produce a large number of offspring through the year (Maqboul et al., 2014). Statistical analysis shows significant differences ($p<0.05$) between *P. acuta* with sites (Table 2).

According to *R. auricularia*, *R. euphratica* and *Radix* sp. distributed with various prevalence in three sites except in Qandil site. Statistically showed significant ($p<0.05$) differences with study sites (Table 1 and 2). The high number of *R. auricularia* and *R. euphratica* were in the Sufaia habitat with *Physella acuta* and minimum numbers in Khabat site. The *Radix* species, it's very variable species and widespread across Greater Zab River (Figures 2,3,4), the variability and plasticity of shell forms and size depend on environmental conditions (Jouet et al., 2010). The morphological identification of lymnaeids species in the genus *Radix* is very difficult because of the continuous variability and plasticity of the different criteria depending on environmental conditions; consequently, molecular tools are extensively used to overcome these difficulties (Pfenninger et al., 2006; Dung et al., 2013; Caron et al., 2017). Recently, molecular biology brought a new insight into the taxonomy of *Radix* snails (Huňová et al., 2012).

In the other way, the other new record *Gyraulus huwaizahensis*, statistical analysis showed significant differences with study sites with this species (Table 2). Previously, recorded as new species in Basrah by Glöer and Naser (2007). Ali (2007) recorded *Planorbus albs* in Qandil site on the same River. Other species registered in Iraq; *Gyraulus euphraticus*, *G. convexiusculus*, *G. convexiusculus* as a widely distributed and common species with a geographical range from Lower Mesopotamia (Glöer and Naser, 2007), *Gyraulus ehrenbergi* (Najim, 1959), *Gyraulus iraqensis* (Harris, 1965). Recent papers by Plaziat and Younis (2005) mentioned that use *Gyraulus albus* species names not distributed in Iraq, as well as *Gyraulus intermixtus*, which belongs to the genus *Planorbis* (Glöer and Naser, 2007). Planorbid species tend to happened in high levels of organic matter decaying and water bodies with a mud bottom (Spyra and Strzelec, 2013).

The latest freshwater snail *Melanopsis praemorsa* recorded only in Qandil site and considered as the first record in Greater Zab River and in Kurdistan Region. In spite of non-observed during cold months (December, January, February and March) may be related to temperature. Regarding the effect of water temperature on snails population it was found in Summer and Autumn was included in the optimum temperature required for breeding and reproduction of snails (Karimi et al., 2004). Also, Al-Daoody (2006) recorded in pedol resort in Mosul province, and Farman and Almukhtar (2015) recorded M. praemorsa reached its maximum density in Diyala River. Statistical analysis showed significant differences with study sites (Table 2).

3.3. Sites Variation of Freshwater Snails Distribution

In Table (2) and Figure (9), shows significant differences between freshwater snails and study sites.

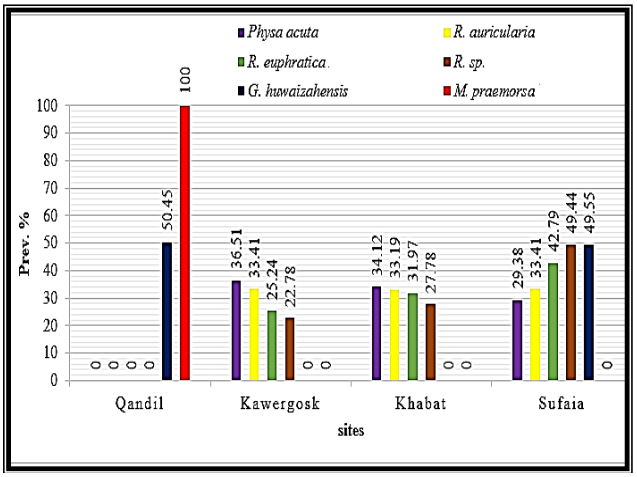

Figure 9: Site variation of freshwater snails distribution

In Qandil site, there were less diversity and snail abundant than other sites, two species were found, the first one is *M. praemorsa* (100%), not present in other sites, this result slightly similar to Al-Daoody (2006) was recorded in two sites in Mosul province with (13.6%-86.4%), and the second one is *G. huwaizahensis* was recorded in Qandil site (50.45%), and in Sufaia site (49.55%), may be due to fast flowing River body which does not allow snail population to build up, it washes and sweeps off the foot of snails. The similarity and differences of sequences between *G. huwaizahensis* were collected in Greater Zab River compared with other in Basrah due to a thermal adaptation involves functionally relevant changes to the genome and therefore leads to a stronger dependence of organisms to their specific environment (Lagerspetz, 2006). There is also absence of organic matter/suspended matter to support snail population and this result supported by Njoku-Tony (2011), reducing the devastation of the natural environment resulting from the decline of heavy industry can stop the decrease in the biodiversity of freshwater gastropods, and geomorphological conditions also belong to the factors affecting the diversity of snail species (Michalik-Kucharz, 2008). Previously, recorded in Iraq by (Shamsuddin and Al-Adhami, 1969; Al-Daoody, 2006; Ali et al., 2007; Ali et al., 2008).

In Kawergosk and Khabat sites, four species were recorded: *Physella acuta* (36.51%), *R. auricularia* (33.41%), *R. euphratica* (25.24%) and *Radix* sp. (22.78%); and in Khabat site *Physella acuta* (34.12%), *R. auricularia* (33.19%), *R. euphratica* (31.97%) and *Radix* sp. (27.78%), the similarity distribution between two neighbor sites due to water temperature is considered to be one of the important aquatic environmental factors, especially in areas with slightly different seasons. The high temperatures concomitant with water can affect the development of the snail population (Mardin et al., 2018). The maximum number of *P. acuta* and *R. auricularia* collected in Kawergosk site in small ponds linked to River, where dries in the Summer, most individuals migrated from the exposed substratum towards the submerged wet zone, this result agree with Gulanicz et al. (2018) stated that behavioral strategy under unfavorable conditions is burrowing to cooler and more humid sediment layers. (Kuk-Dzul and Díaz-Castañeda, 2016). In Khabat site, four specie of snails were previously recorded namely *Gyraulus ehrembergi*, *Lymnaea lagotis*, *L. truncatula* and *Physa acuta* (Abdullah, 2002).

In Sufaia site, the snails were more diverse and abundant than other sites; *Physella acuta* (29.38%), *R. auricularia* (33.41%), *R. euphratica* (42.79%), *Radix* sp. (49.44%) and *G. huwaizahensis* (49.55%). The vegetation types and abundance have a great role in the distribution of freshwater snail species (Brogan III and Relyea, 2015).

All of the snails present in the study were found in habitats with both clear ground/rocky bottoms, but also in habitats with mud covering the bottom, this result agree with Lydig (2009) argued the importance of the substratum in the water bodies. Distributed of various species of snails due to the biophysiological differences among these species (Al-Salman et al., 2019). In the present study, snail population density in the pond was highest, this could be attributed to the fact that favorable conditions such as presence of organic matter content and high concentrations of electrolytes abound in pond water (Njoku-Tony, 2011).

4. CONCLUSIONS

We conclude that six species of freshwater snails (*Physella acuta*, *Radix auricularia*, *Radix euphratica*, *Radix* sp., *Melanopsis praemorsa* and *Gyraulus huwaizahensis*), were collected from four sites (Qandil, Kawergosk, Khabat, and Sufaia) on Greater Zab River. All species (except *Physella acuta*) recorded for the first time in Greater Zab River (Kurdistan Region)/Iraq.

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