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Study of Aquatic Gastropods (Mollusca) in Shatt Al-Arab River, Iraq.

Khaled Kh. Al-Khafaji*, Rafid M. Karim and Nada M. Al-Baghdadi
Marine Biology Department, Marine Science Centre, University of Basrah, Iraq.
***Corresponding Author: khaled.saleh@uobasrah.edu.iq**

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ABSTRACT

The present study was conducted to determine the diversity and density of aquatic Gastropoda community, and study some factors associated with water quality in Shatt al-Arab River; namely, water temperature, salinity, pH and dissolved oxygen. Samples of aquatic Gastropoda and water were collected monthly from three study sites along Shatt Al- Arab River in Basrah Province, during the period from January to December 2019. The highest species diversity of Aquatic Gastropod snails were found in Al-Qurna site (site 1) (10 species), while in Al-Garmat Ali site (site 2) (9 species) and in Abu Al-Khasib site (site 3), 5 species were found. A total of 12239 individuals of the three sites were collected during the study period. The higher annual density was recorded in aquatic Gastropoda snails *B. bengalensis* (Lamarck, 1822) with 5333, 1800 and 875 Individual/m² in the three sites, respectively while the other aquatic Gastropoda species together recorded a density of 1691, 1313 and 1227 Ind./m² in the three sites, respectively. The monthly densities of *Bellamya bengalensis* varied from 0 Ind./m^2 in January, October, November and December 2016 at Abu al-Khasib site to 966.0 Ind./m^2 in June 2016 at Al-Qurna site. Statistical analysis showed significant differences of dissolved oxygen and salinity between the first and the third sites. The temperature correlated positively with the mean of pH and salinity, and negatively with the number of the recorded species and the total densities of the aquatic Gastropoda species. In addition, salinity correlated positively with the mean density of Gastropods. On the other hand, the total number of the recorded species correlated positively with the total densities of aquatic Gastropoda species.

INTRODUCTION

Shatt al-Arab River is a link between the largest rivers of Mesopotamia (i.e. Tigris, Euphrates, and Karun rivers). The confluence of the Tigris and the Euphrates rivers was at the city of Qurna (previously) on the Iraqi side and then runs south-eastwards for a distance of 204 km to its mouth in the Arabian Gulf, which is the real distance during the lowest water level at low tide. Hence, the waters of the Tigris, flowed into the Arabian Gulf. (**Al-Mahmood and Mahmood, 2019).**

Benthic invertebrates are communities of Endemic individuals that move very slowly in a specific area of the river or lake, along their life. Since the numbers of those

communities affect the hydrological properties of the water quality in which they live and hence can change the numbers of benthic invertebrates, so the number the taxonomic units of benthic invertebrates in a site and the number of individuals can give useful information about the hydrology and the water quality of the environment **(Strong *et al.*, 2008)**.

Gastropoda is one of the major components of benthic macroinvertebrates in coastal areas that is known to have a crucial position in the food chain **(Strong *et al.*, 2008)**. It is a considerable food source for many waterbirds, some small carnivores and fish **(Hann *et al.*, 2001; Johnson, 2009 and Sitnikova *et al.*, 2010)**, Moreover, they are intermediate predictors of many species of parasites that infect humans and animals.

Comment [I1]: Rearrange the citations and the data attached chronologically.

The aquatic environment plays a radical role in the distribution and installation of communities of living organisms represented by fish and other aquatic organisms **(Johnson, 2009)**.

Most of the freshwater gastropods are micro-herbivorous and/or micro-omnivorous grazers feeding on bacterial films, algae and diatoms **(Sitnikova *et al.*, 2010)**. They inhabit a variety of habitats like rocky bottoms, soft substrate of ponds, and aquatic plants **(Johnson, 2009)**. Numbers of aquatic snails were much higher on aquatic plants than in sediments or other substratum **(Hann *et al.*, 2001; Qazar, 2009; Zêbek and Szymañska, 2014**). The leaves of aquatic plant provide a good substratum for laying eggs, and offer a shelter from predators **(de Nie, 1987)**. Besides, they protect snails from bright sunlight, high temperature, enhance oxygen levels and reduce the current velocity **(Van Schayck, 1985)**.

The various physico-chemical factors like temperature, turbidity, pH, dissolved oxygen, free carbon dioxide etc., the aquatic vegetation, and substratum have definite interrelated direct or indirect effects on snails and its habitat **(Saha *et al.*, 2017)**. Notably, Basrah province abounds with rivers, branches, canals, ponds. Moreover, cultivable low lands offer a good habitat for viviparid and other gastropods. In Iraq, some authors **(Salman and Nassar, 2013; Almamoori *et al.*, 2014; Qazar, 2016)** studied the diversity, occurrence, seasonal variation and population ecology of *B.bengalensis* and some of freshwater gastropod snails in some natural and artificial freshwater bodies in the middle and southern parts of Iraq. Nevertheless, there is a general lack of information on gastropod species. Recently, several studies by Iraqi authors to study the diversity, ecology occurrence of snail species and some ecological notes of Gastropods related to some waterbodies in the southern area of Iraq e.g.: **Plaziat and Younis, (2005); Naser *et al.*, (2008); Mohammad, (2014); Qazar, (2016); Mirza and Nashaat, (2019).**

This study aimed to determine the diversity and density of freshwater gastropod snails and analyze the information conisdering the impact of some factors on the environment of Shatt al-Arab river in Al- Basrah province, south of Iraq during a period from January to December, 2016.

MATERIALS AND METHODS

1. Collection of samples

The samples of gastropod snails were collected monthly using a quadrat (25 X 25 cm) from three water bodies (three branches connected to Shatt al- Arab river) in Basrah city, southern Iraq (Fig. 1), during the period from January to December 2016. The first site was a branch connected to Shatt al- Arab river near Al-Qurna city (30° 31′ 32.39″N, 47° 50′ 33.43″ E). The second site was a branch connected to Shatt al-Arab river in Garmat Ali city (30°34'46.96"N, 47°46'27.37"E), and the third site in Abu al-Khasib region (30° 27′ 49.88″ N, 48° 00′ 30.89″E) opposite to one of the branches of Shatt al-Arab in Abu al-Khasib city. For the identification and abundance of Gastropoda species, different sizes of live specimens of Gastropoda species were collected by hand. All specimens were brought to the laboratory and kept in the field in alcohol 70%.

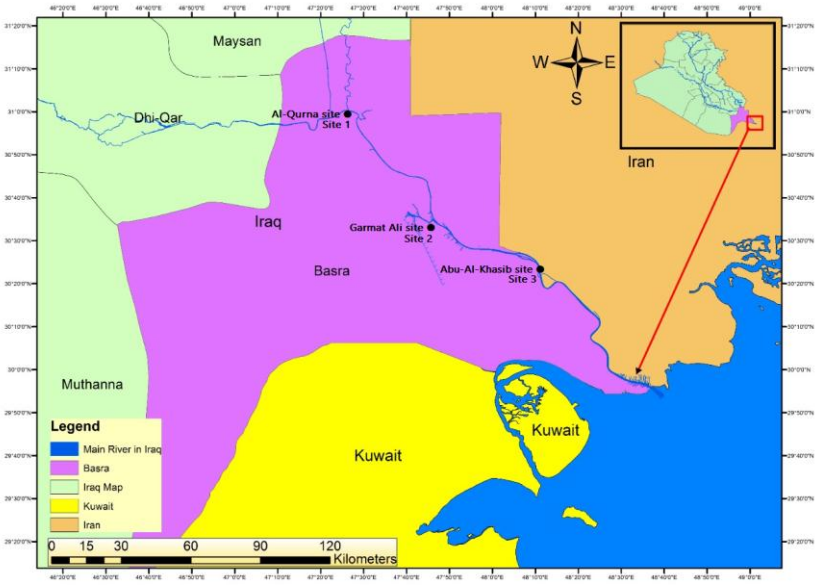

Fig. 1. A Map of Shatt al-Arab River in Al-Basrah Province with Spotted Study Sites: **Site 1**: in Al- Qurna , **Site 2**: in Garmat Ali, **Site 3:** in Abu –Al-khasib.

Map source: Dr. Ayman Abdel Latiq- Teaching in Department of Marine Geology - Marine Sciences Centre.

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Note: Samples of Gastropoda species and water were collected during the lowest tide, which may cause a decrease in numerical measurements of some environmental factors such as salinity, especially at Site 3 due to its proximity to the marine waters of the Gulf and its exposure to great influence during the highest tide.

2. Identification and Water Quality Measurement References

The number of snails and individuals were counted in three sites. Snails species were classified following the method of **Najim (1959)**, **Ahmed (1975)** and **Frandsen (1983)** using dissecting microscope. The previous method was updated according to **WoRMS (2016)**. Plants were classified according to **Al-Mayah and Hameem (1991)**.

The shell length, width and aperture width, aperture length of the snail *B. bengalensis* were measured by using Digital Vernier Caliper (Fig. 2). While the weight of the animals was measured by using Metler electric balance. Some of the physical and chemical parameters of the water in addition to water temperature were recorded using thermometer during each sampling. Salinity and pH measurements were performed by YSI 556 MPS.

The statistical analysis of the ANOVA test was carried out between the study sites and with regard to the aquatic environment factors as well as the intensities and number of recorded species. Correlation between the registered environment factors and the number of species and the monthly variation of densities were also used. All data were analyzed using the Spss statistical software number 18.

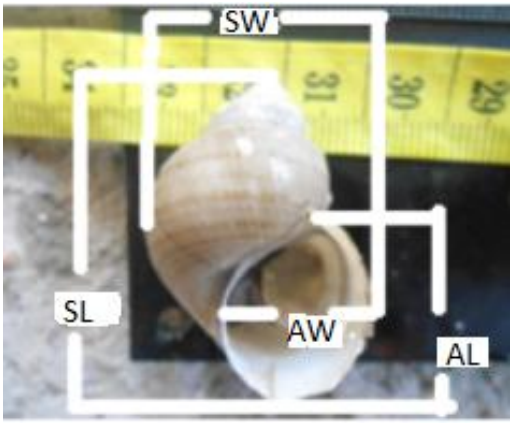

Fig. 2. The Shell Length (SL), Shell Width (SW), Aperture Length (AL) and Width (AW) of the Snail *B. bengalensis*.

RESULTS AND DISCUSSION

The values of dissolved oxygen, salinity, pH, as well as water temperature were measured on site, during the period from January to December 2016 in some water bodies in Basrah city (three branches connected to Shatt al-Arab river). Values of water temperature at the three sites were very close to each other, ranging between 12 ^{0}C at site 1 in January 2016 to 33 ^{0}C at site 3 in August 2017. Salinity changed from 1.4 psu at site 1 in February 2016 to 6.4 psu at site 3 in August 2016. While the pH values varied from 7.0–8.4 at site 3 and site 1 in January and October 2016, respectively. Dissolved oxygen fluctuated from 4.6 mg/l at site 3 in August 2016 to 9.6mg/l at site 1 in February 2016 (Table 1).

Table. 1. Some Physical and Chemical Parameters in Some Water Bodies (three branches connected to Shatt al- Arab river) during Study Period in 2016.

Dates	W.T.(^{0}C)			Sal (psu)			D.O (mg/L)			pH		
	Site 1	Site 2	Site 3	Site 1	Site 2	Site 3	Site 1	Site 2	Site 3	Site 1	Site 2	Site 3
Jan. 2016	12	14	15	1.6	2.0	2.4	8.4	7.7	6.8	7.3	7.2	7.0
Feb.	14	15	16	1.4	2.2	2.6	9.6	7.2	6.5	7.6	7.2	7.3
March	18	19	22	1.8	2.4	2.7	8.8	7.4	6.5	7.6	7.4	7.4
April	22	24	23	1.9	2.5	2.5	6.5	6.8	6.0	7.8	7.6	7.1
May	25	27	27	2.1	2.8	2.8	6.2	6.0	5.5	7.9	7.5	7.2
June	29	30	30	2.3	2.9	3.2	6.0	5.6	5.0	7.5	7.3	7.1
July	30	31	32	2.5	3.4	3.8	6.4	5.4	4.8	7.7	7.4	7.6
Aug.	31	32	33	2.5	3.6	6.4	6.0	5.7	4.6	7.8	7.5	7.5
Sep.	29	28	30	2.7	3.3	5.6	6.9	6.5	4.8	8.2	7.8	7.2
Oct.	26	27	28	2.4	3.2	4.5	7.2	6.8	5.4	8.4	7.6	7.6
Nov.	24	26	26	2.6	3.0	3.4	7.9	6.9	6.2	7.7	7.3	7.4
Dec.	18	19	20	2.0	2.5	3.0	8.2	7.2	6.4	7.5	7.2	7.1

1. Diversity and density

Results of the diversity and distribution of 11 aquatic gastropod species of snails in the three sites were observed during the study period.

The highest species richness of aquatic gastropod snails was found in the Al-Qurna site (Site 1) (10 species) and Garmat Ali site (Site 2) (9 species). In the Abu al-Khasib site (Site 3), only 5 species were found (Table 2).

Table 2. Occurrence of Aquatic Gastropoda snail species Collected from Three Sites during 2016.

Snail species	Family	Site 1	Site 2	Site 3
Melanoides tuberculata (Műller, 1774)	Thiaridae	+	+	+
Melanopsis nodosa (Férussac, 1874)	Melanopsidae	+	+	-
M. costata (Oliver, 1804)	Melanopsidae	+	-	-
M. subtingitana (Annandale, 1918)	Melanopsidae	+	-	-
Bellamya bengalensis (Lamark, 1822)	Viviparidae	+	+	+
Bithynia badiella (Kűster, 1852)	Bithyniidae	+	+	-
Gyraulus convexiusculus (Müller, 1774)	Planorbidae	+	+	-
Lymnaea.(Radix)auricularia (Linnaeus, 1758)	Lymnaeidae	+	+	+
Physa acuta (Draparnaud, 1805)	Physidae	+	+	+
Theodoxus jordani (Sowerby, 1832)	Neritidae	+	+	-
Neritina violacea (Gemlin, 1771)	Neritidae	-	+	+
Total	**9**	**9**	**10**	**5**

As shown in Table (3), the *B. bengalensis* was found to be the most abundant aquatic Gastropoda snail in Al-Qurna city (St.1). Its density varied from 966 Ind./m^2 in June 2016

to 236 Ind./m^2 in December 2017. While in Garmat Ali canal (St.2), its density varied from 261 Ind./m^2 in May 2016 to 102 Ind./m^2 in January 2016. Remarkably, in Abu al-Khasib city (St. 3), its abundance varied from 124 ind./m^2 in June to 0 Ind./m^2 in January, February, November and December 2016.

The snail lives in rather wide range of water temperatures during summer when the water temperature rises above 30 °C. Meanwhile, the banks of intertidal zone of Shatt al-Arab river and waterbodies are connected, which have relatively range of temperatures of 12-33 °C. At the end of autumn and in winter, when the water temperature falls down sharply, the abundance and occurrence of snails retreats below in the intertidal zone to find their preferable temperatures.

Table (3& 4) show that *B. bengalensis* was found in higher density and body sizes in the (Site1) in Al-Qurna city, northern parts of the Shatt al-Arab river, while in the extreme south part of the Shatt al-Arab river, the specimens of this species were dominant in lower density. This result may directly correlate with high water salinity or may rather be related to the effect of other factors in the southern areas compared to the northern parts, which is the more preferable habitat. This is almost in accordance with the study of **Al-Waaly *et al.* (2014)**, who found that *B. bengalensis* is present mainly in stagnant water and low saline water resources such as rivers, streams, lakes, ponds, wetlands, marshes, ditches, paddy fields, etc., and added that it can tolerate a maximum level of salinity of 0.2mg/l. Furthermore, *B. bengalensis* is widely distributed throughout southern Asia and assessed as least concern from the conservation point of view (**Ramakrishna and Dey, 2007; Budha *et al.*, 2010**). Considerably, it is known as a common and abundant species found in high numbers in all kinds of freshwater bodies, mainly stagnant water and low saline water resources.

A total of 12239 individuals of the three sites were collected during the study period. The higher annual density was recorded by aquatic Gastropoda snails *B. bengalensis* with 5333, 1800 and 875ind/m² in three sites, respectively. While other aquatic Gastropoda species together recorded an annual density of 1691, 1313 and 1227ind/m² in the three sites, respectively (Table 3& Fig. 3).

The total annual density of the *B. bengalensis* snails in Site 1 was 5333, which is due to the fact that it is an environment suitable for the presence of this species of snails **(Al-Waaly *et al.*, 2014).** The density recorded for this species of snails at the Site 2 may be attributed to being an astounding source of drainage of agricultural land rich in fertilizers and pesticides, leading to the nutritional enrichment of phytoplankton and algae **(Kalyoncu, 2009; Agudo-Padrón, 2011)**. In addition, the increase in this species of snail often appears in areas with a slow and calm current **(de Nie, 1987; Qazar, 2016)** The few densities recorded at the water of Site 3 may be due to the increase of the industrial waste of electric plants and boats in water, which is an environment unsuitable for snails and which apply to the status of pollution **(Budha *et al.*, 2010)**.

Table 3. Mean Monthly Densities (ind./m²) of the Snail *B. bengalensis* from Three Branches Connected to Shatt Al- Arab River, during 2016.

Species	Sites	Jan.2016	Feb.	March	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
B. bengalensis	Site. 1	263	276	345	336	795	966	642	436	427	356	255	236	5333
	Site. 2	102	122	154	188	261	156	72	142	130	134	117	122	1800
	Site. 3	-	-	86	89	118	124	122	120	118	98	-	-	875

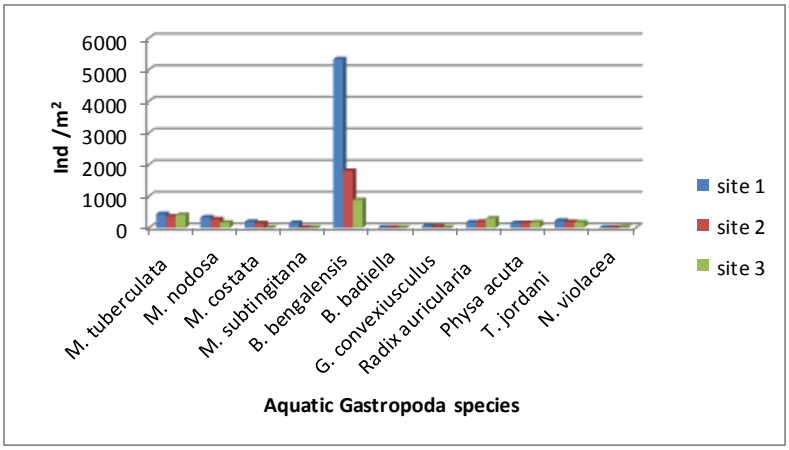

Fig. 3. Annual Density (Ind./m^2) of Aquatic Gastropoda Species in Three Sites from Three Branches Connected to Shatt Al- Arab River, during 2016.

Table 4. Body Measurements of the Snail *B. bengalensis* in Three Sites from Three Branches Connected to Shatt Al- Arab River, during 2016.

Species	Sites	Shell Length	Shell Width	Aperture length	Aperture width
B. bengalensis	Site.1	28.5(16.3- 48.6)±8.2	23.1(20.2-26.1)± 2.9	16.8(14.2-19.8)± 2.3	13.5(11.4-15.7)± 1.8
	Site.2	24.4(11.4-36.5)± 7.6	18.6(16.5-21.7)± 2.3	16.8(11.6-17.8)± 2.0	10.3(8.5-13.9)± 1.5
	Site.3	18.8(7.5-28.4)± 6.2	16.3(14.2-20.5)± 2.0	13.6(10.5-15.9)± 1.8	13.5(7.9-12.5)± 1.4

2. Statistical analysis

The statistical analysis showed a significant difference in the dissolved oxygen and salinity between the first and the third sites, while no significant difference was recorded between the study sites with respect to other studied factors. As for the correlation coefficient analysis, a positive correlation was found (at a probability level of 0.01) between the temperature and the pH of the study sites (r = 0.706). Remarkedly, the temperature was positively correlated (at a probability level of 0.05) with salinity (r = 0.408). On the other hand, a positive correlation was found (at a probability level of 0.05) between the salinity and the density of the aquatic Gastropoda species (r = 0.382). In addition, the temperature was significantly negatively correlated (at a probability level of

0.05) with both the number of species recorded (r = -0.396) and the density of the aquatic Gastropoda species.

It was noticed that, the values of water temperature ranged from 12 to 33 ˚C during the study period. Low water temperature was associated to the very low occurrence of aquatic plants and gastropods. It is worthmentioning that, seasonal changes in water temperatures had a great effect on snail numbers. Water temperatures were very low in winter, reaching a zero˚C in some sites due to their association with macrophytes which disappear in most of the study area in winter. The reproduction of snails reduces significantly as the predation by omnivorous fish increases, recording a low density of macrophytes **(Van Schayck, 1985)**.

CONCLUSION

The present investigation on the abundance and occurrence of *B. bengalensis* and other aquatic Gastropoda in three branches connected to Shatt al- Arab river enriched data on the habitat of those water bodies. Although *B. bengalensis* is herbivorous and completely aquatic, the snail occupies the permanent waterbodies with a slow and calm current. The influence of each conditioning on the habitats appeared to be interrelated. In addition, the abundance of *B. bengalensis* showed negative correlation with the temperature and salinity.

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