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DIVERSITY AND DENSITY OF MOLLUSCA (GASTROPODA AND BIVALVIA) POPULATION IN THE EUPHRATES RIVER AT AL-NASIRIYAH, SOUTHERN IRAQ

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Diversity and Density of Mollusca (Gastropoda and Bivalvia) Population in the Euphrates River at Al-Nasiriyah, Southern Iraq. Al-Yacoub, Gh. A. A., Najim, Sh. A., Al-Khazali, A. M. — The current study was conducted in one of the most important water sources in Iraq, the Euphrates River to evaluate the diversity and density of Gastropoda and Bivalvia by using appropriate biodiversity indices. The samples were taken monthly from the river sediments, during the period from 1 July 2018 to 1 June 2019 from 3 stations, the distance between the first and second stations is 5 km and the second and third station is 7 km. The results showed the presence of 9 species, 7 of them belong to the Gastropoda and 2 belong to the Bivalvia. The total number of Mollusca was 2675 ind/m^2. The species *Melanoides tuberculata* (Muller, 1774) showed more relative abundance in the Euphrates River during the study period. The highest value for richness was recorded in March at station 3, while the Shannon Wiener diversity index, the results showed that the highest values were in April and May for all sites, and the highest value for eveness was recorded in January at Station 3, while the highest value for dominance was during October at station 3. Moreover, the current study included the monthly measurement of five environmental factors: water temperature, pH, salinity, dissolved oxygen, and organic matter.
Key words: diversity, gastropoda, Bivalvia, Euphrates River, Iraq.

Introduction

The biodiversity of ecological communities can affect the performance of ecosystem processes (Hooper et al., 2005). Freshwater ecosystems are rich and provide habitats for about 10 % of all known living species (Winemiller, 2018).

Mollusca is one of the most numerous invertebrates, thus are the most diverse after arthropods, they are found in various terrestrial and aquatic habitats, and freshwater Gastropods are founded in all continents except Antarctica and in innearly all aquatic environments including rivers, streams, lakes and swamps (Strong and Gargominy, 2008).

Mollusca including Gastropods and Bivalvia are extremely important communities of many ecological communities, they have proven to be of benefit in the nutrient cycle by providing food for many animals and grazing on vast amounts of algae and detritus (Agudo-Padrón, 2011), and also extremely beneficial from economic and medical terms (Wosu, 2003), it also plays an important role in public and veterinary health (Supian and Ikhwanuddin, 2002).

The study of the classification and ecology of the Iraqi freshwater snails was few, including (Plaziat and Younis, 2005; Naser et al., 2008; Alzurfi et al., 2019). The Euphrates River is passing through eight provinces from the west, centre, and south of Iraq, the river water are fresh with a steady increase in salinity to the south. Some studies on Euphrates river or its branches, which focused on studying Mollusca including (Al-Fanharawi and Ibrahim, 2014; Salman and Nassar, 2014; Ghulam, 2019).

The aim of the current study is to provide a database for those interested in studying Mollusca by knowing their diversity and densities in the study area.

Material and methods

The Euphrates River is one of the most important water sources in Iraq, it reaches a length of 1160 km in Iraqi lands (Al-Ansari, 2019). The study area included three sites on the Euphrates River in Al-Nasiriyah City, at 31°02′16.8″ N 46°10′45.8″ E, 31°03′04.8″ N 46°14′05.3″ E and 31°01′37.1″ N 46°18′01.3″ E, respectively, which is located in the centre of Thi Qar province, southern Iraq. The distance between the first and second stations is 5 km and the second and third stations is 7 km.

The specimens of Mollusca were collected monthly during the period from July 2018 to June 2019 from three stations on the Euphrates River in Al-Nasiriyah City, Thi Qar province, southern Iraq (fig. 1). Gastropods and bivalvia individuals were obtained by metal quadrate with dimensions (50 cm × 50 cm) five times from shallow water region. Soft substratum and plant material on specimens were removed by washing with the river water and were kept in plastic containers and placed in a cooler box until it reaches the laboratory. Ecological factors such as water temperature, pH, salinity and dissolved oxygen are directly measured using multi meter, While the organic matter in the sediments was measured by total organic carbon. Specimens of Mollusca were preserved in 70 % alcohol, after which they were diagnosed according to the keys of Ahmed (1975) and Frandsen (1983). The density of each species was calculated within repeaters for each station in individual/m^2. The ecological factors were measured monthly.

The relative abundance index calculated depending on formula contained in Odum (1970).

Several indicators have been used to assess the biological diversity of Mollusca at the site, including:

Shannon-Weiner Index. This index was calculated according to the formula: $H' = -\Sigma$ pi ln pi by Shannon and Weaver (1949).

Richness Index: it is the number of species present in a specific sample by Margalef (1968).

Evenness Index: This index is calculated using the following formula: E = H/Hmax = H/lns by Pielou (1966).

Statistical analysis of correlation was done by using IPM SPSS statistic program version 20.

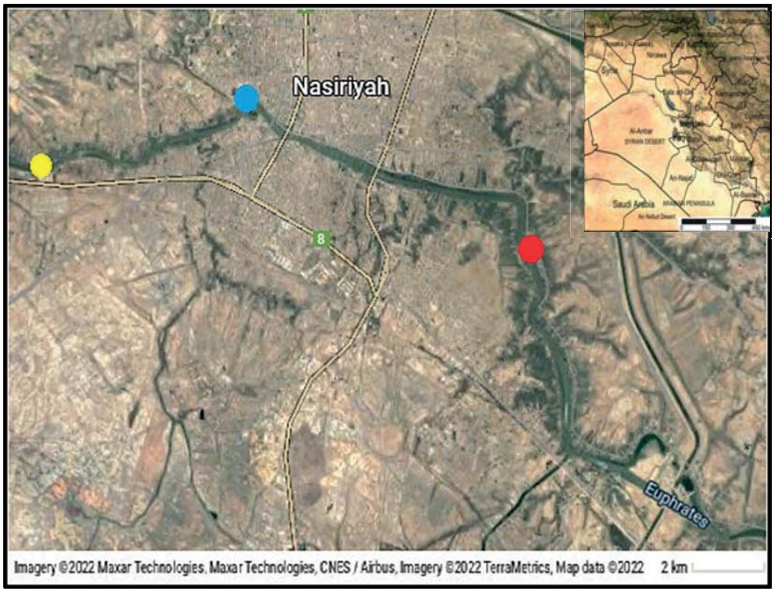

Fig. 1. Shows the three study stations on the Euphrates River within Al-Nasiriyahcity. Yelow circle: station 1; blue circle: station 2; red cicle: station 3.

Results

The results of the water temperature values in Euphrates river was between 33 °C at station 3 during July, and 17 °C at station 1 during December (fig. 2).

The values of the pH ranged between the highest value of 8.5 in St. 1 and St. 2 during October, while the lowest value reached 7.1 in St. 3 during July, September and May (fig. 3).

The highest value of salinity was recorded during August, reached 3.5 ppt in St. 2, while the lowest value was in October at St. 2 reached 1.9 ppt (fig. 4).

The dissolved oxygen ranged between the highest value of 9.6 mg/L in St. 3 during January and the lowest value of 4.3 mg / L in St. 1 during July (fig. 5).

The organic matter content in Euphrates river sediment was between 2.2 mg/L as the highest recorded at St. 3 during September and December, and 1 mg/ L at its lowest at St 2 during December (fig. 6).

In current study, a total 2675 specimens of Mollusca belonging to 9 species, 7 of them belonging to 6 families and 6 genera of gastropods, and two species with two genera belonging to two families of Bivalvia were recorded during the study period (table 1). The total density of Mollusca species in ind/m^2 and number of occurrences of all species during the study period were given in (table 2). The results show that the species *M. tuberculata* recorded the high density 1615 ind/m^2, while the lowest density was recorded to species *Unio tigridis* Bourguignat, 1852 at 15 ind/m^2 the study period.

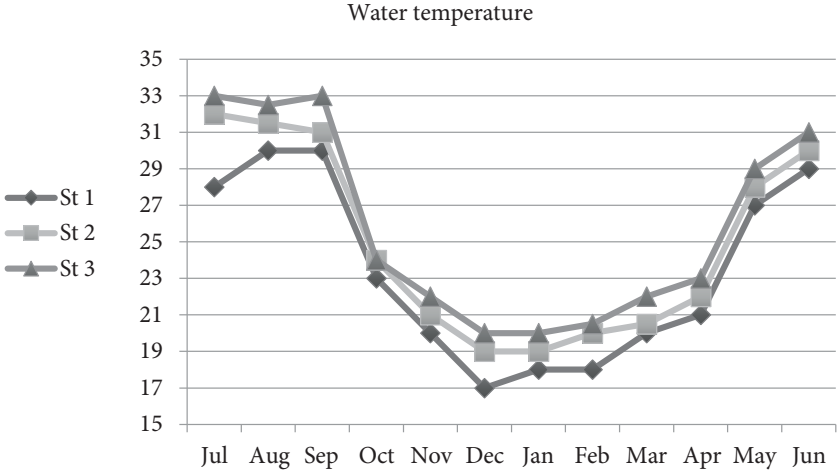

Fig. 2. Monthly variations in water temperature values at Euphrates River during period study.

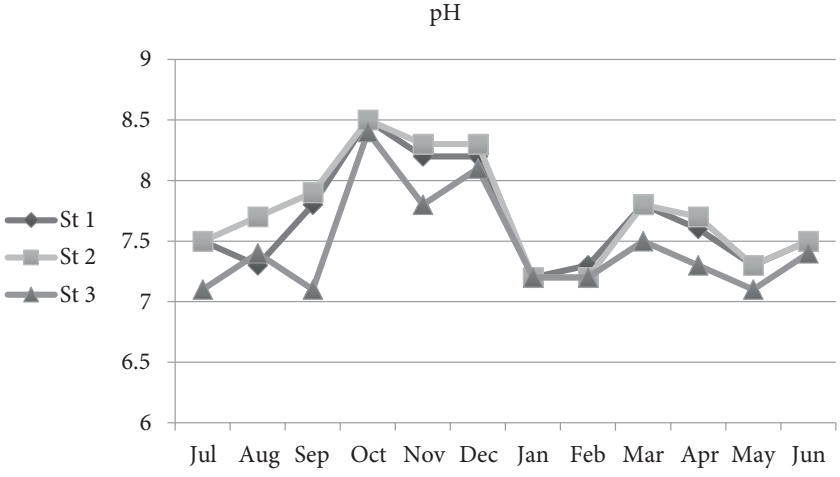

Fig. 3. Monthly variations in pH values at Euphrates River during period study.

Table 1. Taxonomic position of Mollusca species in study stations from July 2018 to June 2019 in the Euphrates River

Phylum	Class	Family	Genus	Species
Mollusca	Gastropoda	Melanopsidae	*Melanopsis*	*costata*
				nodosa
		Thiaridae	*Melanoides*	*tuberculata*
		Lymnaeidae	*Lymnaea*	*auricularia*
		Physidae	*Physa*	*acuta*
		Viviparidae	*Bellamya*	*bengalensis*
		Nreitidae	*Theodoxus*	*jordani*
	Bivalvia	Corbiculidae	*Corbicula*	*fluminea*
		Unioidae	*Unio*	*tigridis*

Table 2. The annual density of Mollusca of ind/m² (above) and number of occurrence (lower) of Mollusca species in study stations from July 2018 to June 2019 in the Euphrates River

Species	Stations			
	1	2	3	Total
Melanoides tuberculata	680	421	514	1615
	12	12	12	
Melanopsis costata	20	10	6	36
	8	6	6	
Melanopsis nodosa	126	109	80	315
	12	12	11	
Lymnaea auricularia	50	37	20	107
	11	9	11	
Physa acuta	13	8	8	29
	8	6	8	
Bellamya bengalensis	54	54	47	155
	11	12	9	
Theodoxus jordani	38	12	59	109
	11	7	6	
Corbicula fluminea	249	27	18	294
	10	9	7	
Unio tigridis	3	10	2	15
	2	5	1	
Total station	1233	688	754	
Total stations	2675			

Table 3. Correlation values of density with parameters

Parameters		Temp.	pH	Salinity	DO	OM
Densities	r	0.370	– 0.676	– 0.683	0.168	0.561
	p	0.118	0.008	0.007	0.301	0.029

The results of statistical analysis (table 3) shows density was positively correlated with temperature (r = 0.370, p = 0.118), dissolved oxygen show positive but not significant correlation with density (r = 0.168, p = 0.301), the organic matter show positive significant correlation with density (r = 0.561, p = 0.029), while both pH value and salinity showed negative correlation with density (r = -0.676, p = 0.008; r = -0.683, p = 0.007) respectively, in all stations.

The relative abundance of Mollusca species in study stations from July 2018 to June 2019 in Euphrates River:

The high value of relative abundance was 68 % at St. 3, 61 % at St. 2 and 55 % at St. 1

for *Melanoides tuberculata* and a lowest value was 0 in st. 1 and st. 2 for *Unio tigridis* (fig. 7, 8 and 9).

The current study showed that the highest abundance of mollusca was recorded in October 35 %, followed by each of the months of September and August with 18 % and 16 %

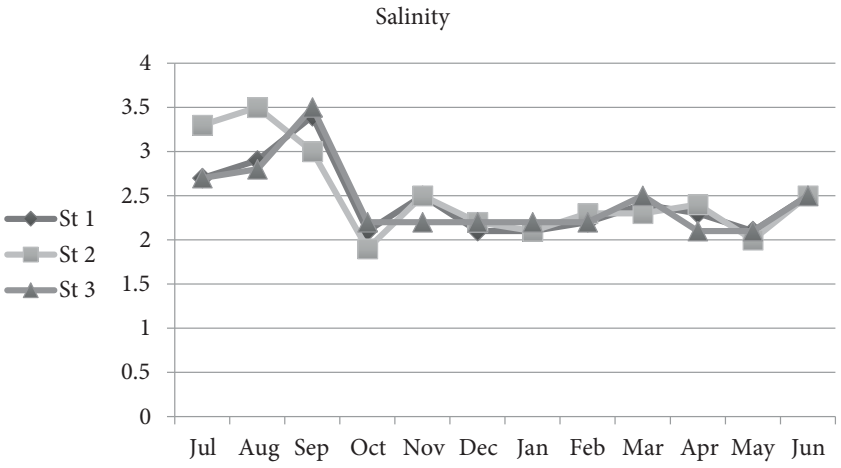

Fig. 4. Monthly variations in salinity values at Euphrates River during period study.

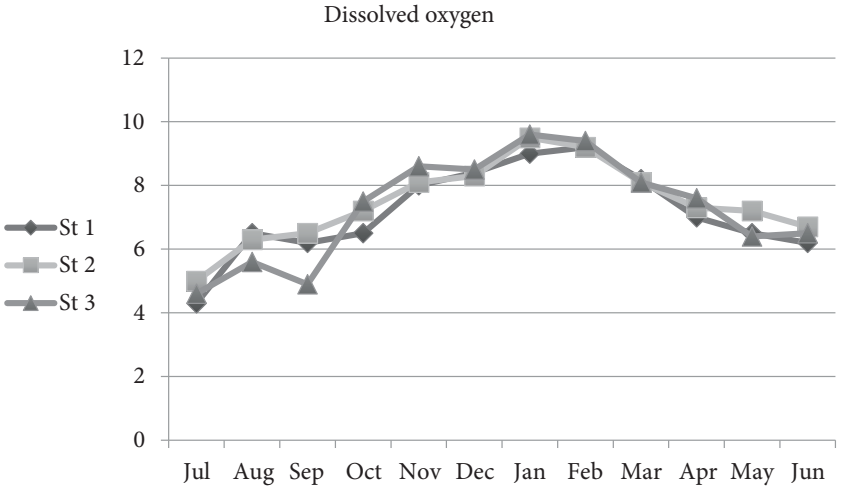

Fig. 5. Monthly variations in dissolved oxygen values at Euphrates River during period study.

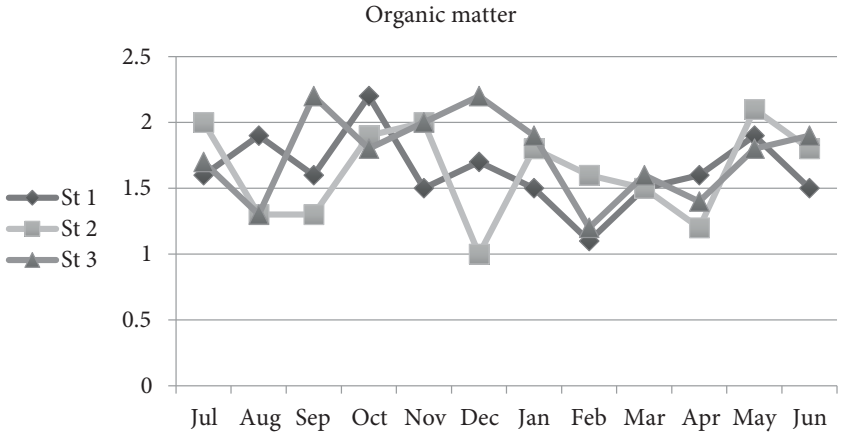

Fig. 6. Monthly variations in organic matter values at Euphrates River during period study.

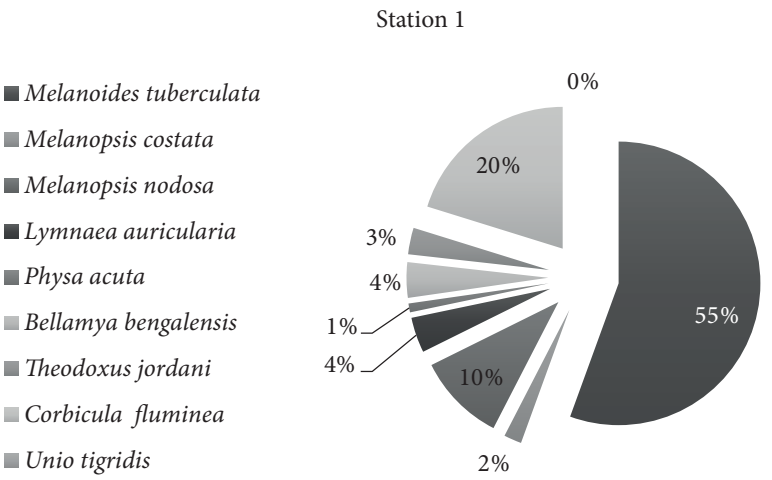

Fig. 7. The relative abundance of mollusca species in Station 1 at the Euphrates River during the study period.

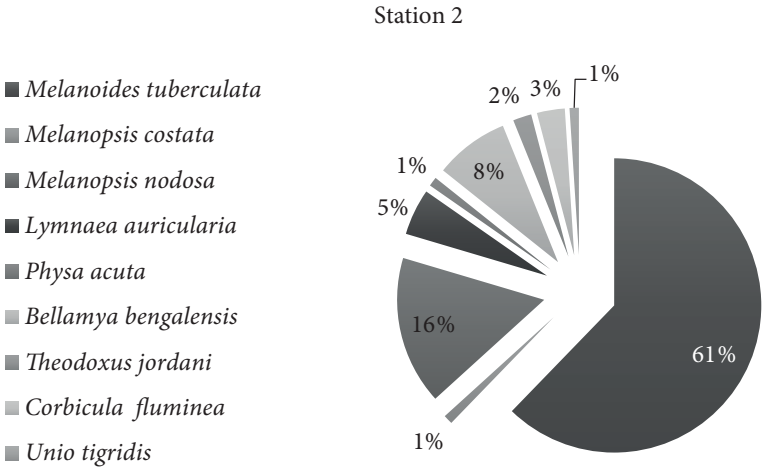

Fig. 8. The relative abundance of mollusca species in Station 2 at the Euphrates River during the study period.

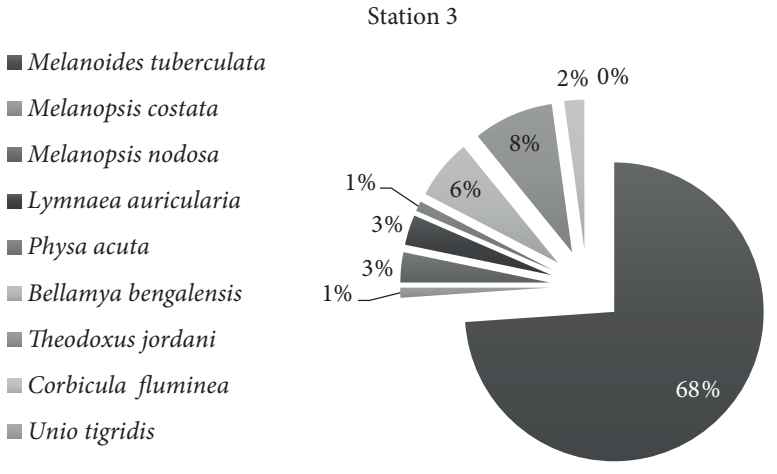

Fig. 9. The relative abundance of mollusca species in Station 3 at the Euphrates River during the study period.

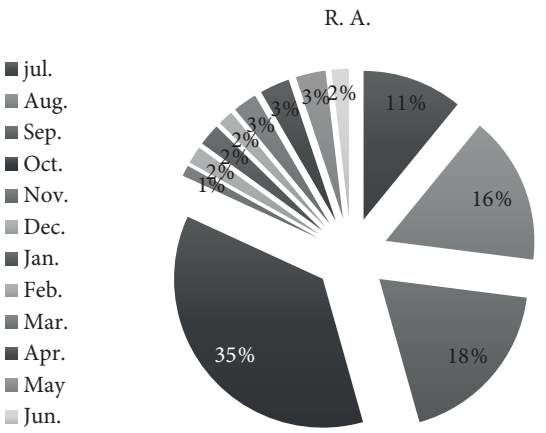

Fig. 10. Totally relative abundance of Mollusca species from July 2018 to June 2019 in Euphrates River.

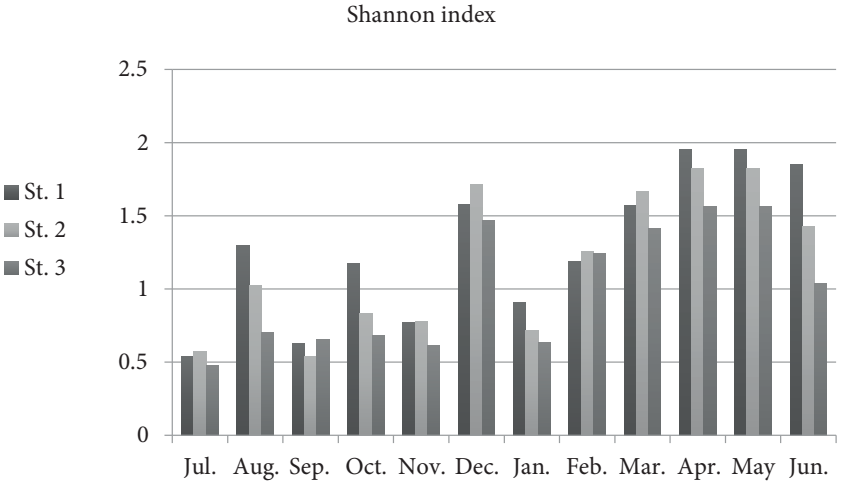

Fig. 11. Shannon index values of Mollusca species from July 2018 to June 2019 in the study stations at the Euphrates River.

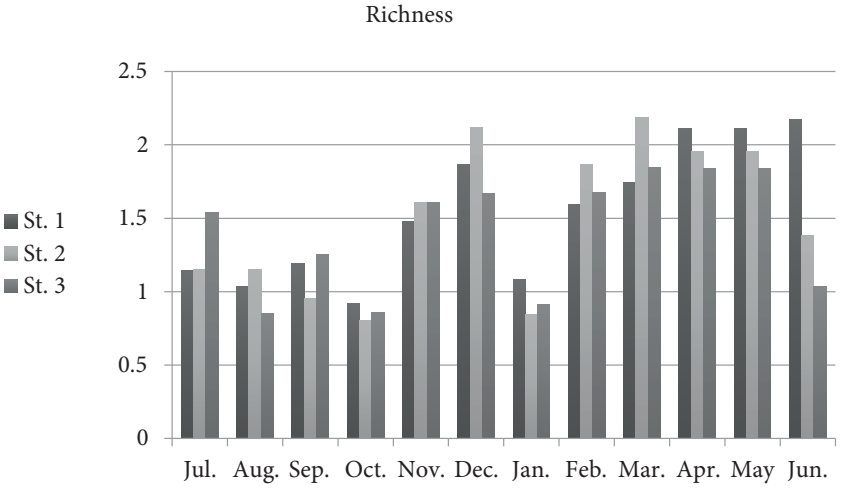

Fig. 12. Richness values of Mollusca species from July 2018 to June 2019 in the study stations at the Euphrates River.

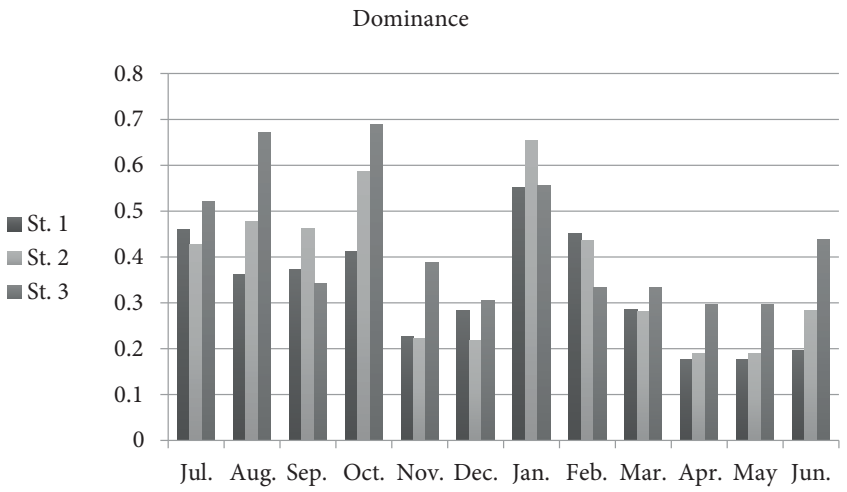

Fig. 13. Dominance values of Mollusca species from July 2018 to June 2019 in the study stations at the Euphrates River.

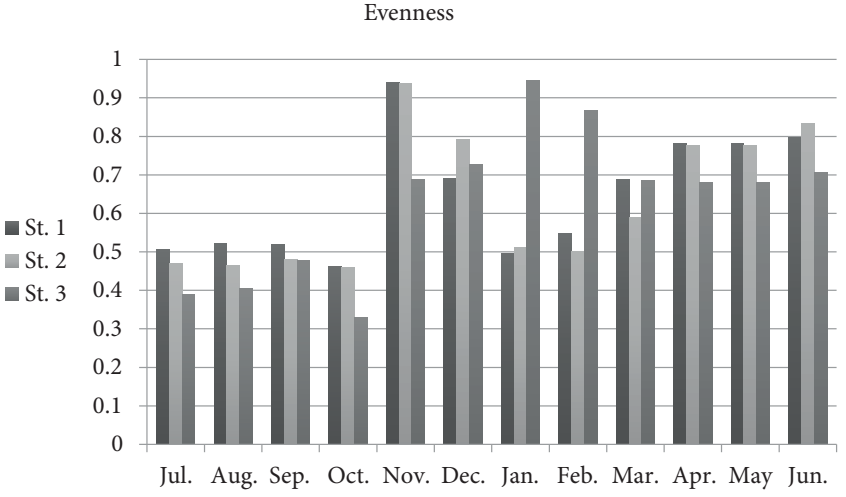

Fig. 14. Evenness values of Mollusca species from July 2018 to June 2019 in the study stations at the Euphrates River.

respectively, while the lowest relative abundance was recorded in November 1 % (fig. 10).

The results for indecies of diversity of mollusca at the Euphrates river in southern Iraq, showed that the Shannon index as in fig. 11, where the highest value was in April at St. 1 reached 1.95, and the lowest was 0.47 in Juyl at St. 3.

The richness index (Margalef) as show in fig. 12, the high value was 2.18 in March at St. 2 and the lowest value was 0.80 in October at St. 2.

According to fig. 13, the high value of adominance was 0.68 in October at St. 3, while the lowest value was 0.17 in April and May at St. 1.

Evenness index was as shown in fig. 14, the highest value was 0.94 in Jan at St. 3, while the lowest value was 0.3302 in October at St. 3.

Discussion

Some physico-chemical factors as temperature, pH and dissolved oxygen have direct or indirect effects on mollusca and its habitat (Saha et al., 2017).

The increase in water temperature leads to an increase in the chemical and biological reactions of water as well as a decrease in the solubility of gases (Sharma et al., 2013), and it also has a role in many vital activities of aquatic organisms (Stewart and Garcia, 2002), and the results of the current study showed a positive correlation between the values of water temperature and mollusca density, this result is consistent with the result of Al-Khafaji et al. (2021) in Shatt al-Arab when they found that snail density decreases in winter and at the end of autumn.

The pH is affected by weather and soil factors and directly affects the abundance and diversity of any aquatic environment (Peterson et al., 1987), the results of the current study showed a negative relationship between pH and the density of mollusca, and this result agreed with Alzurfi et al. (2019) in the Euphrates river at Najaf Province.

The results of the current study showed a negative relationship between mollusca density and salinity values, as Kefford and Nugegoda (2005) confirmed that mollusca density is negatively affected when salinity concentrations rise in fresh water, and this is consistent with the study of Al-Khazali (2012) and Mizhir et al. (2014). The results in the current study also showed a positive relationship between dissolved oxygen and mollusca density, stated Wetzel (2001) that dissolved oxygen in water is necessary for the metabolic processes of all aquatic organisms. Hashim and Al-Taee (2015) found that in the summer, the decrease in the concentration of dissolved oxygen leads to a decrease in the density of mollusca, except for the speceis *M. tuberculata*.

The organic matter content was the highest in the third station, because the river in this region passes through the agricultural lands that dump their organic residues into the river directly without treatment, and this result agreed with the study of Ali (2021) in the Euphrates river. The results of the current study showed that there is a positive correlation between organic matter and mollusca density, and this was confirmed by Mirza and Nashaat (2019) when they found that the highest value of the mollusca density was in January, and the highest values of the organic matter were in the winter months.

The density values varied according to the collection stations, as the highest density of mollusca was recorded 1233 ind/m^2 in St. 1 and the lowest density was 688 ind/m^2 in St. 2. The higher density of gastropods is more than that of bivalves, as the gastropods are characterized by a high ability to reproduce and spread and, while the appropriate conditions are available, it builds an integrated population more than other neighborhoods in the aquatic environment (Aho, 1978).

In the results of the current study, the high abundance was recorded in the autumn season during October, and the lowest values started with the winter months, and this was also confirmed by Akbar (2013) that the high values of mollusca were in the autumn season, as well Whitton (1975) when pointed out that the relative abundance of the mollusca shows high values during the hot months and attributed this to the fragile nature of the bottom and the richness of the sediments in organic matter and alluvial deposits that lead to the flourishing growth of the mollusca.

The values of the diversity index varied for the months, as the highest values of diversity were recorded for all stations during the spring and winter months, while the lowest values were recorded in some summer months, and this is consistent with study of Khalaf (2011), which recorded the highest value for the diversity of the mollusca in the Shatt Al-Arab River during December 0.92 and that attributed to the effect of environmental factors such as temperature and concentration of dissolved oxygen. The months in which the rains decrease are accompanied by a decrease in diversity (Watson and Omerod, 2004). Shannon index of diversity in the current study was less than 3 and this is in agreement with the study of Hashim and Al-Taee (2015) when they found values between 1.22–1.95, and Al-Saffar (2007) recorded diversity ranging from 0 to 2.083 in Abu Zirig marsh. While Sabtie (2009) recorded the values of the diversity index (0.194–1.083) in the other southern marshes

(Al-Hawizah, Al-Chibaysh and Al-Hammar) and the water source for these marshes is the waters of the Tigris and Euphrates.

The evenness index usually used as environmental indicator of the presence of disturbance and imbalance in the ecological habitats because it is considered an evidence of improvement of the environmental changes in the ecosystems (Park et al., 1999), where evenness refers to the opposite situation of dominance, and its values range between 0–1, as the lowest value of 0 represents the dominance of one species, while the value 1 indicates an equal distribution of species (Stiling, 1999). In current study the high value of evenness was recorded in January at station 3, because the number of individuals distributed on species equally.

Al-Qarooni (2005) was recorded only four species of Mollusca: *Lymnaea auricularia* (Linnaeus, 1758), *Physa acuta* (Draparnaud, 1805), *Bellamya bengalenis* (Lamarck, 1822) and *Gyrulus* Charpentier, 1837 in three southern marshes. While Akbar (2013) study in Al-Gharaf Canal was recorded 10 species of Mollusca. Akbar and Al-Ghezi (2014) in the Euphrates river at Nasiriyah city recorded the presence of 10 species, 3 of which belong to Bivalvia (*Corbicula fluminea* (Müller, 1774), *Pseudodontopsis euphruticus* (Bourguignat, 1852) and *U. tigridis*) and 7 to Gastropoda (*Melanopsis nodosa* A. Férussac, 1822, *Melanopsis costata* (Olivier, 1804), *Melanoides tuberculata*, *Bellamya bengalensis*, *Theodoxus jordani* (G.B.Sowerby I, 1836), *Lymnaea auricularia* and *Physa acuta*), this result was consistent with the current study, except *P. euphraticus* was not recorded. Mizhir et al. (2014) found in Shatt al-Kufa/ Euphrates river all the species that appeared in the current study except for *Physa acuta* and *Theodoxus jordani*. As for Salman and Nassar (2014), they recorded five species of gastropods, which are *Melanopsis costata*, *Melanopsis subtingitana* Annandale 1918, *Melanopsis nodosa*, *Melanoides tuberculata* and *Viviparus bengalensis* (Lamarck, 1822) in the Euphrates river at central Iraq. Hashim and Al-Taee (2015) recorded seven species of gastropods (*Melanopsis costata*, *Melanoides tuberculata*, *Cerithidea cingulate* (Gmelin, 1791), *Theodoxus jordani*, *Hydrobia ventrosa* (Montagu, 1803), *Lymnaea auricularia* and *Physa acuta*) and three species of bivalves (*Laevicardium flavum* (Linnaeus, 1758), *Corbicula fluminea* and *Unio tigridis*) in Al-Razzaza Lake in Karbala province.

Melanoides tuberculata, *Melanopsis* spp., *Bellamya bengalensis* and *Physa acuta* have a wide distribution in the central and southern regions of Iraq, while *Theodoxus jordani* is not very widespread (Al-Bdairi et al., 2014). *Bellamya bengalensis* is widespread in southern Asia (Ramakrishna and Dey, 2007). Glöer and Pešić (2012) mentioned *Melanopsis costata*, distributed in Asia Minor, Syria, Palestine, Iraq, and Iran.

Melanopsis spp. is widespread in all regions of Iraq (Al-Bassam and Hassan, 2006; Mohammad, 2014). Ramakrishna and Dey (2007) also confirmed that it is common in the Arabian Peninsula and Southeast Asia.

All species in the current study were recorded by Al-Bdairi et al. (2014) except for *Melanopsis buccinoidea* (Olivier, 1801) and *Gyraulus* sp., which were not recorded.

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