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Original Article

Fish diversity of the Euphrates River between Medina and Qurna cities, southern Iraq

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Abstract: The present study was conducted to evaluate the fish community and diversity status in the Euphrates River between Medina and Qurna cities, northwest of Basrah Province, Iraq. In addition, the relationship between some environmental parameters, including water temperature, dissolved oxygen, salinity, pH, and turbidity, and fish abundance were investigated by sampling from November 2020 to October 2021. Based on the results, there were no significant differences (P>0.05) in the environmental factors between the two studied sites except for salinity and turbidity. During the study, a total of 7387 fishes were collected belonging to 12 families, 21 genera, and 22 species. The Cyprinidae was dominated by seven species, followed by the Luciscidac with three species, the Cichlidae and Mugilidae families with two each, and the rest with one species each. There were ten natives, eight exotics, and four marine fish species. *Planiliza abuc* was dominat species with 26.11 % of the total catch. Significant differences (P<0.05) were found in species richness and number of the collected individuals between two sites. Based on the results, fish species can be classified into three groups based on their distribution; common species with nine species, accounting for 98,66%; seasonal species with four species accounting for 0.798% and rare species, with nine species accounting 0.541% of total richness. Three species of *P. abu, Coptodon zillii* and *Carassius auratus* were dominant species with 63.110% of the total catch.

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Introduction

A study of fish communities gives a clear picture of their stocks (Dwivedi et al., 2016) that are used in managing aquatic systems (Simonovic et al., 2017; Pyron et al., 2019). The fish community is affected by environmental factors that can be observed using diversity indices (Abdullah et al., 2019b; Al-Helli et al., 2019; Zarei and Krakhmalnyi, 2019) such as richness, diversity, and evenness (Abbas et al., 2017). Several studies have been performed in the inland waters of Iraq to investigate the environmental and biological effects the fish composition e.g. in the Euphrates River, Al-Noor et al. (2009) analyzed fish population structure and recorded 21 species, Hussein et al. (2015) worked the fish structure in the Euphrates River between Chibyaish and Mudyna and recorded 24 species belonging to seven families, and 12 species, Khaddara (2014) studied the physiochemical of fish structure in the Euphrates River, Abdullah (2017) documented the fishes of the Tigris River at Al-Qurna city and Abood (2018) reported the structure of fish assemblages in the Shatt Al-Arab River. In this regard, the current study aimed to assess the fish structure of the Euphrates River's Medina and Qurna cities, Southern Iraq using diversity indices by providing their relationships by some environmental parameters.

Material and methods

The Euphrates River has a length of 2775 km as the 27th longest river in the world (Vander, 1975). It feeds large agricultural land in the northern Basrah Province of Iraq. For this study, two sampling sites were selected between the cities of Medina and Qurna, including (1) the northwest site in the Al-Medina bridge (718852N, 3425256E) and (2) Al-Qurna city at Pipe bridge (729605N, 3431444E).

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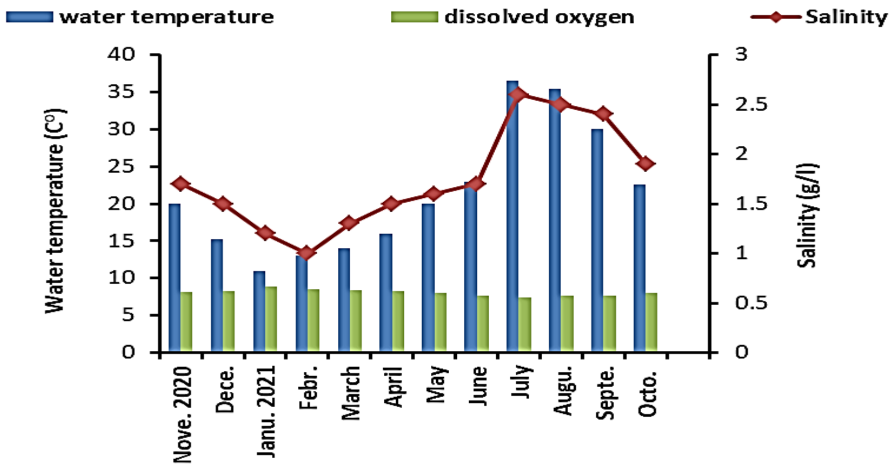

Figure 1. Monthly variations in water temperature, dissolved oxygen and salinity in the study area of the Euphrates River during 2020-2021.

Water samples were collected from the study area monthly from the middle of the river at a depth of 20 cm. Water physiochemical parameters were measured during fish sampling between November 2020 and October 2021**.** Water temperature (°C) was measured using a thermometer, Dissolved oxygen (DO) using a YSI55 device, salinity as PSU using Extech 31156 device, pH using Lovibond-Senso Direct 150 device, turbidity as Nephelometric turbidity unit (NTU) by HANNA HI93703 device.

Several fishing methods, such as bottom net (160 m in length with 6.4 mm mesh size), gill nets (1x60 m^2 with 15 mm mesh size), cast net (with a diameter of 4 m with 1.5 mesh size) and a hand net for small fishes were used to collect fishes. In addition, some data are based on the catches of local fishermen. The fish were identified based on Carpenter (1997), Coad (2015), and Eagderi et al. (2019, 2022).

The relative abundance of fish species was calculated according to Odum (1979). Biodiversity indices, including diversity (Shanon, 1949), evenness (J) (Pielou, 1977) and richness index (D) (Margalef, 1968) were also calculated. Fish were also divided based on their occurrence in the monthly samples (Tyler, 1971), and dominance (D3) (Kwak and Peterson, 2007). SPSS (ver. 19) was used for statistical analysis by applying ANOVA to assess differences in ecological indices, the number of species and individuals ($P \leq 0.05$) between the two sites and Principal Component Analysis (PCA) to analyze the relationship between physicochemical characteristics and the study period's months.

Results

Water temperatures, salinity and DO during the study period are presented in Figure 1. Water temperatures were between 11°C in January and 36.5°C in July, with a mean of 21.3±8.5°C. DO was recorded between 7.4 mg/l in July and 8.9 mg/l in January, with a mean of 8.07±0.43 mg/l. Salinity levels ranged from 1 g/l in February to 2.6 g/l in July, with a mean of 1.7±0.5 g/l. Ph was within the alkaline range ranging from 6.9 in July to 8.5 in March, with a mean of 7.85±0.4 (Fig. 2). The turbidity ranged from 7.8 NTU in August to 23.6 NTU in December, with a mean of 7.85±0.49. There were no significant differences between the environmental parameters of the two sites ($P>0.05$) except salinity and turbidity.

In the PCA, the first two PCs accounted 82.79 and 11.11% of the variances, respectively (in total 93.90%). The PC1 mostly includes factors of temperature and salinity. There was a correlation between July and September. Some parameters, such as DO and pH were correlated with January, February, March, April, and November. Based on the results, there is a positive correlation between turbidity and December and May (Fig. 3.)

Figure 4 shows the correlations between the abundance and fish richness and water temperature, dissolved oxygen, salinity, pH, and turbidity. The water temperature positively correlated with the

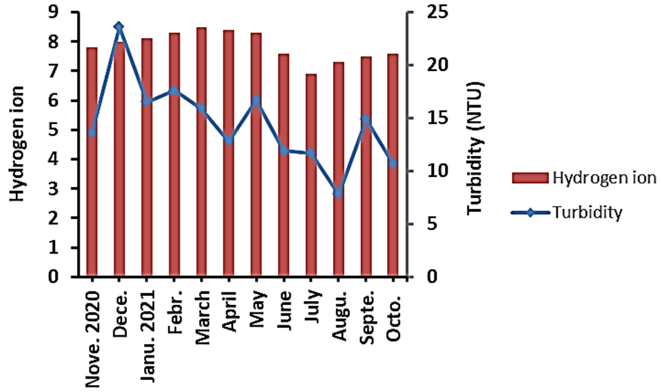

Figure 2. Monthly variations in hydrogen ion and turbidity in two sites of the Euphrates River during 2020-2021.

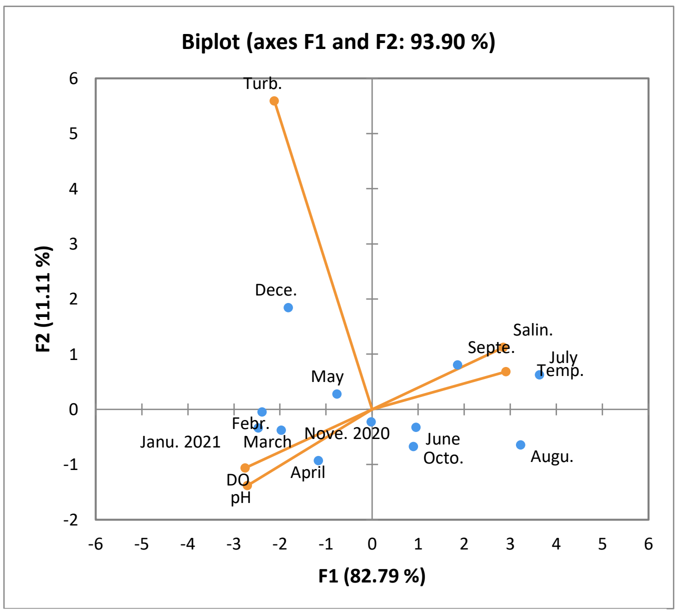

Figure 3. Principal Component Analysis between physicochemical factors and months in the Euphrates River during 2020-2021.

richness and species abundance (r = 0.430, r = 0.07, respectively). The richness and fish's abundances had weak positive correlation (r = 0.45, r = 0.08, respectively) with salinity and negative correlation (r = -0.31, r = -0.01, respectively) with DO and turbidity (r = -0.69, r = -0.12, respectively). PH showed a negative correlation (r = -0.38) with richness and a positive correlation (r = 0.25) with the fish's abundances.

A total of 7387 fish individuals were collected during the study period belonging to 12 families, 21 genera, and 22 species, of which 10 were native, eight exotic fish species, and four marines. The Cyprinidae was dominated group by seven species, followed by the Luciscidac with three, the Cichlidae and Mugilidae with two species each, and the rest with one species each (Table 1).

The monthly variation in the abundance and richness in the two study sites are shown in Table 2. At the northwestern sites, the total number of individuals was 3515, ranging from 154 in June to 423 in March, including 17 species ranging from 8 in February to 13 in May. The total number of individuals in southeast sites was 3872, ranging from 223 in January to 426 in May. There were 19 collected species in this site, ranging from ni9ne in May to 15 in August. The results showed significant differences ($P<0.05$) in species and individuals between the two studied sites.

The relative abundance of fish species ranges from 376 in June to 724 in May, with 22 species and 21 genera. The species ranged from ten in December 2020 to 15 in July, with the lowest numerical abundance as 5.1% in June and 9.8% in May. *Panaliza abu* was dominated species, with 1929 specimens and 26.11% of the catch, ranging from 9.9% in June to 29.8% in February. *Coptodon zilli* had the second position with 1807 individuals and 24.46 %, ranging from 8.5% in June to 24.9% in July. The collected *C. auratus* was 926, accounting for 12.54% of the total catch, fluctuating from 5.9% in November to 18.4% in December. *Alburnus sellal* constitutes 12.33% of the total composition ranging from 3.5% in July to 14.7% in November, with 911 specimens. *Oreochromis auratus* had 11.09% of the total catch, then *Carasobarbus luteus* with 9.46%, *Cyprinus carpio* with 1.11%, and *Siluris triostegus* with 0.80%. The rest species ranged from 0.76%, representing *A. marmiad* species, to *C. idella* and *G. rufa*, which accounted for 0.01% of the total catch (Table 3).

The monthly variation in the number of species is depicted in Figure 5. The number of native species fluctuated from four in November to eight in January 2021. The alien species number differs between

Table 1. Fish species were collected from November 2020 to October 2021.

No	Species	Habitat	Family	Relative abundance%
1	*Carassius auratus +*	F	Cyprinidae	23.40
2	*Carasobarbus luteus**	F		
3	*Garra rufa **	F		
4	*Ctenopharyngodon idella+*	F		
5	*Cyprinus carpio +*	F		
6	*Hemiculter leucisculus +*	F		
7	*Mesopotamichthys sharpeyi**	F		
8	*Coptodon zillii +*		Cichlidae	35.55
9	*Oreochromis aureus+*	F		
10	*Planiliza abu**	F	Mugilidae	26.22
11	*Planiliza subviridis*	M		
12	*Acanthobrama marmid**	F	Leuciscidae	13.60
13	*Alburnus sellal **	F		
14	*Leuciscus vorax**	F		
15	*Silurus triostegus**	F	Siluridae	0.798
16	*Tenualosa ilisha**	M	Clupeidae	0.09
17	*Gambusia holbrooki +*	F	Poeciliidae	0.08
18	*Mastacembelus mastacembelus**	F	Mastacembelidae	0.07
19	*Heteropneustes foosilis +*	F	Heteropneustidae	0.05
20	*Acanthopagrus arabicus*	M	Sparidae	0.05
21	*Thryssa whiteheadi*	M	Engraulidae	0.04
22	*Aphanius dispar**	F	Cyprinodontidae	0.03

* = Native species,+ = Alien species, F=Fresh water species, and M= Marine water species.

Table 2. Monthly variations in the number and richness of fish species in the Euphrates River from November 2020 to October 2021.

	Richness		Number of individuals	
Months	Site 1	Site 2	Site 1	Site 2
November 2020	10	14	321	393
December	9	12	221	279
January 2021	12	10	275	223
February	8	13	298	358
March	11	14	423	272
April	10	12	350	332
May	13	9	298	426
June	10	13	154	231
July	12	14	265	323
August	11	15	297	371
September	11	12	271	401
October	9	13	342	263
Total			3515	3872

three in December and seven in July. The abundance of marine species at the second station was notable, with one species recorded in December, January, March, May, July, and October and four in November.

The results of biodiversity indices, including diversity (H), evenness (J) and richness (D), are presented in Figure 6. The lowest rate was recorded as 1.432 in December and the highest as 3.204 in July. The range of the evenness index was 0.365 in November to 0.754 in September. The values of the richness index were between 1.48 in August and 3.57 in October. The fish assemblage in the study area was divided into three groups (Fig. 7). The common species comprised nine, accounting for 98.695% of the total catch, including *P. abu, C. zillii, C. auratus, A. sellal, O. aureus, C. luteus, C. carpio, S. triostegusa* and *A. marmid*.

Table 3. Monthly variations in the relative abundance of species in the Euphrates River from November 2020 to October 2021 (Euphrates River).

	Nov. 2020		Dec. 2020		Jan. 2021		Feb.		Mar.		Apr.		May		June		July		Aug.		Sep.		Oct.		
	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%	T. Num
Penaliza abu	190	22.4	120	19.7	102	17.8	220	29.8	259	28.1	126	11.4	175	18.2	55	9.9	178	26.7	156	18.9	178	19.5	175	25.1	1929
Coptodon zili	177	20.8	75	12.3	120	20.9	165	22.4	199	21.9	221	20.0	165	17.2	47	8.5	166	24.9	161	19.5	167	18.5	144	20.6	1807
Carassius auratus	50	5.9	112	18.4	67	11.7	66	8.9	60	6..6	55	5.0	79	8.2	76	13.7	80	12.0	105	12.7	78	8.6	98	14.0	926
Alburnus sellal	125	4.7	65	10.7	75	13.1	76	10.2	78	8.6	115	10.4	76	7.9	54	9.7	23	3.5	73	8.8	85	9.4	67	9.6	911
Oreochromis aureus	143	16.8	35	5.7	25	3.8	65	8.9	56	6.2	79	7.1	85	8.8	67	12.1	59	8.9	101	12.2	50	5.5	56	8.0	819
Carasobarbus luteus	19	2.2	87	14.3	120	18.3	51	6.9	35	3.8	57	5.2	86	8.9	60	10.8	54	8.1	41	5.0	61	6.8	43	6.2	699
Cyprinus carpio	3	0.4			3	0.5	1	0.1			7	0.6	6	0.6	7	1.3	8	1.2	10	1.2	35	3.9	2	0.3	82
Silurus triostegus	2	0.2			1	0.2			5	0.5	6	0.5	27	2.8			6	0.9	8	1.0	2	0.2	2	0.3	59
Acanthobrama marmid			3	0.5	6	1.0	8	1.1			6	0.5	7	0.7	5	0.9			9	1.1	10	1.1	2	0.3	56
Leuciscus vorax			1	0.2	2	0.3					3	0.3	12	1.2			4	0.6			4	0.4	12	1.7	38
Hemiculter leucisculus					1	0.2			2	0.2	4	0.4	4	0.4			5	0.8							16
Penaliza subviridis	1	0.1	1	0.2			1	0.1			1	0.1			1	0.2			1	0.1	1	0.1	1	0.1	8
Tenualosa ilisha	1	0.1							1	0.1	1	0.1			1	0.2	1	0.2	1	0.1	1	0.1			7
Gambusia holbrooki	1	0.1							1	0.1					1	0.2	1	0.2			1	0.1	1	0.1	6
Mastacembelus mastacembelus					1	0.2	1	0.1	1	0.1					1	0.2	1	0.2							5
Acanthopagrus arabicus	1	0.1					1	0.1					1	0.1							1	0.1			4
Heteropneustes fossilis									1	0.1			1	0.1			1	0.2	1	0.1					4
Mesopotamichthys sharpeyi					1	0.2											1	0.2	1	0.1			1	0.1	4
Thryssa whiteheadi	1	0.1			1	0.2					1	0.1													3
Aphanius dispar							1	0.1							1	0.2									2
Ctenopharyngodon idella																							1	0.1	1
Garra rufa			1	0.2																					1
Number of Individuals	714		500		507		656		695		682		724		376		588		668		672		605		
Relative abundance		9.7		6.8		6.9		8.9		9.4		9.2		9.8		5.1		8.0		9.0		9.1		8.2	
Number of Species	13		10		14		12		13		14		13		13		15		13		14		14		

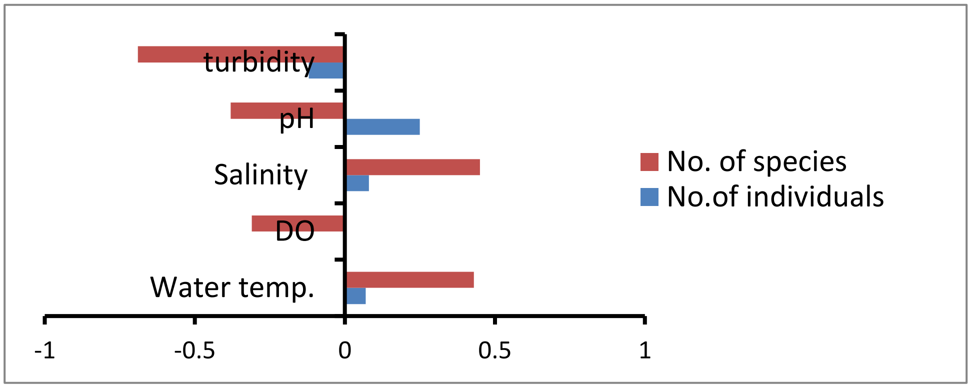

Figure 4. Some ecological factors that influenced the richness and individuals of fishes in the Euphrates River during 2020-2021.

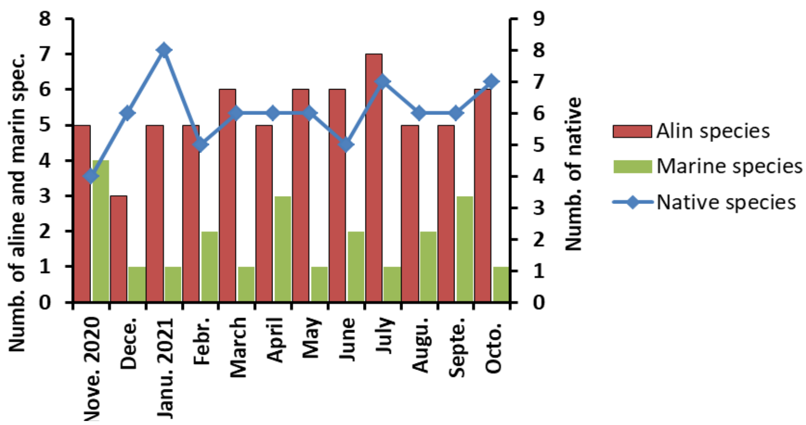

Figure 5. Monthly variation in the number of exotic, marine, and native species in study sites during November 2020 to October 2021 in the Euphrates River.

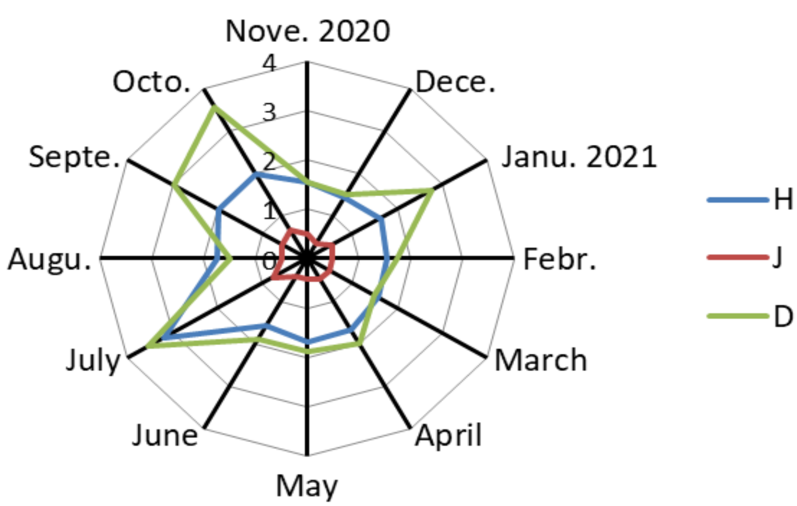

Figure 6. Monthly variations in the values of biodiversity indices in the study area in the Euphrates River during 2020-2021.

Seasonal species included four species accounting 0.798% of the total catch: *L. vorax*, *P. Subviridis, T. ilisha,* and *G. holbrooki.* The occasional species consist of night species and by 0.541% formed *H.leucisculus, M. mastacembelus, A. arabicus, H. foosilis, M. sharpeyi, T. whiteheadi, A. dispa, C. idella* and *G. rufa.* Three species of *P. abu, C. zillii* and *C. auratus* were 63.1% of the total catch and *P. abu* with 26.11 % had the highest dominance index (D3) (Fig. 8)

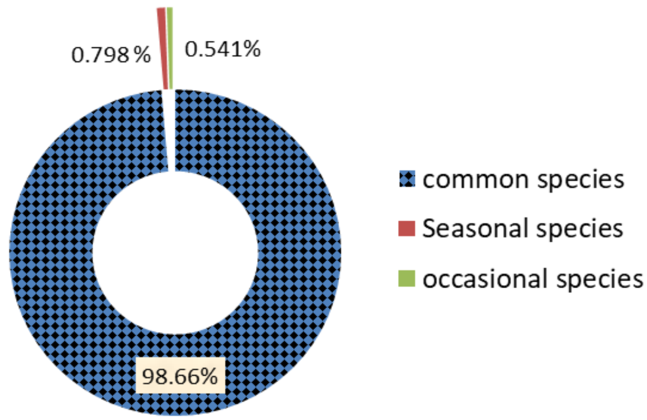

Figure 7. Fish species occurrence in fishing samples from the two study sites from November 2020 to October 2021 in the Euphrates River.

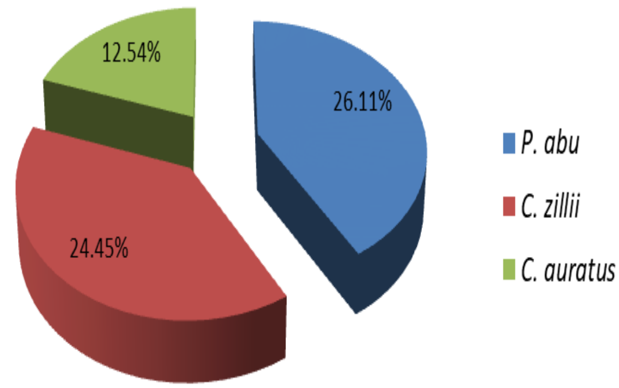

Figure 8. Dominated three fish species in the study area from November 2020 to October 2021 in the Euphrates River.

Discussion

Ecological factors directly impact fish distribution in aquatic ecosystems (Roa-Fuentes and Casatti 2017). Based on the results, DO was negatively correlated with water temperature and salinity, but DO and PH had little fluctuation despite the temperature. Salinity is changed based on various factors, including evapotranspiration, agriculture fertilization, soil erosion, runoff water and other anthropogenic activities, and its value was within the permissible limits for the collected fishes (Al-Helli et al., 2019). Turbidity can be caused by a variety of factors, including dissolved organic compounds, bacteria, microscopic algae, suspended clay particles and colloidal solids, and it was in two sites were to be above 5 NTU, indicating a higher rate (WHO, 2010).

The fish fauna of the studied area was 22 species belonging to 21 genera and 12 families, including 10 natives, 8 exotics, and 4 marines; the family of Cyprinidae was dominated taxa. Lazem and Atte (2016) in their work to assess the fish structure in the Euphrates River at Al-Samawa city, recorded 24 fish species that some of them not found in our work, including *A. grypus, C. sublimus, C. kais,* and *L. xanthopterus.* Mohamed and Abood (2017) on the assemblage of Shatt Al-Arab structure in the supremacy of Cyprinidae and the difference of species number caught and ecological factors during his study. The rest of the families, such as the Luciscidac family, have three species each, the Cichlidae and Mugilidae families have two species, while the remainder of the families has only one species; this study coincided with many researchers in recording several families in Iraqi inland waters such as Hossain et al. (2012), Coad (2015).

At both sites, *P. abu, C. zillii, C. auratus* and *A. sellal* were the most abundant species forming 69.3% of the total catch. The rest of the species had little abundance (30.7%) of the total number of individuals in the study area. The native fish species constituted 50.142% of the total catch, but eight exotic species consist 49.56% of the total catch. Al-Amari et al. (2012) reported some of these fishes in the Euphrates River near Al-Hinia town, showing a high occurrence of exotic fishes that can threaten the native fishes as they grow faster by declining the water quality of the Euphrates River. The second site had four marine species, accounting for 0.297% of the total catch. Abdullah et al. (2021) reported increasing marine species in the lower Euphrates River.

The biodiversity indices are used as a single number to describe the diversity of a system (Magurran, 1988). The biodiversity index values (H) in this study range from poor to medium, according to Shannon-Weaver index values, revealing differences between sites due to the appearance of marine species (Younis et al., 2010) in the second site. The result of the evenness index (J) indicates that two sites are within the half balanced to the unbalanced range, with a minor increase in the second site, due to the presence of some marine species in the lower of the Euphrates River (Mohamed et al., 2015). The richness (D) of the fish structure in the Euphrates River, according to Jorgensen et al. (2005), varied between disturbed and semi-complete, as found in the current work.

According to Tyler (1971), the fish assemblage in the studied area was divided into three groups; common, seasonal, and occasional fish species. *Panaliza abu, C. zillii, C. auratus, A. sellal, O. aureus,* and *C. luteus* were common species, i.e they are collected during the 12 months sampling period. Mohamed and Al-Jubouri (2017) have also reported the presence of these species in a study of the fish community in the Al-Diwaniya River. Other species found in the monthly fishing samples were *C. carpio*, *S. triostegusa*, and *A. marmid* in this river (Al-Zaidy et al., 2019). Four seasonal fish species (*L. vorax, P. Subviridis, T. ilisha,* and *G. holbrooki*) were recorded i.e. their presence varied monthly. The rest of the fishes were rare species. The three most abundant fish species of *P. abu, C. zillii* and *C. auratus* were dominant (D3) in the Euphrates River as reported by other researchers in Iraqi inland waters (Salman, 2012; Jawad et al., 2021).

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