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Diversity of fishes in the lower reaches of Tigris River, north east of Basrah province, Southern Iraq

Sajad A. Abdullah

Department of Biology, College of Education-Qurna, University of Basrah, Basrah, Iraq

Corresponding author: E-mail:sajadabd1964@gamil.com

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Abstract: The present work is to assess the fish structure and diversity status in the Tigris River, northeast of Basrah province from October 2015 to September 2016 in relation to some ecological factors. Three stations were selected; first station was located at the north of the east Qurna city in Al-Jewber village, the second station was located at a distance of 7 km after the first station in the Abu Aran village and the third station was in Qurna city. Water temperature, dissolved oxygen, salinity and total alkalinity were measured from the study areas. Several fishing methods were adopted to collect fishes, electric fishing and gill nets. Twenty- seven fish species were collected belonging to 25 genera and 12 families. A total of 9400 individual fishes were collected. Fishes were classified into three categories, common, seasonal and occasional species which were formed 98.04, 1.08 and 0. 88%, respectively of the total number of species. The value of the Shannon and Weaver diversity index (H), Evenness (E) and Margalef richness (D) were calculated according to months and stations. The mean value and standard deviations of Shannon and Weaver in the three stations were 1.53 ± 0.499, 1.841± 0.259 and 2.432± 0.767 respectively. The average value and standard deviations of Evenness (E) in these stations were 0.695 ± 0.087, 0.741± 0.101 and 0.725± 0.101 in the same order. Mean values and standard deviations of Margalef richness (D) in these stations were 2.010 ± 0.898, 2.299 ± 0.851 and 2.893 ± 0.667, respectively. The dominance (D_3) value of the main three abundant species was 59.24%.

Key words: Fish structure, diversity, Tigris River, Basrah.

Introduction

The information on water quality is an important target for implementation of sustainable water use for management strategies (Bu *et al.*, 2010). Fish community structure of rivers and streams is influenced by ecological factors (Peterson & Rabeni, 2001). Environmental factors like temperature , dissolved oxygen, salinity and total alkalinity are of important role in regulating fauna diversity and population densities (Fisher & Willis, 2000). Temperature can influence fish distribution and community structure (Weherly & Wiley, 2003). Dissolved oxygen content of natural waters is one of the essential and limiting parameters for survival and existence of aquatic organisms (Durmishi *et al.*, 2008). Salinity is a measurement of the total sodium and chloride present in water (A.P.H.A, 2005). The normal conduction of alkalinity of natural water is associated with carbon dioxide, bicarbonates and carbonate (Lind, 1979) . The fish population is widely considered as an integral indicator of ecological status of water bodies (Mohamed *et al.*, 2013). Biodiversity indications are measurements that summarized complex data into simple, standardized and communicable manners (Yong *et al.*, 2005; Lazem, 2009). Featuring surveys of fishes give a description of the nature and structure of fish stocks (Korsbrekke *et al.*, 2001). The demographic weakness of the community of fish product in the absence of the good administration, the exercise of over-fishing, the use of means and methods are illegal and not allowed to fish recruitment in order to get the best sustainable production (Pauly *et al.,* 2002).

The Tigris and Euphrates rivers are the main source of water in the marshes of Iraq; almost 70% of the water entering Iraq comes from rivers flow controlled by other countries (Partow, 2001). Many researchers are using indices for richness, diversity, evenness and similarities to analyze the composition of fish populations in Iraq, as well as the other regions and environments of water marshes of southern Iraq (Younis *et al.*, 2001; Mohamed *et al.*, 2009). Many studies have been conducted on the inland waters of southern Iraq which focused on studying the environmental aspects on the composition of different species of fishes in the marshes area and Shatt al-Arab river, Tigris River and lower reaches of the Euphrates River (Mohamed *et al.*, 2006; Al-Noor *et al.*, 2009; Hussain *et al.*, 2009).

The present study aims to assess the modern statistical information of the environmental situation and the demographics of the communities of fishes after the water recedes from the Tigris River, especially in the southern segment, which is considered as the most important fishing areas in southern Iraq.

Materials and Methods

The present study was conducted in northeast of Basrah province on the Tigris River from October 2015 to September 2016, which was located between latitude 31° 09' 53.45" N and longitude 47° 26' 23.23" E with a distance f 30km. The study area included three stations on the Tigris River. The first was station located between latitude 31° 09 53.45" N and longitude 47° 25' 56.89" E at the north of the east Qurna city in Al-Jewber village, the second station was located at a distance of 7km after the first station in the Abu Aran village between latitude 31° 07' 48.15" N and longitude 47° 26' 38.79" E and the third station was located between latitude 31° 00' 42. 71" N and longitude 47° 26' 23.23" E in Qurna city (Fig. 1).

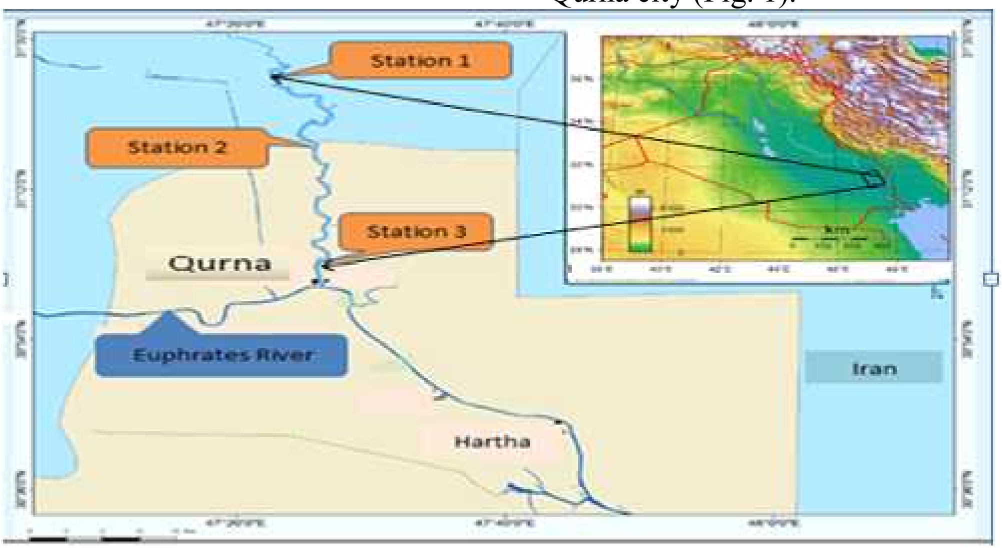

Fig. (1): A map of stations location of the Tigris river, northeast of Basrah, Southern Iraq.

Water samples were collected monthly from each station. The rate of one sample per month was taken from the middle of the river at a depth of 20 cm from the surface of the water, using polyethylene containers and by three replicates per each station. Some physicochemical factors were measured, namely water temperature (°C), dissolved oxygen (mg/l) and salinity by YSI 556 MPS models 2005. Total alkalinity was determined according to A.P.H.A (2005).

Fish samples were collected from each station. Several fishing methods were adopted to collect fishes such as electro fishing by generator engine (provides 300-400 V. 10A) and gill nets (160m to 200 with 6.4 mm mesh size). Moreover, the adoption of commercial fishing samples was to investigates the types and numbers of fishes caught by fishermen. Fish species were identified and counted according to Carpenter (1997) for marine fishes and Coad (2017) for freshwater fishes and both groups were updated according to Eschemyer (2017) The analysis of fish assemblage in the three stations were carried out by the following methods and indices: relative abundance (Odum, 1970), occurrence (Tyler, 1971), Diversity (Shannon & Weaver, 1964), evenness (Pielou, 1977), richness index (Margalef,1968) and dominance (D_3) by Kwak & Peterson (2007) Rating of ecological index levels was adapted from Jørgensen *et al.* (2005).

Results

Physicochemical environment

There are physicochemical environmental features which show rates of monthly variation and standard deviations in some ecological factors that have been conducted during the duration of the study stations (Fig. 2). The lowest rate of water temperature (10°C) was in December and the highest (37. 6°C) in August and mean value was 24.8°C± 10.4. The lowest value of dissolved oxygen was 6.3 mg/l in August and the highest (8.5 mg/l) in December with a mean value of 7.4mg/l ± 0.67. Salinity values ranged from 1 g/l in December to 1.6 in July of the mean value was 1.3 g/l ± 0.2. Alkalinity values were always within the alkaline direction ranged from 99.7 mg/l in December to 143.3mg/l in August with a mean value of 139.8 mg/l ± 24.17. Water temperature and dissolved oxygen exhibited no significant differences between the three stations (F = 0.057, F= 2.06, P>0.05 respectively). Significant differences (F= 2.50, P<0.05) in salinity between station 3 and station 1 were noticed. Results showed no significant differences (F= 0.080, P >0.05) in total alkalinity had among the three stations. Water temperature, salinity and total alkalinity is impact factors on the total number of species and the total number of individuals. Water temperature was positively corrected with number of species (r= 0.530) and number of individuals (r = 0.208). Salinity was positively corrected with the number of species (r =0.515) and negatively with number of individuals (r = -0.119). Total alkalinity was positively corrected with number of specie r = 0.537) and number of individuals (r= 0.085), while dissolved oxygen was negatively correlated with the total number of species and number of individuals (r= -0.559, r= -0.363 respectively).

Fish community

A Total of 27 fish species were collected from the study area in south east of Tigris River which belonged to 25 genera and 12 families (Table 1). Cyprinidae, was the dominant family with 10 species (*Carassius auratus*, *Cyprinus carpio*, *Carasobarbus luteus*, *Leuciscus vorax*, *Alburnus mossulensis*, *Acanthobrama marmid*, *Hemiculter leucisculus*, *Garra rufa*, *Hypophthalmichthys molitrix*, *Mesopotamichthys sharpeyi*). Other species belonged to the families Cichlidae (*Coptodon zillii*, *Oreochromis aureus*),Clupeidae (*Tenualosa ilisha, Nematalosa nasus*), Cyprinodontidae (*Aphanius dispar*), Engraulidae (*Thryssa hamiltonii*, *T. whiteheadi*) Hemiramphidae (*Hyporhamphus limbatus*), Heteropneustidae (*Heteropneustes fossilis*), Mastacembelidae (*Mastacembelus mastacembelus*), Mugilidae (*Planiliza abu*, *P. subviridis*, *P. klunzingeri)*, Poecilidae (*Gambusia holbrooki*, *Poecilia latipinna),* Siluridae (*Silurus triostegus*), and Sparidae (*Acanthopagrus arabicus*).

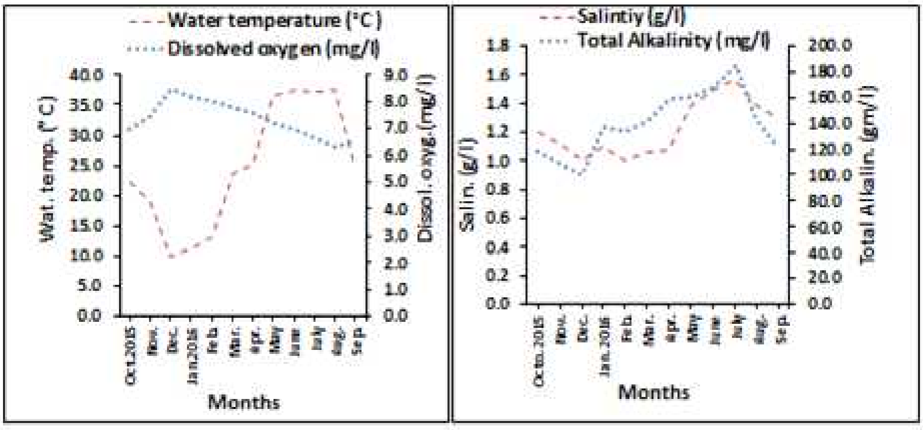

Fig. (2). Monthly variations in some ecological factors at the study area.

Table (1): Families of fish species collected from October 2015 to September 2016. F = Freshwater fish, M = Marine fish, + = Alien species

Families	Scientific name	Habitat
Cichlidae	*Oreochromis aureus* +	F
	Coptodon zillii +	F
Clupeidae	*Tenualosa ilisha*	M
	Nematalosa nasus	M
Cyprinidae	*Carassius auratus* +	F
	Cyprinus carpio +	F
	Carasobarbus luteus	F
	Leuciscus vorax	F
	Alburnus mossulensis	F
	Acanthobrama marmid	F
	Hemiculter leucisculus +	F
	Garra rufa	F
	Hypophthalmichthys molitrix +	F
	Mesopotamichthys sharpeyi	F
Cyprinodontidae	*Aphanius dispar*	F
Engraulidae	*Thryssa whiteheadi*	M
	Thryssa hamiltonii	M
Hemiramphidae	*Hyporhamphus limbatus*	M
Heteropneuetidae	*Heteropneustes fossilis* +	F
Mastacembelidae	*Mastacembelus mastacembelus*	F
Mugilidae	*Planiliza abu*	F
	Planiliza subviridis	M
	Planiliza klunzingeri	M
Poeciliidae	*Gambusia holbrooki* +	F
	Poecilia latipinn	F
Siluridae	*Silurus triostegus*	F
Sparidae	*Acanthopagrus arabicus*	M

Species abundance and distribution

A total of 9400 individuals of fishes ranged from 558 in June and 1106 in April were collected from the study stations. The number of species varied from 12 in December to 22 in May (Table 2, Fig. 3). The maximum number (2339) was counted for *P. abu* and the minimum (one individual) was for *L. klunzingeri* (Table 2). The lowest number of native fish species (six) was recorded in November, December and June. The highest was nine in May and September. The number of alien species ranged from four in December to eight in May, June and September. Eight marine species were recorded from the stations which varied from two in December and August to six in November and April. A total of 2297 fish individuals were recorded at station 1, and they ranged from 216 in October to 425 fish in August. A total of 3254 fishes were caught in station 2. They varied from 276 in June to 625 fishes in September. A total of 3850 fishes were recorded from station 3. They ranged from 325 in December to 878 in April. Significant differences (F= 2.54, P<0.05) was noticed in number of species among station 3 and the other stations. The relative abundance of species in Tigris river from the study stations is shown in Table (2). It has been found that the fish assemblage were dominated by *P. abu* (24.9%) as it ranged from 12.1 in June to 33.0% in March, followed by *C. zillii* (22.9%) as it varied from 15.6 in May to 31.5% in March. *Carassius auratus* formed 11.5% and relative its abundance ranged from 6.0 in April to 20.5% in December. *Alburnus mossulensis* constituted 11.2% from the total assemblage and it varied from 3.0 in July to 17.1% in November.

Monthly variations of number of fish species in the study area (Fig. 4) showed that 15 fish species were caught from station 1. They varied from six species in January to 11 species in July. Eighteen fish species were recorded from station 2. They ranged from seven species in November to 15 species in September. Station 3 included most of the fish species (26 species). They varied from ten species in December to 19 in August. The result showed significant differences (F=21.15, P<0.05) in number of species among stations.

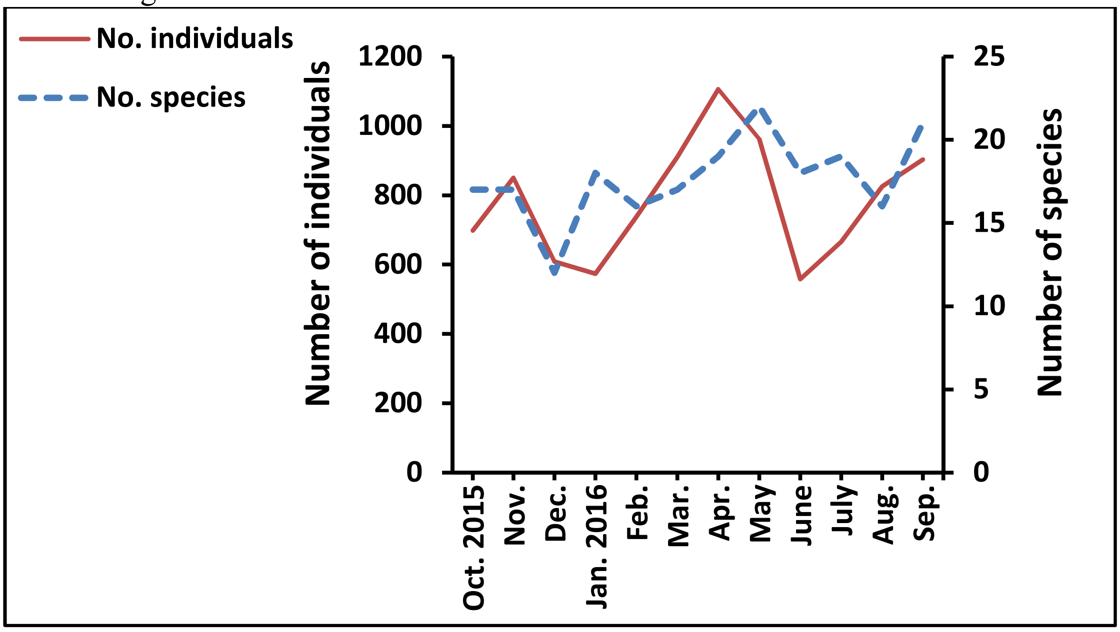

Fig. (3): Monthly variations in number of individuals and species of fishes collected during the period of study.

Table (2): Monthly variations in number of individuals and relative abundance of fishes collected during the study period.

	Oct. 2015		Nov.		Dec.		Jan. 2016		Feb.		Mar.		Apr.		May		June		July		Aug.		Sep.			
Species	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%	T. Num.	Total %
P. abu	190	27.2	200	23.5	120	19.7	100	17.4	222	30.1	300	33.0	347	31.4	175	18.2	67	12.1	178	26.7	150	18.2	290	32.1	2339	24.88
C. zilii	178	25.5	234	27.5	109	17.9	123	21.4	200	27.1	287	31.5	255	23.1	150	15.6	89	16.0	150	22.5	178	21.5	200	22.1	2153	22.90
C. auratus	111	15.9	75	8.8	125	20.5	80	13.9	76	10.3	73	8.0	66	6.0	121	12.6	87	15.7	80	12.0	105	12.7	78	8.6	1077	11.46
A. mossulensis	75	10.7	145	17.1	99	16.3	90	15.7	78	10.6	89	9.8	123	11.1	108	11.2	66	11.9	20	3.0	75	9.1	89	9.9	1057	11.24
O. aureus	62	8.9	144	16.9	39	6.4	24	4.2	66	8.9	67	7.4	110	9.9	101	10.5	77	13.9	64	9.6	105	12.7	56	6.2	915	9.73
C. luteus	44	6.3	23	2.7	106	17.4	129	22.5	55	7.5	39	4.3	58	5.2	97	10.1	65	11.7	55	8.3	42	5.1	66	7.3	779	8.29
T. ilisha	1	0.1	2	0.2				0.0			3	0.3	44	4.0	23	2.4	34	6.1	67	10.1	78	9.4	19	2.1	271	2.88
M. mastacembelus		0.0	2	0.2			7	1.2	19	2.6	22	2.4	45	4.1	68	7.1	31	5.6	4	0.6	21	2.5	4	0.4	223	2.37
A. marmid	2	0.3		0.0	3	0.5	7	1.2	9	1.2			22	2.0	22	2.3	13	2.3	4	0.6	18	2.2	15	1.7	115	1.22
C. carpio	1	0.1	3	0.4			1	0.2	1	0.1			8	0.7	6	0.6	6	1.1	10	1.5	9	1.1	44	4.9	89	0.95
S. triostegus	2	0.3	3	0.4			1	0.2	2	0.3	5	0.5	6	0.5	37	3.8			7	1.1	9	1.1	2	0.2	74	0.79
P. subviridis	4	0.6	10	1.2	1	0.2	2	0.3	3	0.4	5	0.5	2	0.2	9	0.9	4	0.7	6	0.9	10	1.2	15	1.7	71	0.76
L. vorax	23	3.3		0.0	1	0.2		0.0					4	0.4	12	1.2				0.0			4	0.4	44	0.47
G. holbrooki	1	0.1	2	0.2				0.0			1	0.1	1	0.1	2	0.2	3	0.5	3	0.5	14	1.7	10	1.1	37	0.39
M. sharpeyi	1	0.1		0.0			1	0.2			4	0.4		0.0	8	0.8	1	0.2	6	0.9	9	1.1	3	0.3	33	0.35
H. leucisculus		0.0		0.0			1	0.2			2	0.2	6	0.5	5	0.5			5	0.8	1	0.1		0.0	20	0.21
G. rufa		0.0	1	0.1	3	0.5	2	0.3	1	0.1	4	0.4		0.0	4	0.4			2	0.3			1	0.1	18	0.19
P. latipinna	1	0.1		0.0	2	0.3		0.0	2	0.3	3	0.3		0.0	5	0.5	1	0.2		0.0			2	0.2	16	0.17
A. arabicus	1	0.1	2	0.2			1	0.2	1	0.1	4	0.4	2	0.2	1	0.1	2	0.4		0.0			1	0.1	15	0.16
H. fossilis		0.0		0.0				0.0			2	0.2	4	0.4	1	0.1	3	0.5	1	0.2	2	0.2	2	0.2	15	0.16
N. nasus		0.0	1	0.1	1	0.2		0.0						0.0	3	0.3	5	0.9		0.0				0.0	10	0.11
T. whiteheadi			2	0.2			1	0.2					2	0.2			3	0.5		0.0					8	0.09
H. limbatus		0.0						0.0							4	0.4			2	0.3			1	0.1	7	0.07
T. hamiltonii			1	0.1			2	0.3					1	0.1					2	0.3					6	0.06
H. molitrix	1	0.1					2	0.3															1	0.1	4	0.04
A. dispar									2	0.3							1	0.2							3	0.03
P. klunzingeri									1	0.1															1	0.01
Number individuals	698		850		609		574		738		910		1106		962		558		666		826		903		9400	
Relative abundance		7.4		9.0		6.5		6.1		7.9		9.7		11.8		10.2		5.9	0.0	7.1		8.8		9.6		
Number species	17		17		12		18		16		17		19		22		18		19		16		21			
N. of native specis	7.00		6.00		6.00		8.00		8.00		7.00		7.00		9.00		7.00		8.00		7.00		9.00			
N. of alien specis	7		5		4		6		5		7		6		8		7		7		7		8			
N. of marine specis	3		6		2		4		3		3		6		5		4		4		2		4			

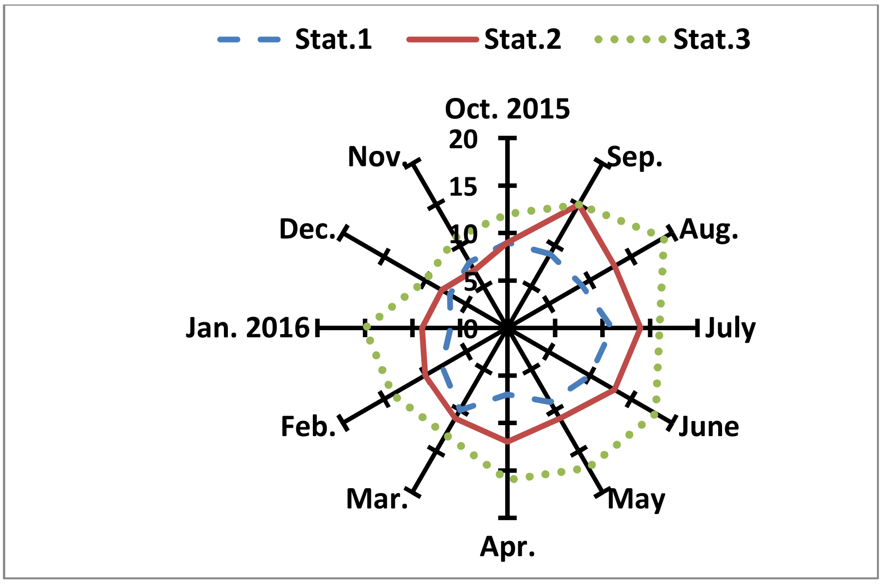

Fig. (4): Monthly variations in number of fish species during the study period.

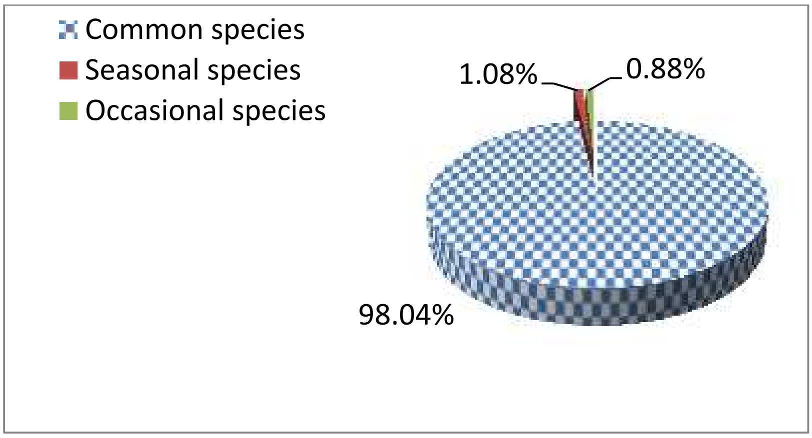

Fig. (5): Percentage of fish species according to their appearance in fishing samples during the study period.

Occurrence of fish species

The sampled fishes can be classified into three categories (Fig. 5). The common species were represented by 14 species and formed 98.04% of the total catch. The seasonal species comprised of five species and constituted 1.08% of the total catch, while the occasional species consisted eight species and included 0.88% of the total number of the total catch.

Diversity status

The value of Shannon and Weaver diversity index (H), Evenness (E) Margalef richness (D) were calculated according to months and stations (Fig. 6). The mean value and standard deviations of Shannon and Weaver in the three stations were 1.53 ± 0.499, 1.841± 0.259 and 2.432 ± 0.767 respectively. Lowest Shannon diversity index (1.21) was recorded in January and the highest (1.96) was in July at station 1. In station 2, it varied from 1.483 in November to 2.26 in September. The rang from 1. 678 in December to 3.9 in August was recorded at station 3. Significant difference ($F = 4.521$, $P<0.05$) was found in the Shannon diversity among the stations. The mean value and standard deviations of Evenness (E) in the three stations was 0.695 ± 0.087, 0.741± 0.101 and 0.725± 0.10, respectively. The evenness varied from 0.533 in December to 0.866 in July in station 1. Lowest evenness index (0.557) was in November and the highest (0.870) was in May in station 2 and in station 3, it ranged from 0.560 in March to 0.910 in April. No significant difference (F = 0.681, P>0.05) was found in the Evenness index among the stations. The mean value and standard deviations of Margalef richness (D) in the three stations was 2.010 ± 0.898, 2.299 ± 0.851 and 2.893 ± 0.667, respectively. The lowest value of Margalef richness (1.136, 1.216 and 2.00) were recorded in January in these three stations respectively, while the highest values (3.858, 3.900) was in June at stations 1 and 2, respectively and 3.9 in July at station 3. Significant difference (F=3.690, P<0.05) was recorded in the Margalef richness among the stations. Three fish species (*P. abu, C. zillii* and *C. auratus*) formed 59.24% of the total number of species according to dominance index (D_3).

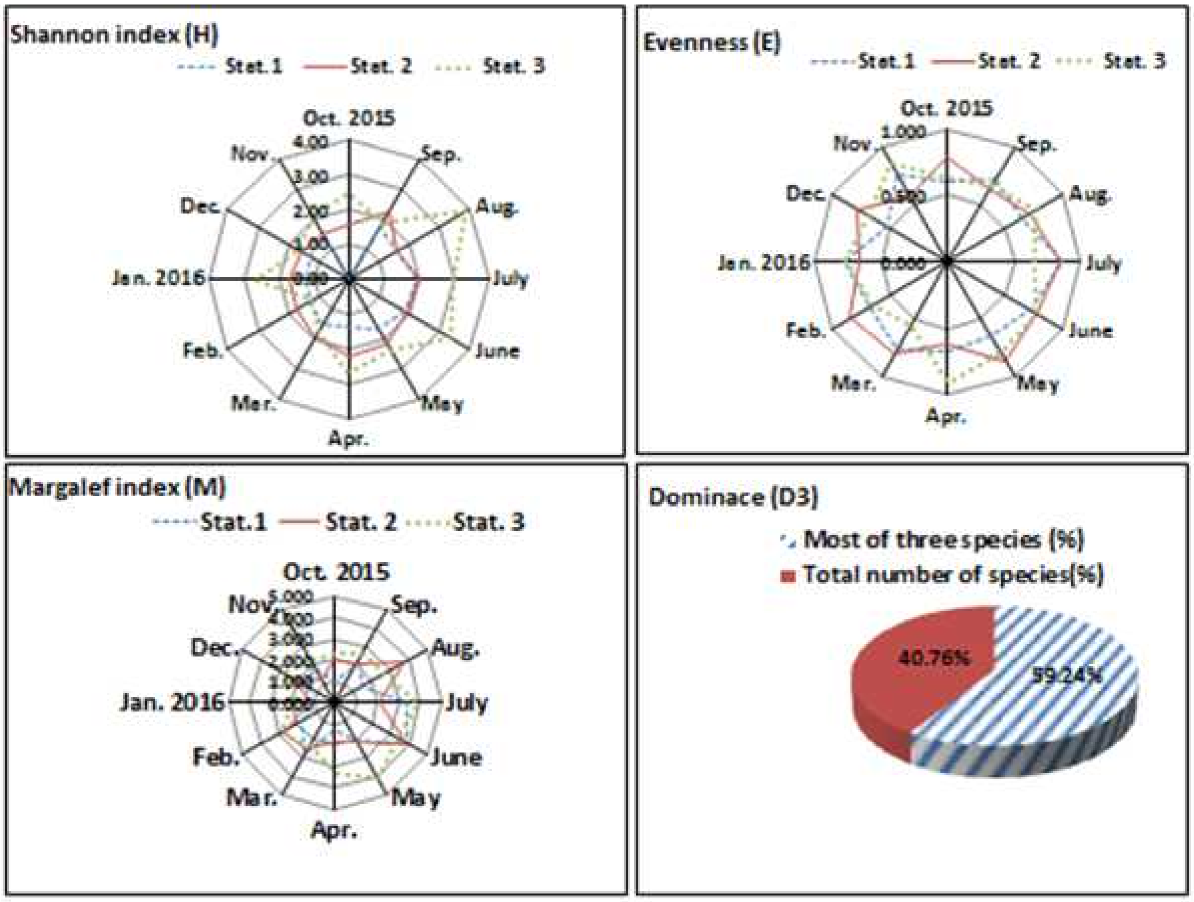

Fig. (6): Fishes diversity index during the study period.

Discussion

The quality of water depends on physical, chemical and biological parameters (Sargaonkar & Deshpande, 2003). Environmental factors have a direct role in the distribution of fish population in aquatic ecosystem (Thirumala *et al.*, 2011). The present results showed high concentrations of dissolved oxygen in a relatively cold months (December, January and February) for the three stations due to the rapid melting, lack of consumption and continuous mixing of the water. This is coincided with that of Hussein & Fahad (2008). Minimum values of dissolved oxygen were recorded at station 3, which may be attributed to its receiving the effluents of sewage water to the river directly through discharge which leads to the depletion of dissolved oxygen (W.H.O, 2008). Moreover, the solubility of gases in water is inversely proportional to the temperature of water (Lind, 1979). According to Reid & Wood (1961) classification, the water in the present study can be classified as Oligohaline (0.5-5g/l). The values of salinity were increased relatively and gradually at downstream at station 3 of the river. This is because of the inflow of water of Shatt Al-Arab river through the high tide as a result of decrease of riverine discharge from the Tigris and Euphrates rivers (Alkam & Abdulmunem, 2011). Total alkalinity is attributable to the amount of bicarbonates and this what record in Iraqi inland waters (Hussein *et al.*, 2008). The results indicated that such values were at within the limits of natural waters (A.P.H.A, 2005) as the range was from 20- 200 mg/ L. The most abundant fish species were *P. abu*, *C. zillii*, *C. auratus*, *A. mossulensis*, *O. aureus* and *C. luteus*, which were constituting 88.51% of the total number of individuals in all stations. This was also indicated by some researchers, such as Coad (2010) and Mohamed *et al.* (2012). The rest of species in Tigris river were recorded in lowest abundance (11.49%) of the total number which formed 21 fish species included six native freshwater fish species (*M. mastacembelus*, *A. marmid*, *S. triostegus*, *L. vorax*, *M. sharpeyi*, *G. rufa*) which formed 5.39%, seven of aliens species (*C. carpio*, *G. holbrooki*, *H. leucisculus*, *P. latipinna*, *H. fossilis*, *H. molitrix* and *A. dispar*) which constituted 1.95% and eight marine species (*T. ilisha*, *P. subviridis*, *A. arabicus*, *N. nasus*, *T. whiteheadi*, *T. hamiltonii*, *H. limbatus* and *P. klunzingeri*) which formed 4.13% of fish assemblage. Most of marine species were recorded in station 3. The present results varied with that of Mohamed *et al.* (2006) on fishes structure of lower reaches of Tigris River.

Occurrence of species in the studied stations was divided into three groups: common, seasonal and occasional species. Common species comprises *P. abu*, *C. zillii*, *C. auratus*, *A. mossulensis*, *O. aureus and C. luteus.* These species appeared in 12 months. This agreed with Abdullah (2015) during the study of the occurrence of these species in the lower reaches in Euphrates river. Other species (*T. ilisha*, *M. mastacembelus*, *A. marmid*, *C. carpio*, *S. triostegus*, *P. subviridis*, *G. holbrooki* and *A. arabicus*) were varied in occurrence in the monthly fishing samples, which confirmed with Younis *et al*. (2001). Five of seasonal species (*H. leucisculus*, *P. latipinna*, *M. sharpeyi*, *G. rufa* and *H. fossilis*) were involve they had monthly variations presence during study period, which coincided with Hussain *et al.* (2012). Occasional species were formed 0.88% of the total number species. *Nematolosa nasus* formed the highest value with in the group (0.11%) and lowest (0.01%) was that of *P. klunzingeri* in fishing samples for the stations. The present study differs from that of Al-Noor *et al.* (2009) of the lower reaches in Euphrates river in the appearance of these species with occasional species.

A biodiversity index seeks to characterize the diversity of a sample or community by a single number (Magurran, 1988). The biodiversity index values (H) obtained from the present study is poor according to Shannon-weaver index values and they do not exactly show the differences occurring in the stations 1 and 2. These indicated by Hossain *et al.* (2012) at anther environmental in Banglades. In station 3, the recorded values were medium. These coincided by Younis &

Al-Shamary (2011) during the studies of species composition of fish assemblage in Shatt Al- Basrah canal. According to months, the values of evenness index were varied between balanced and unbalanced guide among stations (Hussain, 2014).

According to Jorgensen *et al.* (2005), the overall status of Margalef richness (Fig. 5) of the fish assemblage in the Tigris River is considered as troubled which was calculated in the studied stations to be 2.010, 2.229 and 2.893, respectively.

The dominance (D_3) value for the main three abundant species (*P. abu*, *C. zillii* and *C. auratus*) was dominated in stations of Tigris river, while three species (*S. triostegus*, *C. auratus* and *P. abu*) formed 86.93% of the total number in Mohamed *et al.* (2006) on the same region.

Conclusions

The present study is coincided with Mohamed *et al.* (2006) for species population of fish assemblage in lower reaches of Tigris River in Qurna city. Their study has been recorded these fish species in different rates of ecological indices.

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