Status of Fish Assemblage Structure in the Garmat Ali River, Iraq

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Abstract: *The status of fish assemblage structure in Garmat Ali River, north of Basrah, Iraq was assessed. Fish were sampled monthly by different fishing gears from November 2015 to October 2016. Water temperature varied from 14.3^{o}C in December to 32.7^{o}C in September, and salinity ranged from 1.5‰ in June to 6.0 ‰ in December. A total 34 fish species belonging to 16 families were collected, 7 of them were native, 8 exotic and 19 marine species. The most abundant species were Poecilia latipinna, comprising 57.66% of the total catch, Tenualosa ilisha (15.29%) and Thryssa whiteheadi (7.96%). The dominance value (D3) was 80.9%. These results were contrasted with the past findings on the river. The mean annual values of diversity, richness and evenness indices were 1.91, 2.95 and 0.76, respectively. Associations between the distribution of fish species and the environmental variables were quantified by using canonical correspondence analysis (CCA).*
Keywords: *Fish assemblage, ecological factors, biodiversity indices, Garmat Ali, Iraq*

I. Introduction

Over the past years, the rivers have been increasingly subjected to the cumulative effects of anthropogenic disturbances such as point-source pollution, urbanization, agriculture, channel modification, impoundment, and nonnative species introductions. These human disturbances have directly and indirectly influenced fish assemblage structure by altering flow regimes, degrading water quality and habitat structure, disrupting energy inputs, shifting biotic interactions (Parks, *et al*., 2014).

The Garmat Ali River was subjected to multiple impacts from hydrological and human activities. After inundation of the southern marshes in 2003, the East Hammar marsh was fed primarily from the Euphrates River and entering the Garmat Ali River then the Shatt Al-Arab River that eventually flows into the Arabian Gulf. So, this river affected by the water from the Euphrates and tidal current of the Gulf through the Shatt Al-Arab River. But, the flow of the Euphrates was diverted away from the north East Hammar marsh during the last years, consequently the water level in the marsh dropped sharply, causing the water salinity higher than before, which led to negatively affected on water quality and quantity of the Garmat Ali River (Al-Tememi, *et al*., 2015).

Moreover, the Shatt Al-Arab River suffered from massive regression in water quality related to the decline in rates of discharge from the Tigris and the Euphrates Rivers (Al-Mahmood, *et al*., 2015) as a result of several hydrological projects constructed in the riparian countries (Partow, 2001), and the diversion of the Karun River into Iranian terrene (Hameed and Aljorany 2011). The average rate of discharge in the upstream of the Shatt-Al-Arab River was declined from 207m^3/s during 1977-1978 to 60m³/s during 2014 (Alaidani, 2014). Several studies have been supportive of the deterioration of the Shatt al-Arab water quality which attributed to reduced freshwater discharges from Tigris and Euphrates Rivers and the negative impact of salt intrusion from the Arabian Gulf over the past decade (Brandimarte, *et al.*, 2015; Moyel and Hussain, 2015; Yaseen, *et al*., 2016). The specific objective of this study is to describe the status of fish assemblage structure of the Garmat Ali River and then to compare this with the state of the fish assemblage in this river before a decade.

II. Materials and Methods

The study was carried out in the Garmat Alit Ali River, situated in the north of Basrah city, and is a waterway between the east Hammar marsh and the Shatt Al-Arab River (Fig. 1). The total length of the river is about 6 km, 280m width and the mean depth is 9m. The river is affected by the tidal current of the Arabian Gulf. Sampling on the river was conducted once a month from November 2015 to October 2016. Three sampling sites were selected: site 1 is located at the junction of the river with Shatt Al-Arab River, whereas site 2 is located north Garmat Ali Bridge and site 3 is located at the confluence of the river with the East Hammar marsh (Al-Mas`hab waterway). The predominant vegetations on the banks were *Phragmites australis*, and *Typha domingensis,* whereas *Ceratophyllum demersum* was dominant in the deeper areas.

Water temperature, salinity and pH were measured *in situ* using YSI portable instrument model 556 MPS. Transparency was evaluated by extinction method using the Secchi disc. Fish sampling was carried out

from each station using seine net (140 m long with a 36mm mesh size), fixed gill nets (120 m long with 2.5 cm to 10 cm mesh size) and electro- fishing gear (provides 300-400V, 3–5 A). Fishes were counted and classified to species following Carpenter *et al.* (1997), Durand, *et al.* (2012) and Coad (2017).
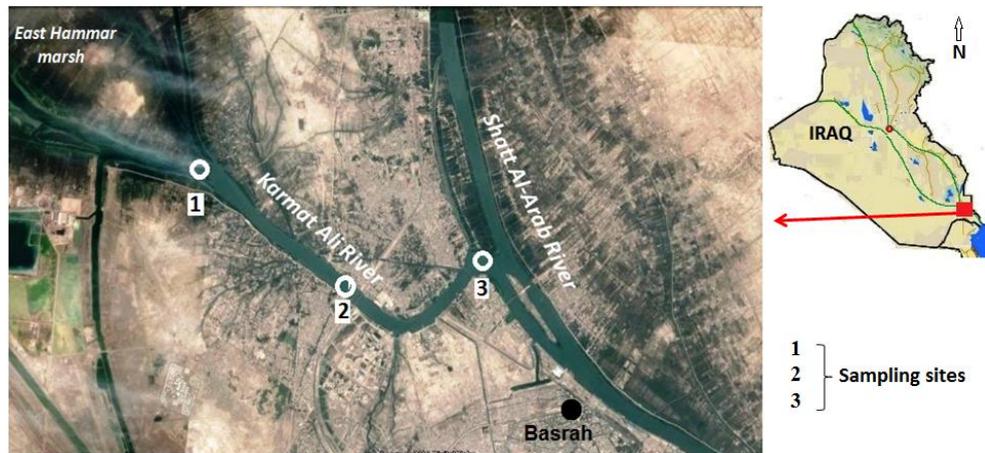

Fig.1. Map of southern of Iraq showing the sampling sites in the Garmat Ali River

The relative abundance was calculated from the equation $n_i /N \times 100$ (Odum, 1970), where n_i is the number of individuals of 'ith' species and $N= \Sigma n_i$. Shannon-Weaver index of diversity was obtained by the following equation $H'= -\Sigma p_i \ln p_i$ (Shannon and Weaver, 1949), where $p_i= n_i/N$; n_i is the number of individuals of 'i'th species and $N= \Sigma n_i$. The species richness was calculated using the equation $D= (S-1)/\ln N$ (Margalef, 1968), where S is the number of species, N is the total number of individuals. The evenness is $J= H'/\ln S$ (Pielou, 1977), where H' is the diversity and S is the number of species. The three most abundant species was determined by the following equation $D_3= [\sum_{i=1}^{3} pi.]\ 100$ (Kwak and Peterson, 2007), where P_i is the proportion of the total sample represented by the ith species.

All statistical analyses were performed using the SPSS version 16 for Windows. The multiple linear correlation analysis was carried out on water parameters and fish to verify if there is any significant relationship by applying the multivariate analysis of ecological data using CANOCO program (Ter Braak, 1986).

III. Results

Ecological factors

Water temperature, salinity, transparency and pH were not significantly differences between the three sampling stations ($F= 0.47, 0.81, 0.33$ and 0.20, $p \leq 0.05$), respectively. Therefore, the monthly variations in the mean values of these factors in the river are shown in Figure 2. The water temperature in this study varied from the lowest value (14.3^{o}C) which recorded during December to the highest value (32.7^{o}C) recorded during September, with overall value 23.5. The values of salinity ranged from 1.5‰ in June to 6.0 ‰ in December, with overall value 2.8. Transparency values varied from 17.7 cm in July to 55.0 cm in January, with overall value 29.9. Narrow fluctuation of pH was observed during the study period, with the highest average value of 8.3 was recorded during November and a low of 7.2, with overall value 7.7.
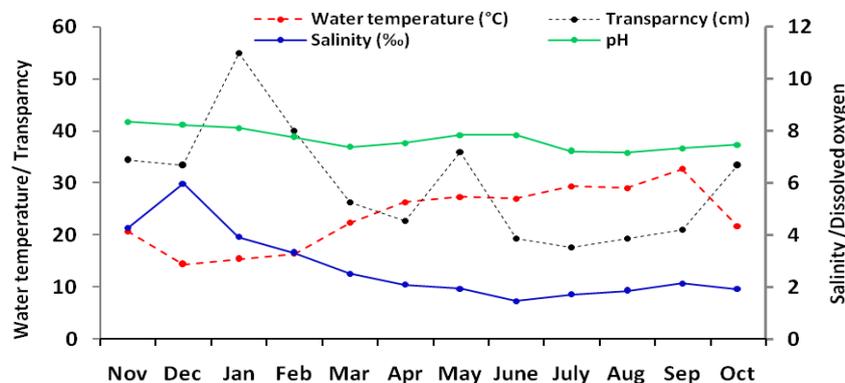

Fig. 2. Monthly variations in the some ecological factors of the Garmat Ali River

Species composition

Altogether, thirty four fish species belonging to 16 families were collected from three stations in the river (Table 1). Cyprinidae was the most dominated family in terms of number of species represented by seven species,

Table 1. Monthly variations in relative abundance of fish species collected from the Garma River
(* Native, + Migratory, ° Exotic)

Family	Species	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Total
Poeciliidae	*Poecilia latipinna* °	85.4	88.0	99.0	97.2	85.2	23.7	35.7	50.4	17.6	3.8	25.84	27.13	57.66
Clupeidae	*Tenualosa ilisha* +	2.17	1.04	0.04	0.25	1.26	2.09	2.02	1.16	63.8	61.2	42.39	34.62	15.29
Engraulidae	*Thryssa whiteheadi* +	6.41	1.01		0.08	2.84	47.1	3.73	2.17	8.23	18.3	17.3	12.05	7.96
Cyprinidae	*Carassius auratus* °	1.42	3.34	0.28	0.31	0.44	0.64	45.8	22.0	1.63	1.76	0.99	3.34	7.64
Engraulidae	*Thryssa vetrirostris* +	2.81	0.52	0.02	1.01	2.93	15.6	2.6	0.89	2.18	8.2	3.44	6.89	3.3
Cichlidae	*Oreochromis aureus* °	0.16	1.4	0.08	0.23	4.35	1.35	3.06	8.34	2.03	2.12	3.62	4.23	2.64
Mugilidae	*Planiliza abu* *	0.28	0.66	0.01	0.03	0.06	0.15	1.38	5.18	2.45	2.58	3.16	10.05	2.03
Cichlidae	*Coptodon zilli* °	0.2	2.44	0.53	0.74	0.7	2.83	2.11	5.7	0.23	0.32	1.09	0.8	1.47
Hemiramphidae	*Hyporhamphus limbatus* +	0.08	0.05			0.77	2.02	0.85	1.71	0.68	0.59	0.62	0.03	0.6
Gobiidae	Bathygobius fuscus +	0.53	0.03	0.01	0.01	0.2	0.51	1.69	0.76	0.12	0.39	0.22	0.11	0.38
Cyprinidae	*Alburnus mossulensis* *	0.22	0.47		0.01	0.08	0.1	0.07	0.49	0.81	0.04	0.35	0.24	0.21
Mugilidae	*Planiliza klunzingeri* +						2.79	0.08	0.02			0.02		0.18
Leiognathidae	*Photopectoralis bindus* +	0.11	0.03		0.02	0.05	0.03	0.32	0.01	0.05	0.64	0.79	0.37	0.17
Cichlidae	*Oreochromis niloticus* °	0.11	0.58	0.02	0.03	0.69	0.09	0.01	0.52				0.01	0.16
Cyprinidae	*Hemiculter leucisculus* °	0.03	0.47		0.08	0.08	0.54	0.16	0.08	0.03		0.01	0.06	0.1
Cyprinidae	*Acanthobrama marmid* *	0.08				0.33	0.22	0.04	0.08	0.03	0.04	0.07		0.07
Cyprinidae	*Cyprinus carpio* °							0.17	0.2					0.04
Cyprinidae	*Leuciscus vorax* *	0.02						0.01	0.01	0.1	0.05	0.05	0.05	0.02
Poeciliidae	*Gambusia holbrooki* °						0.01	0	0.17					0.02
Sparidae	*Acanthopagrus arabicus* +							0.17		0.02	0.01			0.02
Siluridae	*Silurus triostegus* *					0.01		0.02	0.02	0.02		0.01	0.02	0.01
Cyprinodontidae	*Aphanius dispar* *						0.02	0.01	0.03		0.01			0.01
Cyprinidae	*Carasobarbus luteus* *						0.08	0.01		0.01				0.01
Sillaginidae	*Sillago sihama* +					0.01	0.01	0.03				0.02		0.01
Mugilidae	*Planiliza subviridis* +						0.05			0.01		0.01		0.004
Gobiidae	*Boleophthalmus dussumieri* +					0.01		0.03						0.004
Scatophagidae	*Scatophagus argus* +							0.02						0.002
Sillaginidae	*Sillago attenuata* +						0.01							0.001
Bagridae	*Mystus pelusius* +					0.01								0.001
Engraulidae	*Thryssa dussumieri* +					0.01								0.001
Soleidae	*Brachirus orientalis* +					0.01								0.001
Mugilidae	*Planiliza carinata* +						0.01							0.001
Clupeidae	*Nematalosa nasus* +							0.01						0.001
Sillaginidae	*Sillago arabica* +						0.01							0.001

followed by Mugilidae (4 species), and Engraulidae, Cichlidae and Sillaginidae (3 species) each. Other families were contained one species each.

The monthly fluctuations in the number and individuals of species in the river are shown in Figure 3. The number of species ranged from 9 in January to 27 in May. Generally, the number of species captured increased during March to June. A total of 141437 fish were caught from the river, they ranged from 3650 in December to 23313 fish in February.
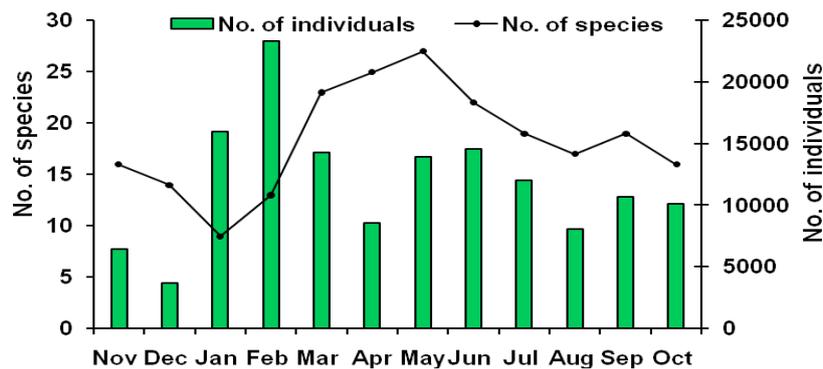

Fig. 3. Monthly variations in the number of species and individuals in the Garmat Ali River

The fish fauna of the river comprised of seven native, eight exotic and 19 marine species. The monthly variations in these categories are given in Figure 4. The native species constituted 20.6% of the total number of species and varied from one species in January to seven species in May, whereas the exotic species formed 23.5% and changed from five species in January, July and August to eight species in May and June. The migratory species consisted 55.9% of the total number of species and varied from three species in January to 13 species in April.
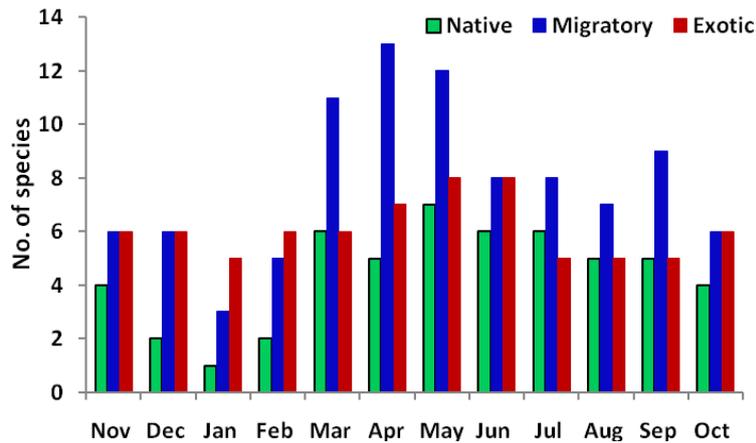
Fig. 4. Monthly variations in the number of native, migratory and exotic species in the Garmat Ali River

Relative abundance

The relative abundance of species in the Garmat Ali River during the study period are given in Table 1. It has been found that the fish assemblage was dominated by *Poecilia latipinna*, composed of 57.66% of the total catch, it varied from 3.8% in August to 99.0% in January. *Tenualosa ilisha* comprising 15.29% of the total catch, it fluctuated from 0.04% in January to 63.8% in July. *Thryssa whiteheadi* was formed 7.96% and the relative abundance ranged from 0.08% in February to 47.1% in April. These three species formed 80.9% of the total catch of species according to dominance index (D_3). However, *Carassius auratus* and *Planiliza liza* constituted only 7.64 and 2.03% from the total catch, respectively.

Fish diversity indices

Monthly variations in diversity, richness and evenness indices of fish assemblage in the river are illustrated in Figure 5. The diversity index (*H*) fluctuated from 0.47 in February to 1.66 in October, with overall value 1.91. The richness index (*D*) changed from 1.05 in February to 2.26 in April, with overvalue 2.95. The evenness index (*J*) ranged from 0.23 in February to 0.63 in October, with overall value 0.76.
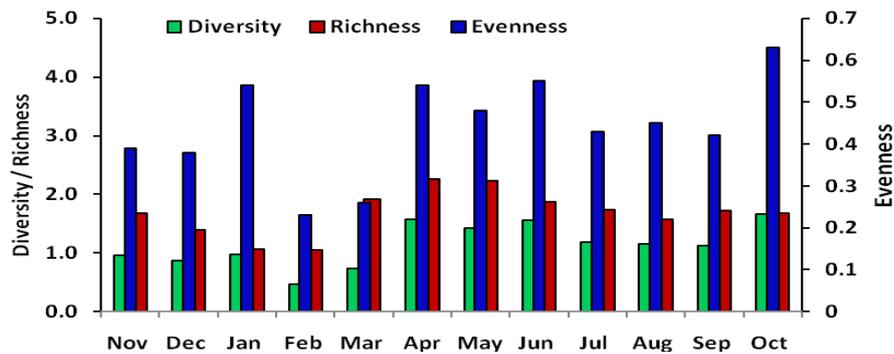

Fig. 5. Monthly variations in the ecological indices values of the Garmat Ali River

Relationships of fish with the ecological factors

Figure 7 illustrated the canonical correspondence analysis (CCA) ordination plot which summarized the relationships between the availability of the most numerous fish species and the environmental variables in the Garmat Ali River. The number of species and the following species *Thryssa vetrirostris, T. whiteheadi, Oreochromis aureus, P. abu, Coptodon zilli*, *C. auratus* and *T. ilisha*) were positively correlated with water temperature, and negatively correlated with salinity and transparency, except *P. latipinna*.
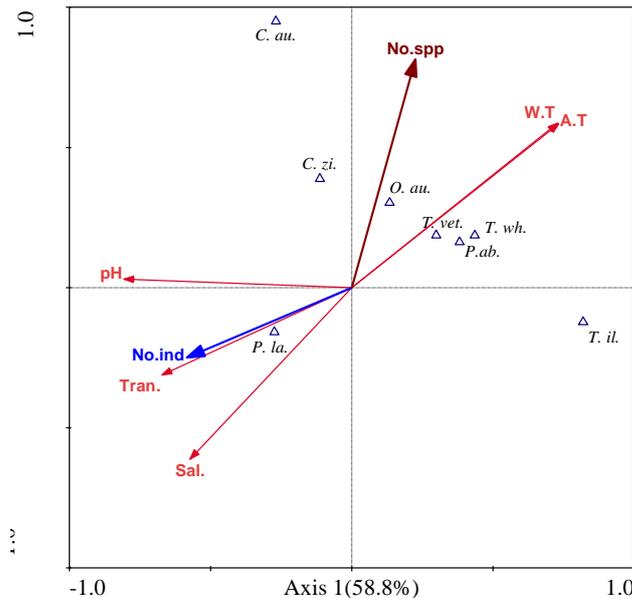
Fig. 5: CCA ordination plots showing the relationship among fish species and various ecological factors in the Garmat Ali River

IV. Discussion

The results of this study revealed that the fish assemblage was clearly shifted in the percents of exotic and marine species, the dominancy species and the fish diversity compared with the previous status. The fish fauna of the river comprised of seven native, eight exotic and 19 marine species, constituted 20.6, 23.5 and 55.9% of total number of species, respectively. *P. latipinna*, *T. ilisha*, and *T. whiteheadi* were most abundant species, comprising 57.66, 15.29 and 7.96% of the total catch, respectively. These results were contrasted with the past findings reported earlier on the river. Younis *et al.* (2010) collected 28 fish species from the river during 2003-2004, 13 species were native freshwater, representing 46.4% of the total number of species, 10 marine species consisted 35.7% and five exotic species formed 17.9%. The most abundant species during this period were *L. abu* and *C. auratus* constituting 58.8 and 11.72% of the total catch, respectively. Moreover, Mohamed *et al.* (2013) recorded 25 fish species from the river during 2007-2008, 10 (38.5%) of them were native, 10 (38.5%) marine and 6 (23.1%) exotic species, and the most abundant species were *L. abu*, *C. auratus* and *P. latipinna* constituting 39.3, 21.2 and 7.0% of the total catch, respectively. However, Mohamed, *et al.* (2014) mentioned that the fish assemblage in the East Hammar marsh during 2012 -2013 was dominated by exotic species of which *C. auratus* comprised 22.1% followed by *P. latipinna* (14.3%), while, *P. abu* and *C. zilli* (a new exotic species) formed 13.4% and 5.1%, respectively.

This could be as a result of unfavorable environmental parameters, especially higher salinity and the changes in hydrological conditions. Formerly, the ranges of salinity in the river were 1.33-2.35‰ during 2003-2004 (Younis *et al*., 2010) and 1.2-3.18‰ during 2007-2008 (Mohamed *et al.,* 2013), whereas in the present study was 1.5-6.0‰. During the last years, water influx the river was coming primarily from the Shatt Al-Arab River which affected by the tidal current of the Arabian Gulf. Several studies have been supportive of the deterioration of the Shatt al-Arab water quality in recent years (Al-Tawash, *et al.,* 2013; Brandimarte, *et al.*, 2015; Moyel and Hussain, 2015; Yaseen, *et al.*, 2016).

The degradation of water quality of the southern water led to several cyprinid species disappearance or substantially decreased in abundance, such as *Luciobarbus xanthopetrus*, *Arabibarbus grypus*, *Luciobarbus kersin, Mesopotamichthys sharpeyi* and *Carasobarbus luteus* (Richardson, *et al.,* 2005; Mohamed, *et al.,* 2012, 2013). Hughes and Whittier (2005) mentioned that native species represent the basic building blocks of a fish assemblage, and are a key component of diversity and the exotic species indicate biological pollution and a serious diversion from natural conditions, especially when they constitute a substantial percentage of the assemblage, and including when they are deliberately introduced. The extremely tolerant species are the last to disappear in response do environmental degradation (Costa and Schulz 2010). Researchers have commonly observed habitat degradation facilitating the underlying mechanisms causing the loss of native fish diversity, the temporal replacement of specialized native fish by exotic fish (Scott and Helfman, 2001; Olden and Poff, 2003; Parks, *et al*., 2014).

There were seasonal changes in fish diversity in the river and the richness indices had a general tendency to show high values during the period from March to July which could be attributed largely to the penetration of marine species especially anadromous species, such as *T. ilisha* and *T. whiteheadi*, corresponding

with increased in water temperature and decreased in salinity. This result is supported by the positive correlations between the number of species and abundances of all species, except the exotic species, *P. latipinna* with water temperature, and the negative correlations with salinity. The abundance of marine species has led to an increase in the richness, evenness and diversity indices and created seasonal fluctuation in the relative abundance (Hussain, *et al.*, 1989). This was comparable to the previous studies on the East Hammar marsh and the river (Mohamed *et al.*, 2009, 2013; Younis *et al.*, 2010).

V. Conclusions

The present study shows that the fish structure of the Garmat Ali River was clearly altered by increase percents of exotic and marine species, and decline in native species compare with the state of the fish assemblage of this river before a decade.

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