Structural Diversity of Fish Assemblage in the Southern Sector of Main Outfall Drains northwest of Basrah, Iraq

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Abstract: Fish assemblage was studied for a first time in the Southern part of Main Outfall Drain, in the Al-Kaii bridge region, northwest Basrah Iraq in the Al-Kaii bridge region. The study was conducted during the period from May 2016 to April 2017. Many types of fishing nets were used to collect the samples. Water temperature ranged from 14° C in February 2017 to 30° C in July and August 2016, while salinity ranged from 9 PSU in April 2017 to 42 PSU in December 2016. A total of 6161 individuals of fishes were caught represented 21 fish species. Six species were freshwaters fishes; four were alien species and 15 marine species. The species *Acanthurus sohal* was fished for the first time from the Iraqi inland waters. The most abundant three species were *Poecillia latipinna*, *Planiliza subviridis* and *Thryssa whiteheadi* formed 26.68%, 25.00% and 17.58%, respectively of the total number of samples. Values of the diversity index varied from 1.23 in November to 2.17 in May, evenness index values fluctuated between 0.52 in June to 0.88 in May, whereas richness index ranged from 1.14 in January 2017 to 2.02 in May. The present study concluded that there is a significant monthly fluctuation in salinity and the composition of fish community was changing continuously according to the salinity variation.
Keywords: Fish assemblage, Main Outfall Drain, Basrah, Iraq..

Introduction

Most modern studies have shown that fish communities are composed of different, non-random species and are largely controlled by the characteristics of the ecosystem and the nature of community through the combination of the influences of biotic and abiotic factors (Gebrekiros, 2016). Fish assemblages are defined as evidence indicators of habitat nature, natural circumstance degradation,

ecology pollution and total productivity of the ecosystem (Thorp *et al*., 2006).

Expected community composition based on the existence of species diversity and environmental conditions on extending longitudinal axis of the river is available ideas, so many recent concepts indicate that several external factors impact in dispersal, distribution and dynamics of species in an instant, human control, river shape and

design, river discontinuities, climate changes, floodplains and bronchial canals (Benda *et al.*, 2004; Thorp *et al.*, 2006).

Occurrence of species and distribution in different regions is highly related in their historical geography and its location about the latitude due to physiological factors which linked particularly in temperature and salinity (Cox and Moore, 2005).

There were no previous studies on this section of the Main outfall drain which deal with community structure, except one taxonomy study by Mutlak and Al-Faisal (2009), However, there were many studies executed dealing with fish assemblage in the neighboring the areas that have a link with investigated area which have similar environmental conditions such as Shatt Al-Basrah canal in the South of Iraq. Al-Daham and Yousif (1990) reported 47 species when they performed a study on fish community in Shatt Al-Basrah canal Younis and Al-Shamary (2011) collected 38 fish species, while Younis and Al-Shamary (2012) studied the impact of salt front on fishes assemblage in Shatt Al-Basrah canal and caught 56 species.

The present study was aimed to assess nature of fish community structure and knowing the impacts of temperature and salinity on fish assemblage, species occurrence and diversity.

Materials and Methods

Description of the study area

The Main outfall drain is one of the major development projects in Iraq. It's important for the transfer of salt water from the reclamation of agricultural land in central and southern Iraq as it transfers salt water and chemical fertilizers used widely in agriculture to the Arabian Gulf across Shatt Al-Basrah canal to Khor Al-Zubair lagoon. The project was completed in 1992 with a length of 565 kilometers from the northwest of Baghdad city to the Arabian Gulf.

The study area of the Main outfall drain was studying for the first time, because of the difficulties of reaching as it is located in the middle of a large oil field. The extend of the studying area stretch is 30 km from the meeting of Umm- Al-Marik river (N 30° 42 36″ E 47° 10′ 12′) with Main outfall drain to beyond Kii bridge in ten kilometers (N 30° 42 ′ 36″ E 47° 24′ 36″.) The positions were fixed by GPS etrex type Garmin Company manufactured. The width of the river is 110 meters in the surface and 50 meters in the bottom, but the submerged sides increase the area to 800 meters, the waters of this section reach the Arabian Gulf through the Shatt Al-Basrah canal (Al-Munshed, 1998). Salinity concentration is high, and largely monthly fluctuations; due to the water discharges of the river as a result of human control (Fig. 1).

Samples were monthly collected from the studying area during the period from May 2016 to April 2017. Many net types were used to collect fishes such as the fixed gill net (80 to 100m length mesh size 22 to 50mm), drift gill net (60 to 80m length mesh size 22 to 57mm) and cast net (22mm mesh size). Fish were identified according to Carpenter *et al*. (1997), Mutlak and Al-Faisal (2009) and Coad 2010).

Environmental factors were measured in synchronization with the time of fishing. Water temperature was measured by mercurial thermometer (-10 to100 °C) and salinity (PSU) measured by Lovibond-Sensor Direct 150 manufactured in Germany. Community structure analysis was done as relative abundance according to Krebs (1974) as in the following:

$$\% = (n_i / N)\ 100$$

Where n_i= number of individuals species in the sample and N= Total number of individuals of all collected species.

Diversity Index equation was calculated according to Shannon and Weaver (1949) as the following:

$$H = -\sum p_i \ln p_i$$

Where H= diversity index and P_i = the proportion of individuals in the (i) the species.

Evenness index was calculated according to Pielou (1977) as in the following:

$$J = H / \ln s$$

Where J= evenness index and S= number of species

Richness index was calculated according to Margalef (1968) as in the following:

$$D= S-1/lnN$$

Where D= richness index N= number of all individuals in samples.

To analyze the correlations between both temperature and salinity and number of species and individuals, SPSS program version 20 was adopted to execute the correlation relationships.

Species occurrence was done according to Hussain and Naama (1989) as in the following:

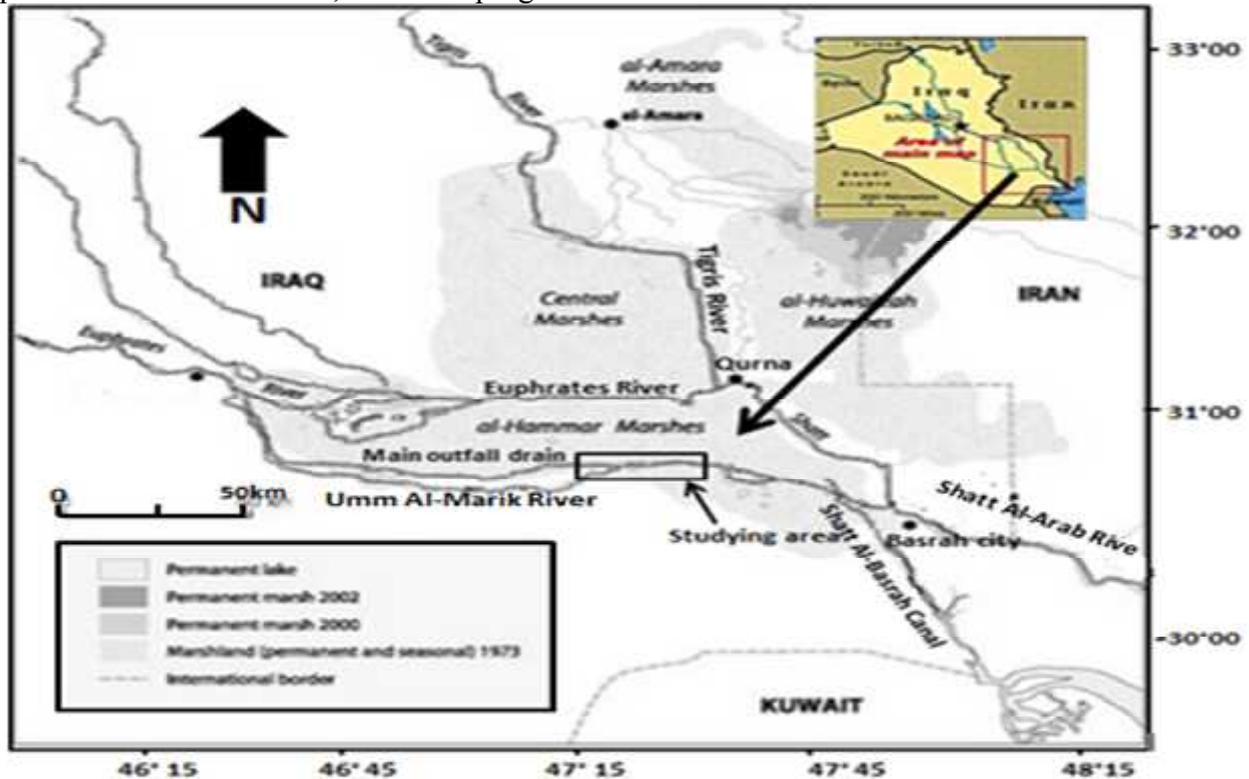Common species (> 50), rare species (6-50) and very rare species (< 6).

Fig. (1): Map of the studying area.

Results and Discussion

Ecological factors

Monthly changes in water temperature varied from 14 ºC in February to 30 ºC in July and August, while the lowest salinity (9 PSU) was obtained in February and the highest (42 PSU) in December (Fig. 2).

The correlation relationships of temperature with number of species and individuals addressed as correlation coefficient (r) value. A weak positive correlation (r= 0.385) was found between temperature and the number of species and number of individuals (r= 0.319). Negative correlations (r= -0.449 and r= -0.358) were observed respectively between number of species, individuals and salinity.
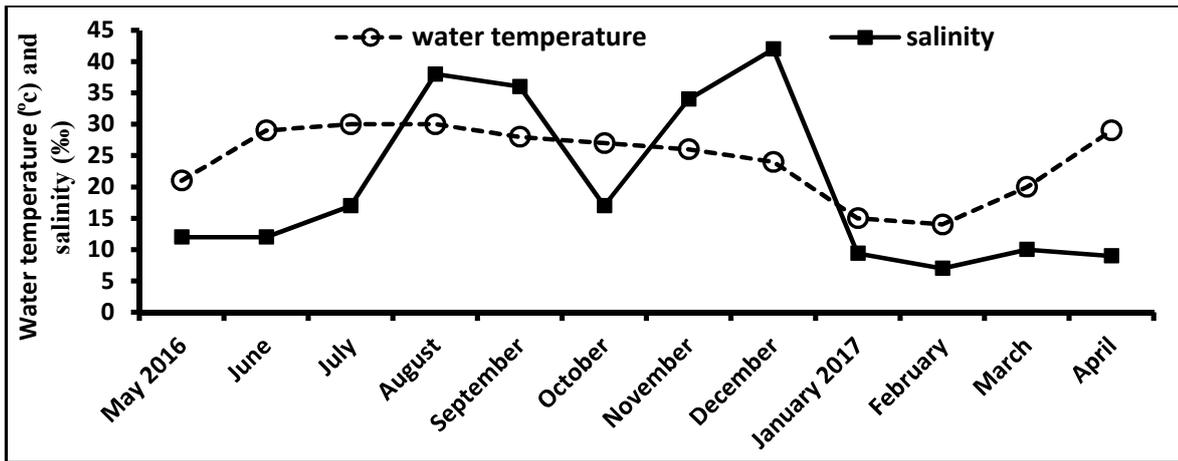
Fig. (2): Monthly variations in temperature and salinity in the northwest Basrah sector of Main outfall drain.

Fish catch composition

Number of species

A total of 21 species belonging to Osteichthyes were caught from the Main outfall drain northwest of Basrah. These belonged to 18 genera, 13 families and seven orders. Marine species included 15 species of which six affiliated to the freshwater. Six species represented freshwater species: two of them were native and four of them were alien species. The occurrence of *Acanthurus sohal* represented first record in Iraqi inland water, while *Boleophthalmus dussumieri* which is a marine species can live in freshwater habitat (Table 1). The numbers of species in the study area were fluctuated between 14 species in April (formed 66.67%) and seven in December (formed 33.33%) of the total number of species (Fig. 3).

Number of individuals

Large variations in number of individuals were observed among the different month of the study area. A total of 6161 individuals of fishes were collected from Main outfall drain in the northwest Basrah. The lowest number of individuals in December (135 specimens formed 2.19%) while the highest (1377 specimens in April) comprised 22.35% of the total number of fish (Fig. 4).
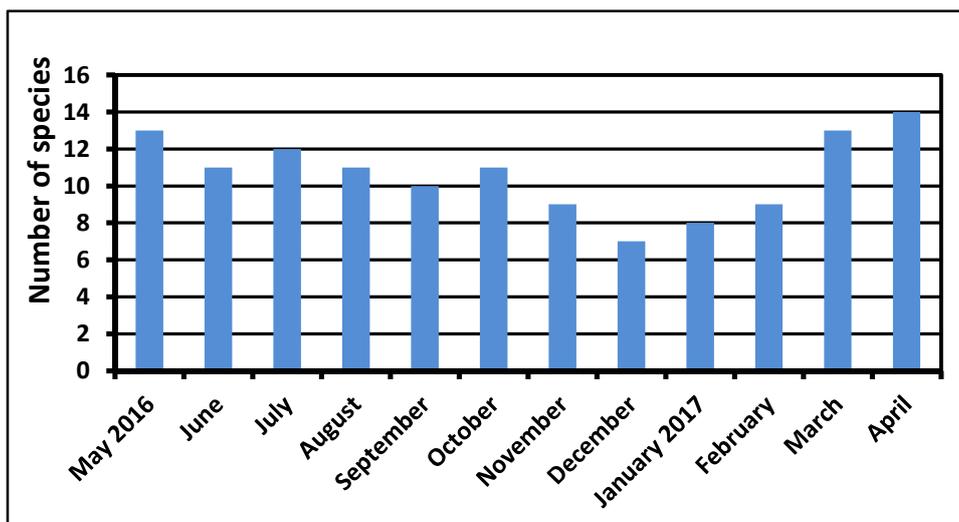

Fig. (3): Monthly changes in number of species in northwest Basrah portion of Main outfall drain.

Table (1): Fish species collected from northwest Basrah sector of Main outfall drain during the period from May 2016 to April 2017. (M: Marine species, F: Freshwater species, ×: Alien species)

| Species	Habitat	Family	Order
Tenualosa ilisha	M	Clupeidae	Clupeiformes
Nematalosa nasus	M		
Thryssa whiteheadi	M	Engraulidae	
Thryssa vitrirostris	M		
Carassius auratus ×	F	Cyprinidae	Cypriniformes
Carasobarbus luteus	F		
Poecillia latipinna ×	F	Poeciliidae	Cyprinodontiformes
Platycephalus indicus	M	Platycephalidae	Scorpaeniformes
Pseudosynanceia melanostigma	M	Synanceiidae	
Coptodon zillii ×	F	Cichlidae	Percifomes
Oreochromis aureus ×	F		
Acanthopagrus arabicus	M	Sparidae	
Sillago sihama	M	Sillaginidae	
Sillago arabica	M		
Acentrogobius dayi	M	Gobiidae	
Boleophthalmus dussumieri	M		
Acanthurus sohal	M	Acanthuridae	
Planiliza subviridis	M	Mugilidae	Mugiliformes
Planiliza abu	F		
Planiliza klunzingeri	M		
Brachirus orientalis	M	Soleidae	Pleuronectiformes
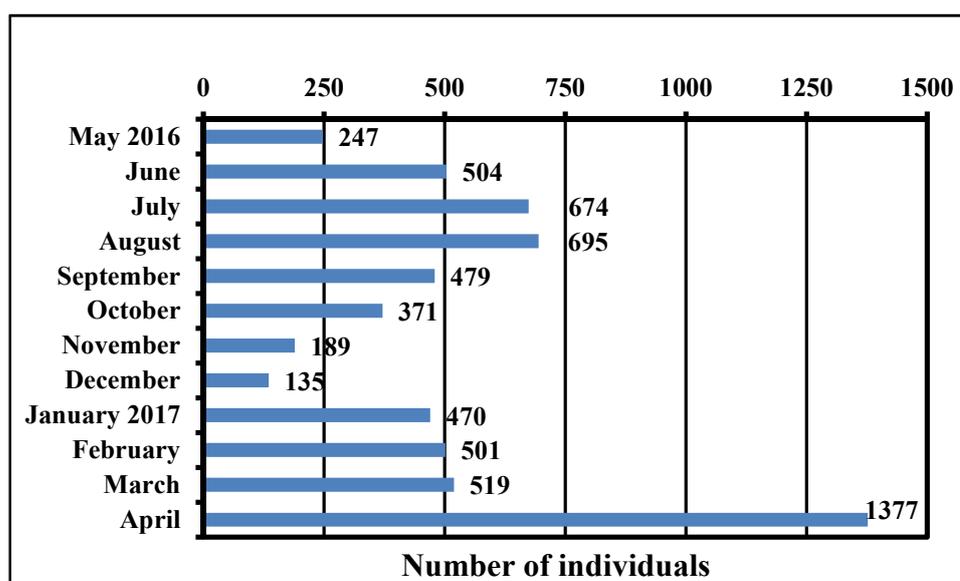
Fig. (4): Monthly variations in the number of individuals in the northwest Basrah sector of Main outfall drain.

Relative abundance

Three species topped the numerical relative abundance formed 69.26% of the total number of species in the study area during the period from May 2016 to April 2017. *P. latipinna* was the most abundant fish species, followed by *P. subviridis, T. whiteheadi, O. aureus* and *P. abu*. Mugilidae, the most abundant family, included *P. subviridis, P. abu and P. klunzingeri*, Poeciliidae included *P. latipinna*, Engraulidae comprised of *T. whiteheadi* and *T. vitrirostris* Cichlidae consisted of two species: *O. aureus* and *C. zillii* Gobiidae included *A. dayi* and *B. dussumieri*.

Three species appeared in 12 months *P. subviridis*, *T. whiteheadi* and *A. arabicus*. *P. latipinna* caught during ten months, while two species month (*N. nasus* and *A. sohal*) occurred during one month (Table 2).

Table (2): Relative abundance of species and their families in the northwest Basrah portion of Main outfall drain during the period from May 2016 to April 2017.

Species	%	Occurrence months	Family	%
P. subviridis	25.00	12	Mugilidae	30.23
P. abu	5.10	5		
P. klunzingeri	0.12	2		
P. latipinna	26.68	10	Poeciliidae	26.68
T. whiteheadi	17.58	12	Engraulidae	18.20
T. vitrirostris	0.62	2		
O. aureus	6.83	8	Cichlidae	9.98
C. zillii	3.15	8		
A. dayi	3.99	9	Gobiidae	6.32
B. dussumieri	2.34	8		
T. ilisha	2.11	6	Clupeidae	2.29
N. nasus	0.18	1		
A. arabicus	2.24	12	Sparidae	2.24
C. auratus	1.49	2	Cyprinidae	1.77
C. luteus	0.28	4		
S. sihama	0.91	6	Sillaginidae	1.07
S. arabica	0.16	2		
B. orientalis	0.57	8	Soleidae	0.57
P. indicus	0.52	7	Platycephalidae	0.52
P. melanostigma	0.10	3	Synanceiidae	0.10
A. sohal	0.03	1	Acanthuridae	0.03

Ecological indices

The monthly variations in ecological indices were very clear during the period of study. Values of the diversity index varied from 1.23 in November to 2.17 in May. Evenness index values fluctuated between 0.52 in June to 0.88 in May, whereas richness index ranged from 1.14 in January 2017 to 2.02 in May (Fig. 5).
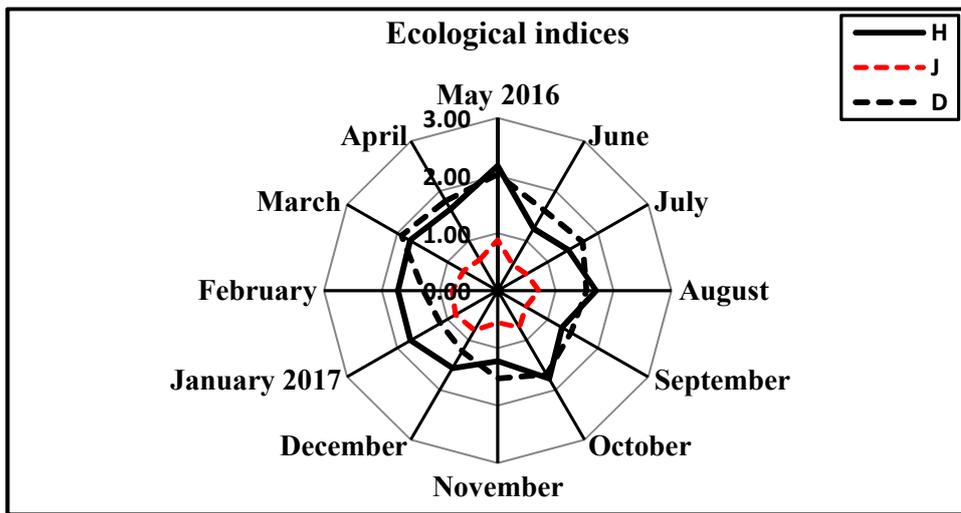
Fig. (5): Monthly variations in the ecological indices in the northwest Basrah portion of Main outfall drain.

Analysis of cluster results due to temporal variations revealed three main groups. The first main group included March and April. The second main group consisted of two secondary groups: the first secondary group included June, July and August the other secondary group included May only. The third main group was divided into two secondary groups: first group included January and February, but the other group included December only. The second secondary group had two groups: the first September and October, while the other had November only (Fig. 6).

Occurrence of species

Fish species guilds were separated into three groups according to their occurrence. The common species included 12 species (formed 97.42% of the total number of species), rare species included eight species (comprised 2.55%) and one very rare species which contains 0.03% of the total number (Table 3.and Fig. 7).
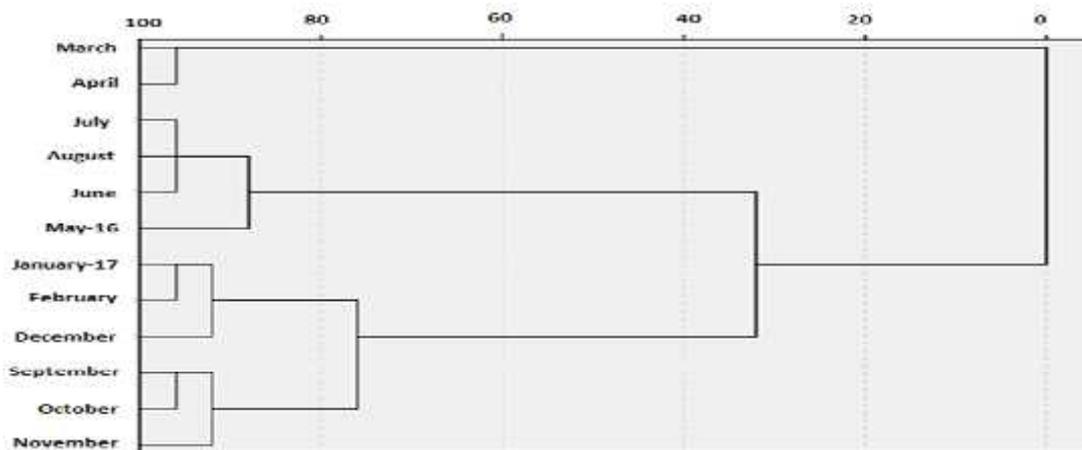

Fig. (6): Cluster analysis of temporal variations of fish species groups in the northwest Basrah portion of Main outfall drain.

Table (3): Occurrence of fish groups in the northwest Basrah of Main outfall drain.

Number	Group	Species
More than 50	Common	*A. arabicus, A. dayi, B. dussumieri, C. auratus, C. zillii, O. aureus, P. abu, , P. subviridis, P. latipinna , S. sihama, T. ilisha, T. whiteheadi,*
6-50	Rare	*B. orientalis, C. luteus, N. nasus, P. klunzingeri, P. indicus, P. melanostigma, S. arabica, T. vitrirostris,*
< 6	Very rare	*A. sohal*

Legend: Common species, Rare species, Very rare species.
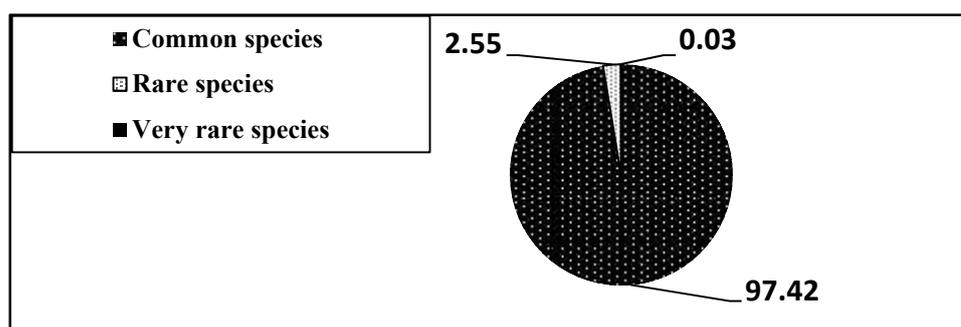Values: 2.55, 0.03, 97.42

Fig (7): Occurrence of species in the northwest Basrah portion of Main outfall drain.

Discussion

The present studying area differs from other riverine regions in the South of Iraq. It is characterized by large fluctuation in salinity concentrations, level of water and continuous variations in fish community structure due to salinity variations in the south part of main outfall drain, as it is under human control.

Salinity strongly shafting in fish community structure in southern portion of Main outfall drain is due to entry or absence of freshwater species depending on water salinity concentrations that release from the dam North of the river in Al-Siphone area in Al-Nassiria city according to human controls of water discharge and this evidence in monthly variations in species composition, However; salinity plays an important role in nature of community structure through its influence on widespread distribution of fishes within the longitudinal zonation of the river (Kautza and Sullivan, 2012). Tolerance of species to salinity differs from species to another, so the composition of assemblage,

species richness and diversity varied on the longitudinal sectors of the river according to salinity gradient (Pombo *et al*., 2005). The results shown negative correlation relationships between temperature and salinity on one side and both number of species and individuals on the other side which may be related to anthropogenic influence.

Naturally, structuring of fish community in Main outfall drain was varied due to the variations in abiotic and biotic factors in the large scale of the river with the variance clearly appears, during spatial and temporal fish guilds structure (Higgins, 2009). Numbers of species were highly fluctuated during the study period depending on physical, chemical and biological factors such as species salinity tolerance, nature of food and competition. Low salinity concentrations below 20 PSU allow freshwater fishes to occur in the investigated area (Hossain *et al*., 2012). The permanent presence of marine species may be due to high concentrations of salinity and due to the link with Arabian Gulf

by Shatt Al-Basrah canal (Younis and Al-Shamary, 2011).

Jarah Al-Maliki *A. sohal* was catch for the first time from the main outfall drain. It is usually occurring in the vicinity of coral reefs or rocky bottoms. It also may occur in aggregations, but the presence of species in the Arabian Gulf gave the possibility of entering the main outfall drain that linked with the Arabian Gulf, especially when some of the bottoms and edges of the river are lined with rocks. This finding iscompatible with (Carpenter *et al.*, 1997; Abed, 2010).

The number of individuals of fishes exhibited high monthly variations, perhaps linked with season, fishing effort and period, width, deep of river, stability of environmental conditions, overfishing and biotic factor that may agree with Higgins and Wilde (2005).

Mugilidae was the most abundance family in the studying area as it shared in three species (*P. subviridis*, *P. abu* and *P. klunzingeri*) which formed 30.23% of the total species ARDI (2006) and Al-Noor and Abdullah (2015) reported that *P. abu* is characterized by high thermal tolerance and have large potential to live in badly water quality due to their tolerance to low concentrations of oxygen and high salinity, in addition to availability of its food in habitat which formed mainly from organic detritus.

The species *P. latipinna* ranked the second in relative abundance. It is an alien species which prefers warmer temperature and can live in fresh, brackish and sea water, characterized by high tolerability of salinity (euryhaline) and available nutrients in environments which consist of plant, algae, small crustaceans and aquatic insects (Coad, 2010). The family Engraulidae is coming in the third ranked in relative abundance as it participated in two marine species, also entering fresh water for feeding, mostly on zooplankton, and prefer warm water. However; the current study came close to results of Younis and Al-Shamary (2011), as they found that members of this family ranked second in terms of relative abundance and obtained 16.9% of the total number in Shatt Al-Basrah canal which is an expansion of the current study area.

Increases of salinity concentrations in freshwater are used as criteria of pollution. Sensory parameters (color and smell) insure existence of organic pollution. These indicators indicate poor water quality; therefore, only tolerable of the tolerance freshwater species of Mugilidae, Cichlidae, Poeciliidae and some of marine species were presented over the year in southern part of Main outfall drains.

Table (4): Comparison of diversity (H), evenness (J) and richness (D) indices with the previous studies in the Sothern sector of Main outfall drains.

The study	The study area		H	J	D
Yousif (1986)	Shatt Al-Basrah canal		0.49-2.84	0.07-0.50	1.33-5.32
Jasim (2003)	Shatt Al-Basrah canal and Shatt Al-Arab River		0.17-2.13	0.24-0.98	0.28-2.87
Younis and Al-Shamary (2011)	Shatt Al-Basrah canal	Station 1	1.01-2.32	0.37-0.86	0.95-3.05
		Station 2	0.88 -2.24	0. 37-0.79	1.45-3.06
The present study	Main outfall drain (Al-Kii bridge area)		1.23-2.17	0.52-0.88	1.14-2.02

Jun *et al*. (2012) stated that the ecological indices work on the qualitative and quantitative assessment of aquatic communities, and reflects the heterogeneity of the ecosystem. The greater diversity creates more stable communities which are composed

of a large number of species which are widespread and balanced. The results showed values of diversity index between medium and poor, while the evenness index showed semi-balanced case except in May which was due to moderate temperatures in this month, and richness index seems troubled (Jorgensen *et al*., 2005).

The comparison of previous studies on Shatt Al-Basrah canal with the present study showed the diversity and evenness indices within the range of these studies, while the richness index values were more than values of the present study, which may be due to increased number of marine species in Shatt Al-Basrah canal more than that of the present region, due to its proximity to the Arabian Gulf (Table 4).

The temporal appearance of fish species is strongly related to their vital activities such as feeding, reproduction and migration. Their vitality was a major reason for their hunting. Thus, they appear in time groups controlled by temperature (Scott and Poynter, 1991; Lucas *et al*., 2001).

Conclusions

The study concluded that the community structure was in continuous dynamic changes due to largely monthly fluctuated in salinity. Therefore, the community structure of fishes was highly monthly different, which influences speared and distribution of fishes, because the region was under human control according to specific water discharges.

Acknowledgements

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