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Analysis of Natural Food Composition of Fishes in Shatt Al-Arab River, Southern Iraq

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Abstract

A total of 1469 fishes of 39 species were caught between July 2010 and March 2011, using coastal seine net from three stations in Shatt Al-Arab River (Al-Daeir, Hamdan and Al-Fao). Environmental factors in the river were measured (water temperature (21.85±4.71°C), pH (7.96±0.25), salinity (3.26±2.25 ppt), D.O.(9.15 ±1.77 mg/L) transparency (37.29±16.08cm).The dominant species in Shatt Al-Arab River was *Carassius auratus* which comprises 20.76% and 42.90% from total numbers and weight, respectively. The feeding intensity (8.79 - 12.37 point/fish) for all fed fishes indicates that most fishes fed with half fullness stomach at all seasons. The food contents of 593 individuals belonging to 15 species were analyzed for reliable results. Sixteen food items used to calculate standardized diet compositions and trophic levels of fishes. Plant origin food items comprise 48.54% of preponderance index, while it was 39.43 and 12.03 % for animal and organic matter food items, respectively. Shatt Al-Arab feeding index showed two peaks at spring and autumn (61.87, 59.74, respectively).While the mean value of trophic level for vegetarian fish species was 2.06 which differ significantly (F=12.14,145.01 P= 0.013,0.00) from both species which depend on detritus (1.36) and on animal (3.38) food items, respectively, which were also significantly different (F=350.04,P=0.00) from each other.

Keywords: Shatt Al-Arab, Preponderance Index, Trophic Level, Feeding Intensity.

1. Introduction

The quality and quantity of the available natural food resources influence aspects of the life history of fishes including inter alia, growth rate, longevity, reproductive investment, sexual maturity and fecundity (King, 1994). The study of the food and feeding habits of fish species is a subject of continuous research because it constitutes the basis for the development of a successful fisheries management programmed on fish capture and culture and because the aquatic ecosystem is dynamic. The gut content is a reflection of the water quality, all other factors being constant (Oronsaye and Nakpodia, 2005; Ekpo *et al.,* 2014). Nature offers a great diversity of organisms that are used as food by fish, and these differ in size and the taxonomy group (Olojo *et al.,* 2003), most studies which are aimed at obtaining such information on food, feeding ecology are based on the analysis of gut content of organism caught from their natural habitats (George *et al.,* 2013; Job and Udo, 2002; Odum, 1971). The diet composition of fish within an assemblage is determined not only by the food availability but also, to some extent, by the factors related to the interspecific competition for food (Casaux and Barrera-Oro, 2013).

Southern Iraq is part of the Mesopotamian lowland bounded to the west by the Arabian plateau, to the east by the Zagros mountain range of Iran, and to the south by the Arab Gulf and Kuwait. The area is characterized by its saline soil washed by the waters of Tigris-Euphrates River system (Al-Daham and Yousif, 1990). During the past years, the Mesopotamian rivers were suffering from various problems, like the new hydrological projects, several large dams in Turkey, Syria, Iran, and Iraq have diverted water from the Tigris and Euphrates and their tributaries for irrigation, flood control, and hydroelectric power (Mohamed *et al.,* 2012).Thus, because of the distinguished environment besides the fluctuations during the last years, it was expected that Shatt Al-Arab river fish species, especially its feeding status, may reflect these alterations.

The present study describes the natural food composition, feeding intensity and feeding habits of the most abundant species caught from Shatt Al-Arab river, evaluating the possible effects of the environmental changes on stomach content; such important information is needed for the continuous successful management of this vital river.

2. Materials and Methods

2.1. Study Area

The Shatt Al-Arab River represents the most northwestern end of the Gulf (Fig. 1). It is formed by the confluence of the Tigris and Euphrates rivers at Qurna,

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flows southeastern direction to open in the Arabian Gulf south of Al-Fao city. The total length of Shatt Al-Arab River is about 204 km, the width varies from 400 to 1500m, and hundreds outlets in the form of small rivers and canals are found on both sides of Shatt Al-Arab River (Al-Lami, 2009; Mohamed *et al*.,2012).

Sampling on the river was conducted once a season from June 2010 to March 2011. Three sampling stations were selected: Al-Daeir (north), Hamdan (middle) and Al-Fao (south).

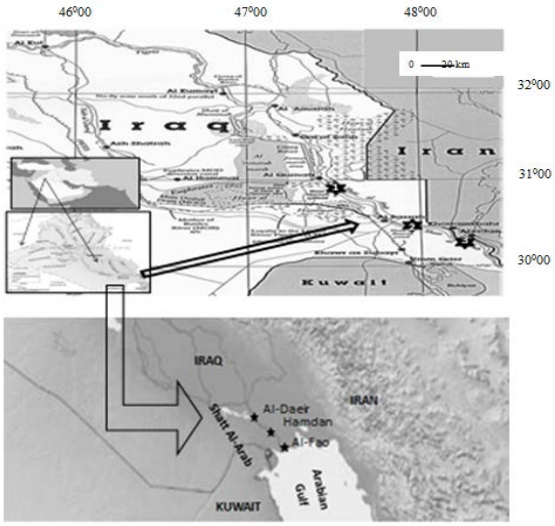

Figure 1.Map of the Shatt Al-Arab River showing the sampling area.

2.2. Fish Collection

Fishes were collected seasonally from Shatt Al-Arab River using coastal seine net with 100 meters length, 8 meters height and a mesh size 10×10 mm. The fish were preserved in cold ice box until reaching the laboratory where they were transferred into a freezer. Total lengths and weights of fishes were measured and the digestive tracts were removed and given a degree of fullness and emptied into a Petri dish to count different food items. Frequency of occurrence and point methods were used to analyze different food items (Hynes, 1950). The food contents of 593 individuals analyzed belonged to 15 species, which occurred in sufficient numbers for reliable results. For further details, see Mohamed *et al.* (2012) and Al-Lamy *et al.* (2015).

2.3. Data Analysis

The feeding data of fish species were analyzed using different parameters as follow:

- 1- Feeding intensity (Hyslop,1980)
  Feeding intensity = Σ points/ Σ feeding fish
- 2- Feeding index (Sarkar and Deepak, 2009)
  Feeding Index = P x 100/ X x N

where, P= total point of the gut that were examined, N= No. of guts examined, X= total points allotted to the full gut.

- 3- Index of Preponderance (Natarajan and Jhingran, 1961)
  I = ViOi/ Σ ViOi

where, I = Index of Preponderance of the food item; Vi = Percentage of volume (points) index of the food item; Oi = Percentage of occurrence index of the food item.

- 4- Feeding selectivity (Lawlor, 1980)
  PXi = Xi/ Σ i
- where Xi = quantity of item i in stomach of specie (i)and Σ i= sum of item (i)in all stomachs of all species present in station.
- 5- Trophic level (Corte´s,1999)
  TrL=1+ [Σ Pj.TLj]

where,TLj is the trophic level of each prey category j and Pj is the proportion of prey species j in the diet of species i Trophic level (TrL) of prey categories was taken from several published accounts (Table1).

Table 1. Prey categories used to calculate standardized diet compositions and trophic levels of fishes in Shatt Al-Arab River.

Code	Group	Trophic level*
Fish, Molluscs, Crustaceans, Zooplankton, Eggs and Worm	Animal	2.515
Plant, Ph.plank, Fil. Algae, Green algae, Spirogera and Diatom	Plant	1

*Calculated from Corte´s (1999).

2.4. Statistical Analysis

The SPSS (Statistical Package for the Social Sciences) version 17.0 (2008) was used. Data were expressed as Mean ± SD and analyzed by ANOVA followed by LSD test for multi-group comparisons. A probability level of $P<0.05$ was considered statistically significant.

3. Results

3.1. Ecological Factors

The ecological factors showed seasonal changes in the studied stations of Shatt Al-Arab River (Table 2). All factors, except transparency and salinity, revealed obvious variations among different stations, especially between Al-Fao and the other two stations.

Table 2. Mean values of the environmental factors at the three studied Stations in Shatt Al-Arab river during 2010-2011

Environmental Factors	Station											
	Al-Daeir				Hamdan				Al-Fao			
	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter	Spring
Temperature(°C)	28.3	23.0	15.2	21.0	26.7	22.0	15.4	23.0	27.0	25.0	14.6	21.0
pH	8.3	8.2	8.0	7.8	7.7	7.9	8.1	7.6	8.0	7.8	7.9	8.2
Salinity (PSU)	1.2	0.8	1.8	1.9	1.4	2.3	3.8	2.0	5.8	6.2	7.6	4.3
O_2 (mg/L)	8.5	9.5	12.5	10	7.5	8.6	12.5	8.5	7.2	7.5	8.2	9.3
Transparency (cm)	47	56	55	43	47	42.5	48	36	12	8	20	33

3.2. Fish Species

A total of 39 fish species were caught from Shatt Al-Arab River during the four seasons belonging to fresh and marine environments. The total number of individuals were 1469 fish that ranged from 305 (*Carassius auratus*), which comprise about 20.76% and 42.90% from total numbers and weight, respectively, to only one individual for seven different species (Table 3). Only nine species (23%) occurred in all the four seasons while most species occurred in one season (44%) especially in summer (eight,21%).Also most species occurred in one station (46%) and two stations (41%) while only five species (13%)occurred at all three stations.

Table 3. Total numbers and total weights of fish species collected from the Shatt Al- Arab river, Southern Iraq (July 2010 to March 2011). Species are listed in order of abundance.

Rank	Species	Number		Weight		Appearance	
		Total	%	Total(gm)	%	station	season
1	*Carassius auratus*	305	20.76	30385.46	42.90	1,2,3	All
2	*Liza abu*	175	11.91	6569.64	9.27	1,2	All
3	*Tenualosa ilisha*	149	10.14	5108.41	7.21	1,2,3	All
4	*Chelon subviridis*	140	9.53	7468.23	10.54	1,2,3	All
5	*Johnius belangerii*	90	6.13	3224.08	4.55	3	S,W,Sp
6	*Thryssa hamiltonii*	89	6.06	1136.94	1.61	2,3	All
7	*Acanthopagrus arabicus*	66	4.49	2243.94	3.17	2,3	All
8	*Liza klunzingeri*	62	4.22	2658.85	3.75	2,3	A,S,Sp
9	*Poecilia latipinna*	57	3.88	265.07	0.37	1,3	S,W
10	*Thryssa whiteheadi*	57	3.88	748.32	1.06	1,2,3	All
11	*Johnius dussumieri*	56	3.81	2054.25	2.90	1,2	A,S
12	*Acanthobra mamarmid*	41	2.79	789.86	1.12	1,3	All
13	*Anodontostoma chacunda*	30	2.04	680.60	0.96	2	S
14	*Ilisha compressa*	28	1.91	513.98	0.73	3	All
15	*Sparidentex hasta*	24	1.63	2423.64	3.42	1,2,3	A,S,Sp
16	*Johnius sp.*	15	1.02	644.66	0.91	2,3	W,Sp
17	*Alburnus mossulensis*	9	0.61	291.02	0.41	3	A,S,W
18	*Boleophthalmus dussumieri*	7	0.48	40.78	0.06	1,2	A,S
19	*Scomberomorus commerson*	7	0.48	258.05	0.36	3	A
20	*Leuciscus vorax*	6	0.41	534.51	0.75	3	S
21	*Bathygobius fuscus*	6	0.41	106.03	0.15	2	A,S,W
22	*Cynoglossus bilineatus*	6	0.41	193.10	0.27	2,3	W
23	*Sillago sihama*	5	0.34	155.53	0.22	3	A,S,W
24	*Otolithes rubber*	5	0.34	155.63	0.22	2,3	A,S,W
25	*Carasobarbus luteus*	4	0.27	321.40	0.45	1,3	S
26	*Cyprinus carpio*	4	0.27	245.46	0.35	1,2	S,Sp
27	*Eleutheronema tetradactylum*	4	0.27	264.75	0.37	1,3	S
28	*Mastacemblus mastacemblus*	4	0.27	516.34	0.73	3	Sp
29	*Brachirus orientalis*	4	0.27	101.62	0.14	1,3	A,W
30	*Mystuspelusius*	3	0.20	203.30	0.29	1	S
31	*Arabibarbus grypus*	2	0.14	122.85	0.17	2	S
32	*Coptodon zilli*	2	0.14	67.60	0.10	2	A
33	*Amblygaster sirm*	1	0.07	22.80	0.03	2	A
34	*Ctenopharyngodon idella*	1	0.07	221.00	0.31	2	S
35	*Gerres oyena*	1	0.07	23.10	0.03	3	W
36	*Hemiculter leucisculus*	1	0.07	22.50	0.03	1	W
37	*Ilisha melastoma*	1	0.07	29.73	0.04	3	Sp
38	*Periophthalmus waltoni*	1	0.07	8.88	0.01	3	A
39	*Platycephalus indicus*	1	0.07	13.60	0.02	2,3	S
	Total	1469	100.00	70835.51	100.00		

3.3. Feeding Analysis

The feeding intensity for all the fed fishes in Shatt Al-Arab river during 2010-2011(Fig.2) demonstrates that all fishes exhibited a high feeding intensity in spring except in Al-Fao, where its fishes had the upper values in summer, no significant differences were noticed between stations (F= 0.035, P= 0.965),while in Shatt Al-Arab river, spring and autumn were higher than summer followed by winter, the overall values (8.79-12.37 point/fish) indicate that most fishes fed with half full stomach at all seasons.

1= Al-Daeir, 2 = Hamdan, 3 = Al-Fao - A=Autumn, W=Winter, S= Summer, Sp=Spring

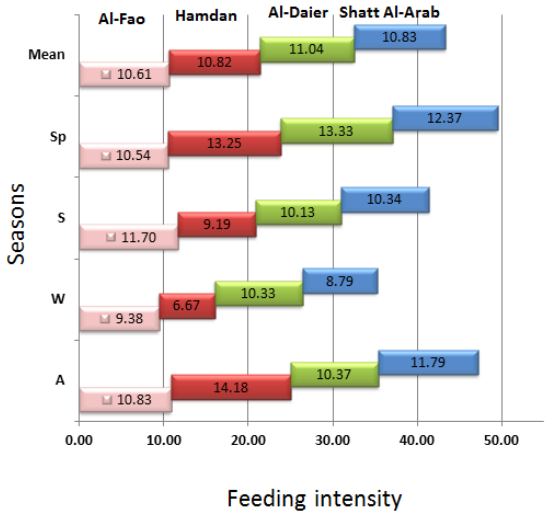

Figure 2. Seasonal variation in feeding intensity for all fish species in Shatt Al-Arab river.

From 39 species caught in Shatt Al-Arab River, only 15 species (Table 4) were included in the details of the feeding study because the number of the fed fishes was enough to be analyzed. Most fishes used in this analysis were caught from Hamdan and Al-Fao station (585, 512 individuals, respectively), while 272 of the analyzed fishes from Al-Daeir. Also *C. auratus* was the dominated species both in total numbers and fed fishes (86), while the other 14 species ranged between 15 to 82fed fish. Mean total length of fishes ranged between 6.37 to 16.46 cm and mean total weight between 4.12 to 57.41gm (*P. latipinna* and *C. subviridis*, respectively).

The main food items of the fifteen fish species were listed in Table 5 along with the identification code used in the following figures and tables; sixteen food categories were considered to calculate standardized diet compositions and trophic levels of fishes.

Preponderance index of fish species in Shatt Al-Arab River, as shown in Fig. 3, points out that there were two groups of feeding habits: The first contained eight species depending on vegetarian and detritus food items while the second contained the other seven species which depend on animal food items. This was confirmed in Fig.4 where plant origin food items comprise 48.54% of preponderance index, while it was 39.43 and 12.03 % for animal and organic matter food items, respectively; about 80.41% plant items comprise the food of six species, 73.97% organic matter of two species and 88.51% animal items of seven species (Fig.5).

No significant differences (F= 0.944, P= 0. 059) were noticed between stations in the values of feeding index (Fig. 6), the highest value found in Hamdan station at autumn (70.90) while the lowest value in the same station at winter. Shatt Al-Arab feeding index showed two peaks at spring and autumn (61.87, 59.74, respectively).

The mean value of the trophic level (Fig.7) for vegetarian fish species was 2.06 which differs significantly (F=12.14,145.01 P= 0.013,0.00) from both species which depend on detritus (1.36) and on animal (3.38) food items, respectively, which were also significantly different (F=350.04,P=0.00) from each other.

Table 4. Numbers, total length (cm)) and weight (gm) of abundant species from the Shatt Al- Arab river, Southern Iraq (July 2010 to March 2011).

Rank	Species	Numbers				No. fed	Mean	
		Al-Daeir	Hamdan	Al-Fao	Total		Length	Weight
1	*Carassius auratus**(F)	86	216	3	305	86	12.17	33.49
2	*Liza abu*(F)	100	75	0	175	63	13.83	32.76
3	*Tenualosa ilisha*(M)	16	51	82	149	82	15.48	34.01
4	*Chelon subviridis* (M)	13	87	40	140	71	16.46	57.41
5	*Johnius belangerii*(M)	0	0	90	90	40	14.02	33.87
6	*Thryssa hamiltonii*(M)	0	11	78	89	32	12.93	12.92
7	*Acanthopagrus arabicus*(M)	0	26	40	66	24	10.21	31.33
8	*Liza klunzingeri*(M)	0	45	17	62	15	12.22	24.62
9	*Poecilia latipinna**(F)	15	38	4	57	21	6.37	4.12
10	*Thryssa whiteheadi*(M)	1	3	53	57	50	12.14	12.15
11	*Johnius dussumieri*(M)	0	0	56	56	33	13.15	35.15
12	*Acanthobra mamarmid*(F)	39	2	0	41	26	12.63	19.95
13	*Anodontostoma chacunda*(M)	0	30	0	30	15	11.99	22.69
14	*Ilisha compressa*(M)	0	0	28	28	16	15.66	23.08
15	*Sparidentex hasta* (M)	2	1	21	24	19	13.96	44.91
Total		272	585	512	1369	593		

*Alien species, F= Freshwater fish, M= Marine fish

Table 5. Food items ingested by studied species. Identification codes are in parenthesis.

Animal	Vegetal	Detritus
Insect (IN)	Diatom (DI)	Organic detritus (OD)
Eggs (EG)	Filamentous Algae (FA)	Sediments (SD)
Zooplankton (ZP)	Spirogyra (SP)	
Crab (CR)	Phytoplankton (PP)	
Fish (FS)	Green algae (GA)	
Shrimp (SH)	Aquatic plant (AP)	
Mollusca (MO)		
Nematodes (NE)		

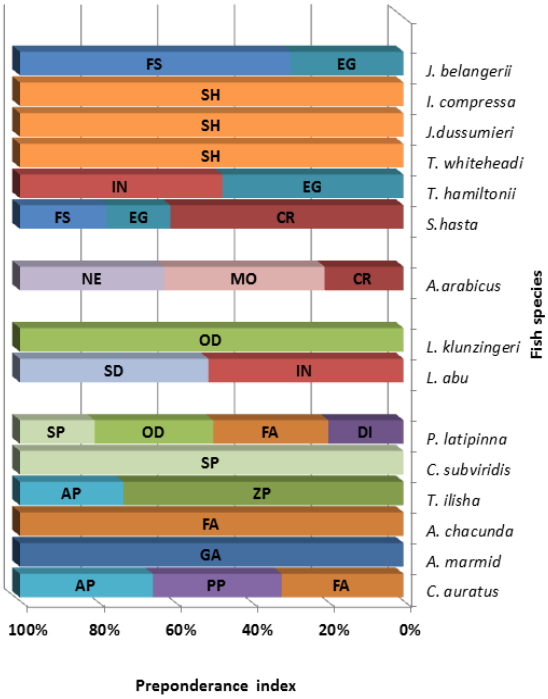

Figure 3. Preponderance index of primary food items of fish species in Shatt Al-Arab river. (Code of food items in Tab.4)

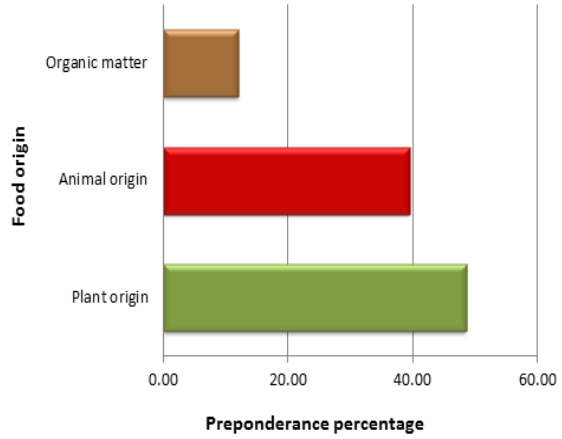

Figure 4. Preponderance index of food items origin of all studied fish species in Shatt Al- Arab river.

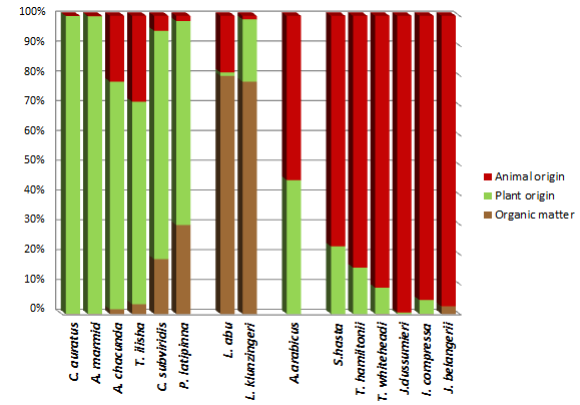

Figure 5. Feeding selectivity of fish species in Shatt Al-Arab river.

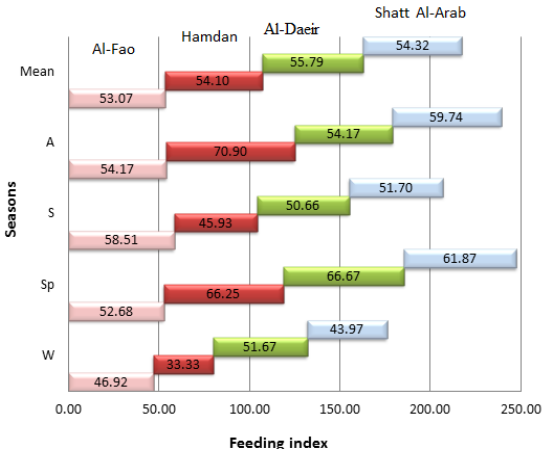

Figure 6. Feeding index of studied fish species in Shatt Al- Arab river.

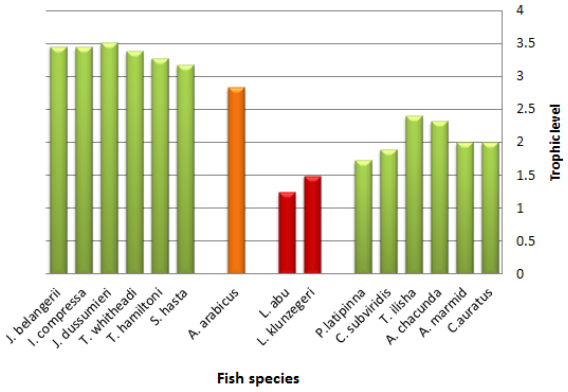

Figure 7. Trophic levels of studied fish species in Shatt Al- Arab river.

4. Discussion

The result of Mohamed *et al.*(2012), in the same period, confirmed that the physical properties, especially salinity, may provide some possible causes for the differences in the distribution, abundance and species composition along Shatt Al-Arab River, which refers to Al-Hassan *et al.* (1989) who stated that the marine species are limited to the middle and the lower regions of Shatt Al-Arab River and their number decreased toward the

upper reaches of the river, and freshwater fauna exhibited a reverse trend of distribution in the river. Mohamed *et al.,* (2015) reviewed the previous studies about the fish assemblage in Shatt Al-Arab river where the number of species was recorded in different papers, ranging from25 to 58 at different periods in the same region. Jasim *et al.* (2007) indicate that only 22 species were caught from Shatt Al-Arab river, mostly riverine species and 33 mostly marine species from Basrah canal during 2001-2002.

The study of Al-Dubakel (2011) showed that there has been an increase in the workers number in the marine fishing sector in the recent years offset decrease in catches, thereby reducing the revenues of fishermen and increasing the fishing effort to obtain sufficient quantities of fish, which in turn affects fish stocks, as it was found by Jabir (1995) that the rate of exploitation of the Shad was 0.8, which indicates that this fish was exposed to overfishing in the Shatt al-Arab River.

The limited number of feeding fish (15 from 39 species) in the present study reflects the dramatic environmental alterations including the "climate change", where Shatt Al-Arab river discharge has declined about – 34.7 % in recent years (Palmer *et al.,* 2008);this will affect the primary production and will also impact the fish (Jennings *et al.,* 2008).The highest primary production was encountered during spring 92.0 mg C/m3 / day (Al-Essa *et al.,* 2007).The annual production of fish in Shatt Al-Arab river is considers low compared to other water bodies (Jasim *et al.,* 2007).

The feeding intensity of the fishes in Shatt Al-Arab river was higher in spring and autumn which indicates appropriate water temperature (21- 25 °C) and resource availability, the majority of the studied fish (species and individuals) belong to marine environment, where more than 73% of fishes were caught from downstream where salinity ranged between 1.4 to 7.6 ppt in two stations (Hamdan and Al-Fao). Breine *et al.* (2011) stated that the contribution of marine migrants and estuarine species is higher in the mesohaline zone.

The composition of the diet and the prey items of most fish sampled at the Shatt Al-Arab River showed common agreement with those indicated for the same species in prior studies, with some minor differences in the main food items; moreover, the feeding habits did not show remarkable differences from the original grouping of the studied species. Delariva *et al.* (2007) indicate that most tropical fishes have variable diets and may exhibit high flexibility, ingesting all food items available in an aquatic environment. They also exhibit an acute ability to shift food quickly as a response to environment variations or food shortage. Therefore, changes in the diet of fish over time and space may be a function of food resources availability (Hahn *et al.,* 2004). This suggests that the diet composition of fish within an assemblage is determined not only by the food availability but also, to some extent, by factors related to the interspecific competition for food (Casaux and Barrera-Oro, 2013), so fish species forage on alternative prey or on different amounts of the same prey (Klemetsen, 1993; La Mesa *et al.,* 1997; Høines Bergstad, 2002). The preference shown by a species to a diet component or group is a biological strategy which discouraged the competition for the available food resource within a species (Olojo *et al.,* 2003; Job and Nyong, 2005; George *et al*.2013).

Love (1980) recorded the dominance of carnivores (85%) out of 600 species of fish. Pandian and Vivekanandan (1985) concluded that the majority of fishes resort to carnivory as against herbivory, detritivory and omnivory due to their relative low energy cost to maintain body temperature, the ease with ammonia excretion and their capacity to effectively digest a protein diet; this conclusion opposes the conclusion of the present study, the dominance was for species that depend on plant origin items (53%), carnivores (30%) and detritivory (17%);this may reflect the wide variety of food items that occurred in all the fish species which show that they are non-selective in feeding and each species can utilize various food sources. Shep *et al.* (2013) and Ekpo *et al.* (2014) observed such feeding on a wide range of food organisms that makes them euryphagous feeding, while Sarkar and Deepak (2009) explain the high incidences of animal parts in the stomach, particularly bones and scales resist digestion and tend to be over represented in gut content analysis. Some species radically changed the quality of their food while others did not. The changes affecting the diets of invertivores, piscivores and omnivores are not fundamental in the sense that they probably do not involve a strong modification of their feeding behavior. Conversely some herbivores and detritivores seemed to deeply modify the way they feed (Mérona and Vigouroux, 2006).

Many considered 'trophic level' as an operational term as the feeding habits and trophic level of the majority of fish groups are subjected to change depending on age, seasons, and the availability of prey and the area of distribution (Vander Zanden and Rasmussen, 1996; Cortes, 1999; Figueiredo *et al.,* 2005). Higher trophic levels of carnivore fishes were recorded in many species which reached four (Corte´s, 1999) where Abdurahiman (2006) concluded that it is mainly due to the presence of carnivorous fishes in the diet; he observed very low trophic in detritivores in accordance with the result of the present study. Vivekanandan *et al.* (2009) divided fishes occurring along the Indian coast into six groups ranging from one to more than four for detritivores and top predators, respectively.

5. Conclusion

Estuaries known to be very productive in terms of biota especially planktons, have been described as spawning, nursery, and feeding grounds. From the present study, we concluded that fish species in the Shatt Al, Arab River estuary consume more than one component of food and depended mainly on autochthonous food items. Many species had a significant commercial importance, so the stock of fish in the river should be evaluated accurately along with monitoring the magnitude of environmental instabilities and pollution in the estuary; this leads to qualify suitable management approaches.

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