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Fish assemblage of restored Al-Hawizeh marsh, Southern Iraq

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Abstract

Al-Hawizeh marsh is one of the largest wetlands in south Iraq. During last two decades, 65% of a permanent marsh was drained and it led to a substantial loss of native aquatic flora and fauna. The marsh was reflooded in April 2003. The characteristics of fish assemblage in this marsh were described after three years of the restoration. A total of 4715 fishes of 15 species were caught since October 2005 to September 2006, using different fishing gears. The fish species in the marsh were divided into resident, seasonal and occasional groups. *Liza abu* was the most abundant species comprising 37.1% of the total numbers followed by *Barbus luteus* (29.4%), *Carassius auratus* (15.3%), *Alburnus mossulensis* (4.88%) and *Aspius vorax* (4.14%). Fish species diversity index ranged from 0.88 to 2.1, richness from 0.73 to 2.42 and evenness from 0.49 to 0.85. The diet varied among the fish species, most of them depended on two or three major food items. Several cyprinid species disappeared from the restored marshes or decreased in their abundance. This could be related to reduced water supply and effectively eliminated the spring flood pulses that sustained wetland ecosystems in the lower Tigris-Euphrates basin. Increase of salinity, scarcity of benthic food resources and competition with alien/introduced species have also detrimental effects on native cyprinid fishes.

Key words: Species compositions, alien species, diversity indices, food habits, Mesopotamia wetlands.

1. Introduction

The inland freshwater bodies in Iraq cover between 600 000 and 700 000 ha, made up of marshes (44%), natural lakes (39%), dams and reservoirs (13.3%) and rivers and their branches (3.7%), in addition to coastline of approximately 50 km along the NW Arabian Gulf (FAO 1999). There are over 58 freshwater fish species in Iraqi inland waters, about a further 53 marine species penetrating estuarine and fresh water (Coad 1991) and 125 fish species and five species of shrimps in the Iraqi marine waters (Mohamed *et al.* 2001).

The marshes of southern Iraq were the largest wetlands in southwest Asia and covered more than 15000 km^2. These marshes were a natural refuge for many aquatic organisms, especially fish and birds. Because of their environmental, hydrological and meteorological conditions they form an unique ecosystem, that allows aquatic biota to flourish. In 1990, FAO estimated that the total inland catch of fish in Iraq was 23600 tones, with over 60% of this coming from the Mesopotamian marshes (Partow 2001). They were the permanent habitat for millions of birds and a flyway for millions more migrating between Siberia and Africa (Maltby 1994; Evans 2002).

During the last three decades, the Mesopotamian marshlands were suffering from various problems amongst them new hydrological projects - more than 30 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. In the 1980s Iran-Iraq War, water was used for military purposes and several obstructions were built along the border with Iran at Al-Hawizeh marsh. Tanks used during most of the warfare contributed severely to the marches destruction. The constructions of drainage systems by diversions of major rivers surrounding the marsh areas, and drainage processes in the 1990s affected the southern marshlands and led to substantial loss of native aquatic flora and fauna well-known for a long period as marsh biota of southern Iraq. In 2002, 85% of permanent marshes described in 1973 had been environmentally destroyed. Only 3% of the Al-Chybaesh marshes, 14.5% of the East Al-Hammar marshes and 35% of the Al-Hawizeh marshes near the Iranian border, remained (Richardson, Hussain 2006).

Since 2003, great efforts have been made to restore the natural marshes morphology. Blowing up dikes and earthen dams started, releasing water back into the former marsh areas through control structures, and revive the plant cover and fishery enhanced. However, major dams across the border have reduced the river discharge significantly. As of August 2007, the marshes had recovered almost 58% of their former levels, according to UNEP. Satellite imagery shows the southern marshlands now occupy about 3500 km^2 after having dwindled to just 760 km^2 and vegetation cover was expanding at 800 km^2 per year.

Several taxonomic studies were previously published about freshwater and marine fishes of Iraq (Khalaf 1961; Mahdi 1962; Al-Nasiri, Shamsul-Houda 1975; Banister 1980; Al-Daham 1982; Coad 1991) and these refer to the marshes in passing. Other studies have focused on water quality, plankton and plant communities in the marshes before desiccation (Maulood *et al.* 1979; Pankow *et al.* 1979; Al-Saadi *et al.* 1981; Al-Saboonchi *et al.* 1982, 1986; Mohamed, Barak 1988a) or on biological aspects of some of the freshwater fishes in the marshes (Barak, Mohamed 1982, 1983; Jasim 1988; Mohamed, Barak 1988b; Al-Kanaani 1989; Mohamed, Ali, 1994).

Even the southern marshes were consider as major source of freshwater fishes in Iraq, no proper studies were conducted about the species composition, fish ecology and fisheries. In this context no previous studies were traced about species composition, dominant species and fluctuation in ecological indices in the marshes.

The specific objective of this research was to describe the composition, occurrence, abundance, size frequency distributions and food habits of fish assemblage in Al-Hawizeh marsh after restoration.

2. Materials and methods

Study area

The Al-Hawizeh marsh lies to the east of the Tigris River, straddling the Iran-Iraq border (Fig. 1). The Iranian section of the marshes is known as Hawr Al-Azim, where it is fed primarily by the Karkeh River. In Iraq, this marsh is largely fed by two main distributaries departing from the Tigris River near Amarah, known as Al-Musharah and Al-Zahla. Its surface area is approximately 3000 km^2 with a maximum depth of 6 m (Al-Rubaiy 1990). The northern and central parts of the marshes are permanent, but towards the southern sections they become increasingly seasonal in nature. The permanent marshes are typically characterized by moderately dense vegetation alternating with open stretches of water.

Draining of the Al-Hawizeh marshland began with construction of oil fields (Majnoon Island) and during the Iran-Iraq war (1980-1988). The marsh was further dried during the 1990s by water diversion, by the construction of embankments along the Tigris and its distributaries and by construction of a dam on the Karkeh River in Iran. By 2002, only about a third of the Al-Hawizeh marsh remained (Richardson, Hussain, 2006); however, this represented the only remaining portion of the Mesopotamian marshlands. In 2003, several of the embankments were breached and water from the Tigris River is returning (Anonymous 2006).

Fish sampling

Fishes were collected monthly from two selected sites, Um Alnaaj (N 31° 38’ 30”, E 47° 35’ 21”) and Taraba (N 31°^{0} 29’ 48”, E 47^0 31’ 48”) in Al-Hawizeh marsh (Fig. 1) from October 2005 to September 2006. Sampling was carried out using seine net (20 m long with a 2.5 cm

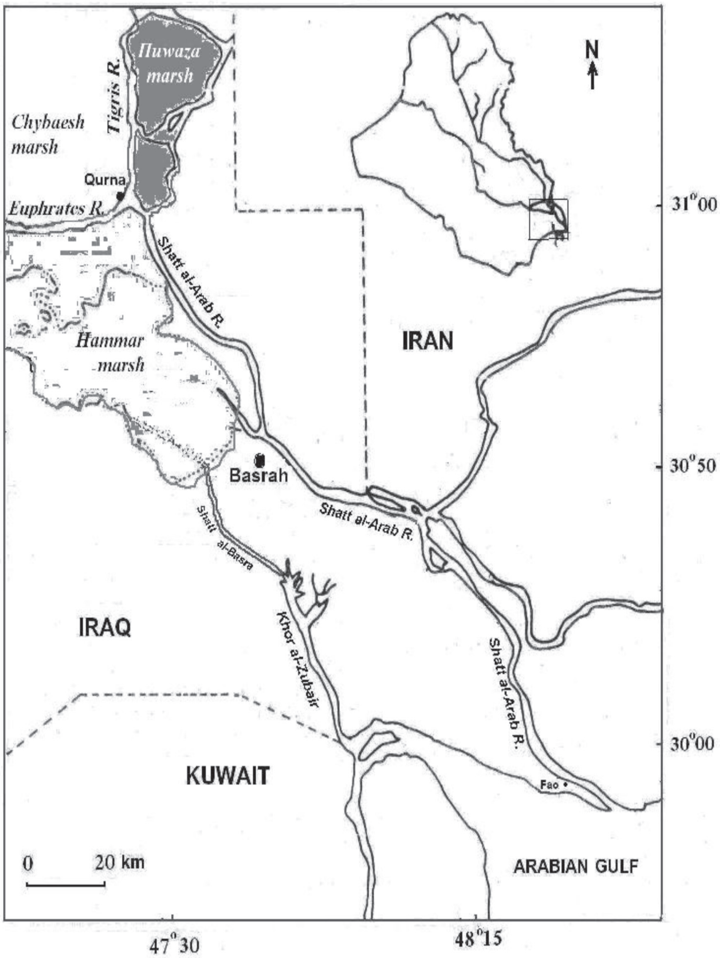

Fig. 1. Map of southern of Iraq, showing the location of Al-Hawizeh marsh.

mesh), fixed gill nets (50 to 100 m long with 2.5 cm to 10 cm mesh size) and electro- fishing gear. Specimens were immediately transported to the laboratory on crushed ice. Water temperature and salinity were measured to determine the relationships of these two factors with the number of species and total catch of species. Fishes were identified to species by using Khalaf (1961), Mahdi (1962) and Beckman (1962). The total length (TL mm) of all fish captured was recorded. Three analytical methods were used to analyze stomach contents, i.e. numerical, volumetric and frequency of occurrence (Windell 1971). The importance of food item was determined by using the index of relative importance (IRI) of (Pinkas *et al.* 1971). The similarity among fish species based on their diet was calculated according to Jaccard similarity coefficient, using SPSS software (ver. 11, 2001) statistical package.

The ecological indices of the fish assemblage in Al-Hawizeh marsh; relative abundance, diversity, evenness, richness and similarity were calculated monthly according to Odum (1970), Shanon, Weaver (1949), Pielou (1977), Margalef, (1968) and Boesch (1977), respectively. Fish species were divided into three categories according to their occurrence in the monthly samples following Tyler (1971).

3. Results

Species composition and occurrence

The overall number of fish species caught from the marsh was 15, belonging to 5 families (Table I). Cyprinidae, the dominant family in terms of number of species was represented by eleven species (*Carassius auratus, Barbus luteus, Barbus sharpeyi, Aspius vorax, Barbus xanthopterus, Barbus grypus, Cyprinus carpio, Acanthobrama marmid, Hemiculter leucisculus, Alburnus mossulensis* and *Cyprinion microstmum*). Other species belonged to the families Mugilidae (*Liza abu*), Siluridae (*Silurus triostegus*), Mastacembelidae (*Mastacembelus mastacembelus*) and Heteropneustidae (*Heteropneustus fossilis*).

The fish fauna was comprised of 12 native species (*B. luteus, B. sharpeyi, A. vorax, B. xanthopterus, B. grypus, A. marmid, A. lissneri, A. mossulensis, C. microstmum, L. abu, S. triostegus* and *M. mastacembelus*) constituted 80% of the total number of species and three alien species (*C. carpio, H. fossilis* and *C. carassius*) comprised 20% of the total number of species. The highest numbers of total and native species were in July and the lowest in December. A slight variation in the number of alien species has been observed throughout the year (Table I).

The occurrence of collected species in the Al-Hawizeh marsh was classified into three groups. The resident species were nine ones, four of them appeared in all 12 months (*C. auratus, L. abu, B. luteus* and *S. triostegus*), two in 11 months (*A. vorax* and *H. fossilis*), two in ten months (*B. sharpeyi* and *M. matacembelus*) and one in nine months (*A. mossulensis*). The resident species formed 60% of the total number of species. Of the three seasonal species, two of them (*C. carpio* and *A. marmid*) were captured in eight months and the other (*B. xanthopterus*) in six months.

Table I. Monthly variations in relative abundance (%) of fish species caught in Al-Hawizeh marshes (October 2005 - September 2006).

Fish Species	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	**Total**
Liza abu	12.3	33.01	10.8	21.6	58.5	41.4	38.4	20.4	24.2	41.9	46.51	45.27	**37.1**
Barbus luteus	54.6	5.26	72.7	62.88	16.9	42.9	35.5	32.9	21.1	25.5	25.3	11.4	**29.4**
Carassius auratus *	11.0	13.9	12.05	4.96	5.1	2.7	2.86	20.4	6.3	16.7	10.85	30.9	**15.3**
Alburnus mossulensis	-	21.3	-	0.8	4.24	-	0.4	0.66	8.4	1.98	6.20	5.97	**4.88**
Aspius vorax	2.45	17.9	-	3.2	4.24	5.1	4.9	6.58	7.4	2.55	1.3	1.57	**4.14**
Heteropneustus fossilis *	9.2	0.24	-	2.4	5.93	1.8	6.9	0.66	2.1	1.7	1.81	1.34	**2.31**
Silurus triostegus	3.07	0.7	4.0	1.6	1.98	2.7	2.45	4.6	10.5	1.98	2.33	0.82	**1.99**
Barbus sharpeyi	5.52	-	-	2.24	1.7	1.8	3.27	7.24	3.16	1.4	0.26	0.15	**1.4**
Acanthobrama marmid	0.6	7.4	-	0.16	0.28	-	0.4	-	7. 4	1.13	-	0.22	**1.04**
Matacembelus matacembelus	0.61	-	0.4	-	0.28	0.9	4.1	0.66	7. 4	0.57	2.07	0.15	**0.76**
Cyprinus carpio *	-	0.2	-	-	0.57	0.3	0.82	5.26	-	3.68	1.03	0.2	**0.72**
Hemiculter leucisculus	-	-	-	-	-	-	-	-	-	-	-	1.57	**0.45**
Cyprinion microstmum	-	-	-	-	-	-	-	-	1.05	0.57	2.33	0.45	**0.38**
Barbus xanthopterus	0.61	-	-	0.16	-	0.3	-	0.66	1.05	0.28	-	-	**0.13**
Barbus grypus	-	-	-	-	0.28	-	-	-	-	-	-	-	**0.02**
Total catch	163	418	249	625	354	333	245	152	95	353	387	1341	**4715**
Total no. of species	10	9	5	10	12	10	11	11	12	13	11	13	**15**
No. of native species	8	6	4	8	9	7	8	8	10	10	8	10	**12**
No. of alien species	2	3	1	2	3	3	3	3	2	3	3	3	**3**
Diversity index	1.50	1.56	0.88	1.14	1.43	1.30	1.58	1.81	2.11	1.64	1.56	1.44	**1.50**
Richness index	1.77	1.08	0.73	1.40	1.87	1.55	1.82	1.99	2.42	2.05	1.68	1.67	**1.67**
Eveness index	0.65	0.80	0.55	0.49	0.57	0.56	0.67	0.76	0.85	0.64	0.65	0.56	**0.65**

* Alien species

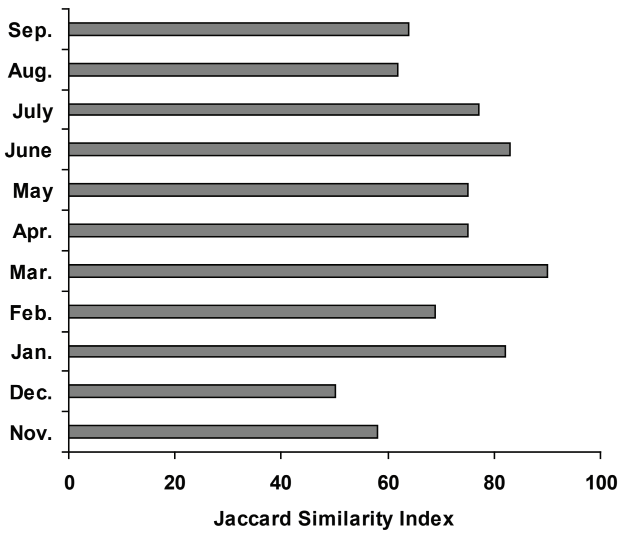

Fig. 2. Monthly variations of similarity of species in Al-Hawizeh marsh.

The seasonal species comprised 20% of the total number of species. Three species were categorized as occasional; one of them was appeared in four months (*C. microstmum*) and the remaining two in one month (*B. grypus* and *H. leucisculus*). The occasional species formed 20% of the total number of species.

The monthly variations of similarity of fish species composition in the marsh during the study period is shown in Fig. 2. The highest similarity level was found during March (90%) and the lowest was during in December (50%). Generally, the similarity level was high during spring and early summer months.

Relative abundance

A total of 4715 fishes from 15 species were collected from the marsh (Table I), the highest number (1341) was in September and the lowest number (95) was in June. The *L. abu* was the most abundant species comprising 37.1% of the total numbers followed by *B. luteus* (29.4%), *C. auratus* (15.3%), *A. mossulensis* (4.88%) and *A. vorax* (4.14%). These five species accounted for over 90.8% of the total catches. The remaining species comprised 9.2% of the catch. *L. abu* was the dominant species throughout the year, except December and January, with a peak in September and *B. luteus* for these two months, with a peak in January (Table I).

Figure 3 illustrated the monthly fluctuations in water temperature and salinity in Al-Hawizeh marsh. Water temperature changed from 13°C in January to 32°C in June. The minimum value of salinity was 0.4 g dm^{-3} in June and July, and the maximum value was 1.5 g dm^{-3} in November. Water temperature showed a significant positive correlation (r=0.536, P<0.05) with the number of species and a week positive correlation (r=0.138) with the total catch of fish species. Salinity showed a significant negative correlation (r=-0.747, P<0.01) with the number of species and a very week negative correlation (r=-0.097) with the total catch of fish individuals.

The overall length frequency distributions of the most abundant fish species in the marsh are illustrated in Figure 4. *L. abu* was the most abundant species in the marsh and appeared in the catch throughout the year. The length ranged from 4 to 20 cm and length groups of 7 and 12cm dominated the catch. The second most abundant fish species was *B. luteus,* which was found throughout the year. Lengths from 7 to 34 cm were represented in the samples and the dominant length groups were 18 to 21 cm. The *C. auratus* was very common and regularly found in the catch throughout the year. The length range of this species includes sizes from 5 to 37 cm with fish of 9 cm dominating the catch.

Monthly variations in ecological indices of species in the marsh are given in Table I. The diversity index (H) fluctuated from 0.88 in December to 2.11 in June, with overall value 1.50. The richness index (D) changed from 0.73

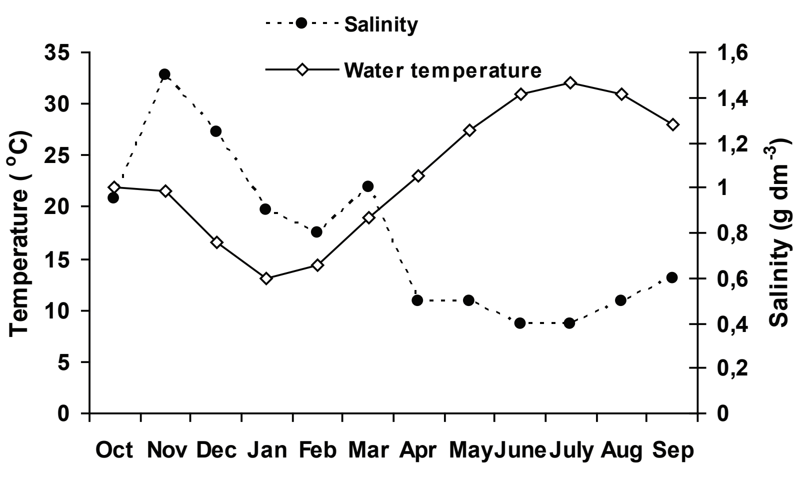

Fig. 3. Monthly variations in water temperature and salinity in Al-Hawizeh marsh.

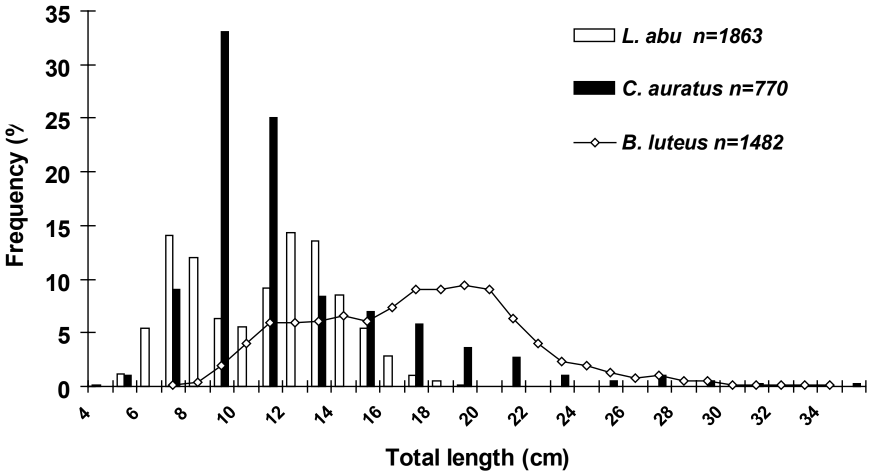

Fig. 4. The length frequencies of dominated fish species in Al-Hawizeh marsh.

in December to 2.42 in June, with overall value 1.67. The evenness index (J) ranged from 0.49 in January to 0.85 in June, with overall value 0.65.

Food composition

The diet composition of some fish species in the marsh are given in Figure 5. The food items which represented more than 10% relative importance were considered to be major items in the diet of each species. It appeared that most species depend on two or three major food items, except *C. carpio* and *H. fossilis*. The *C. auratus* fed on algae 36%, diatoms 25.5% and copepods 17.5%. *B. luteus* fed primarily on algae 55% and diatoms 24%. Algae dominated the food items consumed by *B. sharpeyi* constituting 52% following by diatoms 26.7% and plant tissues 15.9%. Detritus formed 53.3% of the

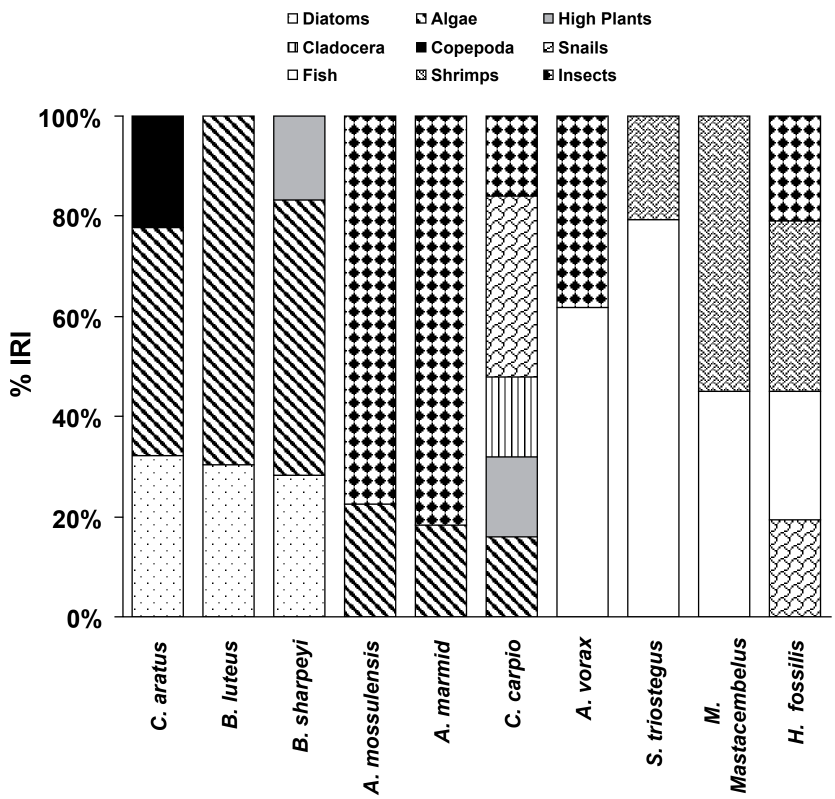

Fig. 5. Diet composition of fish species in Al-Hawizeh marsh.

food items of *L. abu* followed by diatoms 41.5%. The *A. mossulensis* fed on insects 66.2% and algae 19.2%. Insects comprised 62.4% of the total food items of *A. marmid*, followed by algae 14.1%. The *C. carpio* fed on snails 27.3%, insects 12.1% and 12.1% for each of algae, plants and cladocera. Fish formed 47.4% and insects 29.4% of the food items of *A. vorax*. The *S. triostegus* preyed on fish 79.2% and shrimps 20.8 %. *M. Mastacembelus* preyed mainly on shrimps 55% and fish 45%. The *H. fossilis* fed on shrimps 33.9%, fish 25.8%, insects 20.8% and snails 19.2%.

Similarity dendrogram among fish species based on their diet is presented in Figure 6. Three main groups could be distinguished. Group I, consists of three subgroups, first includes *S. triostegus* and *M. mastacembelus,* which preyed mostly on fish and shrimp, second includes *A. vorax,* preyed on fish and insects and third includes *H. fossilis* preyed on shrimps, fish, insects and snails. Group II, consists of two subgroups, first includes *B. luteus* and *B. sharpeyi,* which fed mainly on algae, diatoms and high plants, and second *C. auratus*, which fed on algae, diatoms and copepods. Group III, consists also of two subgroups, first includes *A. mossulensis* and *A. marmid,* which fed mainly on insects and algae, and second *C. carpio,* which fed on snails, insects, algae, plants and cladocera.

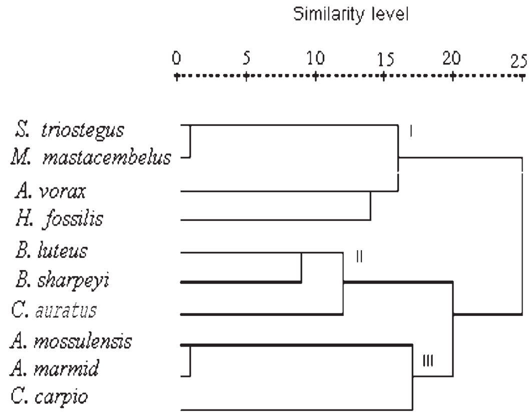

Fig. 6. Similarity dendrogram among fish species based on their diet in Al-Hawizeh marsh.

4. Discussion

The desiccation of the marshes alter largely the fish assemblage and brought major changes in the structure due to harsh environment prevailing and to change in the ways of productions especially primary production of aquatic plants and phytoplankton, consequently change in secondary productivity of zooplankton and benthos**.** Fifteen fish species recorded in Al-Hawizeh marsh, three of them were exotic species. Al-Daham (1988) stated that 65 species existed in the inland waters of Iraq, half of them occurred in the southern marshes. Coad (1991) put the total number of fishes in fresh water system of Iraq to be 58 consisting of 43 freshwater, 8 marine and 7 exotic species. Al-Shammaa (2005) collected 20 species from the marshes in Nasiriah province, half of them were non-commercial. Mohamed *et al.* (2007) recorded 31 fish species from the East Hammar marsh consisting of 20 freshwater and 11 diadromous species. However no separate check list were published concerned with fish composition of the marshes before desiccation, but in any case they never exceed 35 species as compiled from different resources (Mahdi 1962; Al Daham 1982; Banister 1980; Al-Hassan, Naama, 1986; Coad, 1991). The alien species did not appear in old survey (Mahdi 1962), but occurred in recent one (Coad 1991).

The ichthyofauna of the marsh is dominated by cyprinid species. This was also found in East Hammar marsh (Mohamed *et al.* 2007), Chybaesh marsh (Hussain *et al.* 2006) and other Iraqi waters (Al-Daham 1982, Coad 1991, Hussain *et al.* 1997).

Deterioration of water quality of the marshes led to disappearing of several cyprinid species like *B. sub-quicucitus* and *B. scheich* even before desiccation, or to a substantial decrease in abundance, especially of cyprinids species, *B. xanthopetrus*, *B. grypus*, *B. sharpeyi* and *B. luteus*. Several factors caused the shift in the species composition and disappearance of many cyprinid species from the restored marshes. First of the most important impacts is the construction of more than thirty large dams, particularly those recently built in the headwater region of Turkey, the Southeast Anatolia Project (GAP). It has substantially reduced the water supply and effectively eliminated the flood pulses that sustained wetland ecosystems in the lower Tigris-Euphrates basin (Partow 2001). Till the end of the XXth century the discharge rate of the Tigris decreased from 3000 m^3 sec^{-1} to less than 500 m^3 sec^{-1}, while that of the Euphrates from 2000 m^3 sec^{-1} to less than 250 m^3 sec^{-1} (Plaziat, Younis 2005). In addition, there has been a marked degradation of water quality in the mainstreams of the Tigris and Euphrates, due to saline return drainage from irrigation schemes and dam retention of sediment and nutrients (Partow 2001), salinity of the marshes increased then from 0.4 g dm^{-3} in seventies (Al-Saadi *et al.* 1981) to 6.3 g dm^{-3} in early ninties (Al-Rikabi 1992). Second impact is the construction of drainage systems by diversions of major rivers surrounding the marsh areas, and drainage processes of southern marshlands in the 1990s (Richardson, Hussain 2006). Third impact is the scarcity of benthic food resources and competition with alien/introduced species, *C. carpio* (Al-Kanaani 1989) and recently with *C. auratus* (Hussain *et al.* 2006).

The dominant species in restored Al-Hawizeh marsh were *L. abu*, followed by *B. luteus* and the alien species *C. auratus,* whom appear in Shatt Al-Arab River in early nineties (Al-Shammaa *et al*. 2002). Availability of detritus could lead to increase in number of *L abu* since it is known as main food item. *L. abu* was also dominated in the restored East Hammar marsh, followed by *C. auratus* and *A. marmid* (Mohamed *et al.* 2007) and in Chybaesh marsh (Hussain *et al.* 2006). Due to lack of information before desiccation about species composition in the marshes, we obliged to compare with inland water bodies. Epler *et al*. (2001) found in the eighties in Lakes Habbaniya, Tharthar and Razzazah (middle of Iraq) that *L. abu* was the most dominant species followed by *Alburnus shetina.* In late nineties Al-Rudainy *et al*. (1999, 2001) showed that the fish assemblages in Habbaniya lake and Al-Qadisiya reservoir (west of Iraq) were also dominated by *L. abu* followed by *C. auratus* in Habbaniya lake and *C. carpio* in Al-Qadisiya. Moreover, IMRP (2006) report on the restored marshes in 2004-2005, indicated that *L. abu* was the most dominant species followed by *C. auratus* except in Al-Hawizeh by *B. luteus.*

Higher diversity and richness in Al-Hawizeh marsh in June-July period could be related to joining of recruits of resident species after spring spawning and individuals brought with spring flood of Tigris river tributaries. However, the value of richness in East Hammar marsh was slightly higher than that in Al-Hawizeh marsh, due to the higher number of freshwater species both native and alien (n=14 and 6, respectively) and invasion of marine species (n=11) from Arabian Gulf to East Hammar marsh, which take place more in summer than winter, considering that the same fishing effort was applied at both marshes (Hussain *et al.* 2006; Mohamed *et al.* 2007).

Examination of the stomach contents of the investigated fishes has shown that while the diet varied among the fish species, most of them depend on two or three major food items. In general the diets of examined species were similar to that previously reviewed by Hussain, Ali (2006) with certain differences. These differences could be related to the developing environment after more than decade of desiccation. Species like *B. luteus* changed its diet to be herbivorous previously consider as omnivorous, the same for *C. carpio* alter its diet to be carnivorous, previously consider as omnivorous. *S. triostegus* and *A. vorax* shift their diet to be fully predators on small fish previously carnivorous. *M. mastocemblus* tend to be predator on fish in certain due to scarcity of other food items. These changes were also recognized by Hussain *et al*. (2008).

Acknowledgments

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