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Seasonal Variations of Zooplankton Abundance in Shatt Al-Arab River, Southern Iraq

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Abstract Zooplankton samples were collected seasonally from three stations in the Shatt Al-Arab River southern Iraq by Plankton net (0.085 mm mesh-size and 40 cm mouth aperture) during 2013. Physical and chemical parameters of the water were studied such as, water temperature, salinity, pH, dissolved oxygen, TDS and Turbidity. The population density of zooplankton ranged between 253 ind./m^3 at second station (Abu Al-Khasib) to 69223 ind./m^3 at third station (Al-Faw) in winter. The important groups of zooplankton in the study area were Copepoda (56.1%), then Cirripede larvae (19.5%) and Cladocera (12.4%).

Keywords Zooplankton; Density; Distribution; Shatt Al-Arab River; Basrah

Introduction

Shatt Al-Arab River is located in the southeastern part of Iraq at latitude 31° 00′ 15″ longitude 47° 26′ 35″ at the confluence of the Tigris and Euphrates region and extends until the estuary in the Arabian Gulf at latitude 31° 53′ 28″ longitude 47° 39′ 50″ distance of 204 kilometers (Al-Mansouri, 1996).

Zooplanktons are the links in the food web between phytoplankton and higher animals such as fishes and shrimps. Many species are herbivorous grazers, although there are also numerous carnivorous predators. Zooplankton are generally small, with little ability or inability to swim against the currents. They are often divided by size, such that meso-zooplankton is 0.2 -20 mm in size and macro-zooplankton are 2-20 cm in size. Many species of fish and commercially-important invertebrates have larval stages and they are members of the zooplankton for at least part of their lives (Sieburth et al., 1978). The zooplankton determines the quantum of fish stock. The failure of fishery resources is attributed to the reduced copepod (zooplankton) population (Stottrup, 2000).

The studies on zooplankton in Iraq are very few. The first study was carried out by Gurney (1921), which included the study and classification of crustaceans of the region between the estuaries of the Shatt Al-Arab to the city of Amara on the Tigris River, and found 77 species belonging to different groups, including Rotifera, Cladocera, Copepoda, Ostracoda and Phyllopoda. Mohammad (1965) collected and classified the species of Cladocera from central and southern Iraq, included a study of the Shatt Al-Arab area from the estuary in Khour Al-Amaya to Qurna, and he found that there are differences between species in the estuary and the other regions.

Salman et al. (1986) explained the seasonal variations of the zooplankton in the Shatt Al-Arab, they founds that Cladocera constitute 68% of zooplankton which are followed in importance Copepoda. In Abdul-Hussein et al. (1989) described 11 species of zooplankton belonging to 5 genera of Rotifers in the northern part of the Shatt Al-Arab. Al-Zubaidi and Salman (2001) study the distribution of zooplankton in the estuary of the Shatt Al-Arab north-west Arabian Gulf, they said the group of Cladocera constitute 58% of the zooplankton in the Shatt al-Arab, followed by Copepoda 27%, and while in the estuary of the Shatt al-Arab Copepoda is prevalent. While Hammadi, (2010) studied the density of zooplankton in Shatt Al-Arab and found it ranged between 1360 and 836310 ind./m^3. Then Morad (2011) investigated the seasonally changes of the zooplankton in Shatt Al-Arab River, its ranged

between 6671–28064 ind./m^3. Whereas Jebir (2013) reported that the zooplankton was between 21–53211 ind./m^3 in south Shatt Al-Arab River. Moreover Abbas et al. (2014) studied the abundance and distribution of Zooplankton in the northern sector of Shatt Al-Arab, zooplankton density it was ranged between (79–65170 ind/m^3), where Cirripede larvae dominated the zooplankton community at all the stations. Cladocera was second in number, followed by Copepoda.

Materials and Methods

Study area

Samples were taken seasonally from three stations south of the Shatt Al-Arab River, (Fig. 1). The first station near the Basrah city centre at Al-Ashar region at latitude ((30° 31′ 32.39″) and longitude (47° 50′ 33.43″) (near Marine Science Centre anchorage) this station is affected by sewage coming from side branches like Al-Ashar and Al-Khandaq creeks, in addition to excretions of boats. Second station in Abu Al-Khasib region at latitude (30° 27′ 49.88″) and longitude (48° 00′ 30.89″) versus one of the branches of Abu Al-Khasib, and the third station in Al-Faw region (near the oil anchorage and boats of fishing) at latitude (29 °59′ 20.06″) and longitude (48° 28′ 02.22″).

Fig. 1 Map of lower Mesopotamia showing the sampling stations taken by using Google Earth program.

Sample collection

Seasonally zooplankton samples were collected at 2013 from surface water of Shatt Al-Arab using a 0.085 mm mesh-sized net with 40 cm mouth opening. A digital flow-meter was mounted in the middle of the mouth of the zooplankton net. The net was horizontally towed behind a boat running at its lowest speed for 10-15 minutes, and then the zooplankton that has been retained by the net was collected. The reading of the flow meter was taken before and after towing. At each station, samples of zooplankton were collected, transferred to containers (plastic bottles). The plankton samples were immediately fixed in 4% formaldehyde.

Water temperatures were measured by a thermometer with 0.1 ℃ sensitivity. Salinity, pH and TDS measurements were performed by YSI 556 MPS. Dissolved oxygen concentration measured by Winkler method. Turbidity was measured by HANNA instrument, Microprocessor Turbidity Meter HI 93703.

In the laboratory, samples were poured into a graduated vessel, and diluted if densely populated. Then a 10 ml subsample was taken and placed in a Bogorov chamber, examined and counted under a dissecting microscope. This procedure was repeated for three times, and then the whole sample was examined for the rare species.

Total filtered volume of water (V) was calculated from the following equation (DeBernardi, 1984):

$V = d\, r^2\, \pi$

Where:

d = the distance (m) travelled by net, which equals to 0.3 x numbers of the flow meter revolutions.

r = the net radius which equals to 0.2 m.

π = equal to 3.143.

The numbers of individuals were calculated in the sample diluted to 1000 ml in the manner prescribed by American Public Health Association (2006), and expressed the result in cubic meter.

$No./m^3 = (C \times VI) / (V\,II \times VIII)$

Where:

C = the number of individuals in the subsample

VI = volume of sample (ml).

VII = the size of the subsample (10 ml).

V III = volume of water filtered in cubic meters

Identification of the species was done by utilizing various publications Brook (1959), Smirnov (1971, 1992 and 1996), Benzie (2005), Kotov and Stifter (2006).

Results

Physical and chemical parameters

Water temperatures at the three stations are convergent to each other; they ranged between 15–27.5 ℃ in January and July 2013 respectively. Salinity ranged from 1.8 psu at station 2 (Abu Al-Khasib) in winter, to 40 psu at station 3 (Al-Faw) in summer, while the hydrogen ion concentration pH varied from 6.2–8.7 at station 3 (Al-Faw) in spring and summer respectively. Whereas dissolved oxygen ranged from 5.1 mg/l at station 1 (Al-Ashar) in summer, to 9.9 mg/l at station 2 (Abu Al-Khasib) in spring. As for the total dissolved solids (TDS) values were ranging from 1467 mg/l at station 1 (Al-Ashar) in autumn, to 33590 mg/l, at station 3 (Al-Faw) in summer, While the highest value of turbidity 180.6 FTU were encountered during winter at station 3 (Al-Faw), whereas the lowest value 7.1 FTU were recorded during spring at station 1 (Al-Ashar), (Fig. 2, 3, 4).

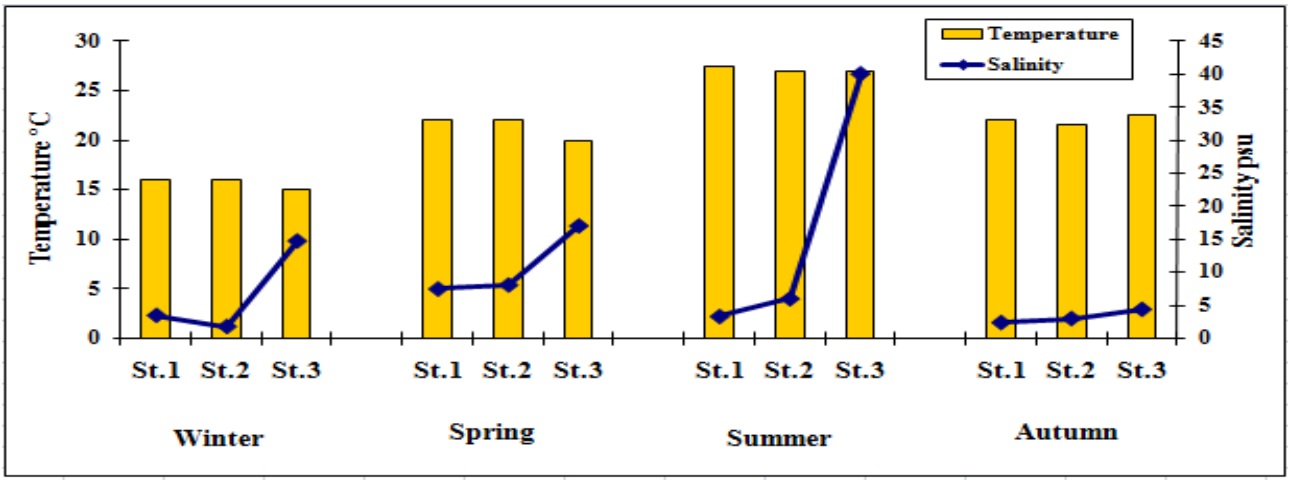

Fig. 2 Water temperatures and Salinity at three stations in Shatt Al-Arab River during the study period.

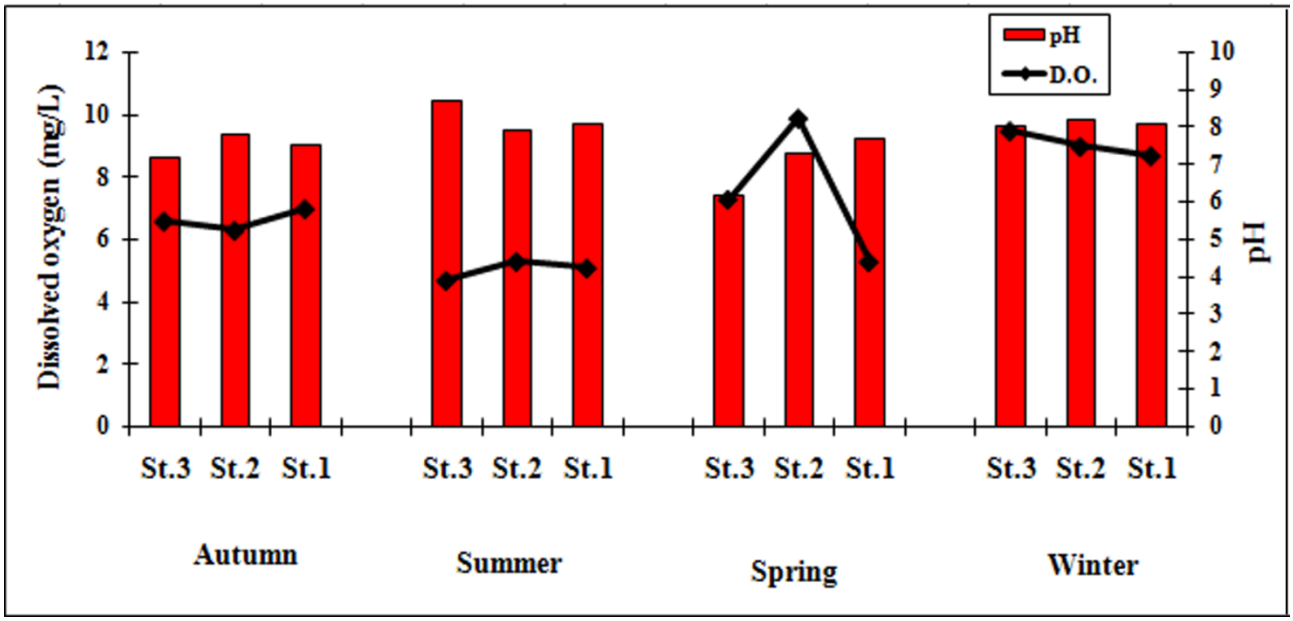

Fig. 3 Potential Hydrogen Ion (pH) and Dissolved oxygen at three stations in Shatt Al-Arab River during the study period.

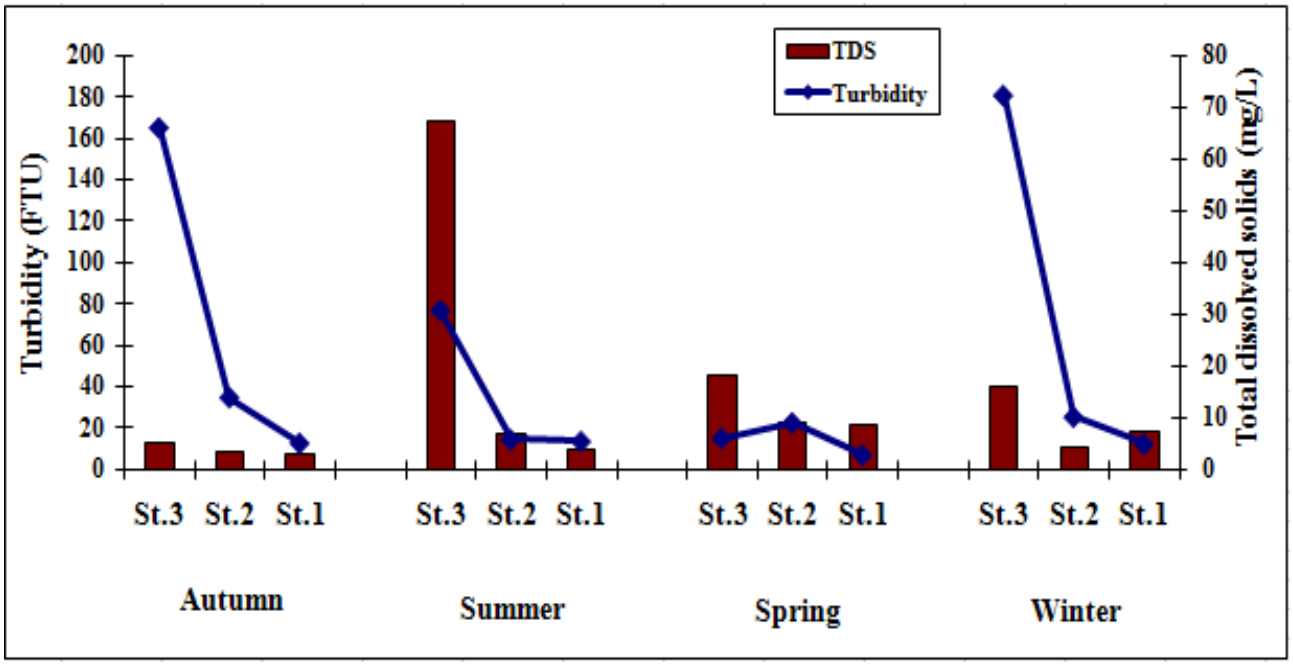

Fig. 4 Total dissolved solids (TDS) and Turbidity (FTU) at three stations in Shatt Al-Arab River during the study period.

Zooplankton

The numerical abundance of zooplankton reached its maximum (69223 ind./m^3) were recorded in winter at (St. 3), while the minimum density (253 ind./m^3) were reported in winter at (St. 2) (Table 1). The seasonally average zooplankton density reported in the present study were 23378, 6693, 29106 and 3842 ind./m^3, in winter, spring, summer and autumn respectively.

The Copepoda were dominant in most stations (57%) then Cirripede larvae (20%) and Cladocera (12%) of the total zooplankton (Fig. 5). The nauplii of Copepoda were dominant in Shatt Al-Arab River which comprising 31.5% of the total zooplankton then Calanioda 21.6%, Cyclopoida 2.3% and Harpactecoida 0.7% (Fig. 6). The Cyclopoida was dominant in station 1 (Al-Ashar) while the Calanoida was dominant in station 3 (Al-Faw) (Fig. 7).

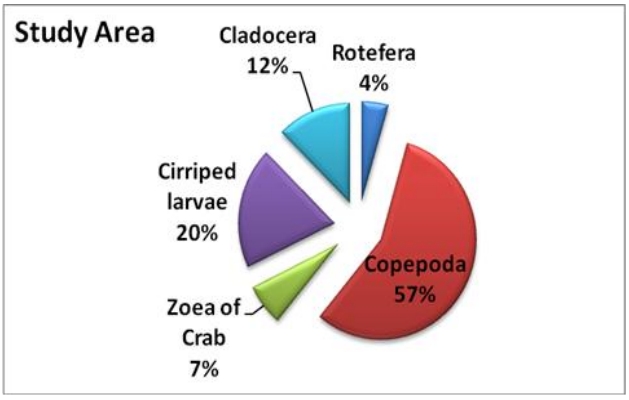

Fig. 5 Percentage of important groups of zooplankton at study area in Shatt Al-Arab, sampled seasonally through 2013.

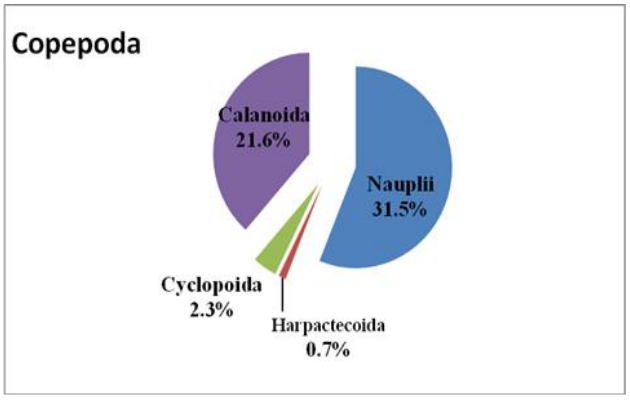

Fig. 6 Percentage of Copepods groups of zooplankton at study area in Shatt Al-Arab, sampled seasonally through 2013.

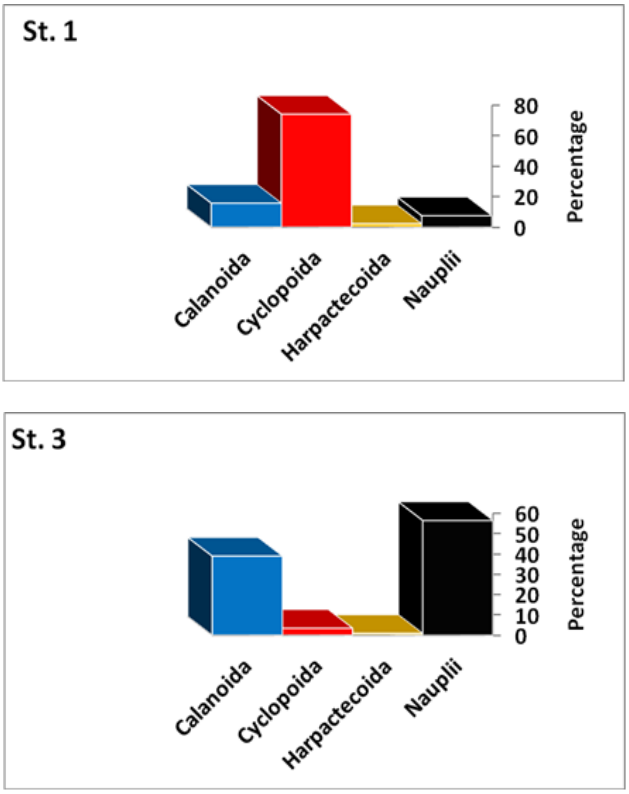

Fig. 7 Percentage of Copepoda at stations 1, 2 and 3 in Shatt Al-Arab, sampled seasonally through 2013.

Station 1 (Al-Ashar)

The density of zooplankton ranged from 659 ind./m^3 in winter to 23607 ind./m^3 in summer (Table 1). The average seasonal density was 7504 ind./m^3.

The Cladocera was the dominant group which constitute 73% of the total zooplankton, the highest peak was 18922 ind./m^3 in summer. The dominant species were Moina affinis (51.3%) and Diaphanosoma brachyurum (21.9%). The second important group was Cirripede larvae (24%) then Copepoda (3%) (Fig. 8).

Station 2 (Abu Al-Khasib)

The population density of zooplankton ranged from 253 ind./m^3 during winter to 23981 ind./m^3 during summer (Table 1). The average seasonal density was 7959 ind./m^3. The Cirripede larvae was the dominant group comprising 87% of the total zooplankton, the highest peak was 22283 ind./m^3 in summer. The second important group was Copepoda (5%) then Cladocera and Rotifera (4%) (Fig. 8).

Table 1 Seasonal density of zooplankton (ind./m^3) in Shatt Al-Arab River.

	Winter			Spring			Summer			Autumn			
Zooplankton	Al-Ashar	Abu Al-Khasib	Al-Faw	Al-Ashar	Abu Al-Khasib	Al-Faw	Al-Ashar	Abu Al-Khasib	Al-Faw	Al-Ashar	Abu Al-Khasib	Al-Faw	**Total**
Moina affinis	-	3.3	0.2	0.01	31.3	-	15163	666	-	247	414	149	**16674**
Simocephalus (*Simocephalus*) *vetuloides*	0.07	-	-	-	-	-	-	-	-	-	-	-	**0.07**
Diaphanosoma brachyurum	-	1.6	-	-	45	-	3759	152	-	2831	18	-	**6807**
Daphnia hyalina	0.04	-	-	-	-	-	-	-	-	-	-	-	**0.04**
Chydorus sphaericus sphaericus	0.41	-	-	-	-	-	-	-	-	-	-	-	**0.41**
Total of Cladocera	**0.52**	**4.9**	**0.2**	**0.01**	**76.3**	**0**	**18922**	**818**	**0**	**3078**	**432**	**149**	**23481**
Calanoida	8.6	0.03	17111	1.04	31.3	3913	123	190	19310	-	1.3	216	**40905**
Cyclopoida	548	102	-	5.2	94	3500	70.1	-		-	45	13.5	**4378**
Harpactecoida	0.01	13.1	-	14.6	282	-	-	-	772	4.5	27	203	**1316**
Nauplii	0.41	-	51852	-	313	456	62.6	380	6000	0.2	-	500	**59564**
Total of Copepoda	557.02	115.13	68963	20.84	720.3	7869	255.7	570	26082	4.7	73.3	932.5	**106163**
Cirriped larvae	101	43	-	1792	2036	1674	4386	22283	331	843	3239	176	**36904**
Rotifera	0.03	90	259	2.1	940	4456	0.6	190		-	27	2459	**8424**
Insecta larvae	0.01	-	-	0.01	-	-	-	-		-	-	-	**0.02**
Fish larvae	0.01	0.03	-	-	18	-	2.5	-	331	-	-	-	**351**
Ostracoda	-	-	-	1.04	13.4	456	17.5	38		-	9	13.5	**548**
Zoea of Crab	-	-	-	1.04	4.5	-	20.1	82	12600	9	14.1	-	**12731**
Amphipoda	-	-	-	0.01	-	-	-	-		0.02	-	-	**0.03**
Shrimp larvae	-	-	0.2	-	-	-	2.5	0.03	13.7	-	-	-	**16.4**
Mycedacea	-	-	0.5	-	-	-	-	-	41.4	-	-	-	**41.9**
Saggeta	-	-	-	-	-	-	-	-	290	-	-	-	**290**
Mollusca	-	-	-	-	-	-	-	-	41.4	-	-	13.5	**54.9**
Medosa	-	-	-	-	-	-	-	-	0.2	-	-	54	**54.2**
Total of zooplankton	**659**	**253**	**69223**	**1817**	**3808**	**14455**	**23607**	**23981**	**39731**	**3935**	**3794**	**3797**	**189060**

Station 3 (Al-Faw)

The density of zooplankton ranged from 3797 ind./m^3 in autumn to 69223 ind./m^3 in winter (Table 1). The average seasonal density was 31801 ind./m^3.

The Copepoda was the dominant group which constitute 82% of the total zooplankton, the highest peak 68963 ind./m^3 in winter. The second important group was Zoea of crabs (10%) then Rotifera (6%) (Fig. 8).

Discussion

Zooplankton plays a very important role in the food chain, they are in the second trophic level as primary consumer and also as contributors to the next trophic level its constitute important food item of many omnivorous and carnivorous fishes (Dewan et al., 1977).

The densities of zooplankton and volume specific biomass are usually greater in the estuaries than in other aquatic habitats, reflecting the generally higher productivity of the estuarine environment. So in the present study the

zooplankton density was observed in the third station more than the other stations, due to the increasing of the Copepoda groups. Also the study results noted the more density of the zooplankton recorded during summer (23607 and 23981 ind./m^3) and less density recorded during winter (659 and 253 ind./m^3) in the first station (Al-Ashar) and second station (Abu Al-Khasib) respectively. While at the third station (Al-Faw) the high density was recorded during winter (69223 ind./m^3) and less density was recorded during autumn (3797 ind./m^3). Also the high density of zooplankton was observed in the last station during winter, spring and summer compared with the other stations due to the increased concentration of salinity. However the concentration of salinity during autumn was low so the zooplankton concentration was similar to the other stations.

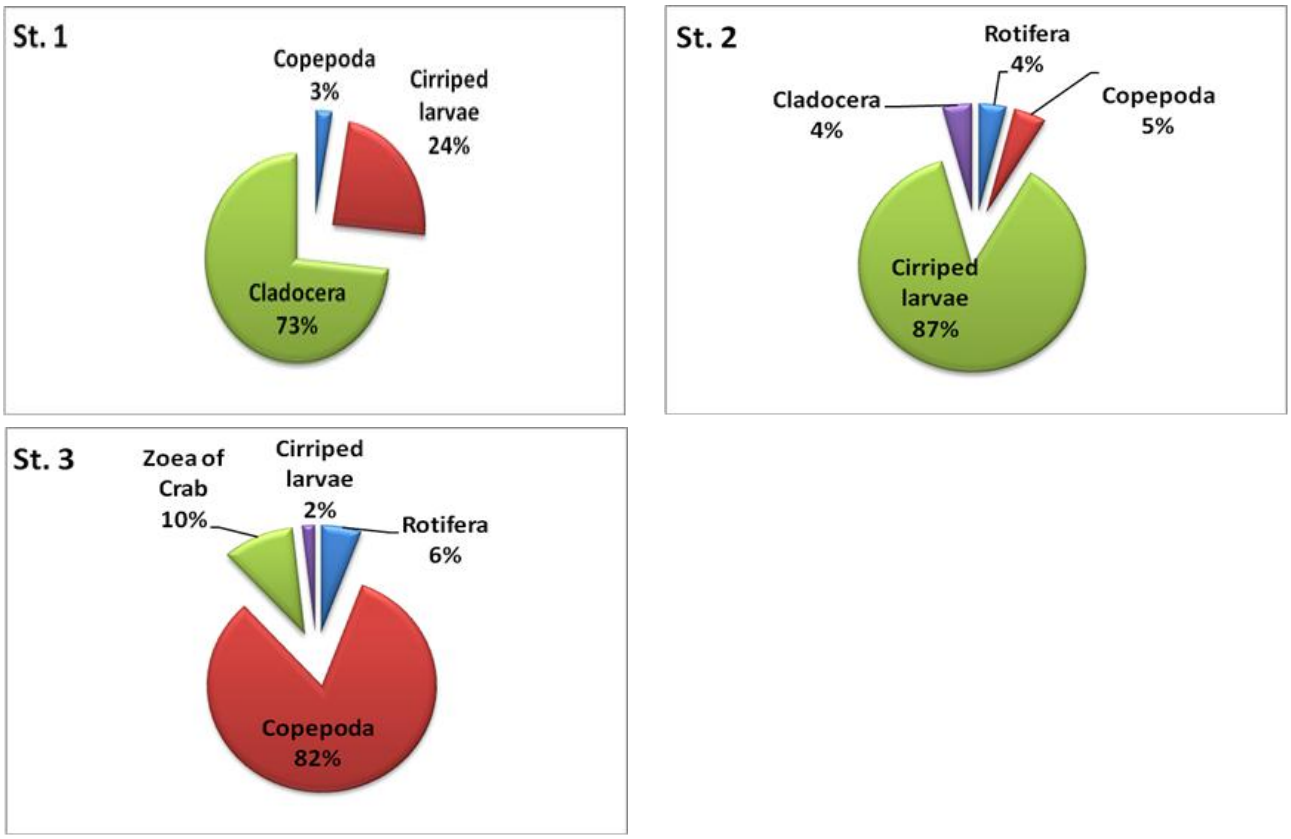

Fig. 8 Percentage of important groups of zooplankton at stations 1, 2 and 3 in Shatt Al-Arab, sampled seasonally through 2013.

Zooplankton assume a great ecological significance in ecosystem as they play vital role in food web of the food chain, nutrient recycling, and in transfer of organic matter from primary producers to secondary consumers like fishes (Krishnamurthy et al., 1979).

The zooplankton distribution varied both spatially and temporally according to the environmental conditions prevailing in the region. Differences might also arise due to the nature of distribution of the plankton, namely patchiness which might be the cause of the great variations in the catches of the nets (Raymont, 1983). Moreover, the mesh-size of the net is an important factor controlling the quality and quantity of the catch.

The present results indicate that there were great differences in the abundance of zooplankton among the three stations sampled, due to the abundance of Cladocera, Cirripede larvae and Copepoda groups in stations 1, 2 and 3 respectively (Fig. 8). It was noted that the density of Cladocera was decreasing towards the south to the sea waters, while intensity of Copepoda group was increasing. This is in agreement with the studies of Ajeel (1990) who stated that the proportion of Copepoda reached to 58.94% in the port of Khour Al-Zubair, 83.97% in the port of Um Qasr and 91.33% in Khour Abdullah of the total number of zooplankton, Al-Zubaidi and Salman (2001) and Ajeel (2004) in Shatt Al-Arab, Shatt Al-Basrah and Khour Al-Zubair, also the study of Ajeel (2012) the Copepoda which accounted for 44.7% in Shatt Al-Basrah and 66.9% in Khour Al-Zubair.

In freshwater the abundance of Cladocera is more than saltwater, so the results noted that the Cladocera predominated in the first station (Al-Ashar) recording five species and amounted to 73.3% of the total zooplankton while at the second station (Abu Al-Khasib) only two species were recorded and amounted to 4.2% of the total zooplankton. As for the third station (Al-Faw) only one species of Cladocera was recorded and was 0.1% of the total zooplankton, while conversely the group Copepoda intensity increased in saltwater more than in freshwater. In the third station dominance of Copepoda was noted due to increased concentration of salinity. Also the results have shown dominance of Cyclopoida group (74.3%) in the first station and dominance of Calanoida in the third station. This is consistent with the study of Ajeel (1990) and (2004).

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