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Distribution and abundance of zooplankton in Shatt Al-Basrah and Khour Al-Zubair Channels, Basrah, IRAQ

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Abstract

Monthly variation in the quality and quantity of zooplankton was studied in Shatt Al-Basrah and Khour Al-Zubair Channels, Basrah, Iraq, during March, 2009 to May, 2010. Samples of zooplankton were collected by plankton net (0.120 mm. Mesh size). In Shatt Al-Basrah Channel, the population density of zooplankton ranged between 5811 – 95514 Ind./m³ during August and April, 2009 respectively. The results showed that the Crustacea was the dominated group 62.9 %. Copepoda constituted about 44.7 % followed by Rotifera 31.0 %, Cirripede larvae 14.7 % , polychaetes 5.5 % and Cladocera 3.1 %. While in Khour Al-Zubair Channel the population density of zooplankton ranged between 3548 and 20328 Ind./m³ during January 2010 and October 2009, respectively. Crustacea was also the dominant group 83.7 % Copepoda formed about 66.6 % , Cirripede larvae and megalopa of crabs 8.4 % , Gastropoda 6.1 % and polychaetes 2.3 %.

Key words: zooplankton, distribution, Shatt Al-Basrah, Khour Al-Zubair, Basrah.

1. Introduction

Most zooplankton are microscopic animals (water invertebrates) floating or drifting, inhabiting all layers of the water even to great depths. They are feed on phytoplankton and some organic materials, suspended in the water so frequently and present in surface water or near the surface. They include larval stages of most of the nektonic and benthic animals. The size ranged from 5 µm, as in some Ciliata and Protozoa, such as flagellates, to large animals such as Jellyfish, which has a diameter of up to one meter or more [1]. It has an importance in the food chain of the aquatic ecosystems throughout the world, channeling energy and nutrients from primary products (phytoplankton) to consumers of economic importance (such as fish, shrimp, etc.), because they are highly productive and important in fish diets. An improved understanding of zooplankton production and growth can be applied to increase fish production in aquaculture facilities and in the wild [2]. which in turn serves as food for larger animals Its greatest density in the upper, lighted zone and in productive waters planktonic organisms may occur in such enormous numbers that the water appears turbid [3]. Therefore, the interest has been focused here on this important group, as it has not been well documented. The abundance of zooplankton in a certain area shows the presence of the prosperity of the zooplankton in that region and thus refers to the abundance of fish and crustaceans commercial [4]. For this the

estimating of the amount of zooplankton in the region of water given it the importance of extremely inference on the productivity of that region [5].

There are no regular monthly studies on the zooplankton in Shatt Al-Basrah. However, there are some studies in the North of the channel (Al-Hammar Marsh) and in the South of the channel (Khour Al-Zubair). In the Marshes, [6] who investigated the Entomostraca, particularly, the Cladocera of the middle and South of Iraq. Furthermore, [7] it studied the zooplankton of the Al-Hammar Marshes, near Garmat-Ali River, qualitatively and quantitatively, between 1980 and 1981.They recorded 21 genera which belong to three groups Copepoda, Cladocera and Ploima, and reported that the rotifers is the dominant group in the region. Then [8] recorded 14 species of Cladocera in Al-Chibaish, Al-Hammar and Al-Fuhod Marshes. [9] studied the seasonal abundance of zooplankton in the southern Iraqi Marshes (Al-Hwaiza and Al-Hammar) and Al-Izze river. The density of zooplankton ranged between 52 ind./m^3 in Al-Barga region south of Al-Hammar Marshes during the summer to 3309 ind./m^3 in Al-Huaiza Marshes during the spring.

However in Khour Al-Zubair [10] he studied the quality of Copepoda, and [11] he described new species of Copepoda in Khour Al-Zubair and Khour Abdullah, and then [12] we studied the marine zooplankton in Khour Al-Zubair and Khour Abdullah and stated that the density of zooplankton increased during spring and summer and decreased during autumn and winter. [13] he studied the seasonal changes in the distribution and abundance of Copepoda in Khour Al-Zubair, [14] we studied the ecology and reproduction of *Acartia (Acartiella) faoensis* in Khour Al-Zubair, and [15] they studied the feeding and reproduction of two species of Copepoda in Khour Al-Zubair, [16] we studied the seasonal variations in the lengths of some important species of marine Copepoda in Khour Al-Zubair and Khour Abdullah. Finally, in Khour Al-Zubair, [17] he recorded 9 species of Copepoda and recorded the highest density of Copepoda 228500 ind./m^3 in the north of Khour Al-Zubair during July, and the lowest density 2400 ind./m^3 was during October in the south of Khour Al-Zubair.

Due to the environmental importance of the North-West Arabian Gulf, and the significant role played by Khour Al-Zubair and Shatt Al-Basrah for being a good place for spawning, breeding and feeding of many fishes, a good source for fishing and an important outlet for Iraqi territorial waters. It also creats an environment for some endemic species due to physical, chemical and biological environmental conditions [18]. In view of the absence of monthly long-term study in this region, it is suggested that the present study aims to identify the environmental characteristics and to study some characteristics of biodiversity by means of the biomass of zooplankton.

2. Materials and methods

2.1. Sample collection:

Zooplankton samples were collected during the period from March, 2009 up to May, 2010 from Shatt Al-Basrah (north to the Dam) and Khour Al-Zubair (near the port of Khour Al-Zubair) (Fig 1). Using mesh-size net was 120 micron and with a mouth aperture of 40 cm. The net was towed behind a boat for 10 - 15 min. at it's lowest speed and the readings of the digital flow meter, mounted in the mouth aperture was taken .The samples were fixed immediately with 4% formalin, while the samples for biomass was freeze-preserved.

In the laboratory, the samples were diluted if densely populated. Then a 10 ml subsample was taken, the sample was placed in a Bogorov chamber, examined and counted under a dissecting microscope. This procedure was repeated for 3 times,

and the average was taken, then the whole sample was examined for the rare species.

The volume of water were calculated by using the method of [19].

$$V = \Pi \ r^2 \ d$$

Where:

V = volume of water filtered by the net and is measured in cubic meters

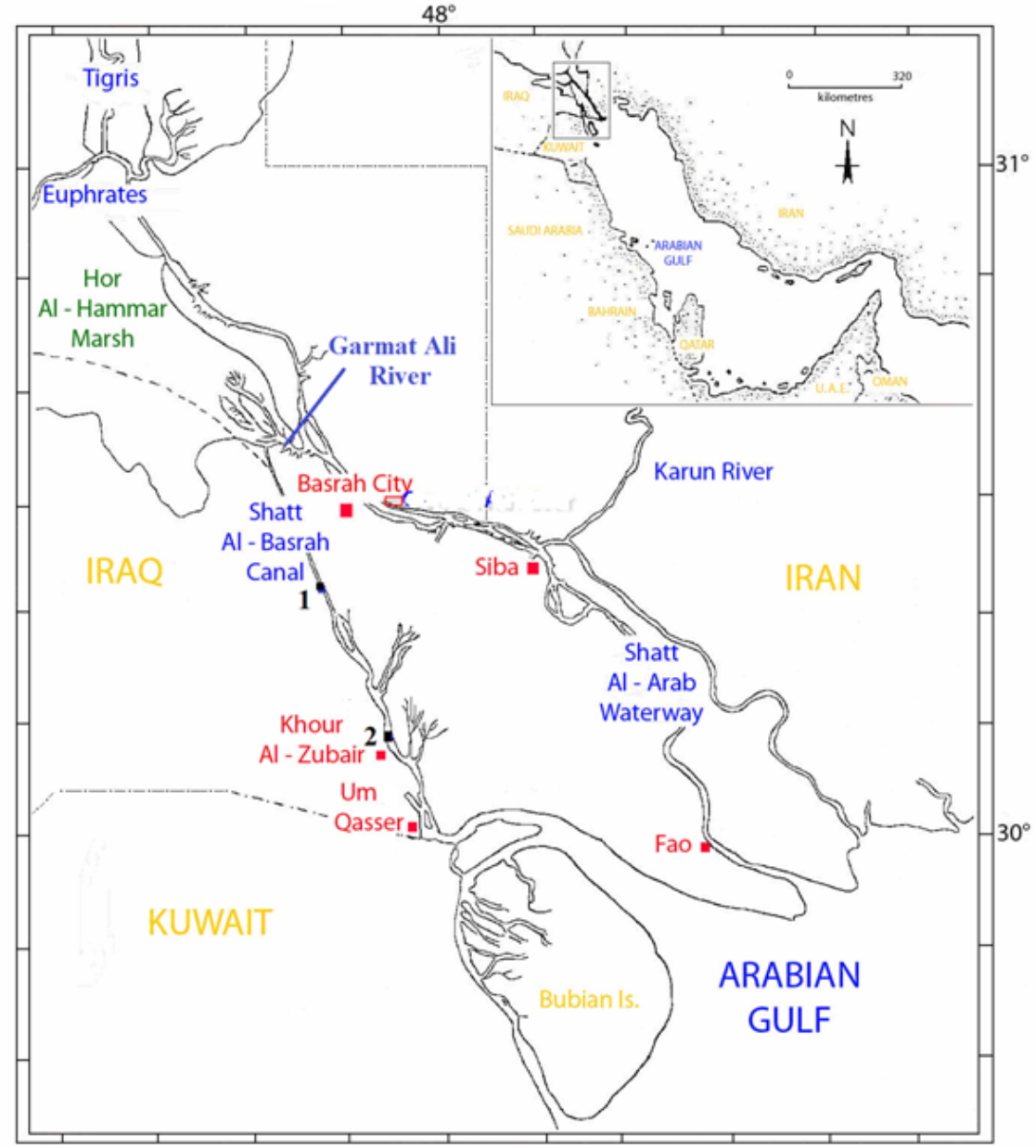

Fig. (1) : Map of low Mesopotamia, showing the sampling stations

$\Pi = (3.14)$

r = half diameter of the net mouth aperture, (20 cm)

d = number of revolutions of the flowmeter multiplied at 0.3.

Then the result was divided by 10,000 to convert the result unit per cubic meter. The number of individuals were calculated in the sample diluted to 1000 ml in the manner prescribed by [20], and expressed the result in cubic meter

$$No./m^3 = (C \times V^I) / (V^{II} \times V^{III})$$

Where:

C = the number of individuals in the subsample
V^{I} = volume of sample (ml).
V^{II} = the size of the subsample (10 ml).
V^{III} = volume of water filtered in cubic meters

2.2. Biomass of zooplankton

2.2.1. displacement volume and standing crop

The volume of water displacement of zooplankton was measured for all samples. The sample was put in the volumetric flask, 500 ml and was completed to the volume of the final mark by the addition of water, then the sample was filtered through a net of a mish-size which was less than that used for the sample collection in another volumetric flask (500 ml), after that the volume was completed to the mark.

The added volume of water is equal to the displacement volume of the zooplankton. The volume of zooplankton (ml/m^3) was then obtained by dividing the volume of zooplankton by the volume of sample, filtered by the net.

The standing crop of the zooplankton ($mg\ C/m^3$) was calculated by using the conversion factor of 65 mg C/ml of displacement volume .[21].

2.2.2. Wet weight and Dry weight

Fresh weight and dry weight of the zooplankton were estimated by filtering the sample through a wet filter paper of a known weight by using a vacuum pump and the wet weight was recorded by subtracting the weight of the wet filter paper from the paper with the zooplankton. Then the paper was oven – dried at 60 ºC for 24 hours and the dry weight was recorded. The dry weight of the filter paper was subtracted from that of the paper with the sample. After that the dry weight of the sample was obtained. Finally the wet weight and dry weight were converted into mg/m^3 by dividing the weight of the sample by the volume of the sample filtered.

3. Results

3.1. Temperature and Salinity

Water temperature ranged between 15.08 °C during January, 2010 to 29 °C and 30 ° C during August, 2009 in Shatt Al Basrah and Khour Al-Zubair, respectively (Fig. 2). The salinity ranged between 5.4 - 39.5 ‰ during April, 2009 and April, 2010 respectively in Shatt Al-Basrah, and between 21 ‰ in March, 2009 to 42 ‰ in August, 2009 and May, 2010 in Khour Al-Zubair (Fig. 3).

3.2. Zooplankton

3.2.1. Shatt Al-Basrah

The density of zooplankton in Shatt Al-Basrah ranged from 5811 $ind./m^3$ in August to 95514 $ind./m^3$ in April, 2009 (Fig. 4). The Crustacea was dominant in this area, where their numbers ranged between 4773 $ind./m^3$ in August to 51086 $ind./m^3$ in April. They comprised 62.9 % of the total number of zooplankton.

Copepoda constituted the majority of the zooplankton (44.7 % of the total zooplankton), and a percentage of total crustaceans they formed 71.0 %. Rotifera comes in the second place (31.0 % of the total number of zooplankton), and was more intense with 44430 $ind./m^3$ during April 2009. Then the larvae of cirripedes was (14.7 %), and polychaetes was (5.5 %), Cladocera, comprised 3.1 % of the total zooplankton, and its highest density was 5267 $ind./m^3$ which occurred during March 2009, (Table 1).

Twenty species of Copepoda and eight species of Cladocera were recorded in Shatt Al-Basrah (Table 1). Cyclopoida was the dominant group, which accounted for 19.5 % and Calanoida formed 13.9 % of the total zooplankton. The nauplii of Copepoda was formed in numbers, and accounted for 23.4 % of the total Copepoda. The highest density was 11204 ind./m^3 in November 2009.

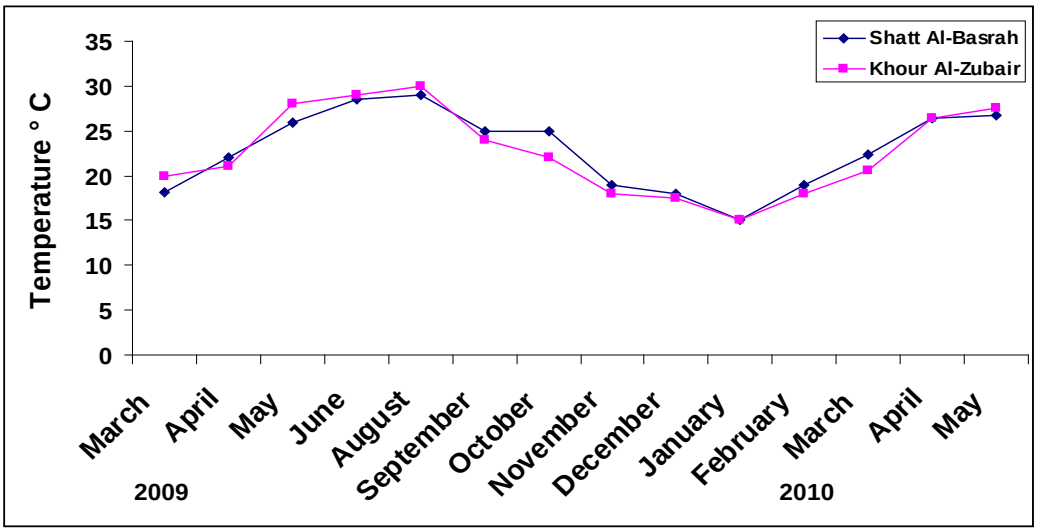

Figure 2. Water temperature in Shatt Al-Basrah and Khour Al-Zubair sampled from March, 2009 to May, 2010.

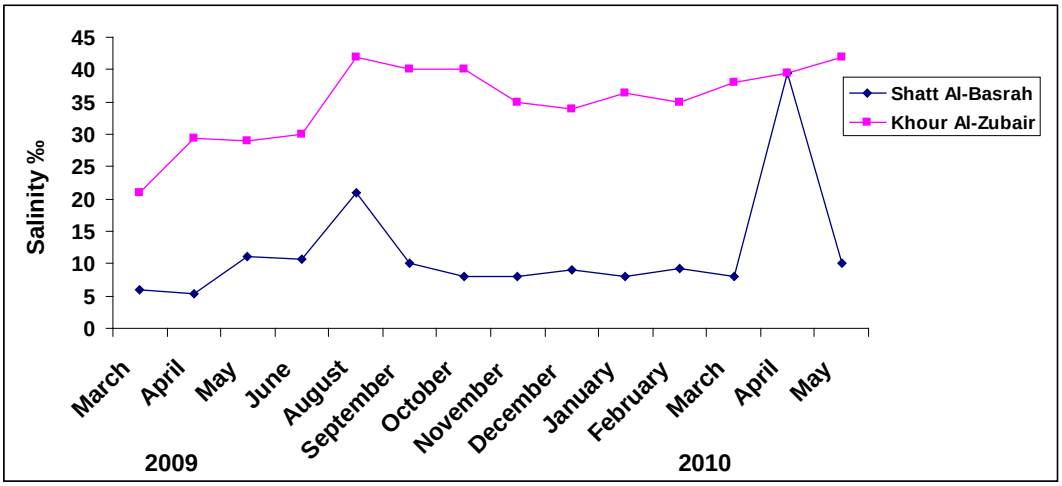

Figure 3. Concentration of salinity in Shatt Al-Basrah and Khour Al-Zubair sampled from March, 2009 to May, 2010

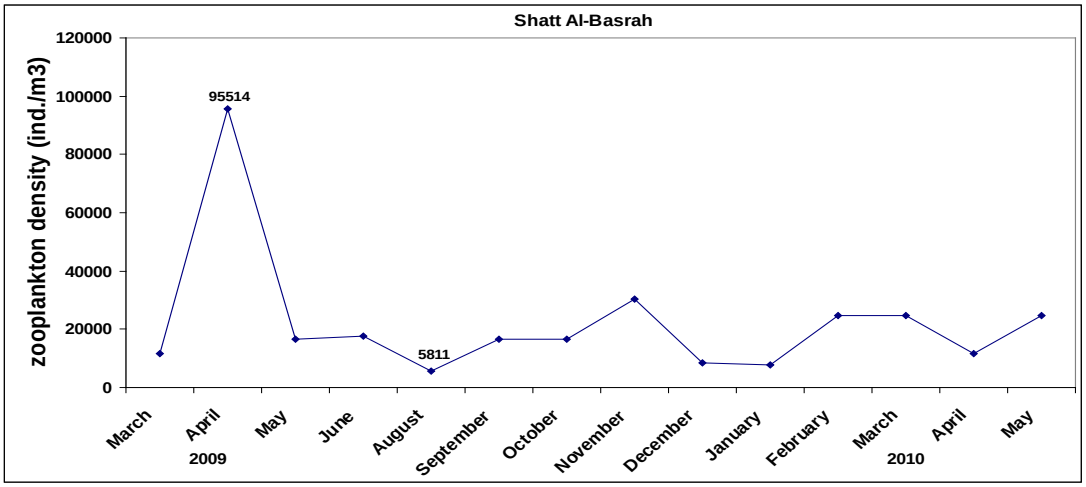

Figure 4. Zooplankton density (ind./m^3) in Shatt Al-Basrah, sampled from March, 2009 - May, 2010

Table 1. Zooplankton density (ind./m^3) in Shatt Al-Basrah during March, 2009 - May, 2010

Zooplankton	March 2009	April	May	June	Aug.	Sep.	Oct.	Nov.	Dec.	Jan. 2010	Feb.	March	April	May	Total	Percentage %
Acartia sp.	-	1	163	34	-	-	56	-	-	-	199	-	1	-	454	0.1
A. pacifica	-	-	-	-	30	123	56	-	90	28	-	-		31	358	0.1
A. (Acartiella) faoensis	-	-	-	34	30	1.2	56	1	271	85	696	1	1	31	1207	0.4
Acrocalanus gibber	-	-	-	-	-	-	-	-	-	-	-	-	-	218	218	0.07
Arctodiaptomus salinus	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	0.0003
Bestiolina arabica	-	-	-	1462	-	-	1174	-	1	-	-	-	1577	685	4899	1.6
Centropages sp.	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	0.0003
Clausocalanus sp.	-	-	-	-	-	370	-	-	-	-	199	-	-	-	569	0.16
Diaptomus sp	5604	918	217	-	-	987	-	-	-	-	-	-	-	-	7726	2.5
Eucalanus subcrassus	-	-	-	-	-	-	-	-	-	38	-	-	-	-	38	0.01
Paracalanus aculatus	-	-	-	1292	1126	3701	391	-	-	-	99	-	-	-	6609	2.1
P. crassirostris	-	-	-	-	-	-	-	89	-	85	332	31	96	-	633	0.2
Parvocalanus crassirostris	-	-	-	-	-	-	-	-	-	-	-	-	96	1121	1217	0.4
Phyllodiaptomus inakensis	-	-	-	-	-	-	-	-	-	-	33	-	-	-	33	0.01
Pseudodiaptomus sp.	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	0.0003
P. marinus	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	0.0003
Copepodite stages	-	-	489	1768	3260	5798	4468	59	316	704	696	-	1147	716	19421	6.2
Total of Calanoids	5604	919	869	4591	4446	10980	6201	149	679	942	2254	-	2918	2802	43386	13.9
Oithona sp.	-	1606	109	-	-	-	-	-	-	-	-	-	-	-	1715	0.5
Other Cyclopoids	-	36400	1195	3435	1	-	3351	13433	362	347	166	-	-	31	58721	18.8
Total of Cyclopoids	112	38006	1304	3435	1	308	3351	13433	362	347	166	217	48	31	60436	19.5
Oncaea sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	93	93	0.03
Total of Poecilostomatida	-	-	-	-	-	-	-	-	-	-	-	-	-	93	93	0.03
Euterpina acutifrons	-	-	-	-	30	-	-	-	-	-	-	-	-	-	30	0.01
Harpacticoids	-	152	-	68	-	123	56	-	-	-	33	1	48	62	543	0.2
Nauplii	420	7724	-	1802	119	2652	2569	11204	2215	789	564	403	526	934	31921	10.2
Total of Copepods	**6136**	**46801**	**4725**	**9895**	**4595**	**14063**	**12176**	**24786**	**3254**	**2078**	**3017**	**653**	**3538**	**3922**	**136316**	**44.7**
Alona affinis	-	230	-	-	-	-	-	-	-	-	-	-		-	230	0.07
Camptocercus uncinatus	-	-	-	-	-	-	-	59	-	-	-	-	-	-	59	0.02
Ceriodaphnia cornuta	1541	842	109	-	-	-	-	-	-	-	-	-	-	-	2492	0.8
Chydorus barroissi	-	306	-	-	-	-	-	-	-	-	-	-	-	-	306	0.1
Daphnia pulex	3278	1	-	-	-	-	-	-	-	-	-	-	-	-	3279	1.0
Dunhevedia crassa	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	0.0003
Moina brachiata	-	2906	54	-	-	-	-	-	-	-	-	-	-	-	2960	0.9
Simocephalus expinosus	448	-	-	-	-	-	-	-	-	-	-	-	-	-	448	0.1
Total of Cladocera	5267	4285	163	-	-	-	-	59	1	-	-	-	-	-	9775	3.1
Amphipods	84	-	-	-	-	-	-	-	-	-	-	-	-	-	84	0.03
Cirripede larvae	-	-	489	170	178	802	1899	1545	2080	2732	3614	17529	5114	9904	46056	14.7
Megaloba	28	-	109	1	-	62	-	1	-	9	199	1	-	31	441	0.1
Mysis of shrimp	-	-	-	-	-	0.4	-	1	-	1	-	-	-	31	33	0.01
Mysidacea larvae	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	0.0003
Insecta	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	0.0003
Ostracods	-	-	-	-	-	62	1	1	-	28	166	31	48	-	337	0.1
Zoea of Crab	-	-	-	-	-	123	1	-	-	-	-	-	48	-	172	0.05
Crustacea	**11515**	**51086**	**5486**	**10066**	**4773**	**15112**	**14079**	**26393**	**5336**	**4848**	**6996**	**18215**	**8748**	**13888**	**196541**	**62.9**
Appendicularia	-	-	-	-	-	370	56	-	-	-	-	-	-	-	426	0.1
Bivalve	-	-	-	34	-	185	56	-	45	-	-	-	-	-	320	0.1
Foraminifera	84	-	-	-	-	-	-	-	-	-	-	-	1	-	85	0.03
Fish larvae	-	-	-	1	1	-	-	-	-	-	-	1	1	31	35	0.01
Fish eggs	-	-	-	102	59	-	168	178	90	-	1691	-	-	-	2288	0.7
Gastropoda	-	1	54	68	30	864	168	-	45	-	-	-	-	-	1230	0.4
Hydrozoa	-	-	-	-	-	62	-	-	-	-	-	-	-	-	62	0.02
Nematoda	-	-	-	-	-	-	-	-	-	-	-	-	48	-	48	0.01
Polychaet larvae	-	-	163	68	30	1234	726	30	-	-	5471	-	-	-	17289	5.5
Polychaet adult	-	-	-	-	-	-	-	-	-	-	9549	-	-	-		
Rotifers	-	44430	10809	7243	919	1295	1284	3898	2939	2986	829	6608	2676	10932	96848	31.0
Sagitta sp.	-	-	-	-	-	-	-	-	-	9	-	-	-	1	10	0.003
Total number of zooplankton	**11599**	**95514**	**16512**	**17580**	**5811**	**16469**	**16533**	**30491**	**8453**	**7840**	**24536**	**24824**	**11472**	**24851**	**312485**	

The highest peak of Copepodite stages was recorded in September, 2009 (5798 ind./m^3) and constituted 14.2 % of the total Copepoda. The density of Copepoda was: *Diaptomus* sp (5.7 %), *Paracalanus aculatus* (4.8 %), *Bestiolina arabica* (3.6 %), *Acartia (Acartiella) faoensis* (0.9 %), *Oithona* sp. (1.2 %) and *Parvocalanus crassirostris* (0.9 %) of the total Copepoda. While *Daphnia pulex* constituted the highest density of Cladocera which was (33.5 %), followed by *Moina brachiata* (30.3 %) and *Ceriodaphnia cornuta* (25.5 %) of the total Cladocera.

3.2.2. Khour Al-Zubair

The density of zooplankton ranged from 3548 ind./m^3 in January, 2010 to 20328 ind./m^3 in October, 2009 (Fig. 5). The crustaceans were dominant, they comprised 83.7 % of the total zooplankton. Copepoda represented the most dominant group, its density ranged between 2441 ind./m^3 at January, 2010 and 18149 ind./m^3 in October, 2009, and comprised about 66.6 % of the total zooplankton. Megaloba and cirripedes 8.4 %, Gastropoda 6.1 %, fish eggs and larvae 5.0 %, and polychaetes 2.3 % of the total zooplankton.

A total of 22 species of Copepoda were identified in Khour Al-Zubair , and a group of Calanoida are prevalent which comprised 40.7 % , Harpacticoida 0.1 %, Poecilostomatida 0.5 % and Cyclopoida 0.3 %, and Nauplii of Copepoda comprised 25 % of the total zooplankton, and the highest density was (8600 ind./m^3) which occurred in October, 2009. The highest density of the copepodite stages was 4356 ind./m^3, it was recorded in October, 2009 (comprised about 14.0 % of the total zooplankton). The dominant species of Copepoda were: *Acartia pacifica* (11.1 %), *Acartia (Acartiella) faoensis* (9.2 %), *Paracalanus subcrassus* (6.5 %), *Bestiolina arabica* (4.4 %), *Diaptomus* sp. (3.3 %) and *Parvocalanus crassirostris* (1.5 %) of the Copepoda (Table 2).

3.3. Biomass of the zooplankton

3.3.1. Shatt Al-Basrah Channel

The biomass of zooplankton, in terms of displacement volume, varied from 0.18 - 1.9 ml/m^3 during June and April, 2009, respectively (Fig. 6), and the average was 0.80 ml/m^3. In terms of wet mass, the biomass varied from 53.8 - 1992.5 mg/m^3 in May, 2009 and February, 2010, respectively (Fig. 7), and the average was 848.2 mg/m^3. In terms of dry weight, the biomass ranged between 12.2 - 213.0 mg/m^3 in December and August, 2009, respectively (Fig. 8). The average was 70.18 mg/m^3, while the biomass of zooplankton in terms of standing crop varied from 12.0 and 123.0 mg C/m^3 during June and April 2009, respectively (Fig. 9). The annual average was 52.06 mg C/m^3.

3.3.2. Khour Al-Zubair

The highest value of the mass of zooplankton in Khour Al-Zubair was recorded during spring, while the lowest value was recorded during autumn. The biomass, in terms of displacement volume ranged between 0.07 and 3.46 ml/m^3 in November and March, 2009, respectively (fig. 10) , and the annual average was 0.50 ml/m^3. In terms of wet weight, it ranged between 114.9 and 5337.7 mg/m^3 during September and March, 2009, respectively (fig. 11). and the annual average was 647.47 mg/m^3, but in terms of dry weight it ranged between 3.05 and 411.36 mg/m^3 in January, 2010 and March, 2009, respectively (fig. 12). The annual average was 48.37 mg/m^3, while in terms of the standing crope, it ranged between 4.55 and 224.96 mg C/m^3 in November and March 2009, respectively (fig. 13), and the annual average was 32.56 mg C/m^3.

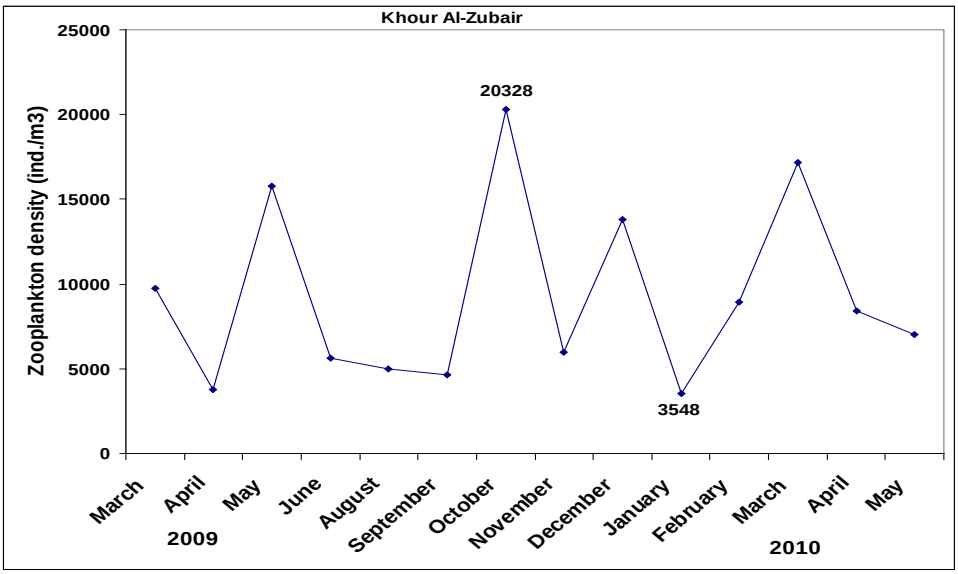

Figure 5. Zooplankton density (ind./m^3) in Khour Al-Zubair from March, 2009 - May, 2010.

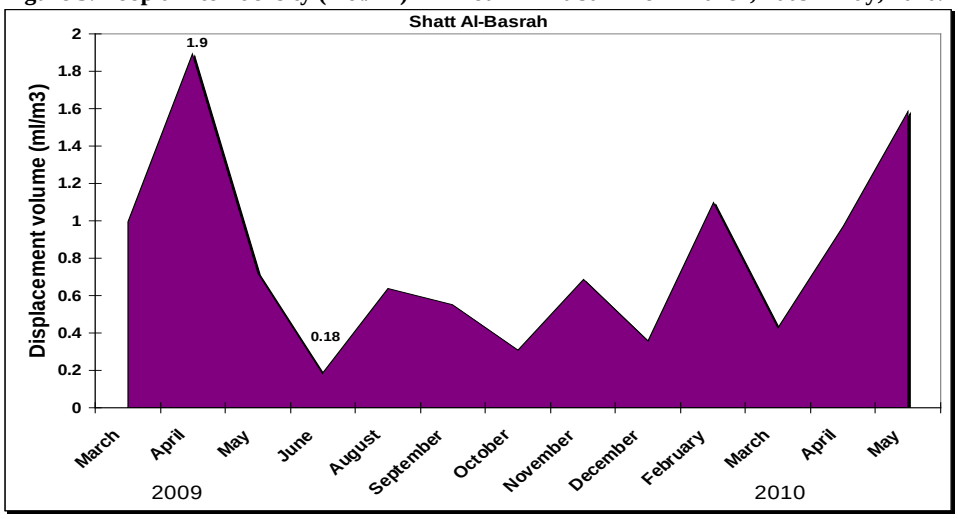

Figure 6. Biomass in terms of displacement volume (ml/m3) in Shatt Al-Basrah for the period from March, 2009 to May, 2010 ..

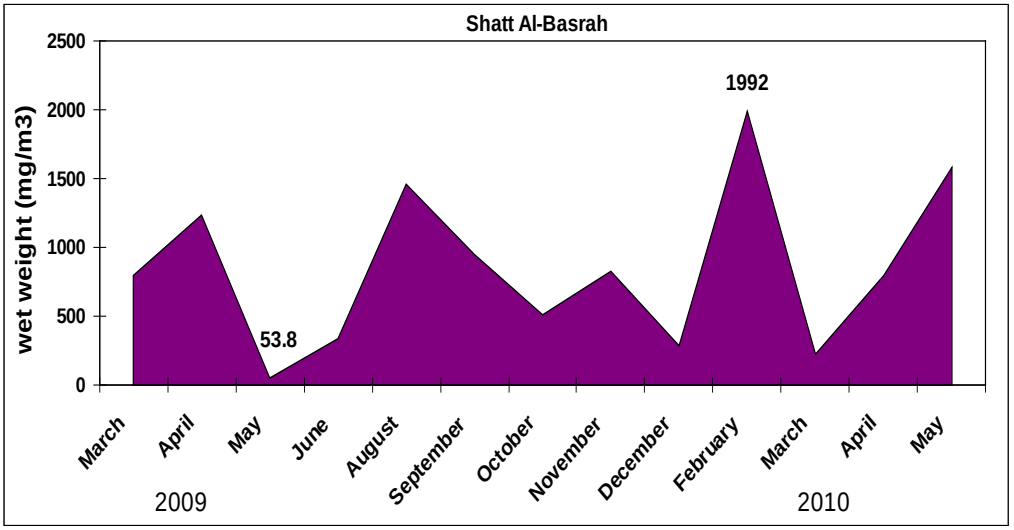

Figure 7. Biomass in terms of wet weight (mg/m^3) in Shatt Al-Basrah for the period from March, 2009 to May, 2010 .

Table 2. Total number of zooplankton (ind./m^3) in Khour Al-Zubair collected from March, 2009 – May, 2010

Zooplankton	March 2009	April	May	June	Aug.	Sep.	Oct.	Nov.	Dec.	Jan. 2010	Feb.	March	April	May	Total	Percentage %
Acartia sp.	189	919	233	141	64	163	-	128	-	172	99	-	-	-	2108	1.6
A. pacifica	-	208	3596	309	64	38	2904	586	67	-	-	254	352	1167	9545	7.4
A. (Acartiella) faoensis	-	-	666	26	128	54	112	641	3239	29	99	2351	244	268	7857	6.1
Acrocalanus gibber	-	-	-	-	-	-	-	-	-	1	-	-	54	-	55	0.04
Arctodiaptomus salinus	-	-	67	-	-	-	-	-	-	-	-	-	-	-	67	0.05
Bestiolina arabica	-	-	-	-	-	-	1507	586	11	420	-	-	868	338	3730	2.9
Clausocalanus minor	-	-	-	-	144	-	391	-	-	324	25	-	-	-	884	0.7
Diaptomus sp	2653	44	-	-	-	163	-	-	-	-	-	-	-	-	2860	2.2
Eucalanus subcrassus	-	-	-	-	1	-	-	-	-	-	-	-	-	35	36	0.03
Paracalanus subcrassus	-	744	383	1556	1154	544	223	147	22	38	49	-	81	618	5559	4.3
Parvocalanus crassirostris	-	-	-	-	-	-	-	-	-	-	-	64	840	397	1301	1.0
Phylodiaptomus sp.	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	0.0008
Pseudodiaptomus sp.	-	-	-	13	-	-	-	-	-	-	-	-	-	-	13	0.01
P. marinus	-	-	200	-	-	-	-	-	-	-	-	-	-	-	200	0.2
Copepodite stages	392	-	1832	1504	1122	888	4356	1300	112	792	567	1334	3199	618	18016	14.0
Total of Calanoida	3234	1915	6977	2045	2677	1850	9493	3388	3451	1777	839	-	5638	3441	52232	40.7
Oithona plumifera	29	-	-	-	-	18	-	-	-	-	-	-	-	-	47	0.04
Other Cyclopoida	65	98	67	-	32	54	-	-	11	-	-	-	54	-	381	0.3
Total of Cyclopoida	94	98	67	-	32	72	-	-	11	-	-	64	54	-	428	0.3
Aegisthus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	12	12	0.009
Euterpina acutifrons	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	0.0008
Microsetella rosea	-	-	-	-		1	-	-	-	-	-	-	1	12	14	0.01
Other Harpacticoida	-	-	-	-	-	-	56	-	-	-	-	-	27	-	83	0.06
Total of Harpacticoida	-	-	-	-	-	1	56	1	-	-	-	635	28	24	110	0.1
Oncaea conifera	-	-	-	373	112	-	-	-	-	-	49	-	-	35	569	0.4
O. cleve	-	-	-	-	-	-	-	-	-	-	-	64	-	-	64	0.05
Total of Poecilostomatida	-	-	-	373	112	-	-	-	-	-	49	-	-	35	633	0.5
Nauplii	2171	1247	3380	810	689	1233	8600	1520	4613	696	1675	4638	190	677	32139	25.0
Total of Copepoda	5481	3260	10424	4732	3509	3806	18149	4908	8075	2441	2563	9404	5909	4177	85542	66.6
Cirripede larvae	152	120	2031	141	176	254	391	311	235	153	1059	5527	190	117	10857	8.4
Megaloba	4037	33	1166	411	32	18	279	147	22	19	567	1398	325	2322	10776	8.4
Zoea of Crab	-	-	-	-	-	-	56	37	1	-	-	-	-	-	94	0.07
Mysis of shrimp	-	-	33	26	1	1	-	-	-	-	-	2	27	12	102	0.08
Amphipoda	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	0.0008
Ostracoda	7	11	17	-	-	-	-	1	-	-	1	127	1	12	177	0.1
Mysids larvae	-	-	-	-	-	-	1	1	-	-	-	-	-	1	3	0.002
Total of Crustacea	9677	3424	18981	5310	3718	4079	18876	5405	8333	2613	4190	-	6452	6642	107552	83.7
Bivalve	-	-	-	26	32	-	168	37	-	315	-	-	108	47	733	0.6
Gastropoda	22	241	1815	77	32	127	503	92	22	124	3769	127	624	222	7797	6.1
Rotifers	36	-	-	13	-	163	391	18	-	-	443	-	-	-	1064	0.8
Polychaet larvae	36	77	200	64	1122	54	168	366	-	57	197	445	108	58	2952	2.3
Appendicularia	-	-	-	116	64	218	223	18	-	-	-	127	81	23	870	0.7
Conifera	-	22	-	-	-	-	-	-	-	-	-	-	-	-	22	0.02
Fish larvae	-	-	83	13	1	-	-	-	-	1	-	1	27	12	138	0.1
Fish eggs	-	-	33	13	-	-	-	18	5450	439	296	-	27	12	6288	4.9
foraminifera	-	-	-	-	-	-	-	-	-	-	-	-	976	-	976	0.7
Sagitta	-	-	-	-	-	-	-	-	-	1	25	-	1	12	39	0.03
Jelly fish	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	0.0008
Ephyra of coelentrate	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	0.0008
Total number of zooplankton	9771	3764	15802	5632	4967	4640	20328	5952	13804	3548	8919	17159	8402	7026	128433	

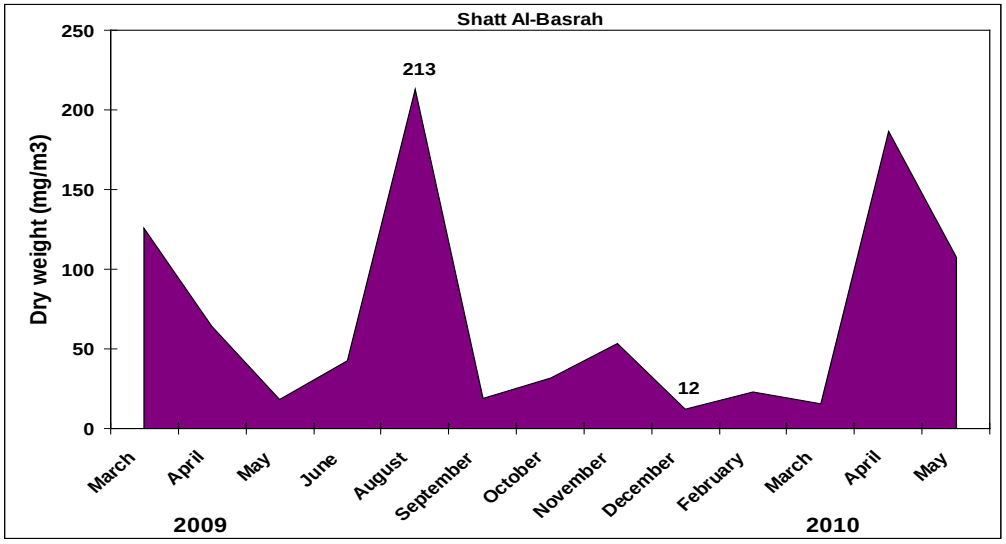

Figure 8. Biomass of zooplankton in terms of dry weight (mg/m^3) in Shatt Al-Basrah sampled from March, 2009 – May, 2010.

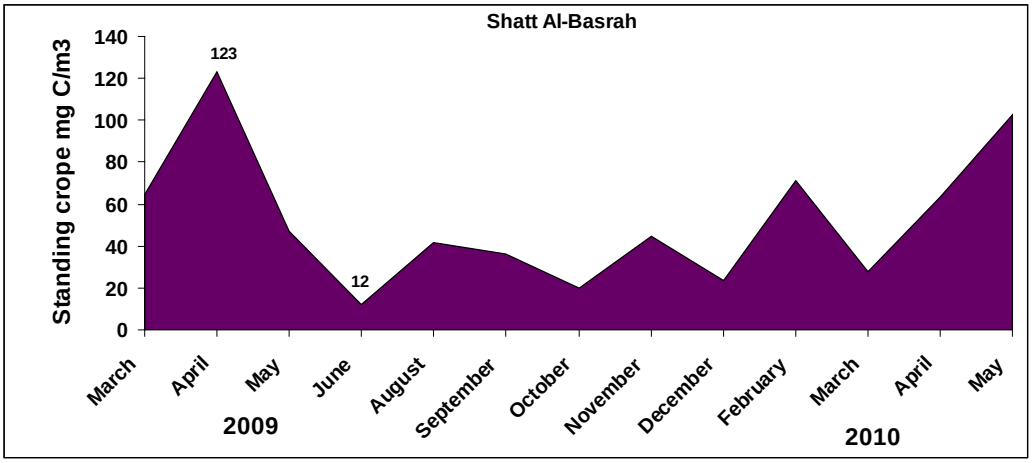

Figure 9. Biomass of zooplankton in terms of standing crop (mg C/m^3) in Shatt Al-Basrah sampled from March, 2009 – May, 2010.

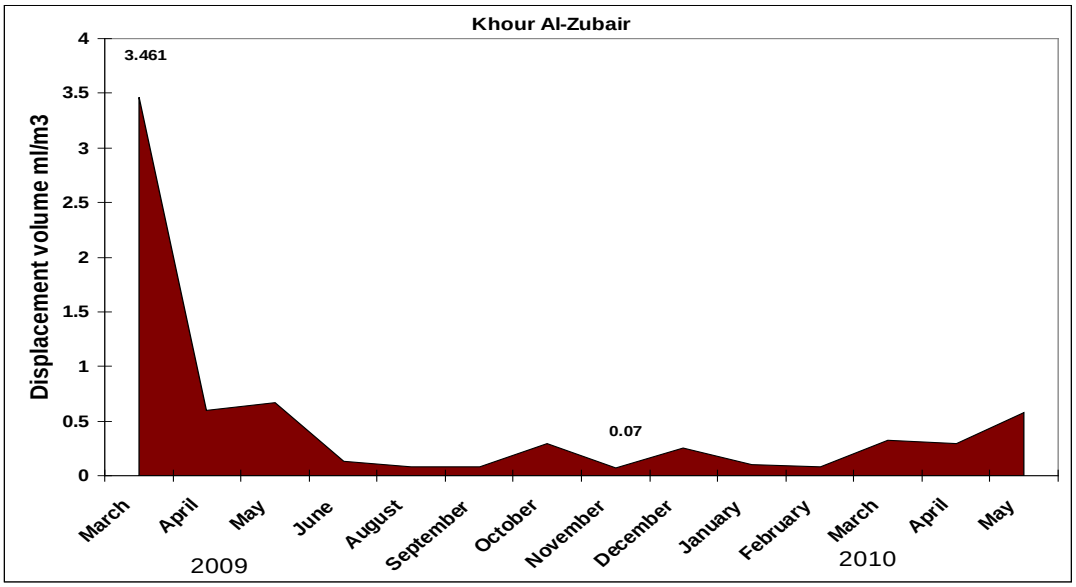

Figure 10. Biomass of zooplankton in terms of displacement volume (ml/m^3) in Khour Al-Zubair sampled from March, 2009 – May, 2010.

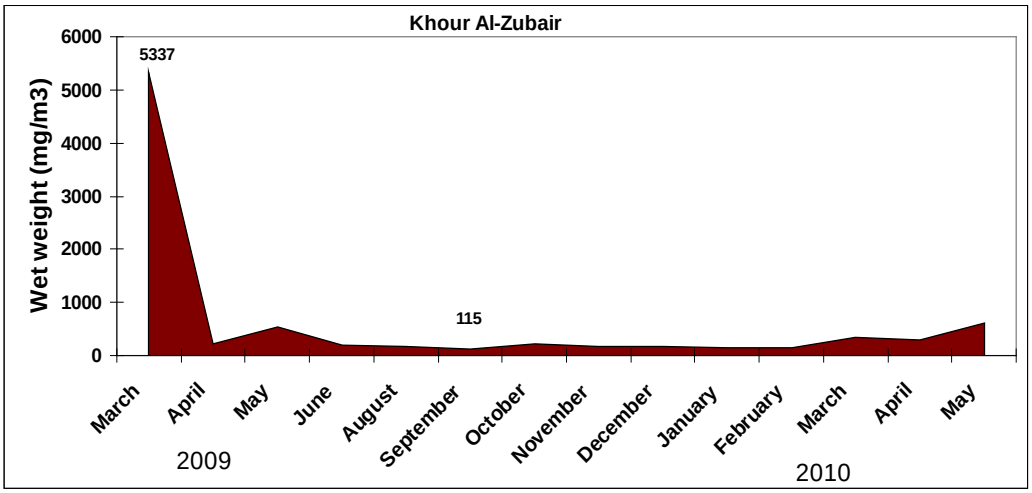

Figure 11. Biomass of zooplankton in terms of wet weight (mg/m^3) in Khour Al-Zubair sampled from March, 2009 – May, 2010.

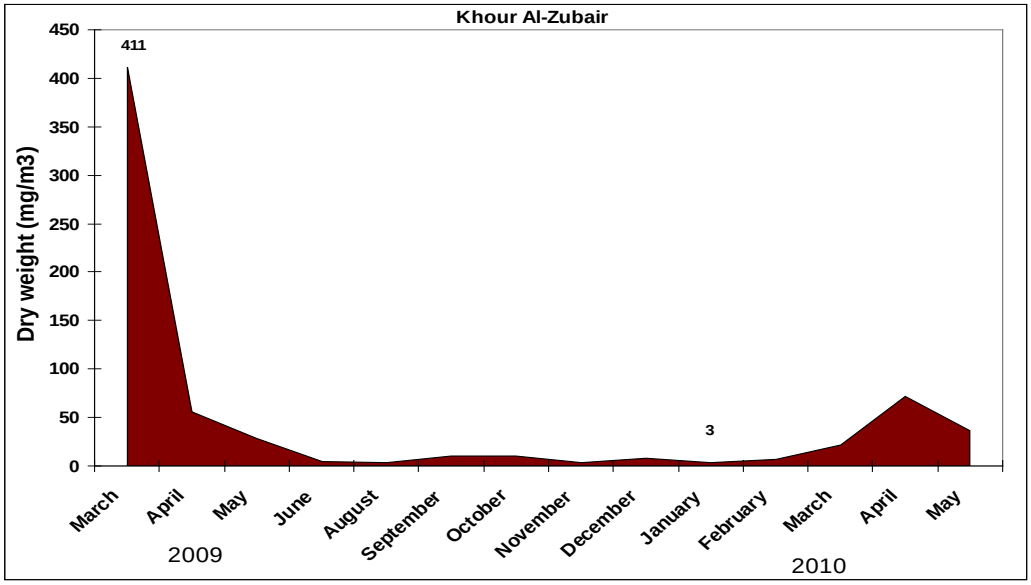

Figure 12. Biomass of zooplankton in terms of dry weight (mg/m^3) in Khour Al-Zubair sampled from March, 2009 – May, 2010.

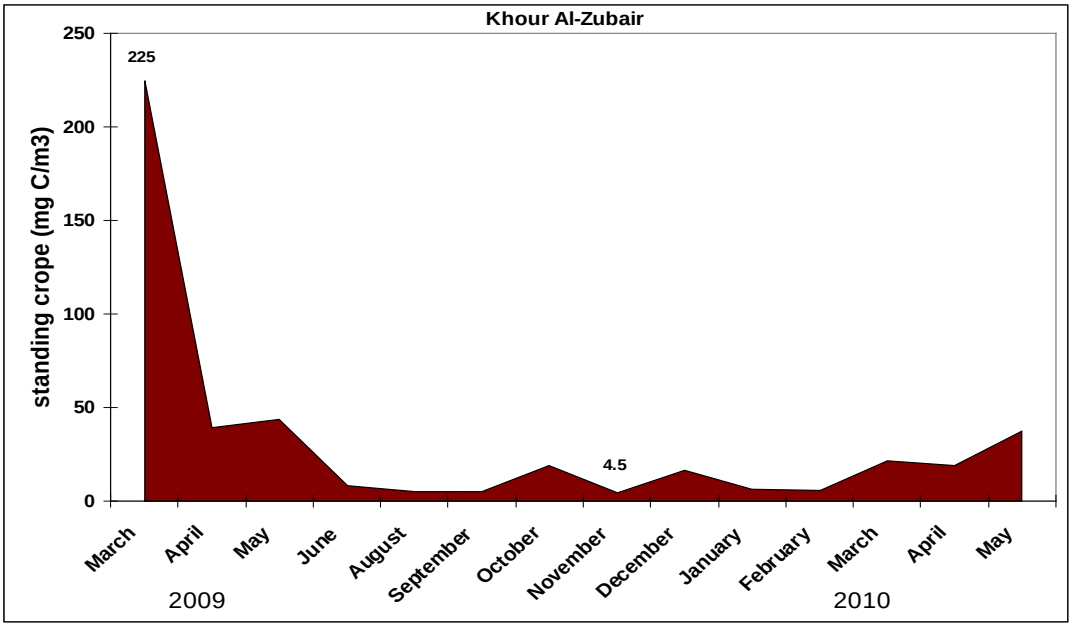

Figure 13. Biomass of zooplankton in terms of standing crop (mg C/m3) in Khour Al-Zubair sampled from March, 2009 – May, 2010.

4. Discussion

Zooplankton distribution was different from one region to another and in the same area from a season to another, because of different environmental conditions, and the natural variations in the distribution of zooplankton and the so-called Patchiness (agglomeration) that may cause large differences in the crop of the nets [4]. The size of the mesh of the net played a large role in determining the quality and quantity of zooplankton, and in general, the net yields a small aperture which is larger than the net with large aperture [22].

The present results showed obvious changes in the number of zooplankton in Shatt Al-Basrah during the different months. It also clarified that the highest density of zooplankton occurred in spring and the lowest one in summer, and this result is consistent with the study of [22] in Khour Al-Zubair and Khour Abdullah and the study of [23] in Shatt Al-Arab.

The results showed that the Crustacea constituted a large proportion of zooplankton in the study area, which comprised 62.0 % in Shatt Al-Basrah and 86.8 % in Khour Al-Zubair. This is consistent with the study conducted [30] in Khour Abdullah, which found that the crustaceans comprised 88 % of the total zooplankton, and the study of [22] in Khour Al-Zubair port, the port of Um Qasr and Khour Abdullah, which radicated that the crustaceans constituted about 97.9 %, 90.7 % and 94.1 %, respectively. However [25] in the northwest of the Arabian Gulf, it was found that the crustaceans constituted about 88.4 %, while [26] stated that the proportion of crustaceans amounted to 85.4 % in Shatt Al-Basrah and 92.1 % and 99.5 % in the ports of Khour Al-Zubair and Um Qasr, respectively.

In this study showed that Copepoda was the most important group of zooplankton, which accounted for 44.7 % in Shatt Al-Basrah and 66.9 % in Khour Al-Zubair. This is in agreement with the study of Ajeel [22] who stated that the proportion of Copepoda reached to 58.94 % in the port of Khour Al-Zubair and 83.97 % in the port of Um Qasr and 91.33 % in Khour Abdullah of the total number of zooplankton. While the study of [26] reported that the Copepoda formed 69.8 % of the total zooplankton in Shatt Al-Basrah and 55.6 % and 61.9 % in the port of Khour Al-Zubair and Um Qasr, respectively.

The proportion of Copepoda increases in the direction of the marine waters, and this is consistent with a study of Madhupratap [27] who stated that the Copepoda are more abundant group during the period of increased salinity. Also Al-Zubaidi [25] found, in the northwest of Arabian Gulf, that Copepoda constituted 87 % of the total zooplankton. Also it was noted that the Copepoda are prevalent in all regions of the Arabian Gulf [28, 29, 30, 31], and it is one of the most important components of the ecosystem and the largest aggregates prevailing in the zooplankton [32], that are fed primarily on phytoplankton and it can transfer the organic matter and energy to the neighborhoods in the upper levels of the food chain [33]. Table (3) shows a comparison of the number of Copepoda in the current study compared with the previous studies in different regions of the world. It is noted that the density of Copepoda is intense in Khour Al-Zubair (228,500 ind./m^3) during July, 2008 [17].

It was also observed that the density of zooplankton in Khour Al-Zubair was more than that in Shatt Al-Basrah and this is primarily due to the increase of density of Copepoda, and this is probably due to increase in the concentration of salinity, as it is much more in Khour Al-Zubair than in Shatt Al-Basrah. This is consistent with the results of Al-Zubaidi [25], who reported an increase in the numerical abundance of zooplankton in Shatt Al-Arab toward the Arabian Gulf. moreover, this is possibly due to the impact of discharge of fresh water coming from the marshes through the channel of Shatt Al-Basrah, loaded with organic matter and phytoplankton [19]. However Kjerfve *et al.*[34] noted that Lagoons are characterized by high

productivity and this may support high production of fish that inhabits coastal waters.

The present results showed significant changes in the biomass of zooplankton between different stations, and found that the highest value was reported during spring and there is a further increase during summer. This is consistent with a study of Al-Zubaidi and Salman [35] who found two peaks of zooplankton biomass in the mouth of Shatt Al-Arab. The first was during summer and the second was during late winter. It further agrees with the results of Al-Zubaidi [25] who stated that the peak of zooplankton was recorded during summer in the Fao and Sybah stations.

Table (4) shows a comparison of the biomass of zooplankton in Shatt Al-Arab, Garmat Ali, Khour Al-Zubair, Khour Abdullah, Arabian Gulf and Gulf of Oman. The highest value of biomass was 3.461 ml/m^3 it was recorded in Khour Al-Zubair in February, 1990, while the lowest value was 0.001 ml/m^3 reported in Shatt Al-Arab in June, 1996.

A comparison of the results of the present study with those of previous studies in different regions may be meaningful because of the different mesh sizes of nets used in the collection of samples (Table 5). It is apparent from the current study that the highest density of zooplankton was recorded in Shatt Al-Basrah (95514 ind./m^3) during April, 2009 and the lowest was in Khour Al-Zubair (3548 ind./m^3) during January, 2010. This due to increase of rotifers in Shatt Al-Basrah, and this is consistent with the study [26].

Table (3): Comparison of the number of Copepoda with previous studies.

	Locality	Ind./m^3	Reference
1	Kuwait water	186 - 1064	**[28]**
2	Kuwait water	16440 -53603	**[30]**
3	Arabian Gulf (Ropme sea area)	5475 - 31173	**[36]**
4	Arabian Gulf (Ropme sea area)	568 - 12192	**[37]**
5	Maghrib water	300 - 900	**[32]**
6	Bardawil lagoon (Egypt)	60491 - 220456	**[33]**
7	Damietta Harbor (Egypt)	10940 - 175780	**[38]**
8	Taiwan water	25.2 - 53.5	**[39]**
9	Gulf of Thailand	2342 - 6446	**[40]**
10	Khour Abdullah	163 - 6074	**[41]**
11	Khour Abdullah	1902 - 23587	**[22]**
12	Khour AL-Zubair	253 - 33989	**[22]**
13	Khour AL-Zubair	2400 - 228500	**[17]**
14	Khour AL-Zubair	2441 - 18149	**Current study**
15	**Shatt Al-Basrah**	**3017 - 46801**	**Current study**

Table (4): Comparison of biomass in terms of the displacement volume (ml/m^3) with previous studies in Arabian Gulf and Gulf of Oman.

	Study area Locality	**Biomass (ml/m^3)**	**Reference**
1	Gulf of Oman	2.35	[42]
2	Gulf of Oman	2.8	[43]
3	Gulf of Oman	2.27	[29]
4	Arabian Gulf	0.11 - 2.0	[29]
5	Kuwait water	0.37 - 1.81	[28]
6	Kuwait water	0.01 - 2.1	[21]
7	Khour Abdullah	0.049 - 1.022	[24]
8	Khour Abdullah	0.116 - 1.268	[22]
9	Khour AL-Zubair	0.081 - 3.15	[22]
10	Shatt Al-Arab	0.001 - 0.045	[23]
11	Garmat Ali	0.002 - 0.261	[44]
12	Khour AL-Zubair	0.07 - 3.461	Current study
13	Shatt Al-Basrah	0.18 - 1.90	Current study

Table (5) The density of zooplankton and common groups (ind./m^3) and the percentage of some groups of zooplankton in Basrah.

	Locality	Mish - size (mm)	Zooplankton	Copepoda	Cladocera	Cirripede larvae	Relative abundance %		References
							Copepoda	Cladocera	
1	Garma Marshes	0.050	640 - 16000	-	-	-	28	13.5	[7]
2	Garmat Ali	0.250	9 - 1050	4 - 1042	3 - 98	0 - 29	81.4	11.7	[44]
3	Shatt Al-Arab	0.090	110 - 2047	30 - 1322	0.3 - 229	0 - 187	49.3	10.2	[23]
4	Shatt Al-Arab	0.090	70 - 27670	61 - 20067	4 - 10854	0 - 1802	26.6	57.8	[25]
5	Shatt Al-Arab	0.120	76 - 12297	0 - 61	0 - 2118	29 - 11859	1.08	22.9	[26]
6	Shatt Al-Basrah	0.120	53 - 3483	14 - 2282	0 - 5	0 - 447	70	0.1	[26]
7	Khour AL-Zubair	0.090	1026 - 42454	253 - 33989	-	0 - 42197	66.8	-	[22]
8	Khour AL-Zubair	0.120	12 - 13625	5 - 8901	0 - 5	0 - 1640	56.3	0.035	[26]
9	Khour Abdullah	0.090	2565 - 24940	1902 - 23587	0 - 0.1	0 - 1044	91.33	-	[22]
10	Khour Abdullah	0.200	214 - 6546	163 - 6074	0 - 1	0 - 63	85	-	[24]
11	Shatt Al-Basrah	0.120	5811 - 95514	3017 - 46801	0 - 5267	0 - 9904	44.7	3.1	Current study
12	Khour AL-Zubair	0.120	3549 - 20328	2441 - 18149	-	117 - 2031	66.6	-	Current study

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توزيع ووفرة الهائمات الحيوانية في شط البصرة وخور الزبير / البصرة - العراق

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الخلاصة

جمعت عينات الهائمات الحيوانية من قناتي شط البصرة وخور الزبير خلال الفترة من آذار 2009 لغاية أيار 2010 بواسطة شبكة الهائمات الحيوانية (0.120 ملم) . تراوحت كثافة الهائمات الحيوانية في قناة شط البصرة بين 5811 - 95514 فرد/م^3 خلال آب و نيسان 2009 على التوالي ، وكانت القشريات هي السائدة 62.9 %. بلغت نسبة مجذافية الأقدام Copepods 44.7 % من العدد الكلي للهائمات الحيوانية وتليها الدولابيات Rotifers 31.0 % ثم يرقات البرنقيلات Cirripeds 14.7% بعدها عديدة الأهلاب Polychaetes 5.5 % ثم متفرعة اللوامس Cladocera 3.1 %. أما في قناة خور الزبير فقد تراوحت كثافة الهائمات الحيوانية بين 3548 - 20328 فرد/م^3 خلال كانون الثاني 2010 وتشرين الأول 2009 على التوالي ، وكانت نسبة القشريات 83.7 % من مجموع الهائمات الحيوانية . الأنواع السائدة هي مجموعة مجذافية الأقدام Copepoda 66.6 % بعدها يرقات البرنقيلات Cirripede ويرقات السرطان Megaloba 8.4 % ثم يرقات بطنية القدم Gastropoda 6.1 % ثم عديدة الأهلاب Polychaetes 2.3 %.

الكلمات المفتاحية: الهائمات الحيوانية، توزيع، شط البصرة ، خور الزبير، البصرة.