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Seasonal Variations of Zooplankton in Al-Hammar Marsh-Southern Iraq

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Abstract

Zooplankton samples were collected seasonally from three stations in the south of Al-Hammar Marshes southern Iraq by Plankton net (0.090 mm mesh-size and 40 cm mouth aperture) during 2011. Physical and chemical parameters of the water were studied such as, water temperature, salinity, pH and dissolved oxygen. The population density of zooplankton ranged between 717 ind /m^3 at third station (Al-Sallal) in winter to 1209879 ind/m^3 at first station (Al-Mashab) in Spring. The important groups of zooplankton in the study area were Cirriped larvae (88.5%), and Cladocera (10.6%). The highest value of average density of Cirriped larvae and Cladocera was recorded in spring.

Keywords: Zooplankton; Density; Al-Hammar Marshes

Introduction

Zooplanktons invariably form an integral component and significantly contribute to biological productivity of freshwater communities [1]. Due to their importance as food for fish, zooplanktons have been studied from various inland ecosystems of Iraq. Information on the ecology of this group of organisms in Iraqis Al-Hammar Marshes, however, is still limited. Zooplankton may also offer insight on productivity of other group of organisms. The rate of zooplankton production can be used as a tool to estimate the exploitable fish stock of an area [2]. In marsh environments zooplankton are good ecological indicators due to their wide physiological tolerances among species. Also, due to their place in the aquatic food chains, changes in population abundance may cascade both up and down. Furthermore, environmental perturbation [3].

Zooplankton research ecosystems near Basrah has a history of over 90 years, starting with Gurney [4], who first identified several species of zooplankton from lower Mesopotamia, the mouth of the Shatt Al-Arab River, and the Tigris River, near the city of Amara, he found 77 taxa belonging to Rotifera, Cladocera and Copepoda. Mohammad [5] research followed, with collections and identifications of cladocerans from southern Iraq. This latter study included the Shatt Al-Arab from the mouth of Khour Al-Amaya to Qurna, where fifteen new species to Iraq were found and a unique species assemblage downstream observed. AL-Hammed [6] studied the zooplankton of the inland waters of Iraq. Khalaf et al. [7] investigated crustaceans, particularly, the Cladocera of the middle and southern region of Iraq, where twenty-three species of Cladocera were described from the marshes extending from the Qurna to Chebaish.

In Shatt Al-Arab River from 1982 – 1984, Salman et al. [8] studied the seasonal abundance of zooplankton, and found that Cladocera was the dominant group, with as much as 68% of species count, followed by Copepoda. Additionally, Al-Saboonchi et al. [9] investigated the seasonal changes in the quality and quantity of zooplankton in Al-Hammar Marshes near Garmat-Ali River, were 21 genera belonging to three groups, Rotifera, Cladocera and Copepoda were identified. Abdul-Hussein et al. [10] surveyed the Rotifera in northern Shatt Al-Arab River. Ajeel et al. [11] found that the peak of density of Simocephalus vetulus in a pond in (Garmat Ali) at Basrah occurred during February 1997. And Ajeel et al. [12] recorded 23 species of Cladocera including six new records to the Shatt Al-Arab River. Whereas, AL-Zubaidi et al. [13] studied the zooplankton of the southern Shatt Al-Arab River. Later Ajeel [14] investigated the zooplankton of the North Shatt Al-Arab, Shatt Al-Basrah and Khour Al-Zubair Canal. Then Ajeel et al. [14] surveyed the zooplankton of Garmat-Ali River. Abbas [15] study abundance of Cladocera and some other zooplankton and diversity in the Northern part of Shatt Al-Arab River. Ajeel et al. [16] (unpublished) study diversity of Cladocera of the Shatt Al-Arab River, Southern Iraq. A high diversity of zooplankton has been recorded in ecosystems around Basrah City. Marshes were found to be dominated by taxa 1 [9,17] whereas lotic systems were dominated by taxa 2 [12,13,15,18], indicating predominance of Cladocera, Cirriped larvae and Copepoda.

In the Al-Chabaish, Al-Hammar and Al-Fuhud marshes of southern Iraq, Al-Qarooni [19] studied the abundance and occurrence of some zooplankton and snails, to find the density of zooplankton range from 5150 ind/m^3 during May in Al-Hammar marshes to 425450 ind/m^3 during March in Al-Fuhud marsh. Whereas Al-Jizani [20] investigated the effect of organic pollution on the diversity and abundance of plankton in Shatt Al-Arab River, Al-Ashaar and Al-Rabat channels [20] she noted that sovereignty was for the Rotifera followed Copepoda then Cladocera. While Ajeel et al. [21] studied the seasonal abundance of zooplankton in the southern Iraqi Marshes, and in other study, Ajeel et al. [21] calculated the secondary productivity of Simocephalus vetulus in a temporary pool in Basra. Finally Abbas [15] recorded 23 species of Cladocera in northern Shatt Al-Arab River and Hammadi [22] study the ecology of Rotifera in five station of the Shatt Al-Arab River, Rotifera dominated the zooplankton at all the stations. Density of zooplankton ranged between 1.36 and 836.31 ind/L, while Rotifera density ranged between 1.09 and 650.99 ind/L. He record about 165

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species of Rotifera, 59 species were new records to Iraq. Finally, report of Salman et al. [8] about zooplankton southern Iraq.

However, the most studies of this review were mainly concerned with the taxonomy of Cladocera and to a lesser extent of Copepoda, whereas the latter articles were investigating the abundance and distribution of Cladocera and Copepoda and only few papers were concerned with rotiferan abundance. Therefore, there is no thorough investigation of the various groups of zooplankton throughout different stations in Basrah and for one complete year. For this reason and for estimating the zooplankton production in various localities in Basrah, which has not been conducted before, the present study was carried out. Most of the reported studies on zooplankton in ecosystems of southern Iraq focus on one or a few taxonomic groups. Few studies extended investigations to include equally important groups of zooplankton. Moreover, studies lacked adequate temporal cover. In this study, we present a more thorough investigation of the abundance and distribution of zooplankton in southern Iraq, including several species assessed over a one-year time period.

Materials and Methods

Methods of sample collection

Zooplankton samples, dissolved oxygen, pH, water temperature and water salinity were collected from three stations located in the southern area of the Al-Hammar marshes (Figure 1). Zooplankton collection was done with a flow meter-mounted, 40 cm diameter, 0.90 mm mesh size plankton net [23]. The net was towed in the mornings at a speed of 1 m/s for 10 minutes. Collections were done in January, March, July and October. Net content was emptied into a 500 ml plastic bottle and fixed in 4% formalin immediately after towing. Samples were preserved in alcohol in laboratory after 24 hours for species identification and counting. A 10 ml subsample was taken for samples consisting of large numbers of zooplankton A Bogorov chamber placed under a dissecting scope was used in species and counting. Identification and counting was conducted in replicates of three to control for measurement error. Species identification was done using keys [24-26]. Species abundance was presented as individuals per cubic meter, calculated by extrapolating samples and from plankton net flowmeter reading.

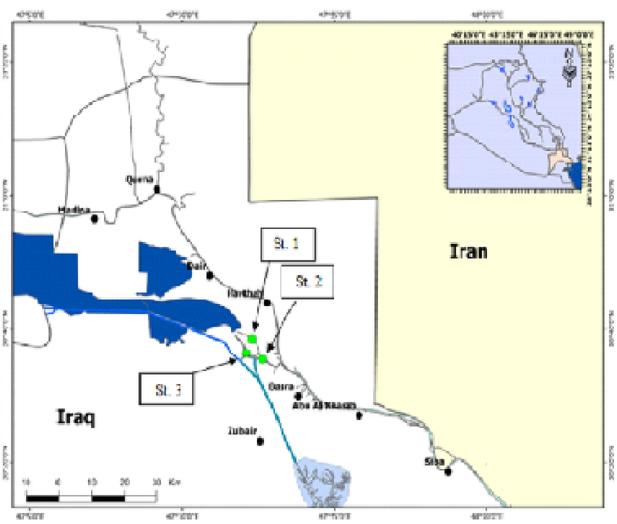

Figure 1: Map of low Mesopotamia showing the sampling stations.

Results

Environmental factors

Water quality parameters varied according to seasonal norms. Temperature ranged from 14.5 to 28.8°C, salinity from 1.3 to 3.2% pH from 5.1 to 8.4 and dissolved oxygen from 4.1 to 11.0 mg/L (Table 1).

	Al-Mashab				Hareer				Al-Sallal			
	Temp. °C	Sal. %	pH	D.O. mg/L	Temp. °C	Sal. %	pH	D.O. mg/L	Temp. °C	Sal. %	pH	D.O. mg/L
Winter	14.6	2	6.6	11	14.9	1.6	5.3	10	14.5	1.8	5.1	11
Spring	23.4	2.4	8.4	8.2	23.4	1.9	7.7	9.5	23.2	2.2	7.9	7.5
Summer	28.1	3.2	8.1	4.1	28.8	3	8	4.7	27.9	3.2	8.1	4.8
Autumn	19.9	1.6	6	8.3	19.6	1.3	6.1	7.8	19.2	1.4	6.1	10

Table 1: Seasonally variations of water parameters at three stations southern of Al-Hammar marshes.

Density of zooplankton

Density of zooplankton ranged from 717 to 1.2 million ind/m^3 with an average and standard deviation of 1.14 × 105 ind/m^3, ± 345458 respectively (Figure 2). Crustacea dominated samples with over 99% of samples by number, its ranged between 657 ind/m^3 at Al-Sallal station during winter and 1.2 million ind/m^3 at Al-Mashab station during spring, and the average density and standard deviation was 114196 ind/m^3 and ± 345610 respectively. The relationship (R) between the temperature and the density of zooplankton was 0.1773.

Cirripede larvae the most abundant groups of zooplankton in the study area were comprised (88.5%), then Cladocera (10.6%) and Copepoda (0.4%). Cladocera, peaked at the Hareer region (41971 ind/m^3) in the spring. Moina affinis dominated, followed by Diaphanosoma brachyurum (Figure 3). The dominant zooplankton groups (ind/m^3) in south Al-Hammar Marshes during the period of study explained in Figure 4.

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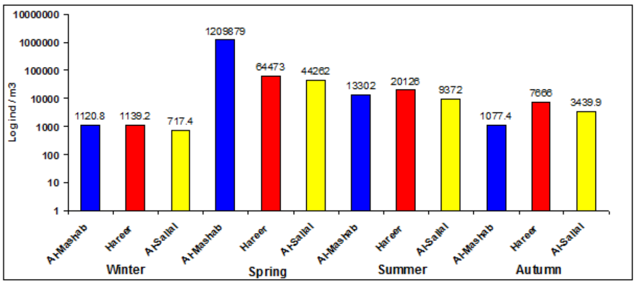

Figure 2: The density of zooplankton (ind/m^3) at study area.

Copepoda peaked in summer (1095 ind/m^3). Calanoida were observed only once at Al-Mashab region during winter. Cyclopoida, were highest (552 ind/m^3) during autumn at Hareer station. Harpacticoida, were highest (58 ind/m^3) during spring at the Al-Mashab station. Copepod nauplii, peaked (603 ind/m^3) during summer at the Hareer station. Rotifera peaked during autumn at the Hreer (3632 ind/m^3) and Al-Sallal (2134 ind/m^3) stations (Table 1). Due to our small mesh size, rotifer generally showed a very low density (Table 2).

The correlation between the zooplankton and physical and chemical characteristics of the three stations that have been drawn by the statistical program Canoco explain in Figure 5.

Zooplankton	**Winter**			**Spring**			**Summer**			**Autumn**			**Total**	**Percentage %**
	Al-Mashab	Hareer	Al-Sallal	Al-Mashab	Hareer	Al-Sallal	Al-Mashab	Hareer	Al-Sallal	Al-Mashab	Hareer	Al-Sallal		
Cirriped larvae	414.5	131	79.2	1185628	22370	3824	1402	534	103	536	2724	719	**1218465**	**88.5**
Cladocera	79.2	261.3	88.8	23969	41971	40204	11051	18226	9061	387	395	209	**145902**	**10.6**
Nauplii	432.5	332	271	19.3	34	19	505	603	32	54	356	278	**2936**	**0.21**
Cyclopoida	120.7	353	192	96	43	115	72	485	84	51	552	73	**2237**	**0.16**
Harpacticoida	28.8	21	26.4	58	34	76	0.02	7	-	24	7.3	6.6	**289**	**0.02**
Calanoida	1.8	-	-	-	-	-	-	-	-	-	-	-	**1.8**	**0.0001**
Total of Copepoda	**583.8**	**706**	**489.4**	**173.3**	**111**	**210**	**577**	**1095**	**116**	**129**	**915**	**358**	**5463**	**0.4**
Zoea of Crab	-	-	-	2	-	2	88	194	72	3.6	0.01	6.6	**368**	**0.03**
Zoea of shrimp	-	-	-	19.3	-	19	48	49	12	-	0.02	6.6	**154**	**0.01**
Ostracods	1.8	-	-	-	-	-	0.02	-	-	-	0.01	0.03	**1.85**	**0.0001**
Insect larvae	-	-	-	-	-	-	-	-	-	-	0.06	0.06	**0.12**	**0.000001**
Amphipoda	-	-	-	-	-	-	-	-	-	-	-	0.01	**0.01**	**0.000001**
Total of Crustacea	**1079.3**	**1098.3**	**657.4**	**1209792**	**64452**	**44259**	**13166**	**20098**	**9364**	**1055.6**	**4034**	**1299.3**	**1370355**	**99.5**
Rotifers	23.4	34.7	48	87	21	1	136	28	4	20	3632	2134	**6169**	**0.45**
Foraminifera	16.2	6.2	9.6	-	-	2	-	-	4	1.8	-	0.01	**40**	**0.003**
Gastropoda	1.8	-	-	-	-	-	-	-	-	-	-	6.6	**8.4**	**0.0006**
Annelida	-	-	2.4	-	-	-	-	-	-	-	-	-	**2.4**	**0.0002**
Oligochaeta	0.04	0.02	-	-	-	-	-	-	-	-	-	-	**0.06**	**0.000004**
Fish larvae	0.07	-	0.02	0.1	-	-	-	-	-	-	-	-	**0.19**	**0.000001**
Total of zooplankton	**1120.8**	**1139.2**	**717.4**	**1209879**	**64473**	**44262**	**13302**	**20126**	**9372**	**1077.4**	**7666**	**3439.9**	**13776575**	**100**

Table 2: Zooplankton density (ind./m^3) at Al-Hammar Marshes collected from January – December 2011.

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Which observed the Cirripede larvae were weak positive relationship with all factors, whereas the Oligochaeta, Ostracoda, Annelida, Fish larvae, Foraminifera, Gastropoda, Insect larvae, Rotifers, Amphipoda, Nauplii and Copepoda low positive relationship with dissolved oxygen and negative relationship with other factors. While Cladocera, Zoea of shrimp and zoea of crab had been linked positive relationship with all factors except dissolved oxygen as recorded negative.

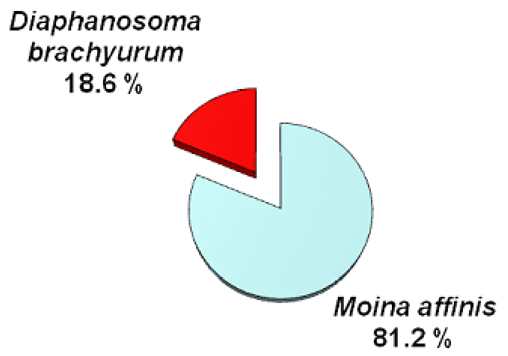

Figure 3: The Cladocera percentage of the total zooplankton at study area.

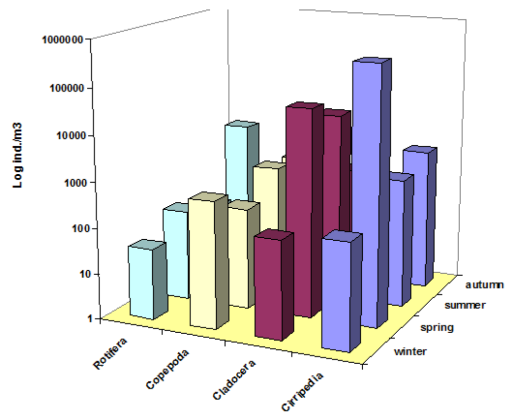

Figure 4: Seasonal distribution of the dominant zooplankton groups (ind/m^3) in South Al-Hammar Marshes during the period of study.

Discussion

Zooplankton community structure is an important indicator of ecosystem health and plays an important role in cascading trophic effects [27]. They occupy an intermediate position in the food web, and mediate the transfer of energy from lower to higher trophic level [28], thus they represent an important link in the aquatic food chain and contribute significantly to secondary production in freshwater ecosystems [29]. The diversity of phytoplankton can influence the diversity of zooplankton, or vice versa, and both can be affected by the environmental factors [30].

The type of the aquatic environment directly affected by the number of different conditions, including the water temperature, water depth, currents, ammonia content, phytoplankton, DOC, etc., The present study showed that the density of zooplankton community in South Al-Hammar Marshes was different according to seasons. In general, the maximum density was observed in spring and summer seasons, while low density was observed in the winter and autumn seasons. The spring season is most favorable period for the growth and multiplication of zooplankton species. The similar results were also obtained by Al-Saboonchi et al. [9] in Garma marshes, Ajeel et al. [12] in Shatt Al-Arab and some temporary ponds in Basrah, Ajeel et al. [14] in Garmat Ali River and Al-Qarooni [19] in Al-Fuhud marshes. This could possibly be due to higher phytoplankton population concentration in the former season in the Shatt Al-Arab River [31], in Garma marshes [9] and in the marshes near the Qurna [32].

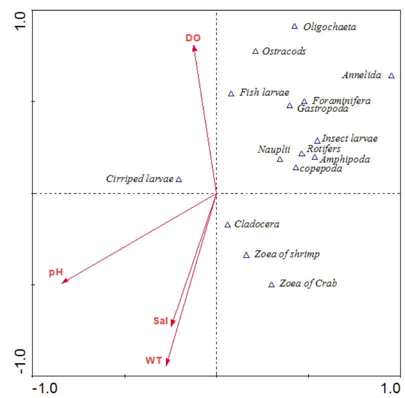

Figure 5: The correlation between Zooplankton and environmental parameters that have been measured using statistical system Canoco.

Cirripede larvae dominated zooplankton in this study. This finding is in agreement with that reported by Abbas [15] in the northern part of the Shatt AL-Arab River. Water quality is a strong determinate of phytoplankton and zooplankton dynamics, as well as diversity in aquatic systems [33,34]. Hence, the diversity of zooplankton communities is used for assessing the productivity vis-à-vis fishery resource, fertility and health status of the ecosystem [35].

Water quality can be regard as a network of variables (pH, oxygen concentration, temperature etc.,) that are linked and co linked; any changes in these physical and chemical variables can affect aquatic biota in a variety of ways. Dissolved oxygen (DO) is an important aquatic parameter whose presence is vital to aquatic fauna. It plays crucial role in life processes of animals. High concentration of DO was recorded during winter; these findings are in agreement with [36]. This may be due to low solubility at low temperature and high degradation of organic substances. This is due to the fact that it is a permanent water body receiving substantial nutrients from a nearby source.

Cladocera is the main component of the zooplankton in lakes, it is not very important in the oceans, and there are only a few species in coastal and brackish areas. If they are abundant, they reproduce by parthenogenesis and usually become in large numbers [37]. The results show that some species of Cladocera were dominant, such as Moina affinis and Diaphanosoma brachyurum. these two species had a wide range of tolerance to the different environmental conditions, The same finding has been also reported by Mangalo et al. [38] whom formed these two species are the most numerous in the Tigris River out of eight species that have been recorded in that River., Khalaf et al. [39] carried out at Al- Zaafaraniyah pools, Abbas [15] at the Northern part of Shatt AL-Arab River, Salman et al. [3] at Al-Hawizah, Al-Hammar and Central Marsh, southern Iraq. Some species of Cladocera have appeared in a limited time and were very few in numbers such as Dunhevedia crassa, Alonella diaphana, Ceriodaphnia rigaudi and Sida sp. The reason behind this may be the narrow limit of tolerances of these species to the environmental conditions prevailed in this region. Cirripede larvae were by far the most important group of zooplankton in the study area, comprising 88.5% of the total population, and the seasonal variation in the total zooplankton population was governed mostly by variations in this group. This dominance of Cirriped larvae was documented previously in the Shatt Al-Arab River [15,16].

S. No	Study Area	Mish size (mm)	Zooplankton	Copepods	Cladocera	Cirripede larvae	References
1	Shatt Al-Arab	0.09	110 - 2047	30 - 1322	0.3 - 229	0 - 187	Ajeel et al. [47]
2	Shatt Al-Arab	0.09	70 - 27670	61-20067	4 - 10854	0 - 1802	Al-Zubaidi [48]
3	Shatt Al-Arab	0.12	76 - 12297	-	-	-	Ajeel [14]
4	Shatt Al-Arab	0.12	6671 - 28064	4419 - 25821	0 - 24	269 - 1075	Morad [49]
5	Garma Marshes	0.05	640 - 16000	-	-	-	Al-Saboonchi et al. [9]
6	Al-Huwaiza Marsh	0.12	61 - 3309	38 - 3155	0.4 - 72	0 - 30	Ajeel et al. [21]
7	Al-Huwaiza Marsh	0.055	4125 -124630	-	-	-	Hussain et al. [50]
8	Al-Huwaiza Marsh	0.055	193160	-	-	-	Al-Sodani, et al. [51]
9	Al-Huwaiza Marsh	0.12	21 - 9817	7 - 1727	Sep-39	0 - 261	Salman et al. [3]
10	Al-Izze river	0.12	188 - 2714	168 - 2659	10 - 290	0 - 5	Ajeel et al. [21]
11	Basrah Marshes	0.12	52 - 2115	8 -1191	0.4 - 235	1.2 - 1287	Ajeel et al. [21]
12	Garmat Ali River	0.09	447 - 45291	-	-	-	Ajeel et al. [47]
13	Al- Chabaish Marsh	0.02	47860-229860	1900 - 39960	-	-	Al-Qarooni [19]
14	Al- Hammar Marsh	0.02	5150-103580				Al-Qarooni [19]
15	Al- Hammar Marsh	0.055	3915 -108585	-	-	-	Hussain et al. [50]
16	Al- Hammar Marsh	0.055	120060	-	-	-	Al-Sodani et al. [51]
17	Al- Hammar Marsh	0.12	197 - 8673	41 - 1361	61 - 6354	0 - 2697	Salman et al. [3]
18	Al- Hammar Marsh	**0.09**	**717 - 1209879**	**79 - 40204**	**111 - 1095**	**79 - 1185628**	Present study
19	Al- Fuhud Marshe	0.02	25100-425450	-	-	-	Al- Qarooni [19]
20	Suq Al Shuyuak Marsh	0.055	2350 – 71925	-	-	-	Hussain et al. [50]
21	Suq Al Shuyuak Marsh	0.055	94310	-	-	-	Al-Sodani, et al. [51]
22	Central Marsh	0.12	99 - 42655	48 - 20450	1 - 4983	0 - 47	Salman, et al. [3]

Table 3: Density of zooplankton, Copepods, Cladocera and Cirripede larvae (ind/m^3) in different stations at Marshes and Shatt Al-Arab River.

The most common and severe problem is the enrichment of water by a nutrient that increases the biological growth and renders the water bodies unfit for diverse uses. Nutrients that are present in fertilizers as well as in domestic and industrial wastewater have been identified as main cause for changing the trophic status of water bodies from oligotrophic to mesotrophic to eutrophic. Although zooplankton exists under a wide range of environmental condition, yet many species are limited by dissolved oxygen, pH, salinity and other physico-chemical factors [40].

The present results indicated that Al-Hammar marshes are oligohaline brackish water according to Reid [41] classification. Sabri et al. [42] pointed out to the various uses of water and high groundwater levels in areas of central and southern Iraq which may lead to higher levels of salinity, besides the water coming from the Arabian Gulf during high tide may play a significant role in increasing the salinity of the studied area. The present study showed that salinity and dissolved oxygen are adversely affected by temperature, and this agreed with several previous studies conducted on the Shatt Al-Arab, such as Al-Jizani [20] and Al-Mahmoud et al. [43] and others on the inland Iraqi waters such as Al-Lami [44] and Al-Qarooni [19], while temperature had a positive impact on pH. Moreover, there are many factors affect the pH, including the decrease or increase in the concentration of carbon dioxide due to the processes of photosynthesis, which lead to the consumption of carbon dioxide and then reduce the values of the pH [42,45].

Zooplanktons are useful indicator of future fisheries health because they are a food source of organisms at higher trophic levels [46]. Table 3 shows a comparison of the density of zooplankton, Copepods, Cladocera and Cirriped larvae (ind/m^3) in the current study compared with the previous studies in different regions and different stations at Marshes and Shatt Al-Arab. It was shown that the high density was in Al-Hammar Marshes and the reason is due to the bloom or increase of Cirripede larvae which reached more than a million ind/m^3, and that was due to the impact of Shatt Al-Arab on these water bodies in Al-Hammar Marshes was more than that of Tigris and Euphrates. Our results for the high abundance of Cirripede larvae in the Al-Hammar Marshes were due mostly to the influence of the Shatt Al-Arab River and secondarily to the Tigris and Euphrates Rivers.

The Marshes usually rich in nutrients so they are rich in phytoplankton and zooplankton, but the changes significantly in recent years due to water shortages have affected a significant impact on the productivity of the region. The changes of salinity that occurred in the Shatt Al-Arab and Marshes in recent years because of a lack of water and the salt front access affected to increase the density of zooplankton, especially Cirripede larvae.

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