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Abundance and diversity of Cladocera in South Al-Hammar Marshes - Southern Iraq

Shaker G. Ajeel*
Mohammed F. Abbas**

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□ ABSTRACT □

Zooplankton samples were collected seasonally from three stations in the south of Al-Hammar Marshes southern Iraq during the period from January to December 2011, by Plankton net of a mouth aperture of 40 cm and a mesh-size 0.90 mm mounted with a flow meter in the mouth. The results showed that the population density of Cladocera ranged between 79 ind/m^3 during winter at station 1 (Al-Mas-hab) and 41971 ind/m^3 during spring at station 2 (Hareer). Density of Cladocera was positively correlated with water temperature and to a lesser extent with salinity. About 13 species of Cladocera belonging to 11 genera were recorded at three stations. The high values of diversity were recorded in winter at all stations (1.68, 1.16, and 1.68 respectively) while the lowest values were recorded during spring at all stations (0.06, 0.03, and 0.01 respectively).

Key words: Cladocera , abundance, diversity, Al-Hammar Marshes.

* **Associate Professor Dep. Of Marine Biology, Mar. Scie. Cen.Uni. of *Basrah, IRAQ*.**
** **Researcher of Dep. of Marine Biology, Marine Science Centre, University of *Basrah, IRAQ***

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وفرة وتنوع القشريات متفرعة القرون Cladocera في جنوب هور الحمار

الدكتور شاكر غالب عجيل*
الدكتور محمد فارس عباس**

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□ ملخّص □

جمعت عينات الهائمات الحيوانية فصليا من ثلاث محطات جنوب هور الحمار الواقع جنوب العراق خلال الفترة من كانون الثاني إلى كانون الأول 2011 ، بواسطة شبكة الهائمات ذات فتحات 0.90 ملم. تراوحت كثافة متفرعة اللوامس بين 79 فرد/م^3 في المحطة الأولى (المسحب) خلال فصل الشتاء إلى 41971 فرد/م^3 في المحطة الثانية (حرير) خلال فصل الربيع. كثافة متفرعة اللوامس في محطات الدراسة كانت مرتبطة طرديا مع درجة حرارة الماء وبدرجة اقل مع الملوحة. تم تسجيل 13 نوعاً من متفرعة اللوامس تعود إلى 11 جنساً في محطات الدراسة. سجلت قيم التنوع خلال فصل الشتاء في المحطات الثلاثة (1.68, 1.16, 1.68 على التوالي) بينما القيم الأدنى سجلت خلال فصل الربيع (0.06, 0.03, 0.01 على التوالي).

الكلمات المفتاحية: القشريات متفرعة اللقرون، الوفرة ، التنوع، هور الحمار

* أستاذ مساعد – قسم الأحياء البحرية – مركز علوم البحار – جامعة البصرة– العراق.
** باحث – قسم الأحياء البحرية – مركز علوم البحار – جامعة البصرة– العراق.

Introduction:

Freshwater zooplanktons are always dominated by three major groups; Rotifera, Cladocera and Copepoda, with relatively few species from other groups such as Protozoa, Insecta, Ostracoda, Nematoda and Mollusca, etc. (Chattopadhyay & Barik 2009).

Cladocera is an order of small crustaceans commonly called water fleas, and is an important component of the micro-crustacean zooplankton. Most species inhabit fresh water. They are more abundant in both temporary and permanent stagnant waters. Around 620 species have been recognized so far, with many more undescribed (Forró, et al. 2008). However, most species of Cladocera are filter-feeders, while Onychopoda and Haplopoda are predatory. They usually reproduce by cyclic parthenogenesis (Figuerola and Green, 2002). Lampert and Sommer, (1997) suggested that cladocerans play a key role in freshwater food chains by transferring energy from primary production to higher trophic levels. Also Figuerola and Green, (2002) concluded that Water fleas are important components of the fauna of fresh waters; they are particularly significant in the food web of stagnant waters. Fryer, (1987) indicated that, most species occur in fresh waters, although two Ctenopods and several Onychopods from the family Podonidae are truly marine, and a few more Ctenopods, Anomopods and Onychopods species occur in brackish waters.

In Iraq the study of Cladocera began more than 90 years ago, Gurney, (1921) was the first reported on freshwater Crustacea of the lower Mesopotamia. He recorded nearly forty species of aquatic invertebrates including eighteen species of Cladocera, collected by Dr. P. A. Buxton during 1917 and 1918 in the neighborhood of Amara and its suburbs. Then Mohammad (1965) identified 23 species of Cladocera, in the middle and south of Iraq, including fifteen species new record to Iraq. Later AL-Hammed (1966) studied the zooplankton of the inland waters of Iraq including Cladocera. While Khalaf and Smirnov (1976) investigated some crustaceans, particularly, the Cladocera of the middle and south of Iraq. The study included twenty-three species of Cladocera, as well as other groups. Also Khalaf *et al*. (1977) studied the seasonal changes in the intensity of two species of water fleas in the salt fish farm in Al-Zafaraniya. Then Shihab and Khalaf (1980) studied the effect of temperature on life cycle of *Moina micrura*, and they found that 5°C and 35°C are located outside the level of tolerate of female, while the fastest rate of growth was at a temperature of 35°C. Whereas, Mohammad (1980) concluded that the Cladocera are dominant in Euphrates River in Fallujah, while the Copepoda was dominant in Tigris in Baghdad. Moreover, Mohammad (1986) recorded thirteen species of Cladocera in the Tigris River at Baghdad and eighteen species in the Euphrates at Fallujah.

In Shatt Al-Arab River, Salman *et al.* (1986) studied the seasonal abundance of zooplankton, and found that Cladocera was the dominant group, followed by Copepoda. Furthermore, AL-Saboonchi *et al*. (1986) studied the zooplankton of the Al-Hammar Marshes near Garmat-Ali River, during 1980 and 1981 recorded seven species of Cladocera . Managalo & Akbar (1986) studied the population density of *Moina affinis* in Diyala River for a year and noted that the highest density was in June and the least in October 1984. Then Lazim and Zeki (1987) recorded *Scapholeberis kingi* at Zaafaraniya ponds, in Baghdad and in Erbil. While Managalo and Akbar (1988) found that the population density of Cladocera in Diyala River is higher than that in Tigris River. Sabri *et al*. (1989) recorded four species of Cladocera in Samarra dam and found that most zooplankton avoid the surface layer while the water fleas were distributed mainly in the upper water layers. Al-Lami (1998) recorded sixteen species of Cladocera in the Tigris River before entering Baghdad City.

Ajeel *et al.* (2000) found that the peak of density of *Simocephalus vetulus* in a pond in (Garmat Ali) at Basrah occurred during February 1997. Poltorak *et al*. (2001) recorded ninety-nine species of zooplankton in Al-Therthar, Al-Razzaza and Al-Habbaniyah, lakes including twenty species of Cladocera. Ajeel *et al*. (2001) recorded 23 species of Cladocera including six new records to the Shatt Al-Arab River. While, Ajeel (2004) reported that Cladocera formed 5.4 - 35 % of the total zooplankton in the Shatt Al-Arab River.

Al-Qarooni (2005) studied the abundance and occurrence of some zooplankton and snails in Al-Chabaish, Al-Hammar and Al-Fuhud marshes southern Iraq, and recorded fourteen species of Cladocera. He found the density of zooplankton ranging 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 (2005) investigated the effect of organic pollution on the diversity and abundance of plankton in Shatt Al-Arab River, Al-Ashaar and Al-Rabat channels, she noted that sovereignty was for the Rotifera followed Copepoda then Cladocera. Ajeel *et al.* (2006) calculated the secondary productivity of *Simocephalus vetulus* in a temporary pool in Basra. Al-Nimrawi (2006) studied the biodiversity of aquatic invertebrates in the Tigris and Euphrates Rivers in the middle of Iraq and recorded fifteen species of Cladocera. Finally Abbas (2010) recorded 23 species of Cladocera in northern Shatt Al-Arab River.

Therefore, there is no thorough investigation of the Cladocera throughout different stations in the south of Al-Hammar Marshes and for one complete years. For this reason and for estimating the population density of Cladocera in three stations in the south of Al-Hammar Marshes, which has not been conducted before, the present study was carried out.

Materials and methods:

Physical and chemical parameters.

Some hydrographic aspects were recorded in the field Water Temperatures, Salinity, pH and Dissolved Oxygen (DO). All of these aspects were measured immediately in the field by a digital multi meter Multi 350i / SET Germany.

Method of samples collection:

Three sampling stations were selected in the south of Al-Hammar marshes, the first station at Al-Mas-hab region near the bridge at latitude 30° 38′ 31.94″ and longitude 47° 41′ 22.51″ and the second at Hareer region at latitude 30° 35′ 26.31″ and longitude 47° 43′ 10.78″ and the third in the Al-Sallal region at latitude 30° 36′ 23.38″ and longitude 47° 40′ 27.15″ (Fig. 1).

Samples were collected seasonally during 2011 by a zooplankton net 0.90 mm mish-size and with a mouth aperture of 40 cm, a flow-meter was mounted at the mouth of the net to determine the volume of water filtered by the net (DeBernardi, 1984). The net was pulled behind a boat and lifted after 10 - 15 minutes, the contents were then placed in a 500 ml plastic bottle and preserved in 4 % formalin.

In the laboratory, the 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 3 times, then the whole sample was examined for the rare species. Zooplankton were diagnosed based on Brooks (1959) ، Lilljeborg (1982) and Balcer *et al.* (1984).

Figure 1. Map of low Mesopotamia showing the sampling stations

Ecological Indices

1- Diversity index (H) Shannon Weaver

The diversity index (H) was calculate from the equation of Shannon-Weaver (1949) as follows:

$$\mathbf{H = - \sum (ni / N) \ln (ni / N)}$$

Where:

ni = Number of members of the same species

N = The total number of individuals in the sample

2 - Evenness (J)

Evenness (J) was calculated by the equation of Pielou (1966):

$$J = H / \ln S$$

Where:
H = Shannon Weaver diversity index
S = Number of species

3 - Richness index (D)

Richness was calculated by the equation of Margalef (1968) as follows: -

$$D = S-1 / \ln N$$

Where:
D = richness index
S = total number of species
N = total number of individuals

Statistical Analysis

The relationships between the different species of Cladocera and the various environmental factors were done using a statistical program (CCA) canonical correlation analyses (CANOCO).

Results:

Environmental factors:

Water temperatures at the study area ranged from 14.5°C (in winter) at station 3 to 28.8°C (in Summer) at station 2 (Fig. 2). Salinity changed from 1.3 ‰ (in Autumn) at station 2 to 3.2 ‰ (in Summer) at stations 1 and 3 (Fig. 3). The pH varied from 5.1 – 8.4 at station 3 in Winter and Spring respectively (Fig. 4). Dissolved oxygen fluctuates from 4.1 mg/L (in Summer) at station 1 to 11.0 mg/L (in Winter) at stations 1 and 3 (Fig. 5).

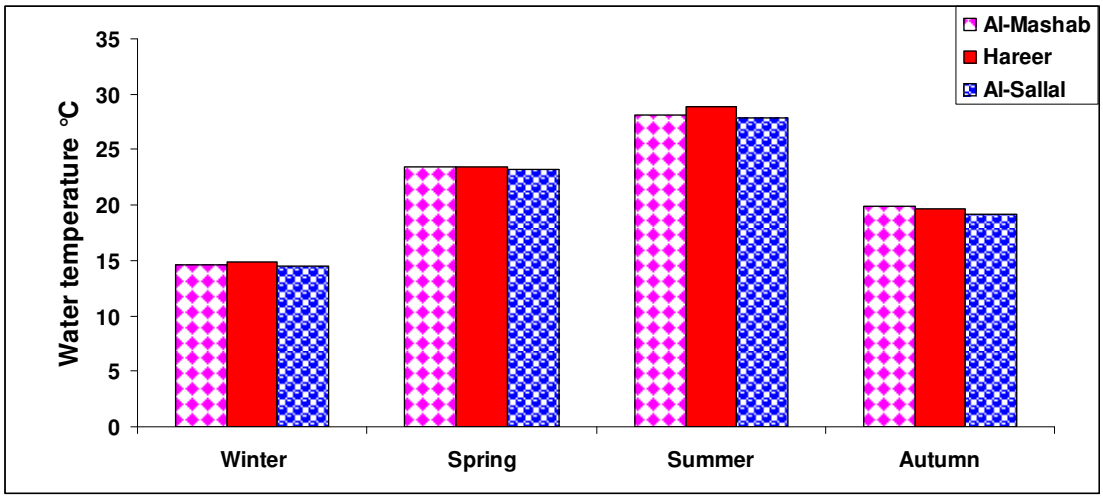

Figure 2. Water temperature at the three stations, south of Al-Hammar marshes during 2011

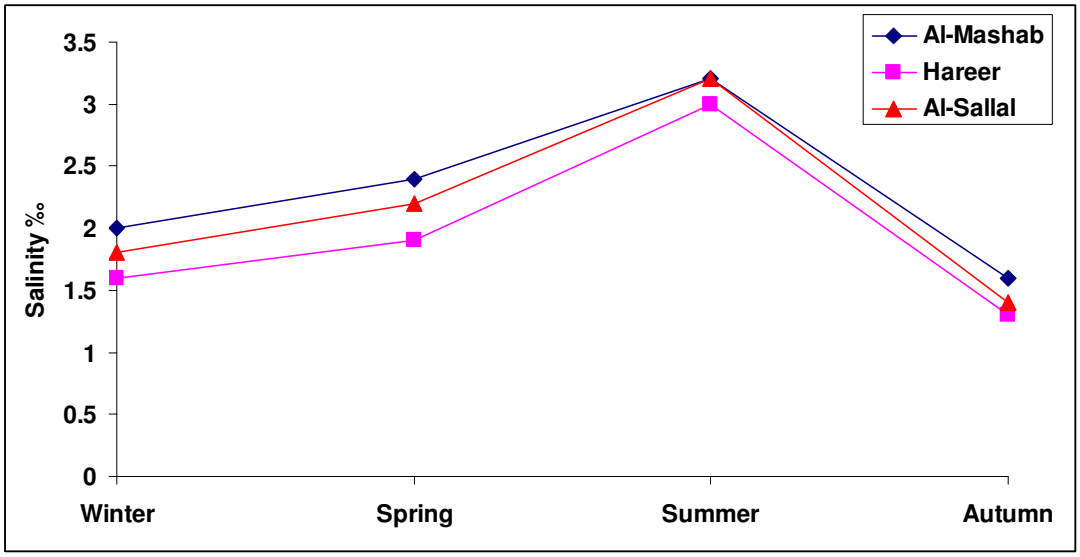

Figure 3. Salinity values at the three stations, south of Al-Hammar marshes during 2011

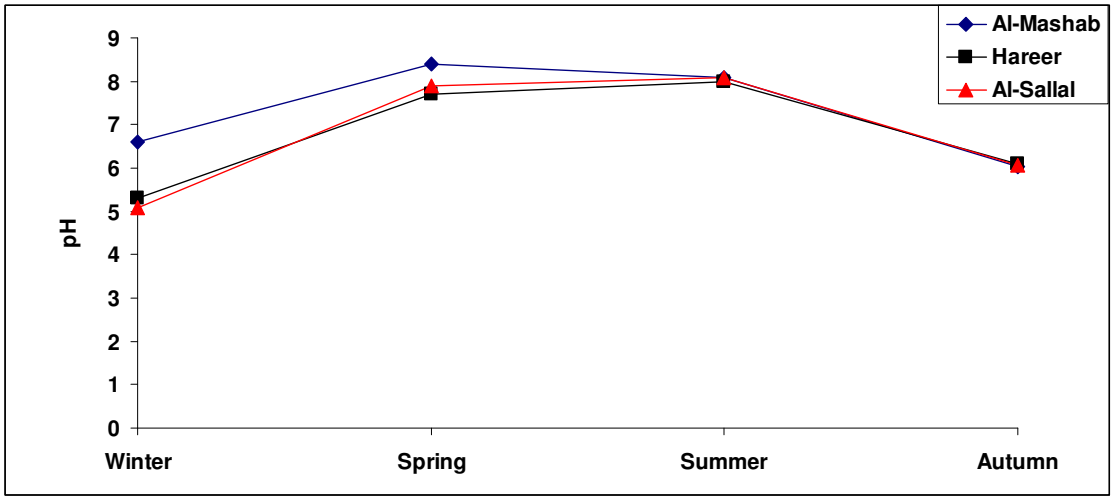

Figure 4. Hydrogen ion concentration (pH) at the three stations, south Al-Hammar marshes during 2011

Cladocera:

A total of 13 species of Cladocera belonging to 11 genera were identified in the study area (Table 1). Eight species were recorded at Al- Mas-hab region, while twelve and eleven species were recorded at Hareer and Al-Sallal region, respectively. Cladocera exhibited a rise in density in spring (41971 ind./m^3) at Hareer region and a fall (79 ind./m^3) was observed in winter at Al-Mas-hab region (Fig. 6).

Maximum numbers of species of Cladocera were 9 species which were recorded in the course of Autumn. Whereas, the minimum species were 2 recorded in spring and summer (Fig. 7).

Moina affinis and *Diaphanosoma brachyurum* were the dominant species in the study area constituting about 81.2 % and 18.6 % of the total Cladocera, respectively, and 8.6 % and 2.0 % of the total zooplankton, respectively.

Ecological Indices

Diversity index (H) Shannon Weaver

The high values of diversity were recorded in winter at all stations (1.68, 1.16, 1.68 respectively) while the lowest values were recorded during spring at all stations (0.06, 0.03, 0.01 respectively) (Fig 8).

Evenness (J)

The highest values of evenness was 1.0 which was recorded at station 3 during summer, while the lowest value was 0.01 and recorded in spring at the same station (Fig 9).

Richness index (D) :

Richness values ranged from 0.09 which was recorded during spring at station 2 and 1.64 during winter at station 1. It is also apparent that winter season has shown high values of this index at all stations (Fig 10).

Relationships of Cladocera with the environmental conditions

Fig (11) shows that *Chydorus sphaericus sphaericus* greatly influenced by dissolved oxygen, while the other environmental factors have little effect on it. Also *Alonella diaphana*, *Moina affinis*, *Macrothrix spinosa* were largely influenced in the same way, while *Diaphanosoma brachyurum* was largely affected by salinity and less by temperature and pH, but did not show a significant impact by dissolved oxygen. However, the other species have shown little impact with other environmental factors.

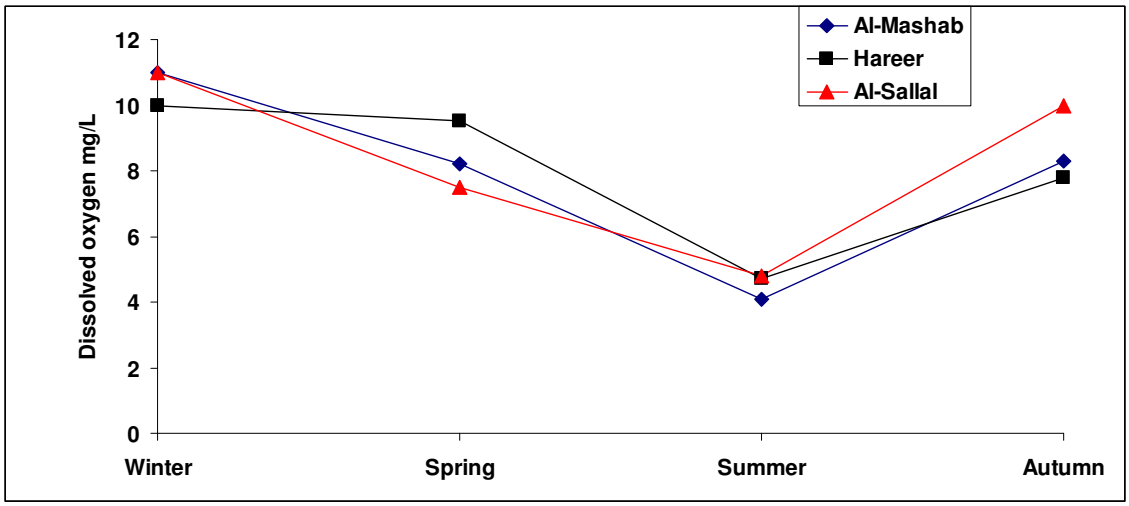

Figure 5. Concentration of dissolved oxygen at the three stations, south of Al-Hammar marshes during 2011

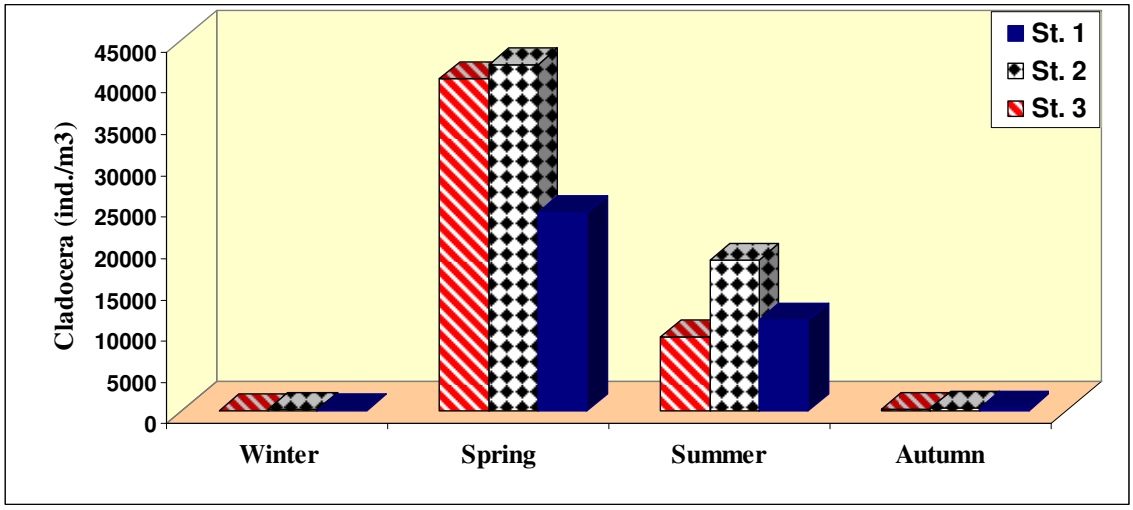

Figure 6. Cladocera density (ind./m^3) at the three stations, south of Al-Hammar marshes during 2011.

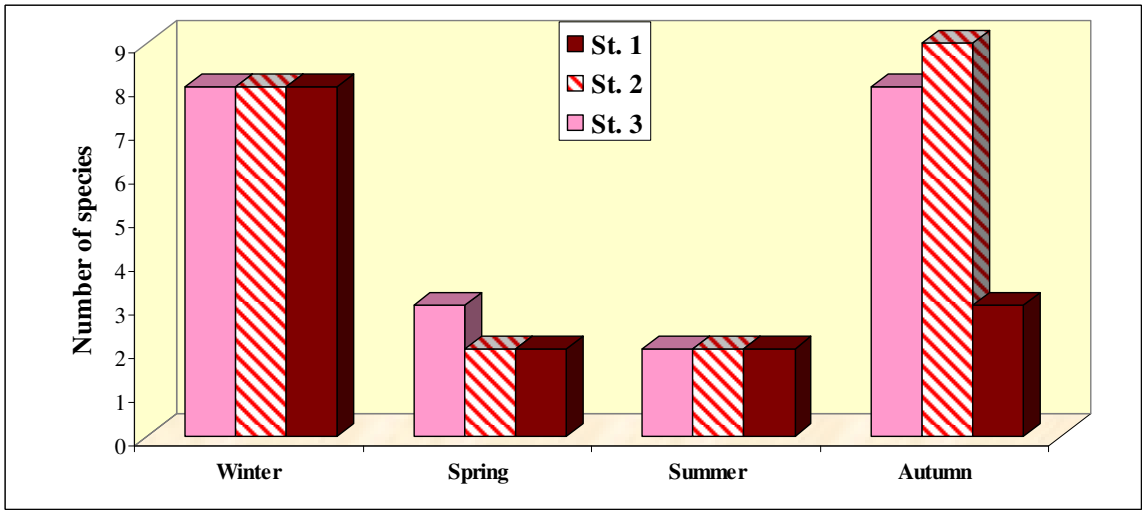

Figure 7. Number of species of Cladocera at the three stations, south of Al-Hammar marshes during 2011

Table 1. Zooplankton density (ind./m^3) at the three stations, south of Al-Hammar marshes during 2011

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		
Alona costata	10.8	88	26.4	-	-	-	-	-	-	-	0.01	0.01	125	0.009
A. rectangula	3.6	7.4	3.6	-	-	-	-	-	-	-	-	-	14.6	0.001
Alonella diaphana	-	-	-	-	-	-	-	-	-	-	0.01	0.01	0.02	0.000001
Camptocercus rectirostris	0.05	6.2	7.2	-	-	-	-	-	-	-	1.2	3.3	18	0.001
Ceriodaphnia rigaudi	-	0.02	1.2	-	-	-	-	-	-	-	-	0.03	1.25	0.0001
Chydorus sphaericus sphaericus	-	-	-	-	-	0.05	-	-	-	-	1.2	-	1.25	0.0001
Diaphanosoma brachyurum	19.8	2.5	2.4	241	213	57	8695	13375	4182	254	36	27	27105	2.0
Dunhevedia crassa	-	-	-	-	-	-	-	-	-	-	0.01	-	0.01	0.000001
Macrothrix spinosa	-	-	-	-	-	-	-	-	-	-	2.4	6.6	9	0.0006
Moina affinis	23.4	137.4	26.4	23728	41758	40147	2356	4851	4879	118	351	169	118544	8.6
Sida sp.	1.8	-	-	-	-	-	-	-	-	-	-	-	1.8	0.0001
Simocephalus (Simocephalus) vetuloides	5.4	17.3	16.8	-	-	-	-	-	-	15	3.6	3.3	61.4	0.004
S. (Echinocaudus) expinosus	7.2	2.5	4.8	-	-	-	-	-	-	-	-	-	14.5	0.001
Cladocera larvae	7.2	-	-	-	-	-	-	-	-	-	-	-	7.2	0.0005
Total of Cladocera	79.2	261.3	88.8	23969	41971	40204	11051	18226	9061	387	395	209	145902	10.6

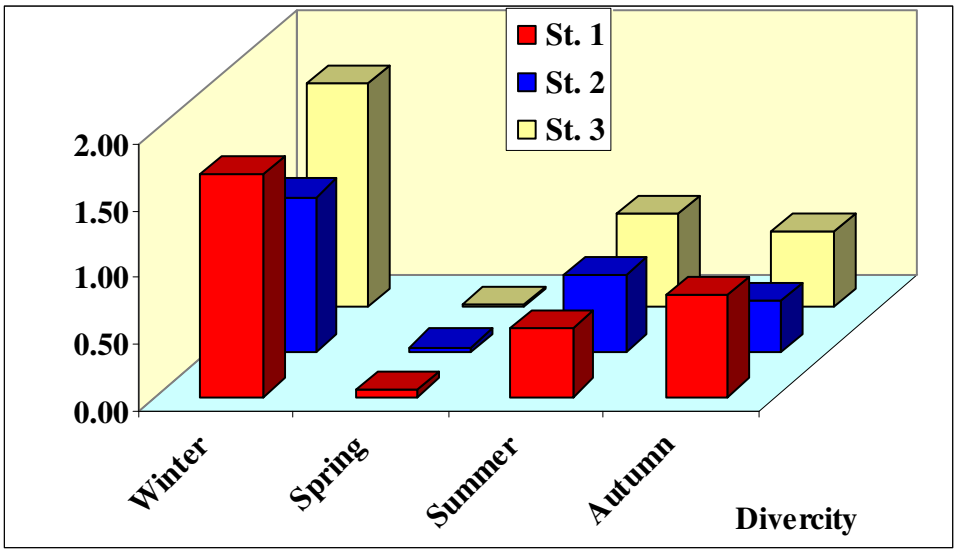

Fig. (8): Seasonally changes of diversity at the three stations during the study period.

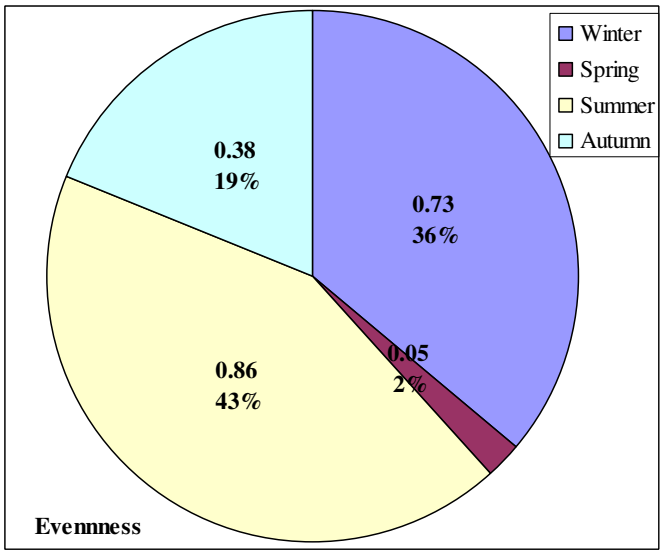

Fig. (9): Seasonally changes of Evenness at the three stations during the study period.

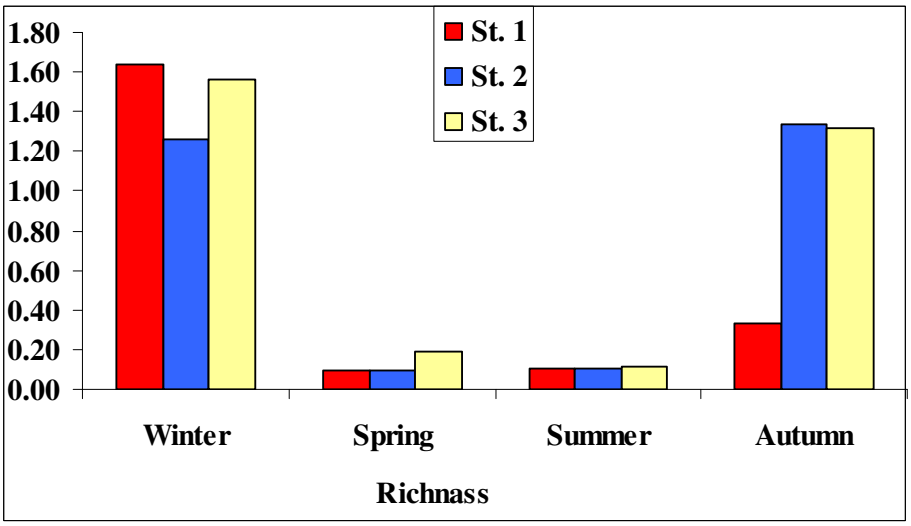

Fig. (10): Seasonally changes of Richness index at the three stations during the study period

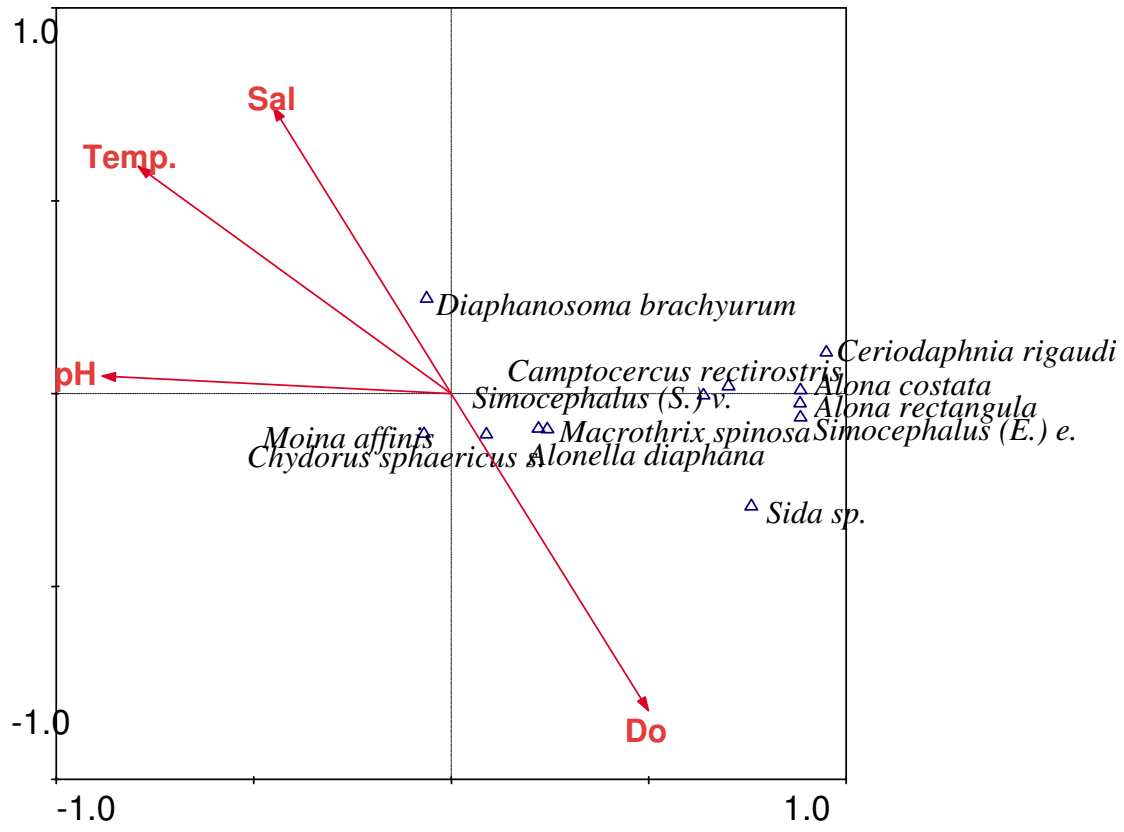

Fig. (11) Relationship of the species of Cladocera with some environmental factors such as water temperature, salinity, dissolved oxygen and pH using the Canoco test.

Discussion :

The present results indicated that Al-Hammar marshes is an oligohaline brackish water according to Reid (1961) classification. Sabri *et al.* (1989) 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 (2005) and Al-Mahmoud *et al* (2008) and others on the inland Iraqi waters such as Ajeel (1990) and Al-Lami (1998) and Al-Qarooni (2005), 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 (Sabri *et al.* 1989 and Al-Moussaoui and Hussein, 1994).

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 (Schram, 1986).

The results of the current study show that some species of Cladocera were dominant, such as *Moina affinis* and *Diaphanosoma brachyurum*, indicating that these two species had a wide range of tolerance to the different environmental conditions, and these results

are consistent with that of Mangalo & Akbar (1986 a) whom formed these two species are the most numerous in the Tigris River out of eight species that have been recorded in that River. It also coincides with that of Khalaf & Shihab, (1979) carried out at Al-Zaafaraniyah pools.

Also its agreed with that of Salman *et al*. (unpublished) at Al-Hawizah, Al-Hammar and Al-Chebaish marshes, southern Iraq, which showed that *Moina* sp. had increased significantly during August in Al-Hawizah marsh.

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.

Biodiversity assessments of any water body depend on the ability to identify the complement of species present, although the degree of sampling required is often uncertain (Muirhead *et al*. 2006). The Shannon-Weaver diversity index indicated that the community structure in the three studied stations was not different. The highest diversity index value was observed at station 1 (1.68), and similar value was observed at stations 3, whereas the lowest value was obtained at station 3 (0.01) .Therefore, the community structure of Cladocera at these two stations was similar.

References:

1. AJEEL, S. G. *Abundance and distribution of zooplankton in some waters in southern region of Iraq*. Mar. Mesop., 19 (1): 2004. 95 - 115.
2. AJEEL, S. G.; ALI, M.H. and SALMAN, S.D. *Population dynamics of Simocephalus vetulus (Crustacea: Cladocera) in Basrah.* Mar. Mesop., 15 (2): 2000. 593 - 612.
3. AJEEL, S.G.; ALI, M.H. and SALMAN, S.D. *Cladocera from Shatt Al-Arab and some temporary ponds in Basrah. Mari*. Mesop., 16 (1): 2001. 309 - 329.
4. AJEEL, S. G. KHALAF, T.A. MOHAMMAD,H. H. and ABBAS, M. F. *Distribution of zooplankton in the Al-Hawizah, Al-Hammar marshes and Al-Izze river south of Iraq.* Marsh Bulletin. 1(2): 2006.140–153.
5. AL-HAMMED, M. I. *Immunological study on the inland water of Iraq*. Bull. Iraq Nat. Hist. Mus., 3: 1966. 1- 21.
6. Al-JIZANI, H.R.G. *Organic pollution and its impact on the diversity and abundance of plankton in the Shatt al-Arab, Al-Ashaar and Al-Robat Channel*. . M.Sc. Thesis, college of Education – Univ. Basrah. 2005.PP.82.
7. Al-LAAMI, A. A. , KASSIM, T. I. and Al-DULYMI, A. A.. *A limnological study on Tigris river, Iraq.* IAECJ. 1998.
8. Al-NIMRAWI, A.M. *Biodiversity of aquatic invertebrates in the Tigris and Euphrates center Iraq*. Ph.D. thesis. Baghdad University - College of Science - Department of Biology. 2006. 161 p.
9. Al-QAROONI, I. H . M. *Abundance and occurrence studies on some of zooplankton and aquatic snails in Al- Chabaish, Al- Hammar and Al- Fuhud marshes southern Iraq.* M.Sc. Thesis-college of Education – Uni. of Basrah. 2005.97 pp.(in Arabic).
10. AL-SABOONCHI, A. A. BARAK, N. A. and MOHAMMAD, A. M. *Zooplankton of Garma marshes , Iraq*. J. Biol. Sci. Rrs. 17(1): 1986. 33-40.

11. BALCER, M.D.; KORDA, N.L. and DODSON, S.I. *Zooplankton of the great lakes. A guide to the identification and ecology of the common crustacean species.* The University of Wisconsin Press. 1984. PP. 174.
12. BROOK, J. L. *Cladocera. In : W.T. Edmondson (ed) ward whippets fresh water biology ;* John wiley and Sons, Inc. New York : 1959.587- 656.
13. CHATTOOPADHYAY, C. and BARIK. A. *The Composition and Diversity of Net Zooplankton Species in a Tropical Freshwater Lake*. International Journal of Lakes and Rivers., 2(1): 2009. 21-30.
14. DEBERNARDI, R. *Methods for the estimation of Zooplankton abundance . In:*
15. *A manual on methods for the assessment of secondary Productivity in Fresh Waters*. (eds., J. A. Downing and F. H. RigIer), BP Hand book No. 17, Blakwell, Oxford. 1984. Pp. 55-86.
16. GURNEY,R.M. A. *Freshwater Crustacea collected by Dr. P.A.Buxton in Mesopotamia and (Persia).*J. Bombay natural History Society. 27(4): 1921. 835-844.
17. FIGUEROLA, J.& A. J. GREEN,. *Dispersal of aquatic organisms by waterbirds: a review of past research and priorities for future studies*. *Freshwater* Biology 47: 2002.483–494.
18. FORRO, L. KKOROVCHINSKY, N.M.; KOTOV, A.A. and PETRUSEK, A.. *Global diversity of Cladocerans (Cladocera; Crustacea) in freshwater*. Hydrobiology. 595 (1): 2008. 177–184
19. FRYER, G. *Morphology and the classification of the so-called Cladocera*. Hydrobiologia 145: 1987. 19–28.
20. KHALAF, A. N. and SMIRNOV, M. N. *On littoral Cladocera of Iraq*. Hydrobiologia. 51(1): 1976. 91-94.
21. KHALAF, A. N. , LATTIF, M. A. and MANGALO, H. H.. *Growth of Simocephalus vetulus Schodler (Crustacea:Cladocera) Under different diet conditions*. Bull. Biol. Res. Cont., 9: 1977. 17-26.
22. LAMPERT, W. and SOMMER, U. *Limnoecology:* The Ecology of Lakes and Streams. Translated by James F. Haney, Oxford University Press, Oxford, 1997.382 pp
23. LAZIM, M. N. and ZEKI, M.. *A study of life span, instar duration, growth and reproduction in Scapholebris kingi sars*. Biol. Sci. Res, 18 : 1987. 1-10.
24. LILLJEBORG, W.. *Cladocera sueciae*. Almqvist and wiksell international Stockholm / Sweden. 1982. PP. 701 + Tab. 87.
25. MANGALO, H. H. and AKBAR, M. M. *Seasonal variation in population density of zooplankton in the lower reaches of Diyala river, Baghdad-Iraq*. J. Biol. Scien. Res. 17(3): 1986. 99–114.
26. MANGALO, H. H. and AKBAR, M. M. *Comparative study of two populations of cladocerans in the Tigris and Diyala Rivers at Baghdad*. J. Biol. Sci. Res. 19(1): 1988. 117-128.
27. MOHAMMAD, M. B.. *A faunal study of the Cladocera of Iraq* .Bull. Biol. Res. Center. 1: 1965.1-11.
28. MOHAMMAD, M. B. *A hydrobiological survey of a polluted canal*. Hydrobiology. 74: 1980.179-186 .
29. MOHAMMAD, M. B. *Associations of invertebrates in the Euphrates and Tigris Rivers at Falluja and Baghdad, Iraq*. Archiv Fur Hydrobiologia. 106(3): 1986. 337–350.

30. MUIRHEAD, J. R., EJSMONT-KARABIN, J. and MACISAAC, H. J. *Quantifying rotifer species richness in temperate lakes . Freshwater* Biol. 51:2006.1696–1709.
31. POLTORAK, T. , BARTEL, R. and SZCZERBOWSKI, A. *Horizontal distribution of zooplankton in lakes Thrthar, Habbaniy and Razzazah*. Archives of polish fisheries. 9 (1): 2001. 111-126.
32. SABRI, A.W.; ALI, Z. H.; THEJAR, L. A.; SHAWKAT, S.F. and KASSIM, T. I.. *Vertical distribution zooplanktonic species in Samarra impoundment (Iraq).* Proc. Sth Sci. Conf./SRC., 5 : 1989. 256-264.
33. SALMAN, S. D. MARINA, B. A. ALI, M. H. and OSHNA, V. K.. *Zooplankton studies. In: Final report:* The 18-month marine pollution monitoring and research programme in Iraq. Marine Science Center of Basrah, Uni. Basrah-Iraq. 1986 pp. 136-166.
34. SHIHAB, A.F. and KHALAF, A.N. *Effect of temperature on growth and reproduction of Moina micrura (Crustacea : Cladocera).* Bull. Biol. Res. Centre. 12(2): 1980.49 – 72.