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Study of relationships between zooplankton, some ecological factors, and water quality index in Shatt Al-Arab River

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Abstract

The study was completed in Basra Governorate in the central part of Shatt Al-Arab River, and two stations were chosen to carry out the study. The first one is near the island of Sindbad located on the coordinates "N30 ° 34´18.4872", E 47 ° 46´44.9292 ", the next station is proximate the Al-Sadr Educational Hospital within about N30 ° 30´34.6608 ", E74 ° 51´7.2108". Samples were collected on a monthly basis for a period of one year, during the low tide, and for the period from September 2018 until August 2019. Some environmental factors of water were measured as well as (water temperature, pH, dissolved oxygen, biological oxygen demand, light penetration, salinity, total dissolved salts, total hardness, reactive nitrate, reactive nitrite and reactive phosphate). The WQI (Canadian Model) was used for assessment as an efficient method for assessing the water environment and determining its suitability. Zooplankton were collected and diagnosed, both quantitative and qualitatively. The results of the study showed that the temperature ranges ranged between (14-37) ° C, pH values were between (7.1-8.1), Dissolved oxygen (6-11) $mg.L^{-1}$, the biological oxygen demand was between (0.5-3.5) $mg.L^{-1}$, the light penetration values were between (22.5-165) cm, salinity ranged between (0.9-15.42) ‰, total dissolved salts between (1646-17158) $mg.L^{-1}$, total hardness between (4800-480) $mg.CaCo3.L^{-1}$, reactive nitrate are between (0.02-3.24) µg nitrogen atom. l^{-1}, reactive nitrite values were between (0.02-1.21) µg nitrogen $atom.L^{-1}$, and reactive phosphate was between (0.01-0.86) µg phosphorous atom. l^{-1}. The water quality index on record the highest value (61.46) in the fourth category Marginal in the summer for the first station, and the lowest value was recorded (33.11) in the fifth group Poor in the winter for the next station. 98 taxa of zooplankton, which recorded in the 1st station, 61 Rotifera, 15 Cladocera, 12 Copepoda, 7 miscellaneous groups and 3 Ostracoda. 79 taxa of zooplankton recorded in the 2nd station, 53 Rotifera, 13 Copepoda, 5 Cladocera, 5 miscellaneous groups and 3 Ostracoda. The maximum total density of zooplankton was 3561.53 and 1532.95 $ind.L^{-1}$ for

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the first and second stations respectively. Statistical analysis was applied to make clear the relationship between environmental factors and zooplankton in the aquatic environment.

Keywords: Zooplankton, Shatt Al-Arab river, Water quality index, Iraq

Introduction:

The quality and quantity of fresh water is important and critical in most countries of the world, especially with regard to water sources, as freshwater pollution is one of the most important environmental issues in the world, so the assessment of water quality can be divided mainly into two parts, one of which depends on physical and chemical methods by taking immediate measurements to know the characteristics of water at that moment and the other section is concerned with the biology methods of evaluation as biology methods is used to monitor water quality and through which to know the effects For long-term environmental (Panich-Pat *et al*., 2009; Ali *et al*., 2003). These biology methods have the potential to reverse conditions that do not exist at the time of sample collection or analysis but arise from the development of the bio-community, so physical, chemical and biology methods are complementary and are the basis for properly assessing the quality of running water (Lopo *et al*., 2004). The use of Water Quality Index (WQI) as a preferred scientific method for assessing water quality This is because it uses many environmental variables and expresses them digitally and includes the integrated impact of these variables on water quality, can be defined as a means of summarizing a large number of data for a range of physical, chemical and biology variables and translating them into a simple and rapid quantitative expression through a mathematical formula to provide necessary information on water quality, Water application of the Water Quality Guide depends on the follow-up of changes in water quality over a period of time and is usually used for one year for observation because the data are collected to reflect the state of water during the measurement period, whether monthly or quarterly, and also depends on the selection of variables, and includes the most important variables to indicate the overall state of water and evidence associated with a particular activity (CCME, 2001). Zooplankton affect water quality due to their short life cycle, as they respond quickly to environmental changes It can therefore be an additional tool for monitoring and tracking changes in the quality of the aquatic environment, so the destruction of these organisms leads to the release of odors, the accumulation of organic debris, the reduction of water quality, increased turbidity and color, the depletion of dissolved oxygen and the rise of organic carbon levels (Als, 2017). Zooplankton have three main groups: Rotifera, Cladocera, Copepoda Others (Chattopadhyay and Barik, 2009). Rotifera a key role in most freshwater ecosystems through their impact on the food chain, as they are found in all freshwater bodies from large permanent lakes to small

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temporary ponds and sewage ponds (Thorp & Covich, 2009). Cladocera is a branch of zooplankton beasts of basic freshwater in the study of freshwater science (Segers and Desmet, 2008). Cladocera is also a sensitive indicator of changes in the aquatic environment because it gives information about environmental factors including temperature, nutritional status, fish preying and water level (Lotter *et al*., 2012) Cladocera is found in the low-turbid waters and their reproduction in the spring and winter depending on the flourishing of certain types of diets that are important food for them (Abbas and Lami, 2001). Copepoda is the largest secondary species of the smallest crustaceans and has a wide variety of about 13,000 known species around the world and is found in all marine and freshwater environments (Boxshall and Defaye, 2008). Foot rowers are only (1)mm small in size and live in warm and cold freshwater and salty environments. Chang (2012). Hammadi (2002) recorded some observations about zooplankton in his study on Hamdan Canal, one of the main branches of the Shatt al-Arab River. The presence of *B. longirostris* was also observed at a high density out of 33 species recorded in the waters of the Tigris River near the lower Zab (Shekha & Al-Abaychi, 2011). Moyle (2010) used the Canadian model to assess the water quality of the northern part of the Shatt al-Arab and its possibility of using it for general purposes, irrigation and drinking, and the results of the study showed that the values of the General Water Quality Index are classified as moderate and the fifth category poor, while the values of the water quality guide Drinking water processing was classified as poor in the fifth category, while the IWQI values were classified as good and vulnerable, Hammadi (2010) concluded that Rotifera were the dominant group during his study of zooplankton in the Shatt al-Arab region. Due to the scarcity of studies that deal with this aspect, it was necessary to conduct this study to find out the relationship of Zooplanktion to some environmental factors and the water quality guide in two stations of the Shatt al-Arab River.

Materials and Methods:

Water temperature is measured using a simple thermometer listed from (0-100) degrees Celsius. Salinity and Total dissolved solids (TDS) were measured using a German-origin WTW multimeter expressed by g/L. and mg/L respectively. pH meter was used to measure pH. Light penetration was measured using a Secchi disk and the results were expressed in cm. Total hardness was measured by the total ions of water samples following the method described in APHA (2005). Dissolved oxygen (DO) has followed the modified method of Winkler called Azid Modification, described in (Lind, 1979).

Water quality index: The Canadian Water Quality Index (CCME WQI) was applied in the current study to assess the water quality of the current study environment, the application of

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Al-Kunooze University College
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which depends on several basic steps, including time limiting. It is a sensitive indicator for assessing water quality if provided with sufficient data to obtain a matrix of numbers that the mathematical model can easily sense to give more acceptable results selected Iraqi standards and specifications for water no. (417) second update for the year (2009). To calculate the Canadian water quality guide described by CCME (2001), which depends on the combination of three factors:

Range or Domain (F1): Represents the proportion of variables whose values do not match the criteria set for the model (failed variables) and is calculated from the following equation:

F1 = (Number of failed Variables/Total number of Variables) X100

Frequency frequency symbolized by F2: represents the proportion of tests whose values do not conform to the criteria set for the model (failed tests) and are calculated from the following equation:

F2 = (Number of failed tests/Total number of tests) X100

amplitude amplitude and symbolized by F3: represents the amount of failed test values whose values do not conform to the criteria set, and is calculated in three steps which is

1- deviation measurement Excursion, which represents the number of times the test value deviates above the value of the standard placed, is calculated from the following equation:

Excursion = (Failed tests value/objective) -1

or the test value is lower than the value of the standard placed and calculated from the following equation:

Excursion = (objective/Failed tests value) -1

2-Calculate the total standard deviations Normalized Sum of Excursion NSE, which represents the accumulated amount of individual tests whose values do not meet the established criteria and are calculated by dividing the total deviations by the total number of tests that conform to and do not conform to the criteria set as follows

$$NSE = \sum_{i=1}^{n} \frac{ecxcursion}{number\ of\ tests}$$

3-The capacity (F3) of the

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*F3= nse equation (0.01*nse +0.01)*

is then calculated and the water quality guide is calculated from the

$$WQI= 100 - [\sqrt{(F1)^2 + (F2)^2 + (F3)^2 \}} \ / \ 1.732]$$

The division by number 1.732 is to keep the resulting guide value 100-0, and then express the state of the water flat by linking the value of the guide to a numerical scale divided into five categories each representing the water quality level and expressing the state of the water flat as in Table (1).

Table 1. Water Quality Guide Scale

The description	Directory value	Classification of Categories
The water is excellently protected and far from pollution sources as it approaches the ideal state	100-95	Excellent
The water is well protected and the specifications are far from ideal	94-80	Good
Water is often protected but contaminated and is far from ideal in some neighborhoods	79-65	Fair
Water is contaminated and is often far from ideal	64-45	Marginal
Water is always contaminated and is far from ideal	45-0	Poor

Quantitative and qualitative study of zooplankton:

Zooplankton samples were collected by a net, Its mesh-size-of 50 micrometers, then placed the concentrated sample in special container on formalin concentration 4%. laboratory, the collected samples are concentrated to 100 milliliters and examined using a counting slide Sedgwick Rafter and a composite microscope to determine their density and identify species that could be used as life guides for the state of the Shatt al-Arab waters. The following taxonomic keys were used for classify of specimens: Edmondson (1959), Fernando (2002), Claude (1984), Al-Yamani and Prusova (2003), Hammadi *et al*., (2012). The total density of individual/litre was calculated by the following equations:

F= V2/V1

V1= concentrated sample size (100ml) V2 = sample examined in slide (1ml)

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V= R2 (22/7) d

V = amount of water passing through R2 = radius of plankton net nozzle

d = distance

A V*F

Density N = number / A (individual/liter)

Results:

Figure 1 shows monthly changes in water temperature during the sampling period, the lowest values were 16°C and 14°C in February at the two stations respectively and the highest 37°C and 36°C in July at the two stations respectively. Figure 3 explains monthly fluctuations in pH values during the sampling period, with the first station recording the lowest values of 7.1 in March, April and June, and the highest at 7.9 in September, with the lowest value at the second station being 7.2 in February, March, June and April, and the highest at 8.1 in September. Figure 4 illustrates monthly variations in dissolved oxygen values during the sampling period, with the first station recording the lowest values of 6 mg/L in July, the highest of 10 mg/L in February, and January, with the second station at 6 mg/L in July and may at 11 mg/L in February. Figure 5 elucidates monthly changes in the values of the biological oxygen demand during the sampling period, with the lowest values of 1mg/L recorded in February for the first station, the highest at 3mg/L in September, and the second station at 0.5 mg/L in February and the highest at 3.5 mg/L in September. Figure 6 represents monthly fluctuations in transparency values during the sampling period, with the two stations recording the lowest values at 22.6 cm and 22.5 cm in July respectively, and the highest in the first and second stations, reaching 120 cm, 165cm in December respectively. Salinity values showed a sharp decline in the first four months and continued to fluctuate slowly in the duration of the study, with the lowest values recorded at the study stations during June and May of 0.9 and 1.3g/L, respectively, with the highest at 12.3g/L in September, and at the second station being 15.42g/L in September (Figure7). Salinity oscillation was accompanied by fluctuation of total dissolved salts values in the water, with severe declines recorded in the first four months (Figure 8) of the lowest values at the study stations during February, respectively 1,708 mg/L for the first station and for the second station 1688 mg/L, the highest in September 13,658 mg/L at the first station and 17,158 mg/L at the second station. Total hardness values declined sharply from the beginning of study in September to January and continued to fluctuate slowly between the various months, with the highest values on the first station registering 2,800 mg.CaCo3.L^{-1}, the second station at 4,800 mg.CaCo3.L^{-1} in September and the lowest values for the first station

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Al-Kunooze University College
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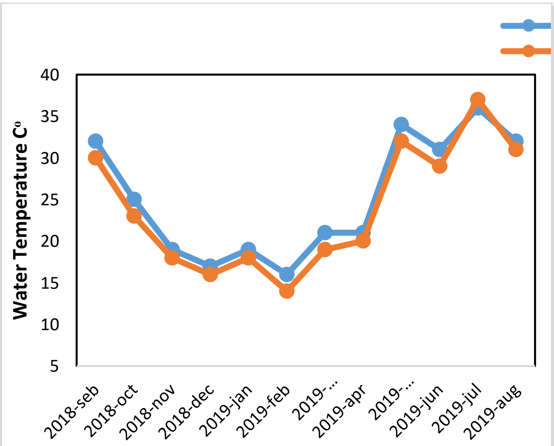
in June at 560 mg.CaCo3.$L^{-1}$and for the second station 480 mg.CaCo3.L^{-1}in January. Figure 9 shows monthly variations in reactive nitrate values of µg N atom /L during the sampling period, with the lowest values recorded during July at 0.02 µg N atom-/L atom for the first station and during August 1.09 µg N atom/L. The top of the second station was 7.98 micrograms of nitrogen/liter atom and 11.46 µg N atom/L at the second station in December. Figure10 illustrates monthly changes in reactive nitrite values, µg N atom L during the sampling period, the lowest values were recorded at the study stations during July at 0.02 µg N atom-/L, the highest of which in December for the two stations were 21 and 1.13 µg of N atom /L respectively. Figure11 explains monthly variations in reactive phosphate values µg P atom/L during the sampling period, with the lowest values in the first station recording 0.01 µg P atom /L in sptember and June. In July, the highest was 0.64 µg P atom /L during January and recorded at the second station 0.86 µg P atom /L in December.



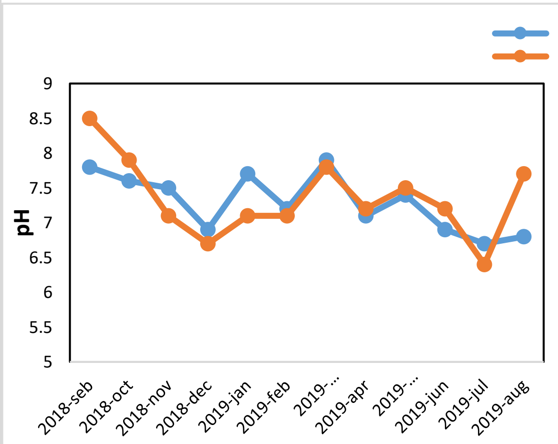


Figure 1. Monthly variations in the water temperature in the two stations of study.

Figure 2. Monthly variations in the pH in the two stations of study

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Al-Kunooze University College
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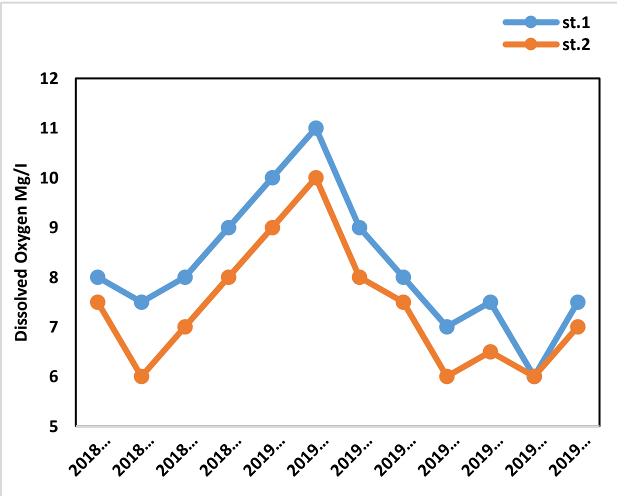

Figure 3. Monthly variations in the dissoived oxygen mg/l in the two

Figure 4. Monthly variations in the biological oxygen damand mg/l

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Al-Kunooze University College
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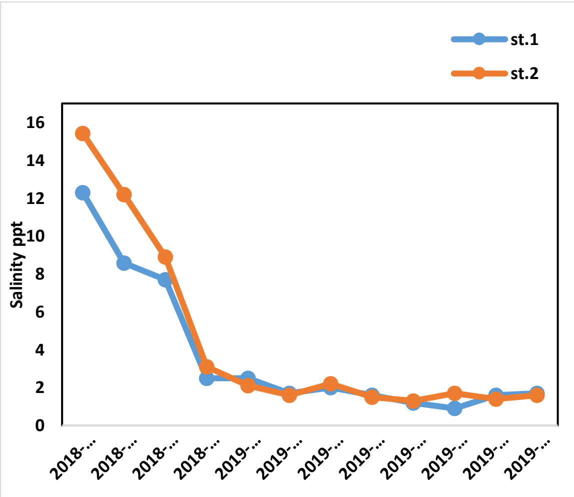
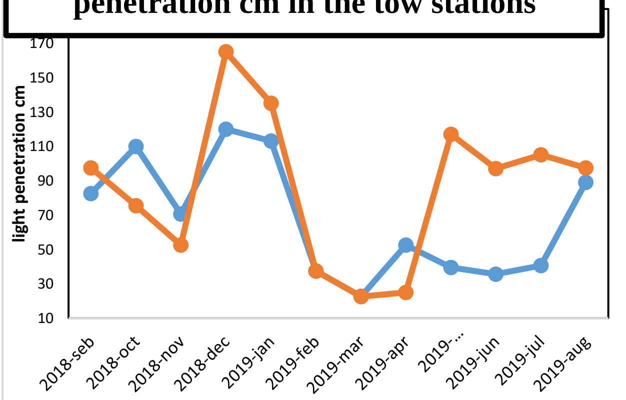


Figure 5. Monthiy variations in the light penetration cm in the tow stations

Figure 6. Monthiy variations in the Salinity ppt in the two stations study.



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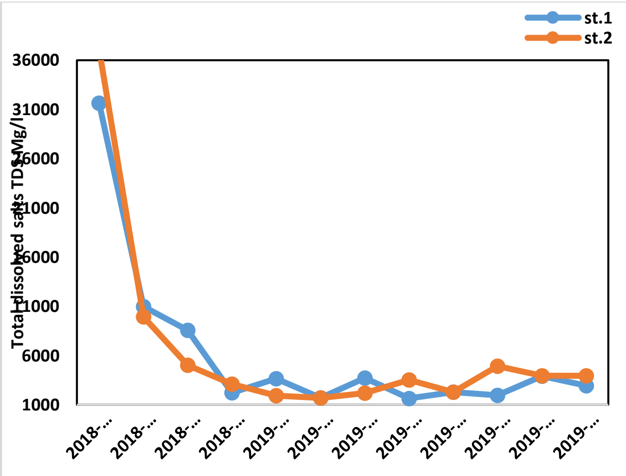

Figure 7. Monthiy variations in the Total dissolved salts TDS mg\l in the two stations study.

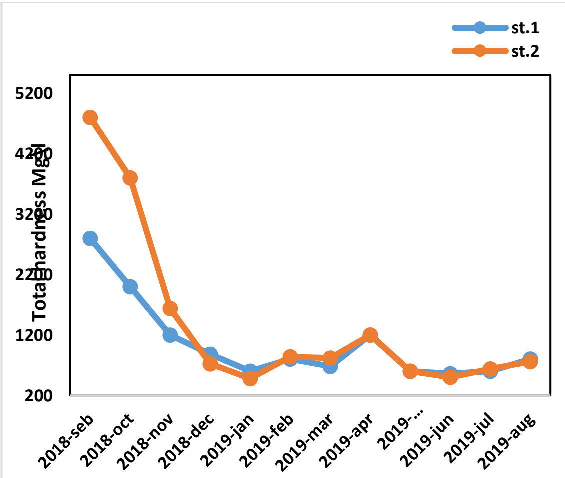

Figure 8. Monthly variations in the total hardness mg\l in the two station study.

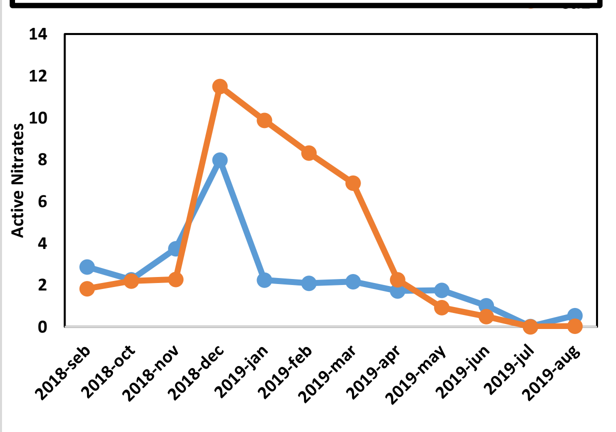

Figure 9. Monthly variations in the reactive nitrate in the two station study.

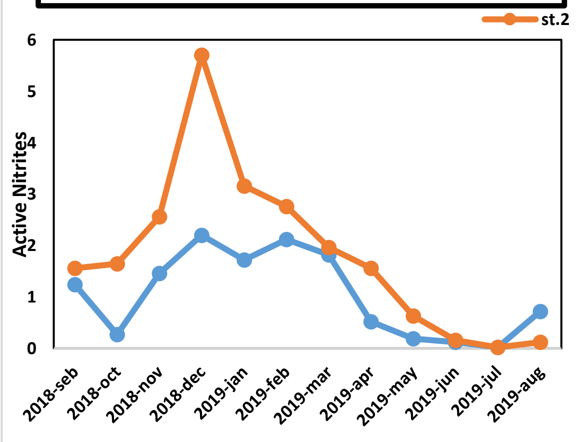

Figure 10. Monthly variations in the reactive nitrite in two station study.

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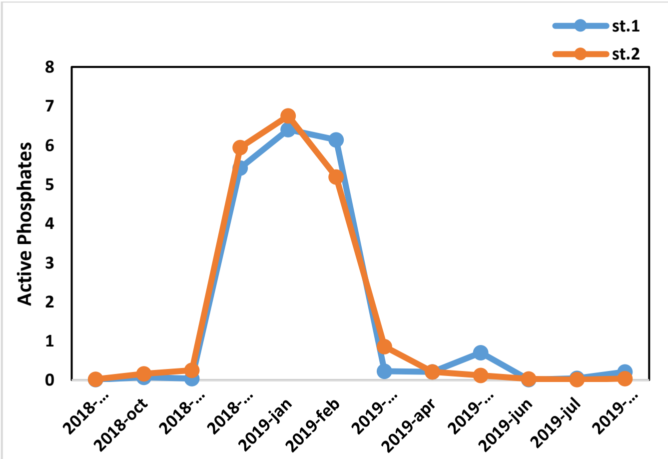

Figure 11. Monthly variations in the reactive phosphate in the two station study.

The water quality index (WQI)

The water quality index was used during the study, selecting 11 environmental variables in assessing the quality of shatt al-Arab water (water temperature, pH, dissolved oxygen, biological oxygen damand, light penetration, salinity, total dissolved salts, total hardness, active nitrates, active nitrite, active phosphates) Table 3 shows the evidence values calculated for the two study stations based on the river maintenance system of 1967, and figure (12) shows quarterly changes to the values of the General Water Quality Index, and shows that the evidence values of the first station The second was high during the summer in the fourth category marginal i.e. the water is exposed to pollution and is often far from ideal and during the whole year was in the fourth category of the first station, while during the autumn of the two stations and during the winter of the second station and during the full year of the second station in the fifth category poor i.e. the water is always exposed to pollution and is far from ideal.

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Al-Kunooze University College
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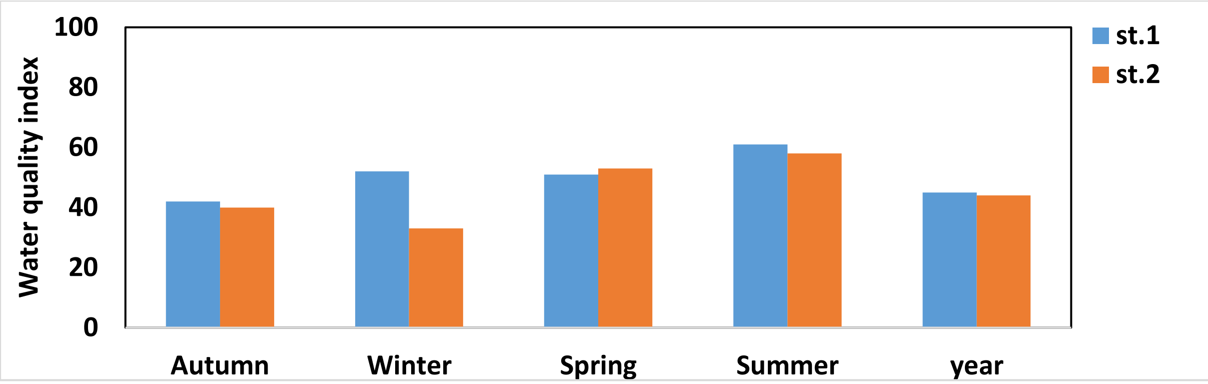

Figure 12. Seasonal changes in the values of the general water quality index for the two studv stations.

Table 3. Values of the General Water Quality and Classification Categories in Stations for September 2018 to August 2019

Classification of Categories	WQI	Station	Seasons
Poor	42	St1	Autumn
Marginal	52	St1	Winter
Marginal	51	St1	Spring
Marginal	61	St1	Summer
Marginal	45	St1	Year
Poor	40	St2	Autumn
Poor	33	St2	Winter
Marginal	53	St2	Spring
Marginal	58	St2	Summer
Poor	44	St2	Year

Quantitative and qualitative study of Zooplanktoin for the first station

In the current study of the first station near Sinbad Island (88) i diagnosed a species of Zooplanktoin recorded (15) types of cladocera and (12) types of Copepoda and (61) types of Rotifera. The total density of Zooplanktoin for the first station (3,538.19 ind/L) and as shown in table 4, and as shown in the form of (16), then the Rotifera group in Jun (1675.9 ind/l) Copepoda group in October (88.23 ind/l) and then a group Cladocera in March (2.38 ind/l)).

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Al-Kunooze University College
Journal homepage: http://journals.kunoozu.edu.iq/1/archive &
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The form (17) shows the percentage of zooplanktoin density in the first stop, with the rotifer dominating by (90.83%) over the rest of the zooplanktion, followed by copepoda (8.88%), and other totals accounting for(0.29%).

Table 4. Zooplanktoin and their density ind/L densities and relative abundance of station First near Sinbad Island from September 2018 to August 2019

Months	Seb	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Types	Ind/L	Ind/L	Ind/L	Ind/L	Ind/L	Ind/L	Ind/L	Ind/L	Ind/L	Ind/L	Ind/L	Ind/L
CLADOCERA												
Alonella nana								0.06				
Bosminopsis deitersi							0.38	1.01	0.57	0.88	0.5	0.06
Daphnia cephalata		1.01										
***Daphnia* Sp.**											0.31	0.13
Daphnia lumholtizi							0.06					
Daphna pulex								0.19				
Daphnia magna							0.69					
Dlaphauosoma brachynrum											0.25	
Diaphanosoma sarsi							0.06					
Macrothrix laticornis							0.13					
Moina macropa												0.13
***Moina* Sp.**							0.94	0.31	0.38	0.31	0.44	1.13
Simocephalus vetulus											0.06	
Simocephalus serrulatus							0.06					
Sida crystaiiina							0.06					
Total		**1.01**					**2.38**	**1.57**	**0.95**	**1.19**	**1.56**	**1.45**
COPEPODA												
Calanoid		10.13	0.13		0.06	0.69	2.26	57.53	1.76	1.19	0.06	0.82
Cyclopoid	1.68	19.81	2.83	0.31	0.63	5.47	0.44	12.51	0.63	0.38	3.65	2.14
Cyclops vicinus		5.41				0.25				0.06	0.19	
egg copepoda		9.31	7.48				0.94					
Epaclophanes riehardi		0.31	0.06	0.06	0.63	1.32						
Eucyciops agiloides					0.13	1.14						
Eudiaptomus gracilis			11.19									
Herpetecodi					0.06	0.94	0.94	4.02	0.63	0.06	0.44	1.26
***Labidocera* Sp.**		0.25										
***Microsetella* Sp.**		1.006	0.06							0.06		
Naupliius	21.00	42.00	2.77	1.64	1.38	17.69	1.45	12.51	2.58	10.94	8.93	17.35
Paracyclops chiltoni								0.44		0.19		
Total	**22.68**	**88.23**	**24.52**	**2.01**	**2.89**	**27.5**	**6.03**	**87.01**	**5.6**	**12.88**	**13.27**	**21.57**
ROTIFERA												
Anuraeopsis fissa									0.69	0.76	0.06	4.34
Ascomorpha saltans							0.06					
Asplanchna priodouta											0.69	
***Asplanchna* Sp.**									0.13	0.19	0.31	
Asplanchna herricki						0.13						
B. plicatilis							0.63		0.503	0.06		0.25
B. quadridentatus						0.06						0.06
B. urceolaris						1.57	0.13		7.48	4.401	8.74	1.95
B. leydigi									0.88	0.06	0.31	
B. rotundiformis									1.13	0.19	0.13	
B. variabilis							0.19		0.19			
B.calyciflorus f. spinosus											0.503	
B.calyciflorus f. amphiceros							4.21					

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B. calyciflorus f. dorcas									0.503			
Bedelloid	0.19			0.06		0.56	1.38	0.06	0.44	0.503	0.31	0.13
B. dimidiatus									0.06			
Biachionus calyciflorus				0.06	0.13	0.63	0.69	0.06		0.19		0.75
B. angularis								1.69	1.26	7.36		1.38
B.rubens								0.63	0.06	0.06		
***Brachionus* sp.**	2.52	0.06			0.44	0.13		0.76				
***Brachionus* spp.**						0.31	0.76		655.95	1647.41	82.87	26.28
Cephalodella Sp.							0.06					
C. megalocephala												1.51
Cephalodella delicata												0.19
Clourella Sp.									0.06			
Clourella adriatia						0.06	0.38		0.06			0.06
Colurella abtusa										0.06		
Conochilus (C.) Sp.									0.13			
Conochilus unicornis		1.26										
egg rotifera	5.09	10.94	1.32	0.44	5.85	10.31	0.76	3.02	68.91	6.66	22.19	1.89
Encentrum eurycephalum				0.44		0.06						
Filinia longiseta												1.19
Gostropus hyptopus							0.25					
Hexarthra mira							0.25					
K. tropica f. Asymmetricu											0.06	
Keratella tropica				0.13	0.19				16.66	5.22	7.86	7.17
K. restudo								0.25				
Keratella heimalis							0.38					
K.testudo									0.06			
K.tecta					0.06	0.13	1.32	3.39	4.46	1.45	2.27	1.26
k.valga					0.25	0.13	0.88	0.06	0.06			
k.Sp.									0.06			
Keratella quadrata				0.13	0.06	1.01	3.33	22.45	3.21			
Lacinularia Sp.									0.06			
Lecane sp.	0.13											
Lecane stenrosi												0.06
Notholca acuminata					1.89							
Notholca squamula				0.5	1.38			0.06				
Notholca candata				0.06	0.38							
P.dolichoptera							5.53					
P.major							1.64	0.31				0.44
Polyarthra remata							1.13					0.06
philodina Sp.				0.06	0.06							
polyarthra euryptera						0.25	17.92					
Rotaria neptunia											0.06	
Rotaria Sp.				0.06	0.13	0.13						
Synchaeta baltica				2.33	0.44	1.45	1.01					
Synchaeta lakowitziana	0.13		8.61	284.2	40.24	81.42	51.87	0.63	0.82	0.88	1.64	
Trichocerca Cylindrica	0.19											
T. rousseleti	0.06											
Testudinella patina									0.06	0.44	0.13	
Total	**8.31**	**12.3**	**9.93**	**288.5**	**51.5**	**98.34**	**94.76**	**33.37**	**763.9**	**1675.9**	**128.1**	**48.98**

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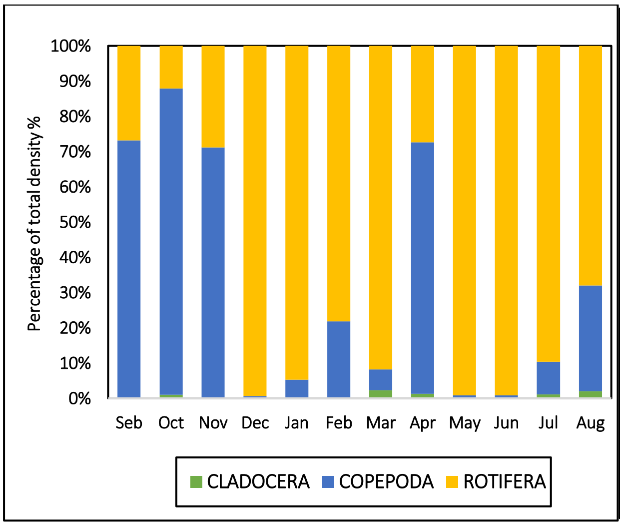

Figure 16. Monthly changes in the percentages of total density of zooplanktoin for station 1 near Sinbad Island from Sep 2018 to Aug 2019.

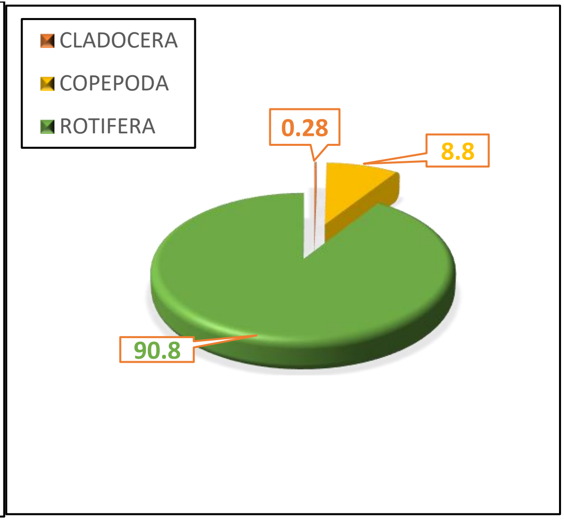

Figure 17. Percentage density of Zooplanktoin for Station 1 near Sinbad Island from September 2018 to August 2019.

The quantitative and qualitative study of Zooplanktoin of the second station

was diagnosed in the current study of the second station near Sadr Educational Hospital (61) species of Zooplanktoin recorded (5) types of cladocera and (12) types of copepoda and (44) types of rotifer. The total density of zooplanktoin (1514.51 ind/L) as shown in table 5 and shown in the form of (18), followed by the Rotifera group in Jun (332.73 ind/L) and the copepoda groups in Apr (268.7 ind/L), then a group cladocera (4.54 ind/l). The shape (19) shows the percentage of the density of zooplanktion, the group of Rotifer (60.21%) and the copepod group (39.19%) and the other totals accounted for (0.6%).

Table 5. Zooplanktoin, densities ind/L and relative abundance of the second station near Sadr Teaching Hospital for the period from September 2018 to August 2019

Months	Seb	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Types	Ind/L	Ind/L	Ind/L	Ind/L	Ind/L	Ind/L	Ind/L	Ind/L	Ind/L	Ind/L	Ind/L	Ind/L
CLADOCERA												
Bosminopsis deitersi							0.13	1.69	0.94	0.19	0.13	0.13

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Moina macropa											0.06	0.57
***Moina* SP.**								0.13	0.31	0.31	0.57	3.84
Simocephalus vetulus											0.06	
Diaphanosoma dubium						0.06						
Total						**0.06**	**0.13**	**1.82**	**1.25**	**0.5**	**0.82**	**4.54**
COPEPODA												
Acanthocyclops americanus						0.19						
Acartia pacifica		0.38										
Acroclanus gibber	0.13	0.38	0.06									
Calanoid		17.29	1.13		0.13	4.4	2.45	245.2	2.33	0.94	1.32	1.13
Cyclopoid	2.08	16.85	15.22	0.5	0.76	10.44	1.13	9.05	0.57	0.38	4.59	3.27
Cyclops vicinus	0.88	2.26	0.79								0.25	
egg copepod		6.48	23.7			12.58		0.44	0.69			
Epaclophanes riehardi		0.06		0.69	0.76	2.52				0.13		
Eucyciops agiloides					1.07	6.29	0.25		0.19			
Herpacticod				0.13	0.5	1.26	0.5	4.4	1.13	0.5	2.201	0.38
Naupliius	20.94	25.65	25.53	2.33	4.97	26.72	6.09	9.49	9.93	7.61	8.68	29.30
Paracyclops chiltoni						0.69	0.94	0.06		0.06	1.08	
Total	**24.03**	**69.35**	**66.43**	**3.65**	**8.19**	**65.09**	**11.36**	**268.7**	**14.84**	**9.62**	**18.12**	**34.08**
ROTIFERA												
Anuraeopsis fissa					0.06				3.39	0.50	0.45	7.89
***Anuraeopsis* Sp.**											0.06	
Bedelloda					0.31	0.25	0.57		0.19	0.63	1.38	2.52
B. Spp					1.01		0.38	0.25	76.65	308.72	92.43	32.19
B. urceolaris						2.45	0.69		5.97	4.21	2.70	2.45
B. quadridentatus	0.06				0.31							
B. calyciflorus f. Dorcas									0.19			0.13
B. plicatilis				0.06	0.31	1.01						
B.rubens								1.51		0.06		

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B. leydigi								0.06	0.19	0.06		
B. angularis	0.94							0.76	0.19	6.04	6.67	0.13
C. megalocephala											0.06	0.31
Colurella adritia						0.38					0.06	0.19
Encentrum eurycephalum									0.06			
Euchlanis dilatata					0.06							0.06
***Euchlanis* Sp.**							0.19					
Euchlanis triquetra									0.06			
egg rotifer	13.46	11.76	7.42	0.19	0.69	3.83	0.13	11.00	11.82	6.09	14.15	4.84
Filina longiseta												0.44
Gastropus hyptopus							0.25					
Hexarthra mira					0.06		0.06					
K. crassa						0.5						
K. earlinae						0.06						
Keratella heimalis						0.06						
K.tecta				0.13	1.19	2.14	1.64	3.71	3.71	1.95	2.45	0.88
K.testudo						0.06						
K. tropica f. Asymmetricu				0.06					12.51			
k.valga						0.25						
K.cochlearis					0.94							
Keratella quadrata					0.88	4.72	6.04	27.92				
K.Spp					0.06	1.13						
Keratella tropica				0.44						3.84	8.99	7.86
N. foliacea						0.13	0.06					
N.acuminata					1.89							
Notholca squamula				0.13	3.14							
P. euryptera						0.19	7.86					
P.majar									0.13		0.06	0.44
P.remata							0.5					14.84

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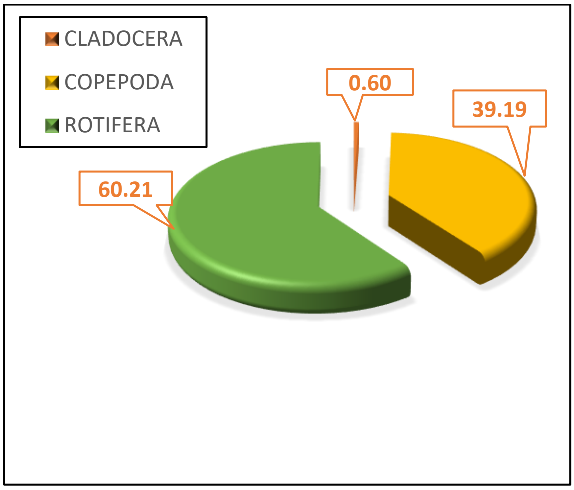
P.dolichoptera												0.13
Rotaria neptunia											0.19	0.06
Synchaeta lakowitziana			13.02	74.19	16.47	14.78	0.41		1.32	0.63		10.44
synchaeta baltica				0.06								
Sinouthriua Sp.											0.13	
Testudinella patina									1.57			0.44
Total	**14.46**	**11.76**	**20.44**	**75.26**	**27.38**	**31.94**	**18.78**	**45.21**	**117.95**	**332.73**	**129.78**	**86.24**



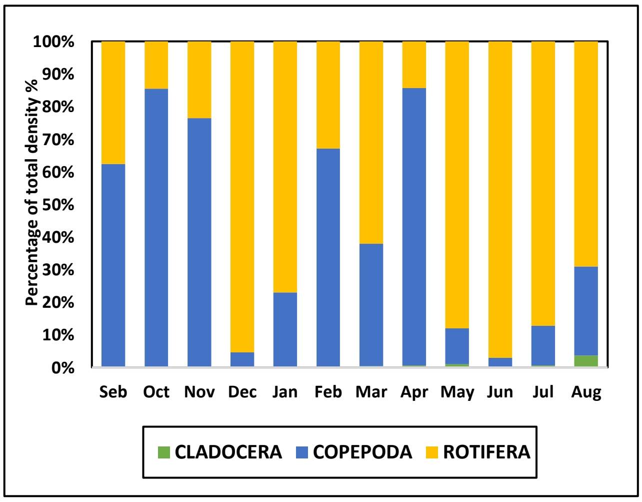


Figure 18. Monthly changes in The percentage of the total density of Zooplanktoin for station 2 near Sadr Educational Hospital from Sep 2018 to Aug 2019.

Figure 19. Percentage density of Zooplanktoin for station 2 near Sadr Educational Hospital from September 2018 to August 2019.

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Statistical analysis:

The results of the variance analysis showed a moral difference in many quarterly values of physical and chemical properties and the density of Zooplanktoin between the study stations, while no moral differences were recorded with regard to transparency, total suspended substances and chlorophyll-a, while there was a spatial difference that recorded a moral difference of some factors quarterly, including oxygen and no3 and NO2 nutrients at a moral level ($0.05 \leq P$). In addition, the arithmetic average and the quarterly standard deviation of the environmental factors.

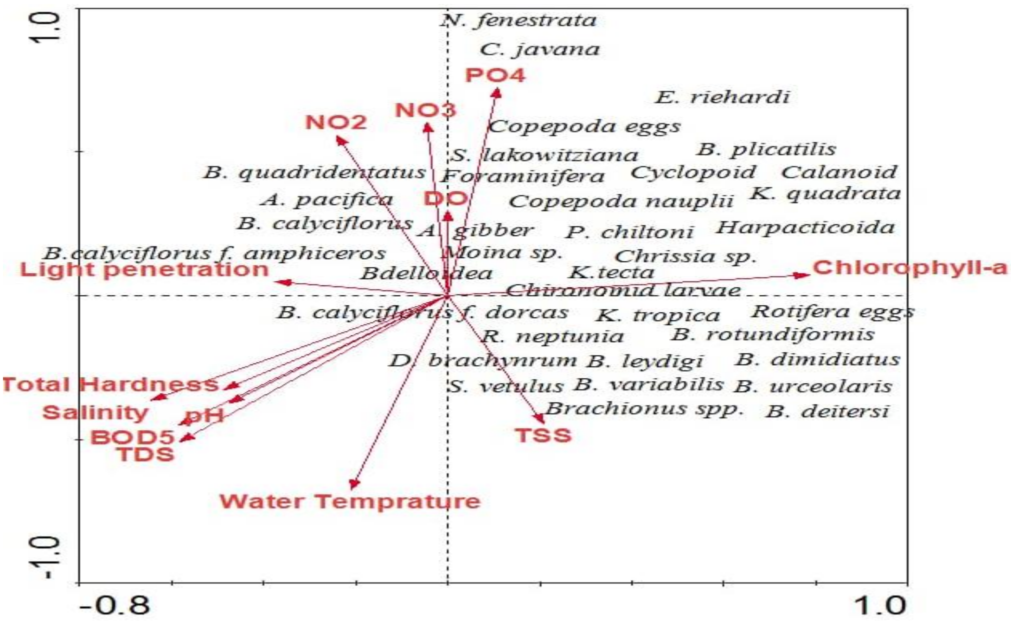

Figure 20. Canoco analysis of the relationship between zooplanktoin species and environmental factors at the two study stations

Discussion:

Physical and chemical properties of water:

The results of the study showed that the water temperature has a close impact on the climate of the region as it found monthly changes, due to the difference in climatic conditions in terms of the intensity of the sun's brightness and the length of the day (Shawi *et al*., 2007) as the highest values were recorded during the warm months and the lowest values During the cold months,

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the current study is consistent with several studies carried out including the study (Abbas *et al*., 2014; Abboud, 2018) High temperature leads to degradation of organic matter and increased activity of microbiology, showed values Water temperatures are clear monthly changes due to differences in the intensity of the sun's brightness, the length of daily lighting, the degree of serenity of the sky and the separation (Al-Allam and Abdel Moneim, 2011), Plant adhesions, algae and invertebrates thrive as water temperature rises (Jsem *et al*., 2008) water temperature recorded a ejection correlation with BOD5 (r=0.73) as high temperature leads to the degradation of organic matter by oxidation and increased microbiology activity (Stirling, 1985) the results of the study are consistent with (Hammadi,2002). PH values were among the base yields for most of the study period and this is a characteristic of Iraqi waters and is consistent with most previous studies due to the abundance of piccarbons and carbons (Rasan, 2001; Ati, 2004; Salman *et al*., 2008; Abboud, 2018) pH values give a reflection of the distribution of neighborhoods and their vulnerability to household and agricultural credits (Sanches *et al*., 2007), whose degradation increases the acidity of water and reduces the value of hydrogenic aces, also due to reduced river discharge, leading to an increased concentration of dissolved salts in Water (Morning, 2007; Hussein *et al*., 2013) on the Shatt al-Arab is attributable to the flourishing of plant-based aces accompanied by increased density of zooplankton and thus increased the effectiveness of photosynthesis leading to the consumption of carbon dioxide and the rise in the grade of hydrogenic aces (Sabri *et al*., 1989). In the current study, pH values were agreed with several previous studies , including (Ressen, 2001; Kanani, 2019) that recorded a correlation of pH with salinity (r=0.74).The abundance of dissolved oxygen in the aquatic environment is essential for living and fish and is one of the most important chemical factors in nature, recorded the highest values of dissolved oxygen during the cold months in the current study and decreased during the warm months, this is consistent with most previous local studies (Hammadi, 2002; Al-Mayahi 2005; Al-Shawi *et al*., 2007; Jafar, 2010) As a result of low temperatures and the increase in gas melting and the low level of degradation of organic waste (Moyle, 2010), the decline during the warm months was due to low melting and high consumption (Hussein *et al*., 2008) and household waste containing organic matter whose decomposition drains dissolved oxygen (Hussein *et al*., 2009). An inverse relationship of oxygen with temperature (r= -0.78) was recorded due to the lack of gas melting at high temperatures consistent with a study (Hammadi, 2002; Lami, 1998).The vital requirement of BOD5 oxygen is the amount of oxygen that microbiologists need to destroy organic matter, The bio-oxygen requirement values showed a relative decline in values during the cold months and a marked rise during the warm months of the current study, which was agreed with the study (Moyle, 2010; Al-Sabah, 2007), due to good ventilation and continuous mixing (Null *et al*., 2009) that increases the activity of microbiology that degrades organic matter (Liu *et al*.,

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2000), due to a decrease in water levels during the autumn and summer months, increased concentration of oxygen-consuming organic pollutants and thus increased the values of the bio-oxygen requirement. Al-Mostaumi *et al*. (2013) in their study on the Euphrates River in Nasiriyah believe that the high values of the bio-oxygen requirement are due to the effect of high temperatures on increased microbiological activity in the degradation of organic matter, leading to higher values of the bio-oxygen requirement (BOD5). According to WHO specifications, which indicated that the water source was poor if the bio-oxygen requirement rate was 5mg/L, the results of the current study of oxygen bio-requirement values were consistent with previous studies, including one (Ressen, 2001; Hammadi, 2002) and a jabbar study (2013) recorded higher oxygen bio-requirement values of 6.5 mg/L.The results of the current study showed a variation in the permeability of light as the permeability of light is an important factor in the growth and spread of aquatic plants, algae and adhesions and that the decrease in permeability values is due to several factors, including the weather condition, such as the degree of clearness of the sky, dust, the angle of sunlight, the intensity of lighting, the amount of suspended substances and the movement of water and hardness (Abdullah *et al*., 2001), while the high values of permeability of light may be due to lack of water movement, low disturbances and rising stability rates of suspended substances. With Hussein *et al*. (2006). The highest permeability values were recorded during the cold months as a result of reduced abundance of wanderers, increased winter discharge rates and low current speed during sampling, which increased the deposition of suspended substances, and decreased them during the warm months as a result of relatively high temperatures and long lighting (Glibert *et al*., 2005) which leads to increased activity of microbiology in the degradation of organic waste and increased activity of the photosynthesis process, and the current study agreed with the records of the meds recorded in the study of al-Akili (2010) recorded Transparency is an inverse association with the overall density of livestock (r= -0.68). Salinity plays an important role in determining the size of the biological society and spatial composition (Power *et al*.,2000) and in the quantitative and qualitative representation of aquatic organisms (Abowei, 2010) recorded the highest salinity values during the first months of the study period due to the lack of water levels in Iraq and the flow of water from the water of the water, which is consistent with the gesture of others The lack of water expenditure due to the construction of dams also contributes to the lifting of salinity concentrations, which in turn affects the composition of the community of neighborhoods such as the obstacle to migration for nutrition or reproduction (Partow, 2001), in addition to all of the above, due to the high salinity due to the diversion of the Karon River towards Iranian territory, which helped to advance salt water from the Arabian Gulf to the Shatt al-Arab (Abdullah *et al*., 2016) The decrease in salinity values is due to rainfall, high water levels in that period that reduces melted salt concentrations and low

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Al-Kunooze University College
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evaporation due to low temperatures (Mansouri and Mahmoud, 2009). The study of Al-Lami *et al*. (2002), Saadi *et al*. (2000) stated that the salinity of water in the Tigris and Euphrates rivers was increasing southward due to various uses of water as well as high groundwater levels in central Iraq. Al-Hajjami (2012) recorded a high salinity in the Shatt al-Arab at 10.2g/L. Total dissolved salt values showed a marked increase in the first months of the study due to the flow of water and the posed unpretanted sewage containing many dissolved substances and salts (Al-Saadi *et al*., 2010). The values of the total melted salts recorded exceeded the Iraqi determinants of the river maintenance system from pollution at all stations and this is consistent with the study (Abdullah, 2015; Jabbar, 2013).Total insolvent is the property of water that prevents the formation of soap foam and is the result of the presence of calcium ions, magnesium and iron ions associated with piccarbons, the total insolvent values exceeded the Iraqi determinants of the river maintenance system from pollution in the two study stations, which means that the water is of a very difficult nature according to lind classification (1979) and the values of the insolvent showed a remarkable rise due to its impact on salt water and to the up to salts as a result of water operations, and this is consistent with the sweet record Al-Obaidi (1997) in their study of the Shatt al-Arab River, where the rise in the values of difficulty was observed with high salinity in many studies (Abdullah *et al*., 2001; Salman, 2006; Gesture *et al*., 2010) indicated that if the values of the insolvent exceed 300 mg CaCo3/liter, the water is very difficult pathak *et al.* (2012). The results showed that the values of active nitrates increased during the cold months and decreased during the warm months of the study stations due to the decrease in river discharge in the summer and the increased concentration of pollutants entering the river directly or through sub-channels associated with the Shatt al-Arab, which receive large amounts of household, agricultural and industrial waste and sewage that are rich in nitrogen compound content and these compounds can be oxidized by microbiology and thus release large amounts of nitrate to Water (Emirate *et al*., 2001; Al-Sabah, 2007) is likely to contribute to the sea water entering the Shatt al-Arab (Jawad, 1994) and the rainfall that washes nitrogen fertilizers from agricultural land adjacent to the river Alkm and Zubeidi, (2012). The sharp decline in nitrate concentration may be due to increased consumption of plant adrimonitions, aquatic plants and algae (Moyle, 2010) and this is consistent with the current study.The relative rise in concentration may be due to low water temperature and good ventilation, resulting in an increase in the concentration of dissolved oxygen that works to oxidation of nitrite to nitrate at low temperature, as al-Assadi (2014). The results of the study showed the presence of nitrite with low concentrations in general due to being an unstable compound as its concentrations are very low added to the environment through household and organic waste and the presence of oxygen converted into nitrates (Samarina, 2008) resulting from the reduction of effective nitrates or the oxidation of ammonium compounds, and agrees

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with the study (Hajji, 2013; Al-Mayahi, 2005) on the Shatt al-Arab. The current study showed a variation in the concentration of effective phosphates, whose presence in the aquatic environment depends on several factors, including population density and the residues of cleaning powders, in addition to the type of agriculture, the nature of the soil and the composition of rocks of the bottom layer geologically, as well as the impact of organic pollution (Hussein, 2001) the results of the study showed a marked increase in the concentration of active phosphates in the cold months as a result of mixing processes resulting from rain that help free phosphates from sediments, which are a source of phosphate. Dissolved in water, as well as the introduction of household waste and sewage loaded with washing materials, and the high phosphate ratios may be due to rainfall being washed away from adjacent agricultural land and the fact that the country's largest oil has been used to produce a large number of waste products (Abdul Ghafoor *et al*., 2011).

General water quality index (GWQI)

The results of the current study showed clear temporal and spatial changes in the values of the General Water Quality Index for the two stations of the study, the first period was autumn (September, October and November) the most degraded periods in water quality, during which water was classified in the fifth category poor amounted to (42 WQI) for the first station and (40 WQI) for the second station, due to the decrease in the levels of water Tigris, Euphrates and Sebaceous water coming from the Karon River led to a rise in salinity values and the impact of salinity water Arabs in the Arabian Gulf, which resulted in a clear increase in the concentration of total melted salts, total insolventness and transparency from the permissible limits, The second period of winter (December, January and February) was the values of the guide in the fourth marginal category reached (52WQI) for the first station and in the fifth category recorded (33WQI) for the second station near Sadr Educational Hospital where there was a relative decrease in some variables such as water temperature, salinity and total difficulty and a clear increase in effective phosphate values from the permissible limits (Ibrahim, 2012), the third period of spring (March, April and May) was recorded in the fourth marginal category of the first station reached (51WQI) and the second station reached (53WQI) and this can be attributed to increased river discharge rates And the precipitation, which increased the water relief of the river, and the decline of salinity, which is evidenced by the decline of most of the values of variables such as transparency, salinity, total dissolved salts and active phosphates, and during the fourth study period of the summer (June, July and August) The general guide values began to rise and were classified as marginal for the first station (61WQI) and for the second station (58WQI) due to the relative improvement in the values of certain environmental variables such as dyslexia, nutrients, salinity and active phosphates, in line with studies

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indicating the high value of the water quality guide as a result of improved values of studied variables (AL-Saadi *et al*., 2010, Al-Sabbaghi *et al*., 2012) And so we summarize that the quality of the waters of the Shatt al-Arab becomes more degraded as we head south (Moyle, 2010).

Zooplanktoin

Zooplanktoin support fish populations economically, a way to transfer energy between plant and fish populations, as abundance and seasonal changes are useful in planning and managing fisheries successfully and numerical differences due to their impact on water quality (Kiran *et al.*, 2007), in general most crustaceans multiply and grow in the warm season of the year so the long day is very appropriate for them so the effect of lighting constitutes 50% of the factors affecting the growth of crustaceans and this information is important in the Find out how adapted, distribution rate, species spread, and understand vertical migration or growth for different seasons (Alekseev, 2004). The quarterly changes of Copepoda showed that the peak of this group's growth boom was in the fall and summer of the first station and the autumn and spring seasons of the second station that the prosperity of this group in the summer is consistent with what was found in the study of Lami *et al*. (2002b) Around the foot rower in the Dam Reservoir of Hamrin, an increase in foot rowing is observed in this study accompanied by a decrease in the branching of the cladosera, due to predation as the foot rowers feed on the branch of the small loams (Marazzo and Valentin, 2004) the density of zooplanktoin in any water surface depends heavily on productivity changes (Panarelli and Casanova, 2010) and the current study confirms the presence of these beasts in small numbers may reflect low productivity. The abundance of copepoda increases when salinity concentration increases in water (Madhupratap, 1979) and this is consistent with (Ajeel, 2012) The Acartia pacifica type showed a remarkable presence during the study period in the second station, and this may be due to its ability to withstand a wide range of temperatures and salinity (Madhupratap, 1979), consistent with the study Khalaf (1988), which indicated the presence of this species throughout the year in Khor Al Zubair. In the southern areas of Zubair Creek with relatively high salinity compared to the northern regions Ramaiah and Nair (1997) have found a clear spread of this sex on the coasts of India. Madhupratap (1979) noted that salinity is a key factor in controlling the abundance of animal wanderers and that copepoda are more abundant during the period of increased salinity(Madhupratap *et al*., 1975;1977). It was noted that the numbers of larval phases and the Noplii phase had clearly flourished for the study stations, explaining the high salinity of water, which played a major role in increasing the abundance of Nauplii and Copepod Stages, noting (Abdel-Aziz *et al*., 2007. Lan *et al*., 2009) noted that sovereignty is for wide-ranging saline and thermal species, which confirms the role of water salinity in

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controlling the distribution and spread of copepoda in the aquatic environment. The increase in the branching of the spirals is due to the large presence of aquatic plants, as confirmed by the Study maria Helene *et al*. (2000), which indicated a relationship between the presence of branched periods and the presence of aquatic plants, as noted in the current study 2000 The environmental nature of the first station near Sindbad Island, which is characterized by the presence of aquatic plants and the increase of agricultural land, recorded the highest diversity of the branch of the fourth time compared to the second station, which showed a decrease in the density of the branch of the spirals and this is due to its influence on temperature and food abundance And predation and pollution resulting from human and agricultural activities, which leads to a decrease in density, which is identical to the conclusions of Jizani, (2005) which stated that pollution reduces biodiversity, the type *Dapnia lumholtizi* recorded at low temperatures and this is consistent with the study (League, 2012; Tudorancea *et al*., 2009) Numbers of Cladocera, particularly Daphnia, were recorded during the first leg due to the apparent decline in water salinity after the first three months. The cupboards have been found in more diversity and numbers than crustacean beasts for a variety of reasons, including the availability of their food (bacteria, algae and diets) and the vegetative growth of any water flat and are not food for fish as the fish feed on the larger crustacean beasts (Spoljar *et al*., 2011) This is consistent with several local studies, including Ahmed *et al*. (2005) and Salman *et al*. (2008), where states have the highest reproduction rate compared to all multicellular organisms (Segers, 2002, 2004) its sovereignty may return to being small in size, making it less vulnerable to predation than large-sized neighborhoods that feed on large zooplanktoin branching out of spirals and foot paddles (Jafari *et al*., 2011). Dolabies are vital evidence of the state of saline, low-nutrition and basal water and are rarely subject to geographical inhibitions.

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