Environmental Study on the Impact of Water Pollution of the Tigris River in Baghdad on the Community of Crustaceans

Harith Qasim Mahdi

***Abstract*—**The study dealt with the biodiversity and spread of crustaceans in the river of Tigris running in the city Baghdad,. central Iraq. Was selected 5 station In the said river that is (Tajii, Kadmia, Kriaat, Juaefir and Wathba) and investigated 21 physical and chemical factors and was analyzed these factors that include the temperature of the water, turbidity, DO, BOD5, pH, EC, total hardness, Ca+2, Mg+2, chloride, NO2, NO3, PO4-3, Fe, F, SO4, AL, NH3, SIO2, Suspend solid and Total solid. Most of these factors recorded standard values nearest to the Iraqi international standard limits. On the other hand were recorded and identified 4 crustaceans including Cyclopoda, Calanoida, Cladocera, and Rotifers.

The study appears that the group of Rotifera has recorded the highest taxonomic richness from the others. The analysis appears that the temperature, EC, turbidity, DO and BOD5 were very important as master factors that limit the abundance and variety of the Crustaceans communities in the river of Tigris.

***Keywords*—** Crustaceans, Tigris River, Environmental study, Cladocera, Cyclopoda, Calanoida, Rotifera. Iraq.

I. Introduction

Water pollution is a global defy that has increased in countries, weakening economic growth, also, the somatic and environmental health for millions of people, also the poor wastewater administration has produced dangerous problems of water quality in many parts of the world, worsening the water crisis and decrease the measure of water that is safe to use (Javier et al., 2017). The Crustaceans community considered one of the essential biotic contained in the aquatic environment consists of a diversity of microscopic organisms organize in all water area as parasitic or free (Borges et al., 2010).

The distribution and growth of the Crustaceans society depend on some environmental factors e.g., salinity, temperature, and pollutants, also, some biotic factors e.g., food limitation, predation, and competition (Hossain *et al.,* 2015). Generally, the Planktonic Crustaceans community in freshwater consists mainly of the *Cladocera*, *Cyclopoda*, *Calanoida,* and *Rotifera*. The *Cladocera* is the main group that has a short life cycle under relevance conditions of temperature and food and they are considered an important food for fish (Ternje *et al.,* 2010). The *Copepods* are also forming one of the most important components of the Crustaceans community in the freshwater they are dependent on sexual reproduction and are divided according to their feeding into herbivorous and carnivorous (Gasca *et al.,* 2007). Overall, many types of research were focused on Crustaceans community of the water ecosystems in different parts of Iraq, such as (Mangalo and Akbar, 1988) who compared the *Cladocera* in the Tigris , Euphrates and Diyala rivers, (Rasheed *et al.*, 2000) who refers to increase in BOD5 is responsible for *Cladocera* absence in Diyala river at the summer season, also (Al-Lami *et al.*, 2005) mentioned that the lower Zab tributary did not contribute to rising the copepod biodiversity in Tigris river, so (Nashaat *et al.,* 2015) who refers that the negative effect of thermal effluent of Al-Rasheed Power station on spread the *Cladocera* in Tigris River (Al-Seria & Jaweir, 2015).

The current study was aimed to investigate the Crustaceans community in the Tigris River and its relationship to pollution in the river and study the impact of some physical and chemical factors on the abundance of these organisms.

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II. Materials and Methods

A. The area of study

The area of study located at river of Tigris within Baghdad in Iraq between latitudes 33-140-33-250 N and longitudes 44-310-4-170 E. the river of Tigris come to Baghdad from 5 km North of the Al-Muthana bridge and end at 3 km South from the embouchure of the Diyala river, the length of river about 58 km between these areas. The river separates Baghdad into the right side known AL-Karkh and left side known AL-Rusafa with the direction of flow water from north to south (AL-Adili, 1998). In the study were chosen five local stations from the Tigris in Baghdad to collect the samples (Fig.1 and Table 1).

B. Sampling procedures

The samples were collected from five locations monthly from January 2018 to May 2018.

The samples of water were collect by throwing the network of crustaceans into the river for a distance of 3 meters and emptying in the plastic containers with capacity 50 ml located at the end of the network and addition of formalin to examine the crustaceans to be studied: Cyclopoda, Calanoida, Cladocera, and Rotifers.

For physical and chemical analysis were used glass bottles with capacity 250 mL to take water samples from the river to save the samples, for measure the phosphate, 1 mL of H2SO4 was added to water sample and 1 ml of MnSO4 and KI were added to the water sample to measure the DO and BOD5, the BOD5 was kept at 25 °C for 5 days. The pH, water temperature and electrical conductivity tests were measured using the WTW device. The samples were kept in a cool box to store it at a low temperature until they are delivered to the laboratory and stored in the refrigerator at a temperature of 4 ˚C until laboratory tests are carried out.

C. Measuring of diversity indices

The Margalef-Diversity Index (D) was measured monthly as followed by Clifford and Stephenson (1975).

D= (s-1)/logN

Where is:

S= the species number.

N = the total individuals number.

D. The statistical analyses

Some analyses of statistical were completed by using the SPSS (version 9.1th edition) the one-way (ANOVA) was do it to account the variation of significant among parameters concentrations that studied, (the scale of significance was set at :P <0.05) (Sas, 2012).

III. Results and Discussion

A. The quantitative and qualitative study of crustaceans

In this study identified 4 zooplankton (*Cyclopoda*, *Calanoida*, *Cladocera* and *Rotifers*) present in table 1 appeared in 5 stations (Tajii, Kadmia, Kriaat, Juaefir and Wathba) of Tiger River respectively.

The *Cyclopoda* density is appeared in Fig. 1 and Table 2. The maximum of density reached to (22 ind/L) appeared at station 1 during April 2018, however the density minimum reached to (0 ind/L) was founded in station 2 during March 2018, station 3 during February and March 2018, station 4 during January, March and May 2018 finally in station 5 during March and April.

The density of *Calanoida* is appeared in Fig. 2 and Table 2. The maximum of density reached to (18 ind/L) at station 5 during February 2018, while the minimum (5 ind/L) at station 1 during January, March and May 2018.

The density of *Cladocera* is appeared in Fig. 3 and Table 2. The maximum (9 ind/L) at station 1 during February 2018, and station 5 during April 2018, while the minimum (3 ind/L) at station 3 during May 2018.

The density of *Rotifera* values is appeared in Fig. 4 and Table 2. The maximum (15 ind/m3) at station 3 during May 2018, while the minimum (9 ind/m3) at station 4 during April 2018. The study appeared that the group of *Rotifera* has recorded the highest taxonomic richness and this result agrees with the results was gained from the some Iraqi studies like as (Mangalo and Akbar; 1988; Al-Lami *etal.,* 1998; Rabee; 2007& 2010). Rotifera already is widespread in sweet water, lakes, mire, and small brook (Neves *etal.,* 2003), while Robertson and Hardy (1984) refer that the reason for the highest of *Rotifera* in the water due to the small size and short life cycle, also, Al-Lami (2001) and Al-Saadi (2006b) refer that the *Rotifera* group had the highest number of zooplankton community that recorded in most of the Iraqi water.

The density of *Cladocera* was appeared at some studies in Iraq like (Abbas and Al-Lami , 2001 and Al-Lami , 2001) and other international studies like as (Hoosier,2000 & Mageed,2008).

B. Physicochemical characteristics

The measurements of the Physicochemical parameters appear in Table 4.

The **temperature** of water amount different from the lowest (11˚C) at stations 1during January, 2018 to the highest (30 ˚C) at station 5 during Jun 2018, the change in the temperature of the water is due to the brightness of the solar radiation and the length of the day (Frondorf, 2001). The correlation coefficient among temperature and Ca and SO4 an inverse relation (Table 3). The range of **pH** was (7.6 to 8.1) has been noted at stations 5 during March and April, 2018 respectively, they generally tend to alkaline (Nashaat, 2010) also the present study showed the narrow values of pH in all five stations are referred to the highest organization of ability in solidity and alkaline water that rich in Bicarbonate (Goldman and Horne; 1983). The range of **electrical conductivity** is (800–1200) lS/cm. when the minimum conductivity value (800 lS/cm) at station 1 through Jun 2018 and maximum value (1200 lS/cm) at stations 1 through March 2018, this result agree with Ankcorn (2003) study that refer that the allochthonous organic materials in the source areas cause an increase in the value of electrical conductivity when the rain is heavy, while the minimum concentrations of electrical conductivity in the summer due to the rise in water levels in the previous months which has been mitigated and generally increase the values of electrical conductivity only towards the south areas depends on the nature of the components of the soil going through the river as well as human and agricultural activities Hussein (2009).

The **turbidity** is one of the physical factors that affect the light permeability, which in turn is one of the most important elements growth of aquatic life and most important in the regulation of biological processes and the distribution of species in the water body (Moheseni and Stefan, 1999), the sand, silt, fine organelles, dissolved organic compounds, microorganisms and microorganisms contribute to raising turbidity values (Ankcorn, 2003), the study refer to the minimum turbidity value as (12 NTU) at station 1, 2, 4 and 5 through January 2018 and the maximumt value (520 NTU) at station 4 through May 2018 and the correlation coefficient among turbidity and Ca, PH and SO4 have an inverse relation (Table 3). The results appeared that station (4) was greatly affected by the addition of the city of Baghdad to the river, including it consists of industrial units (AL-Dulaimi, 2001). Also, the maximum values of turbidity that were amount through the raining months maybe come from high concentricity of the solvent materials in the river which come from rains and soil drift (Welcomme, 1979).

Measuring the **dissolved oxygen** concentration is a good indicator of water quality, and changes in the concentration of dissolved oxygen can be an early inference of changing conditions in the water body (Davis and Cornwell, 1991). The maximum of the water column and the increase in the flow rate due to heavy rain increase confusion in the water column and thus lead to good ventilation of the water (Goldman and Horn, 1983). The lowest concentration of (DO) was (6.3 mg/l) at station 1 through May 2018, while the highest reached to (9.1 mg/l) at station 2 through January 2018, lowest concentration recorded in May 2018 was 6.3 mg /l at station 1 due to the located of this station in southern of Baghdad and exposed to the water from the city of Baghdad and the industrial units south of Baghdad, carrying organic substances that bear the microorganisms, which leads to the reduction concentration of dissolved oxygen in water. This is consistent with many studies (Al-Miyali, 2000 and Al-Tamimi, 2004 and Al-Saraf, 2006).

In general, oxygen consumption **BOD5** by microorganisms is appropriate for a large amount of organic matter available in the water. Oxygen consumption is also rapid if high quantities of dissolved organic compounds are available in water (Goel, 2008). Oxygen concentration is affected by several environmental factors such as temperature, photosynthesis, respiration, salinity and water current disturbances, as well as the daylight period (Green *et al.,* 2000), the lowest BOD5 was (2.3 mg/l) at stations 4 through April 2018, while the highest (8.1 mg/l) at station 1 through February 2018. The BOD5 values recorded in this study indicate that there is high organic pollution in the river where (USGS, 2000) stated that if the BOD value is less than 8 mg / L, the rivers are clean.

The **T. hardness (CaCO3)** also amount and appeared that the lowest (315 mg/l) at station 1 through Jun 2018, while the highest (440 mg/l) at station 4 through January 2018. also the lowest **calcium (Ca)** (60 mg/l) at station 1 through Jun 2018 and the highest (110 mg/l) at station 4 through January 2018 and the lowest **magnesium (Mg)** (26 mg/l) at stations 5 through February 2018 while the highest reached to (39.5 mg/l) at station 5 through May 2018.

The differences between the concentrations of T. hardness are normal, because the factors influencing the concentration of total T. hardness are numerous, including the location of sampling and time, the abundance of rain during the seasons and the speed of the current of the river (Al-Nimrawi 2005). For the positive ions, the calcite ion is more common in freshwater the natural water content of calcium ions depends on natural resources and erosion (Al-Tamimi, 2004 and Al-Saraf, 2006).

The minimum value of **chloride (Cl^-) (**60.5 mg/l) at stations 1 through Jun 2018 and the maximum reached to (120.3 mg/l) at station 1 also through March 2018.

The present study also fixed the minimum values of **nitrate (NO3)** and **nitrite (NO2)** reached to 0.1 mg/l and 0.01 mg/l at stations 2 and 5 through January and May 2018 and the maximum value reached to 1.7 mg/l and 0.15 at station 4 and 2 through February and May 2018 respectively.

Also in the current study was recorded the value of **Orthophosphate (PO_4^{-3})** were the minimum value of 0.021 mg/l at station 2 through March 2018 and the maximum value 0.142 mg/l at station 4 through May 2018, the results of the study also referred to the maximun values of Orthophosphate (PO4-3) were observed during summer, whilst the minimum values observed during spring this result may because the highest of PO4-3 were being wasted by the crustaceans that bloom in the spring and leads to the reducing of PO4-3 concentricity (Pankow, 1991; Nassar *et al.,* 2014). The present study recorded the **Iron (Fe)** and show the minimum value of 0.5 mg/l at S. 2 through January 2018 and the maximum value 4.52 at S. 5 through Jun 2018, also recorded the values of Florid (F) the minimum value reached to 0.1 mg/l at S. 1 through Jun 2018 and the maximum value 0.3 mg/l at S. 3 through February 2018, also the correlation coefficient between Fe and SiO2, $PO4^{-3}$, Ca and SO4 was inverse relation and significant at 0.05 with Ca and Mg .

The values of **Sulfate (SO_4)** likewise fixed in the area of study and showed that the minimum value 140 mg/l at S1 during Jun 2018 and the maximum value 300 mg/l at S. 5 during January 2018. The values of **Aluminum (Al)** fixed to the minimum value 0 at S. 1 and 3 from January to Jun 2018 and the maximum value 0.016 mg/l at S. 4 during April 2018 and the correlation coefficient between it and NO2, SiO2, $PO4^{-3}$ and CaCO3 was inverse relation and significant at 0.05 with NH3 and SiO2 (Table 3). So the minimum value of **Ammonia (NH_3)** 0.02 mg/l at S 4 during January, February and Jun 2018 and the maximum value 0.138 mg/l at S. 5 during May 2018. As well the minimum value of **Silica (SIO_2)** reached to 2 mg/l at S. 5 during Jun and the maximum value 8.8 mg/l at S. 1 during February 2018 and the correlation coefficient among SiO2 and temperature, turbidity, CaCO3, T-Hardness, Ca, CL^-, Mg, PH and conductivity have an inverse relation and the relationship between it and turbidity and CL^- was significant at 0.05 (Table 3). The current study also recorded the **Suspend solid** and **Total solid** and showed that the minimum values reached to 10 and 510 mg/l at S. 3 during January, February and Jun 2018 and the maximum values 820 and 890 mg/l at S. 5 and 4 during March and January 2018 respectively. The correlation coefficient between total solid and SiO2 and Ca was inverse relation and was recorded significant at 0.05 with NO3, SiO2, temperature and conductivity. Also the Suspend solid recorded inverse relation with Ca and SO4 and significant at 0.05 with F, CL^- and turbidity (Table 3).

As for the correlation coefficient among studied water parameters all factors have an inverse relation to the speed of water flow except SiO2, Ca and CL^- and the relationship between the speed of water and total solid and CaCO3 was significant at 0.05 (Table 3).

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TABLE I: THE LATITUDES AND LONGITUDES OF THE STATIONS OF THE RIVER OF TIGRIS.

Stations	Longitudes	Latitudes
Station 1 (Tajii)	44.263423	33.533428
Station 2 (Kadmia)	44.344780	33.381676
Station 3 (Kriaat)	44.3473041	33.4048913
Station 4 (Juaefir)	44.373541	33.341289
Station 5 (Wathba)	44.400733	33.336624

TABLE II: THE DENSITIES OF CRUSTACEANS (IND./L) IN THE STUDY AREA.

Taxa	S.1	S.2	S.3	S.4	S.5	Sum.
Cyclopoda	97	3	11	3	4	118
Calanoida	30	66	66	60	36	259
Cladocera	34	25	27	36	36	158
Rotifers	57	63	56	62	58	296

TABLE III: THE CORRELATION COEFFICIENT AMONGST THE PARAMETERS THAT WAS ACCOUNT IN THE WATER.

	Do(dissolved oxygen)	BoD5	speed	total solid	suspend solid	iron as Fe	fluoride as F	aluminum as Al	nitrite as NO_2	nitrate as NO_3	ammonia as NH_3	silica as SiO_2	orthophosphate as PO_4^{-3}	temperature	turbidity	Alkalinity $CaCO_3$	T. Hardness as $CaCO_3$	Calcium as Ca	Chloride as Cl^-	Magnesium as Mg	pH	Conductivity	Sulfate as SO_4
Do(dissolved oxygen)	1																						
BoD5	0.967 **	1																					
speed	0.238 NS	0.069NS	1																				
total solid	0.260 NS	0.233NS	-0.500*	1																			
suspend solid	0.215 NS	0.159NS	-0.388NS	0.941**	1																		
iron as Fe	0.147NS	0.098NS	-0.166NS	0.544**	0.716**	1																	
fluoride as F	0.383 NS	0.484*	-0.346NS	0.389NS	0.439*	0.710**	1																
aluminum as Al	0.035NS	0.000NS	-0.127NS	0.367NS	0.546**	0.957**	0.670**	1															
nitrite as NO_2	0.228NS	0.229NS	-0.216NS	0.404NS	0.543**	0.931**	0.784**	-0.961**	1														
nitrate as NO_3	0.399NS	0.434*	-0.323NS	0.479*	0.600**	0.855**	0.842**	0.796**	-0.887**	1													
ammonia as NH_3	0.690 **	0.728**	-0.327NS	0.620**	0.648**	0.627**	0.794**	0.470*	0.628**	0.850**	1												
silica as SiO_2	-0.22NS	-0.210NS	0.029NS	-0.487*	-0.615**	-0.552**	-0.488*	-0.479*	-0.453*	-0.528**	-0.481*	1											
orthophosphate as PO_4^{-3}	0.241NS	0.247NS	-0.136NS	0.203NS	0.149NS	-0.009NS	0.228NS	-0.095NS	-0.030NS	-0.033NS	0.284NS	0.256NS	1										
temperature	0.433 *	0.379NS	-0.025NS	0.476*	0.648**	0.941**	0.736**	0.885**	0.921**	0.905**	0.751**	-0.570**	-0.028NS	1									
turbidity	0.315 NS	0.279NS	-0.004NS	0.346NS	0.513*	0.932**	0.768**	0.952**	0.969**	0.859**	0.623**	-0.502*	0.002NS	0.948**	1								
Alkalinity $CaCO_3$	0.057 NS	0.035NS	-0.476*	0.906**	0.958**	0.731**	0.492*	0.586**	0.567**	0.616**	0.570**	-0.626**	0.048NS	0.610**	0.516**	1							
T . Hardness as $CaCO_3$	0.883 **	0.896**	-0.075NS	0.408NS	0.329NS	0.136NS	0.344NS	0.020NS	0.236NS	0.404NS	0.714**	-0.171NS	0.175NS	0.390NS	0.229NS	0.154NS	1						
Calcium as Ca	0.440 *	0.321NS	0.805**	-0.240NS	-0.227NS	-0.345*	-0.317NS	-0.410NS	-0.429*	-0.326NS	-0.142NS	-0.193NS	-0.152NS	-0.156NS	-0.232NS	-0.301NS	0.140NS	1					
Chloride as Cl^-	0.684 **	0.651**	0.163NS	0.295NS	0.434*	0.733**	0.763**	0.647**	0.741**	0.828**	0.804**	-0.501*	0.049NS	0.896**	0.822**	0.377NS	0.554**	0.125NS	1				
Magnesium as Mg	0.100 NS	0.161 NS	-0.561**	0.516**	0.553**	0.442*	0.460*	0.308NS	0.358NS	0.493*	0.637**	-0.224NS	0.306NS	0.406NS	0.276NS	0.453*	0.384NS	-0.542**	0.314NS	1			
pH	-0.019 NS	0.040NS	-0.401NS	0.23NS	0.247NS	0.111NS	0.097NS	0.048NS	0.092NS	0.178NS	0.259NS	-0.010NS	0.002NS	0.109NS	-0.006NS	0.177NS	0.305NS	-0.393NS	0.050NS	0.642**	1		
Conductivity	-0.120 NS	-0.045NS	-0.629**	0.485 *	0.591**	0.677**	0.587**	0.606**	0.613**	0.727**	0.572**	-0.348NS	-0.017NS	0.567**	0.512*	0.644**	0.076NS	-0.649**	0.376NS	0.728**	0.534**	1	
Sulfate as SO_4	-0.201 NS	-0.116NS	-0.352NS	0.004NS	-0.078NS	-0.154NS	-0.011NS	-0.143NS	-0.112NS	-0.096NS	-0.066NS	0.193NS	0.059NS	-0.215NS	-0.204NS	-0.040NS	-0.052NS	-0.312NS	-0.243NS	0.158NS	0.640**	0.193NS	1

TABLE IV: THE ACCOUNT OF MEAN AND STANDARD DEVIATION OF PHYSICOCHEMICAL PARAMETERS IN THE STATIONS.

Parameters \ stations	S1	S2	S3	S4	S5
Do(dissolved oxygen)	8.07±0.30	7.23±0.33	7.28±0.23	8.47±0.26	6.87±0.28
BoD5	5.00±0.32	3.34±0.29	4.84±0.21	5.05±0.28	5.93±0.45
speed	1±0.00	1±0.00	1±0.00	1±0.00	1±0.00
total solid	669.08±22.46	797.00±21.94	645.5±32.78	699.08±37.59	699.25±37.69
suspend solid	296.08±124.06	245.33±66.39	177.5±79.33	379.08±97.07	406.58±110.24
iron as Fe	1.96±0.59	1.05±0.049	1.77±0.41	1.38±0.43	1.46±0.41
fluoride as F	0.15±0.02	0.17±0.01	0.18±0.028	0.15±0.02	0.15±0.02
aluminum as Al	0.01±0.00	0.015±0.00	NO	0.01±0.00	0.01±0.00
nitrite as NO_2	0.01±0.00	0.01±0.00	0.01±0.00	0.03±0.02	0.10±0.00
nitrate as NO_3	1.20±0.02	1.16±0.13	1.05±0.12	0.69±0.12	0.82±0.03
ammonia as NH_3	0.11±0.01	0.03±0.05	0.04±0.00	0.09±0.01	0.09±0.0075
silica as SiO_2	3.23±0.25	6.71±0.20	4.44±0.20	7.76±0.24	7.76±0.24
orthophosphate as PO_4^{-3}	0.05±0.00	0.09±0.01	0.03±0.00	0.03±1.55	0.00±0.00
temperature	21.42±2.53	18.25±2.17	22.51±1.98	21.67±2.16	21.67±2.16
turbidity	243.75±82.22	297.00±90.13	161.00±52.57	327.00±115.19	264.17±80.85
Alkalinity $CaCO_3$	152.72±4.37	170.00±2.97	153.92±2.18	158.92±2.31	158.92±2.30
T . Hardness as $CaCO_3$	354.00±14.78	371.92±14.15	348.42±16.94	299.92±28.25	318.75±10.39
Calcium as Ca	87.17±5.18	89.75±6.39	86.75±4.256	80.08±6.82	73.58±3.31
Chloride as Cl^-	83.67±3.62	92.75±6.07	87.00±3.87	102.50±13.54	95.08±7.68
Magnesium as Mg	33.67±1.82	34.92±1.08	31.42±1.30	33.50±1.18	33.50±1.18
pH	7.96±0.07	8.08±0.02	7.87±0.02	7.90±0.03	7.89±0.03
Conductivity	969.67±40.02	975.83±38.19	971.92±38.85	823.77±171.75	1012.58±54.94
Sulfate as SO_4	222.17±19.24	214.58±8.53	196.33±14.77	191.17±12.38	191.17±12.39

Fig. 1: Maps of 5 stations in the Tigris River of Baghdad city

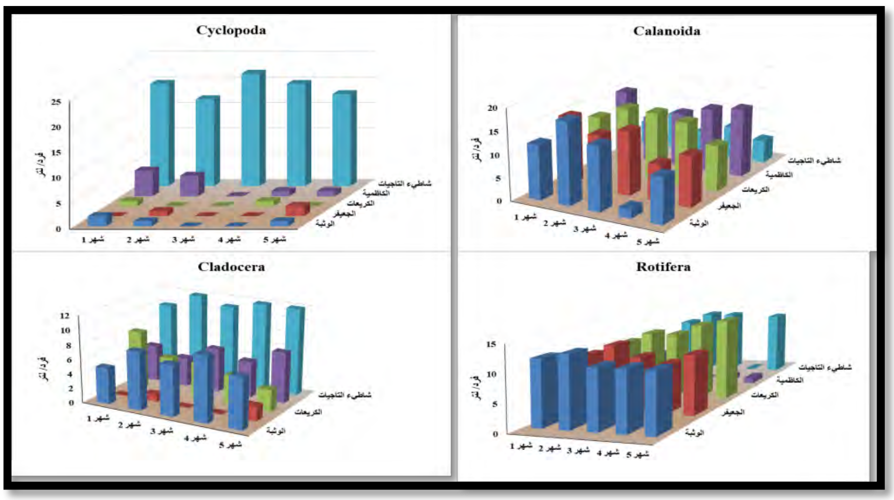

Fig. 2: Total of *Cyclopoda*, *Calanoida*, *Cladocera* and *Rotifera* (ind./L) in the study

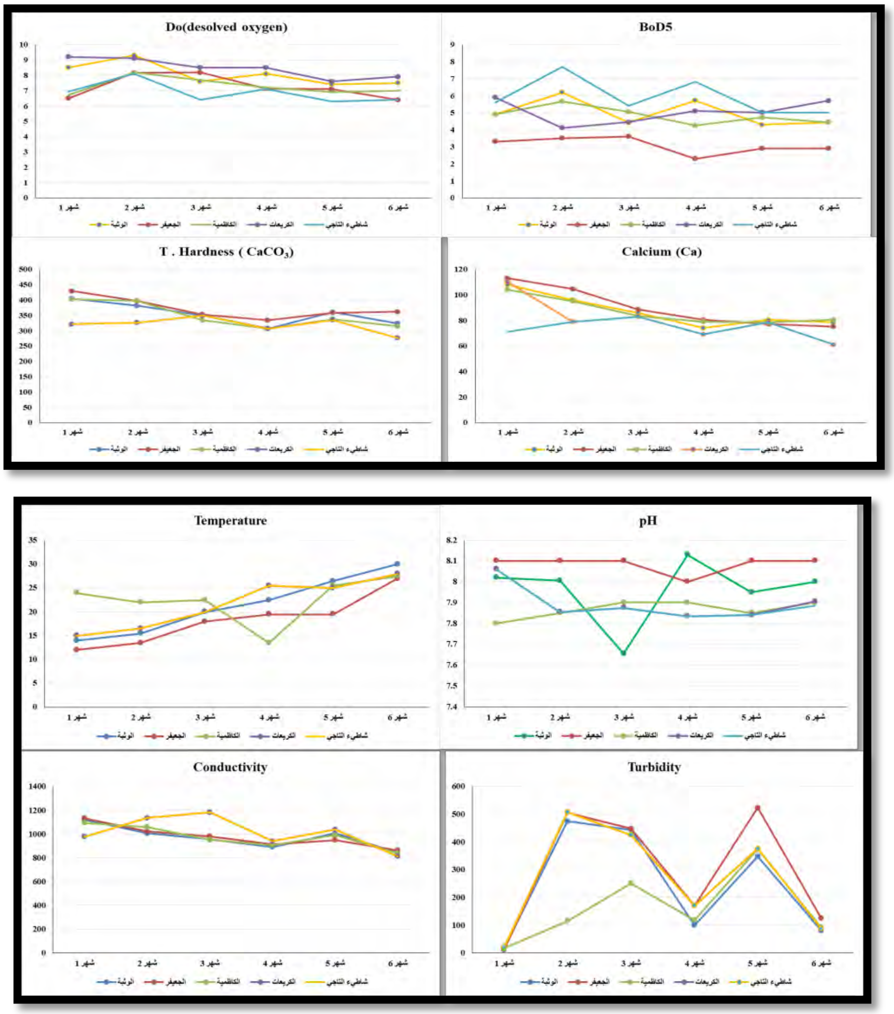

Fig. 3: Variation of the Physicochemical characteristics in the study

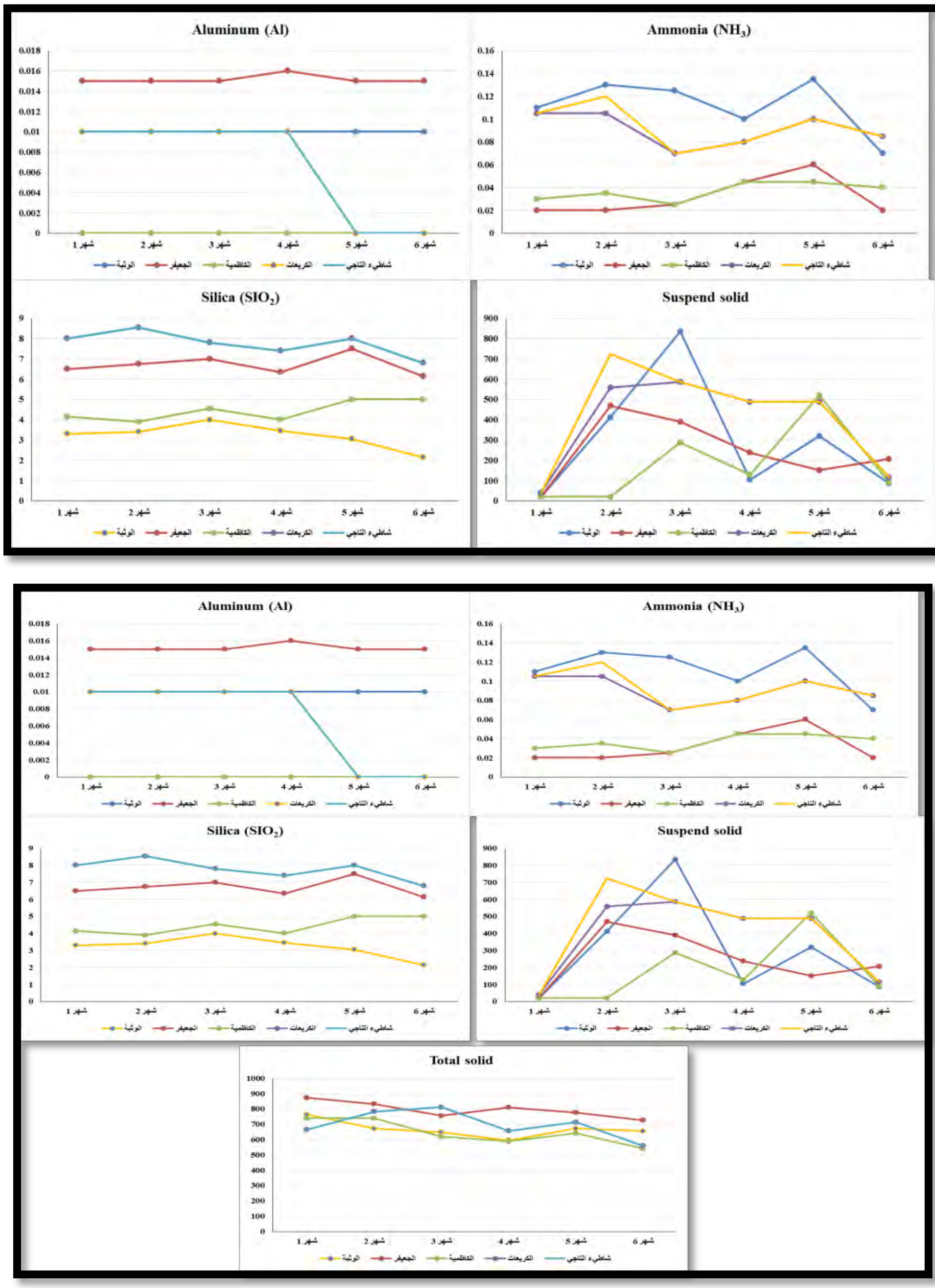

Fig. 4: Difference of the Physicochemical characteristics in the study