IMPACT OF WASIT POWER PLANT EFFLUENTS ON BIODIVERSITY OF BENTHIC FAUNA IN TIGRIS RIVER, PROVINCE WASIT/ IRAQ

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ABSTRACT

The aim of environmental study is to investigate the effects of the discharge of Wasit power plant in Al-Zubaidiya city on the physical- chemical factors and biodiversity of benthic invertebrates community of Tigris River, for a period from October 2017 to Augusts 2018. The total number of benthic invertebrates in four stations was 12866 individual. These benthic invertebrates belonged to 8 taxonomic units. This study includes some statistical environmental indexes (Relative abundance index, Shannon-Weiner Diversity Index, Species Uniformity Index, Species Richness Index and Jaccard Index). The results reveal that the environmental indexes were decreased at station 2 and thermal Wasit power plant negatively effects benthic invertebrate community at station 2 near the effluent waste pipe site.

Keywords: benthic invertebrates, Al-Zubaidiya city, statistical indexes, thermal power plant.

تأثير متدفقات محطة واسط في تنوع أحياء قاع نهر دجلة، محافظة واسط/ العراق.

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المستخلص

تهدف هذه الدراسة البيئية لمعرفة تأثير تصريف محطة كهرباء واسط الحرارية في مدينة الزبيدية على العوامل الفيزيائية – الكيميائية للمياه وعلى تنوع مجتمع اللافقاريات القاعية في نهر دجلة ، للفترة من تشرين الاول 2017 إلى أب 2018. وقد تراوح العدد الكلي للافقريات القاعية حوالي 12866 فردا في المحطات الأربعة والتي تنتمي إلى 8 وحدات تصنيفية. تضمنت الدراسة بعض الادلة البيئية الإحصائية (مؤشر الوفرة النسبية، ومؤشر شانون وينر للتنوع، دليل تجانس ظهور الانواع، ومؤشر ثراء الأنواع، ومؤشر جاكارد للتشابه). اظهرت النتائج انخفاض في المؤشرات البيئية في المحطة الثانية, وكما اظهرت عن وجود تأثير سلبي لمحطة كهرباء واسط على مجتمع اللافقريات القاعية في المحطة الثانية القريبة من موقع انبوب تصريف النفايات السائلة.

الكلمات المفتاحية: لافقريات القاع, مدينة الزبيدية, الادلة الاحصائية, محطة الكهرباء الحرارية.

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INTRODUCTION

The aquatic environment resources are under pressure due to population growth and increased demand for water for agriculture and industry (12). Iraq's need for its natural water resources has increased, the most important of which is the Tigris River, which is the main source but suffers from pollution(22). In order to understand the quality of Wetlands properly it is imperative to undertake proper studies of life organisms, and benthic invertebrates are the most important groups, these organism can provide evidence of the quality of the water environment, alluded by (2,16) that these Benthic Invertebrates living on either the river bottom or within the muddy or attaches itself to the solid surfaces. Any environmental disturbance will have a negative impact on the aquatic organism system(5). The invertebrate groups were used to field study of biomonitoring in aquatic environment (11,26). In 2008 a study revealed that these river-bed organisms have special features which makes them suitable to environmental and pollution studies such as varying degrees of tolerance to different environmental elements, another feature revealed that these organisms moves very little and very slow within their local confines, has a long life span and is very useful in the food chain (15). The composition of these Benthic Invertebrates is effected by the physical and chemical features of the particular Wetland or Lake such as the nature of the river bed, depth, the degree of heat, the quantity of Hydrogen and Oxygen absorbed as well as the level of pollution(50). One of the major impacts that affect rivers is the pollution of their waters by both domestic and industrial waste (10), which endangers the life of not only plants and animal but also human health (27). It is necessary during the present time, to observe the quality of the Tigris river to ascertain that it is suitable for human consumption. Wasit power plant were designed up on the principle of generating steam as an operating power consist of three units at the western side of the Tigris River at the Al-Zubaidiya city (80 km north of Kut). The study was aimed to measure the effects resulting from the station discharge on the organism by apply the diversity indices in water quality assessment and studying the benthic invertebrates communities of the River Tigris before and after the discharge of the Wasit power plant.

MATERIALS AND METHODS

The Tigris River within the Wasit Province was selected for find out the effect of Wasit power plant in the community of benthic invertebrates, For this study, four station were selected along the river in this region, the first station (S1): about 20km before the power plant, The second station (S2): about 100m near the power plant, the third station (S3): about 15km located after the power plant, the fourth station(S4): About 25 km after the power plant Figure 1.

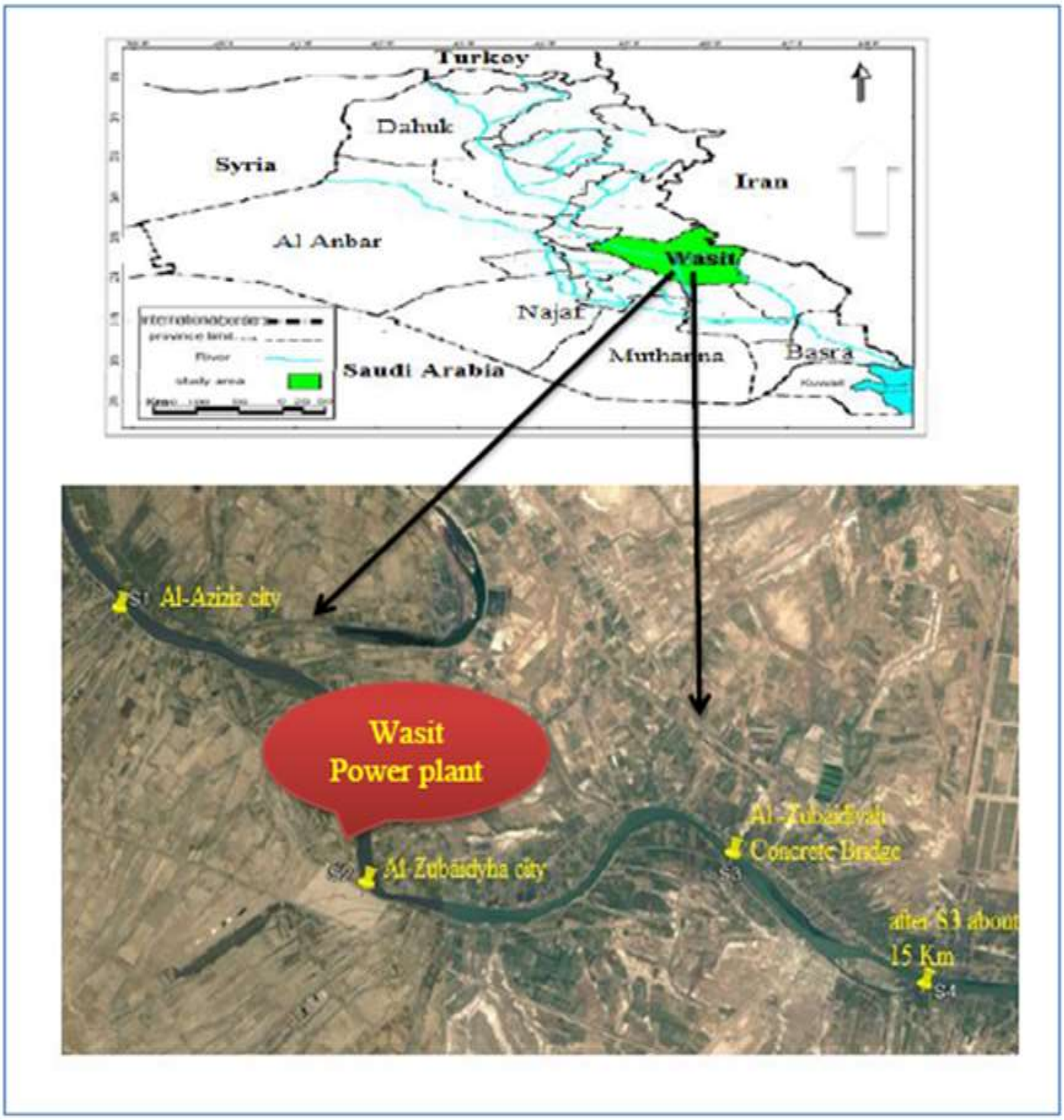


Figure 1. Map of the study stations (Used Arc-GIS Map program).

Table 1. Geographical position system (GPS) of the selected stations

Stations	Longitude (eastwards)	Latitudes (northward)
1	35°98'18.28	54°90'50.22
2	35°96'31.26"	55°05'15.81"
3	35°95'42.41"	55°09'36.30"
4	36°1336.22"	58^0 5320.34

Samples were collected monthly from October 2017 to Augustus 2018, at each sampling stations. Samples were taken at 1-2 meter from the river bank with depth 0.5 meter. The samples of invertebrate were put into separate polyethylene containers with formalin as preservative and brought to the laboratory for further studies. Preserved samples of benthic invertebrates were preliminarily identified according (35). Parameters selected and procedures followed for analysis have been briefly described in Table 1. less significant difference (LSD) were used to determine the differences between environmental factors means at significance of (P≤0.05). All statistics were carried out using Statistical Analysis System (SAS) software (38). And Ecological Indices: Relative abundance was calculated according to Odum (33), And the value of Shannon, Uniformity and Richness indices were calculated as follows (18, 32, 6). The following references were used to identify the benthic invertebrate (13, 17, 21, 24, 25, 29, 43, 45, 50).

Table 2. Measurement methods of selected parameters.

Parameters	Method
Water temperature(T) ^{o} C	Direct reading by using Thermometer
Electrical conductivity (EC) µs/cm	Direct reading by using Martini device (Model/ EC60)
pH	Direct reading by using pH-meter
Dissolved oxygen (DO) mg/l	The dissolved Oxygen values was determined using The Azide modification of Winkler method (3)
Turbidity NTU	determined in laboratory by using Martini device turbidity meter model – 6035
Total dissolved solids (TDS) mg/l	Direct reading by using Martini device (Model/ EC60)
Organic matter%	measured according to (1)

RESULTS AND DISCUSSION

This study indicate that the temperature of the water affected by the existence of the Wasit power plant on the bank of the Tigris River values ranged 15-38.8^{0}C, that have great effects on aquatic ecosystem and the appearance, distribution and abundance of aquatic organisms are either direct or indirect (23),and the pH of water ranged 8.9-6.5, dissolved oxygen concentration and BOD5 values were ranged 3.5-10.5 mg/l and 0.5-4.2 mg/l respectively. The presence of the power plant contributed to the increase of the Conductivity and Total dissolved solids values were ranged 656-1790 µs/cm and 588-1145 mg/l respectively. The water of the River Tigris classified as hard to very hard according to the total hardness values ranged 180-580 mg /l. So increasing in turbidity values 15- 104 NTU, which had great effects on light reflection inside water column depending on increasing of organic matter that may be affected by the discharged water from wasit power plants and their effects on decrease the values of dissolved oxygen that Reached to 3.5 in station 2, This is agreed with (31). (Table 3).

Table 3. Ranges of physical and chemical values in studied stations of Tigris river in Wasit Province during October 2017 to May 2018

	Station				LSD
Parameters	S1	S2	S3	S4	
W.T ^{o}C.	15-33 22.3 ± 1.91 b	19.2-38.8 26.18 ± 2.59 a	15.5-34 22.29 ± 2.31 b	15.8-33 22.32 ± 1.98 b	3.074 *
pH	6.9-7.6 7.28± 0.06	6.6-8.9 7.76± 0.15	6.5-7.7 7.37± 0.09	7.4-8 7.62± 0.06	NS
DO (mg/L)	5-10.5 8.75±0.85 a	4.5-9 7.42± 0.59 b	3.5-8.9 6.54±0.59 b	6-10.5 7.76± 0.75 ab	2.03*
BOD (mg/L)	0.7-2.5 1.67±0.51 a	1.5-4.2 2.43±0.49 b	1.5-3 2.20±0.34 b	1- 3 1.97±0.25 ab	0.597 *
EC µs /cm	660-1125 846.9±43.1 b	919-1790 1220±66.8 a	656-1300 965.8±51.1 b	667-1130 932.1±44.9 b	209.63 *
T.D.S (mg/l)	720-422 577.9±47.17 b	1145-588 774.51±62.94 a	768-419.8 616.78±83.46 b	726-426.8 602.18±74.74 b	127.83 *
Tur. NTU	7.60-33.29 17.84± 2.82 b	15-104 46.01± 10.6 a	14.4-67.5 37.63± 6.34 a	10-64 36.02± 5.87 a	13.701 *
O.M%	0.30-0.79 0.487±0.175 b	1.38-4.52 1.25±0.934 a	0.57-3.32 1.272±0.803 a	0.42-2.90 1.183±0.714 ab	0.718 *

* (P<0.05), NS: Non-Significant.

W.T= Water temperature, Tur.= Turbidity, EC= Electrical conductivity, O.M= Organic matter, TDS= Total Dissolved Soiled, DO= Dissolved oxygen, BOD_5= biological oxygen demend

Table 4. shows the total number of benthic invertebrate sorted during the study period. Total benthic faunal individuals were 12866 distributed over 54 taxonomic units. The Mollusca was the dominate group representing 49% of the total number of benthic invertebrates. the negative effect of discharge of waste of the power plant on the preparation of the benthic invertebrates were found in the nearby station, so that the lowest total number of benthic invertebrates sorted from (S2)due to increased turbidity and waste oil, This is agreed with (39), and the highest total number of benthic invertebrates sorted from (S1), due to appropriateness of environmental conditions from physical and chemical factors in the study station S1 that assist in the growth and diversity. The mollusca group showed a great diversity of species in the collected samples at stations S1,S3, and S4 due to the effect of characters of environmental factors on the density and quality of Mollusca group. Particularly, dissolved oxygen and BOD5 affects the distribution and spread of snails (26). The high number of benthic invertebrates in station 2 is due to the presence of aquatic worms, such as *Limnodrilus hoffmeisteri*, which are capable of tolerating dissolved oxygen depletion. This is common in aquatic environments with low oxygen, It is also one of the most tolerant species for salinity. *Branchiura sowerbyi* is usually associated with thermal pollution, As it was observed in high densities in the water that receives hot water, especially near the power plants (31).

Table 4. Numbers of identified benthic invertebrates from different study stations during the period study

Taxa	Station				Total number of individuals
	1	2	3	4	
Hydrozoa	80	0	7	24	111
Tradigrada	2	0	0	0	2
Turbellaria	158	26	104	98	386
Nematoda	58	23	23	34	138
Annelida	1002	572	594	855	3023
Crustacea	524	80	181	363	1148
Insecta	718	324	394	411	1847
Mollusca	2444	507	1350	1910	6211
Total	4986	1532	2653	3695	12866

Relative abundance index result revealed that Chrironomus sp. is considered dominant in (S2) , This may be due to the fact that these larvae are characterized by their ability to tolerate organic pollution because they benefit from organic food, where breeding rates increase by increasing organic matter and resistance to inappropriate environmental conditions(31), and also the genus *stenostomium* sp. is considered dominant in (S2), while other taxonomy units varied from more and less abundant to rare abundant. Schmoldt (40) revealed that the dominance of some species over the rest of the species indicated the existence of environmental stress in study station. Table 5.

Table 5. Benthic invertebrates of Tigris river , its Relative Availability (Ra Index), and the Constancy Index (S Index)

	Ra%				S%			
Taxa.	S1	S2	S3	S4	S1	S2	S3	S4
Hydra sp.(Linnaeus,1758)	R	-	R	R	AC	-	A	A
Tradigrada	R	-	-	-	A	-	-	-
Nematoda								
Seniura sp (Fusch,1848).	A	La	A	A	C	AC	C	C
Dorylaimus sp. (Dujardin, 1845)	La	A	A	La	C	C	C	AC
Trilobus longus (Leidy,1851)	La	-	-	La	AC	-	-	A

Taxa.	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**
Other Nematoda	**R**	**La**	**R**	**R**	**C**	**C**	**C**	**C**
Turbellaria								
***Macrostomium* sp.(Schmiddt,1848)**	**A**	**-**	**La**	**A**	**C**	**-**	**C**	**AC**
***Microstomium* sp. (Schmiddt,1848)**	**La**	**-**	**R**	**La**	**A**	**-**	**A**	**A**
***stenostomium* sp. (Luther,1960)**	**A**	**D**	**La**	**A**	**AC**	**C**	**C**	**AC**
***Stenostomium bryophilum* (Luther,1960)**	**La**	**-**	**-**	**-**	**A**	**-**	**-**	**-**
***stenostomium unicolor* (Schmiddt,1848)**	**-**	**-**	**La**	**-**	**-**	**-**	**A**	**-**
Annelida								
***stylaria lacustris* (Linnaeus,1767)**	**La**	**R**	**La**	**La**	**C**	**C**	**C**	**C**
***Pristina longiseta* (Ehrenberg, 1828)**	**R**	**-**	**-**	**-**	**C**	**-**	**-**	**-**
***Ophidonais serpentine* (Muller,1773)**	**La**	**R**	**La**	**R**	**C**	**C**	**C**	**C**
***chaetogaster langi (*Von Baer, 1827)**	**La**	**R**	**R**	**R**	**C**	**AC**	**C**	**C**
***Dero digitata (*Mueller, 1773)**	**R**	**-**	**-**	**-**	**A**	**-**	**-**	**-**
***Nais* sp.**	**R**	**R**	**-**	**R**	**C**	**AC**	**-**	**A**
***Branchiura sowerbyi* (Beddard,1892)**	**R**	**La**	**R**	**R**	**C**	**C**	**C**	**C**
***limnodrilus hoffmeisteri* (Claparede,1862)**	**R**	**La**	**La**	**R**	**C**	**C**	**C**	**C**
***Glossiphonia heteroclite* (Linnaeus 1761)**	**R**	**R**	**R**	**R**	**AC**	**-**	**A**	**AC**
***Helobdella stagnalis* (Blanchard, 1896)**	**R**	**R**	**R**	**R**	**A**	**-**	**-**	**A**
Insecta								
Ephemeroptera	**R**	**-**	**R**	**R**	**A**	**-**	**A**	**A**
Trichoptera	**R**	**-**	**R**	**R**	**A**	**-**	**A**	**A**
Zygoptera	**R**	**R**	**R**	**La**	**AC**	**AC**	**AC**	**AC**
Anisoptera	**R**	**R**	**R**	**R**	**A**	**A**	**A**	**A**
Corixidae	**R**	**-**	**-**	**R**	**A**	**-**	**-**	**A**
***Plea leachi (*McGregor and Kirkaldy ,1899)**	**La**	**R**	**R**	**La**	**AC**	**A**	**A**	**AC**
Dytiscidae	**R**	**-**	**R**	**R**	**A**	**-**	**A**	
Hydrophilidae	**R**	**R**	**R**	**R**	**A**	**A**	**A**	**A**
Coleoptera larvae	**R**	**-**	**R**	**R**	**A**	**-**	**A**	**A**
Culicidae	**A**	**R**	**La**	**La**	**C**	**A**	**AC**	**AC**
***Chrironomus* sp.(Meigen,1803)**	**La**	**D**	**A**	**La**	**C**	**C**	**C**	**C**
***Polypedilum* sp. (Townes, 1945)**	**R**	**R**	**R**	**R**	**A**	**A**	**A**	**A**
Lepidoptera larvae	**R**	**-**	**R**	**R**	**A**	**-**	**A**	**A**
Crustacea								
***Ilyocypris* sp. (Brady,1889)**	**R**	**R**	**R**	**R**	**AC**	**A**	**AC**	**AC**
***cypri* sp. (9Muller 1776)**	**R**	**R**	**La**	**R**	**AC**	**AC**	**AC**	**AC**
***Cypridopsis vidua (*Muller 1776)**	**A**	**La**	**La**	**La**	**C**	**C**	**C**	**C**
***Cypris magna* sp. (Zenker 1854)**	**R**	**La**	**La**	**A**	**C**	**C**	**C**	**C**
***Macrobrachium nipponeus* (De Haan, 1849)**	**R**	**R**	**R**	**R**	**AC**	**A**	**A**	**A**
Decapoda(Crab)	**R**	**R**	**R**	**R**	**AC**	**A**	**A**	**A**
Shpaeromaannadalei annandal (Stebbing, 1911)	**R**	**R**	**R**	**R**	**A**	**A**	**A**	**A**
Amphipoda	**R**	**La**	**La**	**R**	**C**	**C**	**C**	**C**
Mollusca								
***Physa acuta (*Draparnaud,1805)**	**A**	**R**	**La**	**La**	**C**	**C**	**C**	**C**
Lymnaea lagotis (Schrank,1803)	**R**	**La**	**R**	**R**	**C**	**C**	**C**	**C**
***Bellamya bengalensis (*Lamarck,1822)**	**R**	**La**	**La**	**La**	**C**	**C**	**C**	**C**
***pseudontopsis euphraticus (*Bourguigant, 1853)**	**La**	**-**	**R**	**R**	**C**	**-**	**AC**	**C**
***Unio tigridis (*Bourguigant,1853)**	**R**	**-**	**R**	**R**	**C**	**-**	**AC**	**C**
***Corbicula flumina* (Muller,1774)**	**R**	**R**	**R**	**R**	**C**	**A**	**C**	**C**
***Corbicula fluminalis* (Muller, 1774)**	**R**	**R**	**R**	**R**	**AC**	**C**	**C**	**C**
***Melano nodosa* (Adams, 1854)**	**R**	**-**	**R**	**R**	**A**	**-**	**A**	**AC**
***Pomacea canaliculata (*Lamarck, 1819)**	**R**	**-**	**R**	**R**	**A**	**-**	**A**	**AC**

indicate D > 70 % Dominant species , A = 40% -70% Abundance species, La = 10% -40% less abundant species and R< 10% rare species. It also shows the values of the stability index (S index), which indicates A = adventitious species1% - 25% and Ac = species 25% - 50% and C = constant species greater than 50%.

The results revealed that the Percentages of benthic invertebrates isolated from plants and bottom sediment, it were high, (figure 2), this is may be due to the abundance of aquatic plant in this stations such as: Phragmites prefuculatus and Ceratophyllum dermersum, also the leaf of trees falls in to the river bottom is considered as a food sources for these benthic fauna. Beside the increase level of the dissolved oxygen, it is help suitable environmental condition for these organism.(48), where The Mollusca recorded 49% , Annelida 23%, Insecta 14%, Crustacea 9%, Turbellari 3% and nematodes 1%. Generally, the results showed that mollusca and annelida had higher ratios at study stations than other taxonomic units.

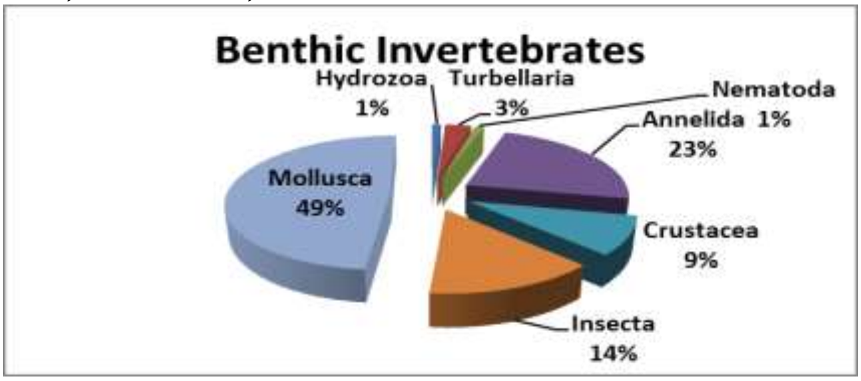
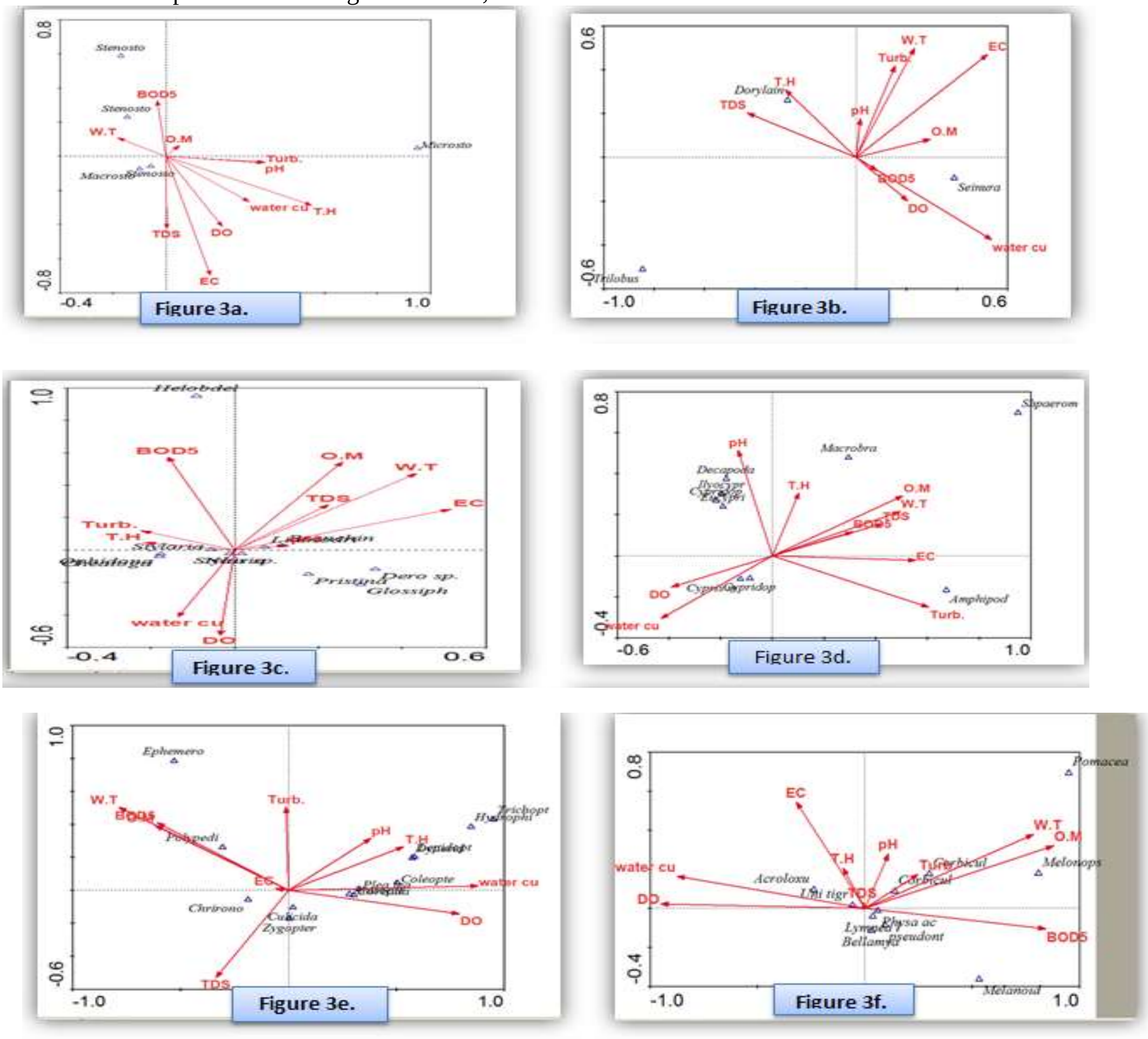


Figure 2. Ratio of benthic invertebrates during the period study

The relationship between the studied environmental factors and the distribution of the benthic invertebrates community were analyzed using the Canonical Correspondence Analysis (CCA) (46) as it is shown in Figure 3. There was a positive relationship between the W.T and the species of Stenostomidae. water temperature which is one of the environmental factors which has the most affected on the Turbellaria community in accordance with (47). on the other hand there was a negative relationship between organic matter and *Macrostomium* sp. Figure 3a. Figure 3b shows. Relationship between Nematoda species in this current study and the environmental factors studied, shows that there is a positive relationship between *Seinura* sp. with Do and BOD_5 , while negative correlation with total hardness and total dissolved Soiled. the Canonical Correspondence Analysis showed that *Dorylaimus* sp. has a positive correlation with the total hardness and total dissolved Soiled. Figure 3c revealed that species of Annelida were distributed were according to environmental factors, so the canonical correspondence analysis showed that the two species L. hoffmestri and B. sowerbyi had a positive relationship with each of the environmental factors water temperature, pH, Electrical conductivity and organic matter, on the other hand, they had negative relationship with dissolved oxygen, due to Most tubificids have the ability to tolerate inappropriate conditions(41), because these worms have a red blood pigment, which effectively extracts oxygen dissolved in the water (28), while that S. lactastris and H. stagnalis were positively associated with turbidity and total hardness. Also O. serpentina and Nais sp. showed Positive relationship with DO, and an negative with both water temperature and pH . The canonical correspondence analysis showed a positive relationship between Decapoda, Ostracoda with pH, while a negative relationship between these species with EC and Tur. this agree with (8) They who found that high turbidity had a negative effect on the growth of crustaceans. The canonical correspondence analysis showed a positive relationship between Isopoda with water temperature, total hardness organic matter and BOD, on the other side, and its relationship was negative with Do , while the CCA analysis showed a positive relationship between Amphipoda with Electrical conductivity, and Turbidity, and a negative with PH. Figure 3d. the canonical correspondence analysis (CCA) showed a positive relationship between the Hemiptera family, Hydrophilidae, Coleoptera larvae, and Dytiscidae with pH and TH, while negative relation with W.T and BOD. these analysis showed a positive relationship between Ephemeroptera and Trichoptera with W.T and inverse relation with Do. This agrees with (19), who found that generally, Ephemeroptera and Trichoptera are more affected by temperature. dissolved oxygen. also, Culicidae, *Chrironomus* sp. and Zygoptera showed were positive relationship with DO, and TDS according to (CCA)and an negative with Turbidity, water temperature, pH, and BOD_5 (Figure 3e). The analysis showed that freshwater gastropods (snails) differed in their sensitivity to dissolved oxygen concentrations, some are positively affected with DO such as *Acroloxus lacustris* and *Uni tigrids*, while others are negatively affected with DO such as *Physa acuta*, *Bellamya bengalensi* and *Lymnea lagotis.* due to their adaptations and behaviors. *Corbicula fluminalis*, *Corbicula fluminea* and *Melano nodosa* were positively affected by water temperature and organic matter, this agree with (4), who found that higher densities of *C. fluminea* and *C. fluminalis* occur during summer, and the lower densities occur during winter due to mortality. In addition to other environmental factors, the analysis showed that *C. fluminalis, C. fluminea ,M. nodosa,* and *U. tigrids* were positively affected with, water temperature, Electrical conductivity, total hardness, Turbidity, pH, and organic matter while were negatively affected with BOD (Figure 3f)



Figures 3. Relationship between the Benthic invertebrates and the environmental factors studied during the study period of the Tigris River according to Canonical correspond analysis (CCA).
W.T= Water temperature, Tur.= Turbidity, EC= Electrical Conductivity, O.M= Organic Matter, TDS= Total Dissolved Soiled, DO= Dissolved Oxygen, BOD_5= biological oxygen Demand

The results of Jaccard Presence –community of similarity showed the highest degree of similarity to be (92.15%) which between (S1) and (S4). Table 6. Benthic invertebrates diversity values by Shannon Weiner (H) varied between the lowest value (0.23) bit/Ind. at station 2 in Augusts 2018 and the highest value (3.2) bit /Ind. at station l in March 2018 (figure 3). The high value of the Shannon-Weiner Index indicates the clean environment that has caused high biodiversity (49), Registered low values of biodiversity may be due to several reasons including: presence of total dissolved soiled in the Tigris River. It Also possible that high velocity of water flow in the drainage areas, as well as increased in turbidity that decrease of benthic invertebrates diversity . (37). The Species Uniformity Index(E) values ranged from 0.33 at station 2 in July to 1 at station 1 in March 2018 (figure 4). Higher values of the (E) Index indicate that there is no environmental stress on the benthic invertebrates community in the rivers, where the values exceeded 0.5 in most months of the study at station S1, so can be considable it uniformity species of benthic invertebrates, and this agree with(36). revealed (44) that the few values of the (E) index of benthic invertebrates existence indicates the dominancy of a few species with high densities, which is an indicator of the existence of environmental stress. Species richness index(D) values of benthic invertebrates were varied from 0.48 at stations 2 in Augusts to 11.78 at station 1 in March2018 figure 5. The greatest (D) index was recorded at station 1 in spring season, it possible that aquatic plants, and stability of physical and chemical environmental factors in the water surface provide suitable environments at that station (14) The increase in the species richness index of taxonomic unites linked with increased bio-community health, and a places in which to live (20). The lowest (D) index was recorded at station 2 in summer season, It can be explain by increasing anthropogenic activities and pollutants, that caused changes in the environment and ecosystem function and generates effects on aquatic organisms (9). aquatic fauna community may not be affected only by pollutants (34) but may be due to other environmental factors such as increased the decaying organic matters and Temperature (30).

Table 6. Jaccard presence community of benthic invertebrates during the period study

Station	2	3	4
1	44	72.5	92.15
2		45.54	48.64
3			73.68

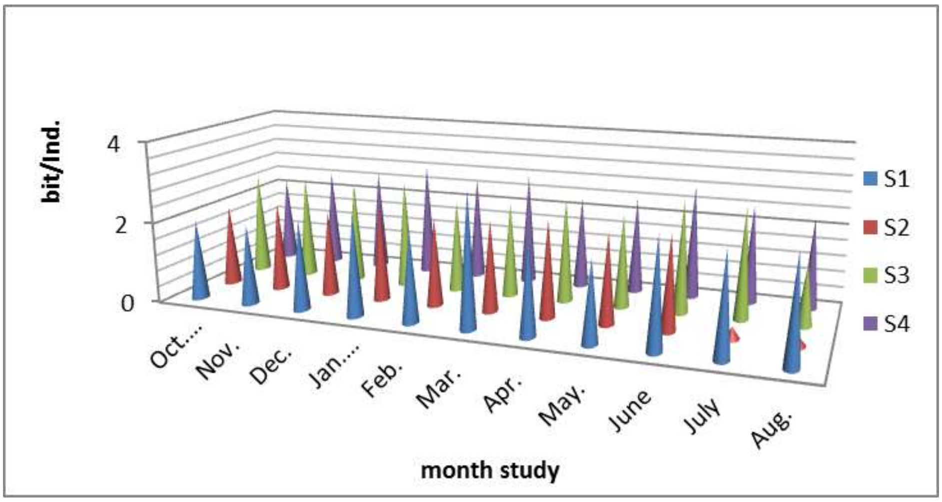


Figure 3. Shannon Weiner (H) of benthic invertebrates during the period study

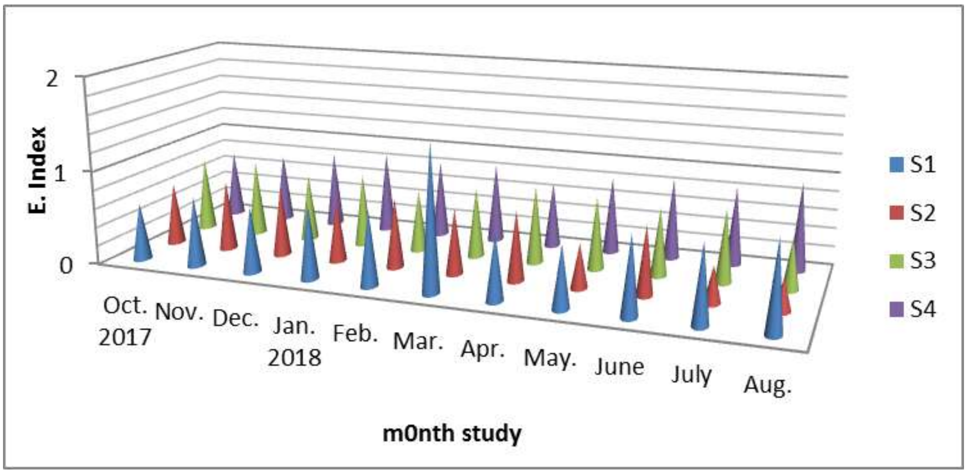


Figure 4. Species Uniformity Index of benthic invertebrates during the period study

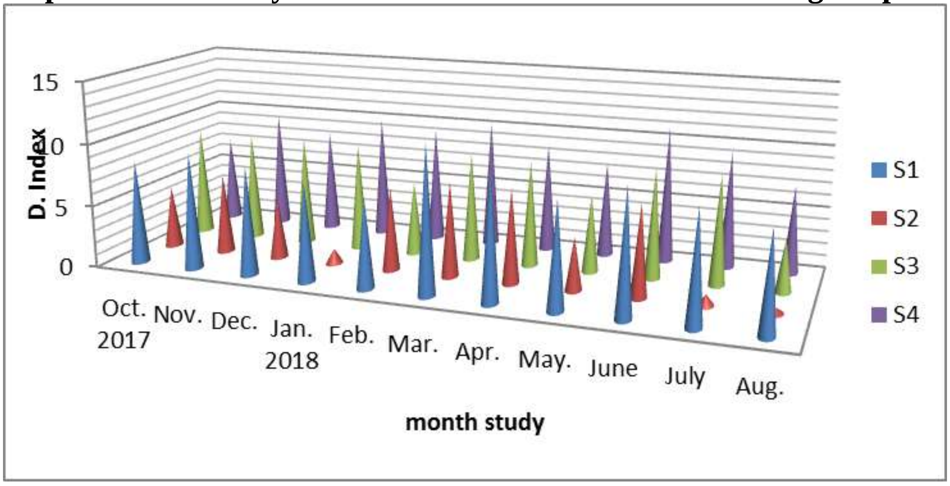


Figure 5. species richness index of benthic invertebrates during the period study

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