# THE EFFECT OF AL-THARTHAR-EUPHRATES CANAL ON THE QUANTITATIVE AND QUALITATIVE COMPOSITION OF ZOOPLANKTON IN EUPHRATES RIVER

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**Abstract**

Four stations were selected to carry out this study. Two stations were located at Al-Tharthar-Euphrates canal, while the remaining two were located at Euphrates River, to know the effect of Al-Tharthar-Euphrates canal on the composition and diversity of zooplankton in Euphrates River. In all the studied stations the total zooplankton showed high densities in autumn and low densities in summer. The statistical analysis results showed significant difference between station 3 and station 4 in Euphrates River. Rotifera were the dominant group quantitatively, followed by Copepoda and Cladocera. 52 taxa of zooplankton were recorded, 32 taxa belonged to Rotifera, 12 to the Cladocera and 7 to the Copepoda. The results also showed that the Rotifera: *Keratella cochlearis* and *Brachionus calyciflours,* the Cladocera: *Bosmina longirostris*, the Copepoda: nauplii were dominant in both canal and Euphrates River. The biodiversity indices indicated high fluctuated with seasons. The results also showed that the species composition in the Euphrates river were not affected by the canal water. The higher values of uniformity index of different zooplankton groups indicate there is no ecological stress on zooplankton in the study area.

## Introduction

The zooplankton groups are considered as characteristic indicator of water quality, eutrophication and pollution levels [1,2]. The total zooplankton abundance and diversity vary according to limnological features and trophic state [3]. In Iraq numerous studies were achieved [4,5,6,7,8,9]. These studies showed that the Rotifera was the dominant group quantitatively and qualitatively in most of Iraqi inland water.

The aim of the present work is to study the effect of Al-Tharthar-Euphrates canal on the composition, community structure, biodiversity and abundance of zooplankton in Euphrates River in study area.

## Materials and methods

- **Study site**

The total length of the Euphrates River is 2940 km, from that 1159 km, inside Iraq. It has no tributaries inside Iraq except for few valleys which aggregate water during the rainy season [10]. The canal of Al-Tharthar-Euphrates is considered one of the important parts of Al-Tharthar lake project, it was established in 1976 to connect the lake (which receives its water from Tigris River) to Euphrates River, with total length reaches to 37 km, and maximum discharge (500 $m^3$/sec.), while the working discharge ranged between 10-200 $m^3$/sec. Four stations were selected to carry out the present study. Two stations were located at Al-Tharthar-Euphrates canal, and the other two were located at Euphrates River. One of them was located in the area before the connection of this canal with Euphrates River as a control station, and the other one was located after the confluence of the canal to evaluate the ecological effects of this canal by comparison with the control station (Fig.(1)).

- **Samples collection**

Seasonally subsurface samples were taken during 2009 from the selected stations. Sampling was performed 4 times, in winter (February), in spring (April), in summer (July), and autumn (October) in 2009. Water temperature, electrical conductivity, TDS and pH were measured in the field using Multimeter HANNA Model (HI 9811-5). While dissolved oxygen was determined following Mackareth *et al* [11].

The zooplankton samples were collected with a standard plankton net (25 cm diameter and 55 µm mesh size) by passing 60 litter from station water. All specimens preserved in 4% formalin. The samples were divided into subsamples (1ml) with a pipette and counted.

Identification of specimens performed according to Edmondson[12] and Pennak [13].

- **Biodiversity indices**

To estimate changes in biodiversity of studied zooplankton, we used the Shannon-Wiener index ($H=-\sum ni / N \ln ni / N$), where (*ni*) are the number and biomass of one species, and *N* are the total number of individuals of all species.

We also used the species richness index (D=(S-1)/Log N), where S represent the number of species, and N are the total number of individuals of all species. To determine the species equivalent used the species uniformity index (E=H/Ln S), where H represent the Shannon-Wiener index values, and S the number of species[14].

## Results and Discussion

### Physico-chemical conditions

Surface water temperatures during study period ranged from 7.5 to 30.5°C in canal, while ranged between 7–32°C in Euphrates River (Table (1)). It was affected mainly by air temperature as expected.

The water was slightly alkaline in the studied stations, with pH ranged between 6.5-8.2 in canal and between 6.5-8.3 in river without pronounced variations between the studied stations. Most of the Iraqi inland water reported as alkaline [15]. The alkalinity of the studied area was mainly due to the bicarbonate ions as it is known in Iraqi inland water.

Higher values of conductivity and TDS were recorded in the river (EC=750-2360 µS/cm and TDS=520-1180 mg/l) comparing with canal (EC = 380-1620 µS/cm and 210-900 mg/l).

The studied area was well aerated with dissolved oxygen values ranged between 8.2-12.5 and 8.6-13 mg/l in the canal and the river respectively. Similar results were reported in Tigris and Euphrates Rivers [4,8,16,17].

### Quantitative study

The annual density of zooplankton was higher in Euphrates River, as it ranged between 780-2090 ind./$m^3$, while the annual density in Al-Tharthar-Euphrates canal fluctuated between 610 to 1425 ind./$m^3$. There was a relative decrease in total zooplankton biomass in summer and a sharp increase in autumn (Fig.(2)). The higher densities of zooplankton in autumn returned to increase primary productivity and high water transparency in this season [18].

The densities of total zooplankton showed significant decrease in station 4 (according to analysis of variance) in all seasons except spring, when it compare with station 3. This is returned to effect of Al-Tharthar Euphrates canal on station 4 in Euphrates River. Rotifera was the dominant group in all of study stations (47%), followed by Copepoda (35 %), and Cladocera (18%). Attayde and Bozelli [19] indicated that Rotifera is the dominant group on other zooplankton groups because of its small size, fast reproductive, short life cycle and high tolerance toward the wide range of environmental factors.

The highest number of Rotifera was found in winter, while the lower densities were recorded in spring (Fig.(3)). Cladocera was found in high densities in autumn (Fig.(4)), followed by spring, summer and winter respectively. In addition, the total numbers of Copepoda were highest in autumn (Fig.(5)).

The dominant Rotifera species was *Keratella cochlearis* (Table (2)) followed by, *K. valga* and *Polyarthra dolichoptera* in station 1 and 2 (Tharthar- Euphrates canal), while, *Brachionuse clyciflorus* followed by *K. cochlearis* were more abundant species in station 3 and 4 respectively. When considering the seasonal species percentages of Cladocera, *Bosmina longirostris* and *Diaphanosoma brachyurum* were the most abundant species (57%) in the total abundance of Cladocera in spring; this percentage decrease to 44 % in winter. Furthermore, nauplii belonged to Copepoda were the dominant in the all stations. High frequencies of these species belonged to Rotifera, Cladocera and Copepoda recorded by other researchers in Iraq [5,6,7,8,9]. Generally, the average seasonal abundances of Cladocera, Copepoda and Rotifera were statistically significant ($P<0.01$).

According to correlation coefficient results a positive correlation with a very significant probability ($P<0.01$) was observed between Rotifera density and dissolved oxygen, while negative correlation with temperature. Population development of Rotifera is limited by the combined effect of dissolved oxygen concentrations and temperature [20].

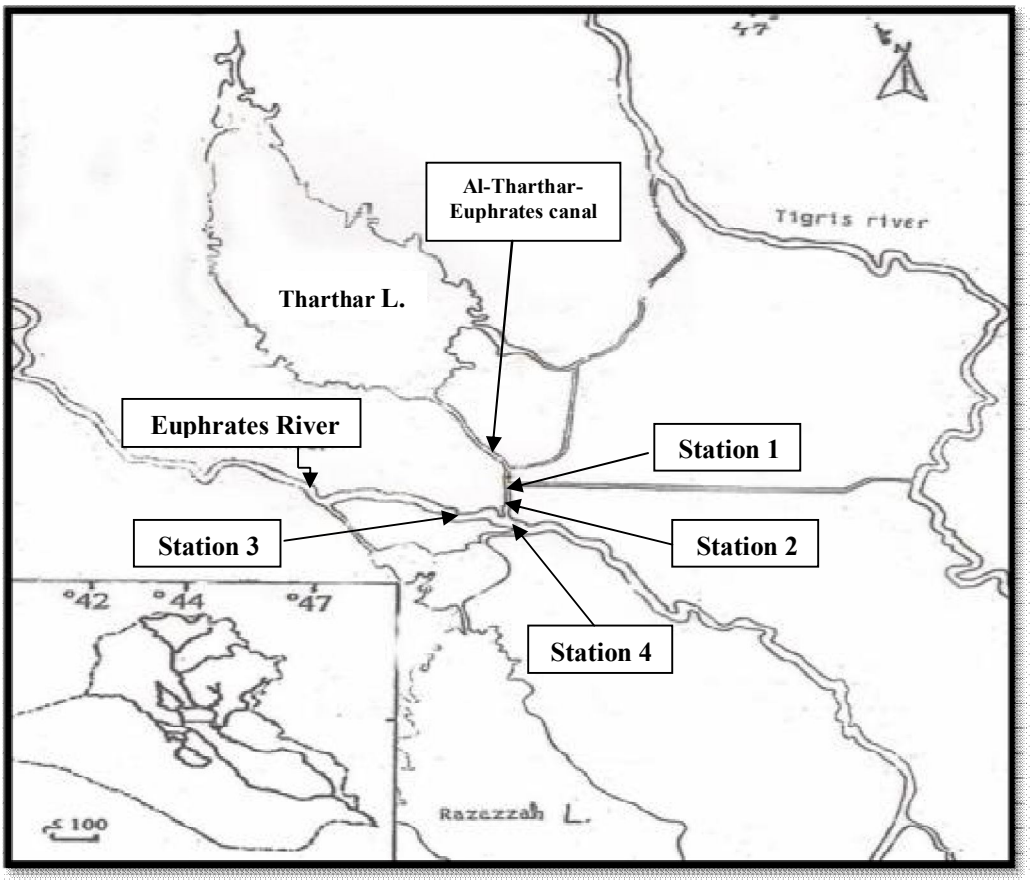


*Fig.(1): Map of studied area showing the locations of the studied stations.*

*Table (1)*
*The range of pysico-chemical parameters in the studied stations.*

| parameter | Station 1 | Station 2 | Station 3 | Station 4 |
|---|---|---|---|---|
| Temperature (°C) | 7.5-30.5 | 9-30 | 7-29 | 10-32 |
| pH | 6.6-8 | 6.5-8.2 | 6.6-8.1 | 6.5-8.3 |
| Electrical cond. (µS/cm) | 380-1620 | 400-1600 | 850-2360 | 750-1900 |
| TDS (mg/l) | 230-810 | 210-900 | 750-1180 | 520-1000 |
| DO (mg/l) | 8.2-12.5 | 8.8-12 | 8.6-12 | 8.7-13 |

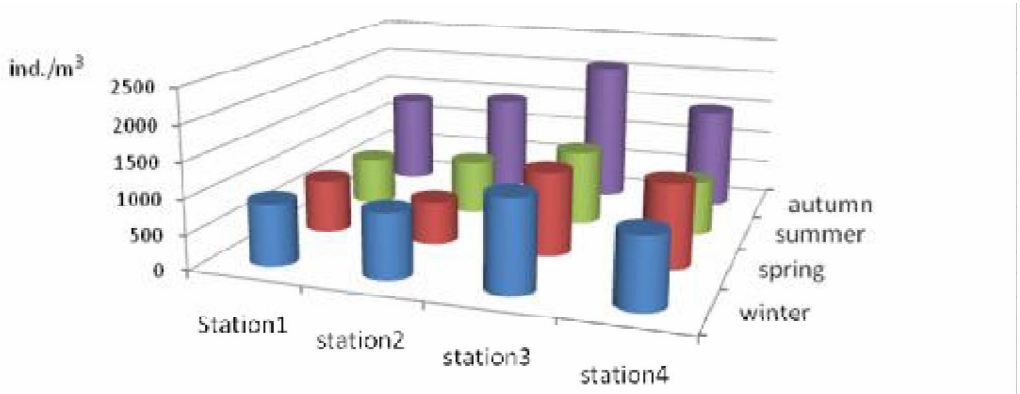


*Fig. (2): Seasonal variation of total zooplankton density in study stations.*

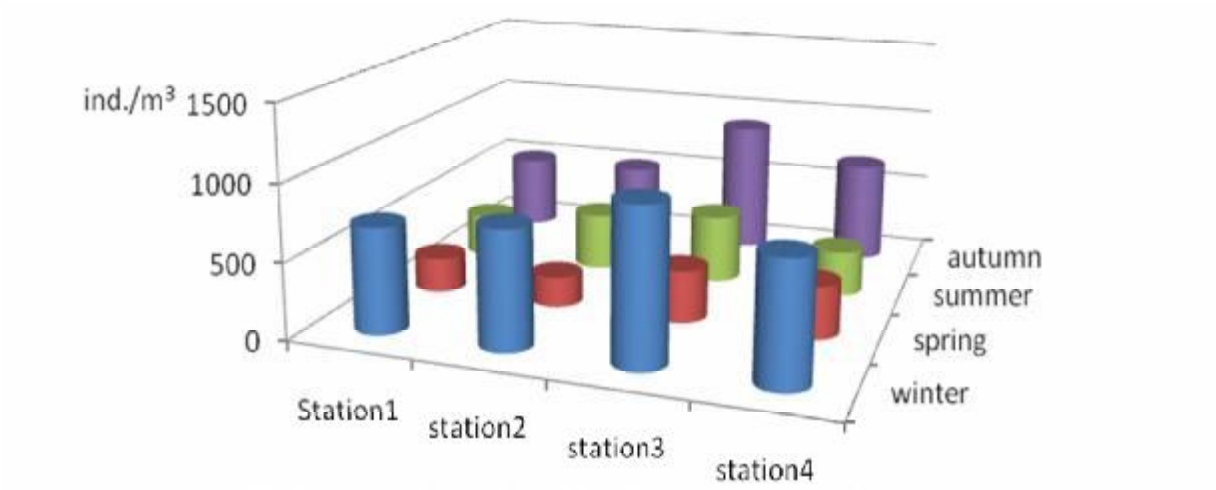


*Fig. (3): Seasonal variation of Rotifera density in study stations.*

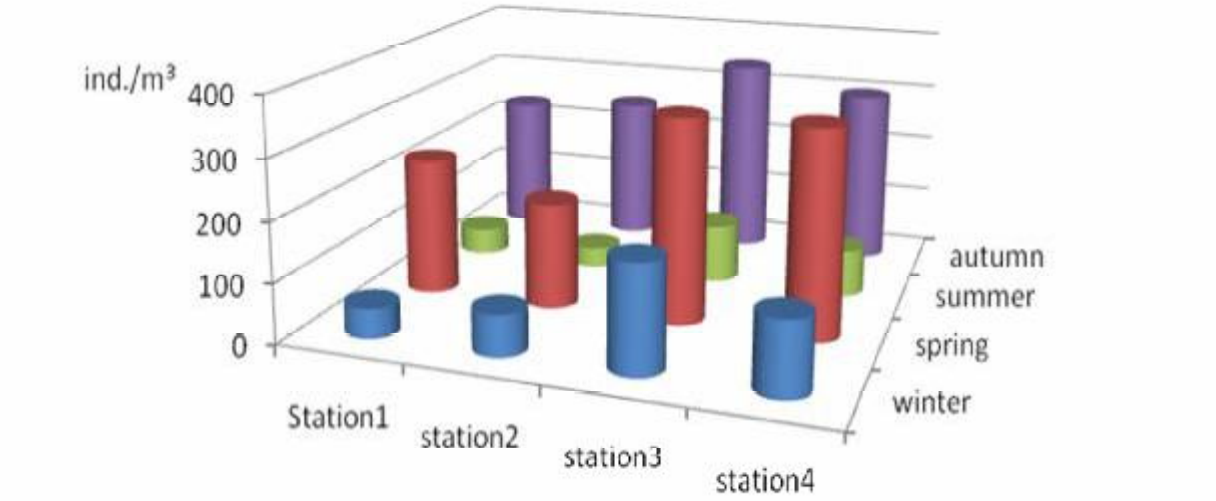


*Fig. (4) : The seasonal variation of Cladocera density in study stations.*

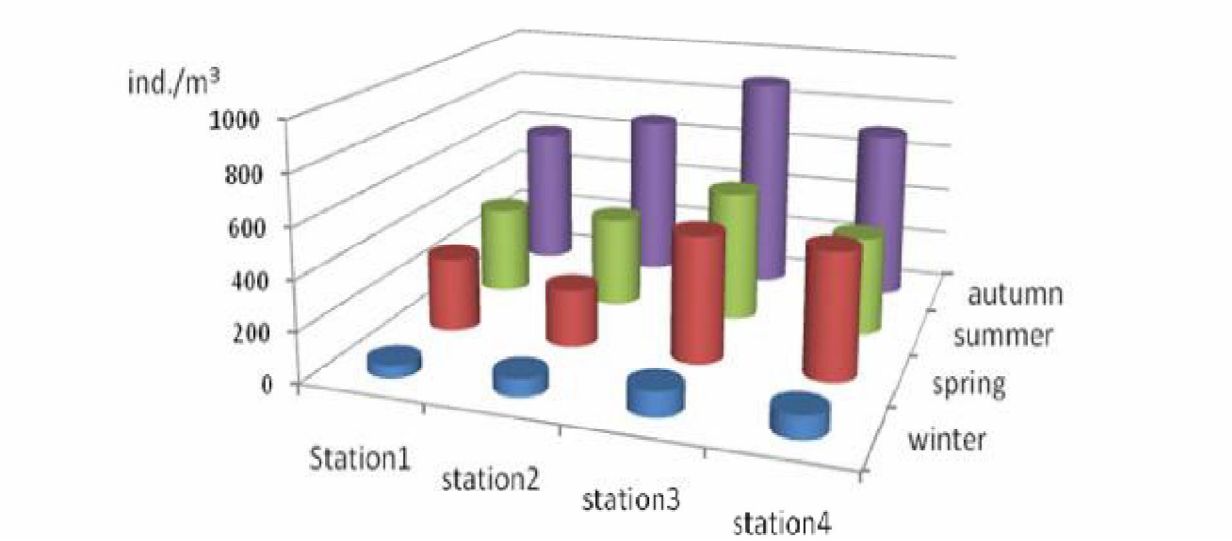


*Fig. (5) : The seasonal variation of Copepoda density in study stations.*

*Table (2)*
*The average of annual density (ind./$m^3$) and (frequencies) of zooplankton in studied stations.*

| Taxa \ Station | Al-Tharthar-Euphrates Canal | | Euphrates River | |
|---|---|---|---|---|
| | Station1 | Station2 | Station3 | Station4 |
| **Rotifera** | | | | |
| *Asplanchna priodonata* Gosse | 20(1) | 16(1) | 40(2) | 18(1) |
| *Brachionus sp.* | 22(1) | 22(2) | - | 24(1) |
| *Brachionus angularis* Gosse | 32(2) | - | 24(1) | 22(1) |
| *Brachionus calyciflours* Her. | 40(2) | 34(1) | 106(3) | 120(4) |
| *Brachionus leydigii* Cohn. | - | - | 22(1) | 4(1) |
| *Brachionus plicatilis* Mull. | - | - | 8(1) | 12(2) |
| *Brachionus rubens* Ehr. | 8(1) | 8(1) | 10(1) | - |
| *Brachionus urceolaris* Mull. | 20(1) | 60(2) | 80(2) | 32(2) |
| *Cephalodella sp.* | - | 24(1) | 40(2) | 4(1) |
| *Cephalodella auriculata* | 22(2) | - | 4(1) | - |
| *C.gibba* | 10(1) | 4(1) | 4(1) | - |
| *C.intuta* | 16(2) | - | - | 4(1) |
| *Colurella adriatica* | 32(2) | - | 16(1) | 8(1) |
| *Epiphanes sp.* | - | - | 16(1) | 16(1) |
| *Filinia longiseta* Her. | - | - | - | 32(2) |
| *Hexarthera mira* Hud. | 8(1) | - | 12(1) | 4(2) |
| *Keratella sp.* | 10(1) | 18(2) | 16(1) | - |
| *Keratella cochlearis* Gosse | 292(3) | 392(4) | 156(3) | 180(4) |
| *K.hiemalis* Carl. | 32(2) | 22(1) | 16(1) | 16(1) |
| *K.quadrata* Mull. | 80(3) | 20(1) | 4(1) | 22(1) |
| *K.valga* Her. | 46(2) | 88(2) | 16(1) | 32(2) |
| *Lecane sp.* | - | - | 24(1) | - |
| *L.elasma* | 16(1) | - | 32(2) | - |
| *L.luna* Mull. | 16(1) | - | 16(1) | 4(1) |
| *Monostyla bulla* Her. | 4(1) | 4(1) | 16(1) | - |
| *M.lunaris* | 8(1) | 16(1) | 4(1) | 32(1) |
| *Notholca acuminata* Her. | - | 4(1) | - | 16(1) |
| *Polyarthera dolichoptera* Ide. | 72(3) | 48(2) | - | 32(2) |
| *p.vulgaris* | 24(1) | 24(1) | 64(2) | 4(1) |
| *Synchyta sp.* | 8(1) | - | - | 16(1) |
| *Trichcerca sp.* | 4(1) | 24(1) | 4(1) | - |
| *Trichcerca elongate* Gosse | - | 8(1) | - | - |
| *Trichcerca similis* Wle. | - | 4(1) | - | 16(1) |
| **Cladocera** | | | | |
| *Alona costata Sars* | 24(1) | 4(1) | 16(1) | - |
| *Alona guttata* Sars | - | - | 4(1) | 16(1) |
| *Bosmina longirostris* Mull. | 176(3) | 88(3) | 224(4) | 48(2) |
| *B.coregoni* Baird | - | 48(2) | 56(2) | 8(1) |
| *Cerodaphnia reticulata* Jur. | 22(1) | 48(2) | 32(2) | 16(1) |
| *Ceriodaphnia rigaudi* Rich. | 72(2) | 16(1) | 22(1) | - |
| *Chydorus spharicus* Mull. | 24(1) | 16(1) | 24(1) | - |
| *Daphnia sp.* | 16(1) | 4(1) | 4(1) | - |
| *Daphnia galeata* Sars | 24(2) | 8(1) | 12(1) | - |
| *D.pulex* | - | 24(2) | - | 4(1) |
| *Diaphanosoma brachyurum* Lei. | 124(3) | 176(4) | 132(3) | 48(2) |
| *Moina affinis* Birge | 8(1) | - | 16(1) | 4(1) |
| **Copepoda** | | | | |
| Calanoida | 16(1) | - | 32(2) | 32(2) |
| *Diaptomus sp.* | 32(2) | 48(2) | 32(2) | 24(2) |
| Cyclopoida | 16(1) | - | 16(1) | 4(1) |
| *Cyclop sp.* | 4(1) | - | - | 16(1) |
| *Halicyclop sp.* | - | - | 16(1) | 8(1) |
| Copepoda nauplii | 532(4) | 780(4) | 800(4) | 686(4) |
| Harpacticoida | 72(3) | 56(2) | 88(3) | 32(2) |

**Qualitative study and biodiversity indices**

Fifty two taxa of zooplankton were identified in this study: 32 species of Rotifera, 12 Cladocera and 7 Copepoda (Table (2)). Zooplankton community at Tharthar-Euphrates river consisted of 43 taxa , while consisted of 51 taxa at stations of Euphrates River. More identified species and frequencies belonged *Brachionus, Cephalodella* and *Keratella,* respectively. The biodiversity of different group of zooplankton were fluctuated with seasons (Table (3)). The values of H index, D index and E index for Rotifera varied between 1.31-1.90, 1.56-2.2 and 0.67-0.87, respectively, in Tharthar-Euphrates canal, while varied between 1.34-2.10, 1.65-2.30 and 0.83-0.91 respectively, in Euphrates River, with recorded high values for H index and D index in winter. Our results also showed the high values of H index and D index for Cladocera were recorded in autumn which ranged between 1.19-1.40 and 1.44-1.65, respectively, in canal, while ranged between 1.18-1.55 and 1.34-1.78 respectively, in Euphrates River, while the values of E index varied between 0.77-0.94 in canal and varied between 0.66-0.92 in the river. The biodiversity indices of Copepoda varied between 0.90-1.2 for H index, 1.1-1.44 for D index and 0.49-0.80 for E index in canal, while varied between 1.03-1.31 for H index,1.25-1.58 for D index and 0.53-0.71 for E index. Our results revealed that the Shannon-Wiener index gave higher values when the proportions of species in a sample were close to each other. In this respect, Copepoda has the highest total individual number in some seasons (spring and summer), but The Shannon-Wiener index was higher for Rotifera. Such results are ascribed to the high proportion of Rotifera species over the zooplankton groups in the same sample.

However, the total abundance of Rotifera is usually higher in winter than other seasons. For this reason, the Shannon-Wiener index and species richness index was higher in winter. The result of E index showed high values for Rotifera and Cladocera. This means that Rotifera and Cladocera species have a more equal distribution in the total abundance of these groups than the Copepoda [21]. The high values of E index refer to the absence of any ecological stress on zooplankton groups in study area [22,23,24]. Proto-Neto (24) indicated that when the values of E index > 0.50 are considered equivalent in occurrence. The statistical analysis showed no significant difference between biodiversity indices for different zooplankton groups in studied stations, this refers to the species composition in the Euphrates River was not affected by the water of Al-Tharther-Euphrates canal.

*Table (3)*
*H index, D index and E index for zooplankton groups in studied stations.*

| Rotifera | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Seasons | Station 1 | | | Station 2 | | | Station 3 | | | Station 4 | | |
| | H index | D index | E index | H index | D index | E index | H index | D index | E index | H index | D index | E index |
| Winter | 1.90 | 2.10 | 0.80 | 1.90 | 2.2 | 0.82 | 2.10 | 2.3 | 0.87 | 1.90 | 2.1 | 0.86 |
| Spring | 1.31 | 1.7 | 0.85 | 1.45 | 1.77 | 0.87 | 1.44 | 1.8 | 0.91 | 1.34 | 1.88 | 0.90 |
| Summer | 1.33 | 1.56 | 0.76 | 1.44 | 1.66 | 0.79 | 1.56 | 1.70 | 0.91 | 1.44 | 1.65 | 0.83 |
| Autumn | 1.45 | 1.70 | 0.80 | 1.50 | 1.80 | 0.67 | 1.53 | 1.78 | 0.86 | 1.50 | 1.70 | 0.91 |
| **Cladocera** | | | | | | | | | | | | |
| Seasons | Station 1 | | | Station 2 | | | Station 3 | | | Station 4 | | |
| | H index | D index | E index | H index | D index | E index | H index | D index | E index | H index | D index | E index |
| Winter | 1.23 | 1.50 | 0.77 | 1.22 | 1.58 | 0.87 | 1.21 | 1.55 | 0.85 | 1.23 | 1.50 | 0.77 |
| Spring | 1.3 | 1.45 | 0.80 | 1.34 | 1.55 | 0.94 | 1.5 | 1.56 | 0.66 | 1.4 | 1.70 | 0.85 |
| Summer | 1.19 | 1.44 | 0.93 | 1.20 | 1.55 | 0.91 | 1.18 | 1.34 | 0.87 | 1.27 | 1.47 | 0.92 |
| Autumn | 1.33 | 1.60 | 0.89 | 1.40 | 1.65 | 0.78 | 1.55 | 1.78 | .0.90 | 1.41 | 1.55 | 0.84 |
| **Copepoda** | | | | | | | | | | | | |
| Seasons | Station 1 | | | Station 2 | | | Station 3 | | | Station 4 | | |
| | H index | D index | E index | H index | D index | E index | H index | D index | E index | H index | D index | E index |
| Winter | 0.90 | 1.10 | 0.80 | 1.01 | 1.24 | 0.65 | 1.03 | 1.43 | 0.71 | 1.05 | 1.30 | 0.53 |
| Spring | 0.95 | 1.12 | 0.67 | 1.2 | 1.44 | 0.68 | 1.31 | 1.55 | 0.71 | 1.28 | 1.58 | 0.59 |
| Summer | 0.99 | 1.19 | 0.51 | 1 | 1.23 | 0.65 | 1.09 | 1.25 | 0.66 | 1.30 | 1.54 | 0.60 |
| Autumn | 1.2 | 1.4 | 0.62 | 1.02 | 1.22 | 0.49 | 1.09 | 1.29 | 0.67 | 1.22 | 1.43 | 0.56 |

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**الخلاصة**

تم في هذه الدراسة اختيار أربع محطات، اثنتان في قناة الثرثار – الفرات، واثنتان في نهر الفرات من اجل التعرف على تأثير قناة الثرثار – الفرات على تركيب وتنوع العوالق الحيوانية في نهر الفرات. سجل المجموع الكلي للعوالق الحيوانية كثافات عالية في فصل الخريف، وكثافات منخفضة في فصل الصيف في كل محطات الدراسة، مع تسجيل فروقات معنوية حسب نتائج التحليل الإحصائي بين المحطتين الثالثة والرابعة في نهر الفرات. كانت الدولابيات هي المجموعة السائدة كميا على المجموعات الأخرى للعوالق الحيوانية تتبعها مجموعة مجذافية الأقدام ثم مجموعة متفرعة اللوامس. سجل في هذه الدراسة 52 وحدة تصنيفية من العوالق الحيوانية، تعود 32 وحدة منها إلى الدولابيات و 12 إلى متفرعة اللوامس و7 إلى مجذافية الاقدام. بينت النتائج أيضا بأن الأنواع *Keratella cochlearis* و *Brachionus calyciflours* من بين الدولابيات، والنوع *Bosmina longirostris* من بين متفرعة اللوامس واليرقات (nauplii) من بين مجموعة مجذافية الأقدام هي السائدة على الأنواع الاخرى في القناة ونهر الفرات. تذبذبت قيم مؤشرات التنوع الإحيائي لمجموعات العوالق الحيوانية المختلفة مع الفصول. و بينت النتائج كذلك بأن التركيب النوعي للعوالق الحيوانية في نهر الفرات لم يتأثر بمياه القناة، وان النتائج العالية لقيم مؤشر تجانس الأنواع تشير إلى عدم وجود ضغوط بيئية على العوالق الحيوانية في منطقة الدراسة.