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Original Article

# Biological diversity of Arthropoda in four sites of Euphrates River in Najaf city (Shatt al-Kufa)

**Anam Ali Tsear***

Department of Ecology, Faculty of Science, University of Kufa, Kufa, Iraq.

**Abstract:** Aquatic mcroinvertebrates are important members of freshwater ecosystems and most of them are arthropods. This study aimed to study the arthropod diversity in Shatt Al-Kufa. Samples were collected monthly from four sites in Euphrates River in Najaf city (Shatt al-Kufa) from March 2020 to April 2021. Based on results, 10 mcroinvertebrates taxa were found. Arthropoda were at their highest densities in spring, with *Chironomus* being a dominant species. In spring, the Shanon-Weiner diversity and Species Richness indices were recorded higher. Based on the results, the Shatt al-Kufa was moderately diverse in spring. There were significant differences between seasons and study sites in terms of the density and diversity of aquatic insects.

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## Introduction

Aquatic habitats are adversely impacted by urbanization, deforestation, irrigation, and pollution during the last two centuries and among them, freshwater rivers have become the most threatened ecosystems suffering from a significant decline in biodiversity due to invasion by alien species, and pollution (Clews and Ormerod, 2009; Abbas and Al-Seria, 2020). Freshwater organisms live almost continuously in the water and respond to all environmental stresses including pollutants (Veroli et al., 2010).

Typically, an unpolluted river contains more than 40 identifiable classifications. This taxonomic and functional diversity can show a myriad of responses to various environmental stresses and disturbances, including the presence of minerals, micro-sediments, nutrients, and hydrological changes (Al-Fatlawi, 2005).

Aquatic macroinvertebrates are important members of freshwater ecosystems and most of them are arthropods (Al-Yasari, 2012). Riparian arthropods are an important component of these systems playing a critical role in connecting aquatic and terrestrial food networks, and they are particularly sensitive to hydrological and chemical characteristics of the rivers inhabits (Durmishi et al., 2008). In addition, worldwide experience has demonstrated that the most useful biological assessment methods for freshwater monitoring are based on benthic macroinvertebrates (Dos Santos, 2011). Some works are available regarding macroinvertebrates of Iraqi aquatic ecosystems e.g. Edmondson (1959) found 21 taxa of arthropods in the Tigris River, south of Baghdad. Ellis et al. (2011) studied the benthic invertebrate community at fish floating cages in the Tigris River before the Al-Kut Barrier, and the results showed arthropod comprised about 35.7% of the total invertebrates with eight taxa belonging to Hexapoda.

Considering the importance of the river ecosystem as sentinels of the whole region, this study was conducted to evaluate arthropod diversity of the Euphrates River in Najaf city known as Shatt al-Kufa using the Shanon-Winner and the Richness indices, and its seasonal variation.

Correspondence: Anam Ali Tsear
E-mail: anaama.alkhafaji@uokufa.edu.iq

## Materials and Methods

**Sampling:** The benthic macroinvertebrates were sampled on a monthly basis from March 2020 to April 2021 in four stations from the Euphrates River in Najaf city (Fig. 1). Triplicate samples of the benthic macroinvertebrates were collected at each site using an Ekman Grab (15×15 $cm^2$). Samples were taken from surface sediments at 60cm depth. Three random replicates were immediately washed with water using sieves with a mesh size of 0.5 mm and then fixed in a 5% formaldehyde solution. The sample was stored in plastic bags and washed in a sieve (0.5mm mesh) in the Laboratory. Specimens were isolated and identified using dissection and compound microscope in the lab (Eyre et al., 2001). Macroinvertebrates were identified under a stereomicroscope by available valid references (Frandsen, 1983; Floder and Sommer, 1999). The individuals were identified to the genus level as possible. The abundance of each taxon was calculated and the results were expressed as individuals per $m^2$. Water temperature, electrical conductivity, total dissolved solids (TDS), and pH were measured at each stream reach using portable equipment (YSI Model 650). A dissolved oxygen meter was used to measure the DO.

**Diversity Indices:** The Shanon-Weiner diversity index was calculated using the formula (Goel, 2008) of $H = -\Sigma (Ni /N) Ln (Ni /N)$, where H = the Shannon diversity index, Ni = the number of individual species, and N = total number of individuals of all species. If the value of the H is less than one, it represents low diversity, between 1 and 3 represents moderate diversity and higher than 3 represents high diversity. The species richness was calculated using the formula (Gotelli and Colwell, 2001) of D = (S1)/Log N, where S = the number of species and N = the Total number of species.

**Statistical analysis:** The statistical analysis was performed using a randomized complete design (RCD) with two factors. The first factor was four sites, and the second one was the seasons. Three replications were used, and the LSD was determined at the 0.05 level.

## Results

Table 1 presents the mean and range of the measured physical and chemical properties of the Shatt al-Kufa at four sampling stations. Based on the results, the lowest value of water temperature was recorded in February as 12.5°C at site 2, and the highest as 38.8°C in August at site 2. The lowest pH was recorded in August as 7.5 at site 1, and the highest in March (8.6) at site 3. There was a positive correlation between water temperature and pH. The lowest TDS was recorded in January as 531.2 mg/L at site 1, and the highest (768.8) in March at same site 1. The lowest DO was recorded in September (6.5 mg/L) at site 1, and the highest in November (10.1 mg/L) at station 4.

The total density of each taxon during the study period at each site is shown in Table 2. Ten taxa in different growth stages were collected. The genus *Chironomus* had the highest density as larval and pupal stages. The third site had the lowest density in summer 2020 with one ind/$m^2$ and the highest one in spring with 68 ind/$m^2$ at site 4. A significant difference between seasons and sites was found ($P$>0.05) (Fig. 2).

Shannon-Wiener index at site 3 was the lowest (0.2) in summer, while at site 4, it was highest in spring (1.4). A significant difference was found between seasons ($P$>0.05) (Fig. 3). Minimum species richness (D) was observed at site 4 in summer (0.4), while the highest was at site 4 (6) (Fig. 4). The results revealed significant differences ($P$>0.05) between seasons in species richness.

## Discussion

Benthic macroinvertebrates represent an integral part of lotic systems to understand the effects of anthropogenic, as well as natural stressors. Benthic macroinvertebrates possess many advantages, including characteristic sensitivity to water parameters changes such as pollution, limited mobility, and their ease of collection and identification (Mangadze et al., 2016). The pH value

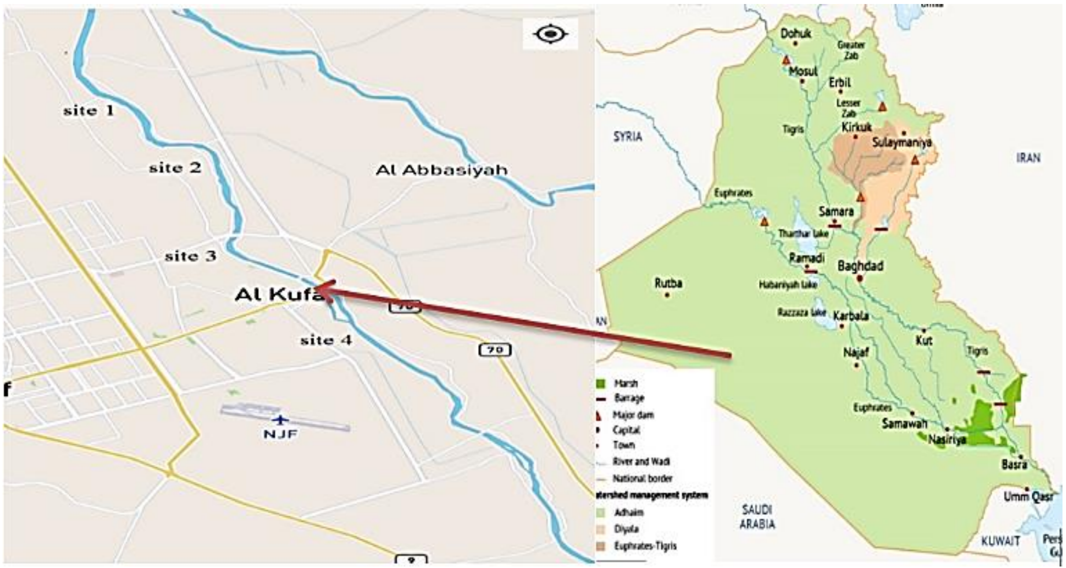


Figure 1. Study area on the Iraqi map.

Table 1. Mean and standard deviation of water physical and chemical parameters (first line and range second line, respectively) for in study sites.

| Parameters | Sites | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| Water Temp. ˚C | 25.3±7.17<br>12.6-36.5 | 23.3±6.8<br>12.5-38.8 | 25.1±7.1<br>13.4-38.4 | 25.4±7.6<br>13.2-37.9 |
| PH | 8.02±0.41<br>7. 5-8.23 | 7.21±0.35<br>7.8-8.1 | 7.4±0.2<br>7.7-8. 6 | 8.3±0.27<br>7.7-8.3 |
| TDS | 622.1±53.71<br>531.2-768. 8 | 589±61.4<br>5 39.3-687 | 611±52.5<br>541.1-734 | 6 37±71<br>562-759.1 |
| DO | 8.21±1.4<br>6.5-9.31 | 8.2±1.1<br>6.87-9.52 | 8.41±1.4<br>6.73-10.2 | 8.61±1.6<br>7.5-10.3 |

of an aquatic system is an essential indicator of water quality (Hershe, 1998). The pH values recorded in the current study were within the optimal limits for aquatic environments, but they tend to be alkaline at times, and this characteristic is common in Iraqi inland waters. This is due to the buffering capacity of Iraqi natural waters, which have a relatively high content of calcium carbonate (Hershe, 1998; Jansson et al., 2005).

Due to the decay and degradation of the majority of microorganisms at lower water levels (Kumar et al., 2021), TDS is relatively higher during droughts seasons than during floods period. The results of our study were in the range reported by Long et al. (2014) for TDS in the riverine systems. Based on these results, the DO of the water was elevated during the winter and decreased during the summer, a pattern that should be expected since gas solubility in liquids is directly related to the water temperature (Maia et al., 2008).

Based on the results, the total density of arthropods and their number were highest at site 4 and lowest at site 2 during the study period. There was a difference in the taxa between the study sites and this may be related to the environmental parameters and pollution from anthropologic sources (Nilsson et al., 2005) since many communities and industrial zones are located along the river banks. In spring, the density was recorded the highest, possibly associated with favorable environmental conditions, water temperature, and the availability of food, phytoplankton, or detritus (Nilsson et al., 2005). There was a low density of macroinvertebrates in the summer, due to the rise of water temperatures. As shown in a previous study Mizhir et al. (2014), there is a direct correlation between the density of macroinvertebrates and temperature with *Chironomus* pupa and larvae as high in the study

Table 2. Number of Arthropoda species (ind/$m^2$) collected in the studied stations of the Shatt Al-Kufa.

| Phylum | Genus | S1 | S2 | S3 | S4 |
|---|---|---|---|---|---|
| Arthropoda | Damselfly nymph | 1 | 0 | 3 | 2 |
| | Dragonfly nymph | 2 | 2 | 0 | 2 |
| | *Eristalis* sp. larvae | 2 | 0 | 3 | 0 |
| | *Metapenaeus* sp. | 3 | 0 | 0 | 2 |
| | Dytiscidae larvae | 2 | 2 | 1 | 2 |
| | Tabanidae Larvae | 1 | 0 | 1 | 0 |
| | Whirligig beetle | 1 | 0 | 2 | 0 |
| | *Chironomus* pupa | 25 | 19 | 22 | 32 |
| | *Whirligig beetle* Larvae | 0 | 1 | 1 | 2 |
| | *Chironomus* larvae | 37 | 29 | 22 | 45 |
| | Total | 74 | 53 | 55 | 87 |

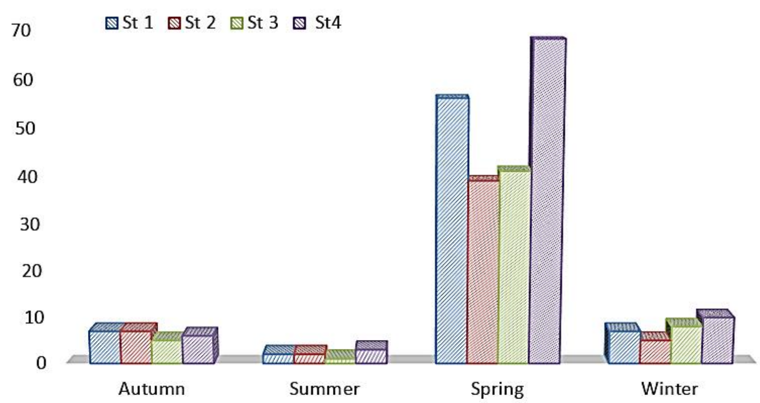


Figure 2. Seasonal variation of Arthropoda density (ind/$m^2$) in Shatt al-Kufa.

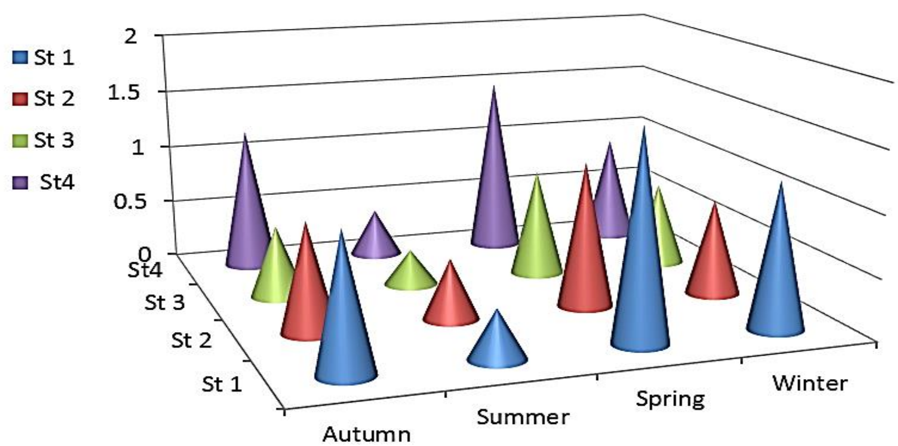


Figure 3. Shannon-Weiner index of Arthropoda in different study sites in Shatt Al-Kufa.

sites.

Washington (2003) pointed out that the calculation of the diversity index of macroinvertebrates is an important structural property of a given ecosystem to understand its biological health. The use of diversity indices in water quality assessment presumes that macroinvertebrates community structure varies in correlation with environmental disturbances where diversity is decreased as some species are influenced severely in comparison with other species (Taylor, 1997). The diversity index is commonly used as a bio-criterion. Ecosystems that are stressed and

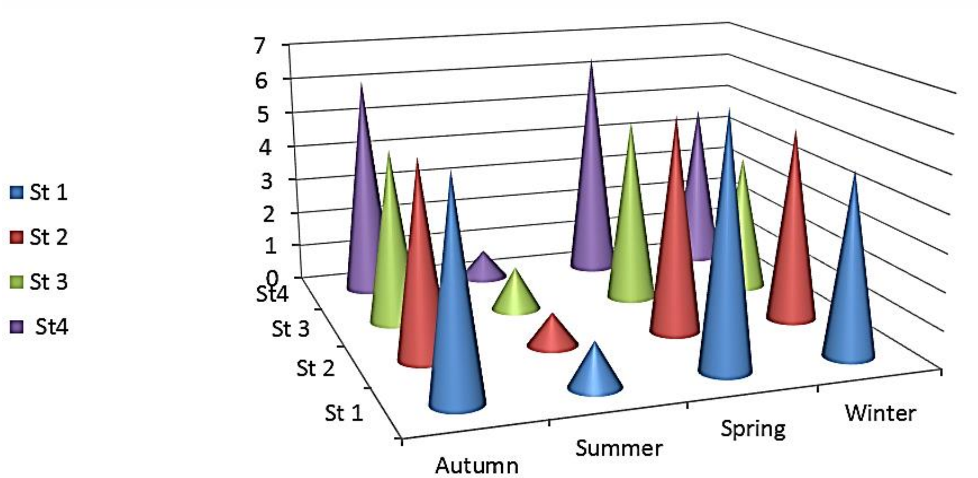


Figure 4. Species Richness index of Arthropoda in different study sites in Shatt al-Kufa.

polluted typically have a reduced diversity of species (Nkansah and Ephraim, 2009). Diversity indexes greater than 3 indicate clean water, and between 1 to 3 indicate moderate pollution (Rabee, 2010). Based on this classification, Shatt Al-Kufa has low biodiversity. In spring, D had a higher value because phytoplankton was abundant and diverse and the conditions are favorable for the growth of macroinvertebrates (Radhiy and Abbas, 2016). Increasing salinity and dissolved solids have caused a low D index during hot months (Sklar, 1985; Richter et al., 2003).

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