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Diversity of aquatic insects in the euphrates River/ Najaf province-Iraq

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Abstract---Five locations were sampled with three duplicates from each throughout the course of a six-month period, from November 2021 to April 2022, in order to assess the biodiversity of crustaceans. Water was also included in the samples. Certain chemical and physical characteristics of water are measured. The overall density of aquatic insects varied from (1–257) individuals/L, the month of April had the greatest density. According to the findings of the isolation and identification of water insects, *Chironomidae larvae* were the most numerous throughout the research period, followed by *Chironomide pupa*, *Zygoptera nymph*, *Odonata larvae*, and *Belostoma corodofanum*. According to the relative abundance index for aquatic insects, the *Zygoptera nymph* species was most prevalent in the first location, whereas *Chironomidae larvae* were more prevalent in the other sites. The constancy species index (S) of aquatic insects, *Chironomidae larvae* and *Chironomide pupa*, were the most constancy across all research locations and throughout the course of the study period. The values of the species richness index (D*) ranged from 0-3.84. While the Shanon-Weiner index ranged between 0-1.361 bit/ind. While the values of the species uniformity index (E) ranged between 0-0.845.

Keywords---Biodiversity; Density; River; Aquatic insects; Water.

Introduction

Diversity is the range of species, groups of organisms, biotic communities, and biotic processes, whether occurring spontaneously or as a result of human intervention. A region's diversity is one of its traits. Two methods of measuring biodiversity include species identification and genetic diversity. There are several

types of populations, including each population's abundance, biomass, cover, rate, and structural make-up. Other types of populations include their size, number of species, biotic communities, and biotic processes (DeLong, 1996).

All habitats' zooplankton development and succession is influenced and regulated by a wide range of physical and chemical factors, including biotic and abiotic elements such as water temperature, salinity, dissolved oxygen, turbidity, and nutrients (TN, TP). For instance, a lack of DO, nutrients like NH_4^+ and PO_4^{3-} , total suspended solids (TSS), and pH would all have a detrimental impact on the growth and survival of zooplankton. For the diversity and dispersion of zooplankton, pH and total suspended solids (TSS) are also essential (Bin Saidin, 2012; Ajeel 2016).

In ten distinct insect orders, there are aquatic species; five of these orders—Ephemeroptera, Odonata, Plecoptera, Trichoptera, and Megaloptera—are aquatic orders with almost exclusively aquatic species and larvae. The remaining five orders (Heteroptera, Coleoptera, Diptera, Lepidoptera, and Neuroptera), which are mostly terrestrial, are orders that are slightly aquatic (Throp and Covich, 2010). All aquatic insects are consumed by fish, amphibians, and other animals. They are important for the digestion of nutrients and energy, gathering resources and redistributing them to terrestrial ecosystems, and filtration of water (Suter and Cormier, 2015). A number of aquatic insects contribute to disease transmission in addition to serving as intermediate hosts for certain parasites that affect humans and domestic animals (Awad et al., 2014).

Studies of aquatic insect biodiversity have largely gone unnoticed, despite the fact that marshes, wetlands, and rivers are home to few of these insects and that they are rare in Iraqi rivers. The previous review makes this clear. In order to diagnose crustacean species and apply biodiversity laws, the current study was conducted in the Euphrates River/Najaf province and included the Relative Abundance Index (Ra), Constancy Index (S), Species Richness Index (D), Shannon-Weiner Diversity Index (H), and Species Uniformity Index (E).

2. Materials and Methods

For the study's purposes, five locations along the Kufa River in the Najaf province were chosen. On both banks of the river, there are farms, orchards, tourist destinations, and public rest areas. The drainage area and the contaminants that residents' residences and riverboat owners waste were among the several pollution sources that flow into the Kufa River and were located using the global positioning system (GPS) (Figure 1).

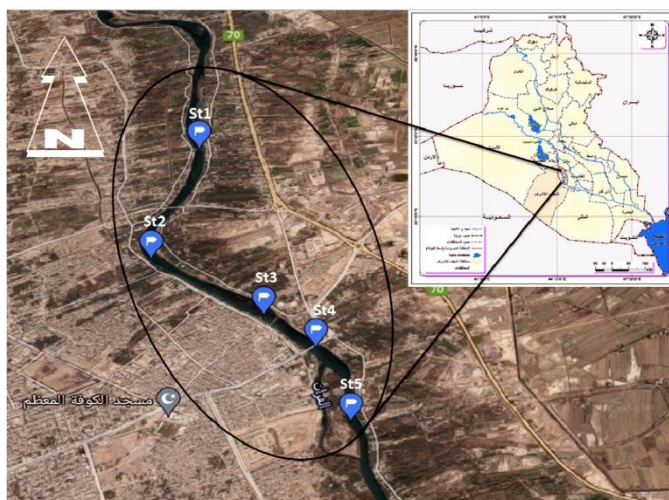


Figure 1. Study area on Al-kufa River by GPS (Google earth)

The first site is 1 km north of the Imam Ali Bridge in the Albu Hadari area, the second site is 1 km south of the Imam Ali Bridge and close to the location where sewage from the city is discharged into the river, the third site is close to the Iron Bridge, the fourth site is in the settlements near the old Kufa Bridge, and the fifth site is in the Albu Numan region (Table 1).

Table 1
A Geographical positions of the studied stations in Euphrates river

GPS coordinates						
Station	Longitude(East)			Latitude (North)		
	°	'	"	°	'	"
1-St1	44	39	30	32	06	40
2-St2	44	39	27	32	04	83
3-St3	44	40	64	32	04	08
4-St4	44	41	28	32	03	64
5-St5	44	41	73	32	02	97

3. Results

3.1 Physical and chemical features of water in study areas:

The water's temperature ranged between (14.5°C - 34.3°C) Figure(1), its salinity ranged between (0.236 - 0.889) ppt Figure(2), its electrical conductivity ranged between (515 - 1933) $\mu\text{s}/\text{cm}$ Figure(3), its pH ranged between (6.9 - 8.3) Figure(4),

its total dissolved solids recorded ranged between (512 - 1773) $\mu\text{g} / \text{L}$ Figure(5), its dissolved oxygen value ranged between (5 - 12.8) $\mu\text{g} / \text{L}$ Figure(6), and its vital oxygen requirement ranged between (0.6-7.6) Figure(7). In terms of nutrients, nitrate concentrations varied from (0.26 to 3.146) $\mu\text{g} / \text{L}$ Figure(8), phosphorus concentrations from (0.00031 to 0.04) $\mu\text{g} / \text{L}$ Figure(9), and chlorophyll concentrations from (5.566 to 10.824) $\mu\text{g} / \text{L}$ Figure(10).

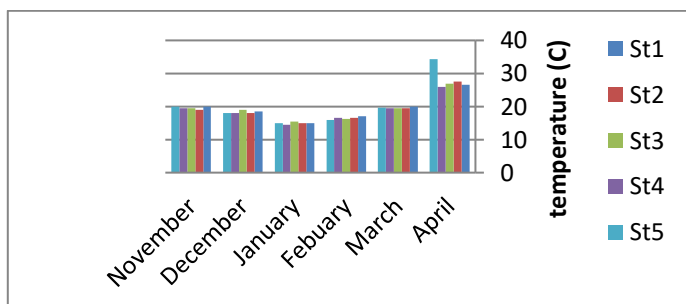


Figure 1. Monthly changes in water temperature (C) in the study sites in the Euphrates River during the study period.

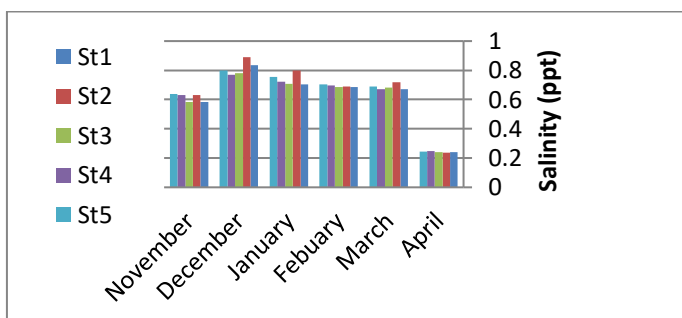


Figure 2. Monthly changes in Salinity (ppt) in the study sites in the Euphrates River during the study period.

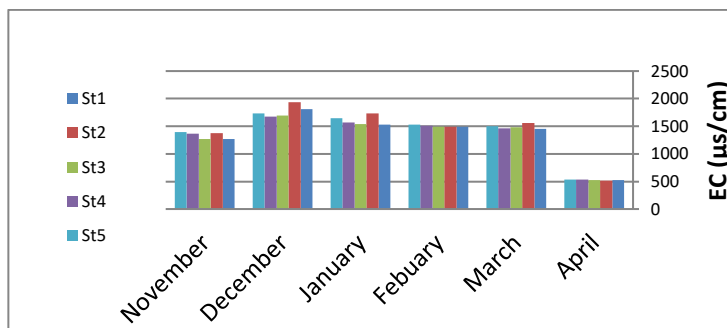


Figure 3. Monthly changes in EC ($\mu\text{s}/\text{cm}$) in the study sites in the Euphrates River during the study period.

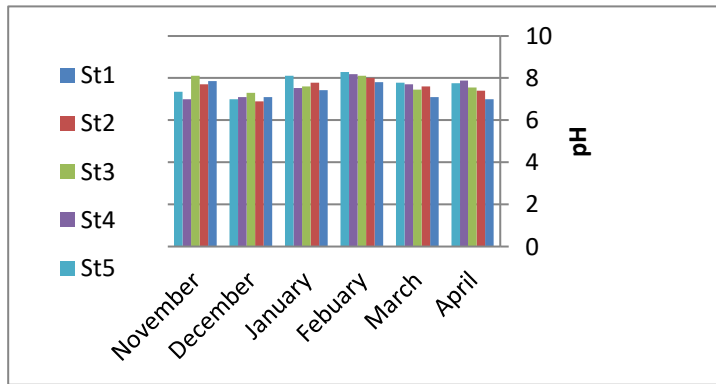


Figure 4. Monthly changes in pH in the study sites in the Euphrates River during the study period.

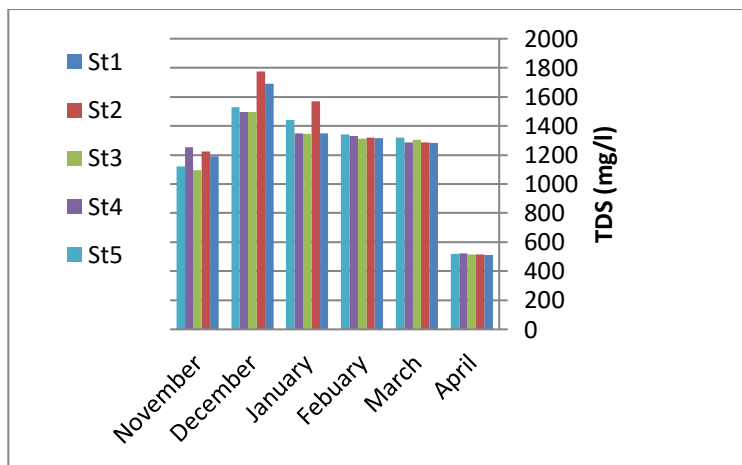


Figure 5. Monthly changes in TDS (mg/l) in the study sites in the Euphrates River during the study period.

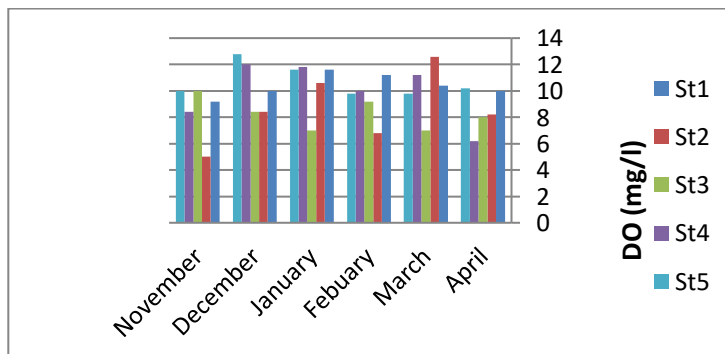


Figure 6. Monthly changes of DO (mg/l) in the study sites in the Euphrates River during the study period.

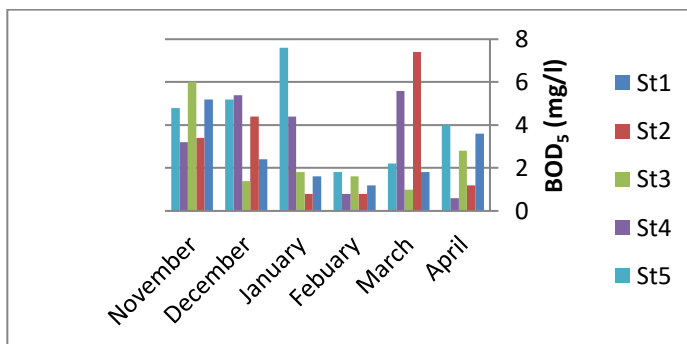


Figure 7. Monthly changes of BOD_5 (mg/l) in the study sites in the Euphrates River during the study period.

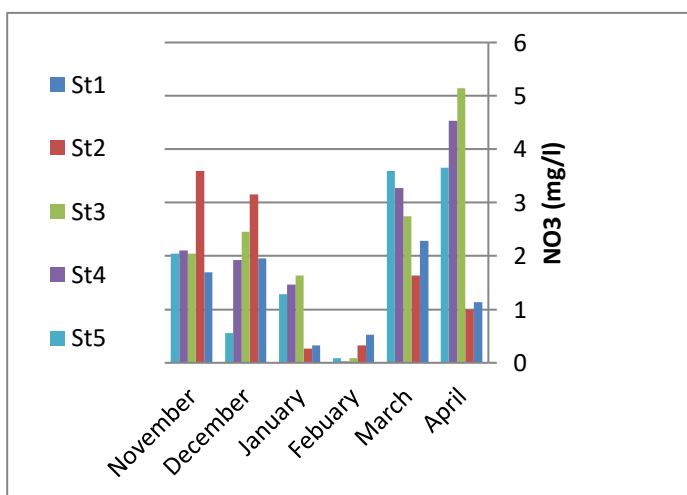


Figure 8. Monthly changes of NO_3 (mg/l) in the study sites in the Euphrates River during the study period.

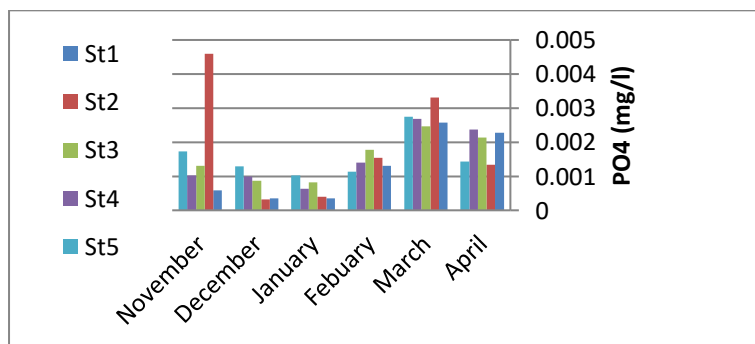


Figure 9. Monthly changes of PO_4 (mg/l) in the study sites in the Euphrates River during the study period.

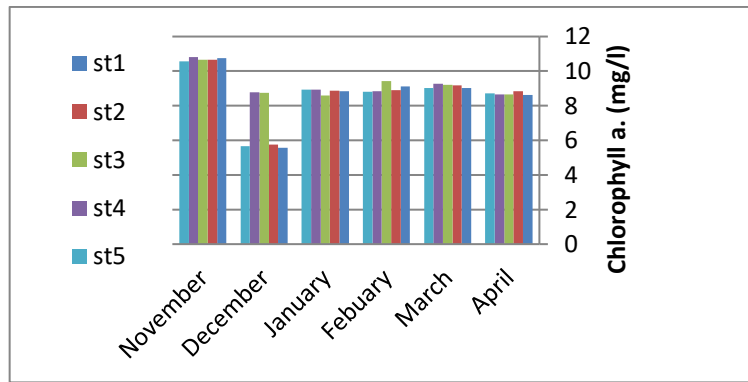


Figure 10. Monthly changes of Chlorophyll a. (mg/l) in the study sites in the Euphrates River during the study period.

3.2 Density and biomarker:

Five genera belonging to three orders were diagnosed during the six-month study period. *Chironomidae* larvae included, *chironomide pupa* (Midges), belonging to the order Diptera, *Zygoptera nymph*, *Odonata larvae*, belonging to the order Odonata, and the genus *Belostoma corodofanum*, which belongs to the order Hemiptera. The genus *Zygoptera nymph* was also the most dense during the study period. The total density of aquatic insects ranged between (1-257) individuals/liter, and the highest density was recorded in April 2022 (Figure 11).

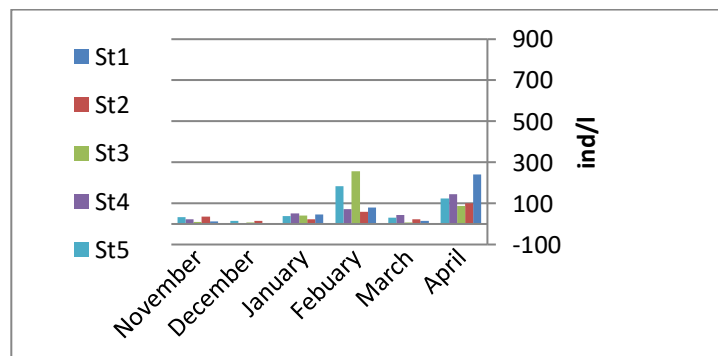


Figure 11. The total density of aquatic insects (ind/l) in the study sites in the Euphrates River during the study period.

Through the results obtained from the study, it was found that the *Zygoptera* nymph was the most abundant species in the first site with a percentage of 53%, followed by *Chironomidae* larvae with a percentage of 36%. While *Chironomidae* larvae was the most abundant in the second site with 52%, followed by *Zygoptera* nymph with 29%. In the third site, *Chironomidae* larvae was the most abundant species, with a percentage of 76%. Also, the species *Chironomidae* larvae was the most abundant in the fourth site with 62%. Also, in the fourth site, a *Chironomide* larva was the most abundant with 62%, followed by *chironomide pupa* with 22% (Figure 12).

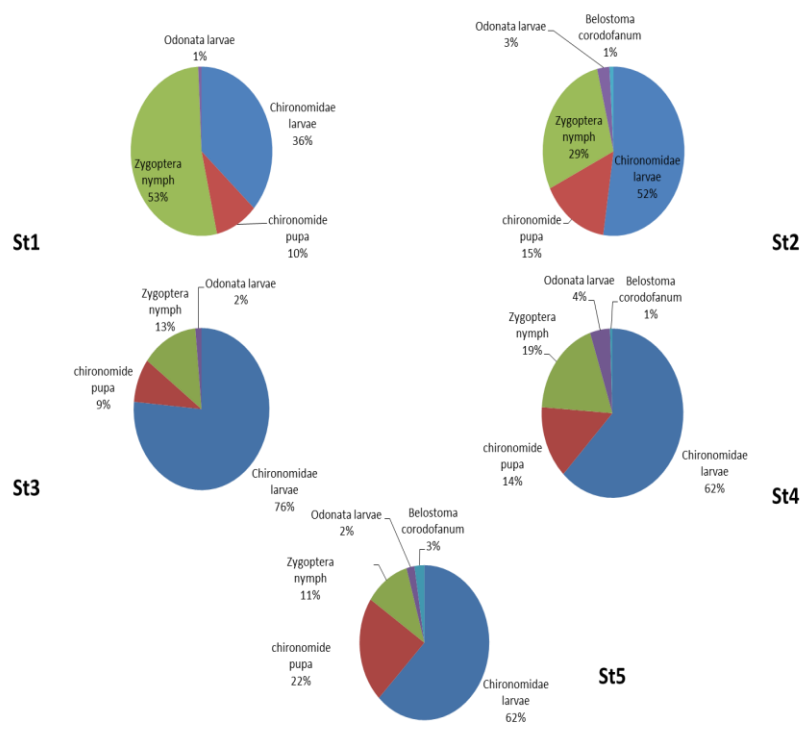


Figure 12. The Relative abundance index (Ra) of Aquatic insects in the study sites in the Euphrates River during the study period

In the table (1) the constancy index showed that the number of species diagnosed in this study that belong to aquatic insects, the most stable species were *Chironomidae larvae* and *Chironomide pupa*.

Table 1
constancy index of aquatic insect species and the frequency of their presence in the study sites in the Euphrates River during the study period.

Species	Locations				
	Site 1	Site 2	Site 3	Site 4	Site 5
Aquatic insects	[Present]				
<i>Chironomidae larvae</i>	[Present]				
<i>chironomide pupa</i>	[Present]				
<i>Zygoptera nymph</i>	[Present]	[Present]	[Present]	[Present]	[Present]
<i>Odonata larvae</i>	[Present]	[Present]	[Present]	[Present]	[Present]
<i>Belostoma corodofanum</i>	[Present]	[Present]	[Present]	[Present]	[Present]
constancy species	Added species		emergency species		Species appearing
					not

Where the values of the species richness index for aquatic insects, it ranged from the lowest value, which was (0), which was recorded in the first site of December 2021, as well as in the second and fourth site of January 2022, to the highest value (3.84) in the third site of December 2021 (Figure 13). And the results of the Shannon Wiener Aquatic Insect Index ranged from the lowest value (0) in the second location of December 2021 and also in the fourth location of January 2022 to the highest value (1.361) in the third location of December 2021 (Figure 14). Finally, the value of the species uniformity index for aquatic insect ranged between (0.845) in the third site of December and (0) in the first site of December 2021 and the second and fourth site of January 2022 (Figure 15).

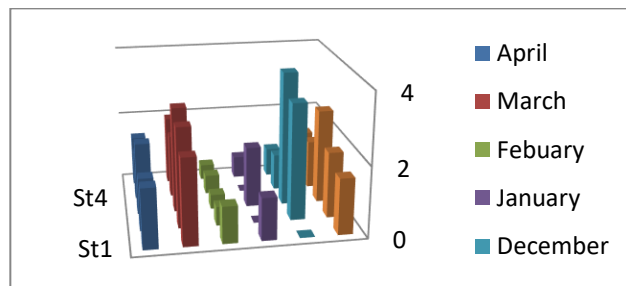


Figure 13. The species richness index (D^*) of aquatic insects species and their frequency in the study sites in the Euphrates River during the study period.

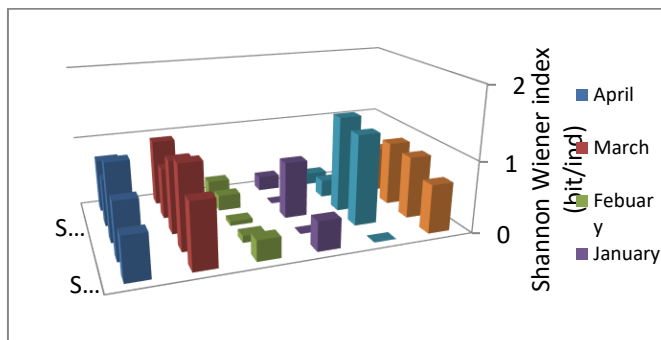


Figure 14. The Shannon Wiener index (H) of aquatic insects species and their frequency in the study sites in the Euphrates River during the study period.

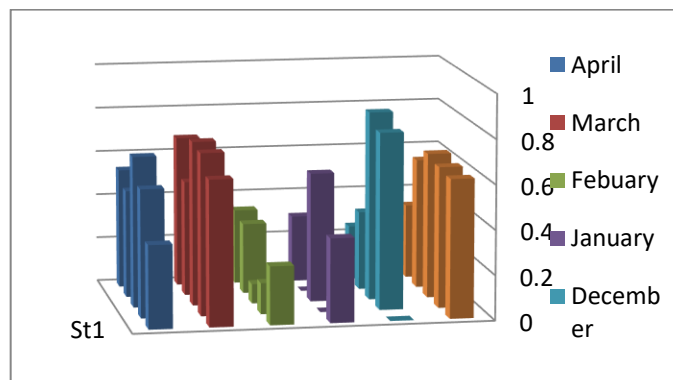


Figure 15. The species uniformity index (E) of aquatic insects species and their frequency in the study sites in the Euphrates River during the study period.

Discussion

Five genera of aquatic insects belonging to three orders were diagnosed during the six-month study period. *Chironomidae* larvae included, *chironomide pupa* (Midges), belonging to the order *Diptera*, *Zygoptera nymph*, *Odonata larvae*, belonging to the order *Odonata*, and the genus *Belostoma corodofanum*, which belongs to the order *Hemiptera*. The genus *Zygoptera nymph* was also the most dense through the study period.

The highest density was recorded in February and April, while the lowest density was recorded in December, when no species were recorded in the first and fourth sites of December Figure(11). The reason may be due to the surrounding environmental elements, such as the dissolved oxygen, nutrition, predation mechanisms, temperature, and water pollution, for Significant effect on zooplankton density (Rahemo and Ami, 2012). In addition, some species enter a state of dormancy to avoid predators and harsh environments, which affects their total numbers (Al-Douri, 2009). In addition, trophic enrichment, competition, and phytoplankton density all influence food sources and alter their overall numbers (Sharma et al., 2013; Salve et al., 2013); The density of zooplankton is directly related to the density of phytoplankton (Al-Khalidi, 2004).

Winter environmental conditions such as higher water levels and increased flow velocity lead to nutrient dilution and thus reduced phytoplankton presence, which is followed by zooplankton (Hashemzadeeh and Venkataramana, 2012). This is confirmed by the inverse relationship between the velocity of water flow and the total number of zooplankton.

The number of individuals and one taxonomic unit as compared to the entire group of individuals is represented by the index of relative abundance (Loreau et al., 2002). According to the results in the current study the aquatic insects, there was a dominance of the type *Chironomidae* larvae over the rest of the species in the third site, while the rest of the sites did not record any dominant species (Figure 12). The Constance Index reveals the stability of taxonomic groups in their environments and the nature of their recurrence (Seraphim et al., 2003),

According to the Constansy index, these species can be considered *Chironomidae larvae*, *Chironomide pupa* and *Zygoptera nymph* were the fixed species in all study sites during the study period as shown in Table (1), Temperature, salinity, turbidity, light, and the presence or absence of predators are some of the variables that impact stable species most. The most stable species have a wide range of tolerance to change in environmental circumstances (Seuront and Vincent,2008).

The D value of the aquatic insect group was high in March, while it was absent and very little in January and February, as shown in Fig. (13). The reason for its low may be the unfavorable environmental conditions. So, low of D index in this months in study sites has been attributed to increase dissolved solids and salinity in this region (Annalakshmi and Amsath , 2012). And the (H) value of aquatic insects, it had the lowest diversity in the first sites of December and the second and fourth sites of January. The highest value of diversity was at the third site of December as in Figure (14). Biodiversity is influenced by environmental factors, with reduced water flow velocity and increased species abundance (Pliurate, 1999) as well as food intake and predation (Saadallah and group, 2000). While the E-index indicates that parity is also a diversity index, which determines how equal a community is numerically (Basavarajappa et al., 2010).The absence of E-index for aquatic insects in the current study (Fig. 15) indicates the predominance of a few species with high densities indicative of environment stresses, when E-index values >0.5 are considered an equivalent species in occurrence. (Al-Jizani, 2005).at the species are evenly distributed in Lake Habbaniyah.

Conclusion



From the results obtained, we conclude that aquatic insects live in a fresh water environment with little alkalinity according to environmental measurements. Although the water of the Kufa River is pure, the biological diversity in it is low, according to the Shannon Wiener index. As well as the presence of added types of aquatic insects to the river water Which is indicated in the stability index.

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