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The values of the species richness index of rotifera varied from 3.42 to18.26 with the greatest values in April ,while lower values in September and June. The Shanon-Weiner index of rotifera ranged from 1.85 to 3.78 bits/Ind., with the highest values in April 2012 and September 2012, while lower values in June 2012 and January 2013. The uniformity index of rotifera varied from 0.01 to 0.9,these high values indicate that there is no ecological stresses on zooplankton in the study area.

I. Introduction

The rotifera play an important role in the freshwater ecosystem as optional feeders on phytoplankton and planctonic bacteria, which considered as predators (Aronovich and Spektova, 1974), most rotifera feed on algae or minutes that less than 20μ in length, but some types can engulf the cells with a total length of 48μ (Erdugan and Guher, 2005). Research has shown a clear interest in studying the rotifera, Mohammed (1986) studying the presence of rotifera in the Euphrates River and found that they are dominant quantitatively and qualitatively, especially the species belonging to the genera *Brachionus* and *Keratella* and *Polyarthra*. Al-Saboonchi *et al.* (1986) identified in their study on the marshes of Iraq's, 32 species of zooplankton were belogated to the 19 species of rotifera, 7 species of copepoda and 6 species of cladocera, the study pointed out that the highest growth of zooplankton occurs at the end of the Spring, and less growth in the Summer, while the rotifera characterized as dominant group, also had considered *Lecane* the most dominant of the rest of the rotifera . Saadallah (1998) showed in his study the impact of Hamrin impoundment on the Diyala River and identified 88 taxonomic units in five locations, the rotifera was the dominant group in that study, and the *K.quadrata, Keratella cochalaris, Polyarthra dolicoptera*, recorded a higher percentage of the total population density of the zooplankton community. Al-Lami (2000) studied the presence of zooplankton in the Tigris and Atham rivers, 38 taxonomic units were recorded with highly occupied of rotifera, while the genus *Brachionus* and *Keratella* recorded the largest number of species.

Kufa River is of great important sources of water in a wide agriculture area, drinking water, different human uses and as a source of fisheries. Due to the lack of studies on the biological diversity of this river, the current study was conducted, which aimed to recognize the quantity and quality of rotifera stationed in Kufa River and the biodiversity of rotifera within the study area by applying some biological indicators index.

II. Materials and Methods

a) Study area

Euphrates River originates from southeastern Turkey and estimated about 2290 Km in length (Al-Masoudi, 2000) it passing inside Iraqi territory for a distance of 1159 Km without any tributary, then extends 150 Km south of Ramadi Province, where Al-Hindia Dam. Then divided into two major branches, the Al-Hindiah River and Al- Hilla River, then the river being from Al-Hindia Dam at a distance of 180km even Al- Kfel district then divided after about 1Km to Al-Abasya and Kufa Rivers. The length of Kufa River within the province of Najaf, about 75.2 Km and discharge is controlled through Kufa Dam.

Four stations were selected for water sample collection. The first station in Al-Kfel City about 1Km. The second station is located after the departure of the river from Al- Kufa City about 2Km, it away approximately 22Km from the first station, the third station is located within an agricultural area in the Gurf Al-Sakhar City and lies about 20Km away from the second station. Fourth station is located at the exit of the river from the Meshkab City about 10Km, its about 20Km away from the third station (Figure 1).

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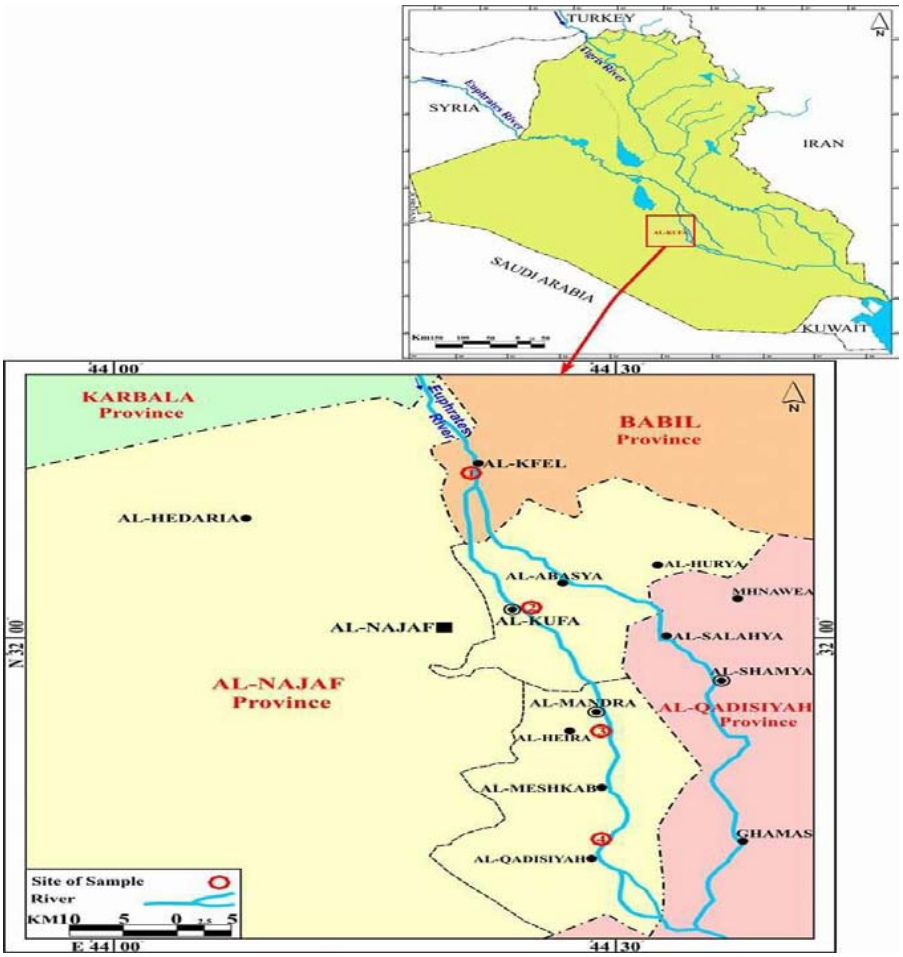

Figure (1): Map showing the study stations in Kufa River

For the purpose of this study 40 liters of water passage through plankton net type (Hydro-bios) with opening diameter 55μ. Samples were concentrated to 10ml and was keeping in bottles after addition of 4% formalin. The sample identfied and counted using a compound microscope depending on (Edmondson, 1959; Pennak, 1978; Pontin, 1978), the results expressed as individual/m^3. Environmental indicators were accounted for as follows: (1) Relative abundance index (Ra): according to the formula contained in Omori & Ikeda (1984). (2) Constancy index (S): the existence and frequency of each type of account according to the formula contained in Serafim *et al*.(2003). (3) Species richness index (D): calculated monthly according to the formula set out in Sklar(1985). (4) Shannon-Wiener index of diversity (H): monthly calculated from this value used the Shannon-Weiner equation as stated in Floder & Sommer (1999). Results expressed as bits/individual. The bit is equal one piece of information, the values less than 1 bit, means have low diversity, while more of 3 bits means high diversity. (5) Species uniformity index (E): this index is computed according to the formula contained in Neves *et al*. (2003),the values greater than 0.5 as equal or homogeneous in appearance (Proto-Neto, 2003).

III. Results and Discussion

The rotifera varied in its density in Kufa River depending on the different of months and study station. Station 1 recorded a higher density of rotifera in October 2012 with 17.925 Ind./m^3, while the lowest density was 425 Ind./m^3 during July 2012 at station 2 (Figure 2).

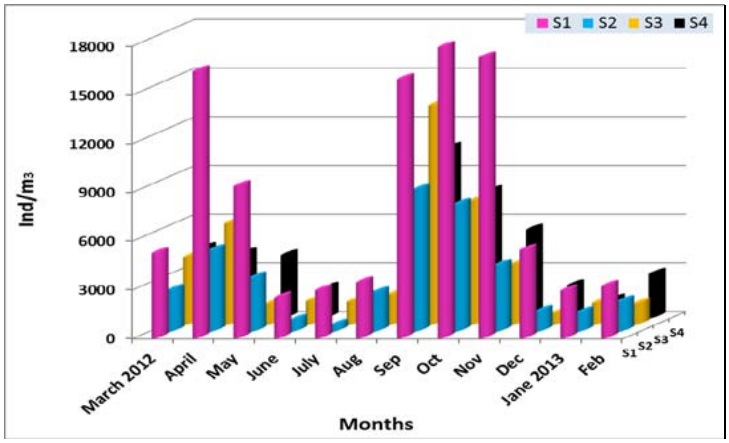

Figure (2): Total density of rotifera (Ind./m^3) in the study stations of Kufa River from March 2012 until February 2013

The high recording densities of rotifera occurred during Autumn season, especially in October, which may be related with the appropriate conditions such as:- temperature, high level of disolved oxygen and the availability of food, such as:- bacteria or phytoplankton or detritus (Dhanpathi, 2000). This result was agree with Mangalo and Akbar (1986) and Sabri *et al.* (1993) that considered the temperature and dissolved oxygen are the main factors that led to increasing the intensity of rotifera during Autumn season. The low values of rotifera density were recorded in the Summer season, which may go back to higher water temperatures, or a lack of dissolved oxygen, generally, the rotifera live with higher oxygen (Sladecek, 1983). Station 2 recorded the lowest population density of rotifera, the reason may be due to the occurrence of the station in the area receive a lot of human waste and the accompanying rise in the proportion of organic pollutants that lead to depletion of dissolved oxygen when organic pollutants degradation (Ahmad *et al*., 2011).

The relative abundance index of rotifera set out in the table (1), the proportion of the species displayed for each station in the study period, as follows: *Euchlanis delatata* recorded the highest percentage compared to the total density of other species at station 1 (12%), followed by the *Keratella valga* (10%), followed by *K. cochlearis* with (5%). *K. cochlearis* recorded the highest percentage compared to the total density of other species in station 2 (15%), followed by the *K.valga* that recorded 14%, followed by *Brachionus calyciflorus calyciflorus* 5%, while station 3 recorded the *K .valga* with the highest percentage compared to the total density of other species in this station reached to 14%, followed by *K. cochlearis* 13%, followed by *B. calyciflorus calyciflorus* 4%. Station 4 has recorded the *K. cochlearis* with highest percentage compared to the total density of other species (13%), followed by *K.valga* (11%) and *E. delatata* followed with 8% (Figure 3).

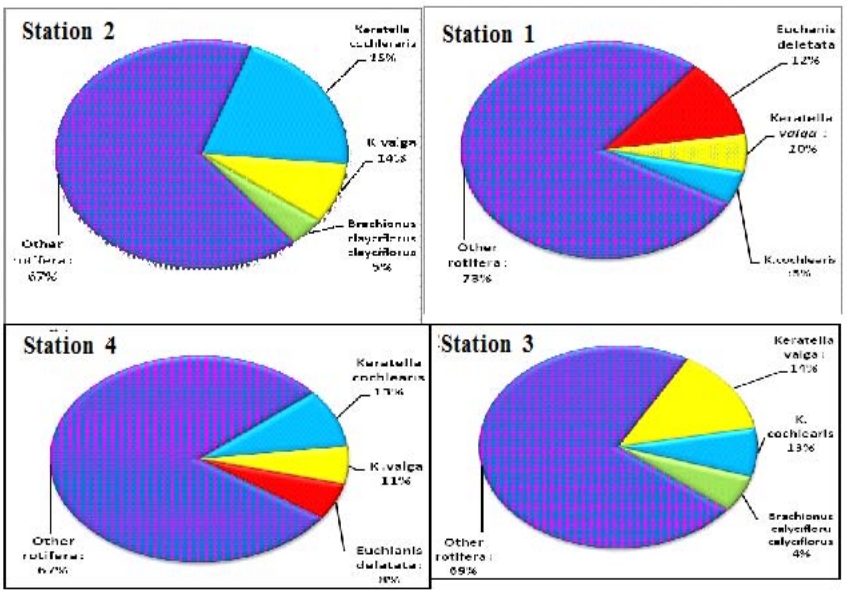

Figure (3): The relative abundance index of dominant rotifera in the study area from March 2012 to February 2013

The lack recording of relative abundance index values of the dominant species of rotifera, which failed to reach to the percentage of abundant species or prevalent as the relative abundance index, provides proof that the Kufa River has non-exposed to any type of environmental pressures during the study period, which may provide suitable for the dominant rotifera species to environment resistance (Ahmad *et al.*, 2011), Neves *et al.* (2003) shows that dominant one species or a few species in Lake Atalaia in Brazil due to the presence of high quantities of organic waste. Proto- Neto (2003) refer in his study on Ovia River in Nigeria, that the presence of many species in large numbers for any group gives evidence of a cleaner environment.

According to the constansy index these species: *Brachionus angularis*, *B. calyciflorus, Euchlanis delatata, Flinia longiseta, Keratella cochlearis, K. valga, Lepadella ovalis, Monostyla bulla, M. closterocerca* can be considered as the most frequent and so it is a constant species in Kufa river, according to this guide as it existed in 50% or more of the total samples in this study.

Nine constant taxa are unequally distributed in the study stations of Kufa River, with numbers 9,4,5,5 taxonomic unit at stations 1,2,3 and 4, respectively. Which formed 85%,41%,59% and 66% of total taxonomic units, respectively. Station 1 recorded more containment of constant species, while station 2 is less, reason for this is the fact that station 1 more environmentally stable than the rest of the stations, as observed through a high total density and diversity of this station, while station 2 was opposite of that. The species with hight frequency appearance often is that recorded with high densities in this study, may be dau to the widespread species in warm water with organic contamination (Hofman, 1998) or perhaps, species that have a wide range to withstand environmental conditions (Kulkarni and Surwase, 2013). The presence of large numbers with high frequency in the current study is compatible with (Porto-Neto, 2003) when he described the clean environment, which that contains a large number of species and high-frequency, especially species that are unbearable to the pollution. Sterner (2002) noted that the existence of the species belonging to the genera *Euchlanis*, *Filinia*, *Mytilinia* and *Monostyla* directory to clean environment.

Table (1): Taxonomic units of rotifera in Kufa River and relative abundance index (Ra Index) Constansy index (S Index). Represent R = Rare species (less than 10%), La = Less abundant species (10-40%), A = Abundant species (40-70%), D = Dominant species (greater than 70%) A = Accidental species (1%-25%), Ac= Accessory species (25% - 50%), C = Constant species (greater than 50%)

	Relative abundance Index				Constansy Index			
Station / Rotifera Taxa	1	2	3	4	1	2	3	4
Anuraeopsis fissa	R	-	R	R	Ac	-	Ac	A
Aspelta bidentata	R	-	-	-	Ac	-	-	-
Asplanchna priodonta	R	-	-	-	Ac	-	-	-
Brachionus angularis	R	R	R	R	C	C	C	C
B. bidentatus	R	R	R	R	Ac	Ac	Ac	Ac
B.calyciflorus amphiceros (long spine)	R	-	R	R	Ac	-	Ac	Ac
B.calyciflorus amphiceros (short spine)	R	R	R	R	Ac	Ac	Ac	Ac
B.calyciflorus calyciflorus	R	R	R	R	C	C	C	Ac
B. falcatus	R	R	R	R	Ac	A	Ac	A
B. haranansis	R	R	R	R	A	A		A
B. quadridentaths	R	R	R	R	Ac	A	Ac	A
B. rubens	R	R	R	R	Ac	A	Ac	A
B . urceolaris	R	R	R	R	Ac	Ac	Ac	Ac
B. zahniseri	-	R	-	-	-	A	-	-
Brachionus sp.	R	-	R	-	A	-	A	-
Cephalodella auriculata	R	R	R	R	Ac	Ac	Ac	Ac
C .intuta	-	-	R	-	-	-	A	-
C .mucronata	-	-	-	R	-	-	-	A
C . forficul	R	-	R	-	A	-	Ac	-
C. gibba	R	R	R	R	Ac	Ac	Ac	A
C. intilloides	R	-	-	-	Ac	-	-	-
Cephalodella sp.	R	-	-	-	A	-	-	-

Colurella adriatica	R	R	R	R	Ac	Ac	Ac	Ac
Colurella sp.	-	R	-	-	-	A	-	-
Dipluchlanis propatula	R	R	R	R	Ac	Ac	Ac	A
Euchlanis delatata	La	R	R	R	C	Ac	Ac	C
Flinia longiseta	R	R	R	R	C	Ac	C	A
F. opliensis	R	R	R	R	Ac	Ac	Ac	Ac
Hexarthra mira	R	R	R	R	Ac	A	Ac	A
Keratella cochlearis	R	La	La	La	C	Ac	A	C
K. hiemalis	R	R	R	-	Ac	A	A	-
K .paloda	-	R	-	-	-	A	-	-
K. quadrata (long spine)	R	R	R	R	Ac	A	A	A
K. quadrata (short spine)	R	R	-	R	Ac	A	-	A
K. valga	La	La	La	La	C	C	C	C
Keratella sp.	R	-	R	-	A	-	A	-
Lecane depress	R	-	-	-	Ac	-	-	-
L. elasma	R	R	R	R	A	A	A	A
L. hegurensis	R	R	R	R	A	Ac	Ac	A
L. luna	R	R	R	R	Ac	Ac	Ac	A
L .plosenensis	-	R	-	-	-	A	-	-
L . nana	R	-	R	-	A	-	A	-
L. ohionsis	R	-	R	R	Ac	-	A	A
L.rhombioes	R	-	-	-	Ac	-	-	-
Lecane sp.	R	-	-	R	A	-	-	A
Lepadella depresa	R	-	-	-	A	-	-	-
L. ovalis	R	R	R	R	C	Ac	Ac	Ac
L. salpina	R	-	-	-	Ac	-	-	-
L . patella	R	-	R	-	Ac	-	A	-
Lepadella sp .	R	-	-	-	A	-	-	-
Lophcaris salpina	R	-	R	R	A	-	A	A
Macrochaetus subqudratus	R	-	R	R	Ac	-	A	A
Manfredium eudactylotum	R	-	R	R	Ac	-	A	A
Monostyla bulla	R	R	R	R	C	C	C	C
M. closterocerca	R	R	R	R	C	Ac	Ac	Ac
M. lunaris	R	R	R	R	Ac	A	Ac	A
M. quadridentata	R	R	R	-	A	A	A	-
M. Stenroosi	-	-	-	R	-	-	-	A
M. thalera	-	R	R	R	-	A	Ac	A
M. thienemanni	R	-	-	-	A	-	-	-
Monostyla sp.	R	R	R	R	Ac	A	Ac	A
Monomata grandis	-	-	R	-	-	-	A	-
Mytilina mucronata	R	-	R	R	Ac	-	A	A
Notholca acuminate	R	-	-	R	Ac	-	-	Ac
N. squamula	R	-	R	R	Ac	-	A	A
Philodina roseola	R	-	R	R	Ac	-	A	A
Philodinavus paradoxus	R	-	R	-	A	-	A	-
Platyias patulus	R	R	R	R	A	Ac	A	A
P. quadricornis	R	-	R	R	Ac	-	A	A
P. polyacanthus	R	-	-	-	A	-	-	-
Polyarthra dolicoptera	R	-	R	R	A	-	A	A
P . vulgaris	R	R	R	R	A	A	A	A
Polyarthra sp.	R	-	-	-	A	-	-	A
Pomopholyx complanata	R	-	R	R	A	-	A	A
P . sulcata	R	-	-	-	A	-	-	-
Rotaria neplunia	R	R	R	R	A	Ac	A	Ac
Scardium longicaudum	R	-	R	-	A	-	A	-
Synchaete oblonga	R	R	R	R	A	A	A	Ac
Synchaete sp.	R	R	R	R	A	A	Ac	A
Pedipartia gracilis	R	-	-	-	A	-	-	-
Testudinella patina	R	R	R	R	Ac	-	A	A
Trichocerca bicristata	R	R	R	R	A	Ac	Ac	A

T . capucina	R	-	R	-	Ac	-	A	-
T . cylindrical	R	-	R	R	Ac	-	A	A
T. longiseta	R	-	-	-	Ac	-	-	-
T . insignis	-	R	-	-	-	A	-	-
T. porcellus	R	R	R	R	Ac	A	A	A
Trichocerca sp.	R	-	-	-	Ac	-	-	-
Trichotria tetractis	R	R	R	R	A	Ac	A	Ac
Tripleuchlionis plicata	R	-	-	-	A	-	-	-
Other Rotifera	R	R	R	R	Ac	A	Ac	Ac

Ninety two taxonomic units of rotifera were identified in this study. The differences and changes in the number of taxonomic units of the current study compared with the previous studies may be return to several reasons, including:- the dominant nature of environmental conditions in the area, as well as, the nature distribution of phytoplankton and the size of the aperture size of plankton net, which may be control the quantity and quality of zooplankton collected (Ajeel *et al.*,2008).

Station 1 recorded the highest value for species richness index of rotifera in April 2012 and amounted to 18.26, while the lowest values (3.42) have been recorded during July 2012 at station 2 (Fig. 4).

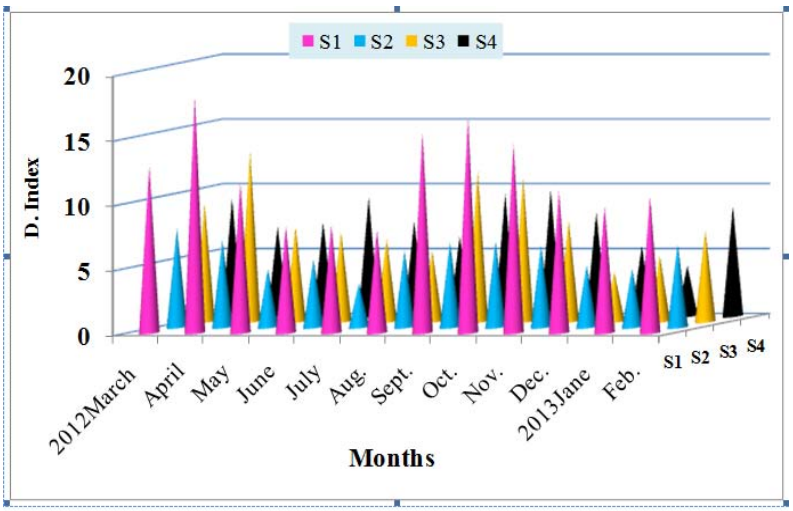

Figure (4): Monthly variations of species richness index (D) of rotifera in the stations of Kufa River from March 2012 to February 2013

Species richness index of taxonomic units abundance was a better indication of the change in the ecosystem. The increase in abundance of taxonomic units associated with an increased of bio-health community and the habitats (Barbour *et al.*, 1999).

The rotifera was the most important groups of zooplankton because of their largest numbers in the aquatic ecosystem, in addition to being vital credible evidence to assess the physical processes (Aquino *et al.*, 2008). This group showed quantity and numerically abundant in all stations, it was found 92 taxonomic units belonging to 32 genera, this which is higher than recorded in many local studies such as the study of Al-Lami *et al.*(1999) which recorded 58 species, while Ibrahim (2005) record 70 species in the Dagharah Rivers and Diwaniyah and Rabee (2007) record 34 species.

The reasons for increasing the species number of rotifera in freshwater ecosystem dating may be related to the lacking of interaction of rotifera with different trophic levels. Some species, such as *Keratella cochlearis* possibly live in a high-nutrition environments, as well as with a low level of nutrition (Ferraz *et al.*, 2009), in addition to their small size and parthenogenesis reproduction and the short periods of their growth (Ozbayl and Altındag, 2009). Also, their ability to adapt to living in low oxygen content (Jappesen *et al.*, 2002). While Jose and Sanalkumar (2012) explained the increasing number of rotifera attributed to the lack of food specialization, parthenogenesis reproduction and high fertility of it.

The genus *Brachionus* showed higher diverse than the rest, As recorded 11 species with varying degrees in all the stations, followed by genus *Lecane* with 8 species and genus *Monostyla* with 7 species and genus *Trichocerca* and *Keratella* with 6 species for each one, this corresponds with what referred to Okogwu (2010) that species belonging to the family of Brachionidae and Lecanidae numerically dominant in environments at higher temperatures and increased content of dissolved oxygen. While the following genus appeared with one species only, *Anuraeopsis, Aspelta, Asplanchna, Lophcaris, Mytilina, Rotaria, Philodinavus,*

Testudinella, Trichotria, Philodina, Pedipartia, Tripleuchlionis, Monomata, Macrochaetus and Manfredium.

The results also showed that some species may be frequented to appear in abundance in all study stations, including *Brachionus angularis*, *B. calyciflorus, Cephalodella auriculata, Colurella adriatica, Euchlanis delatata, Keratella cochlearis, K. valga, Lecane elasma, L. luna, Lepadella ovalis, Monostyla bulla and Polyarthra vulgaris*. While some species appeared only in one station, such as *Aspelta bidentata, Asplanchna priodonta*, which was appearing at station 1 and species *Brachionus zahniseri* appeared at station 2 and *Monostyla stenroosi* appeared at the station 4.

By comparing the current results with local and global studies, Al-Namrawi (2010) have recorded values to the species richness index of rotifera ranged from 2.2-1.56 in the TharThar Canal. Nashaat (2010) record values ranged from 1.23-6.174 on the Tigris River, also on the Tigris River Al-Mashhadani (2012) record a value ranged from 2.53-8.84. Ghazi and Ali (2012) recorded a value for rotifera in the Shatt Al-Arab ranged from 8.47-6.39.

Globally Aquino *et al.* (2008) record value to the species richness index of rotifera in Lake Paoay in the Philippines ranged from 2.5-2, Sleem and Hassan (2010) recorded in the Nile River, values ranged from 4.2 to 8.1.

Station 1 recorded the highest value of Shannon Weiner index for the biodiversity of rotifera through April 2012 and amounted to 3.78 bits/Ind., while the lowest value 1.85 bits/Ind. during July 2012 at the station 2 (Fig. 5).

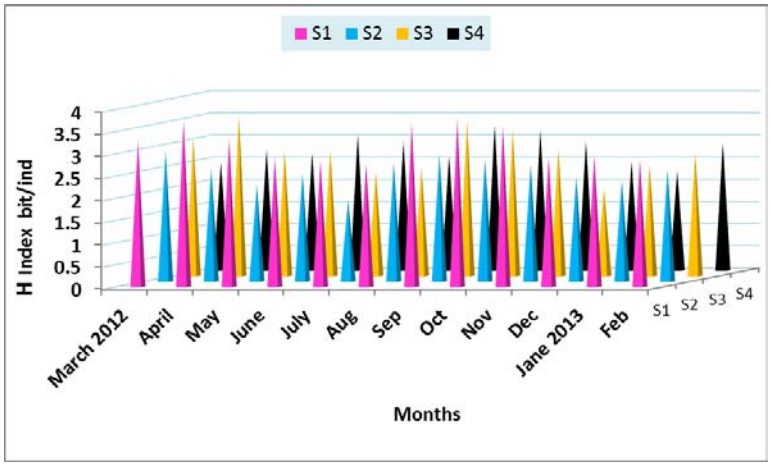

Figure (5): Monthly variations of the Shannon-Wiener diversity index(H) bits/Ind. for rotifera at four stations in Kufa River during March 2012 until February 2013

The diversity of rotifera depends mainly on the water temperature and available food that the diversity is gradually increasing in the Spring to the Summer at rising of water temperature and increasing in the density of phytoplankton, which is the source of food for rotifera and decrease diversity at the end of Autumn, when the water becomes colder (Erdugan and Guher, 2005). According to the values of Shannon- Weiner index in the current study Kufa River has highly biodiversity where exceeded more than 1 bits/Ind. and Kufa River water can be considered at this moment as moderate organic pollution,where the values more than 3 bits/ Ind.= Clean condition, values 3-1 bits/ Ind.= Moderately polluted, while values less than 1 bit/ Ind.=Heavily polluted (Goel, 2008).

By comparing the recorded values of diversity in this study with some local studies, Al-Lami *et al.*(2000) has recorded values from 2-2.2 bits/ Ind.in the Tigris River and TharThar Arm, as Al-Namrawi (2002) recorded values ranged from 0.56-2.8bit/ Ind. in the Euphrates River, while Ibrahim (2005) gives values of diversity ranged from 1.92-2.36 bits/ Ind. in the Diwaniyah and Dagharah Rivers, Al-Namrawi (2005) recorded values from 0.9-1.88 bits/ Ind. in the Tigris River and 0.7-2.4 bits/Ind. in the Euphrates River, also Shekha (2008) recorded values of diversity from 0.69-1.77bits/Ind. in the Great Zab River.

Globally Flinn *et al*. (2005) record a value ranged from 0.75-1.02 bits/Ind. in the Mississippi River in the United States, Okogwu (2010) record values in the Lake Ehoma in Nigeria ranged from 0.68-1.28 bits/Ind., Jafari *et al.* (2011) recorded values ranged from 1.21-2.48bits/Ind. in Haraz River in Iran.

Station 1 recorded the highest value of the species uniformity index of rotifera in April 2012 reached 0.99, while in July 2012 it was recorded values about 0.01 at station 2 (Fig. 6). The highest values of this index in the study stations indicate that the species was homogeneous in appearance because of the absence of any stress or environmental pressure thus providing a favorable environment for the stability of rotifer fauna. While the low-lying values for this index (few species of high density), which is a sign of the presence of environmental pressure and this is agree with what

referred to Green (1993), which is what happened in the stations 2 and 3, when that the decline in species uniformity index value of species may be due to the organic content with decline of dissolved oxygen concentrations and incressed of BOD_5 value. Thadeus and Lekinson (2010) recorded values from 0.99-0.993 in Tropical Jungle River in Nigeria also Ezekiel *et al.* (2011) recorded values ranged from 0.87 - 0.978 in Maceio Sombreiro River in Nigeria and is little like to the record in this study.

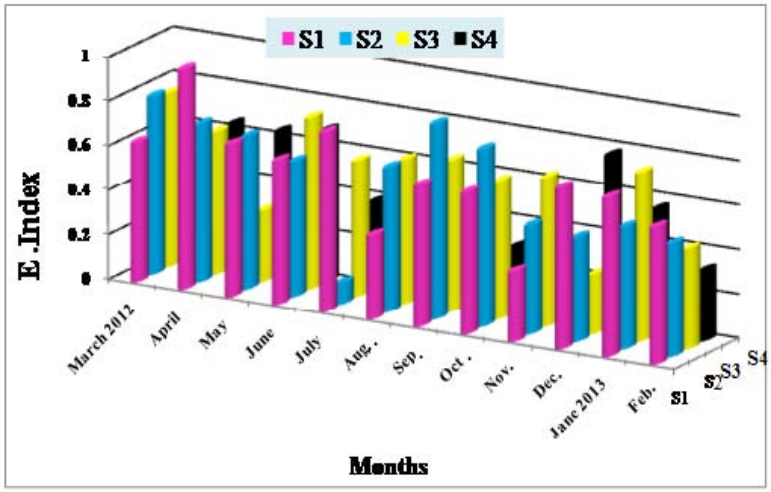

Figure (6): Monthly variations of species uniformity index (E) of rotifera in the Kufa River during the March 2012 until February 2013

Locally Ibrahim (2005) recorded values for this index in the Diwaniyah and Dagharah Rivers ranged from 1.45-1.62, also Rabee (2007) recorded values ranged from 0.41-0.99 in the Euphrates River, Nashaat (2010) recorded values ranged from 0.7-0.99 in Tigris River, Al-Namrawi (2010) recorded values ranged from 0.87-0.67 in the TharThar Canal and from 0.88-0.91 in the Euphrates River, Al-Hilfi (2011) recorded values ranging from 0.000108-0.725 in the Tigris River.

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