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Prevalence of Rotifers in the Tigris River Before and After the Al Kut Dam /Iraq

Rasha M. Salman

Department of Biology, College of Science, Wasit University, IRAQ

Corresponding Author: Rasha M. Salman

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ABSTRACT: The study took place over four seasons at two locations on the Tigris River, both before and after the construction of Al-Kut's Dam. The study period spanned from January to December 2023, during which a total of 48 taxonomic units of Rotifera were discovered. The overall population density of the Rotifera at the initial location prior to Al-Kut's Dam varied between the peak value of 10509.9 individuals/m3 in the spring and the minimum value of 2621.1 individuals/m3 in the winter. The second location downstream of Al-Kut's Dam had a peak density of 5198.8 persons per cubic meter during spring, while the lowest density of 1088.3 individuals per cubic meter was seen during winter. The study examined the indicators of relative abundance and the Shannon-Wiener coefficient of biological diversity. The values observed ranged from 2.198 to 6542 bits per individual. The index of species appearance homogeneity ranged from 0.67 to 0.85, and the index of species abundance ranged from 5.25 to 7.89. The decline in the population of Rotifera during winter is attributed to the adverse impact of cold temperatures, which hampers the restricted growth of the species. During the winter season, there is a reduction in illumination and phytoplankton, resulting in a fall in food availability. This shortage of food is responsible for the decline in Rotifera populations.

Keywords: Rotifera, Invertebrates, biodiversity, Kut Dam.

1. INTRODUCTION

Rotifers are microscopic invertebrates which have no body cavity. As key participants in zooplankton community, ctenophore species are notably flexible in their morphological aspects and can adapt to the new environmental situations. Although their anatomy is simple as they have a head and a torso that is equipped with one or more toes. Secondly, heterotrophic Flagellates or Rotifera is essential in the food chain and web of aquatic ecosystem which transfers energy from producers like bacteria and plankton to the consumers such as crustaceans, insects and fish as small [1]. It is a Nutrition variety feasting on plants and bacteria as well as other single-celled organisms and some of those feed themselves by predation [2]. Respectively, the investigation completed by [3] established such characteristics as smallness of size, short life cycle, and high sensitivity to the environment of rotifers. This project proposes itself as a stepping stone for continuing work on overlooking and providing information about all of the biodiversity indicators in all Iraqi watery areas, as the indicators are the only true reflection of the state of the environment, whereby their increase shows a healthy environment being maintained while the decrease is a sign of environmental pollution [4], [5],The three classes of rotifera reproduce by three different mechanisms: seisonidea only reproduces sexually ;Bdellloidea reproduces mainly by asexual parthenogenesis ; Monogononta reproduce alternating these two mechanism "cyclicalparthenogenesis" [6], The aquatic ecosystems are highly vulnerable to the loss of biodiversity, that is pollutants concentration sometimes kill the majority of aquatic organisms .or it may lead to a decrease in their diversity which can directly affect in the living organisms when they reach high concentration [7], this leads to a reduction in their natural size ,or they cannot complete a certain stage of their life, which often occurs due to pollution [8], Also ,the basic of natural food for most aquatic life is invertebrates, so any environmental imbalance affects these organisms, as is these case with some pollutants introduced in to the water ,which negatively affect living organisms[9], But the movement of water and the velocity of water currents lead to a change in the properties of the water environment ,which affects the growth and distribution of rotifera that

leads to its movement from one place to another inside or outside the ecosystem [10], this organism is essential to maintaining the ecological balance [11], [12].

2. METHODOLOGY

2.1 Study Area

Al-Kut Dam is creating in Wasit Province, in the city of Kut, on the river of Tiger in 1999 [13]. Al-Kut Dam is one of the most important irrigation facilities on the Tigris River, as it controls water distributions between each of the governorates (Wasit - Maysan - Dhi Qar) and provides irrigation for projects on the Al-Gharraf River, Al-Dujaila Project, and the Dalmaj Projects. By constructing the Dam and the Al-Gharraf regulator, it was possible to secure water to irrigate approximately one and a quarter million dunums of arable land and to benefit from the project in securing water to irrigate the lands of the Dujaila project, which has a total area of 396 thousand dunums, and the Dalmaj project, which has an area of 400 thousand dunums, in its three parts (Al-Hawar, Al-Husseiniyah, and Al-Mazak).

Al-Kut Dam, which is 550 meters long, consists of 56 openings, each with a vertical door, its dimensions are 6.00 * 6.50 meters, and it is operated manually and electrically. The design discharge of the dam is 6000 m/s, at a level of 16.75 meters above sea level. Before the doors were raised, however, this level was developed to 18.50 above sea level by raising the doors by 1.20, so that its height was 6.50 meters above its original level at the front of 12.00 and 18.75 at the rear. The operating level of the dam currently stands at 18.00 m above sea level, and the length of the floor is 24.70 m at the front of the dam and 57.80 m at its rear.

Two Sites were chosen to conduct the current study on the Tigris River. The first site (S1) is 2.5 km away from Al-Kut Dam, located at longitude 45° 49' 8.863" and latitude 32° 29' 48.937", and the average width of the river is about 50 m and a depth of 2.5 m. The river bed is characterized by being sandy and containing pebbles of different sizes, and both sides of the river are devoid of vegetation. The second site (S2) is 3.5 km away after Al-Kut Dam and is located at longitude 45° 49' 18.264" and latitude 32° 29' 54.168". The average width of the river is about 45 m and a depth of 2 m. The river bottom is almost alluvial and has almost stable environmental conditions. Agricultural areas surround both sides of the river and it is characterized by the presence of aquatic plants such as reeds and papyrus, and it is a good area for fishing.

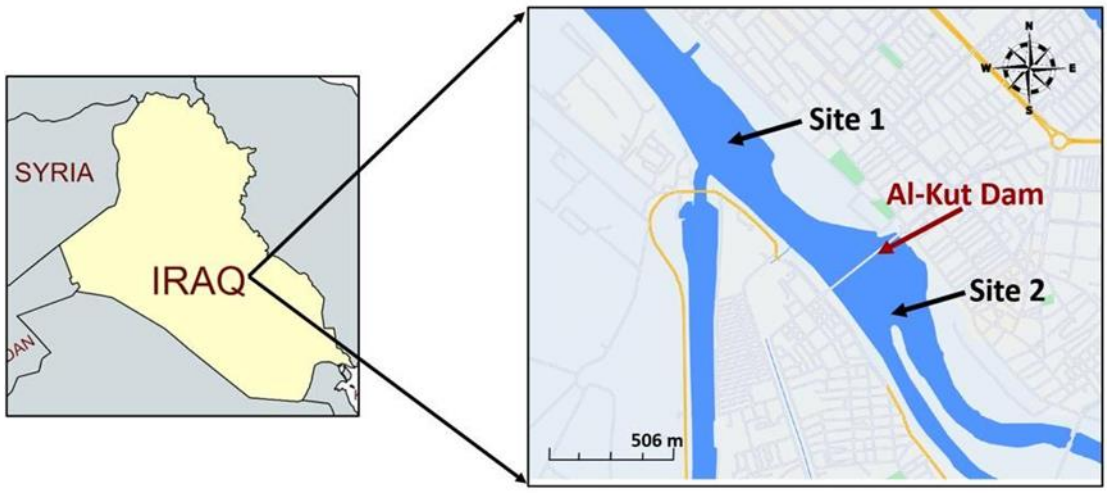

FIGURE 1. Study location on Kut Dam Map

2.2 Sample Collection

Seasonal samples were taken during the year 2023. Forty-five samples were taken from each site's water at a depth of 0.5-1 m below the water's surface. A 55µ Hydro-Bios plankton net was used to filter these samples. Finally, 4% formalin was added to 10 ml samples and kept in special vials [14]. The species were seen using a compound microscope and identified using several identification keys [15], [16], [17], [18]. The results were quantified as the number of individuals per cubic meter (individuals/m3).

Diversity indicators the subsequent ecological indicators have been assessed: The Relative Abundance Index (Ra) is a measure of the proportionate representation of a certain species or group in a given population or community. The computation was performed using the formula proposed by [19]. The formula for calculating the relative abundance (Ra%) is expressed as Ra% = (N÷Ns)*100, where N represents the number of individuals inside each taxonomic unit, and Ns indicates the total number of individuals in the sample. One of the daily trials was to compute the Species Richness Indicator (D) with the aid of [20] formula. To calculate diversity index (D), formula is S-1ASES I = log log N, wherein S is the total number of species and N is the number of individuals. We had used the Shannon-Weiner Diversity Index

(H), which was devised by [21], on a monthly basis. The H formula is given by the sum of the product of arithmetic mean of individuals in each taxonomic unit by the number of individuals and natural multiplied logarithm of mean. Invited special unit presented the evaluation results. By the calculations preset by [22] Species Uniformity Index (E) was computed. E=H/LnS represents the diversity connection, not a specific variable H. In the LNS, n is the maximum diversity value.

H: The Shannon-Weiner value stands for diversity or the richness of an ecosystem when concerns the biodiversity. S: It is just an index representing how many different taxonomical groups are located within a certain area. It was who, in his work [23], found out that an index greater than 0 was one of the most important indicators of stability in an ecosystem. Therefore, the index of 5 would suggest homogeneity of a population.

3. RESULTS AND DISCUSSION

A total of 48 species of Rotifera were detected at all sites during the whole duration of the investigation. The genus Brachionus had the maximum number of recognized species, with a total of 7. The genus Keratella had 6 identified species, the genus Lecan had 7 identified species, and the genus Monostyla had 3 identified species. Out of the 48 species detected throughout the research period, 15 species were found to be frequent among the locations. This discovery aligns with the achievements made by [24].

The first site has 14 Rotifera species, and 1992 Rotifers were found monthly. 3 individuals/m3. The peak of density was in springtime when it reached 10,509 monthly units. The lowest in winter, 2,621 person/m3, and annual average fall to 9/m3. 1 individuals/m3. Two species of Rotifera was found at second location, and the population density was around 9796 per monthly. 8 individuals/m3. The highest amount of them was counted at the beginning of spring, 5198. the 8 individuals/m3 average in summer, and 1088 which is the lowest in winter. 3 individuals/m3. Maybe this happens because of spring bloom of phytoplankton, as well as water temperature one of environmental factors which are affecting population dynamics and abundance of Rotifers in summer. Speeding up the degradation rate benefits the process because the water gets enriched with nutrients. This is then met by an increase in the evaporation process in summer, as well as by rising nutrients, phytoplankton and microrganisms' concentration, and by many factors, one of which is a drop of water level. This decreases the water density. Such an outcome coincides basically with available records of such species numbers. [25]. Figure (2) [26].

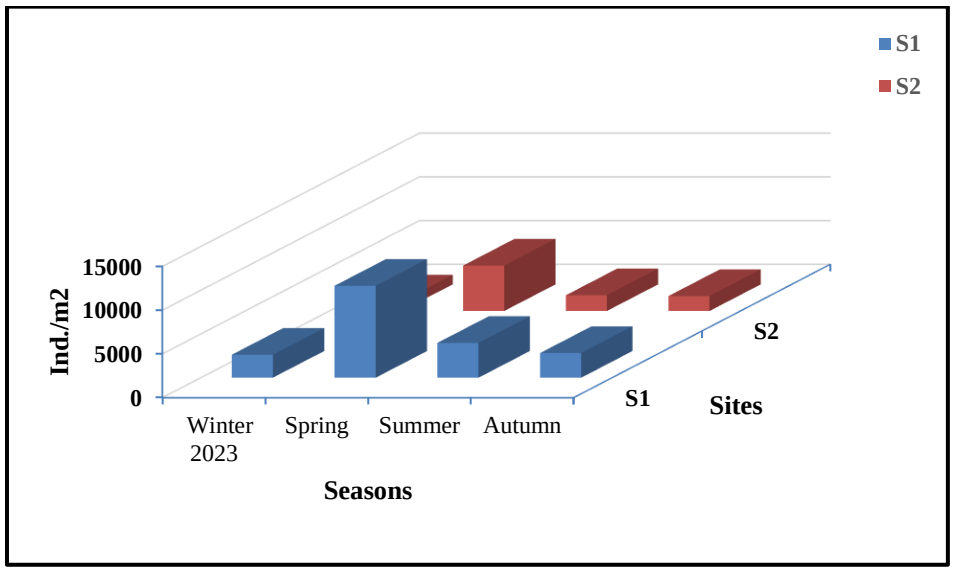

Figure 2. Seasonal changes in Rotifera total density during the study

3.1 Environmental indicators

The values of the Shannon-Wiener index of total diversity for the first ecosystem prior to the Tigris River behind the Kut Dam fluctuated between 6542 bits/individual and 1. 686 bits/individual. The highest value was during winter and the lowest value was during spring. After Al-Kut Dam, the values of the Shannon-Weiner index varied between the highest value, 2.524 bits/ individual during winter, and the lowest value, 2.198 bits/ individual during spring (Figure 3).

The site changes of the first site before the Dam recorded high values for the Shannon-Wiener index for total biodiversity, which is indicate to the availability of suitable environmental conditions, such as high dissolved oxygen concentrations and the abundance of phytoplankton. as a result of storing water in the Dam [27], these conditions

contribute greatly to increasing the diversity of Rotifera, as they depend on them extensively [28]

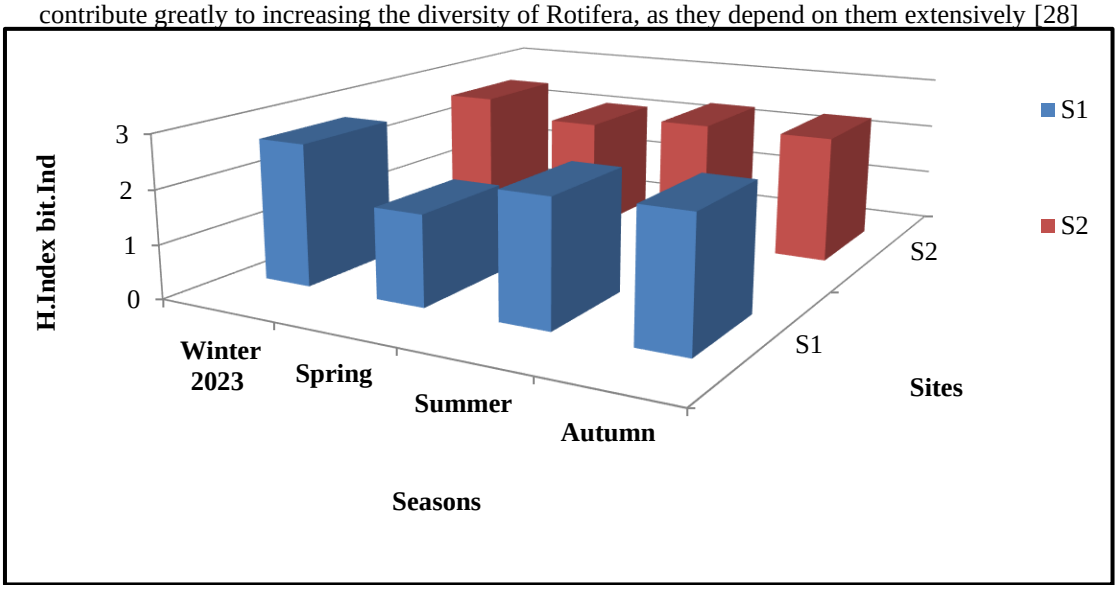

Figure 3. Seasonal variation in the Shannon-Weiner index (H) of rotifers at Kut Dam examined during the study period

The species abundance index, as depicted in Figure (4), serves as a reliable indicator for assessing changes in the ecosystem. It is evident that an increase in the abundance index of taxonomic units, including the count of different species, is closely associated with the growth of the biological community and its habitat [29]. The second location had the lowest abundance percentage, measuring 5.25 during fall. Conversely, the first site had the highest abundance percentage, measuring 7.89 during winter. The rise in the prevalence of Rotifera species can be attributed to multiple factors. One of these factors is the occurrence of drought during the sampling period, which resulted in a reduction in water flow velocity. Additionally, the influx of driftwood from dam reservoirs and tributaries has contributed to the increased abundance of species. Furthermore, the presence of abundant vegetation has created a favorable habitat for coastal species that attach themselves to plants. Similarly, the ample availability of food along the river path influenced the dispersion of the Rotifera population in the food habitats, following the concept of exploiting transported food resources [30]. Also, the variation in the number of Rotifera identified in the water body may be due to the variation in the properties of the water and bottom and the nutrient abundance. In addition to the small size of Rotifera, their parthenogenetic reproduction, their short life spans, and the predation of fish on zooplankton larger than them [31].

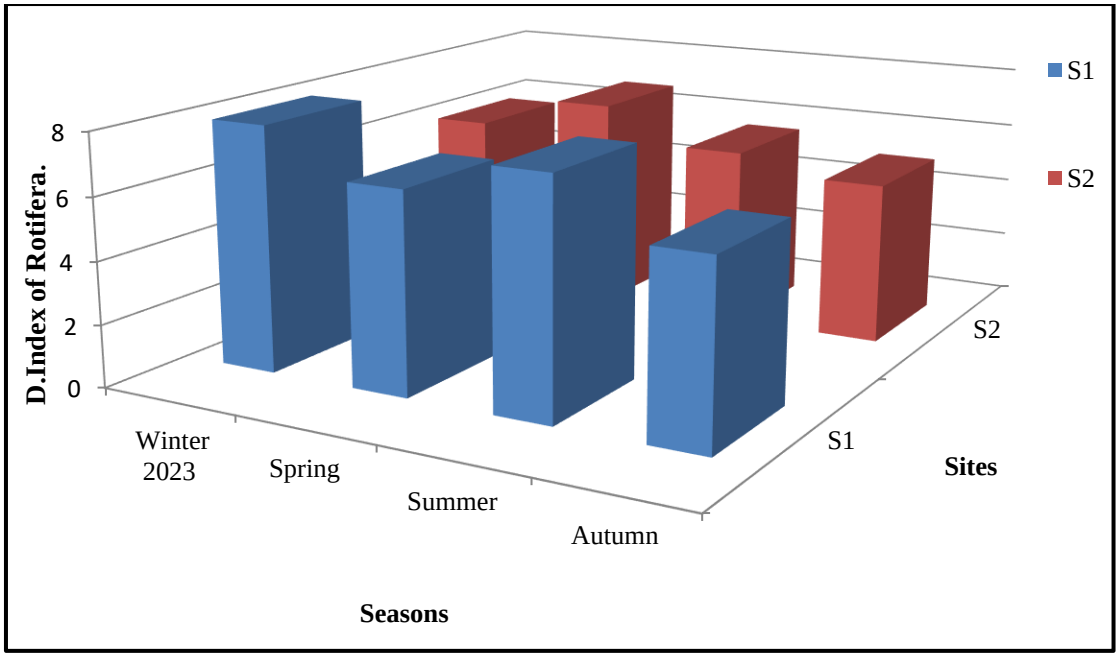

FIGURE 4. Temporal variation in rotifera species richness index was observed at Kut Weir throughout the study period

The results of the homogeneity of species appearance (Figure 5) showed that the highest rates were in winter and reached 0.85 at the first site before the Al-Kut Dam, and the lowest value was 0.51 in spring. The second site after Al Kut Dam recorded the highest rate in winter, reaching 0.87, and the lowest in spring, reaching 0.67. The species homogeneity index values in the current study suggest the lack of environmental pressure, creating a favorable habitat for the stability of zooplankton species in the Tigris River. Most seasons recorded values over 0.5. Thus, the species are considered homogeneous in their appearance, and this is consistent with what [32]. pointed out, that the lack of an index of the homogeneity of species appearance indicates the dominance of a few species at high densities, which is an indication of the presence of environmental pressure. This explains the low index of the homogeneity of the appearance of species in the first site before the Dam. It may be the result of the significantly higher water level this month, which explains the decrease in the index of homogeneity in the appearance of species. This can be related to the increase in organic content with the rise in water and nutrient levels to the point of food abundance that allows the dominance of a few species at high densities.

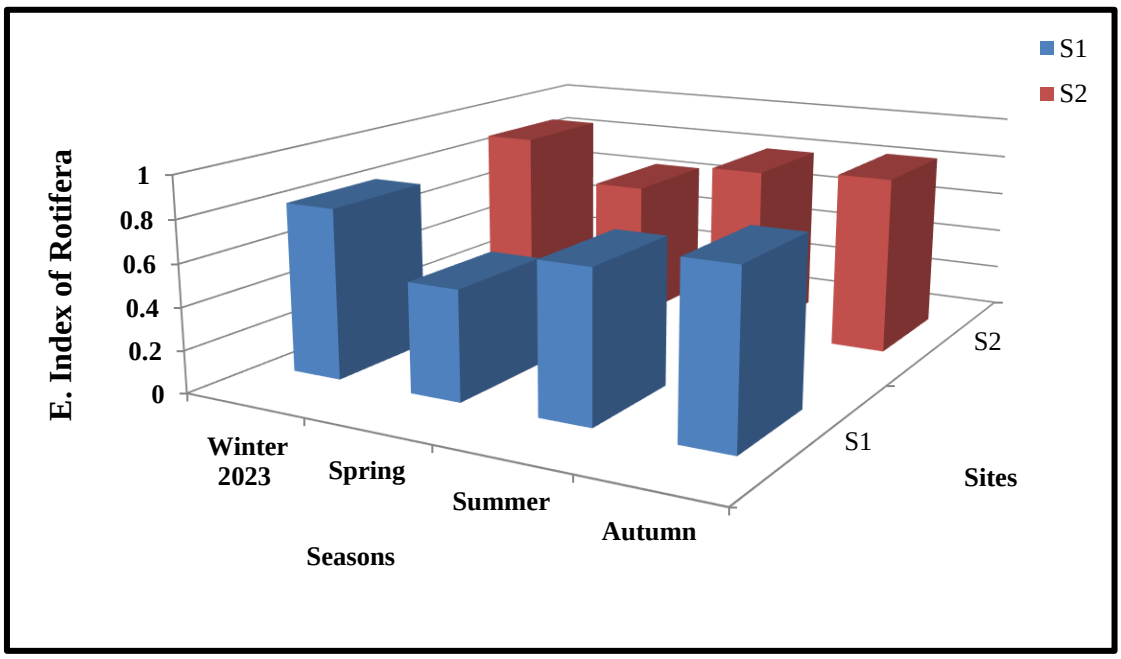

FIGURE 5. Rotifera species homogeneity index (E) seasonal fluctuations in Kut Dam throughout the research period

Based on the relative abundance index, it is evident that there are eight species that were the least numerous in all sites. These species include *B.calcyflorus calcyflorus, Brachionus angularis, K.quadrata* (short spin), B.*calcyflorus amphecerus, Brachionus urceolaris, Keratella cochlearis, K.tropica, and K.valga*. Regarding the remaining species, they exhibited a low occurrence rare, as indicated in Table 1.

Table 1. Relative abundance index (Ra Index) = R = rare species (<10% and La = less abundant species (40%-10%) and A = Abundant species) (70%-40 % and D = Dominant species (>70%). in the samples in the studied sites at the Tigirs River.

	Taxa	Site	Ra	
			1	2
	ROTIFERA			
1	***Anuroaeopsis fissa* Gosse, 1851**		-	-
2	***Aspelta bidentata* (Wulfert, 1961)**		-	-
3	***Asplanecna priodonta* Gosse, 1850**		-	R
4	***Brachionus angularis* Gosse, 1851**		-	La
5	***B.calcyflorus calcyflorus* Pallas, 1766**		R	R

6	***B.calcyflorus amphecerus* (long spin) Pallas, 1766**	-	-
7	***B.calcyflorus amphecerus* (short spin) Pallas, 1766**	R	R
8	***B.quadridentatus* Hermann,1783**	-	-
9	***B.plicatlus* Müller,1786**	-	-
10	***Brachionus urceolaris* Müller, 1773**	R	R
11	***Cephalodella aureculata* (Wulfert, 1938)**	-	-
12	***Cephalodella gibba* (Ehrenberg,1830)**	-	-
13	***Colurella adriatica* (Ehrenberg, 1831)**	-	-
14	***Euchlanis delatata* Ehrenberg, 1832**	-	R
15	***Fillina longisetea* Ehrenberg, 1834**	R	-
16	***Hexarethra mera* Hudson,1871**	-	-
17	***Keratella cochlearis* (Gosse, 1851)**	R	R
18	***K.tropica* (Apstein, 1907)**	R	R
19	***K.quadrata (*Müller, 1786)**	R	-
20	***K.quadrata* (logn spin) Müller, 1781**	-	R
21	***K.quadrata* (short spin) Müller,1781**	La	La
22	***K. valga* Ehrenberg, 1834**	R	R
23	***Lecan crepida* Harring, 1914**	R	-
24	***L.elasma* Harring & Myers, 1926**	-	-
25	***L. luna (*Müller, 1776)**	-	R
26	***Lecan thienimeni* (Hauer, 1938)**	-	-
27	***L.ohioensis* Myers, 1926**	-	-
28	***Lepadella salpina* Donner, 1943**	-	R
29	***Lophocharis salpina* Ehrenberg, 1836**	-	-
30	***Manfridum.eudactylotum* Remane, 1929**	-	-
31	***Monostyla bulla* (Hauer, 1952)**	-	-
32	***Monostyla closterocerca* (Edmondson, 1935)**	-	R
33	***Monostyla hamata* Stokes, 1896**	-	-
34	***Notholca acuminate (Ehrenberg, 1832)***	-	R
35	***Notholca squamula* (Ehrenberg, 1832)**	-	-
36	***Philodina roseola* (Hickernell, 1917)**	R	-
37	***Polyarthra dolicoptera* Idelson, 1925**	R	-
38	***Pomopholyx sulcata* Gosse, 1851**	-	R
39	***Rotaria citrinus* (Weber, 1923)**	-	-
40	***R.neptunia* Ehreberg,1830**	R	-
41	***Stephanoceros fimbriatus (Larva)* Berzins, 1951**	R	R
42	***Syncheta oblonga* Ehrenberg,1831**	-	-
43	***Syncheta pectiraeta* Ehrenberg, 1832**	-	-
44	***Trichocerca bicristata* (Wulfert, 1956)**	-	-
45	***Trichocerca elongata* (Gosse, 1886)**	-	-

46	***Trichotria tetractis* (Ehrenberg, 1830)**	-	-
47	***Testudinella patina* (Hermann, 1783)**	-	-
48	***T.rousseleti* (Voigt, 1901)**	-	-

4. CONCLUSION

1- A total of 48 species of Rotifera were detected at both sites for the whole duration of the investigation. The genus Brachionus had the greatest number of species, with a total of 7. The genus Keratella had 6 species, the genus Lecan had 7 species, and the genus Monostyla had 3 species.
2- high values of the homogeneity index were recorded in this study, which indicates the absence of environmental pressure and thus provides a stable environment for Rotifera species.
3- Higher densities of Rotifera were recorded for the sites before the Dam, while the sites after the Dam had lower densities, as the backwater stored in the Dam, in which Rotifera abound as a result of storage, increased their density after the Dam by releasing the stored water. The increase in their density appeared in spring in the Tigris River.

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