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ORIGINAL ARTICLE

DIVERSITY AND SPATIOTEMPORAL VARIATIONS OF ROTIFERA OF THE SAMARRA DAM, IRAQ

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ABSTRACT

This investigation is the first of its kind in this reservoir for more than three decades, it aimed at evaluating the diversity, abundance, and spatiotemporal variations of rotifers in the Samarra dam during 2023. Three distinct sampling stations were selected to ensure a comprehensive coverage of the dam. The first station was located just below the river's entrance to the dam. The second station was situated near the Samarra Barrage, while the third was positioned close to the Tharthar Regulator. Fifty-seven taxa from fourteen families of rotifers were identified, classified into three orders: Ploima, Flosculariaceae, and Bdelloida, under the Eurotatoria class. Most abundant taxa were *Synchaeta oblonga* Ehrenberg,1832, *Rotaria neptunia* (Ehreberg,1830), *Euchlanis dilatata* Ehrenberg, 1832, *Polyarthra dolichoptera* Idelson,1925, *Brachionus calyciflorus* Pallas, 1766 (long and short spine), *B. urceolaris* Müller, 1773, and *Keratella cochlearis* (Gosse, 1851). Minimum and maximum densities were in winter and spring, respectively. Mean values for richness, evenness and diversity indices were 5.18, 4.75 and 6.37; 0.8, 1.8 and 0.8; 2.2, 1.8 and 2.4 bits/ind. At stations 1, 2 and 3, respectively. Seasonally, the highest and lowest values of evenness and diversity indices were in summer and winter, respectively, while the richness index it was observed in autumn and spring seasons. Also, the highest similarity index value was 68.78% between first and third stations. Whereas the largest difference of species composition observed between second and third stations reached 7.76%.

Keywords: Brachionidae, Constancy, Diversity, Lecanidae, Rotifers, Samarra Dam.

INTRODUCTION

Rotifera, commonly known as wheel organisms, because there is the ciliated ring located on the top of their head (Manickam *et al*., 2019; José de Paggi *et al*., 2020). Generally, it is microscopic, and varies between 40-2,000 µm in size, composed of thousands of cells, unsegmented, bilaterally symmetrical, pseudocoelomate animals (Wallace *et al*., 2015; Manickam *et al*., 2019; José de Paggi *et al*., 2020). Segers (2007) states that this group is found in various aquatic systems and classified into three main groups: Monogononta, Bdelloidea and Seisonida. Most rotifers inhabit freshwater, while some can survive in salty waters (Balian *et al*., 2007; Segers, 2008).

These organisms, particularly Rotifera, give a complete visibility of the condition of an aquatic system and serve as bioindicators for pollution and eutrophication (Renuga *et al*., 2010; Abbas and Talib, 2018; Majeed *et al*., 2022a; Sharaf *et al*., 2023).

Many regional studies have concentrated on zooplankton in the Tigris River, with particular attention given to rotifers such as those by Sabri *et al*. (1993), Majeed *et al*. (2021, 2022 a, b, 2023 a, b) and Abed *et al*. (2022). For a long time, there have been no zooplankton studies conducted in this section of the river. As a result, this research is the first of its kind in this reservoir in over thirty years, aiming to assess the diversity of rotifers in the water of Samarra Dam.

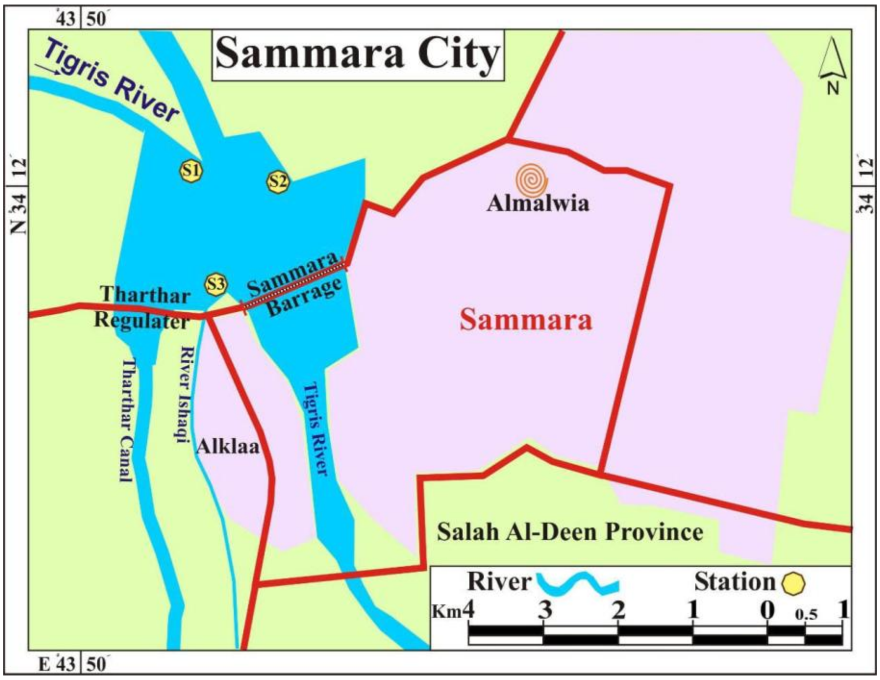
MATERIALS AND METHODS

Study area: In the western part of Samarra City, the multipurpose Samarra Dam sits. The main goal of this project is to redirect floodwaters from the Tigris River to the Tharthar Reservoir during flood periods via the Tigris-Al Tharthar Canal. This system is utilized for irrigation, flood management, and power generation. The Züblin company completed the project in 1956. It has 17 control gates that allow 7,000 m^3/s of water to flow the Tigris, whereas the Tharthar regulator allows 9,000 m^3/s to flow through a canal with 36 gates (Abdulridha and Al Thamiry, 2017).

Study area description: The study area was the Samarra Dam located on the Tigris River in Salah Al-Din Province. Samples were taken from February to December 2023 at three selected stations. The first station was located upstream the dam and directly below the river's entrance (34°12'25.8"N 43°50'50.2"E). The second station was located near Samarra Barrage at 34°12'22.8"N 43°51'28.0"E. Whereas, the third station was located near Tharthar Regulator at 34°11'53.4"N latitude and 43°51'04.9"E longitude (Tab. 1, Map 1).

Table (1): Coordinates for three selected stations in the Samarra Dam for the period from February to December 2023.

Stations	GBS Coordination		Explanation
	Latitude lines	Longitude lines	
S 1	34°12'25.8"N	43°50'50.2"E	Below the river's entrance
S 2	34°12'22.8"N	43°51'28.0"E	Near the Samarra Barrage
S 3	34°11'53.4"N	43°51'04.9"E	Near the Tharthar Regulator



Map (1): Showing locations of studied stations in Samarra Dam. (Source: Ministry of water Resources\ General Authority of Survey, 2023).

Sampling Collection: During a complete year 2023, the samples were taken from the littoral zone at < 1 m depth every two months; 45 litres of water were filtered through a funnel-shaped planktonic net with a 55-micron mesh size, with the aid of a graduated pail. After filtration, the retained material in each mesh was washed with filtered river water. Each sample was preserved in 4% formalin (Juday, 1916; Welch, 1948; Rocha *et al*., 2021).

Identification of Rotifers: After the sample had condensed, the Rotifera were identified to the lowest taxonomic unit using a Sedgewick-Rafter counting slide under a compound microscope. The rectangular hollow slide held precisely one milliliter of water sample, measuring 50 mm in length, 20 mm in width, and 1 mm in depth. The density was determined by the formula provided by Baird *et al*. (2017).

$$\text{Rotifera Ind./m}^3 = \frac{n}{\text{Volume of sample}} \text{X } 10^3$$

Where n is rotifers number.
The results were presented as the number of individuals per m^3

Identification is based on the revisions by Edmondson (1959), Pontin (1978) and Smith (2001) supplemented by recently published additions (Wallace *et al*., 2015; José de Paggi *et al*., 2020).

Following identification keys were used to distinguish and differentiate among the rotifer species based on variations in external morphology, including shape, corona, neck, trunk, spine, foot, and toes.

- Variations in shapes: some species have sack-shaped, e.g., *Asplanchna priodonta* Gosse, 1850, oval-shaped e.g., *Lepadella ovalis* (Müller, 1786), cylindrical-shaped, e.g., *Trichocerca bicristata* (Gosse, 1887), bell-shaped, e.g., *Synchaeta oblonga* Ehrenberg, 1832, and elongated shape, e.g., *Rotaria citrina* (Ehrenberg, 1838).

- Variations of the foot: includes the presence or absence of the foot, the presence or absence of toes, and their structure and length. The foot often extends ventrally from the body. For example, *Keratella cochlearis* Gosse, 1851 lacks a foot, while *Brachionus calyciflorus calyciflorus* Pallas, 1776 has a posterior foot with equally sized toes.

- Toes variations can include number, length, size, and shape. Usually, a foot possesses two toes, but this number can range from zero to four. For instance, *Cephalodella gibba* (Ehrenberg, 1830), and *Lepadella ovalis* (Müller, 1786) each have two long, slender toes. The foot in *Trichotria tetractis* (Ehrenberg, 1830) is composed of 3 segments, the first segment bearing two dorsal triangular spines. The second segment of the foot is longer than the other two. Toes long, slender, ending in a point.

- Variation of the corona: included the presence or absence of cilia, the number of rows of cilia, structure, shape, location, and size. For example, the corona of *Collotheca ornate* (Ehrenberg, 1832) is modified into a funnel surrounding the mouth. In *Testudinella patina* (Hermann, 1783), the cilia around the mouth have disappeared, leaving just two small circular bands on the head. In the bdelloids, the upper band splits into two rotating wheels.

- Variations in the lorica: include its presence or absence, shape, length, size, and rigidity. For example, in *Synchaeta oblonga* (Ehrenberg, 1832), the lorica is absent. In *Brachionus plicatilis* (Müller, 1786), the lorica is spherical in shape. In *Brachionus urceolaris* (Müller, 1773) the lorica is hard with longitudinal lines. While in *Lepadella ovalis* (Müller, 1786), the lorica is without striations.

- Variations of the spines: included the presence or absence of the spines, number, longevity, and location on the anterior edge or posterior of the lorica. For example, *Brachionus angularis* Gosse, 1851, lacks any anterior spines, only the median spines are prominent and there is a deep sinus in between them. *Keratella cochlearis* Gosse, 1851 has six spines along the anterior dorsal margin of the lorica, the median spines being the longest and curved ventrally. Additionally, there are two unequal posterior spines, with the right spine always longer than the left. The genus *Brachionus* is distinguished by the presence of spines along its anterior border. For example, *Brachionus calyciflorus calyciflorus* Pallas, 1776 has four broad-based spines, with the medial spines being slightly longer than the lateral ones, along with two posterolateral spines. In contrast, *Brachionus forficula* Wierzejski, 1891, has four anterior spines varying in length, where the lateral spines are longer than the medial ones.

It is important to note that the differences among species, such as increased body size, thicker lorica, and the development and elongation of spines as morphological defenses, can effectively protect animals from being captured. This phenomenon is known as hidden defensive morphology in rotifers. For example, *Brachionus forficula* Wierzejski, 1891 can develop long or short posterior spines in response to predators or environmental conditions (Ge *et al*., 2012; Yin *et al*., 2017).

Ecological indicators: The following ecological indices have been used to determine Rotifera diversity such as Relative Abundance Index (Ra) (Omori and Ikeda, 1984); Constancy Index (S) (Ishizaka and Labib, 2011); Jaccard similarity index (Jaccard, 1908); Species Evenness Index (J) (Magurran, 2004); Species Richness Index (D) (Margalefe, 1968) and Shannon-Weiner Index (H') for diversity (Shannon and Weaver, 1949). Results are represented in bits per individual, where a bit is defined as a single piece of information. An ecosystem with H' value greater than 2 bits per number has been regarded as medium to high diverse in terms of species (Majeed *et al*., 2022a; Charlotte and Dronkers, 2025).

RESULTS AND DISCUSSION

Species composition

According to the current investigation, fifty-seven rotifer species belonging to 26 genera and 14 families were identified from three stations in Samarra Dam water as listed below: 36 species in station 1, 49 species in station 2 and 44 species in station 3 (Tab. 2).

Findings revealed that the genus *Brachionus* has 11 species including *Brachionus angularis* Gosse, 1851, *B. bidentatus* Anderson, 1889, *B. calyciflorus calyciflorus* Pallas, 1776, *B. calyciflorus f. amphiceros* Ehrenberg, 1838 (long spin), *B. calyciflorus f. amphiceros* Ehrenberg, 1838 (short spin), *B. forficula* Wierzejski, 1891, *B. havanaensis* Rousselet, 1913, *B. quadridentatus* Hermann,1783, *B. quadridentatus* Hermann,1783 (long spin), *B. quadridentatus* Hermann,1783 (short spin) and *B. urceolaris* Müller, 1773. *Lecane* has 11 species including *Lecane elasma* Harring & Myers, 1926, *L. luna* (Müller, 1776), *L. tenuiseta* (Harring, 1914), *L. bulla* (Gosse, 1851), *L. closterocerca* (Schmarda, 1859), *L. hamata* (Stokes, 1896), *L. quadridentata* (Ehrenberg, 1832), *L. lunaris* (Ehrenberg, 1832), *L. stenroosi* (Meissner, 1908), *L. stenroosi* (Meissner, 1908), *L. stenroosi* (Meissner, 1908), *L. stenroosi* (Meissner, 1908), *L. thalera* (Harring & Myers, 1926) and *L. thienemanni* (Hauer, 1938). *Keratella* has 5 species including *Keratella cochlearis* (Gosse, 1851), *K. quadrata* (Müller, 1786) (long spin), *K. quadrata* (Müller, 1786) (short spin), *K. tropica* (Apstein, 1907) and *K. valga* (Ehrenberg, 1834). *Trichocerca* has 3 species including *Trichocerca bicristata* (Gosse, 1887), *T. rousseleti* (Voigt, 1902) and *T. similis* (Wierzejski, 1893). *Asplanchna* has 2 species including *Asplanchna brightwellii* Gosse, 1850 and *A. priodonta* Gosse, 1850. *Lepadella* has 2 species including *Lepadella ovalis* (Müller, 1786) and *L. salpina* Ehrenberg, 1834. *Platyias* has 2 species including *Platyias patulus* (Müller, 1786) and *P. quadricornis* (Ehrenberg, 1832). *Polyarthra* has 2 species including *Polyarthra dolichoptera* Idelson,1925 and *P. vulgaris* Carlin, 1943. *Rotaria* has 2 species including *Rotaria citrina* (Ehrenberg, 1838) and *R. neptunia* (Ehreberg,1830). *Synchaeta* has 2 species including *Synchaeta oblonga* Ehrenberg,1832 and *S. pectinata* Ehrenberg, 1832. Whereas other identified genera had only one species.

Among the various families of rotiferians, Brachionidae and Lecanidae have the highest number of species, with 20 and 11 identified taxa respectively. The dominance of these two families is likely due to the remarkable adaptability of their organisms to different limnological conditions and available food sources (Liu *et al*., 2023; Kuczyńska-Kippen *et al*., 2025). Species from these families are typically predominant in different aquatic systems (Kuczyńska-Kippen and Ejsmont-Karabin, 2020; Phan *et al*., 2021; Bozkurt, 2024).

Density and abundance ratio

Diagram (1) shows the total density of rotifers. In the first station, values of rotifer densities varied between 855.2 Ind./m^3 and 3530 Ind./m^3 in December and April, respectively. In the second station, the values varied between 826.4 and 159198.18 Ind./m^3 in August and February, respectively. In the third station, the minimum value was 621.7 Ind./m^3 in December while the maximum value was 4110 Ind./m^3 in October. As well, the total rotifera density was 10940.26, 310934 and 14010.8 Ind./m^3 in stations 1, 2 and 3, respectively (Tab. 3).

Rotifer density showed seasonal variations, with maximum densities were noticed in spring, whereas minimum densities were in winter (Diag. 1), similar findings obtained by Majeed *et al*. (2022a) related to suitable environmental conditions in the Tigris River, such as temperature and nutrient availability, which play an important role in growing microalgae as an essential feeding resource. This fact supported by Salman (2024) who showed that rotifer density increased in the spring season. While the density values decreased in winter, this may be ascribed to decreasing water temperatures and increasing turbidity and suspended matter, a situation which affected the density of rotifers. The findings of Abdulwahab and Rabee (2015) and Salman (2024) supported this fact. In India, the same results were reported by Kiran *et al*. (2007) who found that rotifer density decreased in the rainy season and increased in the summer season in fish pond, Karnataka.

Spatially, the second station recorded the highest density at 159198.18 Ind./m^3, while the third station had the lowest value at 621.7 Ind./m^3 (Diag. 1). This may be attributed to the changes in environmental factors at the two sites, such as dissolved oxygen, water temperature, nutrients and presence of microalgae, these findings were proved by Czerniawski and Sługocki (2017), Bolawa *et al*. (2018) and Majeed *et al*. (2022a).

The most abundant taxa in the Samarra Dam were *S. oblonga*, *R. neptunia*, *E dilatata*, *P. dolicoptera*, *Brachionus* spp., and *Keratella* spp. (Tab. 2, Diag. 2).

Higher species abundance in station 1 was *S. oblonga* 20%, *E. dilatata* 17%, *R. neptunia* 15%, *P. dolichoptera, B. urceolaris* 10%, *K. cochlearis* 9%, *Notholca squamula* 3% and *Pompholyx sulcata* 3%. In station 2, *S. oblonga*, 59%, *B. calyciflorus amphecerus* (long spin) 13%, *B. calyciflorus amphecerus* (short spin) 8%, *P. dolichoptera*, 6% and *B. angularis* 3%.

Whereas, in station 3, *S. oblonga*, *R. neptunia*, *E. dilatata*, *K. cochlearis*, *A. fissa*, *B. angularis* *B. forficula* and *B. urceolaris* were recorded 28, 15, 8, 7, 4, 4, 3 and 3%, respectively (Diag. 2).

Similar findings were reported in the Tigris River (Sabri *et al*., 1993; Majeed *et al*., 2022a). As well, this is a common feature observed in many various Iraqi reservoirs (Hammadi *et al*., 2015; Al-Ameen *et al*., 2019; Al-Bahathy and Nashaat, 2021; Salman, 2024; Majeed and Nashaat, 2025).

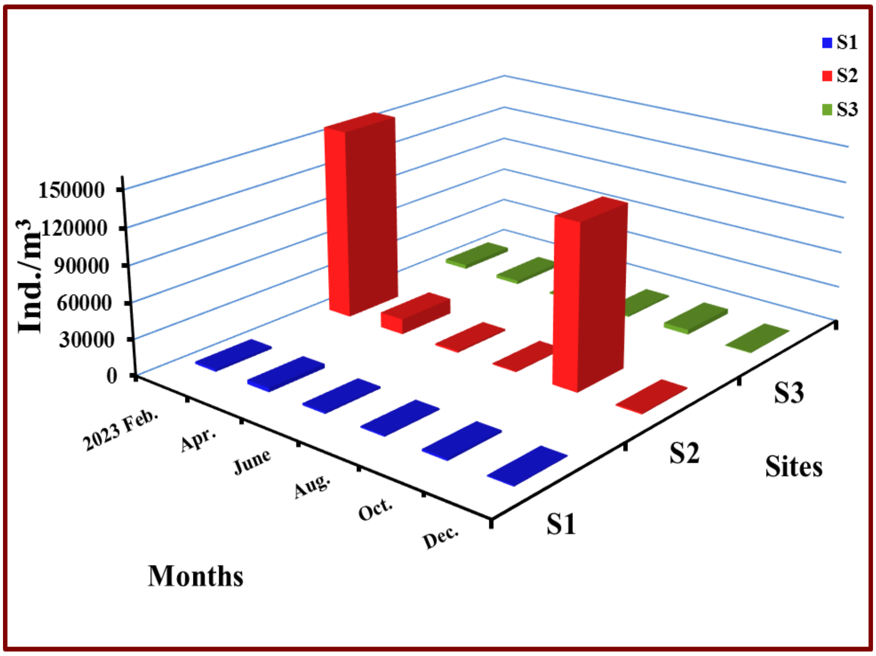


Diagram (1): Total Rotifera density in the Samarra Dam during 2023.

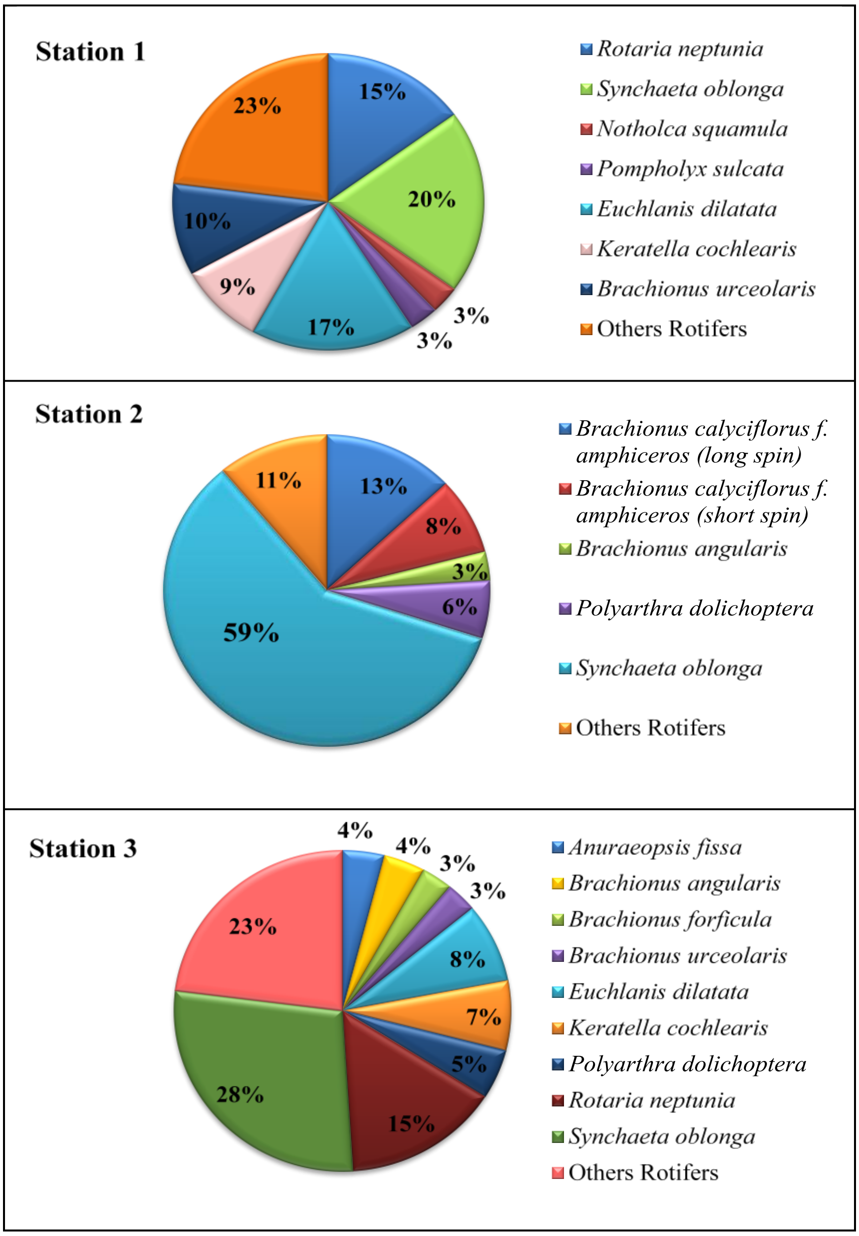


Diagram (2): The most dominant Rotifera in the Samarra Dam during 2023.

Table (2): Distribution, abundance and consistency of Rotifera species in the three stations of the Samarra Dam during 2023.

Subclass: Monogononta Order: Ploima		**Abundance**			**Constancy**		
Family	**Taxa**	**S1**	**S2**	**S3**	**S1**	**S2**	**S3**
Asplanchnidae	*Asplanchna brightwellii* Gosse, 1850	-	R	-	-	Ac	-
	A. priodonta Gosse, 1850	R	R	R	C	C	C
Dicranophoridae	*Aspelta bidentata* Wulfert, 1961	R	R	R	Ac	A	A
Brachionidae	*Anuraeopsis fissa* Gosse, 1851	R	R	R	C	AC	C
	Brachionus angularis Gosse, 1851	R	R	R	C	Ac	C
	B. bidentatus Anderson, 1889	R	-	R	A	-	Ac
	B. calyciflorus calyciflorus Pallas, 1776	R	R	R	C	Ac	Ac
	B. calyciflorus f. amphiceros Ehrenberg, 1838 (long spin form)	R	La	R	Ac	Ac	A
	B. calyciflorus f. amphiceros Ehrenberg, 1838 (short spin form)	-	R	R	-	A	C
	B. forficula Wierzejski, 1891	R	R	R	C	A	C
	B. havanaensis Rousselet, 1913	-	-	R	-	-	A
	B. quadridentatus Hermann,1783	-	-	R	-	-	Ac
	B. quadridentatus Hermann,1783 (long spin form)	R	R	R	C	Ac	Ac
	B. quadridentatus Hermann,1783 (short spin form)	-	R	R	-	Ac	C
	B. urceolaris Müller, 1773	A	R	R	C	Ac	C
	Keratella cochlearis (Gosse, 1851)	A	R	R	C	C	C
	K. quadrata (Müller, 1786) (long spin form)	R	R	-	A	Ac	-

	K. quadrata (Müller, 1786) (short spin form)	R	R	R	Ac	Ac	Ac
	K. tropica (Apstein, 1907)	R	R	R	Ac	Ac	A
	K. valga (Ehrenberg, 1834)	R	R	R	C	C	C
	Notholca squamula (Müller, 1786)	La	R	R	C	A	A
	Platyias patulus (Müller, 1786)	R	R	-	A	Ac	-
	P. quadricornis (Ehrenberg, 1832)	-	R	-	-	A	-
Euchlanidae	*Dipleuchlanis propalula* (Gosse, 1886)	R	R	-	Ac	A	-
	Euchlanis dilatata Ehrenberg, 1832	D	R	R	C	C	C
	Manfredium eudactylotum (Gosse, 1886)	-	-	R	-	-	A
Lecanidae	*Lecane elasma* Harring & Myers, 1926	-	R	R	-	A	C
	L. luna (Müller, 1776)	La	R	R	C	C	C
	L. tenuiseta (Harring, 1914)	-	-	R	-	-	Ac
	L. bulla (Gosse, 1851)	La	R	R	C	C	C
	L. closterocerca (Schmarda, 1859)	R	R	-	A	A	-
	L. hamata (Stokes, 1896)	-	R	R	-	A	Ac
	L. quadridentata (Ehrenberg, 1832)	-	R	R	-	A	Ac
	L. lunaris (Ehrenberg, 1832)	-	R	-	-	A	-
	L. stenroosi (Meissner, 1908)	R	-	R	Ac	-	Ac
	L. thalera (Harring & Myers, 1926)	R	R	R	A	Ac	Ac
	L. thienemanni (Hauer, 1938)	-	-	-	-	Ac	-
Lepadellidae	*Colurella adriatica* Ehrenberg, 1831	R	R	R	C	C	Ac
	Lepadella ovalis (Müller, 1786)	R	R	R	Ac	Ac	A
	L. salpina	-	R	R	-	Ac	A

	Ehrenberg, 1834						
Mytilinidae	*Mytilina nucronata* (Müller, 1773)	R	R	-	Ac	A	-
Notommatidae	*Cephalodella gibba* (Ehrenberg, 1830)	R	R	R	C	C	C
Synchaetidae	*Polyarthra dolichoptera* Idelson,1925	R	R	R	Ac	C	C
	P. vulgaris Carlin, 1943	-	R	-	-	Ac	-
	Synchaeta oblonga Ehrenberg,1832	D	A	La	C	C	C
	S. pectinata Ehrenberg, 1832	R	R	-	A	A	-
Trichocercidae	*Macrochaetus subquadratus* Perty, 1850	-	R	-	-	A	-
	Trichocerca bicristata (Gosse, 1887)	R	R	R	A	C	Ac
	T. rousseleti (Voigt, 1902)	R	R	-	A	A	-
	T. similis (Wierzejski, 1893)	-	R	R	-	Ac	-
Trichotriidae	*Trichotria tetractis* (Ehrenberg, 1830)	R	R	R	Ac	C	C
Order: Flosculariaceae							
Testudinellidae	*Pompholyx sulcata* Hudson, 1885	La	R	R	Ac	A	Ac
	Testudinella patina (Hermann, 1783)	-	R	R	-	A	Ac
Hexarthridae	*Hexarethra mera* (Hudson, 1871)	-	R	R	-	A	Ac
Subclass: Bdelloidea **Order: Bdelloida**							
Philodinidae	*Macrotrachela quadricornifera* Milne, 1886	-	R	R	-	A	Ac
	Rotaria citrina (Ehrenberg, 1838)	-	-	R	-	-	Ac
	R. neptunia (Ehreberg,1830)	D	R	La	C	C	C

[D: dominant > 70%; A: abundant 40-70 %; La: less abundant 10-39 %; R: rare < 10 %. For constancy index; C: constant > 50%; Ac: accessory 26-50%; A: accidental 1-25%].

Ecological indicators

Species richness of planktonic rotifers: Diagram (3) depicts the values of the Rotiferian richness index. At the first station, Richness values varied between 3.74 in June and 6.15 in August. At the second station, the value ranged from 1.37 in August and 8.027 in April, whereas at the third station the minimum values were 4.23 in February and the maximum values were 8.038 in April. As well, the average values 5.18, 4.75 and 6.37 were recorded in stations 1, 2 and 3, respectively.

Spatially, the maximum value recorded in the third station was 8.038 and the minimum value recorded in the first station was 1.37 (Diag. 3). This could be linked to the variations in environmental factors between the two habitats in the impoundment. This view was proved by Majeed *et al*. (2022a) who showed that differences in richness values between the Tigris and Tharthar water.

Seasonally, the maximum and minimum values of the richness index were during the spring and autumn seasons, respectively (Diag. 3). Increasing richness values in spring season may be related to an increase of phytoplankton in this season. This view was supported by Rasheed *et al*. (2016) who indicated that higher richness index values in spring would correlate with increased phytoplankton density in the Al-Shamyiah River.

Whereas, the lowest value was in autumn season which may be linked to the decreasing in phytoplankton density. This fact was proved by Abed and Nashaat (2018) who showed that decreasing in richness values due to decreasing in phytoplankton density, in Dejiala River. In this respect, Phan *et al*. (2021) found that rotifera richness index was significantly affected by environmental factors especially temperature, turbidity, pH and trophic level in Da Nang Lakes.

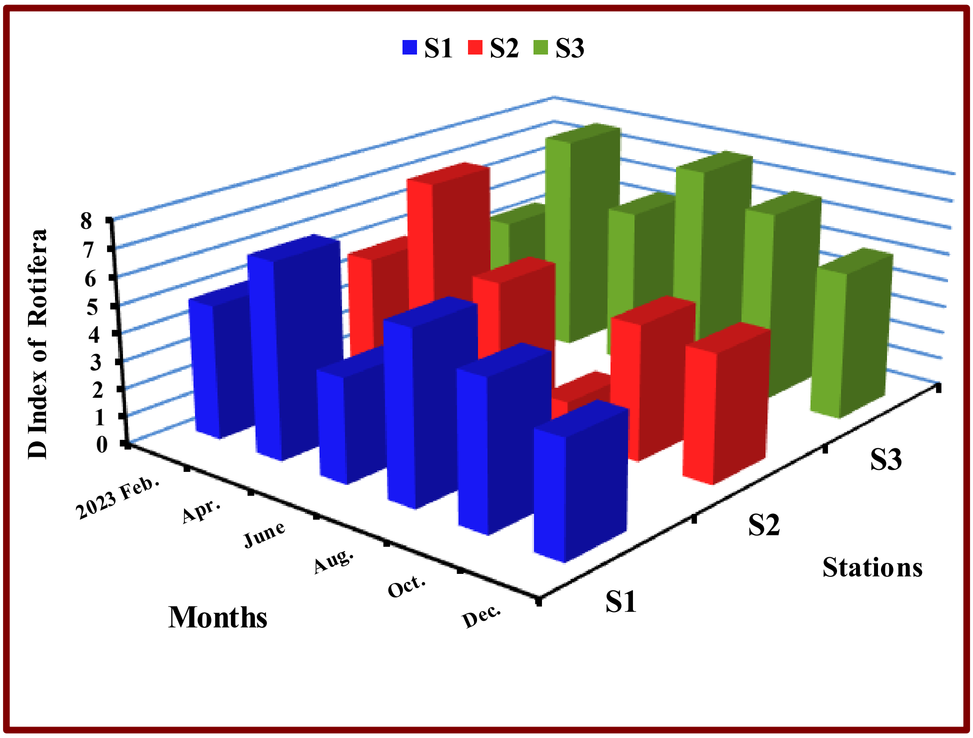


Diagram (3): Monthly fluctuations of D Index for Rotifera at three stations of the Samarra Dam during 2023.

Species evenness of planktonic rotifers: At the first station, the evenness values varied between 0.67 in February and 0.84 in December. Whereas in the second station, the least and highest values were 0.33 and 2.64 in February and April, respectively. In the third station the values fluctuated between 0.63 in October and 0.93 in December (Diag. 4).

As well, the mean values of the evenness index were 0.8, 1.8 and 0.8 in stations 1, 2 and 3, respectively. All values being greater than 0.5, indicates an unbalanced distribution of Rotifera species (Pielou, 1977; Magurran, 2004). This may be related to the various factors affecting the species evenness such as richness index and sampling size (Faith and Du, 2018).

Seasonal variations, showed that the values increased in spring and summer and decreased in winter (Diag. 4). This may be linked to the favorable environmental conditions such as water temperatures, nutrients and chlorophyll availability which consequently support phytoplankton abundance which considered a good food supporting rotifera (Shaker *et al*., 2019; Lu *et al*., 2021). These results are consistent with Majeed *et al*. (2022a) who also proved that Rotiferian evenness index in Tigris water increased in spring and summer and decreased in winter.

Spatial variations, the largest values of evenness index were recorded in the second station while the lowest values were in stations 1 and 3 (Diag. 4). This might be caused by variations in the physical, chemical, and hydrological factors among different stations (Kamboj and Kamboj, 2020).

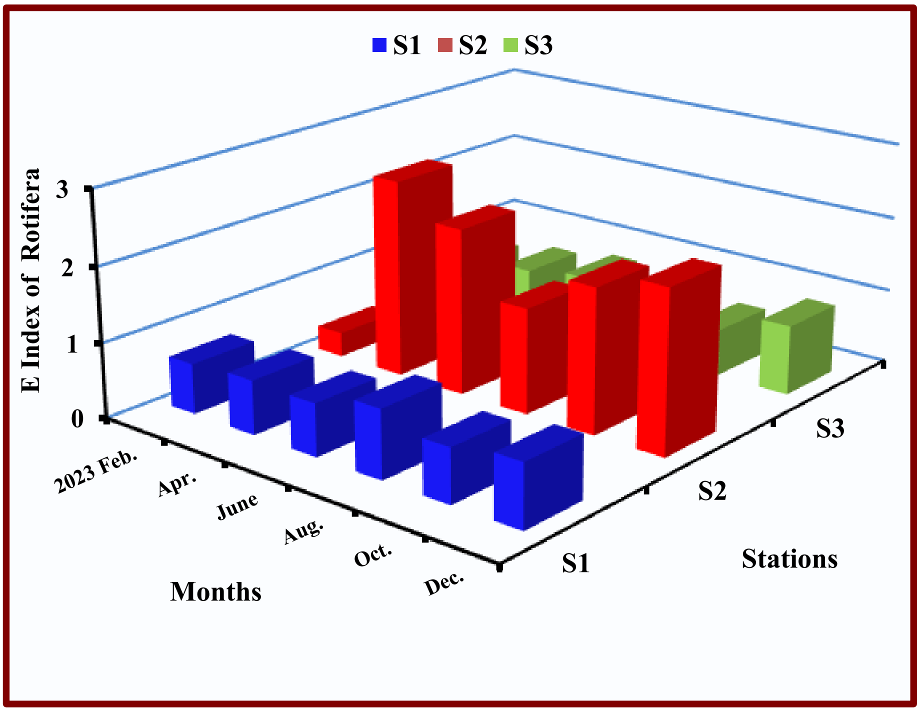


Diagram (4): Monthly fluctuations of the Evenness index at three stations of the Samarra Dam during 2023.

Diversity index of planktonic rotifers: In the first site, the values of the Shannon-Weiner diversity index ranged from 1.81 bits/ind. in June to 2.73 in August bits/ind. Whereas in the second station, the values varied from 0.33 bits/ind. in February to 2.64 bits/ind. in April. In the third station, the values fluctuated between 1.79 and 2.81 bits/ind. in February and August, respectively (Diag. 5). As well, the mean values of the diversity index were 2.2, 1.8 and 2.4 bits/ind. in stations 1, 2 and 3, respectively (Tab. 3). According to Charlotte and Dronkers (2025) rotifera diversity in the Samarra Dam occurred within good to very good class.

Seasonal variations show that the highest and lowest values of this index fluctuated between summer and winter, respectively (Diag. 5). This may be linked to higher temperature, sunlight and Chlorophyll-a availability, all of which are crucial for supporting phytoplankton as a food source for zooplankton (Sharmila-Sree and Shameem, 2017). In winter, the values of this index decreased due to increased turbidity and suspended matter, which negatively impacts the diversity of rotifers, as noted by Abdulwahab and Rabee (2015) and Majeed *et al*. (2022a).

For spatial variation, the highest value was in the third station and recorded 2.81. Whereas, the lowest value was in the second station recorded 0.33 (Diag. 5). This could be attributed to the heterogeneity among habitats (Majeed *et al*., 2022a). In this respect, Phan *et al*. (2021) mentioned that the high value of rotifera diversity in Da Nang Lakes related to high levels of temperature, turbidity and trophic state.

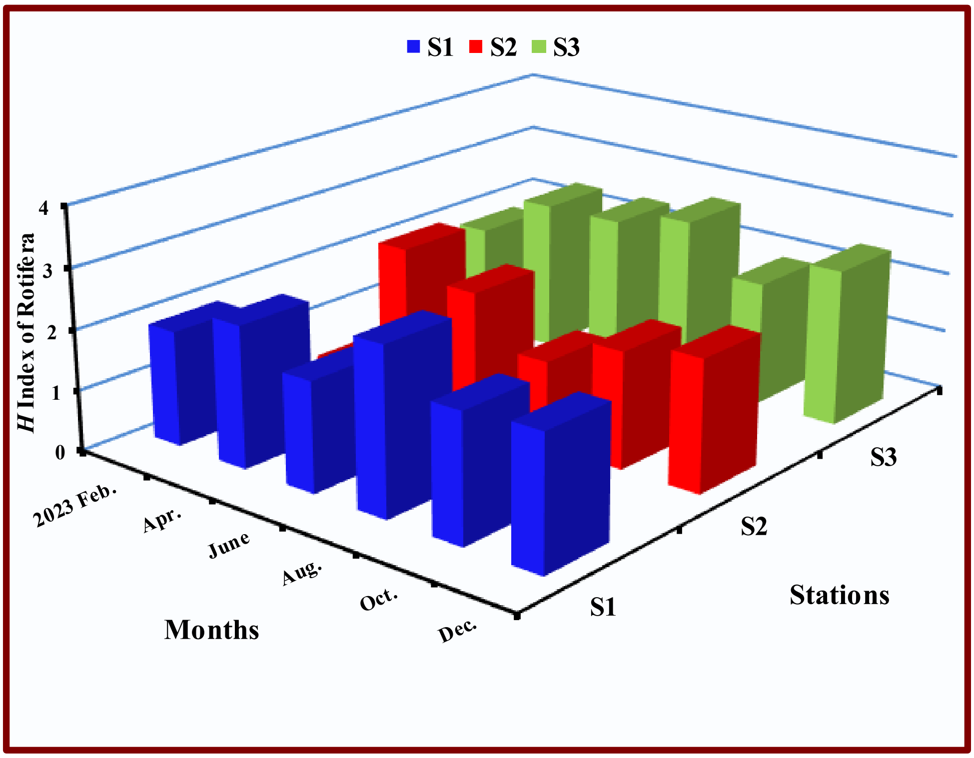


Diagram (5): Monthly variations of the diversity index at three stations of the Samarra Dam during 2023.

Table (3): The average values of species richness, evenness and diversity indices along with total densities of rotifers.

Index	**Stations**		
	1	**2**	**3**
D	5.18	4.75	6.37
J	0.76	1.78	0.78
H'	2.2	1.8	2.4
Total densities	10940.26	310934	14010.8

Jaccard's similarity index: The largest similarity value observed between the first and third stations was 68.78% (Diag. 6). The similarities between the two stations can be attributed to the fact that both are influenced by the same hydrodynamic conditions and limnological factors. Additionally, they share the same physicochemical characteristics, including water sources, temperature, salinity, dissolved oxygen levels and pH.

This result agrees with several Iraqi studies; Majeed *et al*. (2022a) recorded high similarity index values for rotifera among various places in the Tigris River, attributing that to the suitable environmental conditions. In the Euphrates River, Al-Bahathy and Nashaat (2021) recorded similar results between downstream and upstream of the Hindiya Dam, with the highest value reached 76.27 for Rotifera.

In contrast, the lowest value of this index was between the second and the third stations reached 7.76% (Diag. 6). This may be related to the differences between two distinct habitats, including limnological factors and hydrodynamic conditions. Additionally, fluctuations in water currents have a mechanical advective effect on rotifer populations. This view was supported by Hung *et al*. (2021), who demonstrated that variation in species composition of the rotifera community in different water bodies was influenced by variations of physicochemical factors.

A significant inverse relationship between current velocity and zooplankton abundance has been found

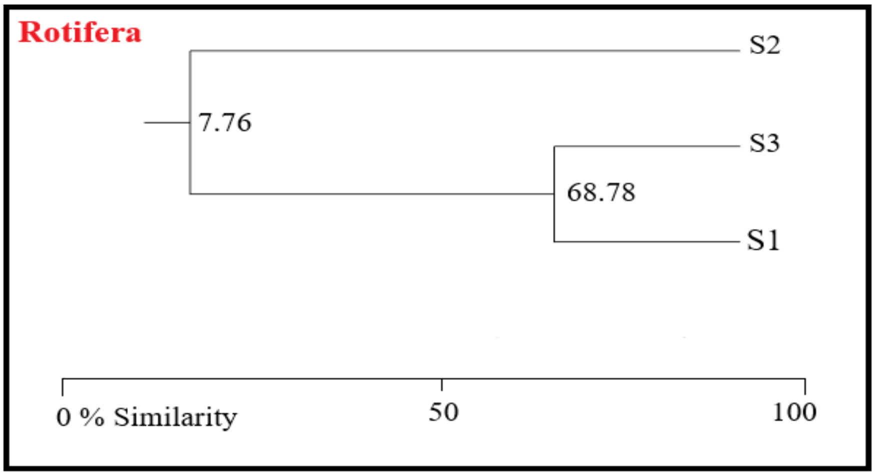


Diagram (6): Shows the values of Jaccard's similarity index among the three stations of the Samarra Dam during 2023.

Constancy index (S): Table (2) depicts the constant species in three stations in the dam. In station 1 we recorded 17 species. Whereas, in the second and third stations ~~2 and 3~~ were 13 and 17 species, respectively.

According to the constancy index, the species *A. priodonta*, *A. fissa*, *B. angularis*, *B. calyciflorus calyciflorus B. forficula*, *B. quadridentatus*, (long spin), *B. urceolaris*, *K. cochlearis*, *K. valga*, *N. squamula, C. gibba*, *C. adriatica*, *E. dilatate*, *L. luna*, *M. bulla*, *R. neptunia*, and *S. oblonga* were the most constant species in the first station. Whereas in the second station, the most constant species were *A. priodonta*, *K. cochlearis*, *K. valga, C. gibba*, *C. adriatica*, *E. dilatata, L. luna*, *M. bulla*, *R. neptunia*, *P. dolichoptera*, *S. oblonga*, *T. tetractys* and *T. bicristata*. In station 3, *A. priodonta*, *A. fissa*. *B. angularis*, *B. calyciflorus amphecerus* (short spin), *B. forficula, B. quadridentatus* (short spin), *B. urceolaris*, *K. cochlearis*, *K. valga*, *E. dilatata*, *C. gibba*, *L. luna*, *L. elasma M. bulla*, *R. neptunia*, *P. dolichoptera*, *S. oblonga*, and *T. tetractys*.

The results we obtained are consistent with other earlier studies conducted on the Tigris River. Majeed *et al*. (2022a) observed that *B. angularis*, *E. dilatata*, *K. valga*, *K. cochlearis*, *R. neptunia*, *P. dolichoptera* and *S. oblonga* were the largest constant rotifers in Tigris water. Al-Azzawii (2015) showed that *B. angularis* and *B. urceolaris* were constant species in the Tigris River. Also, Al-Bahathy and Nashaat (2021) reported that *E. dilatata* constant up and downstream the Hindiya Dam.

Based on the aforementioned, Lair (2006) explained that *Brachionus* sp. can grow at a high current velocity of about 20 cm/s. Also, Jaturapruek (2016) pointed out that *R. neptunia* is tolerant to a wide range of environmental conditions, and thus it dwells in many freshwater habitats like ponds, lakes and rivers. Glime (2017) reported that *E. dilatata* is a cosmopolitan species able to tolerate a wide range of pH and temperature and so it is present in both freshwater and brackish water. In this respect Dang *et al*. (2015) reported that *L. bulla* can survive in widely freshwater aquatic systems like rivers, lakes and ponds.

CONCLUSIONS

We identified 57 species, belonging to 16 families in this study, the predominant species *A. priodonta*, *A. bidentate*, *A. fissa*, *B. calyciflorus calyciflorus*, *B. calyciflorus amphecerus*, *B. forficula*, *B. quadridentatus*, *B. urceolaris*, *K. cochlearis*, *K. tropica*, *K. quadrata*, *K. valga*, *N. squamula*, *C. gibba*, *C. adriatica*, *L. ovalis*, *E. dilatata*, *L. luna*, *L. bulla*, *L. thalera*, *R. neptunia*, *P. dolichoptera*, *S. oblonga*, *P. sulcata*, *T. tetractys*, *T. bicristata* were recorded across all stations in this dynamic environment. The study showed that rotifer density varied seasonally and spatially due to changes in environmental conditions, which were considered the most significant factors affecting Rotifera density. Also, the average values of ecological indices, such as diversity, evenness, and richness, varied by season and site.

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CONFLICT OF INTEREST STATEMENT

"The author has no conflicts of interest to declare".

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التنوع والاختلافات المكانية والزمانية للدولابيات في سد سامراء، العراق

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الاستلام: 2025/4/13، المراجعة: 2025/10/2، القبول: 2025/10/8، النشر: 2025/12/20

الخلاصة

يعد هذا البحث الأول من نوعه في هذا الخزان منذ اكثر من ثلاثة عقود، ويهدف إلى تقييم تنوع ووفرة الدولابيات واختلافاتها المكانية والزمانية في سد سامراء خلال عام 2023. تم اختيار ثلاث محطات مختلفة لأخذ العينات وذلك لضمان التغطية الشاملة للسد. المحطة الأولى تقع أسفل مدخل النهر مباشرةً و تقع المحطة الثانية بالقرب من سد سامراء، بينما تقع المحطة الثالثة بالقرب من ناظم الثرثار. تم تشخيص سبعة وخمسون نوعا تنتمي لأربع عشرة عائلة من الدولابيات تعود الى ثلاث رُتَب هي Ploima، Flosculariaceae و Bdelloida والتي تعود كلها الى صنف Eurotatoria. اكثر الأنواع وفرة كانت *Synchaeta oblonga* Ehrenberg,1832، *Rotaria neptunia* (Ehreberg,1830)، *Euchlanis dilatate* Ehrenberg, 1832، *Polyarthra dolichoptera* Idelson,1925، *Brachionus calyciflorus* Pallas, 1766 (long and short spine)، *B. urceolaris* Müller, 1773 و *Keratella cochlearis* (Gosse, 1851). متوسط القيم لكل من دليل الغنى والتساوي والتنوع كانت 1.8 ,2.2 ;0.8, 1.8 ,0.8; 6.37, 4.75 ,5.18 ,2.4 بت/فرد لكل من المحطات 1، 2و 3على التوالي. فيما يخص التغايرات الموسمية فأن اعلى واقل قيم لكل من دليلي التساوي والتنوع سجلت في فصلي الصيف والشتاء وعلى التوالي. بينما لدليل الغنى سجلت في فصلي الخريف والربيع. وبين دليل جاكرد للتشابه ان اعلى نسبة تشابه كانت بين المحطة الأولى والثالثة اذ بلغت 68.78% ، بينما اقل نسبة كانت بين المحطة الثانية والثالثة حيث وصلت الى 7.76%.