

Diversity and Abundance of Rotifera in Kadıköy Reservoir of Turkey

Hüseyin GÜHER^{1*}

ABSTRACT: This research has been carried out to determine diversity and abundance of Rotifera in Kadıköy Reservoir. For this purpose, Rotifera and water samples were collected monthly from March 2010 to February 2011 at three different stations in the reservoir. A total of 33 species from Rotifera were determined in the qualitative evaluation of samples taken from the reservoir. The quantitative evaluation of the Rotifera samples revealed presence of an average of 70 472 ind m⁻³ in Kadıköy Reservoir. The maximum number of Rotifera were recorded at 1st station (81 819 ind m⁻³); in May (100 901 ind m⁻³) and in spring season (83 458 ind m⁻³). *Asplanchna priodonta*, *Brachionus angularis*, *Filinia terminalis* and *Keratella cochlearis* sampling in all months were found to be the most common species during the study. When we evaluate the species identified in the reservoir, the distribution of the individuals that make up the Rotifera fauna and physical-chemical parameters as a whole, it has been concluded that Kadıköy Reservoir is in meso-eutrophic character in terms of Rotifera.

Keywords: Rotifera, species diversity, water quality, reservoir.

Kadıköy Barajı'nın (Türkiye) Rotifera Bolluğu ve Tür Çeşitliliği

ÖZET: Bu araştırma, Kadıköy baraj gölünün Rotifera faunasını ve kommunité yapısını belirlemek amacıyla yapılmıştır. Araştırmada Kadıköy Barajı'nda belirlenen 3 istasyonda Mart 2010-Şubat 2011 tarihleri arasında Rotifera örnekleri toplanırken bu organizmaları etkileyen bazı çevresel parametrelerde ölçülmüştür. Toplanan örneklerin değerlendirilmesi sonucunda 33 Rotifera türü tespit edilirken Kadıköy Baraj Gölü'nde yıllık ortalama 70 472 birey m⁻³ bulunmuştur. En fazla birey 1. istasyonda (81 819 birey m⁻³); Mayıs ayında (100 901 birey m⁻³) ve ilkbaharda (83 458 birey m⁻³) bulunmuştur. Çalışma süresince tüm aylarda bulunan *Asplanchna priodonta*, *Brachionus angularis*, *Filinia terminalis* ve *Keratella cochlearis* en yaygın türler olarak tespit edilmiştir. Baraj gölü'nde tespit edilen Rotifera türlerine ve ölçülen fizikokimyasal parametrelere göre Kadıköy Baraj Gölü'nün mezo-ötrofik karakterde olduğu belirlenmiştir.

Anahtar Kelimeler: Rotifera, tür çeşitliliği, su kalitesi, baraj gölü.

¹ Hüseyin Güher (Orcid ID: 0000-0001-6206-0912), Trakya University, Faculty of Science, Department of Biology, Edirne, Turkey.

* Sorumlu Yazar/Corresponding Author: Hüseyin GÜHER e-mail: huseying@trakya.edu.tr

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INTRODUCTION

In fresh water ecosystems, phytoplanktonic organisms constitute an important food source of some aquatic invertebrate, whereas zooplanktonic organisms are an important food source of both aquatic invertebrate and fish larvae. The typical zooplankton assemblage in fresh water ecosystem commonly consists of Rotifera, Copepoda, Cladocera and Protozoa (Rocha et al., 1999). Rotifera is always the dominant group among the others, depending on the physicochemical and biological properties of the aquatic ecosystem. Rotifera can be found in various aquatic habitats such as lakes, pools, streams and puddles and provide food for vertebrate and invertebrate animals. Also bdelloid rotifers and some species of Dicranophoridae live in terrestrial habitats such as moss, lichen, soil and bark.

The abundance and composition of Rotifer species in freshwater ecosystems provide important information in determining the productivity of the aquatic ecosystems. Rotifera are also used as indicator organisms for pollution and eutrophication for the habitat they are present in since they are more susceptible to ecosystem alteration compared to other zooplanktonic groups. The zooplankton composition, distribution, diversity and relative abundance of a reservoir can have significant impact on fisheries in reservoir. The diversity and abundance of zooplankton in reservoir often differ according to the physicochemical and biological structure of the reservoir (Jackson and Schmitz, 1987; Sampaio et al., 2002). For this reason, in order to understand the productivity of an aquatic environment, the Rotifer species and its abundance must be well examined and determined. Rotifera species, distribution and diversity in inland waters in Turkey have been carried out a number of studies to examine. (Ustaoğlu, 2004; Ustaoğlu et al., 2012; Erdoğan and Güher, 2012; Güher, 2014). Some other

studies particularly paid to Rotifera in various reservoirs in Turkey. (Bekleyen, 2003; Kaya and Altındağ, 2007; Bozkurt and Sagat, 2008; Dirican and Musul, 2008; Mis and Aygen, 2010; Ayvaz et al., 2011; Yıldız, 2012; Buyurgan, 2010; Bulut and Saler, 2014; Saler and Alış, 2014; Tuna and Ustaoğlu, 2016 and Saler, 2017). This study was conducted to identify the Rotifera fauna of Kadıköy Reservoir located in Keşan District of Edirne province, Turkey and to reveal the species composition and richness.

MATERIALS AND METHODS

Study Area: Kadıköy Reservoir is located 20 km far to the south-east of Keşan district in Edirne province, Turkey (40° 48'51''N, 26° 47'43''E). It was built for flood control and irrigation purposes and also provides drinking and domestic water of Keşan district. It has a maximum depth of 20 m and a surface area of 6.2 km². Although the reservoir is fed mainly by the Doğanca Stream, it is also replenished by other small streams in the region and rainfall (Figure 1).

Sampling: The samples were collected monthly from March 2010 to February 2011 in three different points in reservoir (Figure 1). Because of harsh weather conditions, no sampling could be performed in January 2011. The 1st sampling station was located where the water gathered, the 2nd sampling station was located in the middle of the reservoir and the 3rd sampling station was the shallowest part of the reservoir. Rotifer samples were collected with a Hensen type plankton net (mesh size 55 µ, mouth diameter 15 cm, length 75 cm). The samples were carried to the laboratory in 250 mL plastic bottles containing 4% of formaldehyde solution. In the laboratory, the samples were identified according to Ruttner-Kolisko (1974), Koste (1978), Herzig (1987), De Manuel Barrabin (2000), Segers (2008) and Ustaoğlu et al. (2012) and their counting was done according to Edmondson (1959) using an Olympus

inverted microscope. Some physicochemical parameters, such as water temperature, light permeability, conductivity, pH, dissolved oxygen were measured on site simultaneously with the sampling time. For other physical-chemical features of the water, water samplings were taken by a Ruttner water sampler in the reservoir. The values of PO_4^{-3} (Phosphate), NO_3^{-} -N (Nitrate-nitrogen), NO_2 -N (Nitrite-nitrogen),

SO_4^{2-} (Sulphate), Ca (Calcium), Mg (Magnesium), Cl (Chloride) were measured in laboratories of Trakya University Technology Research Development Application and Research Center (TUTAGEM).

Bray-Curtis Similarity index was used to examine the similarities of sampling months and seasons with respect according to diversity and abundance of Rotifera species (Krebs 1999).

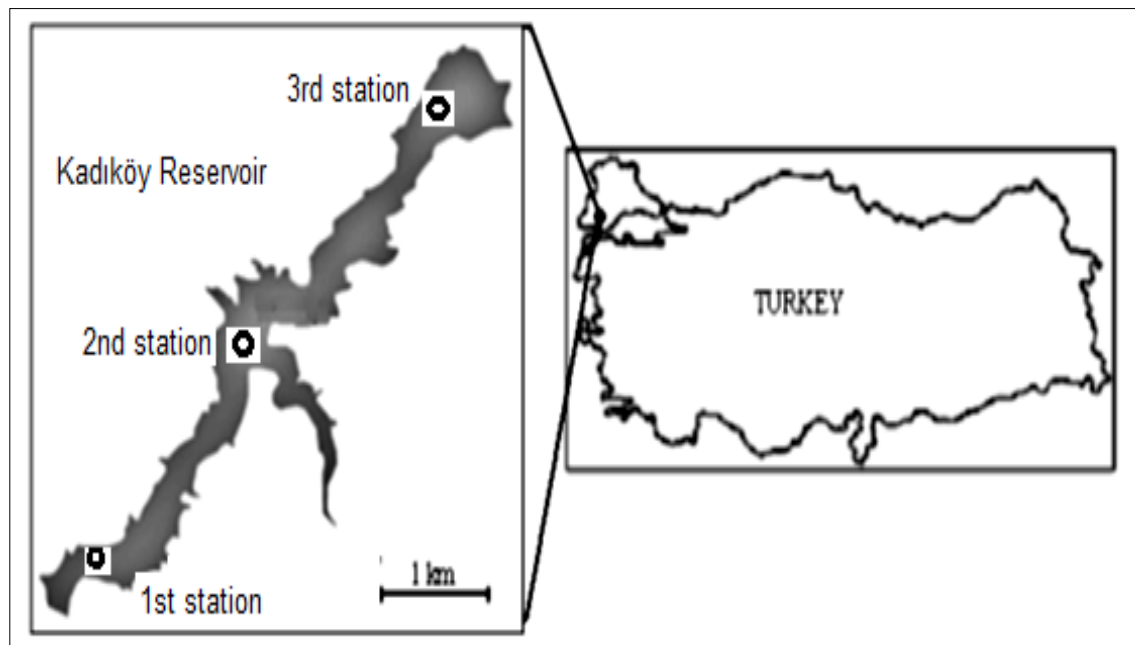


Figure 1: The location of Kadıköy Reservoir and the sampling points

RESULTS AND DISCUSSION

Physical and Chemical Variables: The minimum and maximum values of environmental parameters measured in the Kadıköy Reservoir were as follows; water temperature: 2.00-29.00 ($^{\circ}\text{C}$); DO: 3.40-15.73 (mg L^{-1}); pH: 7.53-8.63; EC: 388.00-613.67 ($\mu\text{S cm}^{-1}$); NO_2 -N: 0.00-0.09 (mg L^{-1}); NO_3 -N: 0.00-9.89 (mg L^{-1}); PO_4 -P: 0.00-0.068 (mg L^{-1}); SO_4 :

0.43-1.60 (mg L^{-1}); Salinity: 0.070-0.100 (‰); Chloride: 18.99-33.32 (mg L^{-1}); total hardness: 11.00-30.00 ($^{\circ}\text{FS}$); Ca: 24.53-61.70 (mg L^{-1}); Mg: 9.93-44.83 (mg L^{-1}). The measured of environmental parameters and their minimum, maximum and average values are given in the Table 1. Variations in these of environmental parameters according to the sampling stations and months are given in Figure 2.

Table 1: The measured of environmental parameters and their minimum, maximum and average values

	Abbreviation	Min.	Max.	Average
Water temperature (C)	WT	2.00	29.00	16.48 ± 10.027
Dissolved Oxygen (mg L ⁻¹)	DO	3.40	15.73	7.65 ± 3.813
Light permeability (cm)	LP	36.3	105.0	71.6 ± 22.958
pH	pH	7.53	8.63	8.29 ± 0.283
Conductivity (µS cm ⁻¹)	EC	388.00	613.67	523.03 ± 88.695
Nitrate Nitrogen (mg L ⁻¹)	NO ₃ -N	0.00	9.89	3.49 ± 2.934
Nitrite nitrogen (mg L ⁻¹)	NO ₂ -N	0.00	0.09	0.05 ± 0.029
Ortho-Phosphate (mg L ⁻¹)	o-PO ₄	0.000	0.068	0.010 ± 0.020
Sulphate (mg L ⁻¹)	SO ₄	0.43	1.60	1.10 ± 0.368
Salinity (‰)	Sal	0.070	0.100	0.082 ± 0.010
Chloride (mg L ⁻¹)	Cl	18.99	33.32	27.02 ± 4.228
Total Hardness (°FS)	TH	11.00	30.00	23.79 ± 4.705
Calcium (mg L ⁻¹)	Ca	24.53	61.70	39.69 ± 9.326
Magnesium (mg L ⁻¹)	Mg	9.93	44.83	34.84 ± 9.840

The average dissolved oxygen value was found as 7.65 ± 3.813 . In freshwater ecosystems, the least dissolved oxygen amount for aquatic life may not be less than 5.0 mg L^{-1} (Kaya and Altındağ, 2007). The amount of zooplankton in fresh water is affected by temperature changes. Because temperature is the most important factor affecting the amount of nutrients in fresh water (Geller and Müller, 1981). In the present study, the lowest total Rotifera abundance was found in winter ($53 \text{ 934 ind m}^{-3}$) when the water temperature reached its lowest values.

Most of the biochemical reactions in living and in the water depends on pH, which is one of the most important parameters affecting distributions of zooplankton, and in terms of pH alkaline limit was reported 8.5 (Berzins and Pejler, 1987). According to the mean pH values (average 8.29 ± 0.283), Kadıköy Reservoir was rated as an alkaline water bearing reservoir. According to the level system of OECD for trophic status of lakes, a lake is considered as eutrophic if the measured Secchi depth is between 0.8 and 1.5 m; mesotrophic if it is between 1.4 and 2.4 m and oligotrophic if it is between 3.6 and 5.9 m (Ryding and Rast, 1989).

According to this classification based on Secchi depths, Kadıköy Reservoir could be categorized as eutrophic since the measured Secchi depth is $71.6 \pm 22.958 \text{ cm}$.

The comparison of the physic-chemical analyses results with National Standard for Turkish inland water revealed that comparison temperature, pH, nitrate nitrogen, sulphate and phosphate were found at first and second quality level. In terms of dissolved oxygen the water was found at first quality level, nitrite nitrogen was found between second and third quality levels (Anonymous, 2016).

Zooplankton community structure: The identifications of the sampled material in Kadıköy Reservoir revealed presence of 33 species belonging to Rotifera (Table 2). When the sampling months were evaluated in terms of species diversity, highest number of species were found in May (23 species) followed by April (20 species), June (19 species), October (18 species) and March (16 species) while lowest species number was found in February (11 species). *Asplanchna priodonta*, *Brachionus angularis*, *Filinia terminalis* and *Keratella cochlearis* sampling in all months were the most

common species during the study. *Philodina megalotrocha*, *Collotheca ornata*, *Filinia longiseta*, *Hexarthra mira*, *Lecane lunaris*, *L. closterocerca*, *Polyarthra remata*, *Pompholyx*

sulcata, *Synchaeta pectinat* and *Trichocerca similis*, were sampling only in one month during the study.

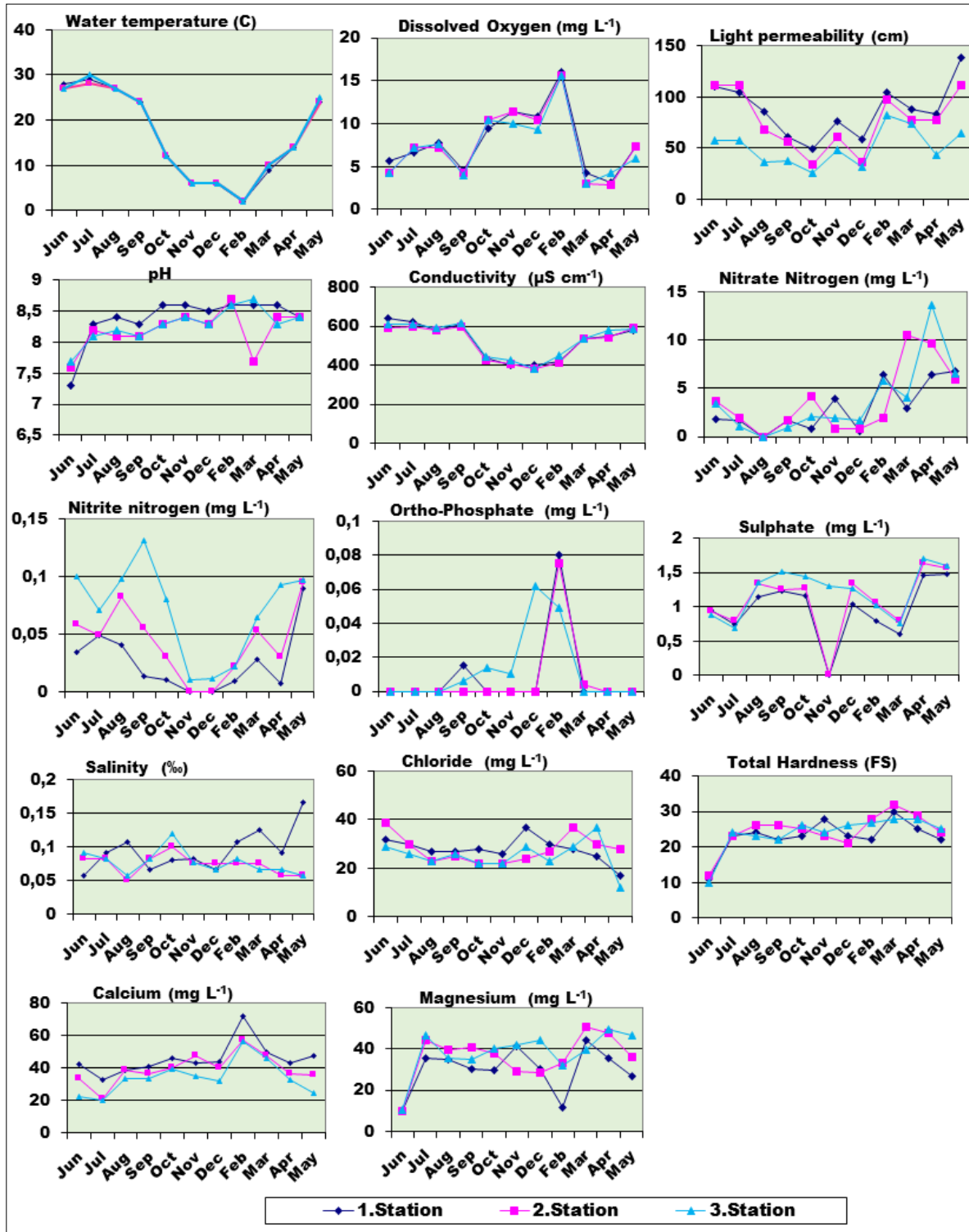


Figure 2: Variations in environmental parameters according to sampling stations and months

Table 2: Rotifera species and minimum, maximum and average values of their annual in per m³

ROTIFERA	Min.	Max.	Average
<i>Philodina megalotrocha</i> Ehrenberg, 1832	0	1 200	148 ± 371.56
<i>Ascomorpha</i> sp	0	7 813	2 712 ± 3 249.61
<i>Asplanchna priodonta</i> Gosse, 1850	5 663	10 878	8 019 ± 1 893.12
<i>Asplanchna sieboldi</i> (Leydig, 1854)	0	1 200	327 ± 560.52
<i>Brachionus diversicornis</i> (Daday, 1883)	0	3 563	606 ± 1 113.35
<i>Brachionus quadridentatus</i> Hermann, 1783	0	3 563	1 405 ± 1 746.83
<i>Brachionus urceolaris</i> Müller, 1773	0	12 828	7 466 ± 4 235.88
<i>Brachionus angularis</i> Gosse, 1851:	5 663	9 156	7 310 ± 1 366.38
<i>Collotheca ornata</i> (Ehrenberg, 1832)	0	1 200	218 ± 485.42
<i>Conochilus dossuarius</i> Hudson, 1875	0	456	41 ± 137.49
<i>Euchlanis dilatata</i> Ehrenberg, 1832	0	1 200	192 ± 380.84
<i>Filinia longiseta</i> (Ehrenberg, 1834):	0	1 446	173 ± 443.84
<i>Filinia terminalis</i> (Plate, 1886)	3 534	7 625	5 406 ± 1 602.56
<i>Hexarthra mira</i> Hudson, 1871	0	6 125	878 ± 2 037.73
<i>Kellicottia longispina</i> (Kellicott, 1879)	0	7 788	4 701 ± 2 843.84
<i>Keratella tecta</i> (Gosse, 1851)	0	6 125	2 234 ± 2 054.36
<i>Keratella quadrata</i> (O.F.Müller, 1786)	0	9 156	5 256 ± 2 923.88
<i>Keratella cochlearis</i> (Gosse, 1851)	1 200	7 663	5 731 ± 1 907.06
<i>Lecane lunaris</i> (Ehrenberg, 1832)	0	5 883	644 ± 1 774.51
<i>Lecane bulla</i> (Gosse, 1886)	0	2 100	713 ± 779.78
<i>Lecane luna</i> (O.F.Müller, 1776)	0	5 838	1 859 ± 1 897.64
<i>Lecane closterocerca</i> (Schmarda, 1859)	0	3 554	365 ± 1 066.63
<i>Notholca squamula</i> (O.F.Müller, 1786)	0	5 838	2 780 ± 2 174.30
<i>Polyarthra remata</i> Skorikov, 1896	0	3 554	455 ± 1 115.76
<i>Polyarthra vulgaris</i> (Carlin, 1943)	0	7 625	3 404 ± 2 730.21
<i>Pompholyx sulcata</i> (Hudson, 1885)	0	3 556	432 ± 1 096.76
<i>Synchaeta oblonga</i> Ehrenberg, 1832	0	5 838	1 224 ± 1 889.80
<i>Synchaeta pectinata</i> (Ehrenberg, 1832)	0	1 446	241 ± 538.00
<i>Trichocerca similis</i> (Wierzejski, 1893)	0	1 200	218 ± 485.42
<i>Trichocerca capucina</i> Wierzejski&Zacharias, 1893	0	1 446	740 ± 695.98
<i>Trichocerca cylindrica</i> (Imhof, 1891)	0	3 534	1 417 ± 1 547.66
<i>Trichocerca pusilla</i> (Jennings, 1903)	0	2 100	495 ± 781.12
<i>Trichocerca</i> sp.	0	5 838	2 908 ± 2 027.23

The quantitative evaluation of the Rotifera samples revealed presence of an average of 70 472 ind m⁻³ in Kadıköy Reservoir (Table 2). When the sampling months were evaluated based on average individual values per m³, the maximum number of organism was found in May (100 901 ind m⁻³) followed by April (89 149 ind m⁻³) and the minimum was found in

February (46 203 ind m⁻³) followed by March (50 239 ind m⁻³) (Figure 3). *Asplanchna priodonta* was the leading species in terms of density (8 019 ind m⁻³), followed by *Brachionus urceolaris* (7 446 ind m⁻³), *B. angularis* (7 310 ind m⁻³), *Keratella cochlearis* (5 731 ind m⁻³), *K. quadrata* (5 256 ind m⁻³) and *Kellicottia longispina* (4 701 ind m⁻³). The lowest density

values were measured for *Conochilus dossuarius* (41 ind m⁻³), *Philodina megalotrocha* (148 ind m⁻³), *Filinia longiseta* (173 ind m⁻³) and *Euchlanis dilatata* (192 ind m⁻³) (Table 2). The

highest similarity was found between December-August and November-July months, while the lowest similarity was found between August-March months (Figure 4).

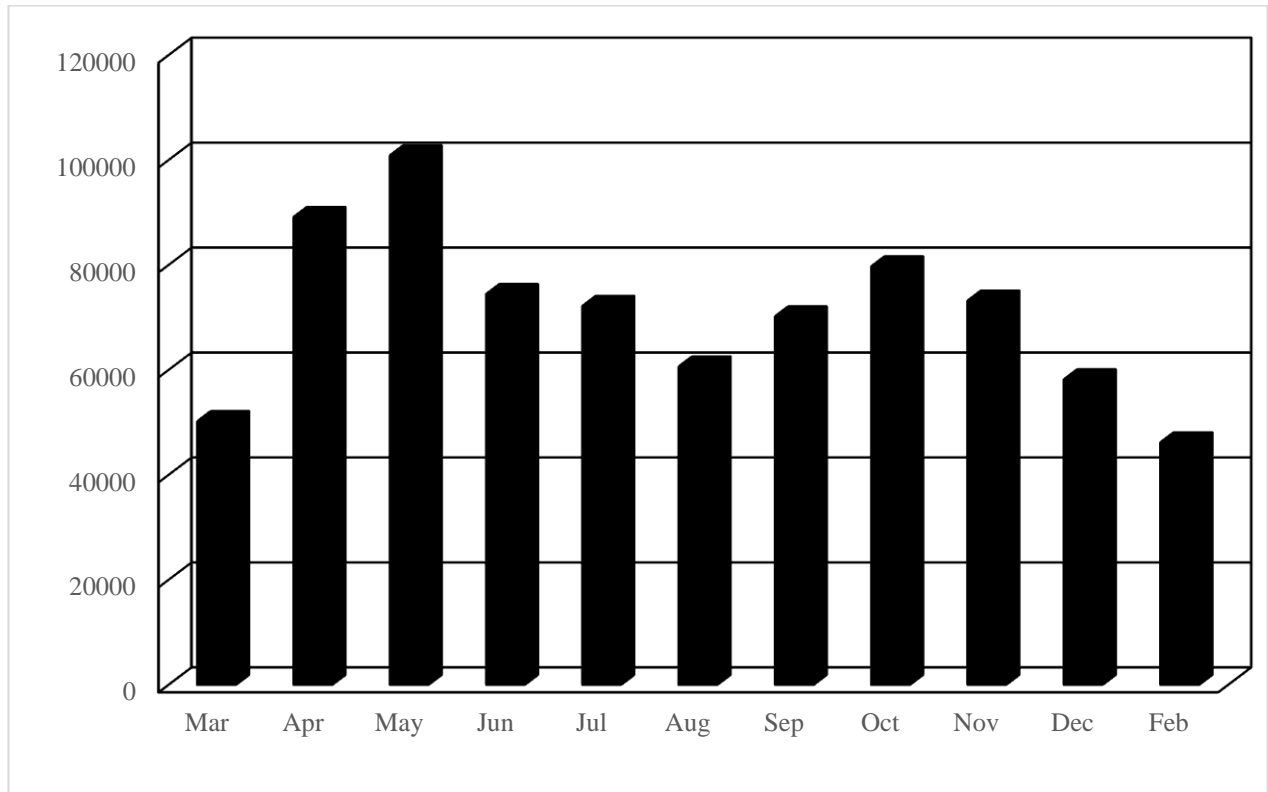


Figure 3: Total abundance of Rotifera according to the sampling months

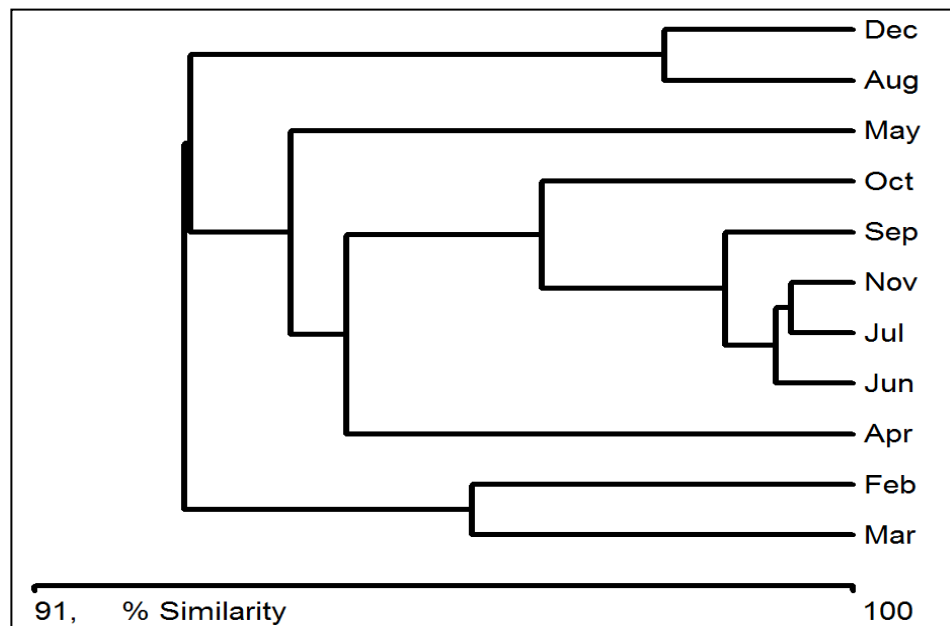


Figure 4: Bary-Curtis index similarity of zooplankton according to the sampling months

The maximum number of Rotifera were recorded at 1st station (81 819 ind m⁻³). This is followed by the 2nd and 3rd stations with 69 214 ind m⁻³ and 60 383 ind m⁻³ respectively (Figure 5). *Philodina megalotrocha* (1st and 3rd stations), *Asplanchna sieboldi*, *Collotheca ornate*, *Hexarthra mira*, *Trichocerca similis* and *T. pusilla* (1st and 2nd stations), *Lecane closterocerca*, *Polyarthra remata* and *Synchaeta*

pectinata (2nd -3rd stations) were found only in two stations, *Conochilus dossuarius* (3rd), *Filinia longiseta* (1st), *Lecane lunaris* (2nd), *Pompholyx sulcata* (1st) were found only in one station and other species were found at all stations. 2nd station was the most species rich station with 29 species while followed by the 1st station with 28 species and 3rd station with 25 species

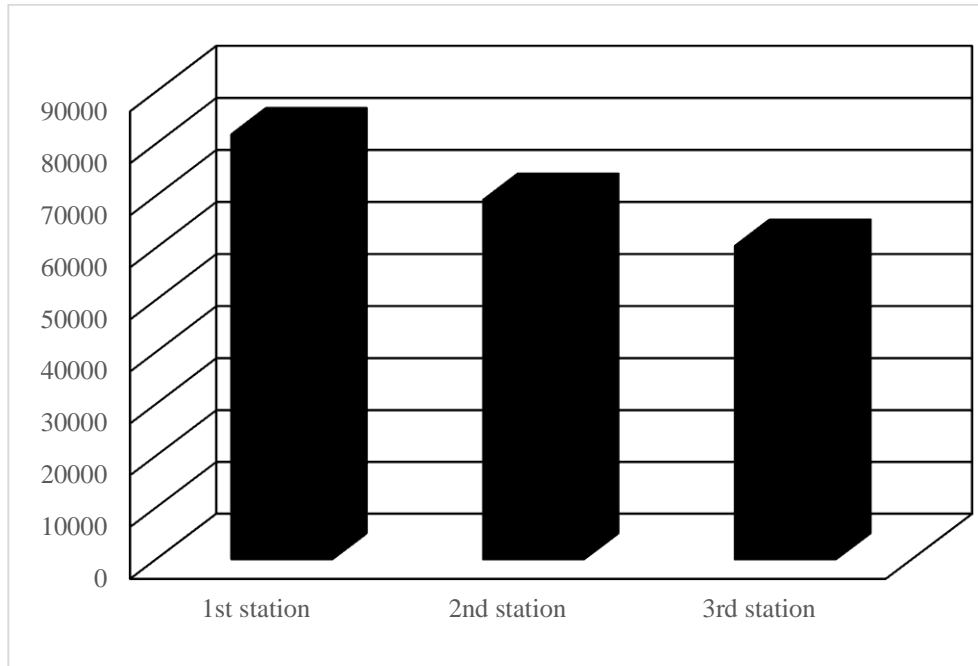


Figure 5: Abundance values of Rotifera according to sampling stations

When the sampling results were evaluated in terms of sampling month groups in their respective seasons, the maximum organism number was found in spring (83 458 ind m⁻³), followed by autumn (73 383 ind m⁻³) and summer (71 114 ind m⁻³) and the minimum was found in winter (53 934 ind m⁻³) (Figure 6). As species diversity, most species are found in spring and summer (28 species) while 22 species in autumn and at the winter 19 species were recorded. A decrease in species numbers in all the stations occurred in winter and an increase was observed in autumn and spring. The most species numbers were recorded in spring but fewer species numbers were observed in winter.

According to the Bary-Curtis index, seasonally are similar to each other over 85% (Figure 7).

All the species of Rotifera found in this study are shows widely distribution around the world and in Turkey (Segers, 2007; Ustaoglu et al., 2012). The most common species in the Kadıköy Reservoir were *Asplanchna priodonta*, *Brachionus angularis*, *Filinia terminalis* and *Keratella cochlearis* found in all sampling months. In addition, *Ascomorpha* sp, *Asplanchna priodonta*, *Brachionus quadridentatus*, *B. urceolaris*, *B. angularis*, *Filinia terminalis*, *Kellicottia longispina*, *Keratella tecta*, *K. quadrata*, *K. cochlearis*, *Lecane bulla*, *L. luna*, *Notholca squamula*, *Polyarthra vulgaris*,

Trichocerca capucina, *T. cylindrica*, *Trichocerca sp.* were the species found in all seasons during the study. These species most of

which are cosmopolitan are widely distributed in Turkey (Ustaoglu et al., 2012).

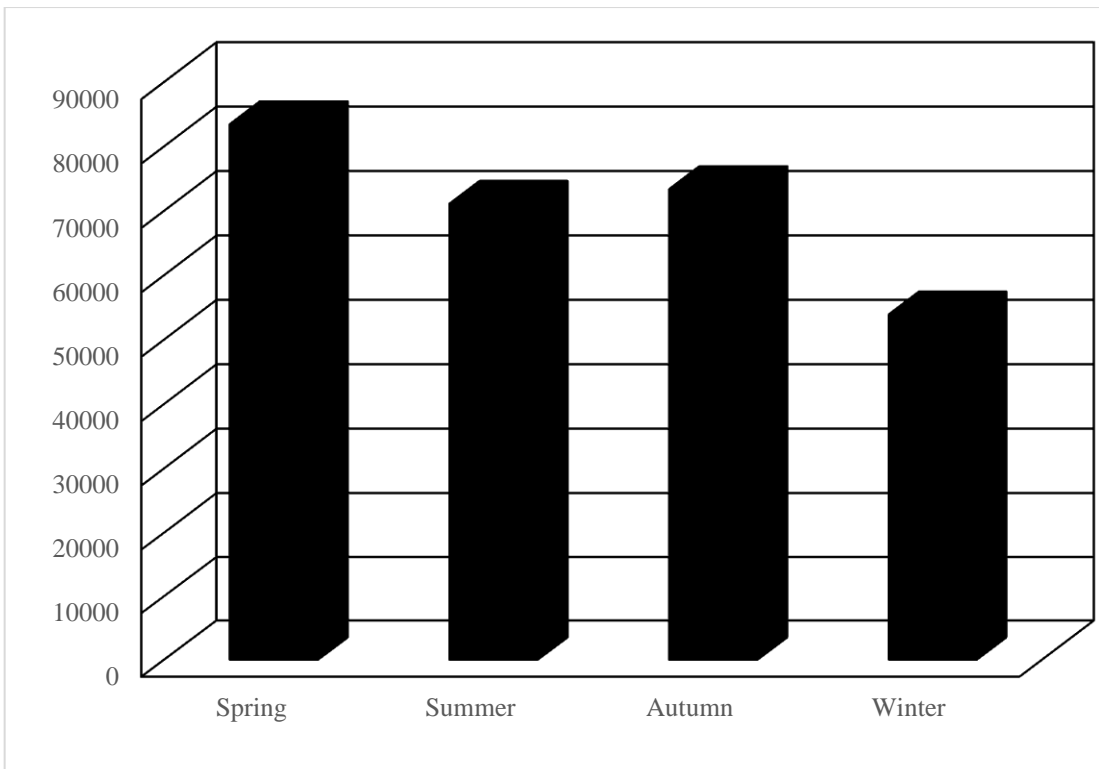


Figure 6: Abundance of Rotifera according to sampling to seasonally in Kadıköy Reservoir

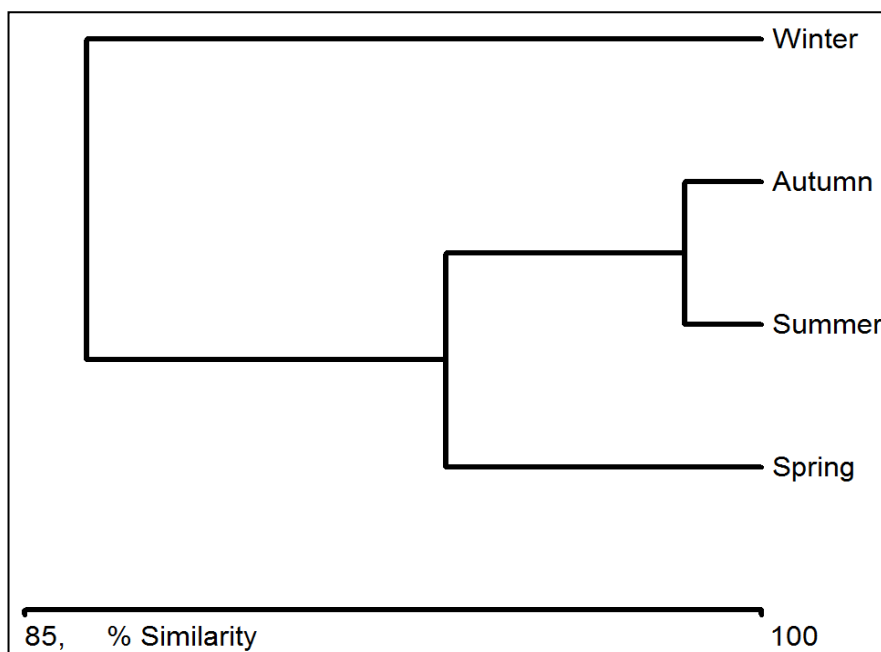


Figure 7: Bary-Curtis index similarity of zooplankton according to sampling stations

Branchionus species were indicate eutrophic habitat. They also suggested the Brachionidae family and *Brachionus* species as indicators of highly trophic habitat (Radwan, 1984; Sladeczek, 1983). In Kadıköy Reservoir 10 species (*Brachionus diversicornis*, *B. angularis*, *B. quadridentatus*, *B. urceolaris*, *Kellicottia longispina*, *Keratella cochlearis*, *K. quadrata*, *K. tecta* and *Notholca squamula*) from Brachionidae were identified. *Keratella cochlearis* an indicator of eutrophic conditions was recorded in all the months during the study. According to these species, the Kadıköy reservoir showed mesotrophic property. But, to determine the trophic index of the lake, *Brachionus:Trichocerca* (QB/T) equality was used (Sladeczek, 1983). According to this, while a quotient between one and two corresponds to mesotrophic conditions and a ratio of >2 is encountered in eutrophic lakes, a quotient of 1 indicates oligotrophic conditions. In this study, Kadıköy Reservoir was determined (4 species of *Brachionus* and 4 species of *Trichocerca*) QB/T = 1. On the other hand, the reservoir showed oligotrophic property according to Rotifera index. However, the index was calculated as 5.7 according to the average abundances of these species determined in the reservoir (*Brachionus* 47 961 ind m⁻³ and *Trichocerca* 8 378 ind m⁻³), thus leading reservoir to show an eutrophic property.

CONCLUSION

Rotifera species in the Kadıköy Reservoir were evaluated both qualitatively and quantitatively. A total of 33 Rotifera species were determined in the qualitative evaluation of plankton samples. The quantitative evaluation of the samples revealed an average value of 70 472 ind m⁻³ in the reservoir. While the maximum organism was found in spring (83 458 ind m⁻³) at 1st station (81 819 ind m⁻³) and in May (100 901 ind m⁻³), the lowest value found in winter (53 934 ind m⁻³), 3rd station (60 383 ind m⁻³) in

February (46 203 ind m⁻³). When we evaluate the species identified in the reservoir, the distribution of the individuals that make up the Rotifera fauna and physical-chemical parameters as a whole, it has been concluded that Kadıköy Reservoir is in meso-eutrophic character in terms of zooplankton.

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