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Communication

Diversity and abundance of zooplankton in Medik Reservoir of Turkey

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Abstract: Zooplankton samples were taken monthly from Medik Reservoir between June 2013 - July 2014. A total of 40 species (28 belonging to Rotifera, 8 to Cladocera and 4 to Copepoda) were identified in the reservoir. Rotifers were the dominant group in the reservoir (70%) followed by Cladocera (20%) and Copepoda (10%). Water temperature, pH and dissolved oxygen were measured during field trips. Shannon Wiever species index value was recorded with the highest value being 2.81. The Q *Brachionus/Trichocerca* index value of 2 indicated that the reservoir was eutrophic.

Key words: Rotifera, Cladocera, Copepoda, zooplankton, Medik Reservoir, Turkey

INTRODUCTION

Zooplankton has a special role as food for fish and aquatic invertebrates. Furthermore, the species composition and the abundance of zooplankton such as rotifers and cladocerans are excellent tools for interpreting the trophic level in aquatic systems since they are very sensitive to environmental variables such as nutrient availability and they can be observed in a wide range of water bodies [1, 2]. Zooplanktonic organisms are the most important source for invertebrates, fishes and sometimes for aquatic birds. Herzig [3] and Saksena [4] indicated some zooplankton species as indicators of water quality and pointed out the importance of these organisms in determining the trophic level of aquatic environments.

Some of the zooplankton researches in Turkey reservoirs have been reported [5-9]. This study was conducted to identify the zooplankton fauna of Medik Reservoir and to acquire information about the species composition and richness.

MATERIALS AND METHODS

Medik Reservoir, built between 1966-1975 for irrigation on Tohma Stream, was sampled monthly between June 2013 - July 2014 at three stations whose coordinates were 38°30′30″N 38°01′13″E, 38°30'32″N 38°01'16″E and 38°30′33″N 38°01′19′E for stations no. 1, 2 and 3

respectively. Samples were collected by using 55-µm-mesh standart plankton nets and were preserved in 4% formaldehyde solution. Relevant literature [10-18] was used for species identification and classification.

Shannon-Weaver species richness index [19], Simpson diversity index [20] and Margalef species richness index [21] were used for measuring biodiversity. They are defined as follows:

Simpson index (D) = $1-\sum n_i(n_i-1)/N(N-1)$,

Shannon Wiever index (H') = $\sum p_i (\ln)p_i$,

Margalef index (M) = $S-1/\ \ln N$,

where n_i is the relative abundance of each species, p_i is the fraction of the entire population made up of species i, S is the number of species in the sample, and N is the total number of individuals in the sample.

The QB/T index was calculated as the ratio of *Brachionus* to *Trichocerca*. If the ratio is equal to 1, the lake is oligotrophic; if it is between 1-2, the lake is mesotrophic; and if it is greater than 2, the lake is eutrophic [13]. Water temperature, pH and dissolved oxygen were measured *in situ* by using a YSI oxygen and pH meter.

RESULTS AND DISCUSSION

In Medik Reservoir 40 zooplankton species, 28 species from Rotifera, 8 species from Cladocera and 4 species from Copepoda were identified. The seasonal distributions of the species are given in Table 1.

Table 1. Seasonal distribution of zooplankton in Medik Reservoir (+ = present, - = absent)

Season	Autum			Winter			Spring			Summer		
Month	(S,O,N)			(D, J, F)			(M, A, M)			(J, J, A)		
Station	1	2	3	1	2	3	1	2	3	1	2	3
Rotifera												
Ascomorpha saltans Bartsch,1870	-	+	+	-	-	+	+	+	-	-	+	+
Asplanchna priodonta Gosse,1850	-	+	-	-	-	-	+	-	-	-	+	+
Asplanchna sieboldi (Leydig,1854)	-	+	+	-	-	+	+	-	+	+	+	-
Brachionus angularis Gosse,1851	-	+	-	-	+	-	+	+	+	-	-	+
Brachionus quadridentatus Hermann, 1783	+	+	-	-	-	-	+	+	-	-	-	-
Cephalodella forficula Ehrenberg, 1830	+	-	+	+	-	-	+	+	-	+	-	+
Cephalodella gibba (Ehrenberg, 1830)	+	-	+	+	-	+	+	-	+	+	-	+
Colurella adriatica Ehrenberg, 1831	-	+	-	-	-	-	+	+	-	-	+	-
Colurella colurus (Ehrenberg, 1830)	-	+	-	-	-	-	+	-	+	-	+	-
Euchlanis dilatata Ehrenberg,1832	+	-	-	-	+	-	+	+	+	-	-	+
Epiphanes senta (Müller, 1773)	-	+	-	-	+	-	-	-	+	+	-	-
Filinia opoliensis (Zacharias, 1898)	+	-	-	+	-	+	+	-	-	-	-	-
Hexarthra mira (Hudson, 1871)	-	-	-	+	+	+	-	-	-	-	-	-
Kellicottia longispina (Kellicott,1879)	-	+	+	+	-	+	+	+	+	+	+	-
Keratella cochlearis (Gosse,1851)	+	+	+	-	+	-	+	+	+	+	+	+
Keratella quadrata (Müller,1786)	-	+	+	-	-	-	+	+	+	-	-	-
Keratella tecta (Gosse,1851)	-	-	-	+	-	-	+	-	+	-	+	+
Keratella valga (Ehrenberg, 1834)	+	-	+	-	-	-	+	+	+	-	-	+
Lepadella ovalis (Müller, 1786)	-	-	-	+	-	-	+	+	-	+	-	-
Lepadella patella (Müller, 1773)	+	-	+	-	+	-	+	-	+	-	-	+
Mytilina ventralis (Ehrenberg, 1830)	+	-	-	-	+	-	+	-	+	-	-	+
Notholca squamula (Müller,1786)	-	-	+	+	+	-	-	-	-	-	-	-
Polyarthra dolichoptera Idelson, 1925	+	+	+	-	+	-	+	+	+	+	-	+
Pompholyx sulcata Hudson, 1885	-	+	+	-	-	-	+	-	+	-	-	-
Rotaria rotatoria (Pallas, 1766)	+	-	+	-	-	+	+	+	+	-	+	-
Synchaeta pectinata Ehrenberg,1832	+	-	-	+	-	-	+	+	+	-	+	-
Testudinella patina (Hermann, 1783)	-	+	-	-	-	-	-	+	+	-	-	-
Trichocerca longiseta (Schrank, 1802)	-	+	-	-	-	-	+	+	-	+	-	-

Maejo Int. J. Sci. Technol. **2017**, *11*(02), 126-132

Table 1. (Continued)

Season	Autum			Winter			Spring			Summer		
Month	(S,O;N)			(D, J, F)			(M, A, M)			(J, J, A)		
Station	1	2	3	1	2	3	1	2	3	1	2	3
Cladocera												
Alona rectangula Sars,1862	+	+	+	+	-	+	+	+	-	+	-	+
Bosmina longirostris (O. F. Müller,1785)	+	+	-	-	+	-	+	-	+	+	+	+
Ceriodaphnia pulchella Sars, 1862	+	-	-	-	-	-	-	+	+	-	-	-
Ceriodaphnia reticulata (Jurine,1820)	-	+	+	-	-	+	+	+	-	+	-	+
Chydorus sphaericus (O. F. Müller, 1776)	-	+	+	-	-	+	+	+	+	-	+	-
Daphnia longispina O. F. Müller, 1785	+	-	+	-	+	-	+	-	+	-	+	+
Leydigia leydigi (Schoedler,1863)	-	-	+	-	-	-	+	+	+	-	-	+
Moina micrura Kurtz, 1874	+	+	-	+	-	-	-	+	+	-	-	+
Copepoda												
Acanthopdiaptomus denticonis (Wierjesky, 1887)	+	+	-	+	-	-	+	+	+	+	+	+
Cyclops vicinus Uljanin, 1875	+	+	+	-	+	+	+	+	+	+	+	+
Macrocyclops albidus (Jurine, 1820)	+	+	+	+	-	-	+	+	+	-	+	-
Nitocra hibernica (Brady, 1880)	-	-	-	-	-	-	+	-	+	-	-	-

In the reservoir rotifers were recorded as dominant organisms. Their species richness was 70% followed by Cladocera (20%) and Copepoda (10%). The most encountered rotifers were *Keratella cochlearis* and *Polyarthra dolichoptera*. *Brachionus longirostris* and *Alona rectangula* were the most common cladocerans and *Cyclops vicinus* was the dominant copepod species. *C. vicinus* was observed in all seasons except winter at the first station. The highest species number was recorded in spring with 34 species at the first station and the lowest was in winter at the third station with 11 species. The seasonal species number of zooplankton groups are given in Figure 1.

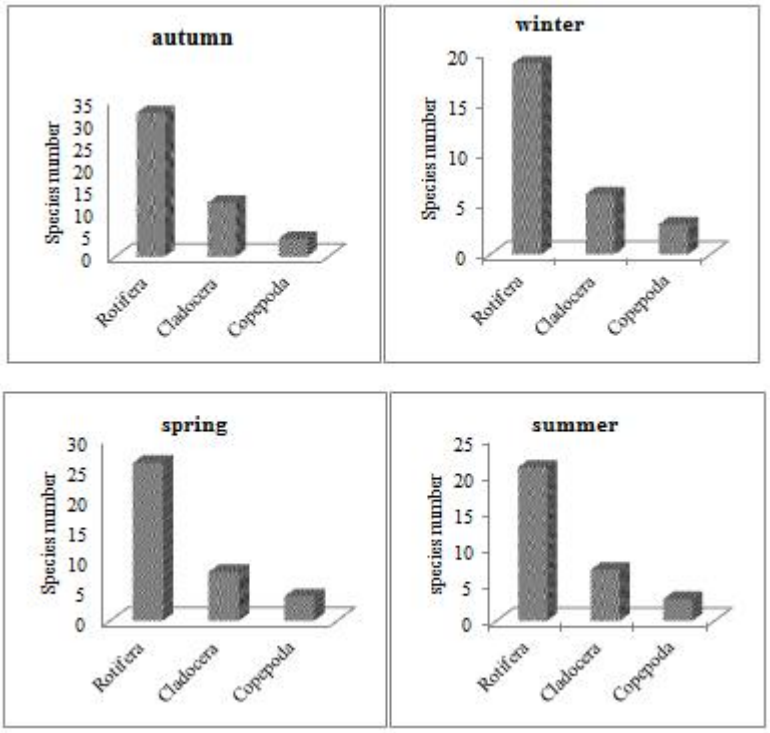

Figure 1. Seasonal species number of zooplankton groups in Medik Reservoir

A decrease in species numbers in all stations occurred in winter and an increase was observed in autumn and spring. The most taxa were recorded in spring (26 rotifers, 4 copepods and

8 cladoceran, 38 species in total), but fewer taxa were observed in winter (19 rotifers, 3 copepods and 6 cladoceran, 28 species in total). In all seasons rotifers were recorded as the dominant zooplankton group. In autumn the relative density of Rotifera was calculated as 70% and in winter, spring and summer it was 65%. Water temperature, dissolved oxygen and pH values of the reservoir were recorded *in situ* and are shown in Table 2. Temperature values ranged between 7.1-21.0. The highest dissolved oxygen level was recorded at 10.7 mg/L in winter at the second station. The pH values varied between 7.1-8.9.

Table 2. Seasonal values of water temperature, dissolved oxygen and pH in Medik Reservoir

Season	Autumn			Winter			Spring			Summer		
Station	1	2	3	1	2	3	1	2	3	1	2	3
Temperature (C^o)	11.3	10.9	11.5	7.5	7.1	7.2	13.8	14.1	14.0	20.9	21.0	20.7
Dis.Oxygen (mg/L)	9.2	9.3	9.0	10.2	10.7	9.9	8.4	8.2	8.5	7.4	7.1	7.3
pH	7.1	7.4	7.3	7.9	8.0	7.3	8.1	8.4	8.4	8.9	8.2	8.1

Shannon-Wiever index (*H'*), Simpson index (D) and Margalef index (M) were calculated and the seasonal index values at each station are given in Table 3. The highest *H'* value (2.81) was obtained in spring at the first station; the lowest value (2.20) was recorded in summer at the same station. D values ranged between 0.08-0.13 and M was between 2.85-6.35.

Table 3. Shannon-Wiever index, Simpson index and Margalef index values

Season	Autumn			Winter			Spring			Summer		
Station	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Shannon - Wiever index (*H'*)	2.47	2.49	2.38	2.30	2.24	2.29	2.81	2.41	2.51	2.20	2.31	2.57
Simpson index (D)	0.10	0.11	0.13	0.09	0.09	0.10	0.08	0.13	0.12	0.12	0.12	0.09
Margalef index (M)	4.21	4.86	4.36	3.76	3.23	3.46	6.35	4.70	5.16	2.85	3.38	4.15

In Medik Reservoir Rotifera comprised 70% of all zooplankton. In Gelingülü Dam Lake zooplankton consisted of 92% Rotifera, 7% Cladocera and 1% Copepoda [22]. Bekleyen [23] identified 16 species of cladocerans, 3 species of copepods and 28 species of rotifers, a total of 47 species from Göksu Dam Lake. From Birecik Dam Lake a total of 39 species were determined: 21 species from Rotifera, 11 species from Cladocera and 7 species from Copepoda [24]. From Sürgü Dam Lake a total of 47 zooplankton species (31 species from Rotifera, 10 species from Cladocera and 6 species from Copepoda) were identified [25]. In Uzunçayır Dam lake 23 zooplankton species (15 species from Rotifera, 6 species from Cladocera and 2 species from Copepoda) were recorded [26]. Bulut and Saler [8] identified 40 species from Kalecik Dam Lake, with rotifers being the majority at a relative abundance of 62.5%. In all these dam lakes, the zooplankton relative density profile was similar to that of Medik Reservoir.

Only 8 species of Cladocera were observed in the reservoir. Among the identified species *Leydigia leydigi*, *Moina micrura* and *Ceriodaphnia pulchella* were rarely found in Medik Reservoir. *Brachionus longirostris*, *Alona rectangula* and *Ceriodaphnia reticulata* were observed throughout all seasons. From Copepoda, *Cyclops vicinus* and *Acanthodiaptomus denticornis* were observed throughout all seasons but *Nitokra hibernica* was only recorded in spring. *C. vicinus* and *A.*

denticornis are the common Copepod species in Turkey inland waters [27]. Among the recorded species, *Brachionus longirostris*, *C. vicinus*, *Polyarthra dolichoptera* and *Keratella cochlearis* are stated as indicators of eutrophy [28]. *P. dolichoptera* and *K. cochlearis* were predominant in the reservoir. *Asplanchna priodonta*, *Hexarthra mira*, *Testunidella patina*, *Trichochocerca longiseta*, *Notholca squamula* and *Pompholyx sulcata* were rarely found in Medik Reservoir. *Rotaria rotatoria* was recorded from polluted waters [16, 29]. *Keratella cochlearis*, *K. longispina* and *Polyarthra dolichoptera* were recorded in all seasons in the reservoir and they are found as common rotifer species in Turkish inland waters [30].

In Medik Reservoir the sequence of dominance of various groups was Rotifera > Cladocera > Copepoda. According to George [31], the abundance of Rotifera followed by Cladocera is an indication of the eutrophic nature of a water body.

During the research, the most common species such as *Ascomorpha saltans*, *Keratella quadrata*, *K. cochlearis*, *K. tecta*, *Kellicottia longispina* and *Polyarthra dolichoptera* are cosmopolitan species [16]. *Bosmina longirostris*, the most recorded Cladocera species, is a well-known indicator of eutrophication [32].

Keratella cochlearis and *Polyarthra dolichoptera*, indicators of productive habitats, were found in all seasons and *Notholca squamula*, an indicator of cold waters, was observed in the cold seasons, i.e. autumn and winter, in Medik Reservoir. Kolisko [29] reported that *K. cochlearis* and *P. dolichoptera* are perennial species while *N. squamula* is a winter species. The results of our study seem to agree with this. *P. dolichoptera* and *K.cochlearis* were frequently found at all sampling stations. These species are considered to be indicators of mesotrophic conditions [34]. The dominance of *Brachionus* and *Keratella* are the general trend in freshwater bodies in Turkey [30]. In our study two species of *Brachionus* (*B. angularis* and *B. quadridentatus*) and five species of *Keratella* (*K. cochlearis*, *K. hispida*, *K. quadrata*, *K. tecta* and *K. valga)* have been identified. Ustaoğlu et al. [30] reported 15 *Brachionus* species and 6 *Keratella* species from Turkey. According to Radwan [1] and Sladecek [2], *Brancionus* species indicate eutrophic habitat. They also suggested the Brachionidae family and *Brachionus* species as indicators of highly trophic habitat. In Medik Reservoir 10 species (*Brachionus angularis*, *B. quadridentatus*, *Euclanis dilatata*, *Kellicottia longispina*, *Keratella cochlearis*, *K. hispida*, *K. quadrata*, *K. tecta*, *K. valga* and *Notholca squamula*) from Brachionidae were identified. *K. cochlearis*, an indicator of eutrophic coonditions, was recorded in 10 samplings in the reservoir.

A quantitative method that used the ratio of the number of species of *Brachionus* to *Trichocerca* was suggested by Sladecek [2]. He used *Brachionus* and *Trichocerca* species as indicators of eutrophic and oligotrophic waters respectively. In Medik Reservoir a QB/T index value of 2 was obtained, which showed a eutropic character.

In the lake the highest H' value of 2.81 was obtained in spring in the first station and lowest value of 2.24 was recorded in winter in the second station. A high value of H' indicates great species diversity. In spring in the first station the highest number of species was recorded at 34 species. A greater species diversity means a larger food chain, more cases of inter-specific interactions, a greater possibility of negative feedback control to reduce oscillations and hence an increase in stability of the community [33]. In Kesikköprü Dam Lake the highest value of H' (2.1) was recorded in autumn and, similar to Medik Reservoir, the lowest H' value was recorded in winter [5]. The highest D value of 0.13 was recorded in autumn and spring, implying high evenness, compared with other seasons, of the community. The highest M value of 6.35 in spring implies the

highest species richness in this season. In Hancağız Dam Lake [34] the highest M value of 6.31 was also recorded in spring as in Medik Reservoir.

Matsubara [34] Castro et al. [35] and Hessen et al. [36] stated a positive correlation between zooplankton species richness and temperature in aquatic habitats. The species composition, which depends on the temperature in Medik Reservoir, supports this statement. An increase in temperature affects the number of individuals and taxa positively.

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