

The zooplankton composition of Lake Ladik (Samsun, Turkey)

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Abstract: The zooplankton composition of Lake Ladik, located in Samsun Province in northern Turkey, was investigated monthly between November 2009 and October 2010. Some physicochemical parameters such as temperature of surface water, pH, dissolved oxygen, salinity, conductivity, and total dissolved solids were also evaluated. A total of 29 zooplankton species were identified. These species were represented by three main groups: Rotifera (59%), Cladocera (24%), and Copepoda (17%). The maximum and minimum numbers of species were found in July and October, respectively. *Bosmina longirostris*, *Keratella quadrata*, *Asplanchna priodonta*, *Cyclops abyssorum*, *Polyarthra dolichoptera*, *Brachionus calyciflorus*, *Keratella cochlearis*, *Brachionus angularis*, and *Chydorus sphaericus* were the dominant species of the lake. According to the *Brachionus:Trichocerca* quotient ($Q_{B/T}$), the trophic level of the lake is eutrophic.

Key words: Lake Ladik, Cladocera, Copepoda, Rotifera, zooplankton, eutrophic, Turkey

1. Introduction

Zooplankton plays an important role in aquatic ecosystems (Baloch et al., 2005). Zooplankton species have been used as an indicator of the trophic states of lakes (El-Bassat and Taylor, 2007; Ahangar et al., 2012) because of their sensitivity to any ecological change in water bodies (Güher et al., 2011). Additionally, Saksena (1987) reported that zooplankton should be considered as an indicator of water quality. Baloch and Suzuki (2009) concluded that Cladocera and Rotifera dominate eutrophic lakes, whereas Copepoda dominates oligotrophic lakes.

Many studies on zooplankton communities of inland water bodies have been carried out in Turkey (e.g., Gündüz 1991a, 1991b; Emir Akbulut, 2000; Yiğit and Altındağ, 2005; Bekleyen and Taş, 2008; Özdemir Mis and Ustaoglu, 2009; Gülle et al., 2010; Saler, 2011; Bozkurt and Akin, 2012a; Ustaoglu et al., 2012a; Gündüz et al., 2013; Apaydin Yağci, 2013).

The phytoplankton of Lake Ladik was investigated by Maraşlıoğlu et al. (2005). The zooplankton species of Lake Ladik were investigated by Bulut and Saler (2013). However, the annual zooplankton composition and species indices of this lake have not been studied before. The aim of this work was to determine the recent zooplankton composition and its annual variations, and to describe the trophic level of the lake.

2. Materials and methods

The study area (40°50'N to 41°00'N, 35°40'E to 36°05'E) is located within the borders of the Ladik district of Samsun Province in the central Black Sea region of Turkey. The lake has an elevation of 867 m a.s.l. and a depth of 2.5–6.0 m, and it is approximately 5 km long and 2 km wide. Lake Ladik has a drainage area of 141.40 km². The lake is fed by small streams coming from Akdağ Mountain. Tersakan Stream, an outlet stream helping to control the water levels of the lake, runs into the Yeşilırmak River (Uğurlu et al., 2009). It has been classified as a eutrophic lake (Maraşlıoğlu, 2001) and is a natural protected area due to its floating islands (Bulut, 2012).

Zooplankton and water samplings were carried out monthly between November 2009 and October 2010 at 3 stations in Lake Ladik (Figure 1). The average depth was ~2 m at Station 1 and Station 3, and 4 m at Station 2. Zooplankton samples were collected horizontally using a plankton net having a mesh size of 55 µm (diameter = 57 cm), and they were fixed with lugol solution immediately after collection in 250-mL dark bottles. Species were examined under a binocular microscope and the species were identified to the species level using the keys of Kiefer (1952, 1955), Dussart (1967, 1969), Koste (1978), Negrea (1983), Smirnov (1996), and Nogrady and Segers (2002). A zooplankton species checklist was prepared

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Figure 1. The study area and sampling stations.

according to Ustaoglu (2004) and Ustaoglu et al. (2012b). Physicochemical parameters such as conductivity, total dissolved solids (TDS), pH, salinity, dissolved oxygen, and water temperature were measured from surface water using a portable Hach Lange model HQ40d. Data were tested for normality using the Shapiro–Wilk test, which rejects the normal distribution hypothesis with small P-values (<0.05). Because data were not normally distributed, logarithmic transformation ($\log [n + 1]$) was applied to the data for cluster analysis (Koçer and Şen, 2014). Using squared Euclidean distances as a measure of similarity, hierarchical agglomerative cluster analysis was performed on the transformed data set by means of Ward's method. The linkage distance is reported as D_{link} / D_{max} , which represents the quotient between the linkage distance for a particular case divided by the maximal distance, multiplied by 100 as a way to standardize the linkage distance represented on the y-axis (Simeonov et al., 2003; Sinha et al., 2009). Statistical analysis was performed using JMP 7 (SAS Institute Inc.) and STATISTICA 8 (StatSoft Inc.). Soyer's (1970) frequency index (F %) was used to define the frequency of species in the research area and results were estimated as constant ($F \geq 50\%$), common ($50\% > F \geq 25\%$), or rare ($F < 25\%$). This index (F) for special species was evaluated using $F = m / M \times 100$, where m is the number of stations for the species and M is the number of all stations.

The *Brachionus:Trichocerca* quotient (Q_{BT}) was calculated to assess the trophic structure of the lake. Sládeček (1983) reported that a quotient of 1 indicates oligotrophic conditions, while a quotient between 1 and 2

corresponds to mesotrophic conditions and a ratio of >2 is encountered in eutrophic lakes.

3. Results

The monthly values of some physicochemical parameters from Lake Ladik between November 2009 and October 2010 are given in Figure 2. The water temperature varied between 3.8 °C (January) and 25.2 °C (July). Values of pH ranged from 8.00 in November to 9.06 in February. The dissolved-oxygen concentration changed from 7.12 mg/L in May to 12.15 mg/L in February. The minimum and maximum salinity was measured as 0.09‰ and 0.14‰, respectively. The highest conductivity value was 300.00 $\mu\text{s}/\text{cm}$ in June, while the lowest value was 227.43 $\mu\text{s}/\text{cm}$ in September. The TDS values were noted between 96.30 and 147.40 mg/L.

A total of 29 zooplankton species belonging to Rotifera, Cladocera, and Copepoda were identified in Lake Ladik (Table). The most dominant group was Rotifera (59%), followed by Cladocera (24%) and Copepoda (17%). The distribution of zooplankton groups by station is presented in Figure 3. *Cyclops abyssorum*, *Bosmina longirostris*, *Polyarthra dolichoptera*, *Asplanchna priodonta*, and *Keratella quadrata* were observed in all months. The highest number of zooplankton taxa (19) occurred at Station 3 in July. The zooplankton diversity was substantially reduced at Station 2 in October. Cluster analysis of species abundances at the 3 stations revealed temporal heterogeneity, and it resulted in a dendrogram (Figure 4) grouping the sampling stations into 4 main

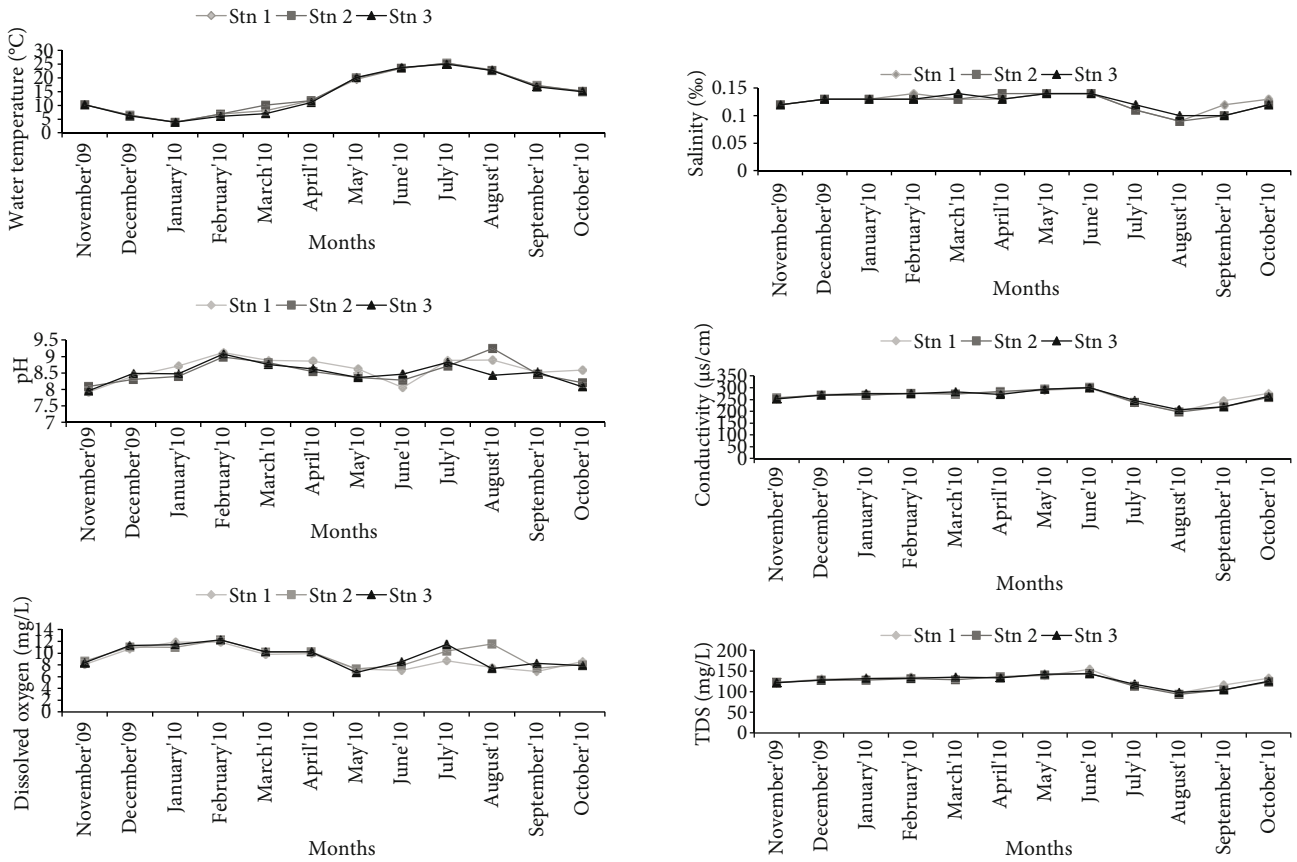


Figure 2. Monthly changes of some physicochemical parameters according to stations in Lake Ladik.

statistically meaningful clusters at $D_{link} / D_{max} \times 100 < 50$. Cluster 1 consisted exclusively of November and May data from all 3 sampling stations, while Cluster 2 included winter and spring data between December and March. Cluster 3 corresponded to summer data in June and July, while Cluster 4 consisted of late summer and early autumn data between August and October. Although there was no clear spatial variation of species abundance despite a marked temporal variation, cluster analysis also showed that there was a spatial variation of species abundances in winter and spring months.

According to frequency index values, 11 species were classified as constant ($F \geq 50\%$), 7 species were classified as common ($50\% > F \geq 25\%$), and 11 species were classified as rare ($F < 25\%$). The constant species *B. longirostris* was determined to have the highest frequency value (94.12%), and this species was found most frequently in all months. *K. quadrata* was followed by the Rotifera (91.18%); *A. priodonta* (88.24%), *C. abyssorum* (88.24%), *P. dolichoptera* (79.41%), *Brachionus calyciflorus* (76.47%), *Keratella cochlearis* (73.53%), *Brachionus angularis* (73.53%), and *Chydorus sphaericus* (70.59%) were other widespread species (Table).

4. Discussion

Of 29 species identified in Lake Ladik, 17 taxa belonged to Rotifera, and the family Brachionidae had the highest number of species. The genus *Brachionus* was represented by 5 species including *B. angularis*, *B. quadridentatus*, *B. urceolaris*, *B. diversicornis*, and *B. calyciflorus*. Seven species of Cladocera were observed during the study. The majority of these species were members of the family Daphniidae. Five copepods were determined, most of them belonging to the family Cyclopoidae (Table). In this study, a total of 13 species were the same as reported by Bulut and Saler (2013): from the rotifers, *B. angularis*, *B. urceolaris*, *K. cochlearis*, *K. quadrata*, *Synchaeta pectinata*, *P. dolichoptera*, *A. priodonta*, and *Hexarthra mira*; from the cladocerans, *B. longirostris* and *C. sphaericus*; and from the copepods, *Eudiaptomus gracilis*, *Cyclops vicinus*, and *Nitokra hibernica*. However, 9 species determined by Bulut and Saler (2013) were not found in this study. *B. calyciflorus*, *B. diversicornis*, *B. quadridentatus*, *Notholca acuminata*, *Ascomorpha saltants*, *Asplanchna girodi*, *Filinia terminalis*, and *Trichocerca similis* from Rotifera; *Daphnia cucullata*, *Ceriodaphnia quadrangula*, *Simocephalus vetulus*, *Moina brachiata*, and *Coronatella rectangula* from Cladocera; and *C. abyssorum* and *Thermocyclops crassus* from Copepoda are new records for Lake Ladik.

Table. Distribution of zooplankton species found in Lake Ladik according to month and station.

Research period	2009												2010												% f	Indicator species			
	Nov		Dec		Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep*		Oct						
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3			1	2	3
ROTIFERA																													
<i>Brachionus angularis</i>	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	-	+	x	
<i>Brachionus calyciflorus</i>	-	+	-	+	+	+	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	76.47	
<i>Brachionus urceolaris</i>	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11.76	x
<i>Brachionus diversicornis</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	47.06	
<i>Brachionus quadridentatus</i>	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.88	x
<i>Keratella cochlearis</i>	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	73.53	x
<i>Keratella quadrata</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	91.18	x
<i>Keratella sp.</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.82	
<i>Notholca acuminata</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11.76	
<i>Trichocerca similis</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11.76	
<i>Ascomorpha saltans</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.94	
<i>Synchaeta pectinata</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.82	
<i>Polyarthra dolichoptera</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	-	+	79.41	x
<i>Asplanchna girodi</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.88	
<i>Asplanchna priodonta</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	-	+	88.24	
<i>Hexarthra mira</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	26.47	
<i>Filinia terminalis</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	44.12	
CLADOCERA																													
<i>Daphnia cucullata</i>	+	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	58.82	x
<i>Simocphalus vetulus</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.94	
<i>Ceriodaphnia quadrangula</i>	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	52.94	x
<i>Moina brachiata</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	29.41	
<i>Bosmina longirostris</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	94.12	x
<i>Chydorus sphaericus</i>	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	70.59	x
<i>Coronatella rectangularis</i>	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17.65	
COPEPODA																													
<i>Eudiaptomus gracilis</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	44.12	
<i>Cyclops abyssorum</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	-	-	88.24	
<i>Cyclops vicinus</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	47.06	x
<i>Thermocyclops crassus</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	26.47	x
<i>Nitokra hibernica</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.88	

*Zooplankton samples could not be taken at the 2nd and 3rd stations in September.

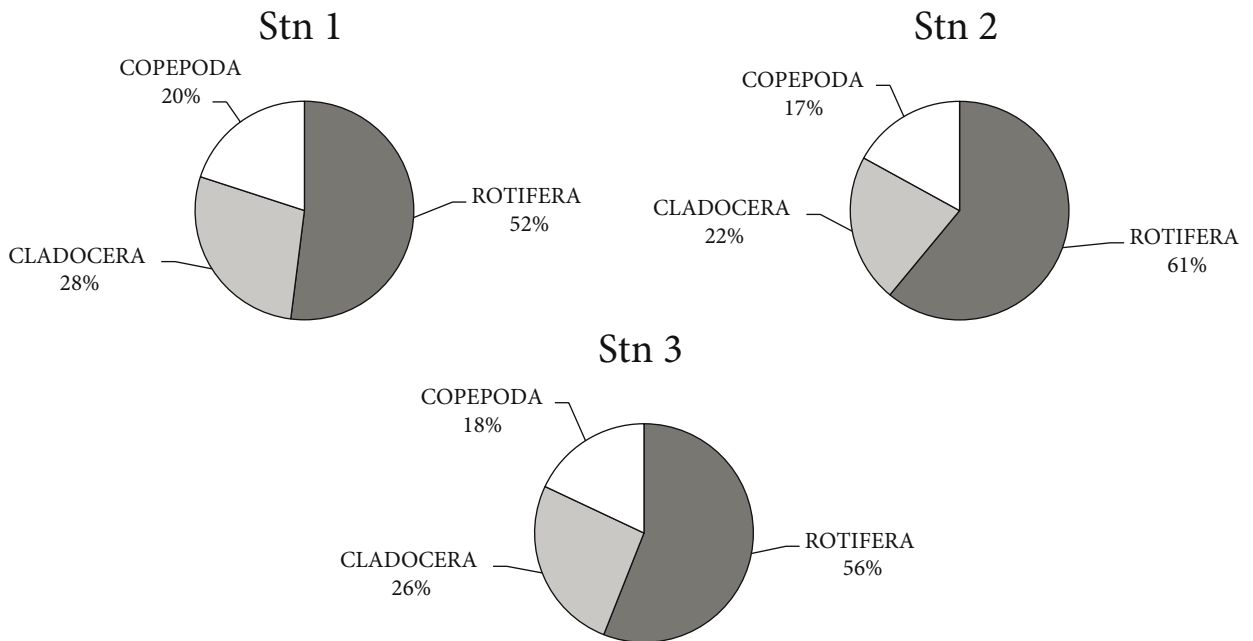


Figure 3. Distribution of zooplankton groups in Lake Ladik during the research period.

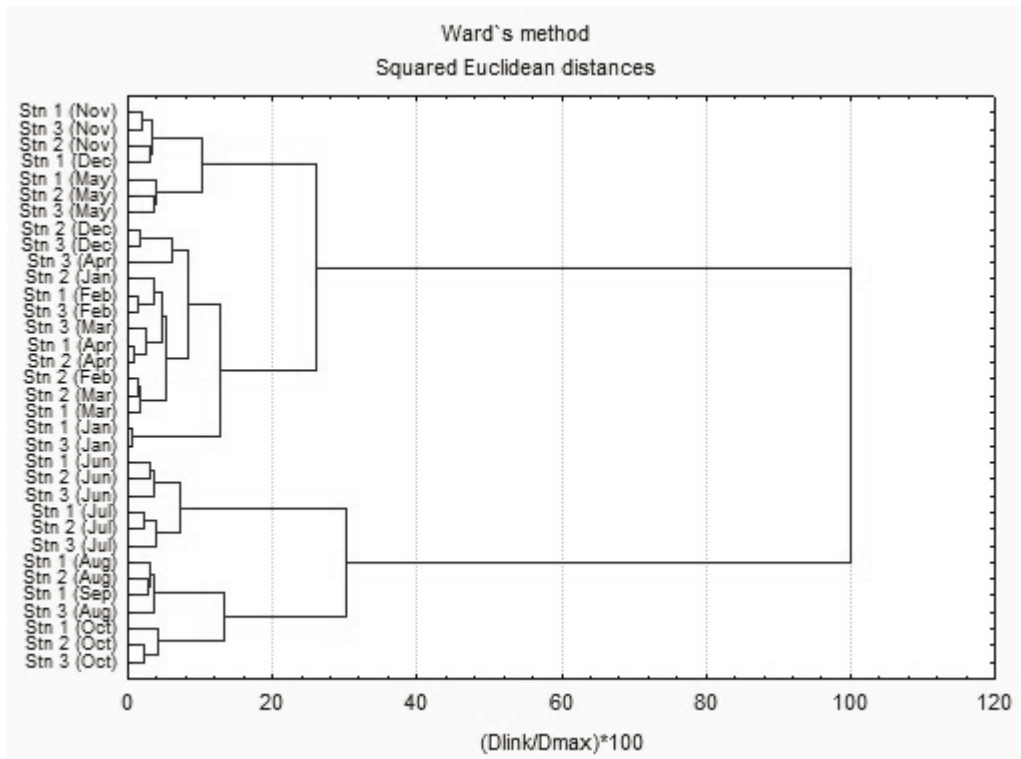


Figure 4. Cluster analysis results of zooplankton for stations in Lake Ladik.

Rotifera was the dominant group in the lakes and some lagoons of past studies (Emir, 1990; Bekleyen and Taş, 2008; Bozkurt and Akın, 2012a; Ustaoglu et al., 2012a; Gündüz et al., 2013). Gündüz et al. (2013) reported similar observations from Lake Karaboğaz in the Kızılırmak Delta.

The number of zooplankton species of Lake Ladik is very low when compared to other inland bodies of water: e.g., Lake Çernek, 31 species (Bekleyen and Taş, 2008); Karaman Stream, 37 species (Altındağ et al., 2009); Lake Gölcük, 33 species (Özdemir Mis and Ustaoglu, 2009); Hasan Uğurlu and Suat Uğurlu Dam Lakes, 42 species (Bozkurt and Akın, 2012a); Lake Karaboğaz, 63 species (Gündüz et al., 2013); and Lake Karataş, 42 species (Apaydin Yağcı, 2013). These studies showed that the number of zooplankton species varied among the natural and dam lakes and rivers. These variations were due to the trophic status of the water, ecological structures of the aquatic systems (Bozkurt and Akın, 2012a), water, and hot climate zones. For example, Gündüz et al. (2013) declared that the number of species also changed at stations with different salinity levels.

Maraşlıoğlu et al. (2005) stated that Lake Ladik is moderately eutrophic in terms of phytoplankton. In the present work, the $Q_{B/T}$ ratio was calculated to be 5.0, and this result showed that the lake is at a eutrophic level. Additionally, zooplankton species (e.g., *B. calyciflorus*, *B. angularis*, *K. quadrata*, *K. cochlearis*, *B. longirostris*, *C. vicinus*, and *T. crassus*) that are indicators of eutrophic conditions were also found. The presence of *B. calyciflorus* clearly indicates increased organic matter in this water body. Moreover, Altındağ et al. (2009) reported that cyclopoid Copepoda and Cladocera species dominated in eutrophic waters. Gutiérrez-Aguirre and Suárez-Morales (2000) associated *Thermocyclops crassus* with eutrophic waters. Duchovnay et al. (1992) associated this species with meso- or eutrophic environments. Imoobe and Adeyinka (2009) determined that *Brachionus* and *Keratella* were indicators of eutrophication. The dominance of Rotifera in eutrophic systems (e.g., *K. cochlearis*, *K. quadrata*, and *B. angularis*) has been documented by several authors (Baião and Boavida, 2005; Baloch et al., 2005; Geng et al., 2005). In this study, 12 zooplankton species were determined, which were mostly indicators of mesotrophic-eutrophic water (Table).

E. gracilis, the most widely distributed calanoid copepod species in Europe, has been determined in higher numbers in eutrophic lakes (Bozkurt and Akın, 2012a). Bozkurt and Akın (2012b) reported the first record of *E. gracilis* from the Yeşilirmak River and Hasan Uğurlu and Suat Uğurlu Dam Lakes in the Black Sea region of Turkey. They stated that *E. gracilis* was determined at pH 6.95–8.84. In this research, *E. gracilis* was observed at pH 8.00–9.06, which is consistent with the pH levels in other studies.

Walkusz et al. (2009) reported that cluster analysis revealed some differences among seasons in terms of zooplankton composition and abundance. Altındağ et al. (2009) performed cluster analysis to determine the similarity level of zooplankton composition among 4 stations in Karaman Stream; they observed the highest similarity between Stations 1 and 4 at 68%. In this study, the cluster analyses revealed some differences between summer/autumn and winter/spring in terms of zooplankton composition and abundances. Such differences may be associated with water temperatures (Figure 2). In addition, the zooplankton species *P. dolichoptera*, *A. priodonta*, *D. cucullata*, *B. longirostris*, *C. sphaericus*, and *C. abyssorum* were similar with regard to their abundances between May and November at Stations 1, 2, and 3. Stations and months have similarities in zooplankton species composition. Cluster analysis showed that the growth pattern of zooplanktonic species in Lake Ladik was similar in summer and autumn months, as suggested by Walkusz et al. (2009).

In Lake Ladik, the maximum numbers of zooplankton species were obtained in June and July, while the minimum was seen in March. Hammer (1986) reported that *T. crassus* was found in marginally saline to fresh water. Despite the low density of *T. crassus* during the study period, it was common in June and July. Bêrziņš and Pejler (1989) reported that *B. calyciflorus* was related with temperature; this species was determined at temperatures above 20 °C. *B. calyciflorus* is a species that is tolerant to dissolved oxygen and pH levels of 7–9 (Güher et al., 2011); the species can also be found throughout the year in this lake. Myers (1931) reported that *Brachionus*, *Asplanchna*, and *Filinia* are present in alkaline water conditions. *B. angularis* and *B. calyciflorus* are recorded as species preferring alkaline waters (Sládeček, 1983; Sukumaran and Das, 2004). According to the pH values, this lake is alkaline. The alkalinity of Lake Ladik was found to be within the limit values for freshwater biota. *P. dolichoptera* is found in aquatic systems with rich dissolved-oxygen concentrations (Baião and Boavida, 2005). In this study, the dissolved-oxygen value was highest in February. Bozkurt and Akın (2012a) reported that *Notholca squamula* was found in fresh water and saltwater. Consequently, this work will be useful as a reference for subsequent studies in Lake Ladik and contributes to the known zooplankton biodiversity of inland waters in Turkey.

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References

- Ahangar IA, Mir MF, Saksena DN, Ahangar, MA (2012). Zooplankton diversity of Anchar Lake with relation to trophic status, Srinagar, Kashmir. *Global J Env Res* 6: 17–21.
- Altındağ A, Buyurgan Ö, Kaya M, Özdemir E, Dirican S (2009). A survey on some physicochemical parameters and zooplankton structure in Karaman Stream, Antalya, Turkey. *J Anim Vet Adv* 8: 1710–1716.
- Apaydın Yağcı M (2013). Seasonal zooplankton community variation in Karataş Lake. *Iran J Fish Sci* 12: 265–276.
- Baião C, Boavida MJ (2005). Rotifers of Portuguese reservoirs in River Tejo catchment: relations with trophic state. *Limnetica* 24: 103–114.
- Baloch WA, Jafri SIH, Soomro AN (2005). Spring zooplankton composition of Rawal Lake, Islamabad. *Sindh Univ Res Jour (Sci Ser)* 37: 41–46.
- Baloch WA, Suzuki H (2009). Summer zooplankton composition, vertical distribution and biomass in Lake Ikeda, Southern Kyushu, Japan. *Sindh Univ Res Jour (Sci Ser)* 41: 35–40.
- Bekleyen A, Taş B (2008). Zooplankton fauna of Çernek Lake (Samsun). *Ekoloji* 67: 24–30.
- Bêrzinš B, Pejler B (1989). Rotifer occurrence in relation to temperature. *Hydrobiologia* 175: 223–231.
- Bozkurt A, Akın Ş (2012a). Zooplankton fauna of Yeşilirmak (between Tokat and Blacksea), Hasan Uğurlu and Suat Uğurlu Dam Lakes. *Turk J Fish Aquat Sci* 12: 777–786.
- Bozkurt A, Akın Ş (2012b). First record of *Eudiaptomus gracilis* (G.O.Sars, 1863) (Copepoda: Diaptomida) in the inland waters of Turkey. *Turk J Zool* 36: 503–511.
- Bulut H, Saler S (2013). Ladik Gölü (Samsun) zooplanktonu üzerine ilk gözlemler. *SÜMDER* 51: 74–78 (in Turkish).
- Bulut İ (2012). Türkiye'nin Yüzen Adaları. 1st ed. Erzurum, Turkey: Mega Ofset Matbaacılık (in Turkish).
- Duchovnay A, Reid JW, McIntosh A (1992). *Thermocyclops crassus* (Crustacea: Copepoda) present in North America: a new record from Lake Champlain. *Internat Assoc Great Lakes Res* 18: 415–419.
- Dussart B (1967). Les Copépodes des eaux continentales d'Europe occidentale. Tome I. Calanoides et Harpacticoides. Paris, France: N. Boubee et cie (in French).
- Dussart B (1969). Les Copépodes des eaux continentales d'Europe occidentale. Tome II. Cyclopoides et Biologie. Paris, France: N. Boubee et cie (in French).
- El-Bassat RA, Taylor WD (2007). The zooplankton community of Lake Abo Zaabal, a newly formed mining lake in Cairo, Egypt. *Afr J Aquat Sci* 32: 185–192.
- Emir N (1990). Taxonomical study on the Rotifera fauna of Bafra Lake in Samsun. *Doğa Tr J Zool* 89–106.
- Emir Akbulut N (2000). Community structure of zooplanktonic organisms in Lake Akşehir. *Turk J Zool* 24: 271–278.
- Geng H, Xie P, Deng D, Zhou Q (2005). The rotifer assemblage in a shallow, eutrophic Chinese lake and its relationships with cyanobacterial blooms and crustacean zooplankton. *J Fresh Ecol* 20: 93–100.
- Güher H, Erdoğan S, Kurguz T, Çamur-Elipek B (2011). The dynamics of zooplankton in national park of Lake Gala (Edirne-Turkey). *Acta Zool Bulg* 63: 157–168.
- Gülle İ, Turna İİ, Güçlü SS, Gülle P, Güçlü Z (2010). Zooplankton seasonal abundance and vertical distribution of highly alkaline Lake Burdur, Turkey. *Turk J Fish Aquat Sci* 10: 245–254.
- Gündüz E (1991a). A taxonomic study on the Calanoida and Cyclopoida (Copepoda) species of Bafra Balıkgölü (Balıkgölü-Uzungöl). *Doğa Tr J Zool* 15: 296–305.
- Gündüz E (1991b). A taxonomic study on the Cladoceran species of Bafra Balıkgölü (Balıkgölü-Uzungöl). *Doğa Tr J Zool* 15: 115–134.
- Gündüz E, Saygı Y, Demirkalp FY, Çağlar SS, Atasağun S, Kılınc S (2013). Seasonal composition and population density of zooplankton in Lake Karaboğaz from the Kızılırmak Delta (Samsun, Turkey). *Turk J Zool* 37: 544–553.
- Gutiérrez-Aguirre M, Suárez-Morales E (2000). The Eurasian *Thermocyclops crassus* (Fischer, 1853) (Copepoda, Cyclopoida) found in Southeastern Mexico. *Crustaceana* 73: 705–713.
- Hammer T (1986). Saline Lake Ecosystems of the World. Dordrecht, the Netherlands: Springer.
- Imoobe TOT, Adeyinka ML (2009). Zooplankton-based assessment of the trophic state of a tropical forest river in Nigeria. *Arch Biol Sci Belgrade* 61: 733–740.
- Kiefer F (1952). Freilebende Ruderfusskrebse (Crustacea, Copepoda) aus türkischen Binnengewässern. I Calanoida. *İÜFF Hidro Araş Enst Yayınları* 1: 103–132 (in German).
- Kiefer F (1955). Freilebende Ruderfusskrebse (Crustacea, Copepoda) aus türkischen Binnengewässern, Cyclopoida und Harpacticoida. *İÜFF Hidro Araş Enst Yayınları* 2: 108–132 (in German).
- Koçer MAT, Şen B (2014). Some factors affecting the abundance of phytoplankton in an unproductive alkaline lake (Lake Hazar, Turkey). *Turk J Bot* 38: 790–799.
- Koste W (1978). Rotatoria, Die Rädertiere Mitteleuropas ein Bestimmungswerk, begründet von Max Voigt Überordnung Monogononta. I Textband and II Textband. Berlin, Stuttgart: Gebrüder Borntraeger (in German).
- Maraşlıoğlu F (2001). An investigation on phytoplankton and algae of coast of Lake Ladik (Ladik-Samsun-Turkey). MSc, Ondokuz Mayıs University, Samsun, Turkey.
- Maraşlıoğlu F, Soylu EN, Gönülol A (2005). Seasonal variation of the phytoplankton of Lake Ladik, Samsun, Turkey. *J Fresh Ecol* 20: 549–553.
- Myers FJ (1931). The distribution of Rotifera on Mount Desert Island. *American Museum Novitates* 28: 494.

- Negrea S (1983). Fauna republici socialiste Romania. Crustacea, Cladocera. Bucharest, Romania: Acedemia Rep. Soc. Romania (in Romanian).
- Nogrady T, Segers H (2002). Asplanchnidae, Gastropodidae, Linderiidae, Microcodidae, Synchaetidae, Trochosphaeridae and Filinia. In: Dumont HJ, editor. Guides to the Identification of the Microinvertebrates of the Continental Waters of the World, Vol. 6. Leiden, the Netherlands: Backhuys Publishers BV.
- Özdemir Mis D, Ustaoglu MR (2009). Investigations on zooplankton of Gölcük Lake (Ödemiş, İzmir). *EU J Fish Aquat Sci* 26: 19–27.
- Saksena DN (1987). Rotifers as indicators of water quality. *Acta Hydrochim Hydrobiol* 15: 481–485.
- Saler S (2011). Zooplankton of Munzur River (Tunceli, Turkey). *J Anim Vet Adv* 10: 192–194.
- Simeonov V, Stratis JA, Samara C, Zachariadis G, Voutsas D, Anthemidis A, Sofoniou M, Kouimtzis T (2003). Assessment of the surface water quality in Northern Greece. *Water Research* 37: 4119–4124.
- Sinha S, Basant A, Malik A, Singh KP (2009). Multivariate modeling of chromium-induced oxidative stress and biochemical changes in plants of *Pistia stratiotes* L. *Ecotoxicology* 18: 555–566.
- Sládeček V (1983). Rotifers as indicators of water quality. *Hydrobiol* 100: 169–201.
- Smirnov NN (1996). Guides to the Identification of the Microinvertebrates of the Continental Waters of the World. Cladocera: The Chydorinae and Syciinae (Chydoridae) of the World. No. 11. The Hague, the Netherlands: SPB Academic Publishers.
- Soyer J (1970). Bionomie benthique du plateau continental de la côte catalane française. III. Les peuplements de Copépodes Harpacticoides. *Vie et Milieu Ser (B) Oceanogr* 21: 337–511 (in French).
- Sukumaran PK, Das AK (2004). Distribution and abundance of rotifers in relation to water quality of some tropical reservoirs. *Indian J Fish* 51: 295–301.
- Uğurlu S, Polat N, Kandemir Ş (2009). Changes in the Lake Ladik fish community (1972-2004) and ichthyofauna of its inlet and outlet streams (Samsun, Turkey). *Turk J Zool* 33: 393–401.
- Ustaoglu MR (2004). A checklist for zooplankton of Turkish inland waters. *Ege Univ J Fish Aquat Sci* 21: 191–199.
- Ustaoglu MR, Altındağ A, Kaya M, Akbulut N, Bozkurt A, Özdemir Mis, Atasagun S, Erdoğan S, Bekleyen A, Saler S et al. (2012b). A checklist of Turkish rotifers. *Turk J Zool* 36: 607–622.
- Ustaoglu MR, Özdemir Mis D, Aygen C (2012a). Observations on zooplankton in some lagoons in Turkey. *J Black Sea/Medit Env* 18: 208–222.
- Walkusz W, Kwasniewski S, Falk-Peterson S, Hop H, Tverberg V, Wieczorek P, Weslawski JM (2009). Seasonal and spatial changes in the zooplankton community of Kongsfjorden, Svalbard. *Polar Res* 28: 254–281.
- Yiğit S, Altındağ A (2005). A taxonomical research on the zooplankton fauna of Hirfanlı Dam Lake (Kırşehir), Turkey. *Gazi Univ J Sci* 18: 563–567.