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Research article/Araştırma makalesi

Assessment of zooplankton by the index analysis in Kaldırım and Halikan Ponds, Malatya/Turkey

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Abstract

In this study zooplankton in Kaldırım and Halikan Ponds were investigated between March 2012 and February 2013. A total of 52 species were identified in Kaldırım Pond including 40 Rotifera, 8 Cladocera and 4 Copepoda species. In Halikan Pond a total of 45 species were identified including 36 Rotifera, 7 Cladocera and 2 Copepoda species. Rotifera group was observed as the most dominant among zooplankton groups.

Certain physical and chemical parameters such as water temperature and dissolved oxygen were measured every month during the study. Shannon-Wiener and Margalef's diversity indexes were used to determine species diversity. In Kaldırım Pond, the highest Shannon-Wiener index value was found at the 1st station in june (H'=2.01) and the lowest value was observed at the 2nd station in september (H'=0.44). In Halikan Pond, the highest Shannon-Wiener index value was found at the 1st station in april (H'=1.54) and the lowest value was observed at the 2nd station in july and august (H'=0.50). In Kaldırım Pond, the highest Margalef index value was found at the 2nd station in june (D=4.45) and the lowest value was observed at the 2nd station in september (D=0.32). In Halikan Pond, the highest Margalef index value was found at the 1st station in may (D=2.89) and the lowest value was observed at the 1st and 2nd stations in february (D=0.58). Scanning electron microscope images were taken for certain Rotifera species.

Key words: Rotifera, Cladocera, Copepoda, SEM, index analysis

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Kaldırım ve Halikan Göletleri Malatya-Türkiye zooplanktonun indeks analizleri ile değerlendirilmesi

Özet

Kaldırım ve Halikan Göletleri'nin zooplanktonu Mart 2012-Şubat 2013 tarihleri arasında incelenmiştir. Kaldırım Göleti'nde 40 Rotifera, 8 Cladocera, 4 Copepoda olmak üzere toplam 52 tür, Halikan Göleti'nde 36 Rotifera 7 Cladocera, 2 Copepoda olmak üzere toplam 45 tür teşhis edilmiştir. Zooplankton grupları içerisinde en baskın grubu Rotifera'nın oluşturduğu gözlemlenmiştir.

Çalışma boyunca her ay su sıcaklığı, pH, çözünmüş oksijen gibi bazı fiziksel ve kimyasal parametreler ölçülmüştür. Tespit edilen türler arasında benzerlik olup olmadığını anlamak için Shannon-Weiner ve Margalef çeşitlilik, indeksleri kullanıldı. Kaldırım Göleti'nin Shannon Wiener indeks'i en yüksek 1. istasyon'da haziran ayında (H'=2,01) ve en düşük değeri ise 2. istasyon'da eylül ayında bulunmuştur (H'=0,44). Halikan Göleti'nin Shannon Wiener indeks'i en yüksek 1. istasyon'da nisan ayında (H'=1,54) ve en düşük değeri ise 2. istasyon'da temmuz ve ağustos aylarında bulunmuştur (H'=0,50). Kaldırım Göleti'nin Margalef indeks'i en yüksek 2. istasyon'da haziran ayında (D=4,45) ve en düşük değeri ise 2. istasyon'da eylül ayında bulunmuştur (D=0,32) Halikan Göleti'nin Margalef indeks'i en yüksek 1. istasyon'da mayıs ayında (D=2,89) ve en düşük değeri ise 1. ve 2. istasyon'da şubat ayında bulunmuştur (D=0,58). Bazı rotifera türlerinin taramalı elektron mikroskobu çekimleri yapılmıştır.

Anahtar kelimeler: Rotifera, Cladocera, Copepoda, SEM, index analizi

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1. Introduction

As in all ecosystems, in aquatic ecosystems, the fact that organisms fed on other organisms and become food for others, concurrently affects the efficiency of this ecosystem positively. Phytoplankton organisms use solar energy in photosynthesis producing organic matter and form the first link in the food chain in aquatic ecosystems. Thus, they called as producers. On the other hand, zooplankton organisms form the main food link between phytoplankton organisms and higher forms in the aquatic ecosystem food chain, and therefore occupy a significant role in aquatic systems (Gündüz, 1984).

Studies conducted to determine the relationships between groups of organisms in aquatic ecosystems, and between these and the chemical and physical characteristics of the ecosystem they inhabit, are required to determine both the limits of utilization of the ecosystem with regard to fishing and aquaculture and the basic biological efficiency of the aquatic ecosystem (Kırgız, 1984).

A change in the physico-chemical aspects bring about a corresponding change in the relative composition and abundance of the organisms in that water (Adeyemi et al. 2009).

The aim of this work was to determine the zooplankton, qualitatively and quantitatively and to evaluate the zooplankton community with index analysis. All zooplankton species identified were the first records for this study field.

2. Materials and methods

Kaldırım Pond is located at 12.5 km northeast and Halikan Pond is located at 23 km southeast of Malatya city center. Both ponds are used for irrigation (Figure 1).

a b

Figure 1. Kaldırım(a) and Halikan(b) Ponds and samples stations

In this research zooplankton distribution of these ponds were determined between March 2012 - February 2013. Zooplankton samples were taken from 2 stations of each pond. The zooplankton samples were collected with a standard plankton net (Hydrobios Kiel, 25 cm diameter 55 μm mesh size) horizontal hauls and the specimens were preserved in 4% formaldehyde solution in 250 ml plastic bottles. The species were identified according to Kolisko (1974), Koste (1978a, b), Segers (1995), Flössner (1972), Negrea (1983) Einsle (1996). Temperature and dissolved oxygen were measured by an Oxi 315i/SET oxygen-meter, pH by a Lamotte (pH 5-WC) model pHmeter. The Pearson Correlation analysis was used for determination the correlation between physicochemical parameter and zooplankton community. Correlation analysis was applied by using Microsoft Minitab computer programme.

Table 1. The Coordinates of Kaldırım and Halikan Ponds

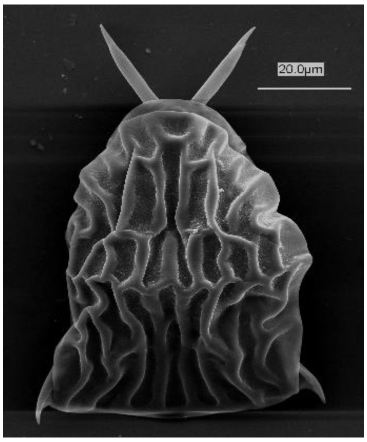
Kaldırım Pond	1. station	2. station
	38^{0}24'02.55"N 38^{0}23'44.03"E	38^{0}23'51.05"N 38^{0}23'35.52"E
Halikan Pond	1. station	2. station
	38^{0}17'32.14"N 38^{0}31'18.31"E	38^{0}17'31.66"N 38^{0}31'09.45"E

3. Results

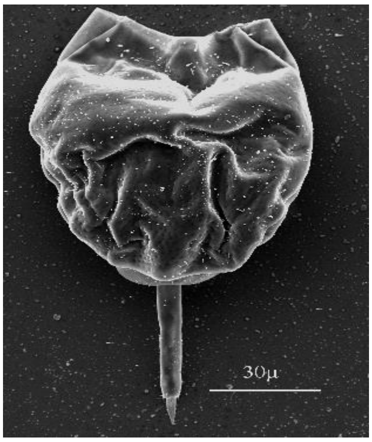
A total of 52 species were identified in Kaldırım Pond including 40 Rotifera, 8 Cladocera and 4 Copepoda species. A total of 45 species were identified in Halikan Pond including 36 Rotifera, 7 Cladocera and 2 Copepoda species. *K. cochlearis* and *P. dolichoptera* from Rotifera were observed during all months of the year in Kaldırım Pond, where *B. longirostris* from Cladocea and *Cyclops vicinus* from Copepoda were the most dominant species. *K. cochlearis* from Rotifera was observed in all months in Halikan Pond except january and february. *A. priodonta* from Rotifera, *B. longirostris* from Cladocera and *Cyclops vicinus* from Copepoda were the most dominant species in this pond (Table 2-3).

In Kaldırım Pond, maximum water temperature was recorded in july as 28^{o}C and the minimum temperature of 5.5^{o}C was recorded in december. The highest pH value 8.6 was recorded in july and the lowest pH value, 7.1 was recorded in march. The lowest dissolved oxygen amount was recorded in july with 7.10 mgL^{-1}, and the highest was recorded in december with 8.89 mgL^{-1}. In Halikan Pond, maximum water temperature was recorded in July as 27.9^{o}C and the minimum of 5.3^{o}C was recorded in december. The highest pH value of 8.5 was recorded in june and the lowest pH value 7 was recorded in april. The lowest dissolved oxygen amount was recorded in july with 7.12 mgL^{-1}, and the highest was recorded in december with 8.90 mgL^{-1} (Table 4).

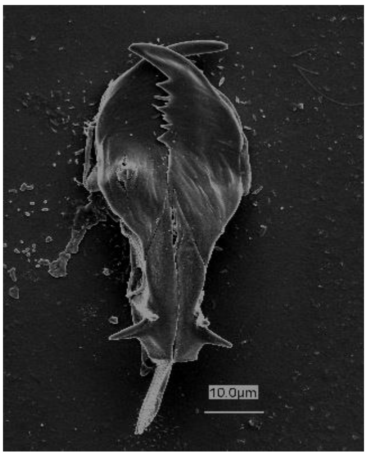
It was determined that the species diversity in Kaldırım Pond was at its highest at the 1st station in june (H'= 2.01) and was at its lowest in september (H'= 0.68), The same results were obtained from Margalef diversity index by reaching the highest value in june (D=3.37) and the lowest value in september (D=0.48). The diversity of the species in Kaldırım Pond was at its highest at the 2nd station in june (H'= 1.99) and was at its lowest in september (H'= 0.44), and also Margalef diversity index reached the highest value in june (D=4.45) and the lowest value in september (D=0.32).
In Halikan Pond highest Shannon Wiener diversity index was calculated at the 1st station in april (H′= 1.54) and the lowest in march (H'= 0.66). Margalef diversity index reached the highest value in may (D=2.89) and the lowest value in february (D=0.58). The diversity of the species in Halikan Pond was at its highest at the 2nd station in april (H'= 1.47) and at its lowest in the months of july and august (H'= 0.50), and Margalef diversity index reached the highest value in april (D=2.81) and the lowest value in february (D=0.58) (Table 5 - 8). Scanning electron microscope images were taken for certain Rotifera species (Figure 2).



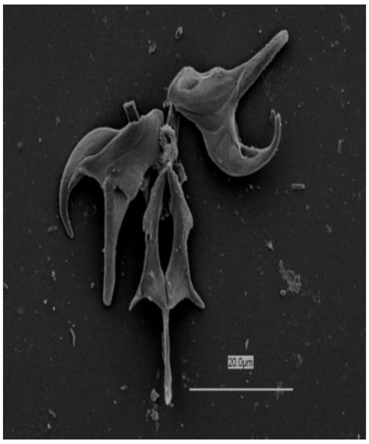
Lecane flexilis



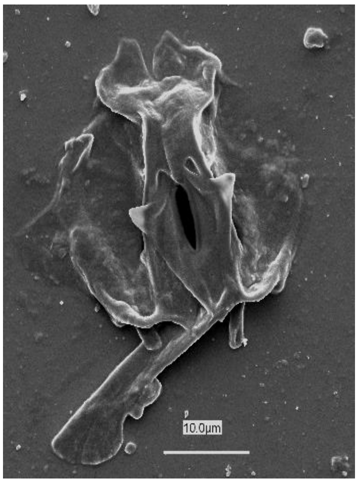
Lecane lunaris

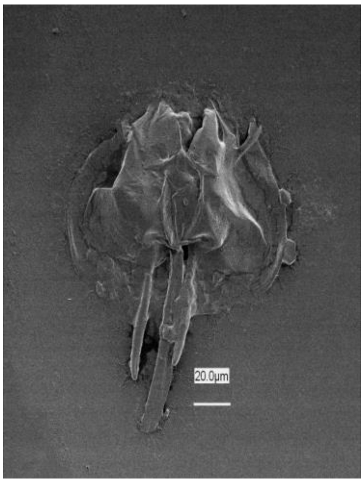


Asplanchna priodonta (Trophi) *Asplanchna girodi* (Trophi)



Brachionus quadridentatus (Trophi) *Lindia torulosa* (Trophi)





Polyarthra dolichoptera (Trophi) *Synchaeta pectinata* (Trophi)

Figure 2. Scanning electron microscope images of certain Rotifera species

In Kaldırım Pond, zooplankton community were positively correlated with dissolved oxygen ($r = 0.157$, $p<0.001$) and pH ($r = 0.256$, $p<0.001$). On the contrary zooplankton community were negatively correlated with water temperature ($r = - 0.112$, $p<0.001$).

In Halikan Pond, zooplankton community were positively correlated with dissolved oxygen ($r = 0.325$, $p<0.01$). On the contrary zooplankton community were negatively correlated with water temperature ($r = - 0.42$, $p<0.01$) and pH ($r = - 0.017$, $p<0.01$). Both of ponds were found to be significant relationship between water quality parameters with zooplankton community.

Table 2. Monthly distribution of zooplankton in Kaldırım Pond

	M	A	M	J	J	A	S	O	N	D	J	F
ROTIFERA												
Ascomorpha ecaudis Petry, 1850							+					
Asplanchna priodonta Gosse, 1850			+	+	+	+		+			+	
Brachionus angularis Gosse, 1851	+	+						+	+	+	+	
Brachionus calyciflorus Pallas, 1766	+									+		
Brachionus quadridentatus Hermann, 1783								+				
Cephalodella catellina (Müller, 1786)		+		+						+		
Cephalodella gibba (Ehrenberg, 1830)	+	+	+	+				+				
Cephalodella ventripes (Dixon-Nuttall, 1901)	+											
Colletheca pelagica(Rousselet, 1893)			+	+								

Table 2. Continued

Colurella adriatica Ehrenberg, 1831		+										
Conochilus dossiarius Hudson, 1885								+				
Conochilus hipocrepis (Schrank, 1803)	+	+										
Conochilus unicornis Rousselet, 1892			+	+								
Encentrum mustela (Milne, 1885)			+									
Encentrum putorious Wulfert, 1936		+										
Epiphanes senta (Müller 1773)			+									
Euchlanis dilatata Ehrenberg, 1832			+						+			
Filinia longiseta (Ehrenberg, 1834)		+			+	+		+		+		+
Filinia terminalis (Plate,1886)	+									+		
Hexarthra fennica (Levander, 1892)				+	+							
Keratella cochlearis (Gosse, 1851)	+	+	+	+	+	+	+	+	+	+	+	+
Keratella quadrata Müller, 1786	+	+	+							+		
Keratella tecta (Gosse, 1851)			+	+		+		+	+			
Keratella tropica (Apstein, 1907)	+											
Lecane bulla (Gosse, 1886)				+								
Lecane flexilis (Gosse, 1886)				+								
Lecane hastata (Murray, 1913)				+								
Lecane luna (Müler, 1776)			+	+								
Lecane lunaris (Ehrenberg, 1832)			+									
Lecane pyriformis (Daday, 1905)				+								
Lepadella ovalis (Müller, 1786)		+	+	+				+				
Lepadella patella (Müller, 1786)				+								
Notholca squamula (Müller, 1786)	+	+									+	+
Polyarthra dolichoptera Idelson, 1925	+	+	+	+	+	+	+	+	+	+	+	+
Pompholyx sulcata Hudson, 1885			+									
Scaridium longicadum (Müller, 1786)			+									
Synchaeta pectinata Ehrenberg, 1832	+	+		+	+							+
Synhcaeta oblonga Ehrenberg, 1832						+	+					
Trichocerca capucina(Wierzejski & Zacharias, 1893)			+			+						
Trichocerca similis (Wierzejski, 1893)			+			+		+	+			
CLADOCERA												
Bosmina longirostris (Müller, 1785)	+	+	+	+		+		+		+		+
Chydorus sphaericus (Müller, 1776)				+								
Daphnia cucullata Sars, 1862			+	+	+			+				
Diaphanosoma lacustris Korinek, 1981			+	+	+	+						
Disparalona rostrata (Koch, 1841)			+									
Macrothrix laticornis (Fischer,1851)				+								
Moina macrocopa (Straus, 1820)				+	+							
Pleuroxus aduncus (Jurine, 1820)			+									
COPEPODA												
Acanthodiaptomus denticornis (Wierzejski, 1887)								+	+			
Cyclops vicinus Uljanin, 1875	+	+		+				+		+	+	+
Diacyclops bicuspidatus (Claus, 1857)				+								
Macrocyclops albidus (Jurine, 1820)				+								
Total number of species (N)	14	15	23	26	9	10	4	15	7	10	6	7

Table 3. Monthly distribution of zooplankton in Halikan Pond

	M	A	M	J	J	A	S	O	N	D	J	F
ROTIFERA												
Ascomorpha ecaudis Petry, 1850								+				
Asplanchna girodi de Guerne, 1888							+			+		
Asplanchna priodonta Gosse, 1850	+	+	+	+	+	+	+	+	+	+		
Brachionus urceolaris Müller, 1773		+										
Cephalodella catellina (Müller, 1786)		+								+		
Cephalodella forficula (Ehrenberg,1830)		+										
Cephalodella gibba(Ehrenberg, 1830)		+			+	+						
Cephalodella ventripes (Dixon-Nuttall, 1901)		+										
Colletheca mutabilis (Hudson, 1885)			+		+	+	+					
Colletheca pelagica (Rousselet, 1893)				+								
Conochilus dossiarius Hudson, 1885								+				
Conochilus unicornis Rousselet, 1892							+					

Table 3. Continued

Dicranophorus epicharis Harring and Myers, 1928			+			+						
Euchlanis dilatata Ehrenberg, 1832		+										
Filinia longiseta (Ehrenberg,1834)		+							+	+		
Filinia terminalis (Plate, 1886)				+						+		
Hexarthra fennica (Levander, 1892)				+	+							
Keratella cochlearis (Gosse, 1851)	+	+	+	+	+	+	+	+	+	+	+	+
Keratella quadrata Müller, 1786	+										+	
Keratella tecta (Gosse, 1851)				+	+							
Lecane bulla (Gosse, 1886)			+									
Lecane luna (Müler, 1776)		+		+		+	+					
Lecane lunaris (Ehrenberg, 1832)			+									
Lecane punctata (Murray, 1913)			+									
Lecane pyriformis (Daday, 1905)			+									
Lepadella ovalis (Müller, 1786)		+	+									
Lindia torulosa Dujardin, 1841				+								
Notholca squamula (Müller, 1786)	+	+										+
Polyarthra dolichoptera Idelson, 1925	+	+	+	+	+	+	+		+	+		
Pompholyx sulcata Hudson, 1885			+									
Synchaeta oblonga Ehrenberg, 1832			+		+			+	+			
Synchaeta pectinata Ehrenberg, 1832		+	+		+		+	+	+	+		+
Trichocerca insignis (Herrick, 1885)										+		
Trichocerca similis (Wierzejski, 1893)					+							
Trichotria pocillum (Müller, 1776)				+								
Trichotria tetractis (Ehrenberg, 1830)		+										
CLADOCERA												
Bosmina longirostris (Müller, 1785)		+	+	+			+	+			+	
Chydorus sphaericus (Müller, 1776)				+								
Coronatella rectangula (Sars, 1861)				+				+				
Daphnia cucullata Sars, 1862						+						
Disparalona rostrata (Koch, 1841)				+		+		+				
Leydigia leydigi (Schoedler, 1863)								+				
Pleuroxus aduncus (Jurine, 1820)			+			+						
COPEPODA												
Cyclops vicinus Uljanin, 1875		+	+						+	+	+	
Nitokra hibernica (Brady, 1880)				+								
Total number of species (N)	5	17	16	15	10	10	9	10	7	10	4	3

Table 4. Monthly recorded values of dissolved oxygen, temperature, and pH in Kaldırım and Halikan Ponds

	M	A	M	J	J	A	S	O	N	D	J	F
Kaldırım Pond												
Temperature (^{0}C)	10.2	21.4	23.2	26.8	28.0	27.0	24.2	19.4	9.4	5.5	10.3	10.2
Dis.oxygen (mgL^{-1})	8.62	8.16	7.32	7.20	7.10	7.60	7.80	7.90	8.65	8.89	8.45	8.56
pH	7.10	7.30	7.50	8.00	8.60	8.40	8.10	7.70	7.80	7.90	7.40	7.30
Halikan Pond												
Temperature (^{0}C)	8.70	17.7	23.1	26.3	27.9	25.9	21.8	19.5	10.7	5.3	10.1	10.0
Dis.oxygen (mgL^{-1})	8.70	8.40	7.35	7.22	7.12	7.85	8.00	8.09	8.50	8.90	8.66	8.60
pH	7.20	7.00	8.30	8.50	7.70	8.10	8.30	7.70	7.40	7.50	7.20	7.30

Table 5. Total number of individual (ind./ m^3), *H′* and D values of 1st station of Kaldırım Pond

	M	A	M	J	J	A	S	O	N	D	J	F
Total	70720	70617	184348	54410	2135	193930	13248	68655	34341	61550	7437	2953
H′	1.80	1.27	1.54	2.01	1.87	1.06	0.68	1.21	1.11	1.31	1.06	1.36
D	2.06	2.27	2.84	3.37	1.80	1.70	0.48	2.27	0.81	1.25	1.05	1.15

Table 6. Total number of individual (ind./ m^3), *H′* and D values of 2nd station of Kaldırım Pond

	M	A	M	J	J	A	S	O	N	D	J	F
T	62974	10492	24143	30865	24863	55230	1222	11103	14977	164785	4176	3666
H′	1.69	1.26	1.32	1.99	0.87	1.03	0.44	0.63	1.08	0.80	0.94	0.97
D	2.08	1.74	2.96	4.45	0.91	1.90	0.32	1.48	1.44	1.53	1.10	0.84

Table 7. Total number of individual (ind./ m^3), *H′* and D values of 1st station of Halikan Pond

	M	A	M	J	J	A	S	O	N	D	J	F
T	73374	118310	151533	212172	74899	68988	130441	66849	185678	466338	5806	2954
H′	0.66	1.54	0.98	1.20	0.99	0.91	0.84	1.31	1.11	0.90	1.18	0.98
D	0.82	2.76	2.89	2.63	1.85	1.65	1.56	1.66	1.14	1.59	0.79	0.58

Table 8. Total number of individual (ind./ m^3), *H′* and D values of 2nd station of Halikan Pond

	M	A	M	J	J	A	S	O	N	D	J	F
T	69297	94871	96399	111993	57881	28227	61858	38718	138697	279946	1832	2750
H′	0.60	1.47	0.88	1.19	0.50	0.50	0.81	1.16	0.76	0.85	1.14	0.88
D	1.03	2.81	2.40	2.37	1.26	0.67	1.25	2.40	1.17	1.10	0.91	0.58

4. Conclusions and discussion

Rotifera species richness and individual numbers are higher than the other zooplanktonic groups in freshwaters. The high levels of nutrients, high reproduction rate of Rotifera species, transportation of rotifers to aquatic environments easily by factors such as birds, wind and currents, and most significantly, repression of Clacodera population by predator fish caused this result (Herzig, 1987).

In Karakaya Dam Lake, that is located in the same region with Kaldırım and Halikan ponds (Özhan, 2007), 14 Rotifera, 5 Cladocera and 1 Copepoda species were identified. Rotifera was the dominant group, followed by Cladocera and Copepoda groups. Kaldırım and Halikan ponds demonstrated similar distribution profile.

Asartepe Reservoir (Buyurgan et al. 2010), Balıklı Lake (Bekleyen and Ipek 2010), Ladik Lake (Bulut and Saler, 2013a), Kalecik Dam Lake (Bulut and Saler, 2013b) and Beyhan Dam Lake (Bulut and Saler, 2014) Ulaş Lake (Saler et al 2015) demonstrated that Rotifera group was predominant over other zooplankton groups with respect to both species diversity and individual numbers as in Kaldırım and Halikan ponds.

Studies by Aygen et al. (2009) in high mountain lake Eğrigöl demonstrated that rotifers were predominant both in species number and abundance, followed by Cladocera and Copepoda. The similar results were observed in Kaldırım and Halikan Ponds. Zooplankton relative densities were recorded as in Kaldırım Pond: Rotifera 77%, Cladocera 15%, Copepoda 8%; Halikan Pond: Rotifera 80%, Cladocera 16%, Copepoda 4%.

Saksena (1987), reported Brachionus species as an eutrophication indicator, while Baker (1979) determined that *K. quadrata*, *K. cochlearis*, *B. angularis* species inhabit shallow and eutrophic lakes. Among these species *K. cochlearis* was identified in high amounts throughout the year in Kaldırım and Halikan Ponds.

It was reported that Rotifera species are diversely found in eutrophic lakes and Copepoda species were found mostly in oligotrophic lakes (Herzig, 1987). The reasons for the abundance of Rotifera species found in freshwater ecosystems when compared to other zooplankton species are the high amount of nutrients in these waters, reproductive success of Rotifera species and especially the repression of Cladocera and Copepoda population increase by the fish (Emir and Demirsoy, 1996). Relatively small numbers of Copepoda and Cladocera groups identified in this study and the dominance of the Rotifera group support the above mentioned findings.

The species that are observed in almost all seasons such as *K. quadrata* and *A. priodonta* have a wide temperature tolerance (Herzig, 1987). In ponds that are the subject of this study, the prevalence of *A. priodonta* in almost every season corresponds to that finding.

Life cycles of zooplankters are related to the environmental factors (*e.g*. water temperature, conductivity, pH, dissolved oxygen). Water temperature and dissolved oxygen values are the most important factors affecting the abundance of zooplankton (Park and Marshall 2000). Water temperature is one of the most important parameter, which manages chemical and biological activity of organisms in aquatic life (Buyurgan et al. 2010). In Kaldırım and Halikan Ponds negative correlations between water temperature and individual numbers have been calculated.

Dissolved oxygen amounts differ based on the photosynthesis rate of the plants and trophic level of the lakes in addition to the temperature (Moss, 1988). Most of the Rotifera species have high oxygen tolerance (Koste, 1978a). Devol (1981), stated that waters with low oxygen content affected zooplankton distribution, reproduction and development, and dissolved oxygen levels below 5 mgL^{-1} in freshwater prevents zooplankton development. The dissolved oxygen levels of 7.10-8.90 mgL^{-1} in Kaldırım and Halikan ponds provide a suitable environment for zooplankton development. Positive correlation results in both ponds, between dissolved oxygen and individual numbers were observed in the study.

It was reported that pH plays a significant role in zooplankton distribution and that the alkali limit was pH 8.5 (Berzins and Pejler, 1987). According to EPA (1979), optimum pH values in freshwaters differ between 6.5 and 9.0 thus, the waters of Kaldırım and Halikan ponds were slightly alkaline. The pH values for all stations during the study varied between 7.10 and 8.60. In both of two ponds no critical level of pH for zooplankton life was recorded.

According to Ataguba et al (2014), Shannon-Wiener and Margalef indexes will not rank communities in the same manner but will increase as richness increases. In Kaldırım Pond, the highest Shannon-Wiener index value was found at 1st station in june (*H′*=2.01) and the lowest value was observed at 2nd station in september (*H′*=0.44). The highest number of taxa was recorded with 26 species in june.

In Halikan Pond, the highest Shannon-Wiener index value was found at 1st station in april (H'=1.54) and the lowest value was observed at 2nd station in july and august (H'=0.50). The highest number of taxa was recorded with 17 species in april.

According to the Margalef diversity index results, Kaldırım pond's 2nd station demonstrated the highest species diversity in june (D=4.45), while halikan Pond, 1nd station showed the highest species diversity in september (D= 2.89).

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