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ZOOPLANKTON OF KILAVUZLU DAM LAKE (KAHRAMANMARAŞ) AND THE EFFECT OF CAGE FISH FARMING ON WATER QUALITY AND ZOOPLANKTON FAUNA OF THE DAM LAKE

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Abstract:

Water quality parameters and zooplankton fauna of Kılavuzlu Dam Lake were determined. It was found that among water quality parameters, sechi depth, temperature, silica, Ca and $CaCO_3$ amounts were higher in the first (referans) station; while conductivity, dissolved oxygen, pH, chlorophyll *a*, nitrate and phosphate values were higher in second (cage) station.

A total of 57 taxa were identified in the study. Of these taxa, 33 belonged to Rotifera, 14 belonged to Cladocera and 10 belonged to Copepoda. It was found that *Keratella cochlearis*, *Daphnia longispina*, *Cyclops vicinus*, *Acanthodiaptomus denticornis* were the most common throughout the year, while *Ascomorpha ovalis*, *Dicranophorus epicharis*, *Keratella tecta*, *Notholca acuminata*, *Testudinella patina*, *T. mucronata*, *Trichotria pocillum*, *Disparalona rostrata*, *Scapholeberis kingi*, *Leydigia leydigi*, *Alona guttata*, *Eucyclops speratus*, *Paracyclops chiltoni* were the least species.

Monommata longiseta, *Trichocerca porcellus*, *Diaphanasoma birgei*, *Eurycercus lamellatus* were only found in the first station, while *Ascomorpha ovalis*, *Notholca acuminata*, *Rotaria neptunia*, *Trichotria pocillum*, *Disparalona rostrata* and *Eucyclops speratus* were only found in the second station.

Rotifera was represented with higher number of species in first station for 5 months but Copepoda was represented with higher number of species in second station for 5 months.

The abundance of groups according to months and stations revealed that Rotifera and Copepoda were abundant quantitatively in first station for 7 months; while Cladocera was abundant in first station for 8 months. On the other hand, amount of all zooplankton species were found to be more abundant in cage station in April (6605 ±4597.35 individual m^{-3}) and more abundant in first station in September (1635 ±2384.852 individual m^{-3}) ($P > 0.05$).

Key words: Zooplankton, Water quality, Fish culture, Kılavuzlu Dam

Introduction

Having rich water resources, Turkey has more than 1.5 million hectares of internal water surface area. Freshwater, salty water and brackish water resources make up of 60%, 20% and 20% of this area respectively, which mostly include stagnant water such as lakes, ponds and dam lakes. State Hydraulic Works (SHW) allowed the use of cages for fish farming in dam lakes in 2000s and increased the interest towards this sector. Several cage trout farming has been established in many dam lakes in Turkey. Discharge of organic waste (feed residue, metabolic wastes etc.) to water environment from these cages might cause pollution especially when the current is slow. Primary pollutants that are discharged to the water environment are solid materials, nitrogen and phosphor. Much of solid materials caused by feces and unconsumed feed accumulate in sediments around the farm. Although they have polluting effects in production area, their effects are not exactly known.

While the majority of aquatic organisms feed on zooplanktons throughout their lives, some of them feed on zooplankton in a certain period of their lives especially at larval stage. In this respect, there is a close relationship between the efficiency of aquatic environment and diversity and abundance of organisms. Rotifera, Cladocera and Copepoda have a character of renewal in a short time due to their short reproduction period and rapid population growth. Therefore, in addition to having a significant effect on the growth, survival and distribution of fish larvae, these species are the primary biotic factors of freshwater environments and are of great importance for freshwater ecosystem.

As the majority of zooplantonic organisms (Copepoda, Cladocera and Rotifera) filter feeding, they transform the phytoplankton to animal protein (Cirik and Gökpınar, 1993), they play a significant role in food chain. It was reported that some species are the indicators of water quality, pollution and eutrophication due to their sensitivity to environmental changes and therefore zooplankton studies on lakes have acquired significant importance (Berzins and Pejler, 1987; Mikschi, 1989; Güher and Kırgız, 1992).

Although the abundance of zooplanktonic organisms is important especially in terms of feeding of fry, this abundance is an indicator also for water quality, eutrophication and pollution levels. Abundance and composition of zooplankton are closely related with water quality parameters and increase or decrease depending on trophic levels of lakes (Canfield and Jones, 1996).

In Kılavuzlu Dam Lake, approximately 300 tons of trout are produced in cages annually. This study examines water quality and zooplankton fauna of the dam lake and analyzes the effects of fish farming on these parameters. Our findings will provide data for future studies and contribute to the follow-up of water quality and zooplanktons.

Materials and Methods

The study was carried out between March 2011 and February 2012 period in Kılavuzlu Dam Lake on Ceyhan River within the boundaries of Kahramanmaraş province. Kılavuzlu Dam Lake, constructed for irrigation and electric production in 1996-2001 period, is located at a distance of 8 km to Kahramanmaraş. It has a surface area of approximately 3.10 km^2 and a lake volume of 69.00 hm^3 at normal water level. The dam lake is at an altitude of 59.00 m from riverbed and 429 m from sea level.

The samples consisted of zooplankton and water was collected from 2 stations on monthly basis, from three depths (surface, middle and deep sections) of each station for two times. The first station (reference station) was located at the upper part of the fish farm that was not exposed to the effects of fish farming enterprise. The second station was located at the lower section of the cages (cage station) (Figure 1).

Physicochemical characteristics of the dam lake, dissolved oxygen, temperature, pH, sechi dept, chlorophyll *a*, conductivity, NO_2-N, NO_3-N, PO_4-P, silica, hardness, Ca and $CaCO_3$ were determined.

Zooplankton samples were taken from the stations with horizontal and vertical hauls by using 60 μm mesh size plankton nets on monthly basis. 5 lt of water samples were collected from every water layer (surface, middle and deep) of each station using Nansen Bottles. Plankton species were identified from the samples collected with plankton net. Zooplankton abundance, water quality parameters and chlorophyll *a* were identified from water samples.

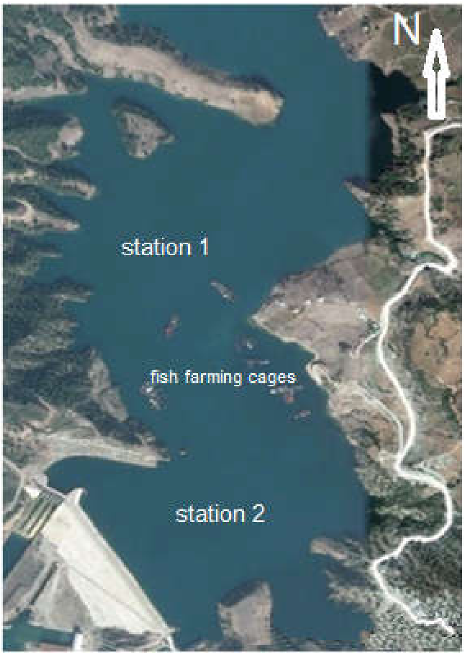

Figure 1. Kılavuzlu Dam Lake and sampling stations

One lt of the water collected with water sampler was used for chlorophyll *a* analysis. The remaining part was filtered from a collector having a mesh size of 60 µm and zooplankton was fixed in 100 cc glass jars. Oxygen, temperature, pH and conductivity were measured directly at the field by means of digital instruments (oxygen and temperature: YSI model 52 oxygen meter; pH: YSI 600 pH meter; conductivity: YSI model 30 salinometer). YSI 9500 photometer was used to determine NO_2-N, NO_3-N, NH_4-N, PO_4-P, silica, hardness, Ca, $CaCO_3$; the method in APHA 1995 was used to determine chlorophyll *a* spectrophotometrically. Sechi depth was measured using a Secchi disk with a diameter of 20 cm.

All zooplankton samples were fixed in 4% formaldehyde. Species identifications were made using a binocular microscope according to the Works of Edmondson (1959), Dussart (1969), Kiefer (1978), Stemberger (1979), Negrea (1983), Segers (1995), De Smet (1996, 1997) and Nogrady and Segers (2002). Zooplankton count was performed using an invert microscope in a petri dish with 2 mm lines at the bottom. Filtered zooplankton was placed in a petri dish and the individuals of each species were separately counted. SPSS package software was used for statistical analyses (t test).

Results and Discussion

Narrow and long structure of Kılavuzlu Dam Lake and high water flow of Ceyhan River causes fast water flow and a high level of mixture in the dam lake. Therefore, it was found that there was no significant difference between zooplankton and water quality parameters at different depths.

The variation of water quality parameters according to stations, depth and months is presented in Figure 2. It is understood from the figure that chlorophyll *a* values decreased with depth; NO_2-N, NO_3-N and PO_4-P were high in deep sections of second station; SiO_2, Ca, $CaCO_3$, conductivity and hardness were similar at all stations and depths.

Sechi depth reached the maximum concentration of 6.8 m at first station (April) and minimum concentration of 2.2 m at second station (September), with a mean value of 4.12 ±1.03 m. Temperature varied from 9.40°C (March at second station) to 14.65°C (August at second station) with a mean value of 12.62 ±1.44°C. Mean chlorophyll *a* concentration was 8.86 ±2.81 mgL^- with a range from 4.25 mgL^- (at first station) in January to 16.13 mgL^- in June. The conductivity value varied from 247.43 µs (March at second station) to 549.13 µs (October at first station) with a mean value of 401.91 ±99.07 µs. Dissolved oxygen varied from 4.15 mgl^- (at first station) in August to a peak of 9.71 mgL^- (second station) in May with a mean value of 7.05 ±1.68 mgL^-. pH value did not vary much among the sitations. The minimum, maximum and mean pH values were 7.48 (January at second station), 8.38 (May at first station) and 7.96 ±0.22 respectively. Nitrite nitrogen reached the maximum concentration of 0.044 mgL^{-1} (June at second station) and minimum concentration of 0.002 mgl^- (July at second station), with a mean value of 0.032 mgL^{-1}. Nitrate nitrogen (1.64 ±0.46 mgL^-) varied from 0.767 mgL^- (March at first station) to 2.8 mgl^- (January at second station), and phosphate (0.93 ±0.69 mgL^-) varied from 0.127 mgL^- (October at first station) to 2.034 mgL^- (January at second station). The maximum, minimum, and mean Silica values were 4.623 mgL^- (August at first station), 0.046 mgL^- (May at second station), and 2.85 ±1.55 mgL^-, respectively. Mean $CaCO_3$ hardness was 239.84 ±108.98 with a range from 135 (at first station) in February to 460 in March (at first station). Ca (83.08 ±40.67 mgL^-) varied from 31.67 mgL^- (January at second station) to 186.67 mgL^- (March at first station), and $CaCO_3$ (78.17 ±17.5 mgL^-) varied from 51 mgL^- (May at first station) to 122.7 mgL- (February at second station) (Figure 2).

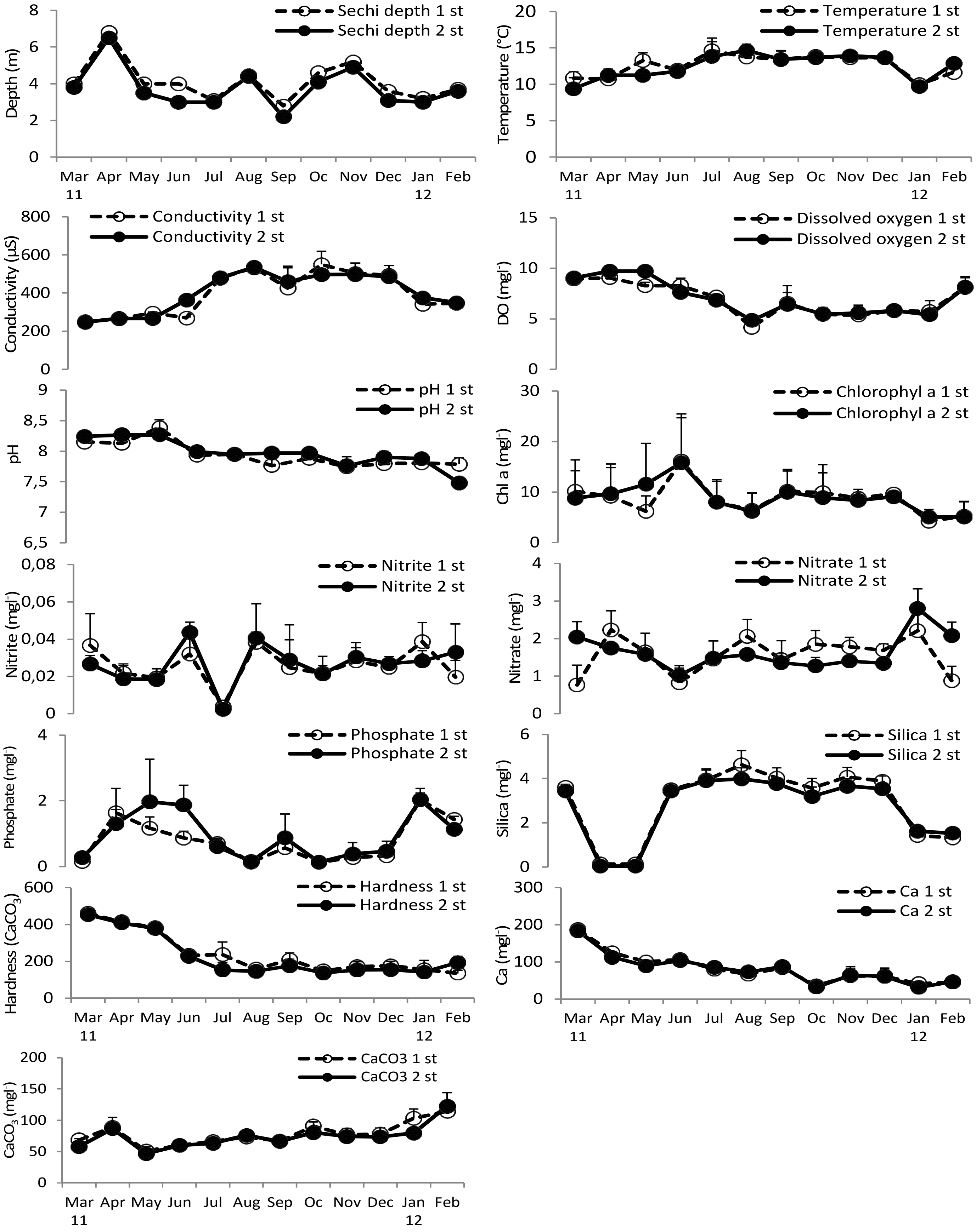

Figure 2. Monthly variations of water quality parameters at stations in the dam lake

Average annual water quality parameters at the stations were determined to display a similar distribution with each other and there was no statistically significant. It was found that sechi depth, temperature, silica, hardness, Ca and $CaCO_3$ amounts were higher at reference station; while conductivity, dissolved oxygen, pH, chlorophyll *a*, nitrate nitrogen and phosphate values were higher at cage station (Figure 3).

The zooplankton fauna of Kılavuzlu Dam Lake consists mainly of rotifers, cladocerans and copepods. A total of 57 taxa composed of 33 rotifers, 14 cladocerans and 10 copepods were identified (Table 1).

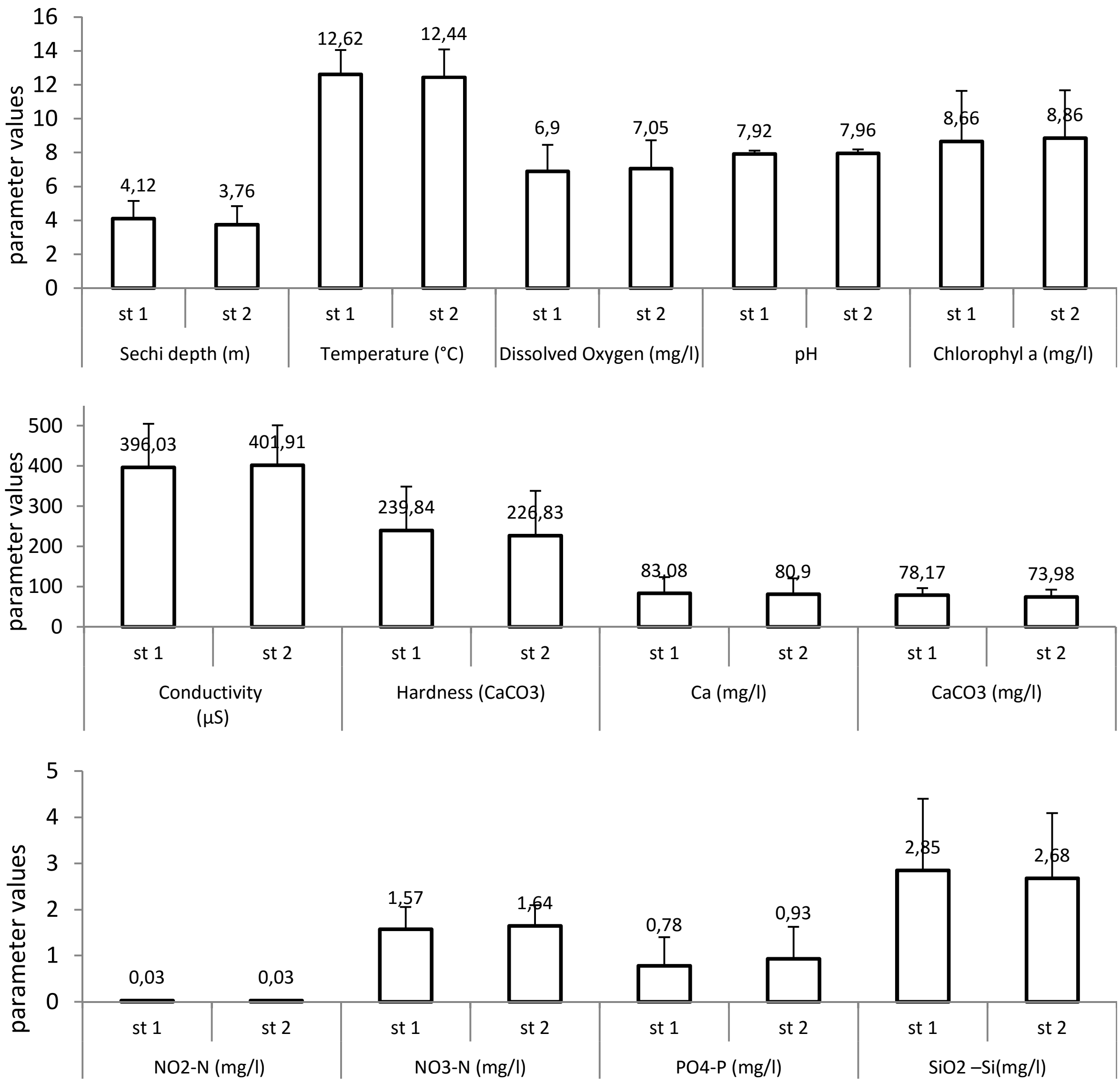

Figure 3. Change of water quality parameters at the stations

Table 1. Zooplankton of Kılavuzlu Dam Lake and monthly presence of the species

Rotifera	**M 11**		**A**		**M**		**J**		**J**		**A**		**S**		**O**		**N**		**D**		**J12**		**F**	
Stations	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**
Asplanchna priodonta Gosse 1850	+	+						+	+		+		+	+					+	+	+	+	+	+
Ascomorpha ovalis (Bergendal, 1892)														+										
Anuraeopsis fissa Gosse, 1851															+	+	+	+						
Cephalodella gibba (Ehrenberg, 1830)	+	+	+	+	+	+	+		+															
Collotheca pelagica (Rousselet, 1893)																			+		+			
Colurella adriatica Ehrenberg 1831					+	+	+		+							+		+						
Dicranophorus epicharis Harring and Myers, 1928																			+		+			
Euchlanis sp					+	+	+		+															
Filinia terminalis (Plate, 1886)			+	+																		+		
Kellicottia longispina (Kellicott, 1879)			+	+	+	+	+	+	+	+														
Keratella cochlearis (Gosse, 1851)	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Keratella tecta (Gosse, 1851)															+									
Keratella quadrata (Muller, 1786)			+	+																			+	+
Lecane luna (Muller 1776)						+																	+	+
Lecane lunaris (Ehrenberg, 1832)			+	+				+		+					+	+	+	+						
Lepadella rhomboides (Gosse 1886)			+	+		+										+		+						
Lophocharis salpina (Ehrenberg, 1834)																+		+	+		+			
Monommata longiseta (Muller, 1786)											+								+		+			
Notholca squamula (Muller, 1786)		+	+	+	+	+																		
Notholca acuminata (Ehrenberg 1832)						+								+										
Polyarthra vulgaris Carlin, 1943	+	+	+	+			+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Pompholyx sulcata Hudson, 1885						+									+	+	+	+						
Rotaria neptunia (Ehrenberg, 1830)						+		+		+														
Rotaria sp					+	+								+										
Synchaeta stylata Wierzejski 1893	+	+			+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Testudinella mucronata (Gosse 1886)																		+						
Testudinella patina (Hermann, 1783)																							+	+
Trichocerca capucina (Wierzejski & Zacharias 1893)						+						+		+	+	+	+	+						
Trichocerca longiseta (Schrank 1802)					+		+	+	+	+														
Trichocerca porcellus (Gosse, 1851)	+																		+		+			
Trichocerca similis (Wierzejski, 1893)					+	+					+		+	+	+	+	+	+	+	+	+	+		
Trichocerca tenuior (Gosse, 1886)	+		+	+		+										+		+	+		+		+	+
Trichotria pocillum (Muller, 1776)																						+		
Species number of rotifers	**7**	**6**	**10**	**10**	**10**	**16**	**8**	**8**	**9**	**7**	**6**	**4**	**5**	**9**	**9**	**12**	**8**	**13**	**11**	**5**	**11**	**7**	**8**	**8**
Cladocera																								
Bosmina longirostris (Müller, 1785)	+	+	+	+	+	+	+	+	+	+		+			+	+	+	+	+		+		+	+
Ceriodaphnia pulchella Sars, 1862	+	+			+	+	+	+	+	+		+	+	+	+	+	+	+	+	+	+	+	+	+
Daphnia longispina (Mueller, 1875)	+	+	+	+		+	+		+			+	+	+	+	+	+	+	+	+	+	+	+	+
Diaphanosoma birgei Korinek, 1981													+						+		+			
Disparalona rostrata (Koch, 1841)		+																						
Eurycercus lamellatus (Mueller, 1785)	+																		+		+			
Macrothrix laticornis (Fischer,1851)			+	+	+	+		+		+		+											+	+
Scapholeberis kingi Sars, 1903												+												
Simocephalus vetulus (Müller, 1776)						+	+	+	+	+		+	+						+	+	+	+		
Alona guttata Sars, 1862						+																		
Alona quadrangularis (Müller, 1785)	+				+	+	+	+	+	+	+									+		+		
Alona rectangula Sars, 1862			+	+	+			+		+			+	+					+	+	+	+		
Chydorus sphaericus (Muller 1776)							+	+	+	+					+	+	+	+					+	+
Leydigia leydigi (Schoedler, 1863)																					+			+
Species number of cladoceran	**5**	**4**	**4**	**4**	**5**	**7**	**6**	**7**	**6**	**7**	**1**	**6**	**5**	**3**	**4**	**4**	**4**	**4**	**7**	**5**	**8**	**5**	**5**	**5**
Copepoda																								
Cyclops vicinus Uljanin, 1875	+	+	+	+	+	+	+	+	+	+	+	+	+		+	+	+	+	+	+	+	+	+	+
Diacyclops bicuspidatus (Claus, 1857)		+					+	+	+	+						+		+	+	+	+	+		
Eucyclops speratus (Lilljeborg, 1901)						+						+												
Macrocyclops albidus (Jurine, 1820)												+	+	+		+		+	+	+	+	+		
Megacyclops latipes (Lowndes, 1927)	+													+		+		+					+	+
Microcyclops rubellus (Lilljeborg,1901)	+	+			+										+	+	+	+	+	+	+	+	+	+
Thermocyclops dybowskii (Lande, 1890)	+		+	+	+	+					+	+	+	+	+	+	+	+					+	+
Paracyclops chiltoni (Thomson, 1882)	+																							
Acanthodiaptomus denticornis (Wierzejski, 1887)	+	+	+	+	+	+		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Nitocra hibernica (Brady, 1880)	+		+	+	+			+		+		+			+			+						
Species number of copepods	**7**	**4**	**4**	**4**	**5**	**4**	**2**	**4**	**3**	**4**	**3**	**6**	**4**	**4**	**5**	**7**	**4**	**8**	**5**	**5**	**5**	**5**	**5**	**5**
Species number of zooplankton	**19**	**14**	**18**	**18**	**20**	**27**	**16**	**19**	**18**	**18**	**10**	**16**	**14**	**16**	**18**	**23**	**16**	**24**	**23**	**15**	**24**	**17**	**18**	**18**

Keratella cochlearis (Gosse, 1851), *Daphnia longispina* (Muller, 1875), *Cyclops vicinus* Ulyanin, 1875, *Acanthodiaptomus denticornis* (Wierzejski, 1887) were found in the lake throughout the year, followed by *Polyarthra vulgaris* Carlin, 1943, *Synchaeta stylata* Wierzejski 1893, *Bosmina longirostris* (Müller, 1776), *Ceriodaphnia pulchella* Sars, 1862 and *Thermocyclops dybowskii* (Lande, 1890). The least common species were *Ascomorpha ovalis* (Bergendal, 1892), *Dicranophorus epicharis* Harring and Myers, 1928, *Keratella tecta* (Gosse, 1851), *Notholca acuminata* (Ehrenberg 1832), *Testudinella patina* (Hermann, 1783), *T. mucronata* (Gosse 1886), *Trichotria pocillum* (Muller, 1776), *Disparalona rostrata* (Koch, 1841), *Scapholeberis kingi* (Sars, 1903), *Leydigia leydigi* (Schoedler, 1863), *Alona guttata* Sars, 1862, *Eucyclops speratus* (Lilljeborg, 1901), *Paracyclops chiltoni* (Thomson, 1883). The species that found only in one month were not included in the assessment as they are not adequately represented in the lake. It was determined that *Monommata longiseta* (Muller, 1786) (August, September, December, January), *Trichocerca porcellus* (Gosse, 1851) (December, January, March), *Diaphanasoma birgei* Korinek, 1981 (August, September, December, January), *Eurycercus lamellatus* (Mueller, 1785) (December, January, March) were found only in first station; while *Ascomorpha ovalis* (August and September), *Notholca acuminata* (May, September), *Rotaria neptunia* (Ehrenberg, 1832) (May, June, July); *Trichotria pocillum* (January, February), *Disparalona rostrata* (February, March), *Eucyclops speratus* (May, August) were found only in second station.

Comparison of number of species between the stations revealed that a higher number of Rotifera species were found in the first station for 5 months; a higher number of Rotifera species were found in the second station for 4 months and number of Rotifera species was equal in both stations for 3 months. Number of Cladocera species was found to be higher in first station for 4 months; higher in second station for 4 months and equal in both stations for 4 months. Number of Copepoda species was found to be higher in first station for 2 months; higher in second station for 5 months and equal in both stations for 5 months. Number of all zooplanktons species was found to be higher in first station for 3 months; higher in second station for 6 months and equal in both stations for 3 months (Figure 4).

Average values of all zooplankton individuals in Kılavuzlu Dam Lake according to months and stations are presented in Table 2.

An analysis of the abundance of groups according to months and stations showed that individuals of groups were more abundant in first station when compared to second station (Rotifera and Copepoda 7 months; Cladocera 8 months) (Table 2, Figure 5).

Stations and months that were found to be statistically significant are presented in Table 2 and Figure 5. It was found that Rotifera was more abundant in April, September and October in first station (6931 ±7237.71 individual m^{-3}, 2933 ±3128.89 individual m^{-3}, 2490 ±2891.39 individual m^{-3} respectively) and more abundant in July and August in second station (3490 ±6677.25 individual m^{-3}, 8629 ±3537.92 individual m^{-3} respectively). Cladocera was more abundant in August in first station (2948 ±2731.21 individual m^{-3}). Copepoda was more abundant in August and September in first station (2866 ±3381.27 individual m^{-3}, 1207 ±1360.00 individual m^{-3} respectively), and more abundant in March, May, June and July in second station (1093 ±1165.98 individual m^{-3}, 3682 ±3899.15 individual m^{-3}, 4677 ±5951.79 individual m^{-3}, 5539 ±8327.86 individual m^{-3} respectively). All zooplankton was found to be more abundant in April in second station (6605 ±4597.35 individual m^{-3}) and more abundant and statistically significant in September in first station (1635 ±2384.852 individual m^{-3}) ($P > 0.05$).

Negative effects of cage fish farming have been analyzed by various researchers and it was reported that nitrogen, phosphor and organic material load in sediment were significantly affected by these negative changes. Researches have shown that negative effects vary according to enterprise capacity, currents, change ratio and total volume of water and the technology used in fish farming (Phillips et al., 1985; Stirling and Dey, 1990; Pitta et al., 1999). The most common effects were reported to be decreased dissolved oxygen, pH values and sechi depth, and increase of suspended solid matter, nutrient, electrical conductivity and chlorophyll *a* (Rast and Holland, 1988; Weglenska et al. 1987; Beveridge 1984, Phillips et al., 1985). However, Cornel and Whoriskey (1993) reported that pH did not vary in cage and reference stations and that the enterprise did not affect pH value. In another study carried out in a rainbow trout farming enterprise, it was found that pH and dissolved oxygen amounts did not significantly vary between the stations, while nutrient elements (N, P) (excluding nitrite nitrogen) were found to be higher in cage stations similar to the findings above (Demir et al., 2001). Similarly, other researchers reported that there was no difference between the enterprise and reference stations in terms of nitrite nitrogen and nitrate nitrogen (Stirling and Dey, 1990). Interestingly, Cornel and Whoriskey (1993) reported that in enterprises that make production below their capacity, N and P levels can be the same in the enterprise and reference stations.

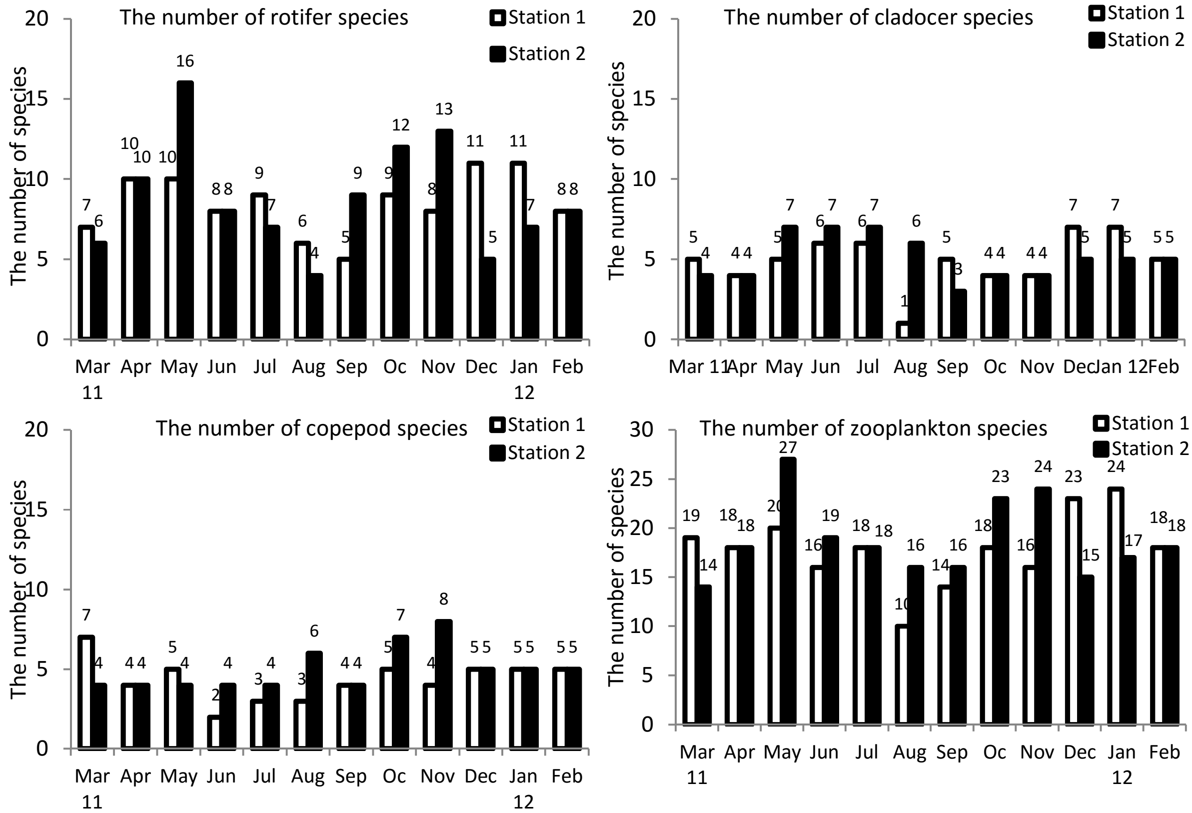

Figure 4. Monthly number of species at stations

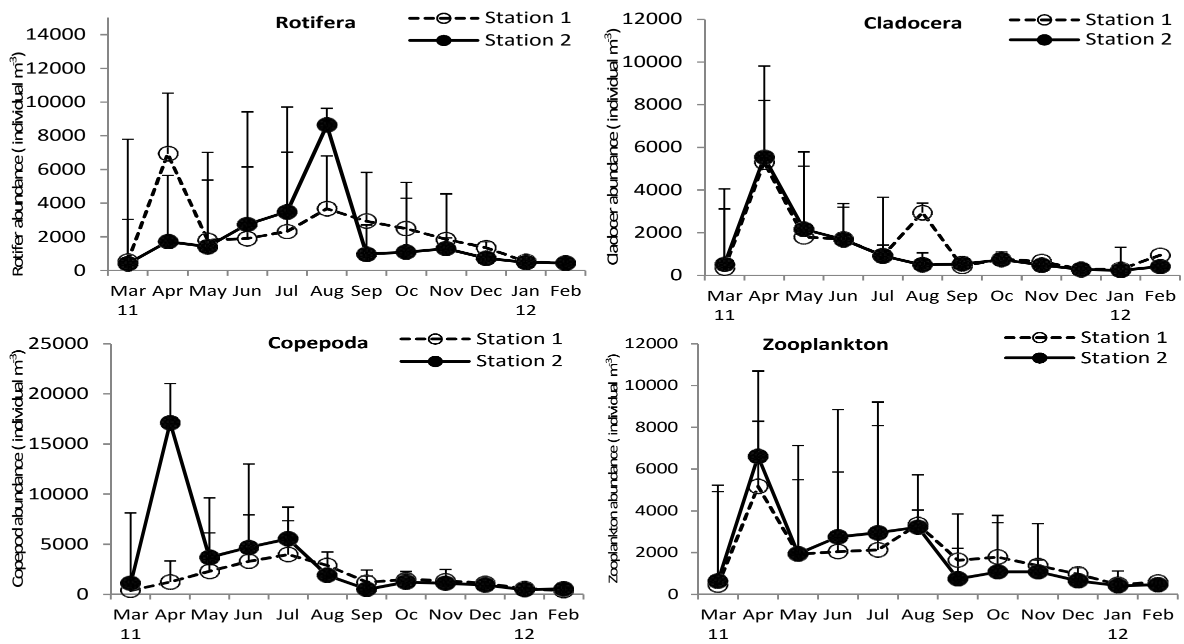

Figure 5. Monthly variation of zooplankton at the stations

Table 2. Monthly variation of the average zooplankton in stations

		Average zooplankton (individual m^{-3}), SD			
Months	**St**	**rotifer**	**cladocer**	**copepod**	**zooplankton**
Mar 2011	1	562±269.17	335±192.53	390±152.11	448±239.7763
	2	414±158.50	523±532.70	**1093±1165.98***	633±741.2495
Apr	1	**6931±7237.71***	5308±2782.13	1233±1010.97	5168±4465.77
	2	1729±2622.13	5543±3533.66	17114±7050.50	**6605±4597.35***
May	1	1802±3606.66	1799±2886.44	2299±2083.94	1925±3117.547
	2	1418±3919.70	2161±4266.99	**3682±3899.15***	1946±4086.705
Jun	1	1902±3569.12	1699±3322.31	3281±3843.58	2045±3567.666
	2	2737±5593.96	1683±3624.72	**4677±5951.79***	2756±5187.113
Jul	1	2312±4257.90	931±1496.70	3973±4666.54	2128±3808.27
	2	**3490±6677.25***	915±1674.41	**5539±8327.86***	2944±6087.178
Aug	1	3675±7393.12	**2948±2731.21***	**2866±3381.27***	3346±5952.038
	2	**8629±3537.92***	495±501.42	1880±3155.77	3218±6270.778
Sep	1	**2933±3128.89***	419±434.31	**1207±1360.00***	**1635±2384.852***
	2	970±1006.22	538±565.58	502±473.66	737±824.9328
Oc	1	**2490±2891.39***	769±314.98	1462±1212.27	1783±2213.002
	2	1103±1737.93	732±309.42	1225±1324.37	1076±1467.661
Nov	1	1848±2740.98	651±325.92	1375±814.68	1385±1995.567
	2	1304±3197.90	490±247.75	1099±788.93	1079±2360.522
Dec	1	1357±2709.73	288±84.35	1095±1130.08	975±2002.067
	2	739±630.66	276±56.77	924±560.72	646±559.3482
Jan 2012	1	542±358.73	292±88.12	572±257.78	472±304.4458
	2	479±219.92	238±38.00	462±225.41	411±217.7832
Feb	1	442±225.02	951±1027.26	375±173.21	583±644.8608
	2	453±172.85	417±165.06	537±112.14	467±162.3528

*bold numbers: statistically significant

Our findings are consistent with the literature. It was found that, among water quality parameters, sechi depth (4.12 ±1.03 m) was higher in reference first station (1); conductivity (401.91 ±99.07 µS), pH (7.96 ±0.22), chlorophyll *a* (8.86 ±2.81 mgl^{-}), nitrate (1.64 ± 0.46 mgl^{-}) and phosphate (0.93 ±0.69 mgl^{-}) values were higher in cage station. Similar to the literature, there was no difference between the stations in terms of nitrite nitrogen. While dissolved oxygen did not vary between the stations in our study, it was slightly higher in cage station. We believe that this can result from large water surface areas and the mixture in Dam Lake. Furthermore, silica (2.85 ±1.55 mgL^{-}), hardness (239.84 ±108.98), Ca (83.08 ±40.67 mgL^{-}) and $CaCO_3$ (78.17 ±17.5 mgL^{-}) amounts were found to be higher in first station. A review of the literature found no study on the impact of fish farming enterprises on these parameters.

Some of previous researchers reported that primary productivity increase in cage station due to the nutrients coming from feed and metabolism wastes and this increased the abundance of zooplanktonic organisms (Demir et al., 2001; Guo and Li, 2003; Köksal et al., 1997; Atay and Demir, 1998; Kirkagac and Köksal, 1999). Matsumura-Tundisi & Tundisi (2003, 2005) reported that zooplankton diversity and abundance, namely the zooplankton structure, changed in cage stations due to increased nutrients, chlorophyll-a, phytoplankton, conductivity, bacteria and other factors. In a study carried out in a tilapia farming enterprise, Santos et al., (2009) reported only small changes in zooplankton levels. Guo and Li (2003) reported that Rotifera was found in small amounts in cage station, however it was more abundant in the station that was outside of the cage; Cladocera was more abundant in the cage station and less abundant in the other station and finally Copepoda abundance was the same in the both stations.

In this study we found that Rotifera and Cladocera were more abundant first station (reference station) for 8 months, while Copepoda species were more abundant in reference station for 6 months. Similarly, total amount of Rotifera, Cladocera and Copepoda was more abundant in first station for 7 months. In parallel to Guo and Li (2003) it can be stated that fish farming enterprises have a suppressor effect on zooplankton abundance.

A total of 57 taxa consisting of 33 Rotifera, 14 Cladocera and 10 Copeoda species were identified in Kılavuzlu Dam Lake, on which no research was carried out in terms of zooplankton and water quality. A review of previous studies in Turkey revealed that 42 taxa were determined in Yenişehir Lake (Bozkurt, 2006); 38 taxa were identified in Yarseli Dam Lake (Bozkurt et al., 2004); 39 taxa were identified in Birecik Dam Lake (Bozkurt and Sagat, 2008); 17 were identified in Burdur Lake (Altındağ and Yiğit, 2002); 41 taxa were identified in Marmara Lake (Yıldız et al., 2007) by various researchers. In this respect, Kılavuzlu Dam Lake is more diverse than other reservoirs in terms of diversity of zooplankton species.

We found that *Keratella cochlearis*, *Daphnia longispina*, *Cyclops vicinus*, *Acanthodiaptomus denticornis* (Wierzejski, 1887) were cosmopolite and widely-distributed species throughout the year (Hutchinson, 1967; Ruttner-Kolisko, 1974; Margalef et al., 1976; Braioni and Gelmini, 1983; Koste and Shiel, 1986, 1987; Ramdani et al., 2001), followed by *Polyarthra vulgaris*, *Synchaeta stylata*, *Bosmina longirostris*, *Ceriodaphnia pulchella*, *Thermocyclops dybowskii*. On the other hand, the least species were found *Ascomorpha ovalis*, *Dicranophorus epicharis*, *Keratella tecta*, *Notholca acuminata*, *Testudinella patina*, *T. mucronata*, *Trichotria pocillum*, *Disparalona rostrata*, *Scapholeberis kingi*, *Leydigia leydigi*, *Alona guttata*, *Eucyclops speratus* and *Paracyclops chiltoni*. These species are known to be widely-distributed (Ruttner-Kolisko, 1974; Margalef et al., 1976).

Benthic *Collatheca pelagica* (Rousselet, 1893), *Monommata longiseta*, cosmopolite cold-water *Trichocerca porcellus*, cosmopolite *Diaphanasoma birgei*, benthic *Eurycercus lamellatus* were only found in first station; cold-water, eutrophic and mostly litoral *Notholca squamula* (Muller, 1786), alkaline, eutrophic, cosmopolite *Rotaria neptunia*, benthic *Alona guttata* and cosmopolite *Eucyclops speratus* were only found in second station. Considering the general bio-ecological characteristics of these species, the presence of them in the reservoir is quite normal, but the situation in the station suggested that they may be related to the fish farm.

The most dominant genus of Rotifera that was found in all stations every month was genus *Keratella,* followed by genus *Polyathra*. As genus *Keratella* is a small form with a large tolerance to the conditions of media, it was reported among the most common zooplanktonic organisms in cage fish farming in previous research (Weglenska et al., 1987, Demir et al., 2001).

Conclusion

In a study which reported that cage trout farming accelerates eutrophication, number of *Keratella*, *Polyathra* and *Bosmina* genus that are found in highly eutrophic waters was observed to increase (Weglenska et al., 1987). In our study high number of individuals of this genus shows the effects of cage system enterprises on zooplanktons.

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