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ZOOPLANKTON OF KEBAN DAM LAKE (YURTBASI LOCALITY) (ELAZIG-TURKEY)

ABSTRACT

In this study it was aimed to determine the zooplankton fauna and its seasonal variations in Keban Dam Lake Yurtbaşı region. Zooplankton samples have been collected monthly between May 2011–April 2012. During the study, 29 species belong to Rotifera, 9 species belong to Cladocera and 2 species belong to Copepoda have been identified from Keban Dam Lake Yurtbası Region. As a result of Shannon Wiener species richness index analysis of Keban Dam Lake Yurtbası Region, species richness was found highest in may (H'=2.72) and the lowest index value was found in february (H'=0.91). According to Margalef index analysis of Keban Dam Lake Yurtbası Region, species richness was found highest in may (D=3.86) and the least value was found in january (D=0.62). Among all zooplankton, Rotifera was represented with 83.5%, Cladocera 11.5% and Copepoda 5%.

Keywords: Zooplankton, Keban Dam Lake Yurtbaşı Locality, Seasonal Variations, Species Richness Indices, Elazığ

1. INTRODUCTION

Many aquatic organisms feed on zooplanktonic organisms, at least during a certain period of their life. Therefore, there is a close relationship between the productivity of the aquatic environment and zooplanktonic organisms [1]. The density of these organisms varies depending on the location and season. Zooplankton is of great importance in the food chain established in aquatic ecosystems, as it forms the basic food ring between primary producers and higher forms. Zooplankton not only forms the nutrients of planktivorous fish, but also feeds all fish larvae, aquatic insects, insect larvae and other aquatic animals in the ecosystem. Changes in zooplanktonic organisms in terms of quantity or variety affect the living groups in the upper stage of the food pyramid [2]. Some genera and species of these organisms are also important in terms of their indicative characteristic of water quality, pollution and trophic status of the waters in which they are present [3]. The determination of the quality and quantity of zooplanktonic organisms, which constitute one of the natural nutrients of the fish which constitute the most important animal protein source in our inland waters, with the environmental factors of the environment, and determination of the changes occurring during the year are important for limnological studies.

2. RESEARCH SIGNIFICANCE

In this study, it is aimed to determine zooplankton fauna and seasonal changes of Keban Dam Lake Yurtbaşı locality based on the sources mentioned and the findings to be obtained as a result of field studies. This study has got an importance as being the first zooplankton research in this region of Keban Dam Lake.

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3. MATERIAL AND METHODS

Keban Dam Lake, which is the most important surface water source of the province along with the Hazar Lake, is located 45km north-west of Elazığ and 45km north-east of Malatya. It is the second largest dam lake in terms of surface area. Its area is 645km^2 [4]. Monthly samples were taken between May 2011 and April 2012 in order to detect zooplankton fauna at Yurtbaşı locality of Keban Dam Lake. 3 stations (1st station 38^{0}36′58.8′′N 39^{0}22′0.3′′E, 2nd station 38^{0}37′59.2′′N 39^{0}23′32.6′′E, 3rd station 38^{0}38′17.09′′N 39^{0}24′0.4.7′′E) were chosen to represent the study area best for sampling (Figure 1).

Figure 1. Keban Dam Lake Yurtbaşı Region sampling stations

The temperature, dissolved oxygen and pH values of the stations were measured immediately in the field during each sampling. Water temperature and dissolved oxygen were measured by Oxi 315i/SET brand and pH value by Lamotte (pH 5-WC) brand digital instruments. The samples were taken from each station 5 times with a plankton net of 55 µ mesh size and placed in 250ml jars and brought to the laboratory as soon as possible. Samples were placed in 4% formaldehyde and stored. Water samples were examined under the Leitz brand inverted microscope and from related sources [5-15] by making use of species identification of zooplankton. Counting slide and Leitz brand inverted microscope were used to indicate the number of zooplanktons per unit volume. For counting, the jar was shaken gently and 1ml was taken by pipette and this process was repeated 10 times according to zooplankton species. The number of organisms in m^3 was calculated by first comparing the results with the volume of the jars and then with the amount of water filtered through the plankton bucket. For detailed identification of organisms, Nikon research microscope was used. The Shannon-Weiner diversity index was calculated to see if there were similarities between the species detected at a station. The index value ranges from 0 to 5. When the species are evenly distributed, the index is at high values, and if the species are concentrated in several families, the index will be at low values. The Shannon-Weiner diversity index was calculated by the following formula [16].

$$H' = -\sum_{i=1}^{S} p_i \ln p_i$$

H: Shannon diversity index,
S: Total number of species in the community
pi: ratio of nth species to S
ln: logarithm

In the predominance calculation, the individual number of a species and the individual numbers of all species are used. Dominance was calculated with the following formula [17].

D=(NA/Nn)x100

D: Dominance value, NA: Number of individuals of type A,

Nn: Number of individuals of all species

The Margalef Species Richness Index provides more relative comparisons due to the fact that it shows a change dependent on the number of species and there is no specific limit value and it is mostly defined as the species richness index [17]. Calculated with the following formula.

D=S-1/Log N

D: Index

S: Number of species

N: Number of individuals

SPSS 12.0 ® computer program was used for statistical analysis. Correlation analysis was performed to determine the effect of physical and chemical parameters on the number of individuals determined at the stations. For this purpose, Pearson correlation analysis was used and the results were evaluated [18 and 19].

4. RESULTS AND DISCUSSION

In Keban Dam Lake Yurtbası locality 40 zooplankton species have been identified, 29 species from Rotifer, 9 from Cladocera and 2 from Copepoda. Relative density of zooplankton species according to stations in Keban Dam Yurtbaşı locality have been calculated and given in Table 1.

The highest water temperature was recorded as 25.2 C^0 in August and the lowest water temperature was 4.6 C^0 in January. During the survey period, the highest pH value at the Keban Dam Lake Yurtbaşı locality was found to be 8.5 at the 3rd station in August. The lowest pH value was recorded as 5.4 in the second station in February. The highest dissolved oxygen level was found to be 11.3 mgL^{-1} at the 3rd station in February. The lowest dissolved oxygen values were recorded as 6 mgL^{-1} in June at the 2nd and 3rd stations (Figure 2).

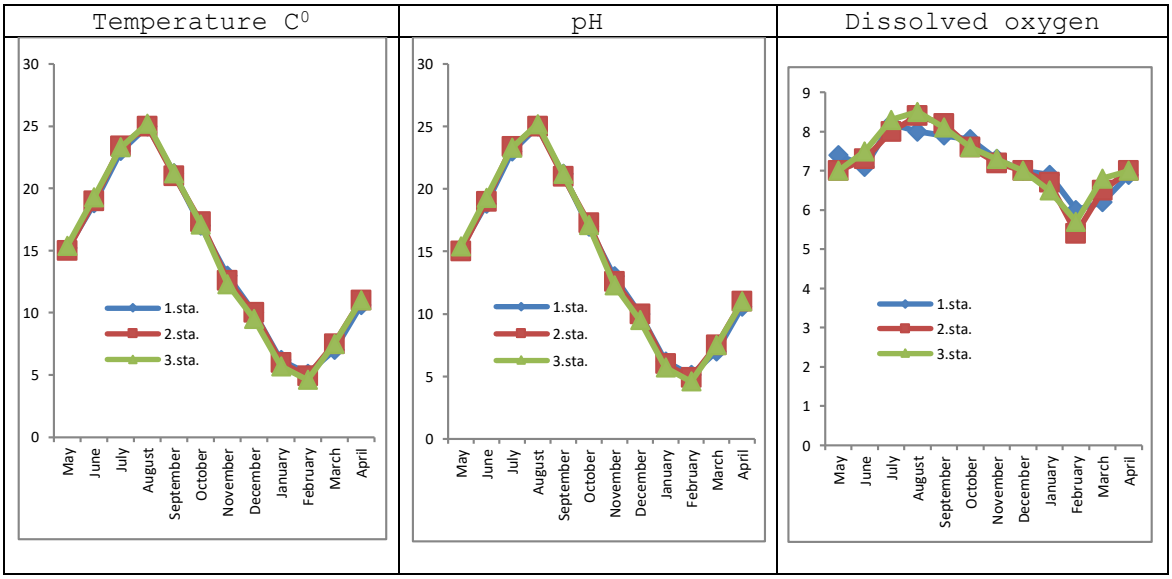

Figure 2. Temperature, pH and dissoleved oxygen values in Keban Dam Lake Yurtbaşı Region

Table 1. Relative density of Zooplankton species according to stations in Keban Dam Yurtbaşı locality (%)

Seasons	Autumn			Winter			Spring			Summer		
Stations	1	2	3	1	2	3	1	2	1	1	2	3
Rotifera												
Ascomorpha ovalis	-	0.9	-	-	-	-	-	-	3.8	-	-	1
Ascomorpha saltans	1.2	1	7.3	13.9	0.7	-	1.5	2.4	-	6.5	9.2	-
Asplanchna priodonta	2	2.8	4.2	-	-	-	4.2	5.8	-	3.4	-	10.9
Asplanchna sieboldi	0.6	-	-	1.8	-	0.8	1.3	-	0.5	1	-	-
Brachionus angularis	-	4.2	-	-	9.7	-	2.6	-	6.7	12.7	-	-
Brachionus calyciflorus	3.4	-	-	-	-	-	0.8	5	-	-	5.8	-
Brachionus urceolaris	2.3	-	5.1	-	-	-	-	2.5	1.9	0.8	-	-
Cephalodella gibba	1.7	2	-	0.6	-	-	3.3	2	-	4.4	-	-
Colurella obtusa	1	1.2	-	-	-	-	1.1	-	2.6	-	-	3.6
Euchlanis dilatata	0.5	-	-	-	1.4	-	3.6	-	-	-	2.2	-
Filinia longiseta	2.5	0.7	6.9	-	5.3	-	-	4.2	-	5.1	-	6.1
Filinia terminalis	3.2	-	5.5	2.5	5	-	2.2	3.8	4	-	3	1.2
Hexarthra mira	4.3	-	4	-	-	-	-	-	-	-	12.4	-
Kellicottia longispina	-	5.8	-	1.6	12.2	-	10.4	7.5	-	4.2	-	-
Keratella cochlearis	19.4	15.5	18.2	5.1	-	-	17.7	14	13.1	9.7	11.1	16.2
Keratella quadrata	-	3.6	-	3.4	-	2.1	-	2.8	-	-	1.1	-
Keratella tecta	-	-	4.7	-	-	17.2	0.8	-	4.1	-	1	-
Lecane costata	2.1	1.6	-	-	10	-	3.7	4.1	2.9	0.9	-	1.7
Lecane luna	0.7	1.3	3.08	-	-	-	1.4	-	4.3	-	1.6	0.3
Lecane lunaris	-	-	-	1.7	-	-	3.1	9.8	-	-	-	-
Notholca acuminata	-	-	-	30.3	-	48.5	-	-	-	-	-	-
Notholca squamula	-	0.3	-	21.5	37.2	18.3	-	-	-	-	-	-
Mytilina trigona	-	-	-	-	-	-	-	0.4	-	5.2	-	-
Polyarthra remata	5.2	-	-	-	-	-	-	-	2.5	-	6.9	-
Polyarthra dolichoptera	11.9	18.1	14.3	5.4	-	7.1	12.7	10.3	16	6.5	8.1	12
Pompholyx sulcata	-	4	-	-	-	-	-	-	-	-	1.5	-
Sychaeta oblonga	0.3	-	-	-	-	-	-	1.1	2.3	5.7	11.2	1.4
Synchaeta pectinata	-	3.1	-	-	-	-	3	-	1	-	-	5.5
Trichocerca capucina	-	-	2.7	-	0.6	-	-	1	0.7	-	-	2
Cladocera												
Coronatella rectangula	2.5	-	3.2	-	-	4.1	2.1	-	4	-	3.1	-
Bosmina longirostris	-	5.2	7.92	1.5	-	1.6	1	1.8	-	2.8	-	7.2
Ceriodaphnia reticulata	3.1	-	-	0.8	3.4	-	0.3	2	1.2	-	6.2	-
Daphnia cucullata	-	2.9	-	-	-	-	3	-	1.9	1	0.7	-
Daphnia longispina	4.8	4.3	-	4.2	-	0.3	-	-	3.4	-	2.9	-
Daphnia magna	-	-	3.5	-	-	-	1.2	-	-	4.7	-	9.3
Diaphanosoma lacustris	-	1.8	-	-	-	-	-	1.6	0.5	-	-	5.1
Leptodora kindtii	1.4	-	-	-	-	-	1.9	-	-	0.9	2.1	-
Sida crystallina	-	0.9	-	-	-	-	1.5	-	2.2	-	-	0.8
Copepoda												
Acanthodiaptomus denticornis	8.2	7.3	9.4	-	-	-	9.1	10.2	11.9	5.4	-	6.6
Cyclops vicinus	17.7	11.4	-	5.7	14.5	-	6.5	7.7	8.5	19.1	9.9	9.1
Total	100	100	100	100	100	100	100	100	100	100	100	100

When Table 1 examined, *Asplanchna sieboldi, Euchlanis dilatata, Keratella quadrata, Lecane costata, Brachionus angularis, Kellicottia longispina, Keratella cochlearis, Synchaeta pectinata, Polyarthra dolichoptera, Ascomorpha saltans, Cephalodella gibba, Daphnia cucullata, Daphnia longispina* and *Cylops vicinus* were recorded in four seasons. *Ascomorpha ovalis, Brachionus calyciflorus, Brachionus urceolaris, Colurella obtusa, Mitilina trigona, Leptodora kindtii, Sida cristallina* and *Acanthodiaptomus denticornis* species were recorded in autumn, spring and summer seasons. *Notholca acuminata* was recorded only in winter, while *Notholca squamula* was recorded in autumn and winter. From Rotifera *Keratella cochlearis* (19.4%) in the first station in autumn, from Cladocera *Bosmina longirostris* (7.92%) in autumn, 3rd station, from Copepoda *Cyclops vicinus* (19.1%) in the 1st station in summer have reached their highest relative densities. The lowest species densities were recorded as: *Mytilina trigona* (0.4%) in spring in 2nd station, Ceriodaphnia reticulata (0.3%) in spring in 2nd

station, Daphnia longispina (0.3%) in winter in 3rd station, *Acanthodiaptomus denticornis* (5.4%) species in the 1st station in the summer.

Table 2. Total Number of individuals (individuals/m^3), *H'*(Species Diversity) and D (Species Richness) values at Keban Dam Lake Yurtbaşı Locality at 1st Station

	M	J	J	A	S	O	N	D	J	F	M	A
T	121737	59866	31048	11971	84634	45662	59101	29295	8518	8662	25608	50716
H'	2.72	1.56	1.31	0.93	1.02	0.95	1.47	1.33	1.10	1.13	1.27	1.53
D	3.02	2.53	2.08	1.74	1.91	0.89	2.23	1.78	0.62	0.70	1.64	2.01

In the first station, it was observed that the species diversity had the highest value (*H'*=2.72) in May and the lowest value *(H'*=0.93) in August. Margalef species richness index value was highest in May in spring (D=3.02) and lowest in January in winter (D=0.62).

Table 3. Total Number of individuals (individuals/m^3), *H'*(Species Diversity) and D (Species Richness) values at Keban Dam Lake Yurtbaşı Locality at 2nd Station

	M	J	J	A	S	O	N	D	J	F	M	A
T	97316	57318	14774	11208	48854	84469	27258	20950	10443	9813	16656	51627
H'	1.89	1.43	1.78	1.12	1.56	1.91	1.40	1.31	0.98	0.71	1.62	1.35
D	2.95	2.18	1.90	0.91	1.23	1.76	1.20	1.01	0.82	0.65	1.19	1.04

In the second station, it was observed that species diversity had the highest value (*H'*=1.91) in autumn in October and lowest value in February (*H'*=0.71) in winter. Margalef species richness index value was highest in May in spring (D=2.95) and lowest in winter in February (D=0.65).

Table 4. Total Number of individuals (individuals/m^3), *H'*(Species Diversity) and D (Species Richness) values at Keban Dam Lake Yurtbaşı Locality at 3rd Station

	M	J	J	A	S	O	N	D	J	F	M	A
T	77845	47128	36426	12954	39447	59612	24260	12239	7266	4076	18187	44623
H'	2.22	1.71	1.63	1.03	1.69	1.82	1.51	1.37	1.03	0.91	1.24	1.47
D	3.86	3.01	2.18	2.03	2.54	3.31	1.94	1.71	0.92	0.83	2.61	2.95

In the third station, the species diversity had the highest value (*H'*=2.22) in May and the lowest value in February in winter (*H'*=0.91). Margalef species richness index value was found to be highest in May (D=3.86).

Table 5. Results of correlation analysis of total number of individuals according to some parameters in Yurtbaşı locality of Keban Dam Lake

	Number of Individual	pH	Dissolved Oxygen
1. Station			
pH	r=0.484 p>0.05		
Dissolved Oxygen	r=0.471 p>0.05	r=0.381 p>0.05	
Temperature	r=0.707 p<0.05	r=0.418 p>0.05	r=0.294 p>0.05
2. Station			
pH	r=0.217 p>0.05		
Dissolved Oxygen	r=0.343 p>0.05	r=0.210 p>0.05	
Temperature	r=0.411 p>0.05	r=0.302 p>0.05	r=0.242 p>0.05
3. Station			
pH	r=0.719 p<0.05		
Dissolved Oxygen	r=-0.210 p>0.05	r=0.189 p>0.05	
Temperature	r=0.560 p>0.05	r=0.411 p>0.05	r=-0.437 p<0.05

According to the results of correlation analysis; In the 1st station, a strong positive relationship (r=0.707) was found between

the number of individuals and temperature, a positive correlation with pH value (r=0.484) and a positive correlation with dissolved oxygen value (r=0.471). At the station 2nd, a moderate positive correlation was found between the number of individuals and temperature (r=0.411), pH value was positively weak (r=0.217), and dissolved oxygen value was positively weak (r=0.343). In the 3rd station, a positive correlation was found between the number of individuals and temperature (r=0.560), pH value was positively strong (r=0.719), and dissolved oxygen value was negatively weak (r=-0.210) (Table 5). In this study, species from all three groups of zooplankton, Rotifera, Cladocera and Copepoda have been investigated at Yurtbaşı locality of Keban Dam Lake. Significant increases in number of individuals and species were observed in spring and autumn months. These increases were observed more especially in the Rotifera individual numbers of and species diversities. Güher and Erdoğan [20] reported that rotifers in Lake Gala were over-recorded in spring and summer. Yiğit [21], found in Kesikköprü Dam Lake that in spring and autumn rotifers are more than other seasons. These findings are consistent with the seasonal distribution of zooplankton fauna at of Keban Dam Lake. In the Pertek region of Keban Dam Lake, the most intense occurrence of *Bosmina longirostris*, *Cyclops vicinus*, *Acanthodiaptomus denticonis* species coincides with the findings at Yurtbaşı locality of Keban Dam Lake. They found the maximum level of Rotifera in spring and autumn as in this study [22].

Saler [23] recorded 11 rotifer species from Kepektaş Dam Reservoir *Polyarthra vulgaris*, *Colurella uncinata, Asplanchna priodonta* and *Keratella cochlearis* were the most common species. In Yurtbası locality *K. cochlearis* was found as dominant species. *Synchaeta pectinata*, which is found in almost all seasons in oligotrophic and eutrophic lakes, is another type of rotifer found in this study. This species, which is maximum in spring season, has been determined in certain numbers in other seasons of the year. Saler [24] observed this species in Keban Dam Lake Gülüşkür region in all seasons, Temel and Ongan [25], in the autumn, Ustaoğlu [26], only in April and May. *K. cochlearis* was found extensively throughout the year in Keban Dam Lake and started to decrease in summer months. This is due to the increase in the metabolic rate of planktivor fish during the summer months due to the fact that these creatures are consumed by the fish and increasing Cladocera species as nutrients. This finding is in line with Özhan's [27] study in Karakaya Dam Lake. In Euphrates River [28], Zıkkım Creek [29], Keban Dam Lake [22] Devegeçidi Dam Lake [30], Keban Dam Lake Pertek region [31], Çernek Lake [32], Maryap pond [33], Kalecik and Beyhan Dam Lake [34 and 35] Uzunçayır Dam Lake [36] Karkamış Dam Lake, [37] Eupharete Basin [38], Çat Dam lake [39] zooplankton species and individual numbers generally increased in spring and winter season was the least number. In all these dam Lakes Rotifer species were recorded the first group in terms of number of individuals and species. In Yurtbaşı locality Rotifer species were recorded 83.5% followed by Cladocera with 11.5% and 5% Copepoda. It is reported that the pH is significantly effective in zooplankton distribution and the alkali limit is 8.5 in density [40]. According to EPA [41], the optimum value of pH in fresh water is between 6.5-9.0. The pH values of Yurbaşı locality values changed between 6.4 and 8.5 and it is slightly alkaline water and suitable for zooplankton life. Temperature is one of the most important factors affecting rotifer distribution. Kolisko [7] reported that in parallel with the increase in ambient temperature rotifer species shortened the time of embryonic development and consequently they proliferate rapidly in a very short time. This finding also explains the reason for the high density of rotifer species in Yurtbaşı locality of Keban Dam Lake in spring. And

also in the statistical analysis, a positive relationship was found between temperature and number of individuals. Oxygen tolerance of most rotifer species is quite wide. Continuous species such as *Keratella cochlearis* and perennial species such as *Kellicottia longispina* can tolerate low oxygen concentrations, although oxygen concentration in water is an important limiting factor. Both species are characteristic organisms of oligotroph lakes [7]. The amount of oxygen recorded in the research area has not been determined at extreme levels. As a result of correlation analysis of dissolved oxygen value and number of individuals, a positive correlation was found.

Shannon Wiener index values were calculated as *H'*=2.72 at station 1 and *H'*=2.91 at station 2 and *H'*=2.22 at station 3. The mean *H'* value was recorded as *H'*=2.61. This value shows a moderate species richness. According to Margalef (Species Richness) index, Keban Dam Lake Yurtbaşı Locality has the highest species richness in May (D=3.86). During this research, zooplankton species were found in all seasons in Keban Dam Lake. The most observed species was *Keratella cochlearis*. In zooplankton, rotifera was the most important group both in terms of number of individuals and number of species. While the number of zooplankton species and number of individuals was the most productive period of spring, significant decreases were recorded in winter months. It is thought that the results of this study will guide other limnological studies in the region.

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