International Journal of Scientific and Technological Research www.iiste.org
ISSN 2422-8702 (Online)
Vol 1, No.1, 2015

# Zooplankton Fauna of Tahtakopru Dam Lake (Gaziantep)

Mitat Ulgu
Mustafa Kemal University, Samandag Vocational School, Antakya, Hatay, Turkey
E-mail: mulgu@mku.edu.tr

Ahmet Bozkurt (Corresponding author)
Mustafa Kemal University, Faculty of Marine Science and Technology, Iskenderun, Hatay, Turkey, E-mail: ahmetbozkurt1966@yahoo.com

The research is financed by MKU BAP commission. No: BAP-07 M 1703

**Abstract**
A total of 44 taxa consisting of 26 Rotifera, 10 Cladocera and 8 Copepoda, were identified during the study performed in the Tahtakopru Dam Lake.
*Asplanchna girodi, Brachionus calyciflorus, B. angularis, Polyarthra vulgaris, Pompholyx sulcata, Bosmina longirostris* and *Leydigia leydigi* were found in every month throughout the year.
In terms of the species diversity, it was found that the richest months were March and May with 30 species and the second richest month was July with 23 species. 67.83% of the total zooplankton was rotifers, 23.59% was cladoceran and 8.57% was copepods. Rotifera was found mostly in September (total 696769 individual$m^{-3}$), rarely in June (total 35241 individual $m^{-3}$), Cladocera was abundant in September (total 230368 individual $m^{-3}$) and rare in March (total 10575 individual $m^{-3}$), and Copepoda was abundant in July (total 435066 individual $m^{-3}$) and rare in December (total 8644 individual $m^{-3}$).
*P. vulgaris* was the most frequently found rotifer species, being the most abundant in September, had different amounts of abundance in March, May, July, November and February. *B. longirostris* and *L. leydigi* were the most frequently found cladocer species, the most abundant in September, and abundant in April, November and January. Naupli was the mostly increased throughout the year, and has been found to be abundant for four times a year.
**Keywords:** Zooplankton, rotifers, cladocerans, copepods, Tahtakopru Dam

## 1. Introduction

In parallel to the development of technologies, the increased industrial, municipal and agricultural wastes and discharging a portion of them to the irrigation systems causes an excessive accumulation of nutrients, and this raises the problem of eutrophication.
In the early 1960s, there were rapid changes in many lakes and water basins located in the industrial areas in terms of quality and extreme deterioration were identified in water quality as a result of nutrient enrichment.
In various studies, it was reported that there is a strong relationship between zooplanktonic organisms and efficiency of the aquatic environment, and the pollution is reported to have adverse effects on zooplankton. Dumont (1983), for example, states that eutrophication and water pollution in general leads to changes in the species composition of zooplanktonic organisms, and therefore zooplankton studies to be conducted in lakes will be very important in this aspect.
Most aquatic organisms are fed with zooplanktonic organisms in a certain period of their lives. The studies on zooplanktonic organisms gained momentum, since they constitute one of the food sources of many fish species, especially in earlier periods, and the main link of the food chain in transforming the plant nutrients into animal proteins in aquatic environments (Güher, 1999).
Zooplankton in freshwater ecosystems largely consists of rotifer, cladocer and copepod groups. Up to now, numerous studies have been conducted and species lists have been reported in order to determine rotifer, cladocer and copepod fauna of Turkey (Emir, 1989, 1994; Ustaoğlu, 1986; Ustaoğlu and Balık, 1990).

Up to now no study has been carried out on zooplankton in Tahtaköprü Dam Lake. Therefore, this lake has been chosen as the study area to investigate the diversity and succession of zooplankton species. This study, performed in the dam lake, is important as an example on determining the zooplankton fauna.

## 2. Materials and Methods

The study was conducted between March 2007 and February 2008 in Tahtaköprü Dam Lake, located in the boundaries of the Province of Gaziantep, 125 km away from the Province of Antakya. Tahtaköprü Dam is on Karasu River near Syrian border, and its construction was started in 1968, completed in 1977, and became operational in 1977. The fishery in the dam lake is an important source of income for the local people. Tahtaköprü Dam Lake constructed for irrigation purposes, has an 11900 ha land irrigation capacity, covering Hassa and Kırıkhan districts. Reservoir volume is 200 $hm^3$, active volume is185 $hm^3$, and reservoir area at the normal water level is 2340 ha, and its water source is the Karasu River (Anonymous, General Directorate of State Hydraulic Works [DSI]).

Zooplankton and water samples were collected monthly from four stations in total. Sampling stations were chosen to represent the general properties of the dam lake. First station was on the river side, the other three stations selected were on the main body of the lake (Figure 1). The depth of the first station was about 16 m, and the others varied between 22 to 39 m.

Oxygen and temperature were measured directly at the field using digital instrument, YSI model 52 oxygen meter.

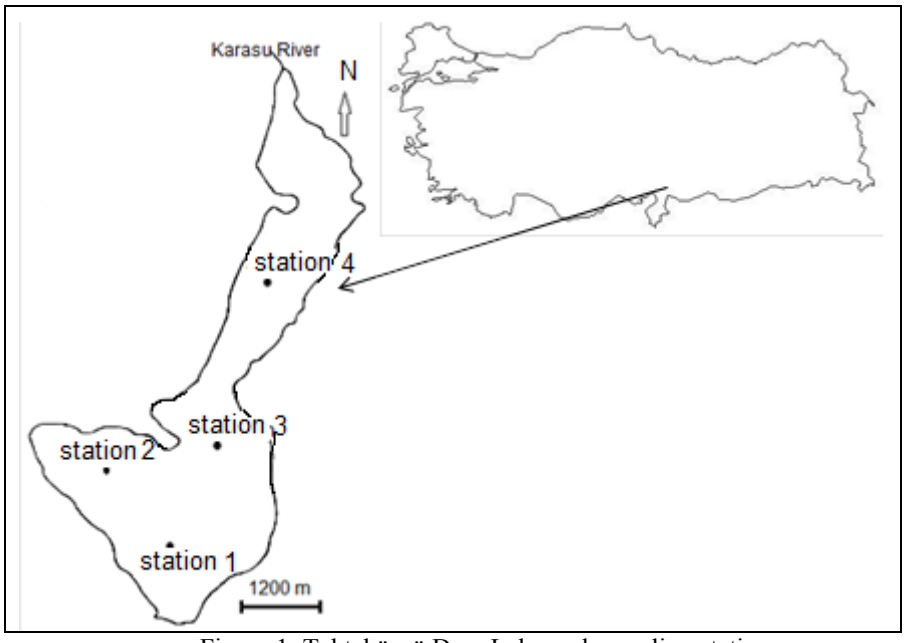



Figure 1. Tahtaköprü Dam Lake and sampling stations

Water samples (1 L) were taken from the surface at four stations of the dam lake for chlorophyll *a* analysis. Chlorophyll a analysis was carried out using acetone extraction method described by APHA (1995). For this purpose, the water samples were, first, filtered through 0.45µm Whatman GF/F filter paper and, then, extracted in 90% acetone. Finally, the pigments were measured using a Shimadzu (UV-1601 PC) spectrophotometer.

Zooplankton samples were collected by means of vertical and horizontal houls, using a standard net (60 µm mesh size) and preserved in 4% formaldehyde solution in the field. The qualitative analysis of zooplankton was performed by examination of the samples taken horizontally and vertically, and the quantitative analysis was performed on the samples taken vertically through a binocular microscope examination.

After homogenizing 250 cc zooplankton samples, the sub samples at certain volumes (2 cc) were put in a petri dish, having stripes with 2 mm intervals, and the organisms were counted for each species, and the amounts in unit volume ($m^3$) were determined by using the (number of organisms at 250 cc x 2 cc x 1 $m^3$) / (2 $\pi$ $r^2$ x h) formula (Tanyolaç, 1993).

To identify the zooplanktonic organisms, the works of Edmondson (1959), Borutsky (1964), Scourfield and Harding (1966), Dussart (1969), Damian-Georgescu (1970), Ruttner-Kolisko (1974), Kiefer (1978), Koste (1978), Stemberger (1979), Segers (1995) were used.

## 3. Results

Monthly mean values of some physicochemical parameters in Tahtakopru Dam Lake are presented in Table 1. The water temperature was highest in July (27°C), lowest in February (10°C) and the mean value was found as 18.08°C. The dissolved oxygen level was highest in July (9.6 mg $L^{-}$), lowest in August (6.7 mg $L^{-}$) and the average was 7.9 mg $L^{-}$. The highest chlorophyll *a* value was observed in July (139.2 µg $L^{-}$), lowest in May (9.0 µg $L^{-}$) and the annual average was found as 55.3 µg $L^{-}$ (Table 1).

**Table 1.** Monthly mean values of some physicochemical parameters in Tahtakopru Dam Lake

| | 2007 | | | | | | | | | | 2008 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Parameters** | **Mar** | **Apr** | **May** | **Jun** | **Jul** | **Aug** | **Sep** | **Oc** | **Nov** | **Dec** | **Jan** | **Feb** |
| Temp (°C) | 14 | 15 | 22 | 24 | 27 | 26 | 22 | 20 | 13 | 12 | 12 | 10 |
| Dis Ox (mg $L^{-}$) | 8.3 | 8.0 | 7.3 | 7.0 | 6.8 | 6.7 | 7.6 | 7.8 | 8.0 | 9.2 | 9.1 | 9.6 |
| Chl *a* (mg $L^{-}$) | 11.5 | 11.8 | 9.0 | 32.4 | 139.2 | 130.9 | 121.9 | 127.2 | 35.2 | 13.4 | 16.6 | 14.5 |

A total of 44 taxa consisting of 26 Rotifera (12 families, 15 genera, 59%), 10 Cladocera (6 families, 10 genera, 23%), and 8 Copepoda (3 families, 8 genera, 18%) were identified during the study period in Tahtaköprü Dam Lake (Table 2).

**Table 2. The zooplankton (rotifer, cladocer, copepod) species in the study**

| | | |
|---|---|---|
| **Phylum:** Rotifera<br>**Classis:** Eurotatoria<br>**Subclassis:** Bdelloidea<br>**Ordo:** Philodinida | **Familia:** Philodinidae | *Rotaria neptunia* (Ehrenberg, 1832) |
| | **Familia:** Brachionidae | *Brachionus angularis* Gosse, 1851<br>*B. budapestinensis* Daday, 1885<br>*B. calyciflorus* Pallas, 1766<br>*B. leydigi* Cohn, 1862<br>*B. quadridentatus* Hermann, 1783<br>*B. urceolaris* (Müller, 1773) |
| **Subclassis:**Monogononta<br>**Superordo:** Pseudotocha<br>**Ordo:** Ploimia | | *Keratella cochlearis* (Gosse, 1851)<br>*K. tecta* (Gosse, 1851)<br>*K. quadrata* (Müller, 1786)<br>*K. tropica* (Apstein, 1907) |
| | | *Notholca squamula* (Müller, 1786 |
| | **Familia:** Euchlanidae | *Euchlanis dilatata* Ehrenberg,1832 |
| | **Familia:** Lecanidae | *Lecane luna* (Müller,1776)<br>*L. closterocerca* (Schmarda,1859) |
| | **Familia:** Notommatidae | *Cephalodella gibba* (Ehrenberg,1838) |
| | **Familia:** Trichocercidae | *Trichocerca* sp. |
| | **Familia:** Synchaetidae | *Synchaeta* sp.<br>*Polyarthra dolichoptera* Idelson,1925<br>*P. vulgaris* Carlin,1943 |
| | **Familia:** Asplanchnidae | *Asplanchna girodi* (de Guerne,1888) |
| **Ordo:** Floscullariacea | **Familia:** Testudinellidae | *Pompholyx sulcata* (Hudson,1885) |
| | **Familia:** Hexarthridae | *Hexarthra mira* (Hudson,1871) |
| | **Familia:** Filiniidae | *Filinia longiseta* (Ehrenberg,1834)<br>*F. opoliensis* (Zacharias,1898) |
| **Ordo:** Collothecaceae | **Familia:** Collothecidae | *Collotheca pelagica* (Rousselet, 1893) |
| | **Infraordo:** Ctenopoda<br>**Familia:** Sididae | *Diaphanosoma birgei* Korinek,1981 |

| | | |
|---|---|---|
| **Phylum :** Arthropoda<br>**Subphylum:**Crustacea<br>**Classis :** Branchiopoda<br>**Subclassis :** Phyllopoda<br>**Ordo :** Diplostraca<br>**Subordo :**Cladocera | **Infraordo:** Anomopoda<br>**Familia:** Daphniidae | *Daphnia* sp.<br>*Ceriodaphnia pulchella* Sars, 1862 |
| | **Familia:** Moinidae | *Moina micrura* Kurz, 1874 |
| | **Familia:** Macrothricidae | *Macrothrix laticornis* (Fischer, 1851) |
| | **Familia:** Bosminidae | *Bosmina longirostris* (Müller, 1785) |
| | **Familia:** Chydoridae<br>**Subfamilia:** Chydorinae | *Pleuroxus aduncus* (Jurine, 1820)<br>*Chydorus sphaericus* (Müller, 1776) |
| | **Subfamilia:** Aloninae | *Alona rectangula* Sars, 1862<br>*Leydigia leydigi* (Schoedler, 1863) |
| **Phylum** : Arthropoda<br>**Classis :** Maxillopoda<br>**Subclassis:** Copepoda<br>**Infraclassis:**Neocopepoda<br>**Superordo :** Podoplea<br>**Ordo :** Cyclopoida | **Familia:** Cyclopoidae<br>**Subfamilia:**Eucyclopinae | *Eucyclops speratus* (Lilljeborg, 1901) |
| | **Subfamilia:** Cyclopinae | *Cyclops vicinus* Uljanin, 1875<br>*Diacyclops bicuspidatus* (Claus, 1857)<br>*Cryptocyclops bicolor* (G.O.Sars, 1863)<br>*Mesocyclops leuckarti* (Claus, 1857)<br>*Thermocyclops crassus* (Fischer, 1853) |
| | **Familia:** Lernaeidae | *Lernaea cyprinacea* Linnaeus, 1758 |
| **Ordo:** Harpacticoida | **Familia:**Canthocamptidae | *Bryocamptus minutus* (Claus, 1863) |

According to Table 3, *Asplanchna girodi, Brachionus calyciflorus, B. angularis, Polyarthra vulgaris, Pompholyx sulcata, Bosmina longirostris* and *Leydigia leydigi* were found in every month during the sampling period. *Filinia longiseta, Hexarthra mira, Keratella cochlearis, K. tecta, Rotaria neptunia, Synchaeta* sp., *Alona rectangula, Ceriodaphnia pulchella, Diaphanosoma birgei, Moina micrura, Cyclops vicinus, Mesocyclops leuckarti* and *Thermocyclops crassus* were encountered in most of the year. On the other hand, *Brachionus quadridentatus* (May), *B. urceolaris* (March), *Cephalodella gibba* (March), *Collotheca pelagica* (July), *Trichocerca* sp. (May), *Bryocamptus minutus* (March) and *Lernaea cyprinacea* (May) was found only for 1 month (Table 3).
Also it was found that the richest months in terms of the species diversity, were March and May with each one 30 species, followed by July and June, with 23 and 22 species, respectively. However, the lowest species number was found in October with 15 species (Table 3).

Table 3. Monthly `availability` of the zooplankton species

| | 2007 | | | | | | | | | | 2008 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Rotifera** | **Mar** | **Apr** | **May** | **Jun** | **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** | **Jan** | **Feb** |
| *A. girodi* | + | + | + | + | + | + | + | + | + | + | + | + |
| *B. budapestinensis* | -- | -- | -- | -- | + | + | + | + | + | -- | -- | -- |
| *B. calyciflorus* | + | + | + | + | + | + | + | + | + | + | + | + |
| *B. quadridentatus* | -- | -- | + | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *B. angularis* | + | + | + | + | + | + | + | + | + | + | + | + |
| *B. urceolaris* | + | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *B. leydigi* | -- | -- | + | -- | -- | -- | -- | -- | -- | -- | -- | + |
| *C. gibba* | + | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *C. pelagica* | -- | -- | -- | -- | + | -- | -- | -- | -- | -- | -- | -- |
| *E. dilatata* | + | -- | + | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *F. longiseta* | + | -- | + | + | + | + | + | + | + | + | + | + |
| *F. opoliensis* | -- | -- | -- | -- | + | -- | + | + | + | -- | -- | -- |
| *H. mira* | + | -- | + | + | + | + | + | + | + | + | -- | -- |
| *K. cochlearis* | + | + | + | + | + | -- | -- | -- | + | + | + | + |
| *K. tecta* | + | + | + | + | + | + | + | -- | -- | -- | + | + |
| *K. tropica* | -- | -- | -- | + | + | + | + | -- | -- | -- | -- | -- |
| *K. quadrata* | + | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | + |
| *L. closterocerca* | -- | -- | + | -- | -- | -- | + | -- | -- | -- | -- | -- |
| *L. luna* | -- | -- | + | + | -- | -- | -- | -- | -- | -- | -- | -- |
| *N. squamula* | + | + | -- | -- | -- | -- | -- | -- | -- | -- | -- | + |
| *P. dolichoptera* | -- | -- | -- | -- | -- | -- | -- | + | + | + | + | + |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *P. vulgaris* | + | + | + | + | + | + | + | + | + | + | + | + |
| *P. sulcata* | + | + | + | + | + | + | + | + | + | + | + | + |
| *R. neptunia* | + | + | + | -- | -- | + | -- | -- | -- | + | + | + |
| *Synchaeta* sp. | + | + | + | -- | -- | -- | -- | + | + | + | + | + |
| *Trichocerca* sp. | -- | -- | + | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **Number of rotifers** | **16** | **10** | **17** | **11** | **13** | **11** | **12** | **11** | **12** | **11** | **11** | **14** |
| **Cladocera** | | | | | | | | | | | | |
| *A. rectangula* | + | + | + | + | + | -- | + | -- | -- | -- | -- | -- |
| *B. longirostris* | + | + | + | + | + | + | + | + | + | + | + | + |
| *C. pulchella* | + | + | + | + | + | + | + | + | + | + | + | -- |
| *C. sphaericus* | + | -- | + | -- | -- | -- | -- | -- | -- | -- | -- | + |
| *Daphnia* sp. | -- | -- | -- | + | + | -- | -- | -- | -- | -- | -- | -- |
| *D. birgei* | + | + | + | + | + | + | + | -- | -- | -- | + | -- |
| *L. leydigi* | + | + | + | + | + | + | + | + | + | + | + | + |
| *M. laticornis* | + | + | + | -- | + | -- | -- | -- | -- | -- | -- | -- |
| *M. micrura* | -- | -- | + | + | + | + | -- | -- | -- | + | + | -- |
| *P. aduncus* | + | -- | + | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **Number of cladocerans** | **8** | **6** | **9** | **7** | **8** | **5** | **5** | **3** | **3** | **4** | **5** | **3** |
| **Copepoda** | | | | | | | | | | | | |
| *C. vicinus* | + | + | + | + | -- | -- | -- | -- | -- | + | + | + |
| *M. leuckarti* | -- | -- | -- | + | + | + | + | -- | + | + | + | -- |
| *T. crassus* | + | -- | + | + | + | + | + | + | + | + | -- | -- |
| *E. speratus* | + | -- | + | + | -- | -- | -- | -- | -- | -- | -- | -- |
| *D. bicuspidatus* | + | -- | -- | -- | -- | -- | -- | -- | -- | -- | + | -- |
| *C. bicolar* | + | -- | -- | -- | -- | -- | -- | -- | -- | + | -- | -- |
| *L. cyprinicea* | -- | -- | + | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *B. minutus* | + | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **Number of copepods** | **6** | **1** | **4** | **4** | **2** | **2** | **2** | **1** | **2** | **4** | **3** | **1** |
| **Number of total spe.** | **30** | **17** | **30** | **22** | **23** | **18** | **19** | **15** | **17** | **19** | **19** | **18** |

+: presence of the species, --: absence of the species

Total zooplankton abundance fluctuated monthly year-around. It was the higest in the Autumn followed by the Summer and the lowest in the Winter. It was found that, the number of zooplankton reached to a maximum (total 1079779 individual $m^{-3}$) in September followed by July (888850 individual $m^{-3}$), and a minimum in December (90650 individual $m^{-3}$) (Figure 2).

It was found that, 67.83% of the total density of the zooplankton sampled from the water column of the lake was rotifers, followed by cladocerans with 23.59% and copepods with 8.57%. The results indicated that rotifers and cladocerans were abundant in Autumn and rare in Winter, and copepod was abundant in Summer and rare in Winter.

Rotifers was found mostly in September (total 696769 individual $m^{-3}$), rarely in June (total 35241 individual $m^{-3}$), cladocerans were found mostly in September (total 230368 individual $m^{-3}$) rarely in March (total 10575 individual $m^{-3}$), and copepods were found mostly in July (total 435066 individual $m^{-3}$) and rarely in December (total 8644 individual $m^{-3}$) (Figure 2).

Among the species identified in the study, *Pompholyx sulcata* from Rotifera was the most abundant species (63557 ± 76040 individual $m^{-3}$), accounted for 21.34% of total abundance, followed by *Polyarthra vulgaris* (28429 ± 29776 individual $m^{-3}$) with 9.55%, whereas the rarest species was *Lecane closterocerca* (122±424 ind.$m^{-3}$) with 0.06%. The most abundant species from Cladocera were *Leydigia leydigi* (34047±50100 individual $m^{-3}$) and *Ceriodaphnia pulchella* (24031±44582 ind.$m^{-3}$), accounted for 11.43% and 8.07% of total abundance, respectively (Table 4). But *Moina micrura* was rarely found (812 ± 1701 individual $m^{-3}$), constituting 1.16% of total abundance (Table 4). The most abundant species from Copepoda were *Thermocyclops crassus* (12571±17716 individual $m^{-3}$) and *Mesocyclops leuckarti* (7341±19363 individual $m^{-3}$), accounted for 4.22% and 2.47% of total abundance, respectively. But the

rarest species was *Criptocyclops bicolor* (1024±2624 individual $m^{-3}$), constituting 0.34% of total abundance (Table 4).

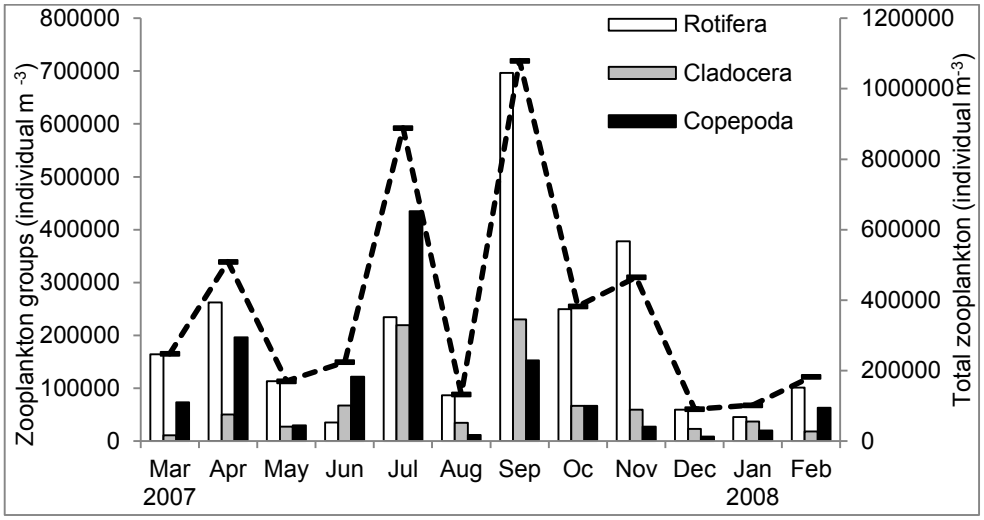



Figure 2. Monthly abundance of the zooplankton

On the other hand, *Brachionus quadridentatus, B. urceolaris, B. leydigi, Cephalodella gibba, Collotheca pelagica, Euchlanis dilatata, Keratella quadrata, Lecane luna, Notholca squamula, Polyarthra dolichoptera, Synchaeta* sp., *Trichocerca* sp., *Alona rectangula, Chydorus sphaericus, Daphnia* sp., *Macrothrix laticornis, Pleuroxus aduncus, Bryocamptus minutus, Diacyclops bicuspidatus, Eucyclops speratus* and *Lernaea cyprinacea* species were not observed in vertical samples taken for quantitative analysis.

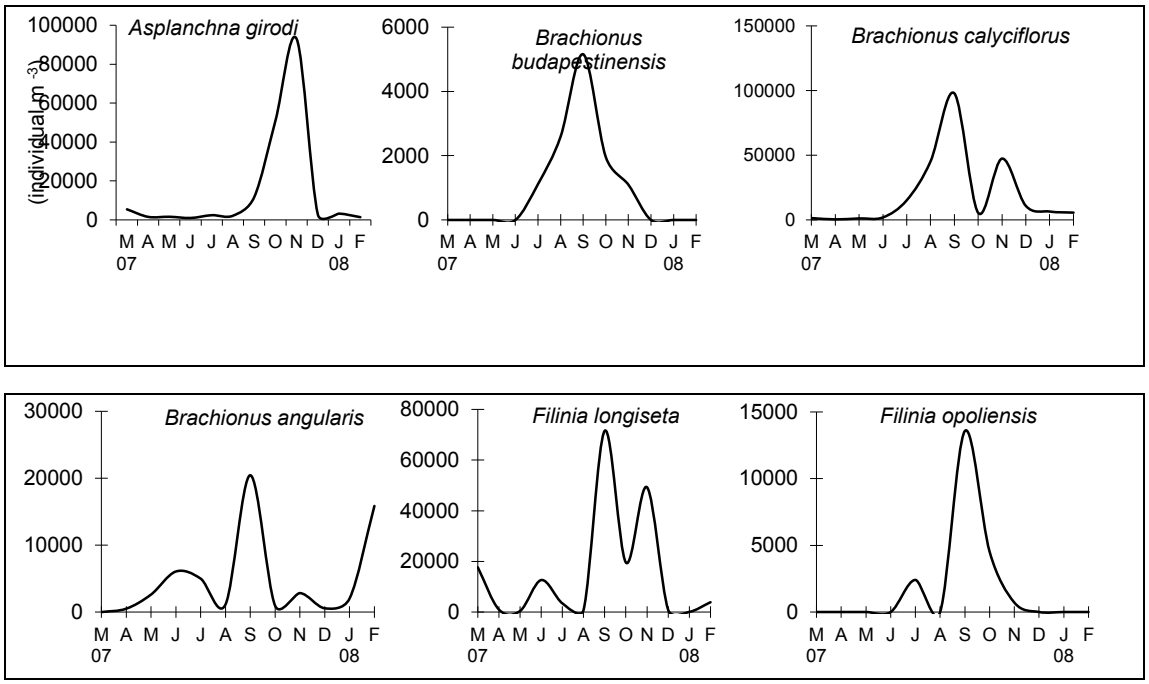
*Table 4. Annual average amounts and % distributions of the zooplankton species (individual m-3)*

| **Rotifera** | **Average (individual $m^{-3}$)** | **% Group in** | **% General** |
|---|---|---|---|
| *Asplanchna girodi* | 14726±28368 | 7.29 | 4.95 |
| *Brachionus budapestinensis* | 994±1589 | 0.49 | 0.33 |
| *B. calyciflorus* | 19865±29484 | 9.83 | 6.67 |
| *B. angularis* | 4838±6568 | 2.40 | 1.62 |
| *Filinia longiseta* | 15123±22775 | 7.49 | 5.08 |
| *F. opoliensis* | 1767±3971 | 0.87 | 0.59 |
| *Hexarthra mira* | 23139±37445 | 11.46 | 7.77 |
| *Keratella cochlearis* | 6513±13463 | 3.22 | 2.19 |
| *K. tecta* | 16042±36576 | 7.94 | 5.39 |
| *K. tropica* | 6409±12991 | 3.17 | 2.15 |
| *Lecane closterocerca* | 122±424 | 0.06 | 0.04 |
| *Polyarthra vulgaris* | 28429±29776 | 14.07 | 9.55 |
| *Pompholyx sulcata* | 63557±76040 | 31.46 | 21.34 |
| *Rotaria neptunia* | 475±983 | 0.24 | 0.16 |
| **Total** | **201998** | **100.00** | **67.83** |
| **Cladocera** | | | |
| *Bosmina longirostris* | 2470±2052 | 3.52 | 0.83 |
| *Ceriodaphnia pulchella* | 24031±44582 | 34.20 | 8.07 |
| *Diaphanosoma birgei* | 8900±16035 | 12.67 | 2.99 |
| *Leydigia leydigi* | 34047±50100 | 48.46 | 11.43 |
| *Moina micrura* | 812±1701 | 1.16 | 0.27 |
| **Total** | **70260** | **100.00** | **23.59** |
| **Copepoda** | | | |

| | | | |
|---|---|---|---|
| *Cyclops vicinus* | 4581±6421 | 17.95 | 1.54 |
| *Cryptocyclops bicolor* | 1024±2624 | 4.01 | 0.34 |
| *Mesocyclops leuckarti* | 7341±19363 | 28.77 | 2.47 |
| *Thermocyclops crassus* | 12571±17716 | 49.26 | 4.22 |
| **Total** | **25518** | **100.00** | **8.57** |
| **General total** | **297776** | **--** | **100.00** |
| **General average** | **12947±11418,61** | | |
| Naupli | 75290±99267 | 100.00 | 20.21 |

### 3.1. Succession of the Zooplankton Species

*P. vulgaris* one of the most frequently found species, was the most abundant in September, varied amounts of its abundance in March, May, July, November and February. It was found that this species is reproductive in most of the year (Figure 3). *P. sulcata, F. longiseta* and *B. angularis* were observed as the second most reproductive species. All three species were the most abundant in September, and were found to have an intensive reproductive function four times a year. *R. neptunia* was abundant in December and has intensive reproductive function for 3 times a year, though lesser in April and August; *B. calyciflorus* was abundant in August and November, *F. opoliensis* was abundant in September and July, *H. mira* was abundant in October and May, and *K. tecta* was abundant in April and September, and these had two intensive reproduction periods throughout the year (Figure 3). The other species (*A. girodi, B. budapestinensis, K. cochlearis , K. tropica* and *L. closterocerca*) were also found abundant by only one time of intensive reproduction throughout the year. Accordingly, it was identified that rotifer species was mostly reproductive in Autumn (September) and Summer (July) and least reproductive in Winter at the Tahtaköprü Dam Lake.



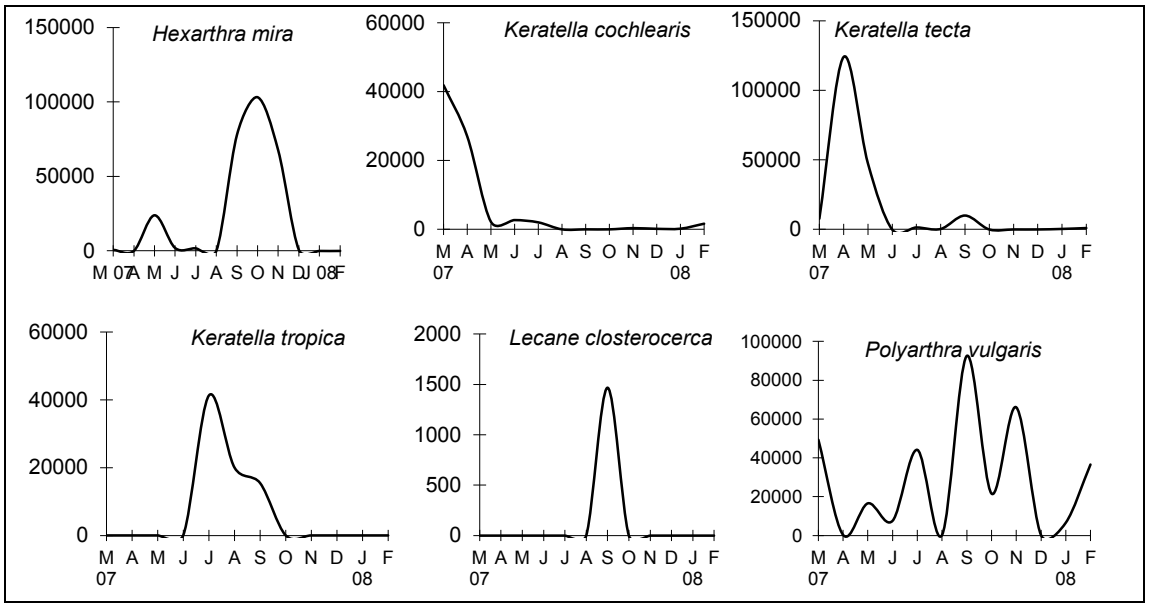



Figure 3. Annual abundance time of the rotifer species

According to Figure 4, *B. longirostris* and *L. leydigi* were the most frequently found cladoceran species, and were the most abundant in September, were abundant in April, November and January. It was observed that the species was more reproductive in the Spring and Autumn periods. *C. pulchella* and *M. micrura* were found as the second abundant species throughout the year. It was determined that both species have a higher reproduction rate three times a year. *D. birgei* has an intensive reproduction two times a year, namely in May and July (Figure 4).

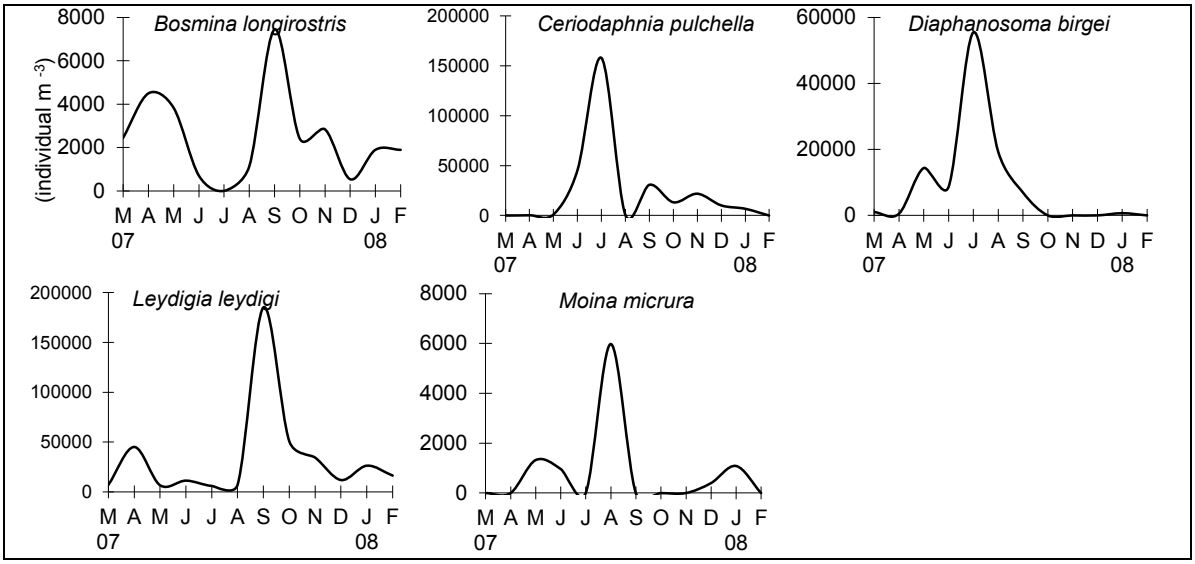



Figure 4. Annual abundance time of the cladocer species

According to Figure 5, Naupli was the most abundant throughout the year, and has been found as abundant for four times. The species being abundant for two times in the study period were *C. bicolar* (March, December), *C. vicinus* (February, April) and *T. crassus* (July, September) (Figure 5). It was determined that all three species have a higher reproduction rate two times in the study period. *M. leuckarti* had an intensive reproduction once a year, namely in June and July (Figure 5).

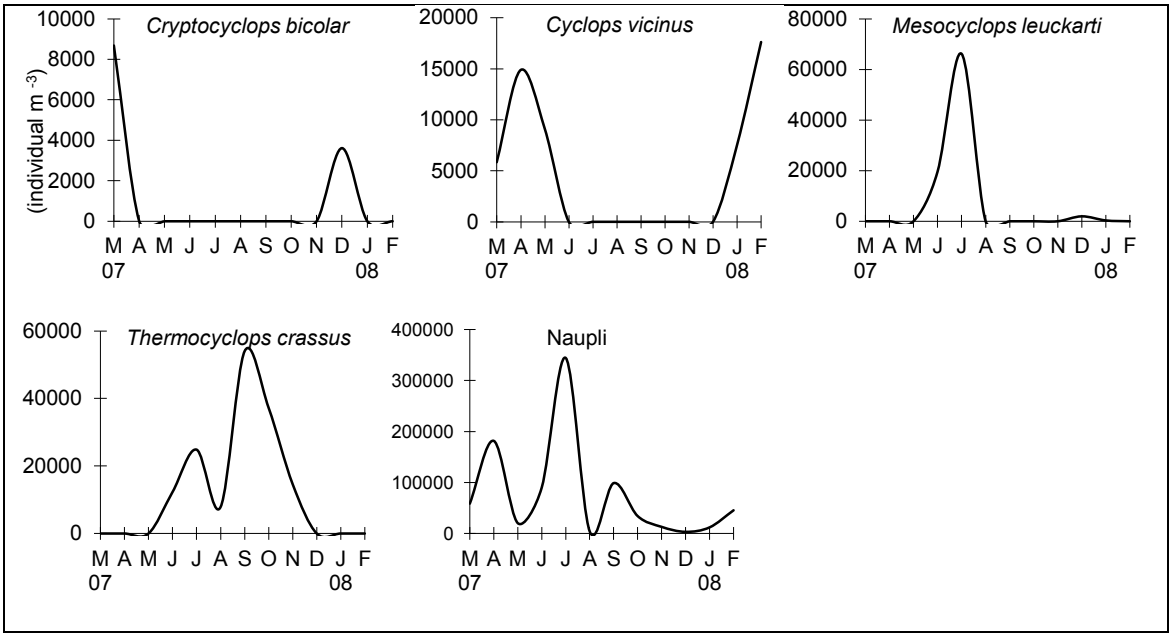



Figure 5. Annual abundance time of the copepod species

## 4. Conclusion and Discussion

In the study, a total of 44 taxons, of which 26 Rotifera (59%), 10 Cladocera (23%) and 8 Copepoda (18%) were identified in Tahtaköprü Dam Lake. It was determined that Rotifera was the dominant group of the dam lake with 67.83% of the total diversity, and followed by Cladocera with 23.59%, whereas the rarest group was Copepoda, represented with 8.57%. According to Saksena (1987), Rotifera is qualitatively and quantitatively dominant group among the zooplanktonic organism in freshwater ecosystems. The diversity and density of Rotifera group in Tahtaköprü Dam Lake confirm this view.

In Tahtaköprü Dam Lake, the zooplankton species found every month during the study were *Asplanchna girodi, Brachionus calyciflorus, Brachionus angularis, Polyarthra vulgaris*, *Pompholyx sulcata* (Rotifera), *Bosmina longirostris*, *Leydigia leydigi* (Cladocera) and naupli, and the species found in most of the year were *Filinia longiseta, Hexarthra mira, Keratella cochlearis , K. tecta, Rotaria neptunia*, *Synchaeta* sp. (Rotifera), *Alona rectangula, Ceriodaphnia pulchella, Diaphanosoma birgei*, *Moina micrura* (Cladocera), *Cyclops vicinus, Mesocyclops leuckarti* and *Thermocyclops crassus* (Copepoda).

Some of these species have also been detected in studies conducted in various freshwater reservoirs of Turkey. The species, *K. cochlearis , Polyarthra dolichoptera, Bosmina longirostris, Diaphanosoma birgei*, *C. vicinus* in Aslantas (Bozkurt, 2002), Seyhan (Bozkurt and Göksu, 1997), Kunduzlar and Çatören (Altındağ and Özkurt, 1998) and Karagöl (Ustaoğlu, 1986) reservoirs were declared each month in the course of the study.

The species detected in the study, *R. neptunia, B. quadridentatus, B. angularis, B. urceolaris, B. calyciflorus, B. budapestinensis, C. gibba, L. closterocerca, L. luna, K. cochlearis, K. quadrata, P. dolichoptera, F. longiseta, N. squamula, M. micrura, B. longirostris, A. rectangula, C. sphaericus, P. aduncus* and *M. leuckarti* were reported as the cosmopolitan species by various researchers (Hutchinson, 1967; Ruttner-Kolisko, 1974; Margalef et al., 1976; Braioni and Gelmini, 1983; Koste and Shiel, 1986, 1987; Ramdani et al., 2001). The species in Tahtaköprü Dam Lake, *B. urceolaris, B. quadridentatus, L. closterocerca* and *L. bulla* was reported as present in stagnant water and warm rivers (Ruttner-Kolisko, 1974; Braioni and Gelmini, 1983; Koste and Shiel, 1987). *K. tropica* and *K. quadrata* were reported as resistant to extreme temperature changes, abundant in Summer and found between the plants in stagnant and slow-flowing waters (Hutchinson, 1967; Braioni and Gelmini, 1983), and also it was reported that *C. vicinus* and *M. leuckarti* were found in littoral areas of lakes, rivers, marshes and small water bodies, with the preference for warm waters (Dussart, 1969).

According to Koste (1978), some of the *Brachionus* species (*B. angularis, B. falcatus, B. budapestinensis, B. calyciflorus, B. urceolaris*) are thermophilic and abundant in tropical and subtropical waters in summer, and Ruttner-Kolisko (1974) reported that stenotherm *N. squamula* is a common

cryophilic species in Alpin lakes. The findings in this study have parallels with this information in general, and the most of the species were present in the rivers and stagnant waters, and again most of them (except *N. squamula*) were thermophilic, cosmopolitan species. *Brachionus* species, in particular, were found abundant in warmer months in accordance with the reports of Koste (1978).

Edmondson (1959) has reported that *Moina* is present in the muddy murky waters mostly, and some of its species are distributed in the salty lakes, and *Daphnia* is present in clean and vegetated of the temperate waters of lakes and ponds. In our study, only single species of *Moina* and *Daphnia* genus were found in Tahtaköprü Dam Lake, which is relatively clean, fresh water, free of vegetation.

The seasonal variations in number of zooplankton species varies according to climatic conditions and regions. Namely, a study conducted by Bekleyen and Taş (2008) in Çernek Lake reports that the most abundant species were found in Spring (March, 19 species) and in Summer, and the rarest species were found in Autumn (October, 7 species); and Yiğit and Altındağ (2005) reported that the most abundant species were in Autumn (29 species), and the rarest species were in Winter (9 species); and Saler (2004) reported that the most abundant species were in Summer (13 species), and the minimum number of species were found in Winter (3 species). In our study, the most abundant species were found in Spring (March, May, 30 species) and the minimum number of species were in Autumn (October, 15 species). As can be seen, the species abundance varies depending on study environment and period, and these differences may arise from the difference in geographical area, the sampling type, frequency, and temperature and climatic differences that change from year to year.

In Tahtaköprü Dam Lake, the amount of zooplankton was the highest in Autumn (September), and the minimum in Winter (December). It was determined that the rotifers and cladocerans groups were abundant in September, and the copepod group was abundant in July. It was detected that rotifers, cladocerans and copepods were at minimum in June, March and December respectively. In addition, a structure different from our study findings has been reported in Govindgarh Lake that the zooplankton abundance was in February, and rare in June and July, and copepod group was abundant in between December and February (Matthew, 1975). Another study reports that most of the zooplankton species were quantitatively lesser in the Summer period, and higher in Autumn; and rare in Winter and abundant in Spring (Bürgi and Spaak, 2002). As a result of the studies conducted in Mert, Erikli, Hamam and Pedina Lakes, it was found that the zooplankton amount was maximum in Summer in Mert, Erikli, and Pedina lakes, and in Autumn in Hamam Lake, and minimum in Winter in all of the lakes (Güher, 2003); and in the study conducted in Sakaryabaşı Western Pond, the highest zooplankton abundance was found in July and the lowest in November (Demir and Kırkağac, 2004). These studies show that the diversity and abundance of zooplankton species changes according to the region and seasons.

Rotifera species are regarded as indicators of water quality (Sharma, 1983; Blancher, 1984; Sendacz, 1984; Herzig, 1987; Branco et al., 2002) and they play a significant role in determining the water quality (pollution, salinity, trophic status, etc.). It was declared that Rotifera react much faster to the environmental changes, in particular, compared to cladocer and copepod species, and are more sensitive indicator organisms against the changes in water quality (Gannon and Stemberger, 1978). Several studies (Sladeck, 1983; Sendacz, 1984; Herzig, 1987; Siegfried et al., 1989) indicated that the lakes with higher Rotifera density have eutrophic characteristics, and the copepod species were present more intensively in oligotrophic lakes. In Tahtaköprü Dam Lake, Rotifera group density was quite high (67.83%) compared to other groups.

In the zooplankton community studies conducted by Sendacz (1984) in 17 different water basins in Sao Poulo, located south of Brazil, the rotifer species were dominant in most of the freshwater ecosystems that have eutrophic characteristics, and this was followed by copepod species. Besides in oligotrophic water basins, cladoceran species were observed as the dominant species. The results of the study conducted by Sendacz (1984) are consistent with this study performed in Tahtaköprü Dam Lake.

As a result of the study, the efficiency of the Tahtaköprü Dam Lake was assessed. Accordingly, *B. calyciflorus, B. angularis, K. quadrata, K. tecta, E. dilatata, L. luna, C. vicinus, B. longirostris, C. sphaericus, P. sulcata, F. longiseta* identified in the study area were reported as having eutrophic characters (Rylov, 1963; Borutski, 1963; Brooks, 1971; Voigt and Koste, 1978). However, Kolisko (1974) reported that many of these species are found in the oligotrophic lakes in the temperate zone, though at minimum levels quantitatively, and the average zooplankton numbers in oligotrophic lakes were 200-500 mg $L^{-}$, and 1000-2000 mg $L^{-}$ in eutrophic lakes. On the other hand *Brachionus* and *Keratella* were reported as the always dominant rotifer species in eutrophic lakes (Tanyolaç, 1993). The samples of these two species were abundant in Tahtaköprü Dam Lake and the species reported as

predictors of eutrophication was identified; however the average amount in the reservoir (18 individual $L^{-}$ ) indicates that it is in oligotrophic lake limits.
Ostojic (2000) reported that, in Grosnica, a meso-oligotrophic lake, chlorophyll *a* was 8.7 mg $m^{-3}$, and average zooplankton was 2355 mg $L^{-}$; Vijverberg and Boersma (1997) detected that annual mean chlorophyll *a* was 225 mg $m^{-3}$, and Cladocera was 1600000 individual $m^{-3}$ in an eutrophic lake; Gulati et al. (1992) reported that the mean chlorophyll *a* concentration was 100-155 mg $m^{-3}$ in Loosdrecht eutrophic lake; and Fuentetaja et al. (2000) reported that the upper limit of chlorophyll *a* was 7.68 mg $m^{-3}$, mesotrophy limit was 35 mg $m^{-3}$ and higher in eutrophic lakes. Accordingly, Tahtaköprü Dam Lake is in oligotrophic limits in terms of the average zooplankton (297776 individual $m^{-3}$), and in mesotrophy limits in terms of the chlorophyll *a* content (55.3 mg $m^{-3}$), and it can be suggested that it has an oligomesotrophic character in terms of the mean zooplankton and chlorophyll *a* content.
The seasons have an important role in the development of zooplankton populations, zooplankton succession and nutrient cycling. Demir (2005) reported that *P. dolichoptera* and *K. quadrata* (rotifer) increase especially in Spring and in Summer. *Diaphanosoma* sp. *B. longirostris* and *Ceriodaphnia* sp. (cladocer) increase in Summer, whereas *Daphnia* sp. increase in Spring. In Tahtaköprü Dam Lake, it was determined that *K. cochlearis* and *K. tecta* have peaks in Spring, species such as *B. budapestinensis, B. calyciflorus* and *K. tropica* have peaks in Summer and Autumn, and *D. birgei* has peaks in Spring and Summer. Cyclopoid copepod *C. bicolar* and *C. vicinus* have peaks in Spring, Autumn and Winter, *T. crassus* and *M. leuckarti* have peaks in Spring, Summer and Autumn. However, *P. vulgaris, P. sulcata, F. longiseta*, *B. angularis*, *B. longirostris, C. pulchella, L. leydigi*, *M. micrura* and Naupli have peaks at various times throughout the year.
Berner-Fankhauser (1983) reported that *K. cochlearis , K. tecta, K. quadrata, P. vulgaris* were abundant and reproductive in throughout the year, *B. angularis, B. calyciflorus, N. squamula* species were reproductive in Winter and Spring, and *P. sulcata* was reproductive in Summer and Autumn. Bozkurt and Güven (2010) reported that *Rotaria neptunia, B. angularis, B. calyciflorus, F. longiseta* and *Lecane closterocerca* were reproductive and abundant throughout the year but some species were abundant and reproductive different times of the year (*K. cochlearis* and *K. quadrata* in Spring, Autumn and Winter, *K. tecta, Cyclops vicinus* in Spring and Autumn, *N. squamula, Thermocyclops crassus* in Winter and Spring, *F. opoliensis, Ceriodaphnia pulchella* in Autumn, *Moina micrura, Mesocyclops leuckarti* in Summer and Autumn, *Bosmina longirostris* in Winter, Spring and Summer).
In the study, although the findings vary slightly it has major similarities, and it was determined that *K. cochlearis* was abundant in Spring and Summer, *K. tecta* was abundant in Spring, *K. quadrata, Cyclops vicinus* was abundant in Spring and Winter, *P. sulcata, P. vulgaris, B. angularis, F. longiseta, Bosmina longirostris* was reproductive throughout the year, *B. calyciflorus, Ceriodaphnia pulchella* was abundant in Summer, Autumn and Winter, *N. squamula* was abundant in Winter, *Lecane closterocerca* was abundant in Autumn, *F. opoliensis, Thermocyclops crassus* was abundant in Summer and Autumn, *Moina micrura* was abundant in Spring, Summer and Winter, and *Mesocyclops leuckarti* was abundant and reproductive in Summer and Spring.
Succession and abundance of zooplankton depend on the temperature, amount of nutrients and fluctuation of food sources, and it was also reported that they are controlled by environmental requirements of the species and pressure of the hunters (Wiens, 1984). Since the water quality properties and the nutrient content of the water basin varies, it can be suggested that the succession and abundance of zooplankton varies accordingly as well.

**References**

Altındağ, A. & Özkurt, Ş. (1998), A study on the zooplanctonic fauna of dam lakes Kunduzlar and Çatören (Kırka-Eskişehir). Turk J Zool 22: 323-331.

Apha, (1995), Standard Methods for the Examination of Water and Wastewater, 19th edt., American Public Health Association, Washington DC USA.

Bekleyen, A. & Taş, B. (2008), Zooplankton fauna of Çernek Lake (Samsun). Ekoloji 17: 24-30.

Berner-Fankhauser, H. (1983), Abundance, dynamics and succession of planktonic rotifers in Lake Biel, Switzerland. Hydrobiologia 104: 349-352.

Blancher, E.C. (1984), Zooplankton-trophic state relationships in some north and central Florida Lakes. Hydrobiologia 109: 251-263.

Borutsky, E.V. (1964), Fauna of U.S.S.R.: Crustacea. Vol. 3, No. 4: Freshwater Harpacticoida. Israel Program for Scientific Translations, Jerusalem.

Bozkurt, A. (2002), Zooplankton of Aslantaş Dam Lake (Osmaniye). Çukurova University, Institute of Sciences, Department of Fisheries. PhD Thesis. pp. 40- 52 (in Turkish).

Bozkurt, A. & Göksu, M.Z.L. (1997), Copepoda and Cladocera (Crustacea) fauna of Seyhan Dam Lake (Adana). Biologists Association III. National Ecology and Environment Congress, Kırşehir (in Turkish).

Bozkurt, A. & Güven, S.E. (2010), Zooplankton succession of Asi River (Hatay- Turkey). Journal of FisheriesSciences.com 4: 337-353 (in Turkish).

Braioni, M.G. & Gelmini, G. (1983), Rotiferi Monogononti. Fauna d'Italia. Ed. Calderini,Bologna, pp. 140-151.

Branco, C.W.C., Rocha, M.A., Pinto, G.F.S., Gomara, G.A. & Filippo, R. (2002), Limnological features of Funil Reservoir (R.J., Brazil) and indicator properties of rotifers and cladocerans of the zooplankton community. Lakes &Reservoirs: Reserach and Management 7: 87-92.

Brooks, J.L. (1971), Eutrophication and Changes in the Composition of the Zooplankton. In Eutrophication, Causes, Consequences, Correctives. National Acad. Sci. Washington D.C.

Bürgi, H.R. & Spaak, P. (2002), Seasonal zooplankton succession and demography in a high-mountain lake. Schweizerische Zeitschrift für Hydrologie, 48: 795-809.

Damian-Georgescu, A. (1970), Copepoda Harpacticoida (forme de apa dulce). Fauna Republicii Socialiste Romania, Crustacea 4: 1-249.

Demir, N. & Kırkağaç, M.U. (2004), The effects of grass carp on aquatic plants, plankton and benthos in ponds. J Aquat Plant Manage 42: 32-39.

Demir, N. (2005), Zooplankton of Two Drinking Water Reservoirs in Central Anatolia: Composition and Seasonal Cycle (Ankara-Turkey), Turk J Zool 29: 9-16.

DSI, (1975), Tahtaköpru Dam Lake Project. General Directorate of State Hydraulic Works (In Turkish.)

Dumont, H.J. (1983), Biogeoraphy of Rotifers. Hydrobiologia 104: 19–30.

Dussart, B. (1969), Les Copepodes des Eaux Continentales d'Europe Occidentale Tale II. Cyclopoides et Biologie. N. Boubee et Cie, Paris.

Edmondson, W.T. (1959), Methots end Equiment in Freshwater Biology 2nd . John Willey and Sons. Inc., New York, 1202.

Emir, N. (1989), On Ecological Study on the Seasonal Variation of the Rotifer Species in Bafra (Samsun) Lake. Turk J Zool 13: 220-226.

Emir, N. (1994), Zooplankton Communitiy Structure of Çavuşcu and Eber Lakes in Central Anatolia. Acta Hydrochim, Hydrobiologia 22: 280-288.

Fuentetaja, A.P., McQuin, D.J., Yan, N.D. & Dillon, P.J. (2000), Zooplankton Biomass Rarely Improves Predictions of Chlorophyll Concentrations in Canadian Shield Lakes that Vary in pH. Aquatic Ecology, Netherlands, 34: 127-136.

Gannon, J.E. & Stemberger, R.S. (1978), Zooplankton (especially crustaceans and rotifers) as indicators of water quality. T Am Microsc Soc 97: 16-35.

Gulati, R.D., Ooms-Wilms, A.L., Van Tongeren, O.F.R., Postema, G. & Siewertsen, K. (1992), The dynamics and role of limnetic zooplankton in Loosdrecht lakes (The Netherlands). Hydrobiologia 233: 69-86.

Güher, H. (1999), A Taxonomic Study on Cladocera and Copepoda (Crustacea) species in Mert, Erikli, Hamam, Pedina (İğneada/Kırklareli) Lakes. Turk J Zool 23: 47-53 (in Turkish).

Güher, H. (2003), The zooplankton community structures of Mert, Erikli, Hamam and Pedina (İğneada, Kırklareli) Lakes. EU Journal of Fisheries & Aquatic Sciences 20: 51-62 (in Turkish).

Herzig, A. (1987), The analysis of Planktonic Rotifer Population: A Plea for Long-Term Investigations. Hydrobiologia 147: 163-180.

Hutchinson, G.E. (1967), A treatise on Limnology II. Introduction to lake biology and limnoplankton. John Wiley and Sons, New York, pp. 245-263.

Kiefer, F. (1978), Copepoda non-parasitica. In Illies (ed.), Limnofauna Europaea. Gustav Fischer Verlag, Stuttgart: pp. 209–223.

Kolisko, R.A. (1974), Plankton Rotifers Biology and Taxonomy. Biological Station Lunz of the Austrian Academy of Science Stutgart.

Koste, W. (1978), Die Radertiere Mitteleuropas Ein Bestimmungs werk, Begründet Von Max Voigt. Überordnung Monogononta. 2 Auflage-Neubearbeitet Von II. Tefelband. Berlin Stutgart.

Koste, W. & Shiel, R.J. (1986), Rotifera from Australian inland waters. I. Bdelloidea Rotifera: Digononta). Aust J Mar Fresh Res 37: 76-92.

Koste, W. & Shiel, R.J. (1987), Tasmanian Rotifera: affinities with the Australian fauna. Dev Hydrob 42: 3 1-43.

Margalef, R., Planas, M.D., Armengol, J., Vidal, A., Prat, N., Guiset, A., Toja, J. & Estrada, M. (1976), Limnología de los embalses españoles. Dirección General de Obras Hidráulicas. Ministerio de Obras Públicas. Publ. 123. Madrid. Pp.246- 267.

Matthew, P.M. (1975), Limnology and lake productivity of Govindgarh, Rewa Maddhy Pradesh. Jou Inl Fish Soc India 11:16-24.

Ostojic, A. (2000), Effect of Eutrophication on Changes in the Composition of Zooplankton in the Grosnica Reservoir (Serbia, Yugoslavia). Hydrobiologia 436: 171-178.

Ramdani, M., Elkhiati, N., Flower, R.J., Birks, H.H., Kraiem, M.M., Fathi, A.A. & Patrick, S.T. (2001), Open water zooplankton communities in North African wetland lakes: the CASSARINA Project. Aquat Ecol 35: 319-333.

Ruttner-Kolisko, A. (1974), Plankton Rotifers, Biology and Taxonomy. DieBinnengenwasser, Volume XXVI/I, Suplement.

Rylov, V.M. (1963), Fauna of The U.S.S.R. Crustacea. vol.III, No.3, Freshwater Cyclopoida, I.P.S.T. Jerusalem.

Saksena, D. (1987), Rotifers as indicators of water quality. Acta Hydrobiol 15: 481-485.

Saler, S. (2004), Observations on the Seasonal Variation of Rotifera Fauna of Keban Dam Lake (Çemişgezek Region) (Elazığ, Türkiye) F.Ü. Fen ve Mühendislik Bilimleri Dergisi, 16: 695-701.

Scourfield, D.J. & Harding, J.P. (1966), Fresh-Water Biology As. Sci. Publ. New York.

Segers, H. (1995), Rotifera 2: The Lecanidae (Monogononta). In: Guides to the identification of the microinvertebrates of the continental waters of the world 9 (eds. H.J.F. Dumont and T. Nogrady). SPB Academic Publishing, The Hague, the Netherlands.

Sendacz, S. (1984), A study of the zooplankton community of Billings Reservoir-Sao Paulo, Hydrobiologia 113: 121-127.

Sharma, B.K. (1983), The Indian species of the genus brachionus(Eurotatoria: Monogononta: Branhionidae), Hydrobiologia 104: 31-39.

Siegfried, C.A., Bloomfield, J.A. & Sutherland, J.W. (1989), Planktonic rotifer community structure in Adirondack, New York, USA. Lakes in relation to acidty, trophic status and related water quality characteristics, Hydrobiologia 175: 33-48.

Sladeck, V. (1983), Rotifers as indicators of water quality. Hydrobiologia 100: 169-201.

Stemberger, R.S. (1979), A Guide to Rotifers of the Laurentian Great Lakes, Environmental Monitoring and Support Laboratory Office of Research and Development, U.S. Environmental Protection Agency, EPA-600/4: 1-185.

Tanyolaç, J. (1993), Limnoloji. Hatipoğlu Yayınevi, Ankara.

Ustaoğlu, M.R. (1986), Zooplankton (Metazoa) of the Karagöl (Yamanlar- İzmirTurkey). Biologia Gallo-hellenica 12: 273-281.

Ustaoğlu, M.R. & Balık, S. (1990), Zooplankton of Lake Gebekirse (İzmir-Turkey). Rapp Comm Int Mer Medit 32: 74

Vijverberg, J. & Boersma, M. (1997), Long Term Dynamics of Small-Bodied and LargeBodied Cladocerans Durind the Eutrophication of a Shallow Reservoir, with Special Attennion for Chydorus sphaericus. Hydrobiologia 360: 233-242.

Voigt, M. & Koste, W. (1978), Rotatoria. Überordnung Monogononta. I. Textband, 650, II. Tafelband, 234, Gebrüderssontrager, Berlin.

Wiens, J. (1984), On understanding a non-equilibrium world: myth and reality in community patterns and processes. Ecological communities. conceptual issues and the evidence (ed. by D.R. Strong et al.), pp. 439-457. Princeton University Press, Princeton. Blackwell Science Ltd 1996, Journal of Biogeography, 23: 1-5

Yiğit, S. & Altındağ, A. (2005), Hirfanlı Baraj Gölü (Kırşehir, Türkiye) Zooplankton Faunası Üzerine Taksonomik Bir Çalışma. G.Ü. Fen Bilimleri Dergisi 18: 563- 567.