Turk J Zool
26 (2002) 341-348

Research Article

Seasonal Fluctuation in the Rotifer Fauna of Kesikköprü Dam Lake (Ankara, Turkey)

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Received: 11.12.2001

Abstract: The individual and seasonal variations of 11 rotifer species identified in Kesikköprü Dam Lake were investigated from April 1995 to May 1996. Species-wise percentages were *Polyarthra vulgaris* 24.5%, *Keratella quadrata* 20.8%, *Asplanchna priodonta* 16.0%, *Brachionus angularis* 11.2%, *Keratella cochlearis* 8.8%, *Synchaeta litoralis* 7.0%, *Lecane luna* 4.0%, *Notholca squamula* 3.8%, *Lepadella patella* 1.6%, *Notholca acuminata* 1.4% and *Colurella adriatica* 0.7%. Apart from two seasonal peaks in spring and autumn, some species such as *S. litoralis, L. luna, N. squamula,* and *C. adriatica* showed smaller fluctuations other than during seasonal peaks. When the annual abundance of species was taken into consideration, *P. vulgaris, K. quadrata, A. priodonta, S. litoralis* and *L. luna* were determined to be eurythermal, *B. angularis* and *K. cochlearis* hot-stenothermal, and *N. squamula* cold-stenothermal species. In addition to these, *P. vulgaris* and *A. priodonta* were determined to be perennial species for this dam's lake.

Key Words: Rotifer, Seasonal variation, Kesikköprü Dam Lake, Turkey

Kesikköprü Baraj Gölü (Ankara- Türkiye) Rotifer Faunasının Mevsimsel Değişimi

Özet: Nisan 1995, Mayıs 1996 arasında Kesikköprü baraj gölünden saptanan 11 rotifer türünün mevsimsel ve bireysel değişimi araştırılmıştır.. Rotifer türlerinin yıl boyunca gösterdiği bolluk; *Polyarthra vulgaris*% 24.5, *Keratella quadrata* % 20.8, *Asplanchna priodonta* % 16.0, *Brachionus angularis* % 11.2, *Keratella cochlearis* % 8.8, *Synchaeta litoralis* % 7.0, *Lecane luna* % 4.0, *Notholca squamula* % 3.8, *Lepadella patella* % 1.6, *Notholca acuminata* % 1.4 and *Colurella adriatica* % 0.7 olarak tespit edilmiştir. Rotifer biyomasında bahar ve sonbaharda belirgin iki mevsimsel pik saptanmıştır, ancak *S. litoralis, L. luna, N. squamula,* ve *C. adriatica* gibi bazı türlerin bu mevsimsel piklerden başka ilave pikler de verdikleri tespit edilmiştir. Türlerin yıllık bolluğu dikkate alındığında *K. quadrata, A. priodonta, S. litoralis ve L. luna'nın eurythermal, B. angularis, K. cochlearis*'in sıcak – stenotermal, *N. squamula*'nın soğuk – stenotermal türler olduğu bulunmuştur. Ayrıca, *P. vulgaris* ve *A. priodonta türlerinin* bu baraj gölünün kalıcı türleri olduğu saptanmıştır.

Anahtar Sözcükler: Rotifer, Mevsimsel değişim, Kesikköprü baraj gölü, Türkiye

Introduction

Zooplankton are the major food source of fish and other aquatic animals, and they play an important role in aquaculture. They are also a characteristic indicator of water quality, eutrophication and pollution levels (1,2). Among zooplankton, rotifers are the most important group because of their short generation time and fast population renewal (3). They respond more quickly to environmental changes than other zooplankton and appear to be sensitive indicators of changes in water quality (4). Furthermore, rotifers are one of the main biotic factors in the aquatic environment, with a major effect on the behaviour, distribution, growth, condition and larval survival rate for all species of freshwater fish (5). They play an important role as grazers, suspension feeders and predators within the zooplankton community. They also serve as an essential food source for invertebrate and vertebrate predators (6).

Turkey is rich in freshwater areas with approximately 200 natural lakes and 120 dam lakes, each with different ecological peculiarities. Several studies on rotifer fauna have been conducted in these lakes (7-16). However, no previous study on the zooplankton fauna of Kesikköprü Dam Lake has been reported. The present study was conducted to determine the seasonal variations of rotifer composition in Kesikköprü Dam Lake.

Materials and Methods

Kesikköprü Dam Lake is located 110 km south-east of Ankara, between the Kapulukaya and Hirfanlı dam lakes. Its total volume is 9500 hm^3, maximum depth 30 m, and total area 650 ha. Kesikköprü Dam Lake is 750 m above sea level and is fed by the Kızılırmak River. This study was conducted at five different stations of the lake, and the depths of the stations were as follows: 1 = 30 m, 2

= 20 m, 3 = 20 m, 4 = 20 m, and 5 = 10 m (Fig. 1). Samples were collected from each station between April 1995 and May 1996 on a monthly basis, using a 55 µ pore size Hydro-Bios Kiel plankton net while making horizontal and vertical hauls. Vertical sampling from the bottom to the surface was made at each depth of 10 m. Samples were evaluated quantitatively, and identification of the species was made for horizontally collected samples. All specimens collected were preserved in 4% formalin soon after collection. Identification of the rotifers was made according to Kolisko (17) and Koste (18). Quantitative analysis and evaluation were carried out based on Edmondson (19) and Telesh (20). During the study period water and air temperature, secchi depth, dissolved oxygen and pH were measured at all stations regularly (Table). Biometric evaluations were performed by the Chi-square method and t-tests (Microsoft Excel, two samples assuming unequal variance).

Results

Kesikköprü Dam Lake is an oligothropic lake, and its nutrient input is restricted to steppe shores (Fig.1). The temperature of this dam lake varied from 4 to 24 ºC, secchi depth 5.5 to 12 m, dissolved oxygen 8.2 to 12 mg /l, and pH 7.2 to 8.6 (Table). A total of 11 rotifer species were identified. All identified species belong to the order Ploima, and the five different families found were as follows:

Family Brachionidae
Brachionus angularis Gosse, 1851
Keratella quadrata (O.F.Müller, 1786)
Keratella cochlearis (Gosse, 1851)
Notholca acuminata (Ehrenberg, 1832)
Notholca squamula (O.F.Müller, 1786)
Family Colurellidae
Colurella adriatica Ehrenberg, 1831
Lepadella patella (O.F.Müller, 1786)
Family Lecanidae
Lecane luna (O.F.Müller, 1776)
Family Asplanchnidae
Asplanchna priodonta Gosse, 1850
Family Synchaetidae
Synchaeta litoralis Rousselet, 1902
Polyarthra vulgaris Carlin, 1943

The average individual number of all rotifer species in the lake was found to be 47940 Ind/m^3. Species-wise the percentages were as follows: *Polyarthra vulgaris* 24.5%, *Keratella quadrata* 20.8%, *Asplanchna priodonta* 16.0%, *Brachionus angularis* 11.2%, *Keratella cochlearis* 8.8%, *Synchaeta litoralis* 7.0%, *Lecane luna* 4.0%, *Notholca squamula* 3.8%, *Lepadella patella* 1.6%, *Notholca acuminata* 1.4% and *Colurella adriatica* 0.7%. Specimens were found most abundantly at station 1 (mean: 54775 Ind/m^3) and least abundantly at station 2 (mean: 39653

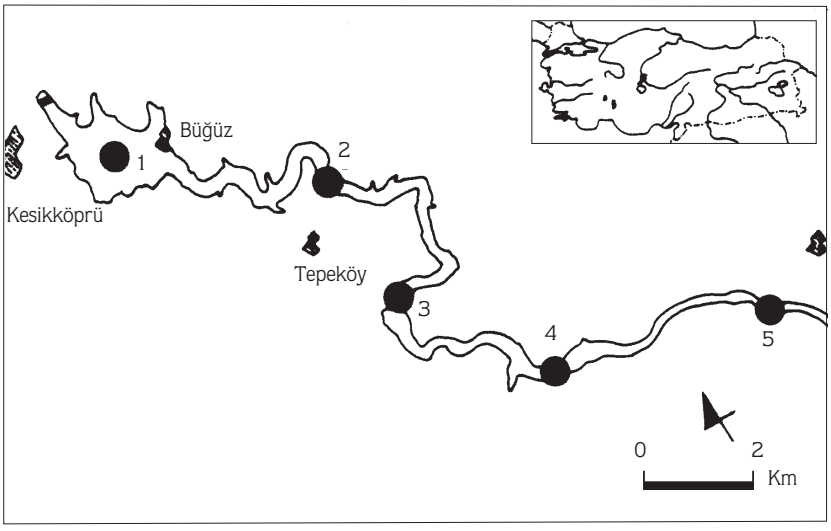


Figure 1. Map showing the locations of Kesikköprü Dam Lake and the sampling sites.

Table. The mean and minimum-maximum values of some physio-chemical parameters in five stations of Kesikköprü Dam Lake.

Months	Water temperature ºC	Air temperature ºC	Transparancy (m)	DO (mg/l)	pH
APRIL 1995	13.6	17	7	9.5	8.1
	(13-14)	(17-17)	(6-8.5)	(9-10)	(8-8.5)
MAY	17.2	21.6	6.1	9.4	8.5
	(16-19)	(21-22)	(6-7)	(9.2-10.6)	(8.2-8.8)
JUNE	19.8	23.2	7.7	8.6	7.8
	(19-21)	(22-24)	(7-8.5)	(8.4-9.1)	(7.2-8.2)
JULY	22.2	28	8.9	8.0	7.8
	(22-23)	(26-29)	(8-10)	(8-8.2)	(7.5-8.2)
AUGUST	23	27.2	9.6	8.3	8.1
	(21-24)	(27-28)	(8-10)	(8.2-8.4)	(8-8.2)
SEPTEMBER	18.4	21	7.1	8.4	8.2
	(17-19)	(20-23)	(6.5-8)	(8.2-8.6)	(7.8-8.4)
OCTOBER	14.5	16.2	6.6	8.8	8.8
	(13-16)	(15-17)	(6-7.5)	(8.4-9)	(7.8-8.4)
NOVEMBER	9.7	11.8	7.6	9.9	8.2
	(9-10)	(11-12)	(6-9)	(9.6-10.3)	(8-8.5)
DECEMBER	5.2	6.2	8.6	9.7	8.0
	(5-6)	(5-7)	(8-9.5)	(9.5-10)	(7.6-8.4)
JANUARY 1996	4	10.8	10.6	7.8	
	(4-4)	(4-5)	(9.5-12)	(9.5-12)	(7.5-8.2)
FEBRUARY	4.4	4.6	9.2	11.2	7.8
	(4-5)	(4-6)	(8.5-10)	(11-11.5)	(7.5-8.2)
MARCH	10.4	12.2	7	9.0	8.0
	(10-11)	(11-13)	(6-8)	(8.8-9.2)	(8-8.2)
APRIL	12	15	6	8.8	8.3
	(11-13)	(14-16)	(5.5-6.5)	(8.6-9)	(8-8.6)
MAY	13.8	20	8.3	8.8	7.8
	(13-15)	(19-21)	(7.5-9.5)	(8.2-9.4)	(7.5-8.2)
ANNUAL AVERAGE	13.4	16.3	7.9	9.2	8.1

Ind/m^3) for total vertical sampling. The values of abundance between the stations were found to be statistically important (Chi-square test $P < 0.01$). This difference could have originated from the increasing water current towards stations 2, 3, 4 and 5. The highest number of rotifer species (84236 Ind/m^3) was recorded in October 1995 and the lowest (12739 Ind/m^3) in February 1996. Peaks were observed in spring (April, May, June) and autumn (September, October). In contrast, the population density decreased in winter (January and February) and in summer (July and August). In addition to the significant abundance of rotifer between the stations, the seasonal abundance of rotifer biomass was significantly different (Chi-square test, $P < 0.01$), and this finding confirmed that the fluctuations of rotifer abundance depended on the season. Seasonal variations were investigated to reveal the occurrences and biomass of the rotifer species. Of the 11 species identified, seven were recorded during the year in five stations, and their individual abundances were compared by using the t-test. It was determined that individual abundances were also statistically important ($P < 0.01$) as well as the seasonal abundance of rotifer biomass. Individual abundance caused the spring and autumn peaks of rotifer biomass. Although the peaks of rotifer biomas occurred in the spring and autumn, the seasonal abundances of *S. litoralis*, *N. squamula*, and *C. adriatica* showed additional small fluctuations during the year.

Polyarthra vulgaris, the most abundant species, was usually found at a depth of 0 – 10 m at all stations, except station 5, with an average of 11623 Ind/m^3 and 24.5%. Its peak was observed in October 1995 with 21630

Ind/m^3, and the lowest number was recorded in February 1996 with 1314 Ind/m^3 (Fig. 2.a). *Keratella quadrata* was found at all stations, and was the second most abundant species, with an average of 9970 Ind/m^3 and 20.8%. The highest number of this species was recorded in April 1995 with 24642 Ind /m^3, and the lowest in January 1996 with 1314 Ind/m^3 (Fig. 2.b). *Asplanchna priodonta* was found at all stations, and is the third most abundant species with an average of 7586 Ind/m^3, and 16.0%. The peak in this species was observed in October 1995 with 25584 Ind/m^3, and the lowest number in February 1996 with 1314 Ind/m^3 (Fig. 2.c). *Brachionus angularis* was found at all stations except station 2. This species was generally observed between 10 and 20 m, and its abundance was 5313 Ind/m^3 and 11.2% (Fig. 2.d). The highest number of this species was recorded in September 1995 with 18564 Ind/m^3 and the lowest in February 1996 with 876 Ind/m^3. *Keratella cochlearis* was mostly found at a depth of 0-10 m at all stations except stations 1 and 5. *K. cochlearis* was determined to have an abundance of 4155 Ind/m^3 and 8.8%. The highest number was observed in May 1995 with 11903 Ind/m^3, and the lowest in August and November 1995 and January 1996 with 1314 Ind/m^3 (Fig. 2.e). *Synchaeta litoralis* was observed at all stations at a depth of 0 -10 m with 3337 Ind/m^3, and 7.0%. The highest number (7962 Ind/m^3) was determined in June 1995 and the lowest (1314 Ind/m^3) in December 1995 (Fig. 2.f). *Lecane luna* was found at all stations at a depth of 0 -10 m with 1911 Ind/m^3 and 4.0%. The peak (3981 Ind/m^3) was observed in June and November 1995 and the lowest number (1314 Ind/m^3) in July 1995. This species was recorded at all stations (Fig. 2.g). *Notholca squamula* was recorded at all stations except station 4. Its depth-dependent occurrence is variable among stations. Its individual number and percentage were 1817 Ind/m^3 and 3.8%, respectively. The highest number (5255 Ind/m^3) was observed in September and December 1995, and the lowest in June 1995 (1752 Ind/m^3) (Fig. 2. h). *Lepadella patella* was found only at stations 1 and 5, with 755 Ind/m^3 and at 1.6%. The highest number (5255 Ind/m^3) was noted in October 1995, and the lowest (2654

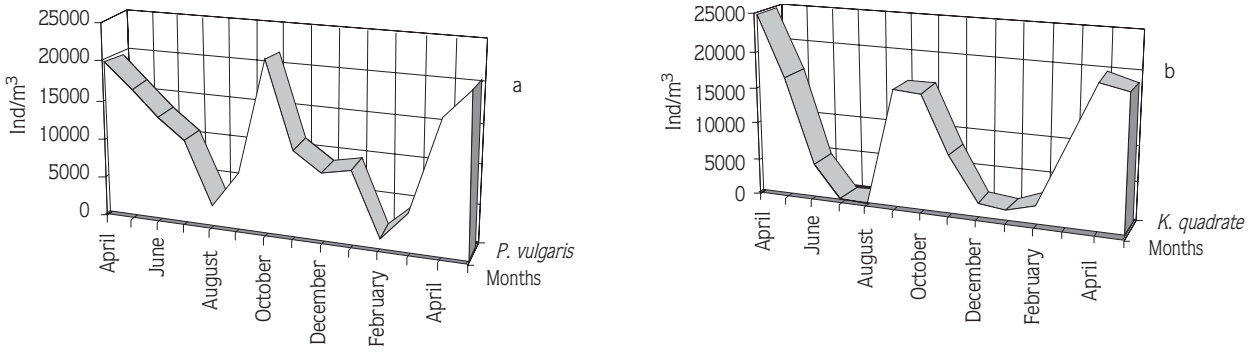


Figure 2. a, b. Mean monthly individual numbers (Ind/m^3) of rotifer species, (a) ***Polyarthra vulgaris*** and (b) ***Keratella quadrata***.

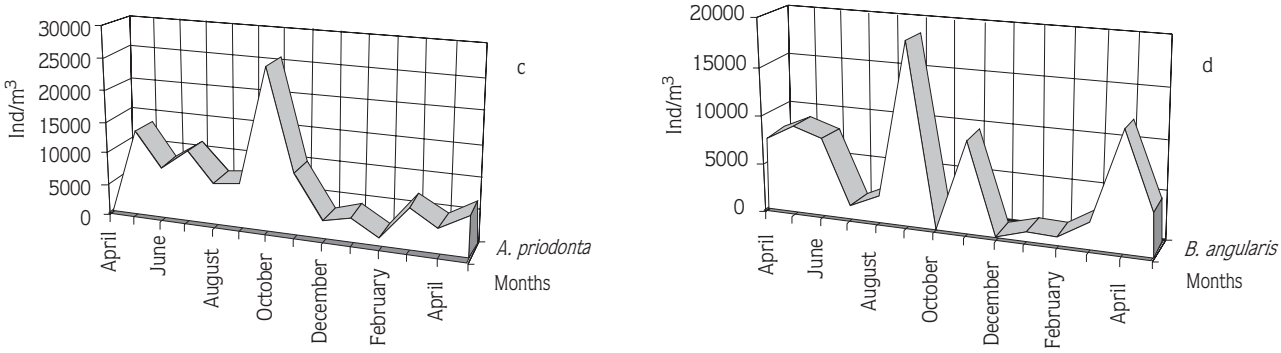
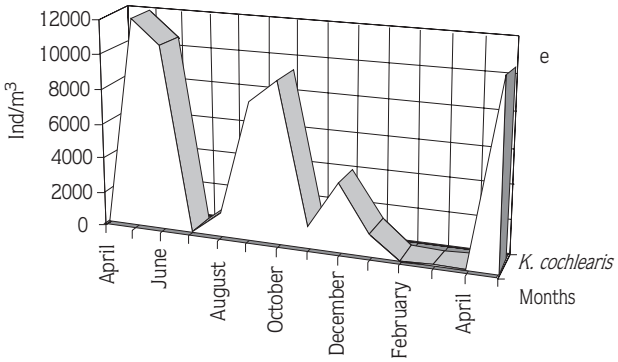


Figure 2. (c) ***Asplanchna priodonta*** and (d) ***Brachionus angularis***.



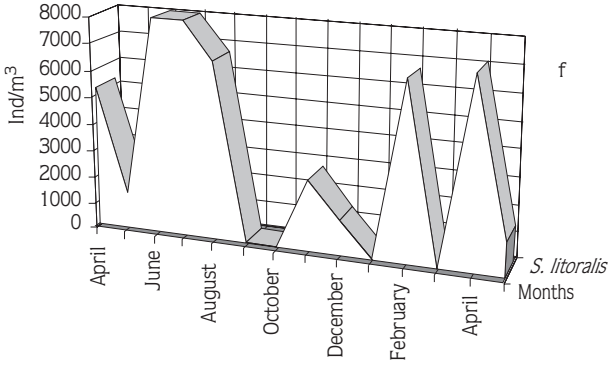
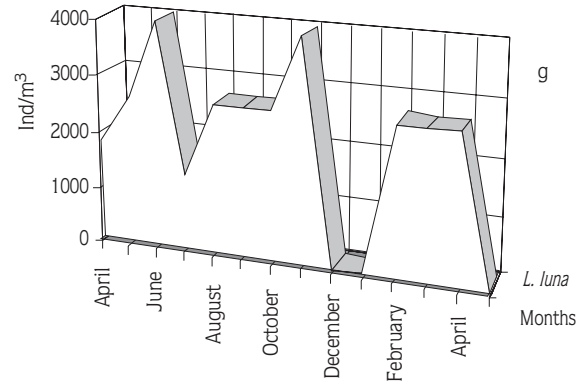


Figure 2. (e) *Keratella cochlearis* and (f) *Synchaeta litoralis*.



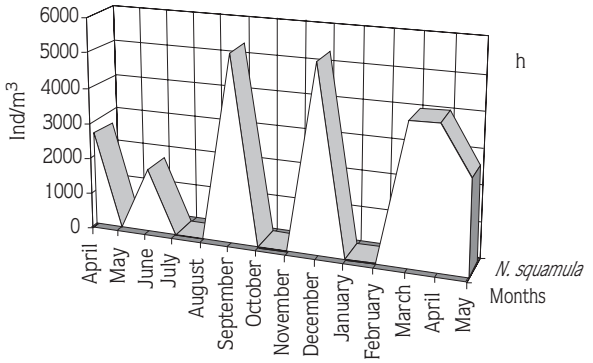


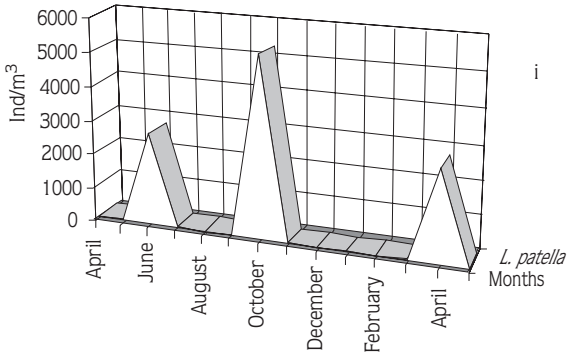
Figure 2. (g) *Lecane luna* and (h) *Notholca squamula*.

Ind/m^3) in June 1995 and April 1996 (Fig. 2.i). *Notholca acuminata* was observed at stations 3, 4 and 5. Its individual number was determined to be 657 Ind/m^3, and its percentage 1.4%. The highest number (5255 Ind/m^3) was observed in May 1996, and the lowest (1314 Ind/m^3) in November 1995 (Fig. 2.j). *Colurella adriatica* was found at all stations except stations 3 and 5 with 344 Ind/m^3 and 0.7%. The highest number of individuals of this species was recorded in April 1996 and the lowest number in August 1995 (Fig. 2.k).

When considering the percentages of the seasonal abundance of rotifer species, *K. quadrata* was found to be the most abundant species (32.5%) in spring, though its abundance markedly decreased to 4.3% in summer. *P. vulgaris* was the second most dominant species (25.6%) in summer, though its abundance slightly decreased to 22.6% in autumn. *P. vulgaris* and *K. quadrata* were also found to be the most abundant species (22.6%) in autumn. While the individual number of *K. quadrata* decreased to 10.1% in winter, the relative abundance of *P. vulgaris* continued in winter at 36.5%. As a result, it can be said that *P. vulgaris* is the most common, dominant species and has a wide ecological tolerance for adapting to the ecologic conditions of this oligotrophic dam lake. *P. vulgaris* and A. priodonta were observed throughout the year, and were determined to be perennial species. The eurythermal peculiarities of *P. vulgaris*, *K. quadrata*, A. priodonta, *S. litoralis* and L. luna were well observed in their annual abundance, but B. angularis and *K. cochlearis* seem to be a hot-stenothermal species. In addition to these, *N. squamula* gave striking autumn and winter peaks, and was classified as a cold-stenothermal species.

Discussion

According to Welch (21), it is well known that annual fluctuations occur in zooplankton biomass as well as two



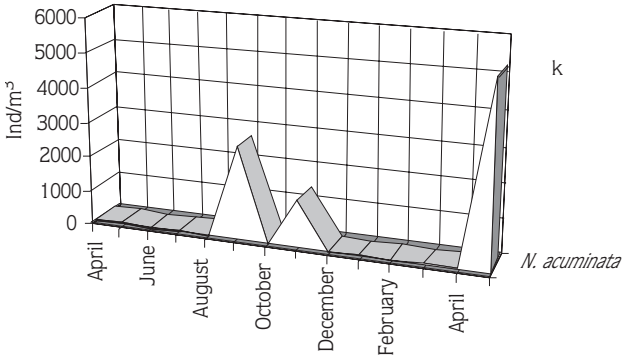


Figure 2. (i) *Lepadella patella* and (j) *Notholca acuminata*.

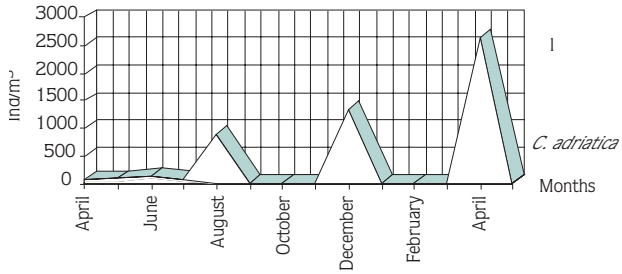


Figure 2. (k) *Colurella adriatica*.

increases, in spring and autumn, and decreases in summer and winter. A marked seasonal variation in terms of increasing rotifer biomass was recorded from April 1995 to the end of June 1995. Biomass then decreased in July and August 1995. This decline was followed by a second increase in September and October 1995, and a second decrease was noted in the winter months. The spring increase in biomass was found to be greater than the autumn increase, and the winter decrease greater than the summer one in Kesikköprü Dam Lake. Geldiay (8) reported a decrease in the density of *A. priodonta*, *K. quadrata* and *B. angularis* in February and August, and an increase beginning in March with a peak in April in Çubuk Dam Lake. He also stated that *P. vulgaris* is a permanent species in Çubuk Dam Lake throughout the year. These findings are consistent with the present study. Tokat (9) noted that *Asplanchna priodonta* was found more abundantly at a depth of 0-10 m in İznik and Sapanca lakes, reaching a maximum in autumn. The same species was similarly found to be more abundant at a depth of 10 m in Kesikköprü Dam Lake throughout the year, except in April 1995. In addition, Laxhuber (22) stated that *P. vulgaris* and *K. cochlearis* were found in their greatest numbers in the surface layers from 0 to 10 m. This finding is consistent with the present study. Lair (23) reported that Brachionus is a cosmopolitan genus living in fresh, salty and brackish waters, and has a world - wide distribution. In the present study, *B. angularis* was found to be the fourth most dominant of all identified species at Kesikköprü Dam Lake. It was recorded at all stations at a percentage of 11.2%, except station 2. *A. priodonta* reached its highest density in spring (3, 24). In addition to this, Vasconcelos (25) stated that *Polyarthra* sp., *Asplanchna priodonta* and *Keratella cochlearis* are dominant rotifer species during most of the year except for the winter months. Vasconcelos (25) also reported that *Asplanchna priodonta* and *Polyarthra* sp. reached their maximum density in spring, and thereafter declined. These findings are similar to those of the present study. However, *A. priodonta* was also found to be abundant in autumn. Laxhuber (22) noted that *P. vulgaris* and *K. cochlearis* were the most abundant species throughout the year. Berzins and Pejler (26) stated that *P. vulgaris*, *K. quadrata*, *A. priodonta*, *K. cochlearis* and *C. adriatica* are eurythermal and are the most common rotifer species during the year. These species were also the most abundant species in Kesikköprü Dam Lake. According to Berzins and Pejler (26), *B. angularis, L. patella* and *L. luna* are hot-stenothermal species but *N. squamula* is a cold-stenothermal species. May (27) also reported that *N. squamula* is a cold-stenothermal species. These findings are consistent with this study. Berzins and Pejler (28) reported that *P. vulgaris*, *A. priodonta* and *K. cochlearis* are characterized in a wide range of oxygen

concentrations. The oxygen concentrations of Kesikköprü Dam Lake ranged from 8 to 11.5 mg/l, and the occurrence of *P. vulgaris* and *A. priodonta* throughout the year could be connected with the range of oxygen concentrations in this dam lake. Spencer et al. (29) reported seasonal population peaks in rotifer density in Lake Charles East, which is a fly ash treated lake. They also reported that relatively diverse rotifer faunas were found in the spring peaks of 1975 and 1976, in contrast to those found in 1977. The present study similarly revealed that the increase in rotifer densities occurred in the spring months. Although the rotifer community seems to be very regular and predictable in terms of time of occurrence and abundance, the same cannot be said about the individual species within the community itself. Spencer et al. (29) indicated that there were population fluctuations within and between years, which is in accordance with the present study. Mengestou et al. (30) stated that most rotifer species tend to peak during July to December, when the lake is mixing. They also noted that, a few species such as *B. angularis, Lecane* sp. and *Keratella* sp. are found in large numbers during the stratifications period (January to April). *B. angularis* and *L. luna* were also found in large numbers during the same period in Kesikköprü Dam Lake. Mengestou et al. (30) also reported that the rotifer community showed a similar seasonal pattern during both years of observation, with the highest numbers occurring during July-December, moderate numbers during January-April and the lowest numbers during April-June. Unlike this, the seasonal pattern of the rotifer biomass in Kesikköprü Dam Lake was as follows: highest numbers from July to December, moderate numbers from April to June, and lowest numbers from January to April. According to Herzig (6), in water bodies of the temperate zone, seasonal changes in environmental factors result in an annual succession of rotifer species. He has described *K. quadrata*, *K. cochlearis*, *P. vulgaris* and *A. priodonta* as perennial species, but *N. acuminata* and *N. squamula* as winter species. However, he also stated that perennial species of rotifer reach peak abundance at any time of the year. *K. quadrata* and *K. cochlearis* cannot be said to be perennial species of Kesikköprü Dam Lake, as can *P. vulgaris* and *A. priodonta*, because these species were not found in all 14 months of the study. *K. quadrata* was not observed in July and August, and *K. cochlearis* in April, July, February and March. Since *N. acuminata* and *N. squamula* were not found throughout the year, they were not identified as perennial species for Kesikköprü Dam Lake.

Acknowledgements

This study was partly taken from my PhD thesis and was supported by the Research Fund of Ankara University.

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