



The Zooplankton Fauna of Yuvarlak Stream (Köyceğiz-Muğla)

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Abstract

This study aims to determine the zooplankton fauna of Yuvarlak Stream that is located at Köyceğiz-Dalyan Specially Protected Area, where the samples were collected in monthly intervals May 2001-April 2002 from 10 stations (8 in Yuvarlak Stream, 2 in Köyceğiz Lake). Plankton samples were collected horizontally by plankton net with a mesh size of 55 µm and hand net with a mesh size of 60 µm. Specimens obtained were than preserved in 4% formalin. As a result of qualitative analyses, a total of 84 taxa were identified from Yuvarlak Stream, including 53 taxa from Rotifera, 20 taxa from Cladocera and 11 taxa from Copepoda. All species are recorded for the first time from the study site, except for *Brachionus plicatilis*, *Keratella quadrata*, *Keratella cochlearis* and *Calanipeda aquaedulcis*, which were previously reported from Köyceğiz Lake.

Keywords: Rotifera, cladocera, copepoda, zooplankton, Yuvarlak Stream

Yuvarlakçay'ın (Köyceğiz-Muğla) Zooplankton Faunası

Özet

Köyceğiz - Dalyan Özel Çevre Koruma Bölgesi'nde yer alan Yuvarlak Çay'ın zooplankton faunasını belirlemek amacıyla, Mayıs 2001-Nisan 2002 tarihleri arasında, seçilen 10 istasyondan (8'i Yuvarlakçay'dan, 2'si Köyceğiz Gölü'nden) aylık periyotlarla örneklemeler yapılmıştır. Horizontal çekimlerle gerçekleştirilen örneklemelerde 60 µm. göz açıklığındaki el kepçesi ile 55 µm. göz açıklığındaki plankton kepçesi kullanılmış olup, toplanan örnekler %4 lük formolde tespit edilmiştir. Örneklerin kalitatif değerlendirilmesi sonucunda, rotiferlerden 53 takson, kladoserlerden 20 takson, kopepodlardan ise 11 takson olmak üzere toplam 84 takson saptanmıştır. Köyceğiz Gölü'nden daha önce rapor edilmiş olan *Brachionus plicatilis*, *Keratella quadrata*, *Keratella cochlearis* ve *Calanipeda aquaedulcis* dışında kalan taksonlar Yuvarlakçay ve Köyceğiz Gölü için ilk kez bildirilmektedir.

Anahtar Kelimeler: Rotifera, cladocera, copepoda, zooplankton, Yuvarlakçay.

Introduction

Zooplankton of stagnant waters has great attention by the scientists in Turkey but researches on the streams are relatively few. By these researches, the rotifer fauna of Gümüldür Stream (Ustaoglu *et al.*, 1996), the rotifer and cladoceran fauna of Seyhan Stream (Göksu *et al.*, 1997), the cladoceran and copepod fauna of Gümüldür Stream (Ustaoglu *et al.*, 1997), the zooplankton of the Streams of west Aegean Region (Balık *et al.*, 1999), the zooplankton of Gediz River Delta (Ustaoglu *et al.*, 1999), the rotifer fauna and its seasonal variations of Fırat River (Saler *et al.*, 2000), the rotifer fauna and its seasonal variations of Zikkim Stream (Saler and Şen, 2001), the rotifer

fauna of Asi River (Bozkurt *et al.*, 2002), the zooplankton fauna of some rivers in Mediterranean Region (Bozkurt, 2004), the Copepoda and Cladocera fauna of Asi River (Göksu *et al.*, 2005), the Rotifera fauna of Euphrates River basin (Akbulut and Yıldız, 2005), zooplankton structure of Karaman Stream (Altındağ *et al.*, 2009), zooplankton succession of the Asi River (Bozkurt and Güven, 2010) and Rotifera fauna of Zamanti River and Homurlu Stream (Kaya *et al.*, 2010) were determined.

In this research, we aim to identify the zooplankton fauna and its monthly composition of Yuvarlak Stream, where no previous relevant data are available.

Materials and Methods

The Yuvarlak Stream is situated at the southwestern part of Turkey, being one of the important rivers falling into Köyceğiz Lake with a length of 30 km. It is fed by Karaboğsak, Akdere and Nasıfdede Streams and drains to Köyceğiz Lake with 3.58 m³/s rate of flow. This stream contributes greatly to local tourism activities and also possesses importance in ensuring drinking and utilization water, irrigation and aquaculture. Turkey's one of the highest capacity trout production facilities, Bağcı establishment, is also located on the stream. Yuvarlak Stream has its own characteristic biological diversity, interacting with its environment both by commercial and ecological means.

Zooplankton samples were collected monthly May 2001-April 2002 from 10 stations selected from Yuvarlak Stream and Köyceğiz Lake (Figure 1, Table 1). Samples were collected using a hand net with a mesh size of 60 µm and plankton net with a mesh size of 55 µm (from 9th and 10th stations in Köyceğiz Lake). They were fixed in 4% formalin for investigation.

The taxonomical identification of species was

performed according to various publications Ruttner-Kolisko (1974), Koste (1978), Segers (1995) for rotifers; Flössner (1972), Smirnov (1974), Smirnov (1996), Korovchinsky (1992), Negrea (1983) for cladocerans; Borutski (1963), Dussart (1967), Dussart (1969), Einsle (1996), Kiefer (1978), Rylov (1963) for copepods.

During the sampling, water temperature, salinity and electrical conductivity were measured by YSI 30 conductivity meter whereas dissolved oxygen determined by WTW Oxi 330i oxygen meter and pH determined using a WTW 330 model pH meter at all stations.

Results and Discussion

It was observed that stations 5th and 6th dried between June and November. Because, the regulator on the stream in Village Beyobası was closed in June and the water was given for irrigation with one each canal, located on sides of the stream. The regulator was opened again in November and the water flow underside of the stream (station 5th and 6th).

According to the Regulation of Water Pollution and Control (RWPC) issued by the Ministry of

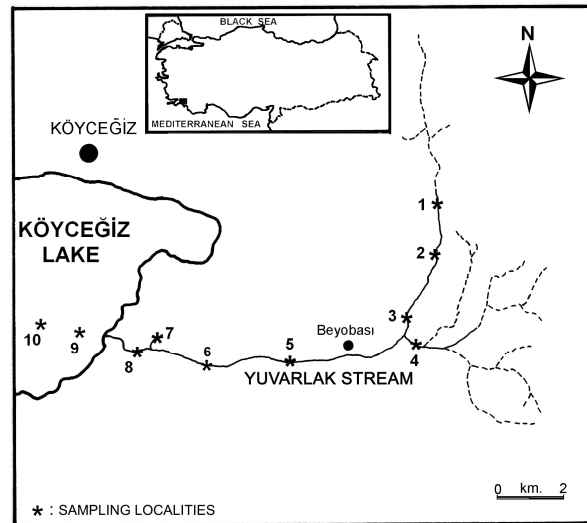


Figure 1. Study area and sampling stations.

Table 1. Sampling stations locality and coordinates

St. No	Locality	Coordinates
1	Source of Yuvarlak Stream	36° 56' 50" N 28° 48' 37" E
2	Before Trout Farm	36° 56' 19" N 28° 48' 37" E
3	After Trout Farm	36° 54' 48" N 28° 47' 53" E
4	Karaboğsak Stream	36° 54' 39" N 28° 47' 47" E
5	Beyobası Village	36° 54' 21" N 28° 45' 30" E
6	Before Nasıf Dede Stream	36° 54' 22" N 28° 43' 30" E
7	Nasıf Dede Stream	36° 54' 34" N 28° 42' 18" E
8	After Nasıf Dede Stream + Stream Mouth	36° 54' 39" N 28° 41' 31" E
9	Lake Köyceğiz + Beyond the Stream Mouth	36° 54' 36" N 28° 41' 18" E
10	Lake Köyceğiz	36° 54' 38" N 28° 41' 07" E

Environment and Forestry (Anonymous, 2004), study area was found between I-IV water quality classes (1. station I class, 2. and 4. stations I-II class; 5., 6., and 8. stations II class; 3. and 10. stations II-III class, and 9. station III-IV class) (Table 2) (Anonymous, 2002). Previous study on the water quality of Yuvarlak Stream has been reported I-III water quality classes (Kazancı and Dügel, 2000; Barlas et al., 2000).

As a result of qualitative determinations, a total of 84 taxa, 53 taxa from rotifers, 20 taxa from cladocerans and 11 taxa from copepods were identified.

While examining monthly distributions of rotifer samples collected from Yuvarlak Stream, most species were found in October (29 taxa) and the least in April 2002 (10 taxa). *E. dilatata lucksiana* and *L. patella* were present in every month. *B. calyciflorus*, *B. urceolaris*, *P. quadricornis*, *E. oropha*, *M.*

ventralis, *S. lamellaris*, *L. acuminata*, *L. imbricata*, *L. unguolata*, *L. nana*, *S. longicaudum*, *Notommata* sp., *T. tenuior*, *S. pectinata*, *S. oblonga*, *D. forcipatus* and *Conochilus* sp. were observed only in one month (Table 3).

Most cladocerans were observed during September 2001 and April 2002 (10 taxa) and the least were found on June 2001 (1 taxa). While *C. sphaericus* was dominant in every month, excluding June, *A. guttata* and *A. rectangula* were seen in 10 months. *D. lacustris*, *C. laticaudata*, *S. vetulus*, *M. micrura*, *M. brachiata*, *I. sordidus*, *P. trigonellus*, *D. rostrata* and *Leydigia* sp. were observed only in one month (Table 3).

According to the examination of monthly distributions of copepods, most taxa were found in March 2002 (6 taxa), followed by June, October, November 2001 and March 2002 (5 taxa for each).

Table 2. Mean and range of some physicochemical parameters and water quality classes at stations of Yuvarlak Stream (modified from Anonymous, 2002).

Parameters		1	2	3	4	5	6	7	8	9	10
Temperature (°C)	Min.	13.5	12.5	14.0	13.8	12.5	12.2	15.6	12.5	11.1	10.3
	Max.	14.7	15.3	20.4	18.4	20.9	25.3	21.7	23.3	28.4	28.6
	Mean	14.0	14.1	17.7	15.8	15.1	15.5	18.5	17.3	18.8	19.3
pH	Min.	6.9	7.5	7.6	7.2	7.8	7.7	7.7	7.1	7.6	7.9
	Max.	7.7	8.2	8.4	8.1	8.5	8.6	8.3	8.5	8.9	8.9
	Mean	7.3	7.8	8.1	7.7	8.2	8.2	7.9	7.9	8.2	8.4
Dissolved Oxygen (mg/L)	Min.	5.6	8.9	7.2	6.1	7.6	7.8	7.7	6.5	5.7	6.3
	Max.	8.5	11.7	10.3	9.2	11.3	10.9	12.3	10.7	11.5	12.3
	Mean	7.5	10.1	8.6	7.6	9.9	9.8	8.9	9.1	8.3	8.6
D.O. Saturation (%)	Min.	60	91	65	61	74	79	81	70	60	75
	Max.	104	106	104	89	126	125	138	113	141	132
	Mean	78	99	89	77	98	98	95	96	86	92
Conductivity (µS ₂₅ ⁻¹)	Min.	375	396	567	399	417	412	639	487	992	3495
	Max.	447	424	608	451	463	459	694	620	8440	8570
	Mean	412	406	589	414	442	441	660	552	4264	5814
Salinity (‰)	Min.	0.06	0.06	0.08	0.09	0.09	0.09	0.09	0.09	0.23	1.17
	Max.	1.17	1.17	1.17	1.17	0.15	0.20	1.17	1.17	3.74	4.40
	Mean	0.20	0.20	0.24	0.21	0.13	0.13	0.23	0.22	2.01	3.00
Water Quality Class		I	I-II	II-III	I-II	II	II	II-III	II	III-IV	II-III

Table 3. The monthly distribution of zooplankton identified from Yuvarlak Stream

Taxa	M	J	J	A	S	O	N	D	J	F	M	A
ROTIFERA												
<i>Brachionus calyciflorus</i> Pallas, 1766			+									
<i>Brachionus plicatilis</i> (O.F.Müller, 1786)		+	+	+	+	+		+	+		+	
<i>Brachionus quadridentatus</i> Hermann, 1783			+	+								
<i>Brachionus urceolaris</i> O.F.Müller, 1773			+									
<i>Cephalodella gibba</i> (Ehrenberg, 1838)				+	+	+	+	+	+	+	+	+
<i>Colurella adriatica</i> Ehrenberg, 1831		+				+	+	+	+		+	+
<i>Conochilus</i> sp.						+						
<i>Dicranophorus forcipatus</i> (O.F.Müller, 1786)					+							
<i>Euchlanis deflexa</i> (Gosse, 1851)	+						+	+	+	+		
<i>Euchlanis dilatata</i> Ehrenberg, 1832	+		+		+		+			+		
<i>E. dilatata lucksiana</i> Hauer, 1930	+	+	+	+	+	+	+	+	+	+	+	+
<i>Euchlanis incisa</i> Carlin, 1939				+	+	+	+	+	+	+	+	+
<i>Euchlanis hyra</i> Hudson, 1886				+	+	+	+	+	+	+	+	+
<i>Euchlanis oropha</i> Gosse, 1887					+							
<i>Filinia longiseta</i> (Ehrenberg, 1834)	+	+									+	+
<i>Filinia terminalis</i> (Plate, 1886)										+	+	

The least were found in May and August 2001 (2 taxa). *C. aquaedulcis* was determined for the every month during the study period, excluding May and July. *C. staphylinus* (8 months), *E. serrulatus* (8 months) and *E. sieboldi* (6 months) followed it. *B. minutus*, *E. speratus*, *M. viridis* and *P. fimbriatus* were found only in one month (Table 3).

8th station was the most rotifer species richness with 29 taxa, followed by 9th station with 28 taxa. *L. patella*, *L. closterocerca* and *C. gibba* were the common and seen in nine stations. The most cladocerans species richness station was the 10th

station with 9 taxa and only one taxon was found in 2nd station. *C. sphaericus* and *A. guttata* were observed in 8 stations, followed by *A. rectangula* and *B. longirostris*. The most copepods richness station was the 8th station (9 taxa), 3rd and 6th stations was the least species richness (Table 4).

In the other studies, 23 rotifers, 17 cladocerans and 9 copepods from Gümüldür Stream (Ustaoğlu et al., 1996); 18 rotifers and 9 cladocerans from the zone which situated in Adana country border of Seyhan River (Göksu et al., 1997); 12 rotifers, 18 cladocerans and 6 copepods from the rivers of North Aegean

Table 4. The distribution of the zooplankton identified from Yuvarlak Stream according to the stations

Taxa	1	2	3	4	5	6	7	8	9	10
ROTIFERA										
<i>Brachionus calyciflorus</i> Pallas, 1766								+		
<i>Brachionus plicatilis</i> (O.F.Müller, 1786)				+					+	+
<i>Brachionus quadridentatus</i> Hermann, 1783								+		
<i>Brachionus urceolaris</i> O.F.Müller, 1773								+		
<i>Cephalodella gibba</i> (Ehrenberg, 1838)	+	+	+	+		+	+	+	+	+
<i>Colurella adriatica</i> Ehrenberg, 1831				+		+	+	+	+	+
<i>Conochilus</i> sp.			+							
<i>Dicranophorus forcipatus</i> (O.F.Müller, 1786)								+		
<i>Euchlanis deflexa</i> (Gosse, 1851)						+		+	+	
<i>Euchlanis dilatata</i> Ehrenberg, 1832						+		+		
<i>E. dilatata lucksiana</i> Hauer, 1930			+				+		+	
<i>Euchlanis incisa</i> Carlin, 1939									+	
<i>Euchlanis lyra</i> Hudson, 1886			+		+				+	
<i>Euchlanis oropha</i> Gosse, 1887								+		
<i>Filinia longiseta</i> (Ehrenberg, 1834)	+							+	+	+
<i>Filinia terminalis</i> (Plate, 1886)										+
<i>Hexarthra fennica</i> (Levander, 1892)	+			+					+	+
<i>Keratella cochlearis</i> (Gosse, 1851)			+	+		+			+	+
<i>Keratella quadrata</i> (Müller, 1786)	+		+	+			+	+	+	+
<i>Lecane bulla</i> (Gosse, 1886)				+			+	+	+	+
<i>Lecane closterocerca</i> (Schmarda, 1859)	+		+	+	+	+	+	+	+	+
<i>Lecane flexilis</i> (Gosse, 1886)	+		+	+		+	+	+	+	+
<i>Lecane hamata</i> (Stokes, 1896)								+	+	+
<i>Lecane imbricata</i> Carlin, 1939				+					+	+
<i>Lecane luna</i> (O.F.Müller, 1776)	+		+	+	+		+	+	+	+
<i>Lecane lunaris</i> (Ehrenberg, 1832)	+		+	+	+		+	+	+	+
<i>Lecane nana</i> (Murray, 1913)			+						+	+
<i>Lecane papuana</i> (Murray, 1913)				+			+	+	+	+
<i>Lecane quadridentata</i> (Ehrenberg, 1830)	+		+					+	+	+
<i>Lecane stenroosi</i> (Meissner, 1908)					+		+	+		
<i>Lecane unguolata</i> (Gosse, 1887)								+		
<i>Lepadella acuminata</i> (Ehrenberg, 1834)			+							
<i>Lepadella ovalis</i> (O.F.Müller, 1786)			+		+		+		+	
<i>Lepadella patella</i> (O.F.Müller, 1773)	+		+	+	+	+	+	+	+	+
<i>Lophocaris salpina</i> (Ehrenberg, 1834)							+	+	+	+
<i>Monommata</i> sp.							+	+		
<i>Mytilina mucronata</i> (O.F.Müller, 1773)							+		+	
<i>Mytilina ventralis</i> (Ehrenberg, 1830)									+	
<i>M. ventralis brevispina</i> (Ehrenberg, 1830)	+		+							
<i>Notholca salina</i> Focke, 1961										+
<i>Notholca squamula</i> (O.F.Müller, 1786)									+	+
<i>Notommata</i> sp.			+	+				+		
<i>Platyas quadricornis</i> (Ehrenberg, 1832)								+		
<i>Polyarthra</i> sp.	+								+	+
<i>Scaridium longicaudum</i> (O.F.Müller, 1786)									+	
<i>Squatinella lamellaris</i> (O.F.Müller, 1786)										+
<i>Synchaeta oblonga</i> Ehrenberg, 1831									+	
<i>Synchaeta pectinata</i> Ehrenberg, 1832										+
<i>Testudinella patina</i> (Hermann, 1783)	+						+	+	+	+
<i>Trichocerca tenuior</i> (Gosse, 1886)							+			
<i>Trichotria pocillum</i> (O.F.Müller, 1776)				+			+	+		+
<i>Trichotria tetractis</i> (Ehrenberg, 1830)			+	+			+	+		+
<i>Tripleuchlanis plicata</i> (Levander, 1894)			+	+			+			

Table 4. Continued

Taxa	1	2	3	4	5	6	7	8	9	10
<i>Trichotria pocillum</i> (O.F.Müller, 1776)				+			+	+		+
<i>Trichotria tetractis</i> (Ehrenberg, 1830)			+	+			+	+		+
<i>Tripleuchlanis plicata</i> (Levander, 1894)			+	+			+			
CLADOCERA										
<i>Alona guttata</i> Sars, 1862			+	+	+	+	+	+	+	+
<i>Alona rectangula</i> Sars, 1862			+	+	+	+	+	+	+	
<i>Alonella excisa</i> (Fischer, 1854)							+	+		
<i>Alonella exigua</i> (Lilljeborg, 1853)			+				+			
<i>Biapertura affinis</i> (Leydig, 1860)			+		+	+		+		
<i>Bosmina longirostris</i> (O.F.Müller, 1785)	+	+		+			+	+	+	+
<i>Ceriodaphnia laticaudata</i> P.E.Müller, 1867									+	
<i>Ceriodaphnia quadrangula</i> (O.F.Müller, 1785)										+
<i>Ceriodaphnia reticulata</i> (Jurine, 1820)									+	+
<i>Chydorus sphaericus</i> (O.F.Müller, 1776)			+	+	+	+	+	+	+	+
<i>Diaphanosoma lacustris</i> Korinek, 1981										+
<i>Disparalona rostrata</i> (Koch, 1841)					+					
<i>Ilyocryptus sordidus</i> (Liévin, 1848)										+
<i>Leydigia</i> sp.							+			
<i>Moina brachiata</i> (Jurine, 1820)										+
<i>Moina micrura</i> Kurz, 1874										+
<i>Picripleuroxus laevis</i> (Sars, 1862)							+	+		
<i>Pleuroxus aduncus</i> (Jurine, 1820)				+		+				
<i>Pleuroxus trigonellus</i> (O.F.Müller, 1785)					+					
<i>Simocephalus vetulus</i> (O.F.Müller, 1776)	+							+		
COPEPODA										
<i>Bryocamptus minutus</i> (Claus, 1863)								+		
<i>Bryocamptus</i> sp.				+		+	+	+		
<i>Calanipeda aquaedulcis</i> Kritschagin, 1873								+	+	+
<i>Canthocamptus staphylinus</i> (Jurine, 1820)	+	+	+	+	+			+	+	+
<i>Cyclops</i> sp.				+			+	+	+	+
<i>Ergasilus sieboldi</i> Nordmann, 1832								+	+	+
<i>Eucyclops serrulatus</i> (Fischer, 1851)	+	+			+		+	+	+	+
<i>Eucyclops speratus</i> (Lilljeborg, 1901)								+	+	
<i>Megacyclops viridis</i> (Jurine, 1820)								+		
<i>Mesochra aestuarii</i> Gurney, 1921									+	+
<i>Paracyclops fimbriatus</i> (Fischer, 1853)				+						

Region (Balık *et al.*, 1999); 40 rotifers, 18 cladocerans and 23 copepods from Gediz River, excluding the fauna of Sazlıgöl Lake which situated in delta (Ustaoğlu *et al.*, 1999); 16 rotifers from Kömürhan Region of Fırat River (Saler *et al.*, 2000); 18 rotifers from Zikkım Stream (Saler and Şen, 2001); 36 rotifers from the zone which situated in Hatay country border of Asi River (Bozkurt *et al.*, 2002); 46 rotifers, 14 cladocerans and 8 copepods from some rivers in Mediterranean Region (Bozkurt, 2004); 15 cladocerans and 7 copepods from Asi River (Göksu *et al.*, 2005); 65 rotifers from Euphrates River basin (Akbulut and Yıldız, 2005); 34 rotifers, 2 cladocerans and one copepod from Karaman Stream (Altındağ *et al.*, 2009), 58 rotifers, 16 cladocerans and 15 copepods from Asi River (Bozkurt and Güven, 2010) and 35 rotifers from Zamantı River and 22 rotifers from Homurlu Stream (Kaya *et al.*, 2010) were reported.

As seen, more zooplankton species were identified in Yuvarlak Stream, when compared with other streams. One of the main causes is probably the length of study area (30 km.) and number of stations (10), which is more than the others. Although no previous study has been carried out on the zooplankton fauna of Yuvarlak Stream, there are

some researches performed by Emir (1991), Kazancı *et al.* (1992) and Buhan (1998) in Lake Köyceğiz. *B. plicatilis*, *K. quadrata* and *K. cochlearis* (Rotifera) and *C. aquaedulcis* (Copepoda) were already known from Lake Köyceğiz. Therefore, all the other taxa are recorded firstly from Yuvarlak Stream and Köyceğiz Lake.

The present survey will be useful as a baseline for future studies in streams and contributions to the knowledge of Turkey's biodiversity.

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