Turkish Journal of Zoology

Volume 29 | Number 3 Article 13

1-1-2005

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SERAY YILDIZ

AYŞE TAŞDEMİR

MURAT ÖZBEK

SÜLEYMAN BALIK

M. RUŞEN USTAOĞLU

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YILDIZ, SERAY; TAŞDEMİR, AYŞE; ÖZBEK, MURAT; BALIK, SÜLEYMAN; and USTAOĞLU, M. RUŞEN (2005) "Macrobenthic Invertebrate Fauna of Lake Eğrigöl (Gündoğmuş - Antalya)," *Turkish Journal of Zoology*: Vol. 29: No. 3, Article 13. Available at: https://journals.tubitak.gov.tr/zoology/vol29/iss3/13

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Turk J Zool
29 (2005) 275-282
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Macrobenthic Invertebrate Fauna of Lake Eğrigöl (Gündoğmuş - Antalya)

Seray YILDIZ, Ayşe TAŞDEMİR, Murat ÖZBEK, Süleyman BALIK, M. Ruşen USTAOĞLU
Department of Hydrobiology, Faculty of Fisheries, Ege University, 35100 Bornova, İzmir - TURKEY

Received: 08.06.2004

Abstract: In order to determine the macrobenthic invertebrate fauna of Lake Eğrigöl, located at 2000 m in the central Taurus Mountains, 4 field studies were conducted between June and September, 2000, and June and September, 2001.
The specimens were obtained by collection of mud samples using an Ekman-Birge grab and by sifting with a fine 500 µm sieve, and were preserved in 4% formaldehyde solution. Additional samplings were also performed from the shore with hand nets with a mesh size of 180 µm.

On average, 1036 benthic invertebrate specimens were found per square meter in Lake Eğrigöl; 939 of these specimens were oligochaets, 95 were chironomid larvae and 2 were chaoborid larvae. With regard to the rational distribution of these groups, oligochaets were the predominant group with 90.64%, followed by chironomid larvae (9.17%) and chaoborid larvae (0.19%). With regard to the rational distribution of these groups by station, Station 4 (25.90%) was the richest and Station 3 (15.05%) the poorest. Since all, the mollusk specimens from the mud samples were already dead and their shells were decalcified, mollusk species are not included in the averages. Amphipod specimens were sampled from a spring just beyond the lake, and Decapoda specimens sampled from the shore are also not included in the averages. As a result of samplings performed from each meter from the shore to 9 m in depth in the first station, the maximum number of specimens was found at the seventh meter. It was also noticed that oligochaets were abundant at the seventh and eighth meters, whereas chironomids were abundant at the second and sixth meters. The abundances of the groups in respect of months were analyzed using the chi-square test and differences between distributions of the groups according to depths were analyzed using 2-way variance analysis.

All of the determined taxa were first records from the lake. Furthermore, *Potamothrix moldaviensis* (Oligochaeta) is reported from Turkey for the first time.

Key Words: Lake Eğrigöl, Taurus Mountains, benthos, fauna, Turkey.

Eğrigöl'ün (Gündoğmuş- Antalya) Makrobentik Omurgasız Faunası

Özet: Orta Toroslarda Taşeli platosunda 2000 m rakımda bulunan Eğrigöl'ün makrobentik omurgasız faunasını belirlemek amacıyla 2000 ve 2001 yıllarında Haziran ve Eylül ayları arasında 4 kez saha çalışması gerçekleştirilmiştir.

Ekman grab ile alınan çamur örnekleri 500 µm göz açıklığındaki elekten geçirilmiş ve örnekler % 4'lük formaldehit solüsyonunda tespit edilmiştir. İlave olarak kıyıdan 180 µm göz açıklığındaki el kepçeleriyle bentik örneklemeler de yapılmıştır.

Eğrigöl'de ortalama olarak metrekarede 1036 birey tespit edilmiş olup, bunun 939 bireyi oligoket, 95 bireyi chironomid ve 2 bireyi de chaoborid larvalarıdır. Bu grupların oransal dağılımları dikkate alındığında, % 90,64 ile Oligochaeta bireylerinin en baskın grubu oluşturduğu ve bu grubu da % 9,17 ile Chironomidae ve % 0,19 ile Chaoboridae larvalarının takip ettiği görülmektedir. Tespit edilen grupların istasyonlara göre oransal dağılımları incelendiğinde, 4. istasyonun (% 25,90) en zengin, 3. istasyonun (% 15,05) en fakir istasyon olduğu dikkati çekmektedir. Mollusk grubuna ait bireylerin tümü ölü kabuklar olduğundan hesaplamalara dahil edilmemiştir. Ayrıca göl dışından bir kaynaktan elde edilen Amphipoda ve kıyıdan alınan Decapoda bireyleri de hesaplamalarda gözardı edilmiştir. 1. istasyonda kıyıdan en derin yere (9 m) kadar her metreden yapılan grab örneklemelerinin sonucunda, en fazla bireye 7. metrede rastlanmış olup, oligoketlerin 7 ve 8. metre derinliklerde, chironomid larvalarının 2 ve 6. metre derinliklerde bol bulunduğu tespit edilmiştir. Grupların aylara bağlı bolluk durumları ki-kare testi ile, derinliğe bağlı dağılımlarındaki farklılıkları ise iki yönlü varyans analizi ile tespit edilmiştir.

Tespit edilen türlerin tümü göl için ilk defa kayıt edilmiş olup, Oligochaeta grubundan *Potamothrix moldaviensis* türü Türkiye faunası için yeni kayıt niteliğindedir.

Anahtar Sözcükler: Eğrigöl, Toros Dağları, bentoz, fauna, Türkiye.

Introduction

Lakes on high mountains and glaciers are unique habitats with their faunal compositions, because they constitute isolated environments. Organisms living in such habitats are known to show some morphological differences from their relatives because of their isolation and climatic factors. Furthermore, considering the difficulty of transportation and difficult working conditions during field studies, the importance of studies on this kind of habitat can be easily understood.

There have been few studies on the benthic fauna of the lakes on the Taurus Mountains (Ustaoğlu et al., 2000; Yıldız et al., 2003; Ustaoğlu et al., 2004), and no studies have been conducted on Lake Eğrigöl.

Materials and Methods

Four field studies were conducted in July and August, 2000, and in June and September, 2001, in order to determine the macrobenthic invertebrate fauna of Lake Eğrigöl (36° 54' – 36° 56' N and 32° 12' – 32° 12' E), located at 2000 m a.s.l., with a surface area and maximum depth of 1.14 km^2 and 10 m, respectively.

Mud samples were taken with an Ekman-Birge grab (15 cm x 15 cm) from 5 stations (Figure 1). Additionally, in the first station, grab samplings were performed at 1 m intervals from the shoreline to the deepest point of the lake; samplings from the shore zone were also performed using hand nets with a mesh size of 180 µm. The specimens obtained by collection of mud samples were

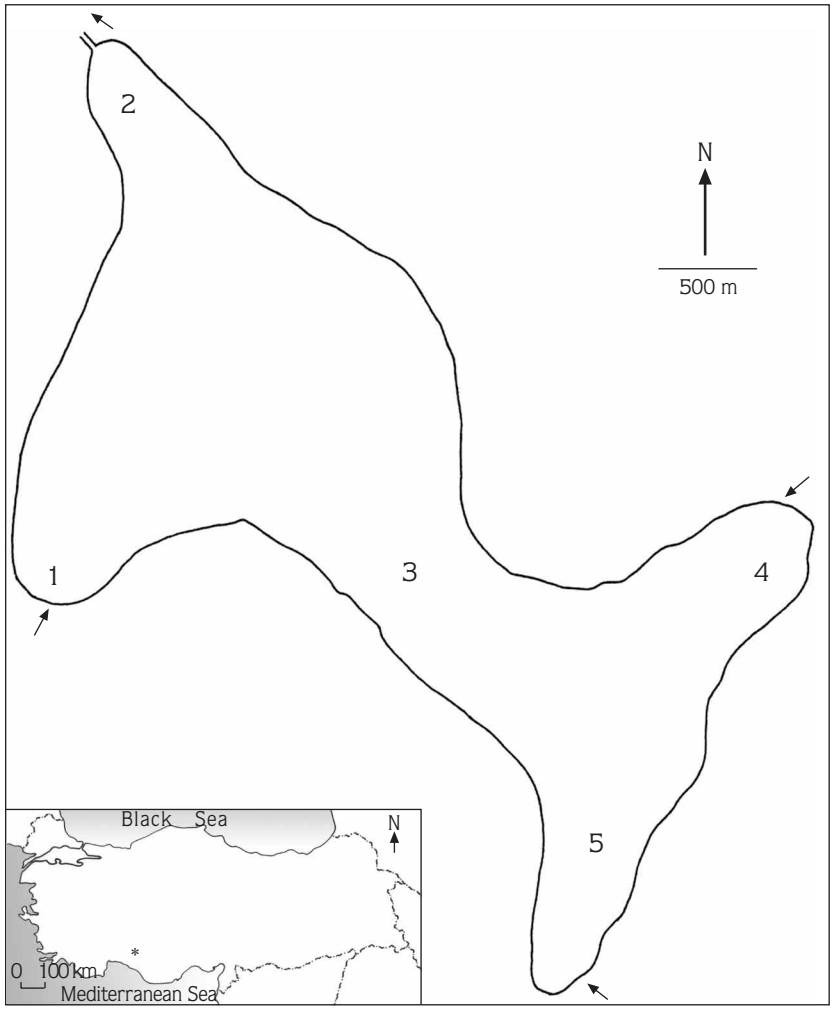

Figure 1. Sampling stations in Lake Eğrigöl.

extracted using a fine 500 µm sieve and stored in 4% formaldehyde solution.

The following references were reviewed for taxonomical determinations of the specimens:

for mollusks: Zhadin (1952), Bilgin (1980), and Glöer et al. (1987); for oligochaets: Brinkhurst (1971), Brinkhurst and Jamieson (1971), Brinkhurst and Wetzel (1984), Kathman and Brinkhurst (1988), and Milligan (1997); for amphipods: Karaman and Pinkster (1987); for decapods: Geldiay and Kocataş (1970); and for insects: Balvay (1977) and Şahin (1984, 1991).

The abundances of groups in respect of months were analyzed using the chi-square test and distributions of the groups according to depths were analyzed using 2-way analysis of variance (Elliot, 1977; Sokal and Rohlf, 1981; Clarke and Warwick, 1994; Sümbüloğlu and Sümbüloğlu, 1997).

Results

Overall, 35 taxa were determined, 20 of which belong to Oligochaeta, 10 to Diptera, 3 to Mollusca and 1 each to Decapoda and Amphipoda. Amphipod specimens were sampled from a spring just beyond the lake. No other groups were taken into account as macrozoobenthic fauna.

The distribution of zoobenthic species by stations in Lake Eğrigöl is shown in Table 1.

The highest number of taxa was found in Station 1 (Table 1). The main reason for this may be the different sampling method applied in this station, in which grab samplings were performed from the shore to a 9 m depth with 1 m intervals. Consequently, almost all of the species living in both shallow and deeper parts of the lake water were sampled by following this method. On the other hand, only the species living in deep zones could be sampled at Station 3, which is located in the middle of the lake and has a maximum depth of 9 m. Mud samples were taken from depths of 3, 6 and 9 m at Station 2, and from 3 and 6 m at Stations 4 and 5. Station 1 has a muddy bottom with well developed aquatic macrophytes, and is well suited to benthic organisms, making it the richest station. Similar ecological conditions were observed at Stations 4 and 5. At Station 2, aquatic macrophytes also exist, but the steeply deepening and sandy bottom was regarded as a limiting factor in the distribution of macrobenthic invertebrates at this station. At Station 3, no macrophyte vegetation was observed.

Regarding the abundance of the benthic organisms observed in Lake Eğrigöl, oligochaets constituted the predominant group (95.79%) in July 2000. The maximal population density of chironomid larvae was found in June, 2001, with 12.49%. Chaborid larvae were found only rarely during the study and represented 0.58% in June, 2001 (Table 2). When the abundances of groups were analyzed in respect of months, there were differences between the months ($\chi^2 \equiv 364.144 > \chi^2_{t\,3,\,0.05} = 7.82$). All the mollusk specimens from the mud samples were already dead and their shells were decalcified. Therefore, mollusk species are not included in Table 2.

Regarding the percentages of benthic groups and the partial distribution of each group, 939 of 1036 specimens belonged to Oligocheata, 95 to Chironomidae and 2 to Chaboridae (Table 3).

Nine grab samples were taken from the first station from the shore to 9 m in depth at 1 m intervals in order to determine the vertical distribution of benthic groups (Table 4). In the sample taken from 1 m, a total of 235 ind./m^2 were counted, of which 42.98% were chironomid larvae and the rest oligochaets (57.02%). On the other hand, the ratio of chironomid larvae to oligochaets in the sample taken from 9 m in depth fell to 4.01%. This implies that oligochaets were becoming the predominant benthic group as the depth increased in this lake. On the whole, the number of chironomid larvae showed 2 peaks, at 2 and 6 m. When the distributions of the groups were analyzed according to months, there was no significant difference between months ($F_{cal} = 1.698 < F_{tab} = 3.01$, $P > 0.05$). When the distributions of the groups were analyzed according to depths, there was no difference between depths ($F_{cal} = 1.186 < F_{tab} = 2.86$, $P > 0.05$). In addition, when the groups were evaluated separately, the distributions of the oligochaets being analyzed in respect of months and depths, there were no differences between months or depths (for months $F_{cal} = 1.344 < F_{tab} = 3.01$, $P > 0.05$; for depths $F_{cal} = 1.454 < F_{tab} = 2.36$, $P > 0.05$). When the distributions of the chironomids were analyzed according to depths, there were no differences between depths ($F_{cal} = 0.855 < F_{tab} = 2.36$, $P > 0.05$), but there were significant differences between months ($F_{cal} = 6.761 > F_{tab} = 3.01$, $P < 0.05$).

Table 1. Distribution of zoobenthic taxa in the stations in Lake Eğrigöl.

TAXA	1	2	3	4	5
Annelida					
Oligochaeta					
Enchytraeus sp.	+	-	-	-	-
Tubifex tubifex (Müller, 1774)	+	+	+	+	+
Tubifex tubifex f. *bergi* (Müller, 1774)	+	-	-	-	-
Tubifex montanus Kowalewski, 1919	-	+	-	-	-
Tubifex nerthus Michaelsen, 1908	-	-	-	+	-
Limnodrilus claparedeianus Ratzel, 1868	-	+	-	-	-
Limnodrilus hoffmeisteri Claparède, 1862	+	+	-	+	+
Limnodrilus hoffmeisteri f. *parvus* Southern, 1909	+	-	-	+	-
Limnodrilus profundicola (Verrill, 1871)	+	-	-	+	-
Limnodrilus udekemianus Claparède, 1862	+	-	-	+	+
Haber speciosus (Hrabe, 1931)	+	-	-	-	+
Spirosperma ferox (Eisen, 1879)	-	-	-	-	+
Potamothrix hammoniensis (Michaelsen, 1901)	+	+	+	+	+
Potamothrix moldaviensis Vejdovsky and Mrazek, 1902	+	-	-	-	-
Potamothrix bavaricus (Öschmann, 1913)	+	+	+	-	-
Potamothrix bedoti (Piguet, 1913)	+	-	-	-	-
Psammoryctides barbatus (Grube, 1861)	+	-	-	-	-
Ilyodrilus frantzi Brinkhurst, 1965	+	-	-	+	-
Ilyodrilus templetoni (Southern, 1909)	-	-	-	+	+
Dero digitata (Müller, 1773)	-	+	-	-	-
Diptera					
Chironomidae					
Tanypus punctipennis (Meigen, 1818)	-	-	-	-	+
Chironomus plumosus (Linnaeus, 1758)	+	+	+	+	+
Chironomus thummi (Kieffer, 1911)	+	-	-	-	-
Chironomus viridicollis Van Der Wulp, 1877	+	-	-	+	-
Chironomus tentans (Fabricius, 1805)	+	-	-	-	+
Polypedilum aberrans Chern., 1949					
Pentapedilum exsectum (Kieffer, 1916)	+	-	-	-	-
Polypedilum nubeculosum (Meigen, 1804)	+	-	-	-	-
Micropsectra notescens (Walker, 1856)	+	-	-	-	-
Chaoboridae					
Chaoborus flavicans (Meigen, 1830)	-	-	+	-	-
Mollusca					
Gastropoda					
Planorbis carinatus Müller, 1774	+	+	-	+	-
Sphaerium corneum (L., 1758)	+	-	-	-	-
Pisidium casertanum (Poli, 1791)	+	+	-	+	+
Crustacea					
Amphipoda					
**Gammarus longipedis* G.S. Karaman and Pinkster, 1987	-	-	-	-	-
Decapoda					
***Astacus leptodactylus salinus* Eschscholtz, 1823	-	-	-	-	-

*Sampled from a spring just beyond the lake.
**Sampled from shore zone of the lake.

Table 2. Densities of zoobenthic groups according to sampling dates and percentages (Ind.: individual).

	Chironomidae		Chaoboridae		Oligochaeta		Total
MONTHS	Ind./m^2	%	Ind./m^2	%	Ind./m^2	%	Ind./m^2
July 2000	32	4.21	-	-	728	95.79	760
August 2000	91	9.46	-	-	871	90.54	962
June 2001	194	12.49	9	0.58	1350	86.93	1553
September 2001	61	7.03	-	-	807	92.97	868
Average	95	9.17	2	0.19	939	90.64	1036

Table 3. Rational distribution of zoobenthic groups according to the stations in Lake Eğrigöl (horizontally: the number on the lower right side of each cell) and rational distribution of each group (vertically: the number on the upper left side of each cell) (Ind.: individual).

Station		Chironomidae		Chaoboridae		Oligochaeta		Total	
		%		%		%		İnd./m^2	%
1		15.18		-		65.12		204	
	%		30.17		-		69.83		19.70
2		18.71		-		6.34		182	
	%		3.30		-		96.70		17.54
3		15.63		100.00		7.19		156	
	%		4.36		1.54		94.10		15.05
4		27.49		-		10.78		268	
	%		3.80		-		96.20		25.90
5		22.99		-		10.57		226	
	%		4.42		-		95.58		21.81
Total Ind./m^2		95		2		939		1036	
	%		9.17		0.19		90.64		100.00

Table 4. Vertical distribution of benthic groups in Station 1 (Average of the 4 months; Ind.: individual).

Depth (m)	Chironomidae		Oligochaeta		Total
	Ind./m^2	%	Ind./m^2	%	Ind./m^2
1	101	42.98	134	57.02	235
2	390	44.78	481	55.22	871
3	89	22.82	301	77.18	390
4	22	7.33	278	92.67	300
5	78	26.90	212	73.10	290
6	212	19.83	857	80.17	1069
7	145	6.93	1947	93.07	2092
8	78	5.31	1391	94.69	1469
9	34	4.01	813	95.99	847

The predominance of oligochaets over chironomid larvae was remarkable when all of the samples taken from different depths of the first station were studied. The numbers of oligochaets and chironomid larvae were similar only in the samples from Station 2, but the number of chironomid larvae failed to exceed that of the oligochaets even in this station.

Morphometric, biological and ecological characteristics and the distribution of Oligochaeta species presented as a new record for the fauna of Turkey are as follows: (L: total length):

Potamothrix moldaviensis Vejdovský and Mrázek, 1902

(Figure 2)

Morphometric Characteristics: L = 25 mm. Anterior dorsal bundles with up to 9 setae, all bifid crotchets, 137.5 µm long with distal tooth longer and thinner.

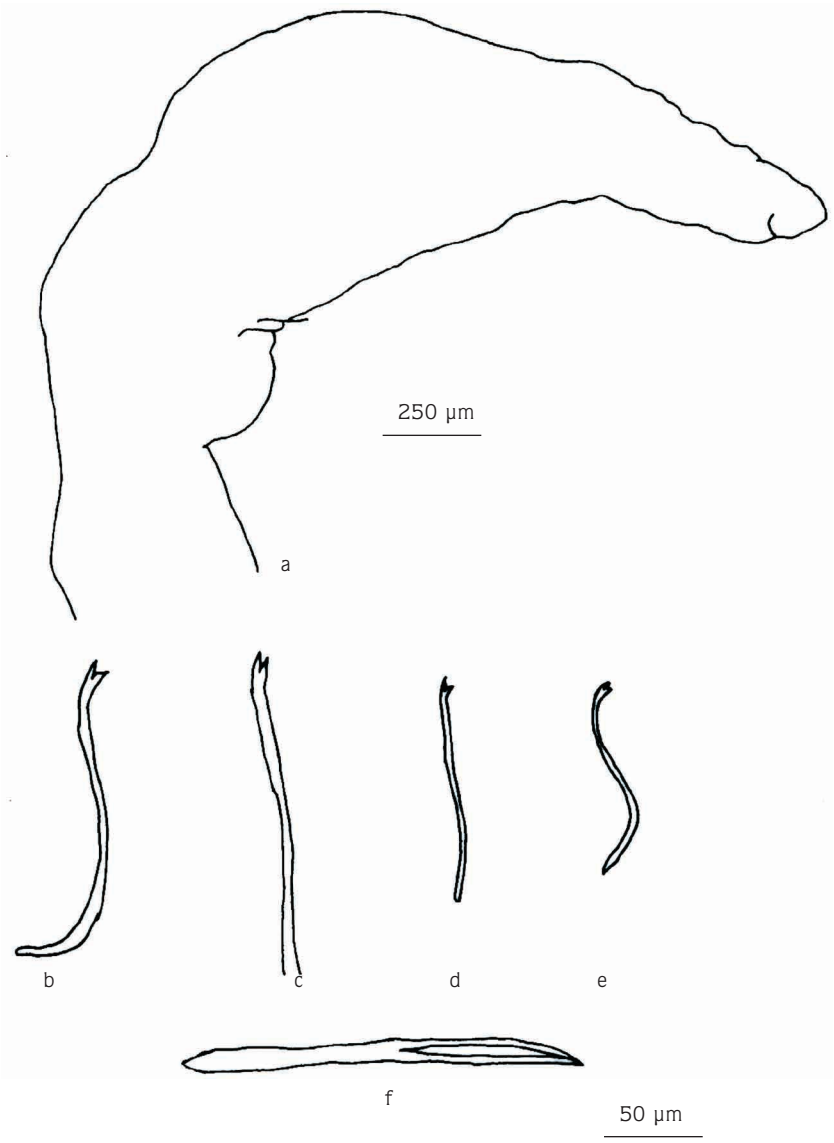

Figure 2. Some characteristics of Potamothrix moldaviensis. (a. Anterior end of body, b. Anterior dorsal setae of the species, c. Anterior ventral setae of the species, d. Posterior dorsal setae of the species, e. Posterior ventral setae of the species, f. Spermathecal setae of the species) (250 µm for a; 50 µm for b-f).

Spermathecal setae modified, 160 µm long, thick with elongate teeth forming a gutter-shaped distal end. Prostate glands absent. No chitinous penis sheaths. Spermathecae in segment 10.

World Distribution: Holarctic (Brinkhurst and Jamieson, 1971).

Ecology: Locally frequent in fresh water.

Discussion and Conclusion

A total of 35 macrobenthic invertebrate taxa were found in Lake Eğrigöl. These 35 taxa consisted of 20 Oligochaeta, 10 Diptera, 3 Mollusca and 1 each of Decapoda and Amphipoda.

Ustaoğlu et al. (2000) determined 59 taxa, consisting of 18 Oligochaeta, 17 Diptera, 4 Malacostraca and 20 Mollusca. Seven of the Oligochaeta taxa (*Tubifex tubifex* (Müller, 1774), *Tubifex montanus* Kowalewski, 1919, *Limnodrilus claparedeianus* Ratzel, 1868, *Limnodrilus udekemianus* Claparède, 1862, *Potamothrix hammoniensis* (Michaelsen, 1901), *Psammoryctides barbatus* (Grube, 1861) and *Ilyodrilus templetoni* (Southern, 1909), 6 of the Diptera taxa (Chironomus plumosus (Linnaeus, 1758), *Chironomus thummi* (Kieffer, 1911), *Chironomus tentans* (Fabricius, 1805), *Polypedilum aberrans* Chern., 1949, *Micropsectra notescens* (Walker, 1856) and *Chaoborus flavicans* (Meigen, 1830), 1 Malacostraca taxon (*Gammarus longipedis* G.S. Karaman and Pinkster, 1987), and 2 of the Mollusca taxa (*Planorbis carinatus* Müller, 1774 and *Pisidium casertanum* (Poli, 1791)) observed from that study were also recorded in our study.

All of the mollusk specimens sampled during the study were dead shells. They were already decalcified. The authors thought that they had died a few decades ago, or more. A very cold period or any other climatic factor may be one of the main reasons for this. Another possible factor supporting this probability was absence of live mollusk specimens in the littoral zone, which was a quite favorable habitat for planorbids.

The amphipod *Gammarus longipedis* was sampled from a spring just beyond the lake, but we did not find any amphipod specimens in Lake Eğrigöl. *G. longipedis* was first described by Karaman and Pinkster in 1987 from a cave called Su Çıktığı Mağarası, near Hadim. The species has been reported only from its type locality and some lakes on the Taurus Mountains range (Karaman and Pinkster, 1987; Ustaoğlu et al., 2004).

Among the oligochaets, the family Tubificidae was the predominant group during the study period. In this family, *Limnodrilus* and *Potamothrix* were the richest genera, and each was represented by 5 species. They were followed by *Tubifex*, whose members can live in both organically polluted and in oligotrophic habitats (Timm, 1970). Of the species mentioned, *L. hoffmeisteri, L. udekemianus, L. profundicola, S. ferox, T. tubifex* and *L. claparedeianus* have a cosmopolitan distribution, whereas *P. hammoniensis, P. bavaricus* and *P. moldaviensis* have a holarctic distribution. *H. speciosus, T. nerthus, T. montanus* and *P. barbatus* are distributed only in Europe (Brinkhurst and Jamieson, 1971). Among the oligochaets, *D. digitata* was the only species belonging to the Naididae. It was determined that there was a difference in the abundances of the oligochaets in respect of months. The reason for this may be predation pressure from other vertebrates and invertebrates (*Astacus leptodactylus salinus, Cyprinus carpio*, and *Carassius gibelio*) that live on oligochaets in the lake.

In addition, *P. moldaviensis* is a new record for the Turkish fauna, while all of the determined species are recorded from the lake for the first time.

When the habitats of all of the chironomid larvae found in this study were reviewed, they were found to be consistent with those in the literature. As is known, some chironomid species indicate the trophic levels of their habitats. For example, an extensive presence of *C. plumosus* and *C. thummi* in a habitat indicates pollution (Armitage, 1995).

Statistical analysis revealed a difference in the distribution of Chironomidae according to months. The reason for this may be that Lake Eğrigöl is located in high mountains. Lake water thus warms up late (in July), and because of the flying of maturing chironomids there is a significant decrease in numbers of individuals. This then results in a difference between the months.

Acknowledgements

This study was financially supported by TÜBİTAK under project TBAG-1795 (199 T 024). The authors wish to thank Prof. Dr. Tufan KORAY and Dr. Hasan M. SARI for their help in performing the statistical analysis and Dr. Cem AYGEN for his assistance during the field studies.

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