TÜBİTAK

Research Article

Turk J Zool
33 (2009) 83-88
© TÜBİTAK
doi:10.3906/zoo-0805-11

Zooplankton Composition and Abundance in Lake Eğrigöl, a High Mountain Lake (Gündoğmuş, Antalya)

Cem AYGEN, Didem ÖZDEMİR MİS, M. Ruşen USTAOĞLU, Süleyman BALIK

Department of Hydrobiology, Faculty of Fisheries, Ege University, 35100 Bornova, İzmir - TURKEY

Received: 21.05.2008

Abstract: Field studies were conducted in July and August 2000, and in June and September 2001 in order to determine the zooplankton composition and abundance of Lake Eğrigöl, a high mountain lake located 2060 m a.s.l. in the middle Taurus Mountain Range.

In total, 41 species were found, including 30 Rotifera, 8 Cladocera, and 3 Copepoda. Based on the number of species and their abundance (individuals m^{-3}), rotifers were the dominant group (49.75%-90.92%), followed by Cladocera (6.54%-27.52%), and Copepoda (2.54%-22.72%). All taxa were first records for the lake.

Key Words: High mountain lakes, zooplankton, composition, abundance, biodiversity

Yüksek Dağ Gölü Eğrigöl'ün (Gündoğmuş-Antalya) Zooplankton Kompozisyonu ve Bolluğu

Özet: Orta Toroslarda deniz seviyesinden 2060 metre yükseklikte yer alan Eğrigöl'ün zooplankton kompozisyonunun ve bolluğunun ortaya çıkarılması için Temmuz, Ağustos 2000 ve Haziran, Eylül 2001 de dört arazi çalışması düzenlenmiştir.

30 tür rotifer, 8 tür kladoser ve 3 tür kopepod olmak üzere toplam 41 tür tespit edilmiştir. Tür sayısı ve bolluk değerlerine göre Eğrigöl'de rotiferlerin baskın olduğu (%49,75 - 90,92), bunu kladoserlerin (%6,54 - 27,52), ve kopepodların (%2,54 - 22,72) izlediği anlaşılmıştır. Tespit edilen türlerin tamamı Eğrigöl'den ilk kez bildirilmektedir.

Anahtar Sözcükler: Yüksek dağ gölleri, zooplankton, kompozisyon, bolluk, biyoçeşitlilik

Introduction

Because high mountain lakes are small and their trophic webs are less complex than those of lowland lakes, they are suitable for measuring and understanding ecological processes. Often located in remote areas, high mountain lakes are also studied to investigate community structure and flow in isolation from human influence, subject only to natural forcing (such as climate variability) or to long-range human impact, such as the impact of atmospheric pollutants.

Today, the global climate is changing rapidly, possibly at a faster rate than at any time in the last 10,000 years, with surface temperatures having increased by 0.6 °C in the last century (Jones et al., 1999; Jones and Moberg, 2003). Looking towards the future it seems likely that human activity will continue to change the composition of the earth's atmosphere by producing more and more greenhouse gases.

Global warming increasingly forces species to exhibit adaptive responses. Holzapfel and Vinebrooke (2005) hypothesized that warming increases invasion of alpine lakes by low-elevation montane zooplankton, which suppresses native competitors and predators. Significant temperature-invasion interactions occur as warming

* E-mail: cemaygen@hotmail.com

suppresses alpine zooplankton, while stimulating certain introduced species. Herbivorous invaders functionally suppress similar alpine species, while larger native omnivores reduce invasions by smaller taxa (Holzapfel and Vinebrooke, 2005).

In the late 19th and early 20th centuries many high-altitude lakes in the European Alps were inventoried, and their plankton fauna and flora were described in detail. There are a number of recent studies on the zooplankton of Turkey, but almost all of these were carried out in lowland lakes. Only a few studies of high mountain lakes are available. A recent study of the mountain lakes in the Taurus Mountain Range indicates that zooplankton species diversity is very high (Ustaoğlu et al., 2005). Additionally, some rare copepod species, such as *Hemidiaptomus kummerloewei* Mann, 1940, included in the IUCN Red List of Threatened Species, only occurs in those sheltered areas.

The lack of previous studies dealing with high mountain lakes limits our ability to adequately conserve these unique environments. This paper, therefore, presents results of a study on the composition and abundance of zooplankton in the high-altitude Eğrigöl Lake collected during the ice-free periods of 2000 and 2001 in an attempt to address this gap in knowledge.

Materials and Methods

Study Area

Eğrigöl Lake (lat 36°55′51N, long 32°12′17E) is located on the Söbüçimen Plateau of Geyik Mountain at 2060 m a.s.l. (Figure 1). Its approximate surface area and maximum depth are 1.14 km^2 and 10 m, respectively. The lake's period of ice cover lasts from October or November until May or June, and its small size brings about rapid gains and heat loss. The oligotrophic and unpolluted Lake Eğrigöl is further characterized by first class water quality levels (Kaymakçı-Başaran and Egemen, 2006).

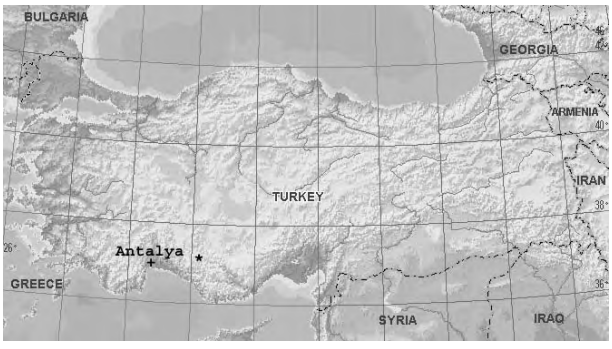

Figure 1. Star indicates the location of Lake Eğrigöl in Turkey.

Sampling and Analysis

Zooplankton samples were collected from Lake Eğrigöl during the ice-free periods of 2000 and 2001. Four field studies were conducted in July and August 2000, and in June and September 2001. The samples were collected from 5 stations (Figure 2) with a plankton net (mesh size 60 µm), taking both horizontal and vertical hauls.

In addition to these qualitative samples, quantitative samples were collected from station 3 with a Schindler water sampler. Samples were immediately preserved in 4% formalin. The following references were reviewed to identify the specimens: Collin (1961), Ruttner-Kolisko (1974), Koste (1978), Segers (1995), Flössner (1972), Negrea (1983), Korovchinsky (1992), Smirnov (1996), Dussart (1967, 1969), Kiefer (1978), and Einsle (1996). Abundance was calculated as the number of individuals per cubic meter of water sampled with a Schindler water sampler, based on total sample counts.

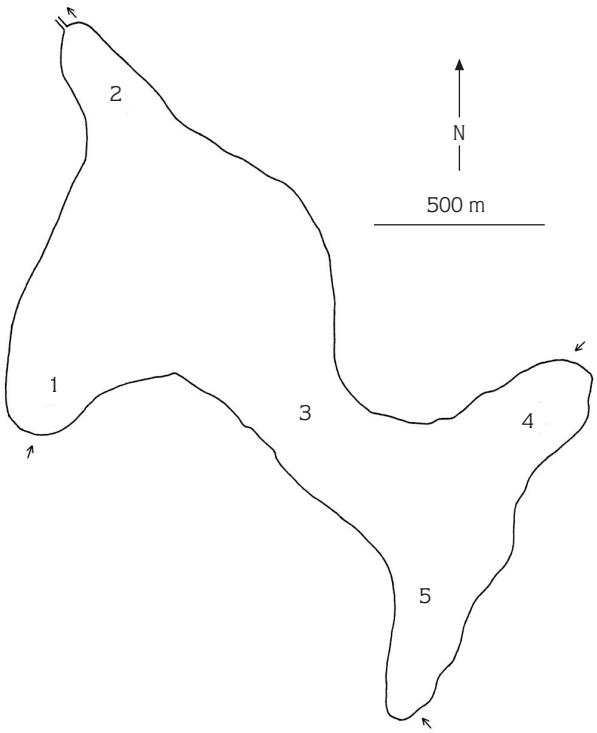

Figure 2. Sampling stations in Lake Eğrigöl.

Results

In all, 41 species were found in the lake, including 30 Rotifera, 8 Cladocera, and 3 Copepoda (Table). No study was previously carried out on the zooplankton of Lake Eğrigöl; therefore, all taxa are new records for the lake.

In July a total of 29 zooplankton taxa were recorded. The dominant rotifers in Lake Eğrigöl were *K. cochlearis, K. quadrata, L. lunaris, P. dolichoptera, A. priodonta,* and *C. dossuaris.* As for crustacean zooplankton, the cladocerans *D. longispina* and *B. longirostris*, and the copepods *A. denticornis* and *M. leuckarti* were dominant (Table). In August, 30 zooplankton taxa were recorded. The dominant zooplankton taxa in August were the rotifers *K. quadrata, L. bulla, L. lunaris, A. priodonta, T. parva,* and *C. dossuaris*, the cladocerans *D. longispina* and *B. longirostris*, and the copepods *A. denticornis, C. vicinus*, and *M. leuckarti* (Table). As shown in the Table, 28 zooplankton taxa were recorded in June. The dominant taxa during this month were the rotifers *K. cochlearis, K.*

Table. Zooplankton species found in Lake Eğrigöl during the ice-free periods of 2000-2001.

	2000										2001									
	July					August					June					September				
Stations	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Rotifera																				
Brachionus quadridentatus Hermann, 1783									+											
Keratella cochlearis (Gosse, 1851)	+	+	+	+	+			+	+	+	+	+	+	+	+	+	+	+	+	+
Keratella quadrata (O.F. Müller, 1786)	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Euchlanis dilatata Ehrenberg, 1832								+		+									+	
Euchlanis dilatata lucksiana (Hauer, 1930)					+					+		+								
Euchlanis dilatata unisetata (Leydig, 1854)						+														
Euchlanis deflexa (Gosse, 1851)			+																	
Euchlanis lyra Hudson, 1886		+																		
Mytilina ventralis (Ehrenberg, 1832)												+								
Mytilina ventralis brevispina Ehrenberg, 1832			+											+						
Lophocharis salpina (Ehrenberg, 1834)					+				+	+						+			+	
Trichotria pocillum (O.F. Müller, 1776)								+	+	+			+							
Trichotria tetractis (Ehrenberg, 1830)															+					
Colurella uncinata bicuspidata (Ehrenberg, 1832)																			+	
Colurella adriatica Ehrenberg, 1831						+		+												
Lepadella acuminata (Ehrenberg, 1834)																			+	
Lepadella ovalis (O.F. Müller, 1786)																			+	
Lecane flexilis (Gosse, 1886)		+	+	+					+		+		+	+	+					
Lecane luna (O.F. Müller, 1776)			+			+		+				+			+					
Lecane bulla (Gosse, 1886)						+	+	+	+	+										
Lecane closterocerca (Schmarda, 1859)	+	+	+		+				+		+	+	+	+						
Lecane lunaris (Ehrenberg, 1832)	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+					
Lecane stenroosi (Meissner, 1908)					+	+					+									
Polyarthra dolichoptera Idelson, 1925	+	+	+	+	+		+	+		+	+	+	+	+	+			+	+	
Asplanchna priodonta Gosse, 1850	+	+	+	+	+	+	+	+	+	+		+	+	+	+	+		+	+	+
Testudinella patina (Hermann, 1783)	+								+						+				+	
Testudinella parva (Ternetz, 1892)		+	+	+	+	+	+	+	+	+		+	+	+		+	+	+	+	+
Conochilus dossuaris (Hudson, 1914)	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+				+	+
Filinia terminalis (Plate, 1886)		+	+		+						+									
Philodina roseola Ehrenberg, 1832													+	+						
Cladocera																				
Diaphanosoma brachyurum (Lievin, 1848)					+		+	+		+						+	+	+	+	+
Daphnia longispina O.F. Müller, 1785	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Ceriodaphnia laticaudata P.E. Müller, 1867		+			+	+			+								+			
Ceriodaphnia quadrangula (O.F. Müller, 1785)		+	+	+			+	+	+	+	+	+	+		+	+	+	+	+	+
Bosmina longirostris (O.F. Müller, 1785)	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Alona guttata Sars, 1862		+	+	+	+				+		+	+	+							+
Alona rectangula Sars, 1862		+		+							+	+	+						+	
Chydorus sphaericus (O.F. Müller, 1776)			+	+	+			+			+	+		+				+		
Copepoda																				
Acanthodiaptomus denticornis (Wierzejski, 1887)	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Cyclops vicinus Uljanin, 1875					+	+	+	+	+	+	+	+	+	+	+			+		+
Mesocyclops leuckarti (Claus, 1857)	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

quadrata, L. lunaris, P. dolichoptera, and *C. dossuaris*, the cladocerans *D. longispina* and *B. longirostris*, and the copepods *A. denticornis, C. vicinus*, and *M. leuckarti* (Table). The lowest number of zooplankton was observed in September, when 23 taxa were recorded. The dominant taxa during September were the rotifers *K. cochlearis, K. quadrata,* and *T. parva*, and the cladocerans *D. brachyurum, D. longispina, C. quadrangula,* and *B. longirostris*. Of the copepods, *A. denticornis* and *M. leuckarti* were found at all the study stations.

Considering all 4 months of the study, the dominant taxa were the rotifers *K. cochlearis, K. quadrata, P. dolichoptera, A. priodonta, T. patina, T. parva*, and *C. dossuaris*, the cladocerans *D. longispina, C. quadrangula, B. longirostris, A. guttata*, and *C. sphaericus*, and the copepods *A. denticornis, C. vicinus,* and *M. leuckarti*.

Based on the number of species and density values (individuals m^{-3}), rotifers were the dominant group in the lake (49.75%-90.92%), followed by Cladocera (6.54%-27.52%), and Copepoda (2.54%-22.72%) (Figure 3). As shown in Figure 4, the dominant rotifer species were *Keratella* spp., *A. priodonta*, and *C. dossuaris*. The dominant Cladocera species were *B. longirostris* and *D. longispina* (Figure 5). As for the copepods, the dominant species was the calanoid *A. denticornis*, followed by cyclopoids (Figure 6). In Lake Eğrigöl the highest zooplankton abundance occurred in June (197,935 ind. m^{-3}). In July and August a small decrease occurred in zooplankton abundance, but in September it again increased (193,375 ind. m^{-3}).

Discussion

In the present study we have shown that the zooplankton composition in Lake Eğrigöl was quite similar to what has been reported for lakes in adjacent areas by Ustaoğlu et al. (2005). Ten Rotifera taxa out of 30 were not previously reported by that author; these were *E. dilatata unisetata*, *E. deflexa*, *E. lyra*, *C. uncinata bicuspidata*, *L. acuminata*, *P. dolichoptera*, *T. parva*, *C.*

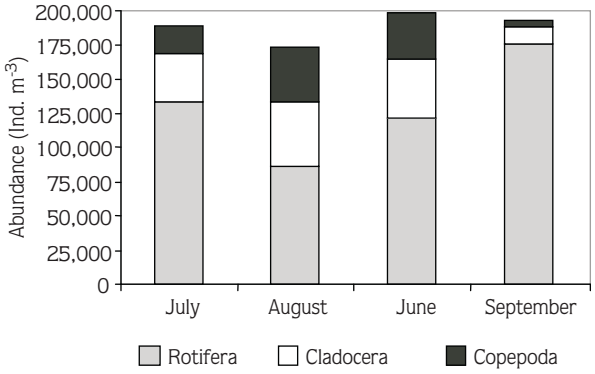

Figure 3. Variation in total zooplankton abundance in Lake Eğrigöl during the sampling period.

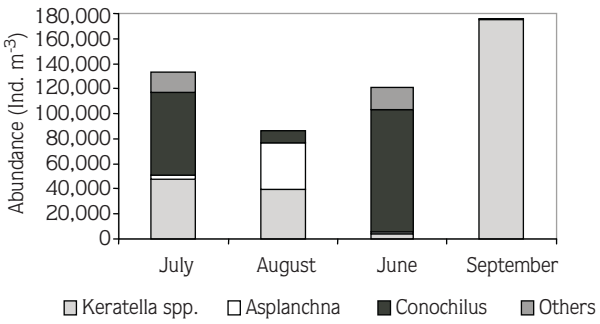

Figure 4. Variation in Rotifera abundance in Lake Eğrigöl during the sampling period.

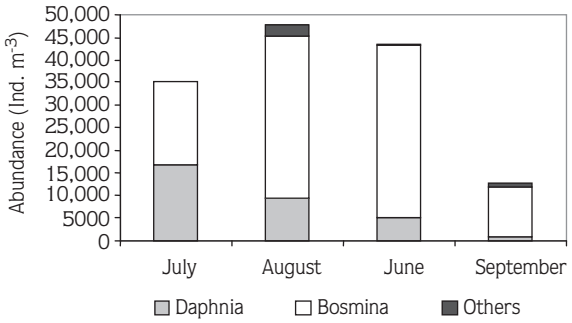

Figure 5. Variation in Cladocera abundance in Lake Eğrigöl during the sampling period.

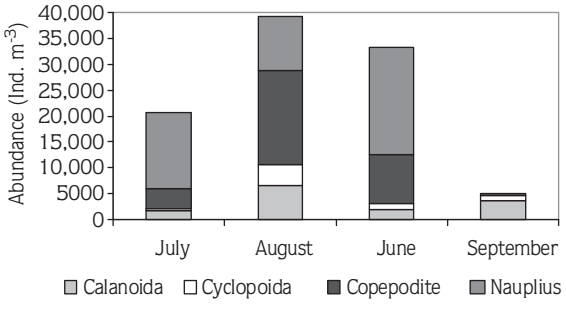

Figure 6. Variation in Copepoda abundance in Lake Eğrigöl during the sampling period.

dossuaris, *F. terminalis*, and *P. roseola*. According to previous studies, rotifers are more sensitive to environmental change than cladocerans and copepods, and are known to be characteristic indicators of water quality (Gannon and Stemberger, 1978). Additionally, they are indicators of saprobity (Sladecek, 1983). Xenosaprobic and oligosaprobic rotifers are considered indicators of oligotrophic conditions, and beta-mesosaprobic and alpha-mesosaprobic rotifers as indicators of eutrophy. In Lake Eğrigöl, 7 oligosaprobic, 17 oligo-mesosaprobic, and 4 beta-mesosaprobic rotifer taxa were found. When the composition of rotifers is considered, Lake Eğrigöl can be classified as an oligo-mesotrophic lake due to the majority of oligosaprobic and oligo-mesosaprobic taxa. Regarding cladoceran abundance, *B. longirostris* and *D. longispina* were the dominant species in the lake; however, these species are generally found in eutrophic lakes (Berzins and Bertilson, 1989). On the other hand, the composition and abundance of copepods again indicates that the trophic level of Lake Eğrigöl is oligo-mesotrophic. Maier (1996) reported that calanoid copepods were predominant in oligo-mesotrophic lakes and that eutrophication increased the dominancy of cyclopoid copepods. Among the cyclopoid copepods, while *M. leuckarti* prefers oligo-mesotrophic conditions, *C. vicinus* prefers eutrophic conditions. Kaymakçı-Başaran and Egemen (2006) reported that the trophic level of Lake Eğrigöl was oligotrophic, but the total composition and abundance of the zooplankton indicates an oligo-mesotrophic state.

In conclusion, the high mountain Lake Eğrigöl can be characterized as rich in zooplankton. High mountain lakes such as Eğrigöl are useful as potential reference sites for monitoring the effects of global climatic change and atmospheric pollution. Unfortunately, the lack of previous information about the high mountain lakes of Turkey limits our current ability to monitor change. The present survey will be useful as a baseline for future studies and contributions to the knowledge of Turkey's biodiversity.

Acknowledgements

This study was financially supported by TÜBİTAK project TBAG-1795 (199T024).

References

Berzins, B. and Bertilson, J. 1989. On limnic micro-crustacean and trophic degree. Hydrobiologia 185: 95-100.

Collin, A. 1961. Rotatoria und Gastrotricha. In: Die Süsswasserfauna Deutschlands. Heft 14, 273pp.

Dussart, B. 1967. Les Copépodes des eaux Continentales d'Europe Occidentale. Tome I, Calanoides et Harpacticoides. N. Boubee et cie, Paris, 500 pp.

Dussart, B. 1969. Les Copépodes des eaux Continentales d'Europe Occidentale. Tome II, Cyclopoides et Biologie. N. Boubee et cie, Paris, 292pp.

Einsle, U. 1996. Copepoda: Cyclopoida, Genera Cyclops, Megacyclops, Acanthocyclops. Guides to the Identification of the Microinvertebrates of the Continental Waters of the World No.10. SPB Academic Publishing bv, 82pp.

Flössner, D. 1972. Krebstiere, Crustacea. Kiemen und Blattfüsser, Branchiopoda, Fischlause, Branchiura., Tierwelt Deutschlands, 60. Teil, Veb Gustav Fischer Verlag, Jena, 501 pp.

Gannon, J.E. and Stemberger, R.S. 1978. Zooplankton (especially crustaceans and rotifers) as indicators of water quality. Trans. Amer. Micros. Soc. 97: 16-35.

Holzapfel, A.M. and Vinebrooke, R.D. 2005. Environmental warming increases invasion potential of Alpine lake communities by imported species. Global Change Biology, 11: 2009-2015.

Jones, P.D. and Moberg, A. 2003. Hemispheric and large-scale surface air temperature variations: An extensive revision and an update to 2001. Journal of Climate, 16: 206-223.

Jones, P.D., New, M., Parker, D.E., Martin, S. and Rigor, I.G. 1999. Surface air temperature and its changes in 150 years. Reviews of Geophysics, 37, 2: 173-199.

Kaymakçı-Başaran, A. and Egemen, Ö. 2006. Orta Toros dağlarındaki Eğrigöl'ün su kalitesi parametrelerinin araştırılması. Tarım Bilimleri Dergisi, 12: 137-143.

Kiefer, F. 1978. Das Zooplankton der Binnengewasser 2. Teil. Freilebende Copepoda. Die Binnengewasser Band XXVI E.Schweizerbart'sche Verlagsbuchhandlung, Stuttgart, 315 pp.

Korovchinsky, N.M. 1992. Sididae and Holopediidae (Crustacea: Daphniiformes). Guides to the Identification of the Microinvertebrates of the Continental Waters of the Waters. SPB Academic Publishing bv, 82 pp.

Koste, W. 1978. Rotatoria. Überordnung Monogononta. I. Textband, pp: 650, II. Tafelband, 234 pp, Gebrüders Bornträger, Berlin.

Maier, G. 1996. Copepod communities in lakes of varying trophic degree. Arch. Hydrobiol. 136: 455-465.

Negrea, S.T. 1983. Fauna Republicii Socialiste Romania Vol. 4, 12. Crustacea Cladocera. Academia Republici Socialiste Romania, Bucaresti, 339 pp.

Ruttner-Kolisko, A. 1974. Plankton Rotifers, Biology and Taxonomy. Die Binnengewasser, Vol. XXVI/I, Suppl., 146 pp.

Segers, H. 1995. Rotifera. Vol. 2: The Lecanidae (Monogononta). Guides to the Identification of the Microinvertebrates of the Continental Waters of the World. SPB Academic Publishing bv., 226pp.

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

Smirnov, N.N. 1996. Cladocera: The Chydorinae and Sayciinae (Chydoridae) of the World. Guides to the Identification of the Microinvertebrates of the Continental Water of the World. No. 11. SPB Academic Publishing bv, 195 pp.

Ustaoğlu, M.R., Balık, S., Özdemir-Mis, D. and Aygen, C. 2005. The zooplankton of some mountain lakes in the Taurus range (Turkey). Zoology in the Middle East, 34: 101-108.