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Contributions to the Knowledge of the Oligochaeta (Annelida) Fauna of Some Lakes in the Taurus Mountain Range (Turkey)

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Abstract: Two expeditions were carried out during July 1996 and July 1997 in order to determine the Oligochaeta fauna of 16 high altitude lakes located in the Taurus Mountains in south-west Anatolia (Turkey). No previous faunistic studies exist from the Taurus Mountains regarding physico-chemical features and Oligochaeta fauna.

Fifteen species were identified, comprised of the families Tubificidae (11 species), Naididae (3 species), and Lumbriculidae (1 species). Among the samples, Tubificidae were the most dominant (73% of the specimens), followed by Naididae (20%) and Lumbriculidae (7%).

Key Words: Oligochaeta, mountain lakes, Taurus Mountains, Turkey

Toros Dağları Üzerindeki Bazı Dağ Göllerinin Oligochaeta (Annelida) Faunası'na Katkılar

Özet: Güney Batı Anadolu'daki (Türkiye) Toros Dağları üzerinde bulunan yüksek dağ göllerinin (16 adet) oligoket faunasının belirlenmesi amacıyla 1996 ve 1997 yıllarının Temmuz ayında iki kez arazi çalışması yapılmıştır. Bu çalışma ile, şimdiye kadar hiçbir faunistik çalışma yapılmamış olan Toros sıra dağları üzerindeki 16 gölün bazı fiziko-kimyasal özellikleri ile oligoket faunası belirlenmiştir.

Araştırma sonucunda, Tubificidae'den 11 tür, Naididae'den 3 tür ve Lumbriculidae'den 1 tür olmak üzere toplam 15 tür tespit edilmiştir. Tüm örneklemeler içinde, Tubificidae familyası dominant (bireylerin % 73'ü) olurken, bunu Naididae (% 20) ve Lumbriculidae (% 7) familyaları izlemiştir.

Anahtar Sözcükler: Oligochaeta, Dağ Gölleri, Toros Dağları, Türkiye

Introduction

High mountain lakes have attracted the interest of limnologists for a long time, mainly because of their extreme climatic and physico-chemical conditions. Bio-ecological characteristics of such lakes in Europe and America have already been determined and most of them have been exploited on the behalf of sport fishing. In Turkey all such lakes are still pristine, but knowledge gained from limnological studies of the high altitude lakes of Turkey is still incomplete. Hence, the ecological and biological (fauna) features of mountain lakes in the Taurus Range need to be described.

Having very rich inland water sources, Turkey has more than 200 natural lakes. Although various limnological studies have been conducted at easily accessible lowland lakes (Kırgız, 1989; Sözen and Yiğit, 1996; Balık et al., 2000; Balık et al., 2001), only a few limnological studies have been performed on Turkey's glacial and tectonic lakes (Geldiay and Tareen, 1972; Ustaoğlu, 1980; Taşdemir et al., 2004), which exist in high altitude mountains. One study was performed on the macro-invertebrate fauna of Lake Egrigöl, located in the Taurus Mountains (Yıldız et al., 2005). In addition, 2 studies were conducted on the Mollusca (Balık et al., 2003) and Malacostraca (Ustaoğlu et al., 2004) fauna of the same lakes studied in the present paper. Furthermore, among the 16 lakes studied for this paper, previous studies exist only on the macrophytes of Yazir Lake, Karin Lake, Dipsiz Lake (Bozkir), Suluklu Lake

(Bozkir), Kovali Lake, Dipsiz Lake (Seydişehir), Suluklu Lake (Seydişehir), and Gavur Lake (Secmen and Leblebici, 1997).

This paper, being introductory to a further detailed study on the limnology and the fisheries of the Taurus Range, aimed to determine the Oligochaeta fauna in the lakes of this region.

The Taurus Mountains are the westernmost branches of the great mountain chain that stretches across all of Asia, the Himalayan Mountain Belt. The Turkish section of this massive mountain range follows the southern border of Anatolia.

The limnological research was conducted at 16 high altitude lakes in the Taurus Mountain Range (Table 1). This range extends through south-central Turkey parallel to the Mediterranean coastline, has an average elevation of around 2500 m, sometimes reaching 4000 m above sea level, and is quite a long mountain range made up of western, middle, and eastern sections. The western and central Taurus Mountains suddenly rise up from the coastline. The western Taurus Range has particular significance in that it separates the southern Turkish coastline, which has a typical Mediterranean climate, from dry and steppe-like central Anatolia (Kumlutaş et al., 2004).

Table 1. Investigated localities and sampling dates.

Station number	Localities	Sampling date	Altitude (m)	Depth (cm)	Surface area (ha)	Presence of macrophytes
1	Yazir Lake	09.07.1996	1500	*	*	+
2	Yeşil Lake	10.07.1996	1600	*	0.2	+
3	Karin Lake	14.07.1996	2000	90	3	+
		13.07.1997				
4	Karincali Lake	14.07.1996	2130	60	1	-
		13.07.1997				
5	Kizilot Lake	14.07.1996	1950	95	200	+
		14.07.1997				
6	Duruca Lake	15.07.1996	1950	250	100	+
		14.07.1997				
7	Susam Lake	15.07.1996	2070	190	3-4	-
		14.07.1997				
8	İlvat Lake	15.07.1996	1890	180	100	+
		14.07.1997				
9	Dipsiz Lake (Bozkir)	16.07.1996	1690	1300	1	+
		14.07.1997				
10	Suluklu Lake (Bozkir)	16.07.1996	1690	*	*	+
11	Kovali Lake (Seydişehir)	17.07.1996	1650	160	2.5-3	+
12	Dipsiz Lake (Seydişehir)	17.07.1996	1600	300	6	+
13	Suluklu Lake (Seydisehir)	17.07.1996	1650	270	6	+
14	Gavur Lake (Seydişehir)	17.07.1996	1850	90	*	+
15	Kara Lake (Bolkar)	11.07.1997	2590	*	6	+
16	Cinili Lake (Bolkar)	11.07.1997	2660	*	*	-

* Could not be measured

The range is snow-covered in winter and patches of snow remain permanently on the higher slopes. In spring, the rivers swell from the melt-off and rage wildly to the Mediterranean.

The geology of the area is responsible for its interesting rock formations and waterfalls. The erosion of limestone has created a fascinating karstic topography and hydrography, especially in the Yedigöller Valley, where karstic underground rivers and caverns collect the surface water. Geographical situation of the Taurus Range and research stations are illustrated in the Figure.

Materials and Methods

In order to obtain data about the physico-chemical characteristics of the lakes, water samples were taken from each lake with a Schindler sampler. Some measurements were carried out in situ (e.g., temperature was measured with a thermometer sensitive to 0.1 °C, pH was measured by a Hanna HI 8014 pH-meter, conductivity was measured by a Hanna HI 8033 conductivity meter, dissolved oxygen was measured by the titration method (Winkler method), and transparency was measured by Secchi disc) and others in the laboratory (e.g., salinity was measured by the Mohr-Knudsen method, alkalinity and temporary hardness were measured by HCl titration method, and Ca^{++}, Mg^{++}, and total hardness were measured by EDTA titration) (Golterman, 1971).

The measurements obtained in 1996 and 1997, including depth, transparency, temperature, pH, conductivity, dissolved oxygen, salinity, alkalinity, Ca^{++}, Mg^{++}, total hardness, and temporary hardness, are presented in Table 2.

Table 2. Some measured physico-chemical features of the investigated localities.

Sta.	Locality	Date	Tran. (cm)	T (°C)	pH (µS/20 °C)	Cond.	DO (mg/l)	Sat (%)	S (‰)	Alk (meq/l)	Ca^{++} (mg/l)	Mg^{++} (mg/l)	TH (mg/l)	TempH (d°H)
1	Yazir Lake	1996	*	28.0	8.4	445	5.9	90	0.33	7.8	44.08	80.25	440	43.6
2	Yeşil Lake	1996	*	11.0	8.0	166	8.8	98	0.02	1.6	32.06	19.45	160	8.9
3	Karın Lake	1996	60	25.5	8.7	127	8.8	138	0.07	2.0	40.08	34.04	240	11.2
		1997	5	15.	10.7	153	8.0	102	0.08	0.6	32.06	34.04	220	3.3
4	Karıncalı Lake	1996	60	25.5	8.9	97	8.8	138	0.05	1.4	24.04	31.61	190	7.8
		1997	*	14.5	9.5	157	7.2	91	0.05	0.6	32.06	34.04	220	3.3
5	Kızılot Lake	1996	70	25.5	9.4	76	8.4	132	0.10	1.4	36.07	26.75	200	7.8
		1997	100	16.0	10.1	84	8.3	108	0.6	0.08	32.06	38.91	240	3.3
6	Duruca Lake	1996	250	23.0	9.2	65	7.8	117	0.08	1.2	24.04	31.61	190	6.7
		1997	135	16.0	9.3	83	9.6	124	0.05	0.6	32.06	34.04	220	3.3
7	Susam Lake	1996	90	22.0	8.5	106	6.0	89	0.10	2.4	32.6	12.16	130	13.4
		1997	*	16.0	8.4	122	8.3	108	0.05	0.4	32.06	48.64	280	2.2
8	İlvat Lake	1996	180	25.5	9.4	52	6.7	104	0.08	0.8	24.04	29.18	180	4.4
		1997	110	16.0	10.0	60	8.0	103	0.08	0.8	24.04	34.04	200	4.4
9	Dipsiz Lake (Bozkır)	1996	210	25.5	7.9	200	5.6	84	0.13	3.0	52.10	36.48	280	16.8
		1997	*	23.5	7.8	202	7.3	107	0.05	1.0	32.06	53.50	300	5.6
10	Suluklu Lake (Bozkır)	1997	*	24.5	7.3	240	8.0	119	0.08	1.4	64.12	43.77	340	7.8
11	Kovalı Lake (Seydişehir)	1996	100	22.5	7.3	114	4.8	68	0.16	2.0	24.04	34.04	200	11.2
12	Dipsiz Lake (Seydişehir)	1996	130	25.5	7.5	203	4.8	71	0.21	2.0	36.07	26.75	200	11.2
13	Suluklu Lake (Seydişehir)	1996	180	25.5	8.8	77	6.2	88	0.14	1.6	20.04	9.72	90	8.9
14	Gavur Lake (Seydişehir)	1996	40	27.0	6.7	72	6.0	94	0.13	1.4	16.03	21.88	130	7.8
15	Karagöl (Bolkar)	1997	*	11.5	8.4	162	*	*	0.02	0.6	32.06	53.50	300	3.3
16	Ciniligöl (Bolkar)	1997	*	12.0	8.4	109	*	*	0.02	0.4	32.06	34.04	220	2.2

* Could not be measured

Trans: Transparency; T: Temperature; Cond: Conductivity; DO: Dissolved Oxygen; Sat: Oxygen Saturation; S: Salinity; Alk: Alkalinity; TH: Total Hardness; TempH: Temporary Hardness

The Oligochaeta specimens were collected from mud samples, using an Ekman-Birge grab (15 x 15 cm) and a hand-net with a mesh size of 180 µm. Subsequently, the samples were sieved (mesh size: 500 µm). The samples were fixed in 4% formaldehyde solution in the field. Later they were preserved in 70% alcohol until identification to species level, following washing in the laboratory. After temporary preparation of sorted Oligochaeta specimens with Amman's lactophenol, worms were identified using a stereomicroscope and a binocular microscope. The reference materials are stored in the collection of the first author as permanent whole mounts.

For taxonomical identification of the specimens, some publications were used (Sperber, 1950; Brinkhurst, 1971; Brinkhurst and Jamieson, 1971; Brinkhurst and Wetzel, 1984; Milligan, 1997; Kathman and Brinkhurst, 1998; Timm, 1999).

Results

Due to the high altitude, most of the sites studied are generally covered by snow and ice for 7-8 months of the year and only in warm months, i.e. July and August, the layer melts. Therefore, 2 expeditions were conducted: in July 1996 and July 1997.

In all, 15 species were observed, comprised of the families Tubificidae (11 species), Naididae (3 species), and Lumbriculidae (1 species) (Table 3).

Among all the samples, Tubificidae were the most dominant (73% of the specimens), followed by the Naididae (20%) and Lumbriculidae (7%).

Station number 6 (Duruca Lake) had the highest species richness (5 species), followed by stations 3, 5, and 8 (Karin Lake, Kizilot Lake, and Ilvat Lake, respectively), each with 4 species. There were no Oligochaeta species observed at stations 1, 10, 11, 13, and 16.

Tubifex tubifex and *Potamothrix hammoniensis* (both Tubificidae) were the most common species (at 4 stations), followed by *Tubifex montanus* and *Tubifex ignotus*, which both occurred at 3 stations.

Naidids were represented by a total of 3 species belonging to 3 genera and each species occurred at a different site.

The lumbriculid species, *Lumbriculus variegates*, was found at only one station (Gavur Lake, Seydişehir).

Discussion and Conclusion

Lakes on the high mountains and on glaciers are unique habitats, in terms of faunal composition, because they constitute isolated environments. Furthermore, considering difficulties with transportation and work conditions during field studies, the importance of research in these kinds of habitats are easily understood.

The depths of the lakes of the present study did not exceed 2-3 m, except Dipsiz Lake (13 m). Thus, there were no profundal zones. Due to the high altitude and cold characteristics of the investigated localities, the presence of Oligochaeta was limited. In high elevation mountainous areas, macro-invertebrates have adapted to

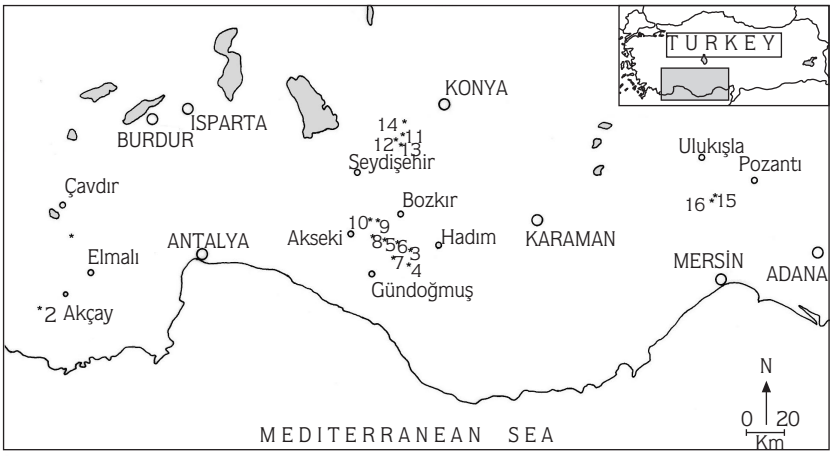

Figure. Geographical situation of the Taurus Mountains and sample stations (from Ustaoğlu et al., 2005).

Table 3. Distribution and average species abundance (ind. m-2) in the investigated stations.

TAXA	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Lumbriculidae																
Lumbriculus variegatus (Müller, 1774)														178		
Naididae																
Chaetogaster diaphanus (Gruithuisen, 1828)									*							
Paranais frici Hrabe, 1941															45	
Pristinella bilobata (Bretscher, 1903)		134														
Tubificidae																
Limnodrilus claparedeianus Ratzel, 1868							89									
Limnodrilus udekemianus Claparede, 1862							445	89								
Psammoryctides albicola (Michaelsen, 1901)						134									45	
Psammoryctides barbatus (Grube, 1861)			534									312				
Psammoryctides deserticola (Grimm,1877)					934	846										
Potamothrix hammoniensis (Michaelsen, 1901)					757	579		89							45	
Tubifex ignotus (Stolc,1886)			757			979		134								
Tubifex montanus Kowalewski, 1939			267	445		712										
Tubifex tubifex (Müller, 1774)			2314		1825		134	89								
Aulodrilus pluriseta (Piguet, 1906)					534											
Ilyodrilus templetoni (Southern, 1909)				1113												

* Only 3 individuals were found from the shoreline of this lake.

unique and often extreme environmental conditions (Mani, 1968).

Tubifex tubifex is a characteristic species indicating oligotrophy in western and northern Sweden, as well as in most of Norway and Iceland (Milbrink, 1980). Numerous studies have found this species in high altitude mountains (Geldiay and Tareen, 1972; Ustaoğlu, 1980; Taşdemir et al., 2004). Moreover, *T. tubifex* was the dominant species in our study. There are similarities between previous studies of high mountain lakes and this study, according to species found (i.e. species belonging to the *Limnodrilus* and *Tubifex* genera). In a previous study of the macro-invertebrate fauna of Lake Egrigöl, which is located in the Taurus Mountains, *T. tubifex, T. montanus, L. claparedeianus, L. udekemianus, Psammoryctides barbatus, Potamothrix hammoniensis*, and *Ilyodrilus templetoni* were also found (Yıldız et al., 2005). Climate and origin of these studied lakes are similar and all were located in high mountain areas.

Due to the similarity of ecological characteristics of some lakes (presence of macrophytes and a cold character), overall species diversity is low and a similar distribution pattern was observed for Oligochaeta communities in these lakes.

The present study may be evaluated as pioneering research in determining the biological diversity in the Taurus Range. We think this study will contribute to a better understanding of the biodiversity of Turkey and be a resource for future studies of glacier lakes in Turkey.

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