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Littoral Fauna of Oligochaeta (Annelida) of Lake Eğirdir (Isparta)

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Özet: *Egirdir Gölü (Isparta) litoral Oligochaeta (Annelida) faunası.* Bu çalışma Türkiye'nin güney batısında 918 m yükseklikte yer alan (38°00'N, 30°54'E) ve önemli bir kuş alanı olan Eğirdir Gölü'nün litoral Oligochaeta faunasını belirlemek amacıyla yapılmıştır. Örnekler Mayıs 2002 ile Ekim 2002 tarihleri arasında 17 istasyondan toplanmıştır. Araştırma sonucunda 17 istasyondan 15 cinse ait 22 tür; Lumbriculidae familyasından 1, Haplotaxidae familyasından 1, Tubificidae familyasından 9 ve Naididae familyasından 11 tür belirlenmiştir. Eğirdir Gölü'nün litoral Oligochaeta faunası geniş dağılım gösteren tubificid ve naidid taxalarından oluşmaktadır. Çalışma alanında *Tubifex tubifex* (%19.2), *Limnodrilus hoffmeisteri* (%17.9), ve *Potamothrix hammoniensis* (%11.3) ve *Ophidonais serpentina* (%9.3) en yüksek bolluğa sahip türler olarak belirlenmiştir. Shannon-Wiener çeşitlilik indeksine göre, Eğirdir Gölü 1.45 zenginliğe sahip olarak bulunmuş, 5. istasyon en yüksek çeşitliliği gösterirken (1.93), 11. istasyon en düşük çeşitliliğe sahip (0.97) olarak belirlenmiştir. Çalışma alanında Tubificidae populasyonunun yüksek olması ve gölün 1, 45 oranında düşük bir Oligochaeta tür çeşitliliğine sahip olması, gölün geleceğinin belirlenmesi için benzer çalışmaların periyodik olarak yapılması gerektiğini göstermektedir.

Anahtar Kelimeler: Oligochaeta, Annelida, Eğirdir Gölü, Litoral, Türkiye.

Abstract: Present study was carried out to determine the littoral fauna of Oligochaeta of Lake Eğirdir, an Important Bird Area (IBA) located at 918 m in the southwestern part of Turkey (38°00'N, 30°54'E). The samples were collected from 17 stations from May 2002 to October 2002. As a result of this study, 22 species, which belong to 15 genera, consisting of 1 species from the family Lumbriculidae, 1 species from the family Haplotaxidae, 9 species from the family Tubificidae and 11 species from the family Naididae, were determined at 17 stations. The littoral fauna of oligochaeta in the lake Eğirdir was dominated by widely distributed tubificid and naidid taxa. The tubificids *Tubifex tubifex* (19.2%), *Limnodrilus hoffmeisteri* (17.9%), and *Potamothrix hammoniensis* (11.3%); and naidid *Ophidonais serpentina* (9.3) were the most abundantly found species in the study area.According to Shannon-Wiener index, Lake Eğirdir was found had 1.45 richness and, 5th station were found to have the widest diversity (1.93) while 11th station to have the poorest (0.97). In the study area high Tubificidae population has been observed, and high pH, relatively low Oligochaeta diversity (1.45) showed that similar studies should be repeated periodically in Eğirdir to determine the future of the Lake.

Key Words: Oligochaeta, Annelida, Lake Eğirdir, Littoral, Turkey.

Introduction

Turkey has been recognized as one of the most important countries in Palearctic in terms of its aquatic ecosystems, water sources, important bird areas (IBA) and wetland owing to its geomorphological structure (Magnin and Yarar 1997). Turkey has 97 Important Bird Areas (IBAs), among them Lake Eğirdir is one of the largest lake in area size (48,800 ha). Lake Eğirdir has a tectonic origin which narrows in its centre and has a maximum depth of 13 m: the northern part of is sometimes referred to as Horan Gölü, and is shallower than the southern part (Magnin and Yarar 1997). The lake has been classified as oligotrophic (Bildiren 1991, Tanyolaç 1993) or mesotrophic (Cirik and Conk 1995, Turna and Yüce 1998) by studies made at different times. Unfortunately, many Turkish wetland sites and important bird area are under increasing pressure-through anthropogenic impacts (water abstraction, pollution) coupled with the (possibly increasing) effects of climatic aridity (Altınsaçlı and Griffiths 2004).

Oligochaetes, a subclass of the class Clitellata, of the phylum Annelida, have a worldwide distribution and frequently are the most abundant benthic organisms in many freshwater ecosystems (Brinkhurst and Jamieson 1971). They have species adapted to every kind of water (brackish water, fresh water or salt water) (Wetzel *et al*. 2000). In addition, Oligochaeta species are one of the most important groups freshwater and are important food sources for some invertebrate animals and fishes (Brinkhurst and Jamieson 1971). Although many researchers have studied Lake Eğirdir from faunistic or ecological points of view at different times (e.g. Yıldırım et al. 1996, Diler ve Yıldırım 1997, Kazancı et al. 1999, Özuluğ et al. 2001, Yıldırım, 2004, İzci 2004, Özbek ve Ustaoğlu 2005, Taşdemir ve Ustaoğlu 2005), there have been few studies on the fauna of Oligochaeta of the lake Eğirdir. Kazanci et al. 1999 reported that the presence of family Lumbriculidae, Yıldız and Balık (2005) determined twenty species of Oligochaeta in Lake Egirdir.

The aim of this study is to evaluate the diversity and distribution of littoral fauna of Oligochaeta and to contribute to the Oligochaeta fauna both Lake Eğirdir and Turkey.

Materials and Methods

Lake Egirdir is one of the Important Bird Area (IBA) in Turkey.

It is located in the southwestern part of Turkey (40°10'N, 28°35'E) at an altitude of 918 m above sea level, and is a oligotrophic lake of tectonic origin (maximum depth = 13 m) (Figure 1). Lake is fed by three major streams (which largely dry up in summer) and a number of springs. The only outlet is in the south where water flows south to Kovada Lake. Lake water is used for irrigation and as drinking water for Isparta and Eğirdir (Magnin ve Yarar 1997).

Sampling was carried out at 17 stations, the locations of which are shown in the Figure 1, from May 2002 to October 2002. The 17 sampling stations were selected randomly, two of them were small stream, stations third and sixth, Koysazı stream and Bavlas stream respectively (Figure 1). Coordinate, some parameters and details of the sampling stations in Lake Eğirdir have been presented in Table 1. During sampling period, the water temperature, hydrogen ion concentration (as pH) and dissolved oxygen (DO) were measured in situ by using Water Quality Checker (TOA W 22). The samples were fixed with 4% formaldehyde after they were sieved several times in the field, brought to the lab, sorted out under a binocular microscope and then transferred to 70 % ethyl alcohol. Samples were examined by preparing temporary (using a glycerin-water (1:5) solution) or permanent preparations (using Canada balsam or Polyvinyl lactophenol). All the samples were identified to genera-species level where possible (with the exception of immature or damaged Oligochaeta, the family Enchytraeidae and Lumbricidae members). For taxonomical identification of the specimens, publications by Sperber (1948, 1950) Brinkhurst and Jamieson (1971), Kathman and Brinkhurst (1998) and Timm (1999) were used.

Analysis of Oligochaeta species diversity was based on the Shannon-Wiener index (*H'*), which were defined as: $H' = -\sum p_i \ln(p_i)$, where p_i is the proportion of species *i* in a sampling station (Krebs 1989).

Results and Discussion

This study was carried out to determine the littoral fauna of Oligochaeta of Lake Eğirdir. As a result of this study, 21 species, which belong to 14 genera, were determined at 17 stations; *Lumbriculus variegatus* (Müller, 1774) belonging to the family Lumbriculidae; *Haplotaxis gordioides* (Hartmann, 1821), belonging to the family Haplotaxidae; *Tubifex tubifex* (Müller,1774), *Limnodrilus hoffmeisteri* Claparede, 1862, *L. udekemianus* Claparede,1862, *Psammoryctides albicola* (Michaelsen, 1901), *Psammoryctides* sp., *Potamothrix hammoniensis* (Michaelsen,1901), *P. bavaricus* (Öschmann, 1913), *Potamothrix sp.*, and *Aulodrilus pluriseta* (Piguet,1906) belonging to the family Tubificidae; *Paranais frici* Hrabe,1941, *Ophidonais serpentina* (Müller, 1773), *Nais communis* Piguet, 1906, *N. variabilis* Piguet, 1906, *N. elinguis* Müller, 1773, *N. bretscheri* Michaelsen, 1899, *Stylaria lacustris* (Linnaeus, 1767), *Dero digitata* (Müller, 1773), *Aulophorus furcatus* (Müller, 1774), *Pristinella jenkinae* (Stephenson, 1931) and *Pristina aequseta* Bourne, 1891 belonging to the family Naididae. Eight of them (*Haplotaxis gordioides, Psammoryctides albicola, Paranais frici, Nais communis, N. variabilis, N. elinguis, N. bretscheri* and *Dero digitata* are reported from Lake Eğirdir and its stream for the first time. Table 2 shows the distribution of the species identified in Lake Eğirdir and its two streams.

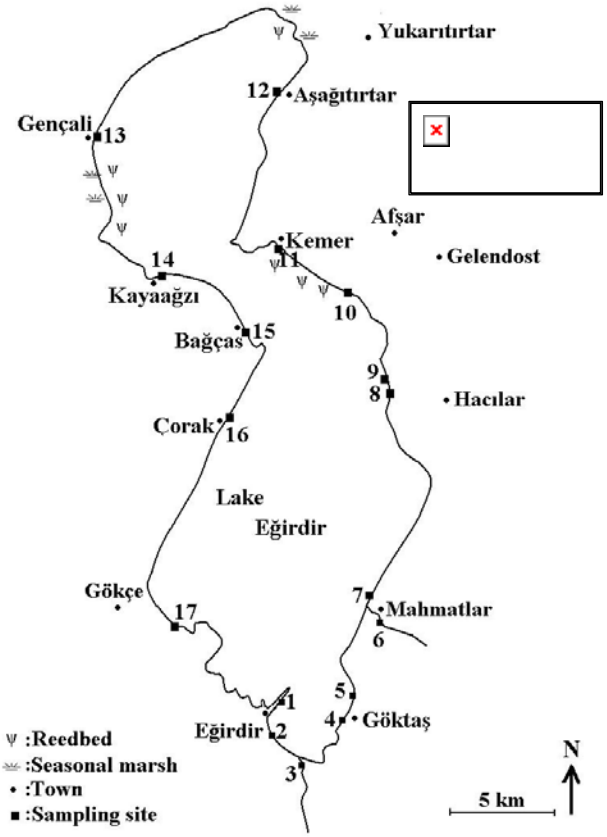

Figure 1. Location of Lake Eğirdir and sampling sites (coordinates: 40°10'N, 28°35'E).

According to Shannon-Wiener index (Table 1), Lake Eğirdir was found had 1.45 richness and, 5th station were found to have the widest diversity (1.93) while 11th station to have the poorest (0.97). *Tubifex tubifex* was found to have the highest abundance (19.2 %) and it was followed by *Limnodrilus hoffmeisteri* (17.9 %), *Potamothrix hammoniensis* (11.3 %) and *Ophidonais serpentine* (9.3). However, *Haplotaxis gordioides* and *N. bretscheri* were found to have the lowest abundance (both of them 0.1 %) and it was followed by *Aulodrilus pluriseta variegatus* (0.3 %), *Lumbriculus variegatus* (0.4 %) and *P. aequiseta* (0.7 %).

Species richness was not high in the study area (Table 2), but the highest number of taxa was found at station 3 (11 species), followed by stations 5 (9 species) and 8 (9 species). Third station was a small stream (Koysazı stream) which flows to Lake Eğirdir. The highest dissolved oxygen level and the highest abundance of Oligochaeta sample were observed at this station and the significant difference of this sampling site

than the others it has dense vegetation and mud substrate. Dissolved oxygen level at this station was generally found as saturated because of abundant aquatic vegetation.

The stations 11 and 16 were represented by only three species (*Limnodrilus hoffmeisteri*, *L. udekemianus* and *Potamothrix hammoniensis*; and *Tubifex tubifex*, *Limnodrilus hoffmeisteri Stylaria lacustris* respectively). In addition the lowest abundance of Oligochaeta sample was found at station 16. Low abundance of the sample may be explained with the sandy-stone substrate and lacking vegetation. Although, only three Oligochaeta species also were found in station 11, the number of samples was higher than the station 16th.

The most common species observed in the stations during the sampling were *Limnodrilus hoffmeisteri, Potamothrix hammoniensis*, *Tubifex tubifex* and *Limnodrilus udekemianus* (Table 2). *Limnodrilus hoffmeisteri* and *Potamothrix hammoniensis* were recorded from twelve stations while *Tubifex tubifex* and *Limnodrilus udekemianus* were recorded from nine stations. It is known that these four Tubificid species (especially *Tubifex tubifex, Limnodrilus hoffmeisteri* and *L. udekemianus*) can tolerate bad conditions and they have clearly adapted to a wide range of environmental conditions (Brinkhurst and Jamieson 1971) and our results supports this knowledge. However, *Haplotaxis gordioides,* and *Nais bretscheri* were found in only one station. *Haplotaxis gordioides* and *Nais bretscheri* were reported at only sixth station which was a small stream near by the Mahmatlar village (Figure 1). Following these *Lumbriculus variegatus, Potamothrix bavaricus* and *Nais variabilis* were found in only two stations among the aquatic vegetation (Table 2).

Our result indicated that species richness and diversity of littoral fauna of Oligochaeta of Lake Eğirdir were low but number of individual was high especially among the vegetation. Tubificid distributed in the lake are generally widespread euryoic species. These especially inhabit shallow and muddy substrates. According to their ecological valence, family Tubificidae and several of its genera (e.g., *Tubifex* and *Limnodrilus*) are considered cosmopolitan species occurring throughout the world and they have clearly adapted to a wide range of environmental conditions and their abundance can reach immense sizes in aquatic systems with high trophic levels (Brinkhurst and Jamieson, 1971).

Table 1. Coordinates and mean values of measured some parameters at the sampling stations in Lake Eğirdir (Abbreviation: St: sampling stations; Coor: coordinates; D: depth (cm); Sub: substrate (m=mud, s=sand, p=stones); Temp: temperature (°C); DO: dissolved oxygen (mg/lt); Veg: Vegetation; *H'*: Shannon-Wiener diversity; *= smal stream which flows to lake).

St.	Coor.	D.	Sub.	pH	Temp.	DO	Veg.	H'	Number of taxa
1	**37° 50'39N 30° 51' 45E**	50	s,p	8.3	19.7	7.2	√	1,36	5
2	**37°51' 24N 30°51' 06E**	60	s	8.4	19.3	7.9	-	1,63	6
3*	**37°50' 36N 30°53' 19 E**	20	m	7.7	12.2	10.7	√	1,93	11
4	**37°51' 19 N 30°53' 47 E**	110	s	8.1	16.7	8	-	1,66	6
5	**37°51' 58 N 30°54' 14 E**	90	m,s	8.2	19.6	8.6	√	1,93	8
6*	**37°55' 32 N 30°55' 20 E**	23	s	7.2	14	7.7	√	1,63	8
7	**37°55' 32 N 30°55' 20 E**	70	s	7.2	19	9.4	√	1,75	4
8	**38°02' 46 N 30°56' 59 E**	55	s,p	8.2	19.8	9.1	√	1,75	9
9	**38°05' 24 N 30°56' 28 E**	120	m,s	8.5	20.6	7.7	√	1,54	6
10	**38° 06'10N 30° 55' 59E**	60	m	8	20.8	9.2	√	1,54	6
11	**38° 08' 33N 30° 52' 34E**	85	m,s	7.2	19.2	8.3	-	0,97	3
12	**38° 14' 34N 30° 53' 23E**	70	m,s	8	18	9	√	1,27	5
13	**38° 14' 36N 30° 46' 20E**	40	m,s	8.1	21.5	7.7	√	1,59	7
14	**38° 08' 17N 30° 46' 19E**	85	m,s	8	20.4	5.9	√	1,22	4
15	**37° 05' 20N 30° 50' 42E**	45	s	8.2	19.5	7.5	√	1,32	6
16	**37° 59' 06N 30° 47' 22E**	50	s,p	8.5	19.9	7.5	-	1,05	3
17	**37° 55' 35N 30° 46' 56E**	60	s,p	8.3	20.1	8.4	-	1,06	4

Table 2. Taxonomical list of littoral Oligochaeta species which were determined in Lake Eğirdir and its streams in the period of investigations and their proportional (as %), (*= smal stream which flows to lake; station 3: Koysazı stream, station 6: Bavlas stream).

Station Species	1	2	3*	4	5	6*	7	8	9
Lumbriculus variegatus	6,1		0,8						
Haplotaxis gordioides						1,6			
Tubifex tubifex	42.9	31.2		15,2	15,3				29
Limnodrilus hoffmeisteri	28,6	10,1	11,1	24,2	19		21,6		25
Limnodrilus udekemianus				22,1	13,5			10	29,2
Psammoryctides albicola	16,3		15,5			41	10,8	15,1	
Psammoryctides sp.		2,8		7					8,3
Potamothrix hammoniensis		19,3		5,1	17,2			5,3	
Potamothrix bavaricus									4,2
Potamothrix sp.					0,7				
Aulodrilus pluriseta			1,8					1,4	
Potamothrix sp.		4,3		0,7		0,8		0,6	
Limnodrilus sp.		3,6		0,4				0,4	
Tubificinae gen. spp.		6,4		0,2		0,2			
Paranais frici	6,1		2,2		6,9				
Ophidonais serpentina							56,8	24,3	
Nais communis			15		19	10,9		4,3	
Nais variabilis			9,7			14,5			
Nais elinguis			2,2			5,5		1,4	
Nais bretscheri						1,8			
Stylaria lacustris		22	33,6	24,6				33,3	
Dero digitata					6,9		10,8	2,9	
Pristinella jenkinae			6,6			20			
Pristina aequseta			1,3			3,6			4,2
Aulophorus furcatus					1,7				
Enchytraeidae									0,2
Lumbricidae								1	

Stations Species	10	11	12	13	14	15	16	17	
Lumbriculus variegatus									
Haplotaxis gordioides									
Tubifex tubifex			46			44,2	40	60.7	
Limnodrilus hoffmeisteri	21,2	55		21,1		26,9	40		
Limnodrilus udekemianus	6,1	30	10,7		15,2			10,7	
Psammoryctides albicola				5,3					
Psammoryctides sp.						1,9			
Potamothrix hammoniensis	18,2	15	32,1	12,3	23,9	21,2		21,4	
Potamothrix bavaricus			3,6						
Potamothrix sp.									
Aulodrilus pluriseta				1.8					
Potamothrix sp.				2		2,5			
Limnodrilus sp.				7					
Tubificinae gen. spp.						1,4			
Paranais frici									
Ophidonais serpentina	39,4			36,8					
Nais communis	12,1								
Nais variabilis									
Nais elinguis			7,1	7					
Nais bretscheri									
Stylaria lacustris							20		
Dero digitata					10,9				
Pristinella jenkinae									
Pristina aequseta	3								
Aulophorus furcatus						1,9			
Enchytraeidae			0,4	2					
Lumbricidae				3					

The lake has the official protection status of Drinking Water Reservoir. Originally, DSI (State Water Works) planned to use up to 355 hm^3/p.a for irrigation, drinking water and hydro-power (for two hydro-power stations built in 1960 and 1971 which require 225 hm^3/p.a). Due to water shortage, at present only 150 hm^3/p.a. is used for irrigation and 30 hm^3/p.a. for drinking water. In spite of reduced water usage, the lake's water level has dropped with 2.5 m during the last 25 years. Furthermore, the town of Eğirdir discharged its untreated sewage into lake prior to the completion of sewage treatment plant in 1995. A number of fruit processing plants have been established in the area south of Eğirdir; massive numbers of fish deaths in the stream which connects the lake with Kovada Lake have been attributed to a cooling warehouse discharging ammoniac, agro-chemicals have been reported to pollute the lake (Magnin and Yarar 1997).

Due to mentioned above reasons, in the study area where anthropogenic effects have become dominant (e.g. fishing, activities and tourism), and discharged of untreated sewage, domestic and agricultural dumping, present high Tubificidae populations has been observed. Similar results have been observed in Lake Eğirdir by Yıldırım (Yıldırım 2004) and Yıldız and Balık (2005). Yıldırım (2004) reported that the most abundant and widespread Gastropoda species were the samples belonging to the family Pulmonata whose species are generally eurytopes. In addition, he indicated that "although the lake maintains an oligotrophic structure, being open to uncontrollable anthropogenic and alluvial deposits and allochthonous factors induce this evolution". In addition, Yıldız and Balık (2005) reported that the most common species observed in the lake disrict (include Lake Eğirdir) were *T. tubifex, L. hoffmeisteri*, *P. hammoniensis, L. hoffmeisteri f. parvus, L. udekemianus*, *P. deserticola*, *I. templetoni* and *P. bavaricus.*

Consequently, irrigation, sewage system, variable flow rate, uncontrollable anthropogenic deposits etc. affect the quality of water Lake Eğirdir. The structure of Oligochaeta and also other invertebrate fauna in the lake may change with effects of environmental variables. Also, similar studies should be repeated periodically in Lake Eğirdir to determine the future of the lake.

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