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Species Distribution of Oligochaetes Related to Environmental Parameters in Lake Sapanca (Marmara Region, Turkey)

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Abstract

In order to determine the oligochaeta fauna of Lake Sapanca (Turkey) samples were collected from 5 stations monthly, between September 2000-August 2001. As a result of the study, 13 species, which belong to 9 genera, were determined. These species are *Aulodrilus limnobius, Tubifex tubifex, Tubifex ignotus, Tubifex nerthus, Limnodrilus hoffmeisteri, Potamothrix hammoniensis, Potamothrix vejdovskyi, Nais communis, Spirosperma ferox, Psammoryctides barbatus, Ilyodrilus templetoni, Psammoryctides deserticola, Paranais frici*. Also some physicochemical parameters of the water (temperature, dissolved oxygen, pH, turbidity and depth) were measured at the sampling site. The average density of total oligochaetes in the benthos of the lake was 1,887 ind m^{-2}. According to Shannon-Wiener index, Lake Sapanca was found had 2.59 richness and, 5th station were found to have highest diversity (3.87) while 3rd station to have the lowest (1.59). There are almost no data on the Oligochaeta fauna of this lake so far. Hence, all the determined taxa from the localities are recorded for the first time.

Keywords: Oligochaeta, fauna, lake, Sapanca.

Oligoket Türlerinin Sapanca Gölü'nde (Marmara Bölgesi, Türkiye) Çevresel Parametrelerle İlişkili Dağılımı

Özet

Sapanca Gölü oligoket faunasını belirlemek amacıyla Eylül 2000-Ağustos 2001 tarihleri arasında 5 istasyondan aylık olarak örnekler toplanmıştır. Çalışma sonucunda 13 tür tanımlanmıştır. Bu türler *Aulodrilus limnobius, Tubifex tubifex, Tubifex ignotus, Tubifex nerthus, Limnodrilus hoffmeisteri, Potamothrix hammoniensis, Potamothrix vejdovskyi, Nais communis, Spirosperma ferox, Psammoryctides barbatus, Ilyodrilus templetoni, Psammoryctides deserticola, Paranais frici*'dir. Ayrıca oligoket örneklerinin alındığı noktalardaki suyun bazı fizikokimyasal değerleri (sıcaklık, çözünmüş oksijen, pH, bulanıklık ve derinlik) de ölçülmüştür. Göldeki ortalama Oligoket yoğunluğu 1,887 birey/m^2'dir. Shannon-Wiener çeşitlilik indeksine göre, Sapanca Gölü 2,61 zenginliğe sahip olarak bulunmuş, 1. istasyon en yüksek (4,01) çeşitlilik gösterirken, 4. istasyon en düşük (1,41) çeşitliliğe sahip olarak bulunmuştur. m^2 deki birey sayıları ile fiziko-kimyasallar arasındaki ilişkiyi anlamak amacıyla Pearson korelasyon indeksi uygulanmıştır. Tanımlanan 13 tür ile sıcaklık arasında doğru, çözünmüş oksijen ile ters orantı olduğu belirlenmiştir. Bu gölde şimdiye kadar Oligoket faunasıyla ilgili herhangi bir çalışma yapılmamıştır. Saptanan türler bu göl için yeni kayıttır.

Anahtar Kelimeler: Oligoket, fauna, göl, Sapanca.

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 128 IBAs qualify currently as Ramsar Sites. Designation coverage is complete within four of these and partial with need of expansion in five. One-hundred-and-nineteen (93%) have no Ramsar designation as yet (BirdLife International, 2001). Lake Sapanca is one of these areas. Lake Sapanca is located on a tectonic hole, which is situated between Izmit Bay and Adapazari Meadow and runs parallel to Iznik Lake and is one of the few lakes in Turkey, which provides drinking water.

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). Many oligochaetes have a worldwide distribution. They are used in biodiversity studies, pollution surveys, environmental assessment and they have economic importance (Mason, 1996; Wetzel *et al*., 2000). Although many researchers have studied Lake Sapanca from faunistic and ecological points of view at different times (e.g. Ongan, 1982; Schütt, 1989; Altınsaçlı, 1997; Tanık *et al*., 1998; Yalçın and Sevinç, 2001; Soylu, 2006; Şahin and Yıldırım, 2007; Özuluğ *et al*., 2007; Gaygusuz *et al*., 2007; Duman *et al*., 2007), there is no data on the Oligochaeta fauna of this region so far.

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

Materials and Methods

Study Area

Lake Sapanca is located in the Marmara region (lat 40º41' N, long 30º09' E-30º20' E) at an elevation of 30 m above sea level and is the second largest lake in the region. The surface area is 46.8 km^2 and maximum depth is 55 m (Figure 1). The lake water is used as a source of drinking water by the city and district of Adapazarı and as a recreational area. Numan (1958), who carried out the first limnological study in Lake Sapanca, pointed out that the lake had an oligotrophic character. Although Lake Sapanca water is enriched by water from trout farms, which are common in this region, with more than thirty in the vicinity of the lake, it has still an oligotrophic character (Albay *et al*., 2003). Several streams and ground water entering from the bottom feed the lake. The locations of the sampling stations are shown in Figure 1 and the description of the stations is given in Table 1.

Oligochaeta Samples

Benthic samples were collected at monthly intervals between September 2000 and August 2001 from five stations on Sapanca Lake (Figure 1).

Oligochaeta specimens were collected from benthic mud samples, obtained by Ekman-Birge grab (15x15 cm), which were sieved through a mesh of 500 µm. Benthic samples were preserved in the field with 70% alcohol. After the temporary preparation of sorted Oligochaeta specimens with Amman's Lactophenol, some worms were identified by means of stereomicroscope and binocular microscope. For taxonomical identification of specimens, publications of Brinkhurst (1971), Brinkhurst and Jamieson (1971), Brinkhurst and Wetzel (1984), Kathman and Brinkhurst (1998), Sperber (1950) and Timm (1999) were used.

Physico-Chemical Factors

During each sampling period, water samples

Table 1. Description of the sampling stations in Lake Sapanca

Stations	Substrate	Macrophytes	Depth (m)
1	Organic mud	+	14
2	mud	No	15
3	mud	No	52
4	Organic mud	+	17
5	Fine sand and mud	+	16

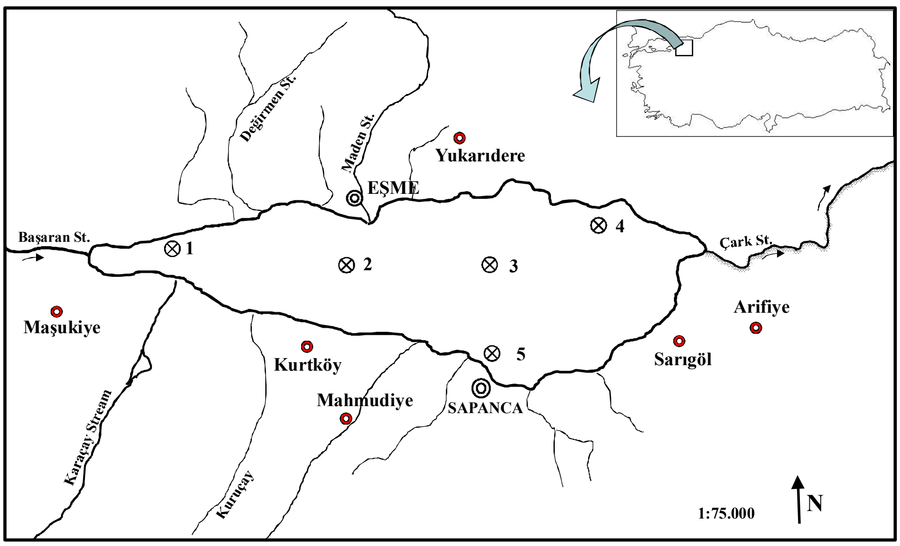

Figure 1. Geographical situation of the study area and locations of sampling stations.

were taken 0.5-1 m above the sediment with Nansen water intake tank at each station using prewashed polyethylene bottles. The temperature was measured with a thermometer with 0.1ºC sensitivity, dissolved oxygen was measured with oxygen meter WTW-OXI 330/SET model and pH was measured with pH meter WTW pH 330/SET-1 model.

Data Processing

Species diversity (*H'*) values were calculated according to Shannon-Wiener species diversity index.

Results

Environmental Parameters

The monthly variations and average values of some physicochemical parameters are given in Table 2. Deep water temperature average was 14.8±3.9°C. The level of dissolved oxygen average was 7.4±1.2 mg/L. pH average was 7.8±0.4. Secchi disc depth average was 3.2±1.1 m. The water temperature average was 19.6±7.8°C.

Oligochaeta Fauna

During our survey 13 species were found, of which 11 species belong to Tubificidae: *Tubifex tubifex* (Müller,1774), *Tubifex ignotus* (Štolc, 1886), *Tubifex nerthus* Michaelsen, 1908, *Limnodrilus hoffmeisteri* Claparède, 1862, *Aulodrilus limnobius* Bretscher, 1899, *Spirosperma ferox* (Eisen, 1879), *Psammoryctides deserticola* (Grimm, 1877), *Psammoryctides barbatus* (Grube, 1861), *Potamothrix hammoniensis* (Michaelsen, 1901), *Potamothrix vejdovskyi* (Hrabe, 1941), *Ilyodrilus templetoni* (Southern, 1909) and 2 species belong to Naididae: *Nais communis* Piguet, 1906, *Paranais frici* Hrabě, 1941. The abundance of each species (ind.m^{-2}) is given in Table 3.

The average density of total oligochaetes in the

Table 2. Selected physicochemical measurements of Lake Sapanca

		2000				2001								
	Parameters	IX	X	XI	XII	I	II	III	IV	V	VI	VII	VIII	Average±SD
1st station	SecchiDisc(m)	2	3.5	4.8	3.2	3.1	2	3.5	2.7	4.1	2.7	3	3	3.1±0.7
	Temp.(°C)	19	19	15	12	11	9	14	13	19	25	20	20	16.3±4.6
	D.O (mg/L)	8	8	9	7	8	6	6	8	10	9	7	7	7.7±1.2
	pH	8	8	7.4	8	8	8.2	8.2	8.1	8.1	8.4	8.6	7.9	8.0±0.2
2nd station	SecchiDisc(m)	3.2	2.5	5.2	4.1	5	3	3.5	1.7	3.2	3	2.5	4	3.4±1.0
	Temp.(°C)	12	14	16	14	14	20	17	20	17	15	15	12	15.5±2.6
	D.O. (mg/L)	8	7.8	8.2	7.9	10	5.3	8.1	7.1	7.8	8.2	6.8	7.1	7.6±1.1
	pH	8	8	7.2	7.6	8	8	8.1	8.1	7.9	8.2	8.3	7.6	7.9±0.3
3rd station	SecchiDisc(m)	3.5	3	5.6	5	2	2.3	4	2	4.4	3.2	4	2	3.4±1.2
	Temp.(°C)	18	17	16	10	9	11	17	13	19	20	20	20	15.8±4.0
	D.O (mg/L)	7.2	7.1	7.5	7.5	8.2	7.1	7.6	8	9.7	8	7.6	8.8	7.8±0.7
	pH	7.2	7.9	7.2	7.6	8	8.6	8.6	8.2	8.4	8.3	8.6	8.1	8.0±0.5
4th station	SecchiDisc(m)	4	4	0	2	-	4	4	5	2.5	3	3	3	3.1±1.3
	Temp. (°C)	19.6	12.3	11	9.5	-	9	16	10.4	12	11	15	20	13.2±3.8
	D.O. (mg/L)	7	7	7.8	7.9	-	5.8	8	4.5	6.8	4.2	3.8	8.6	6.4±1.6
	pH	7	7.6	7.9	8.1	-	8	7.6	7.6	7.3	7.4	7.6	6.7	7.5±0.4
5th station	SecchiDisc(m)	2	2	5.8	5	3.5	3	3	2.7	3	2	3	2	3.0±1.2
	Temp. (°C)	20	18	16	11	9	10	14	16	18	20	14	19	15.4±3.8
	D.O. (mg/L)	7.3	7.9	7.8	7.3	7.1	8.1	6.7	4.6	10.1	7.9	6.8	8.3	7.4±1.2
	pH	7.3	8	7.8	8	8	8.1	7	7.6	8.2	8	7.5	7.7	7.7±0.3

Table 3. Abundance of the species at separate sampling stations (ind.m^{-2})

	1st station	2nd station	3rd station	4th station	5th station
Tubifex tubifex	26	17	20	16	26
Tubifex ignotus	16	4	6	3	3
Tubifex nerthus	8	8	6	13	12
Limnodrilus hoffmeisteri	5	1	0	5	3
Potamothrix hammoniensis	11	8	3	3	12
Psammoryctides deserticola	1	0	10	14	8
Psammoryctides barbatus	6	28	16	4	9
Paranais frici	4	0	0	0	0
Aulodrilus limnobius	3	6	1	2	5
Spirosperma ferox	3	0	0	3	3
Potamothrix vejdovskyi	5	4	7	7	12
Nais communis	0	0	0	5	1
Ilyodrilus templetoni	0	0	0	1	1

benthos of the lake was 1887 ind.m^{-2}. During the study, the most abundant species were *Tubifex tubifex*, *Tubifex ignotus, Tubifex nerthus, Psammoryctides barbatus, Aulodrilus limnobius, Potamothrix vejdovskyi* (at 5 stations) and *Limnodrilus hoffmeisteri, Psammoryctides deserticola* (at 4 stations) in the Tubificidae family (Table 3, Figure 2). The dominant species, *Tubifex tubifex,* was averagely represented 707 ind.m^{-2}, following this species, *Psammoryctides barbatus* with 243 ind.m^{-2}.

Tubifex tubifex was the most abundant species during all 12 months of the research period and formed 21% of the total oligochaeta community in the lake Sapanca. Other species in the lake were represented to a lesser extent (Figure 2).

The total densities in each of the five sampling sites showed moderate fluctuations during the study period (Figure 3).

As is evident from Table 3, number 5 station is the most efficient in terms of species diversity. According to that high level of species diversity of this station, the highest Shannon-Wiener index value, which varied between 1.59-3.87 and average was 2.59, has been determined here (3.87) (Figure 4).

Discussion

This study was carried out to determine the Oligochaeta fauna September 2000-August 2001 in Lake Sapanca. 13 Oligochaeta species, which consists mainly of taxa with wide ecological tolerances and extensive geographical ranges, were found. The family Tubificidae, which origins in the northern temperate zone Timm (1980), was represented by 7 genera in this study. This family and several of its genera (e.g. *Tubifex, Limnodrilus* and *Aulodrilus*) are considered to be cosmopolitan, genus *Potamothrix* is widely distributed throughout the world (Wetzel *et al*., 2000) and other genera (*Ilyodrilus* and *Psammoryctides*) are distributed in Holarctic (Timm and Veldhuijzen van Zanten, 2002).

In this family, *Tubifex*, whose members can live in both organically polluted and in oligotrophic habitats (Timm, 1970), represented by 3 species. Among them, *Tubifex tubifex,* which is the most abundant species in this study, is mainly known as species characteristics of strongly polluted waters, where it can reach very high densities (Poddubnaya, 1980). Milbrink (1983) claims that *T. tubifex* occurs in these environments where competition or predation is weak (after Dumnicka and Galas, 2002). In oligotrophic situations, *T.tubifex* is generally a dominating species together *S. ferox* (Milbrink, 1980). Timm (1996) also found this species in oligotrophic Estonian lakes with such as Oligochaeta communities of oxyphilous as *Spirosperma ferox.* Arslan (2006), in her study of littoral oligochaeta in Lake Eğirdir, which share the same historical development process with Lake Sapanca (Demirsoy, 2002), found that *T. tubifex* has the highest abundance. Our findings showed consistency with these results.

Psammoryctides barbatus, the second dominant species in this study, lives in fresh and brackish water especially on sand, avoiding soft water (Timm and Veldhuijzen van Zanten, 2002). This psammophilous species was typical of less eutrophied and cooler habitats, usually with a sandy or stony bottom and considerable current velocity (Timm *et al*., 2001). Collado and Schmelz (2001) found that, the two tubificids, *T. tubifex* and *P. barbatus*, were the most abundant species in Lake Stechlin, which is an oligotrophic hardwater lake in Northern Germany. Our results showed a similar trend with this finding.

Limnodrilus hoffmeisteri is considered as a biological indicator of organic pollution and eutrophication. *Tubifex tubifex* has the same

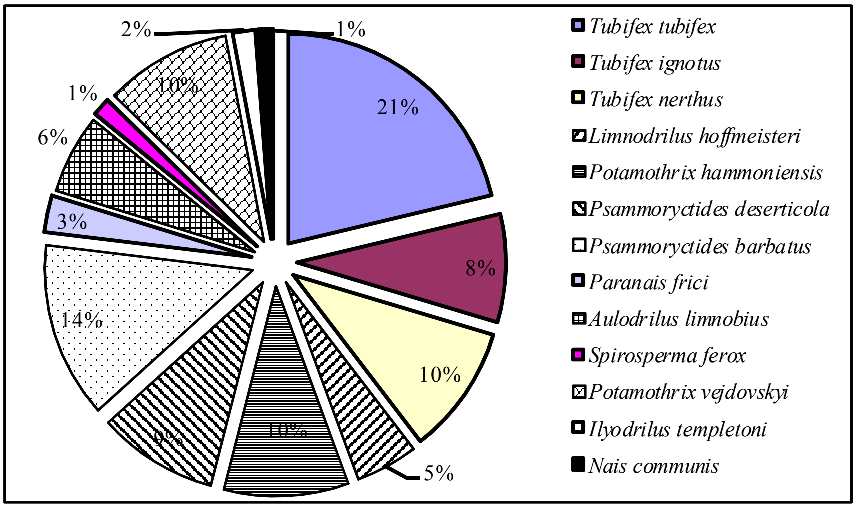

Figure 2. Relative abundance of the Oligochaeta species (%)

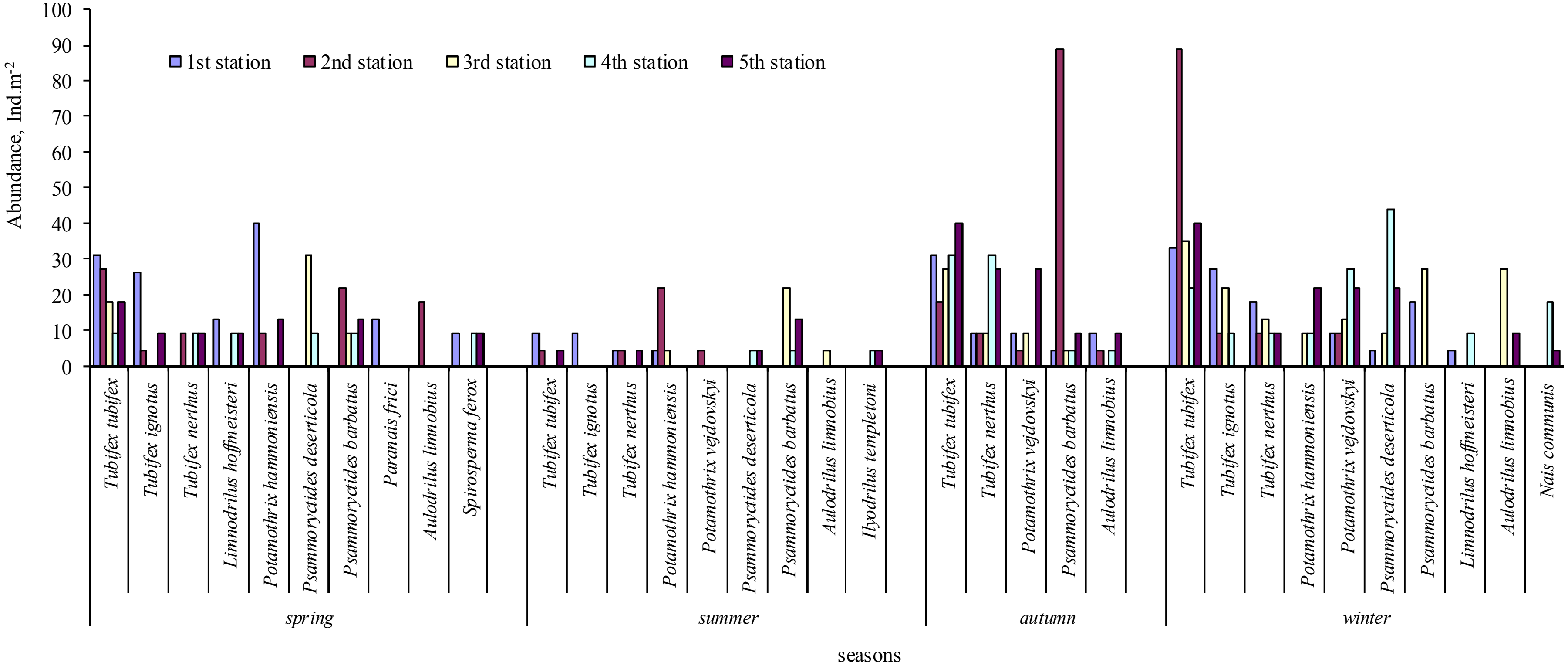

Figure 3. Seasonal abundances of the Oligochaeta species at each station.

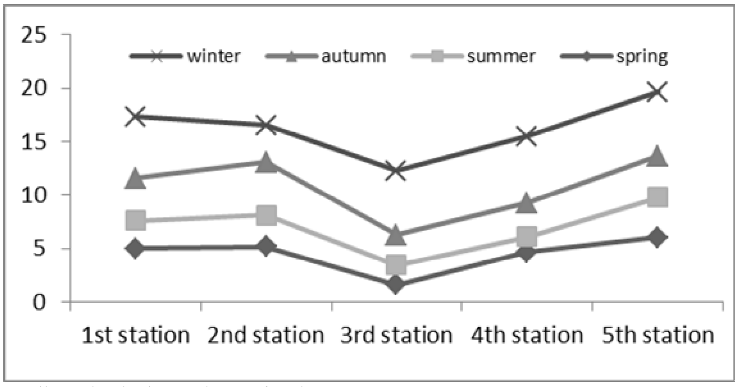

Figure 4. Shannon-Wiener diversity index values of Lake Sapanca.

characteristics, as well; and they exist closely together in the same habitat (Brinkhurst, 1969). *Limnodrilus hoffmeisteri* clearly prefers warmer habitats (Timm *et al*., 2001). Hiltunen (1969) and Saether (1970) have called the species saprophilous (after Milbrink, 1980).

Potamothrix hammoniensis is a freshwater euryhaline form (Grigelis, 1980). It has a wide distribution pattern and can be found in brackish waters occasionally. This species is probably the commonest tubificid species in eutrophic lowland lakes in Europe. On the other hand, Lang (1978) suggests an intermediate position of the species between tolerant and sensitive species (after Milbrink, 1980). Milbrink (1973) found this species generally associated with pollution and most often together with *T. ignotus*, which has Palaearctic distribution, in Swedish waters (after Milbrink, 1980). Bacescu (1966) noticed that in Europe, the Caspian and Ponto-Azovian fauna have spread in different manners and at different geological periods to Turkey, the Aral basin, the Euphrates river, European river systems, and the Adriatic Sea (after Ojaveer *et al*., 2002). According to Panov *et al*. (2009), there are four principal invasion corridors exist in Europe and among them the southern corridor links the Black Sea basin with the North Sea basin via the Danube Main Rhine waterway, including the Main–Danube Canal. This can emphasizes the Danubian relationship of the Lake Sapanca macroinvertebrate fauna. For example, a Danubian species, *Lithoglyphus naticoides*, to which the population in Lake Sapanca can be attributed, was identified by Schütt (1988) in the Balkans (after Şahin and Yıldırım, 2007). Rîşnoveanu and Vădineanu (2003) provide detailed characterization of Danube River Delta's lakes. According to this study, within these lakes the Oligochaeta communities comprise between 7.9% and 36.2% of the total biomass of benthic fauna and among them *P. hammoniensis* was the more efficient under hypertrophic conditions. Our results showed a similar trend with this finding.

Marmara Region, which Lake Sapanca is located in it, is divided into four sections according to the landforms and socio-economic characteristics. Among them, South Marmara Region has large freshwater lakes with tectonic characters, such as Lakes Sapanca, Manyas, Uluabat and İznik. The Oligochaeta fauna of these lakes are naturally expected to be similar. Balık *et al*. (2005) and Arslan and Ahıska (2007), in their studies carried out in Lake Manyas, have found that *Potamothrix hammoniensis* was the dominant species, followed by *Psammoryctides deserticola*, *P. albicola* and *T. tubifex*. Kökmen *et al*. (2007), who studied the zoobenthos of Lake Uluabat and relationship with environmental variables, found that *Potamothrix hammoniensis* was also most common species and followed by *T. tubifex*, *P. albicola* and *Limnodrilus hoffmeisteri*. Our conclusions are similar to these authors' studies.

The lake discharges its water to the Sakarya River through Çark Creek on the eastern end and reaches the Black sea (Tanık *et al*., 1998). Thus, in a study carried out in Porsuk Stream (Sakarya River), Arslan and İlhan (2010) found similar fauna in terms of Oligochaeta.

Aulodrilus limnobius has cosmopolitan distribution (Brinkhurst and Jamieson, 1971). According to Milbrink (1980), *A. limnobius* and *A. pluriseta* occur irregularly and sporadically mostly in mesotrophic or eutrophic lakes, but Särkkä (1979), Särkkä and Aho (1980) indicate that *A. limnobius* seems to occur in more oligotrophic conditions than *A. pluriseta* (after Särkkä 1982).

Ilyodrilus templetoni is a freshwater form and has Holarctic distribution and also found in China and in South Africa (Timm and Veldhuijzen van Zanten 2002). The species is saprophilous like *L. hoffmeisteri* (Milbrink, 1980). In Swedish waters, Milbrink (1973) found that this species is generally associated with *P. hammoniensis* and sometimes with *L. hoffmeisteri* in the profundal of moderately eutrophied waters (Milbrink, 1980).

The Naididae, also origining from the northern temperate zone (Timm, 1980), were represented by two species this study*, Paranais frici* and *Nais communis.* Most naidid species are also cosmopolitan, occurring throughout the world (Wetzel *et al*., 2000) and they have clearly adapted to a wide range of environmental conditions (Brinkhurst and Jamieson, 1971).

Nais communis has a cosmopolitan distribution (Timm and Veldhuijzen van Zanten, 2002), also found in brackish water (Sperber, 1948). This species prefers fine sand covered with detritus (Verdonschot, 1999).

Paranais frici was found at only one station in our study (Table 2). It is known from the Holarctic, China and South Africa and lives both fresh and brackish waters (Timm and Veldhuijzen van Zanten, 2002). In this study, these two naidid species were found at stations 1, 4 and 5, which contain aquatic vegetation, fine sand and detritus. This finding represented that these species were found well-suited with their ecological demand.

Although Lake Sapanca water is enriched by water from trout farms, which are common in this region, with more than thirty in the vicinity of the lake, it has an oligotrophic character (Albay *et al*., 2003) and is one of the few lakes in Turkey, which provides drinking water, but it is exposed to heavy urbanization because of its natural beauty and its proximity to the metropolitan Istanbul. The lake is fed by surface and ground waters and is considered to have enough capacity to supply water for its surrounding settlements until the year 2030 (Tanık *et al*., 1998). Natural forest lands in catchment areas have been vanishing quickly. There is pollution from highways near the coast and also from waste water from settlement areas around the lake. A negative effect on the trophic level of the lake has been observed.

Until now heavy pollution has not been observed in the lake, but nevertheless dumping of waste water from domestic areas should be prevented and no licenses should be given to factories. The region around Sapanca has become very important for day trips and weekend vacations with its charming natural beauty.

As a result, the Lake Sapanca may be called as Mesotrophic Lake since it contains species characteristic of oligotrophic and eutrophic conditions. Because of all these facts are described in here and to fill the lack of information on the taxonomy and ecology of this group of animals, further researches are needed and same studies should be repeated periodically.

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