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Evaluation of the Aquatic Oligochatea Fauna and Seasonal Changes in Water Quality of the Büyükçekmece Dam Lake, which Provides Water to İstanbul

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ABSTRACT

This study was conducted at 4 stations in Büyükçekmece Dam lake in 2020. In this study, water and Oligochaeta samples were collected seasonally. Parameters such as secchi disk depth, water temperature, dissolved oxygen, pH, electrical conductivity, salinity, total hardness, nitrite nitrogen, phosphate and nitrate nitrogen were measured. Water quality parameters were qualified by SKKY (2004) ve TSWQR (2021). Also, the study, *Limnodrilus hoffmeisteri* (Claparède, 1862) and *Limnodrilus udekemianus* (Claparède, 1862) species belonging to Oligochaeta were found in the dam lake. The number of individuals per m^2 and % dominance ratios of species were also calculated. It is recommended that similar and more comprehensive studies be carried out periodically in the dam lake to monitor the water quality of the dam lake regularly and to determine the benthic macroinvertebrate fauna.

Keywords: Büyükçekmece, dam, lake, water quality.

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İstanbul'a Su Sağlayan Büyükçekmece Baraj Gölü'nün Sucul Oligochatea Faunası ve Su Kalitesindeki Mevsimsel Değişimlerin Değerlendirilmesi

Öz: : Bu çalışma 2020 yılında Büyükçekmece baraj gölünde 4 istasyonda yapıldı. Çalışmada mevsimsel olarak su ve Oligochaeta örnekleri toplandı. Gölün secchi disk derinliği, su sıcaklığı, çözünmüş oksijen, pH, elektriksel iletkenlik, tuzluluk, toplam sertlik, nitrit azotu, fosfat ve nitrat azotu gibi parametreleri ölçüldü. Su kalite parametreleri SKKY (2004) ve TSWQR (2021)'na göre değerlendirildi. Çalışmada ayrıca, baraj gölünde Oligochaeta'ya ait *Limnodrilus hoffmeisteri* (Claparède, 1862) ve *Limnodrilus udekemianus* (Claparède, 1862) türleri bulundu. Türlerin m^2 deki birey sayıları ile % dominansi oranları da hesaplandı. Baraj gölünün su kalitesinin düzenli olarak izlenmesi ve bentik makroomurgasız faunasının belirlenmesi için benzer ve daha kapsamlı çalışmaların, gölde periyodik olarak yapılması önerilir.

Anahtar kelimeler: Büyükçekmece, baraj, göl, su kalitesi.

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Introduction

The Büyükçekmece basin is located on the Çatalca Peninsula, in the western side of, the coast of the Marmara Sea, Istanbul. There is Küçükçekmece Lake to the east, Silivri settlement to the west, The Terkos drinking water basin to the north and the Marmara Sea to the south. Settlements are present in Büyükçekmece, Çatalca and Silivri districts within the basin. Büyükçekmece Lake is the second largest water source on the European side of Istanbul (Tekin 2010).

Aquatic Oligochaetas, which are important components of ecosystems, constitute an important part of the benthic fauna. Oligochaetas have a wide distribution in the world (Brinkhurst and Jamieson 1971). They are usually free-living on the ground, but some species are found in vegetation, in organic waste or between leaves. Most of the aquatic

Oligocheata species digest the sand and mud on the ground, as well as bacteria and other microorganisms, and return them to the environment. Thus, they provide the cleaning and aeration of the bottom mud (Arslan and Ahıska 2004). The Oligochaeta group is abundant in almost all seasons and in all kinds of waters increases their importance even more. It is also uses as a food source with high protein value for fish and is used as live feed in aquarium fisheries (Loden 1974).

Previous studies in the lake are mainly focused on fish fauna, fish parasites and fish biology. There have been very few studies on the benthic fauna of the lake. Koşal-Şahin (2006) revealed the benthic macroinvertebrate fauna of the lake in her phD thesis. Dorak (2019) conducted a preliminary study on the Rotifera group to determine the trophic structure of the lake and examined some physicochemical parameters seasonally.

Some studies of this kind in Turkey are by Arslan (2006), Yıldız and Balık (2006); Yıldız et al. (2008); Odabaşı et al. (2018); Fındık et al. (2019); Albayrak et al. (2023).

The aim of this study was to reveal the aquatic Oligochaeta fauna and seasonal changes in the water quality of Büyükçekmece Dam Lake, which provides water to Istanbul.

Materials and Methods

The Büyükçekmece Lake is located in northwestern Turkey, 50 km from the city center of Istanbul (Soyer 2003). Büyükçekmece Dam Lake, built on a lake located at the mouth of the Karasu Stream, flows into the Marmara Sea. As a result of the construction of a 11.4 m dam wall between the Marmara Sea and the lake by DSİ between 1983 and 1988, Büyükçekmece Dam Lake lost its lagoon characteristics and became a freshwater lake (Özuluğ 1999). It has been reported that the lake meets the drinking and potable water needs of Istanbul with 70 hm^3 of water per year (Aktan et al. 2006).

It has been reported that the total watershed area of Büyükçekmece Dam Lake is 622 km^2, with a surface area of 28.5 km, a length of 10 km and a width of 2.5 km (Soyer 2003). The maximum depth of the lake was reported to be 7.15 m by Meriç (1992). The main stream of the lake is The Karasu Stream in the north of the lake. It has many tributaries such as Delice, Karamurad, Tavşan, Ayva, Akalan, Kestanelik and Öncürlü. Keşliçiftiği on the west side of the lake and Çekmece Streams on the east side are other sources (Özuluğ 1999; Dorak 2019). The Büyükçekmece dam lake and sampling locations are shown in Figure 1.

Figure 1. Sampling locations

In 2020, research was planned to be conducted over four seasons. For this purpose, 4 stations were determined. The study was carried out in two phases: field and laboratory work. During the field study, the water the turbidity was measured in meters using a secchi disk. The water temperature of the stations was measured in ºC using a simple thermometer. A tape measure was used to measure the depth of the water at the stations which was determined in m. The pH, electrical conductivity (in µS/cm) and salinity (in ‰) of the water were measured during sampling using a YSI 556 model multiparameter meter.

The Total hardness (in ºFS), NO_2-N, NO_3-N and PO_4 values (in mg/l) were calculated (APHA, AWWA, WPCF 1989). Simultaneously to the water sampling, benthos were also sampled from the sediment part of the lake. The benthos samples taken using Ekman grab (15x15) were homogenized with lake water. Each station was sampled once with an Ekman grab collection. Three sieves with different mesh sizes (1.19 mm, 0.595 mm, 0.297 mm respectively) were passed through the sieves. The organisms remaining on the sieves were placed in plastic mud bottles containing 70% ethyl alcohol with the help of fine-tipped forceps and sealed with the station number. Mud bottles transported to the laboratory were removed from the deposit under a stereobinocular microscope and placed in glass tubes containing 70% alcohol. Sample collection, sieving, fixation The methods of Welch, 1948 were utilized in the identification and conservation. Oligochaeta specimens were identified under an Olympus CK2 inverted microscope by preparing permanent and temporary preparations (temporary preparations were made with glycerin and permanent preparations were made with polyvinyl lactophenol). Brinkhurst and Jamieson (1971), Timm (2009), Wetzel et al. (2000) were used for species identification. Identified organisms were also counted and the number of individuals per m^2 and dominance ratios were determined according to Bellan-Santini (1969).

Results

The seasonal measured values, minimum, maximum, average and quality classes of the stations according to the Turkish Surface Water Quality Control Regulation (TSWQR 2021) and Water Pollution Quality Control Regulation (SKKY 2004) are given in Table 1.

Table 1. Some Physicochemical Data of Büyükçekmece Lake Measured Seasonally

Stations	Variables	Spring	Summer	Autumn	Winter	Average	TSWQR, 2021	SKKY 2004
Station 1	Secchi (m)	0.5	1	1	1	0.8		
	W.T. (ºC)	5	21	15	4	13.2		I
	Depth (m)	1	1	1	1.5	1.2		
	D.O (mg/l)	8	6	7	12	8.6	I and II	
	pH	7.5	7	7.3	7.3	7.27	I	
	E.C (µS/cm)	453	550	498	500	500	I and II	
	Salinity (‰)	0.03	0	0	0.03	0.03		
	T.H. (^{0}FS)	13	13	12	17	13.4		
	NO_2-N (mg/l)	0	0.002	0	0	0.0005		I
	PO_4- (mg/l)	0	0.001	0	0.0103	0.0028		
	NO_3-N (mg/l)	0	0.001	0	0	0.0002	I	I
Station 2	Secchi (m)	0.5	1	0.5	1	0.7		
	W.T. (ºC)	5	24	15	5	14.4		I
	Depth (m)	2	2	2	2	1.9		
	D.O (mg/l)	10	5	8	9	8.8	I and II	
	pH	6.8	7	7	7	7.16		
	E.C (µS/cm)	452	550	514	526	510	I and II	
	Salinity (‰)	0.03	0	0	0.03	0.015		
	T.H (^{0}FS)	14	13	14	17.3	14.5		
	NO_2-N (mg/l)	0	0.001	0	0	0.0005		I
	PO_4 (mg/l)	0	0.001	0	0.008	0.0022		
	NO_3-N (mg/l)	0	0	0	0	0	I	

	(table continues)							
Station 3	Secchi (m)	1	1	0.5	2	1.2		
	W.T. (°C)	5	25	17	5	13		
	Depth (m)	2	2	2	2	2		
	D.O (mg/l)	10	7	7	11	8.75	I and II	
	pH	8	7	7	7.6	7.52	I	
	E.C (µS/cm)	470	545	500	510	506	I and II	
	Salinity (‰)	0.03	0	0	0.03	0.015		
	T.H.(^{0}FS)	13.4	13	12	18.9	14		
	NO_2- N mg/l)	0.026	0.001	0	0.068	0.023		III
	PO_4 (mg/l)	0	0.001	0	0.05	0.012		
	NO_3-N (mg/l)	0	0	0	0	0		
Station 4	Secchi (m)	0.5	1	1	1	1		
	W.T (°C)	5	25	17	5	13		I
	Depth (m)	7	7	7	5	6.5		
	D.O (mg/l)	10	7	7	11	8.75	I and II	
	pH	6	7	7	7.3	6.82		
	E.C (µS/cm)	480	540	514	498	508	I and II	
	Salinity (‰)	0.03	0	0	0.03	0.03		
	T.H. (^{0}FS)	12.9	12	13	18.9	14.2		
	NO_2-N (mg/l)	0.088	0.001	0	0.034	0.031	.	III
	PO_4 (mg/l)	0.011	0.001	0	0.0009	0.003		
	NO_3-N (mg/l)	0	0	0	0	0	I	

(W.T: water temperature; D.O:dissolved oxygen; E.C:electirical conductivity; T.H.:total hardness; NO_2-N:nitrite nitrogen, PO_4: phosphate; NO_3-N: nitrate nitrogen)

As a result of the identification of the Oligochaeta collected from the lake, it was found that 55.07% of the lake was composed of *L. udekemianus* and 44.93% of the lake was composed of *L. hoffmeisteri*. A total of 1976 individuals were detected in each m^2 of the lake. The highest number of individuals was 3333 individuals per m^2 at the 2nd station, followed by 2311 individuals per m^2 at the 1st station. A total of 1554 individuals were found at the 3rd station and 707 individuals were found at the 4th station. The distribution and dominance ratios of Oligochaeta species collected from the dam lake in terms of stations and seasons are presented in Table 2.

Table 2. Distribution and dominance ratios of species in Büyükçekmece dam lake according to seasons and stations

Seasons	Species	St. 1	St. 2	St. 3	St. 4	Total	Dominance %
Spring	*Limnodrilus hoffmeisteri*	-	-	400	-	400	5.06
	Limnodrilus udekemianus	179	311	-	311	800	10.12
Summer	*Limnodrilus hoffmeisteri*	844	533	400	44	1821	23,04
	Limnodrilus udekemianus	756	800	222	132	1910	24.17

(table continues)

Autumn	*Limnodrilus hoffmeisteri*	178	-	44	44	266	3.36
	Limnodrilus udekemianus	222	-	178	-	400	5.06
Winter	*Limnodrilus hoffmeisteri*	88	800	88	88	1064	13.47
	Limnodrilus udekemianus	44	889	222	88	1243	15.72
	Total	2311	3333	1554	707	7904	100

Limnodrilus hoffmeisteri	44.93 %
Limnodrilus udekemianus	55.07 %

When the dominance rates were analyzed, the highest dominance rate was found in summer with 47.21%, followed by winter with 29.19%. Oligochaeta were 15.18% in spring and 8.42% in autumn (Figure 2).

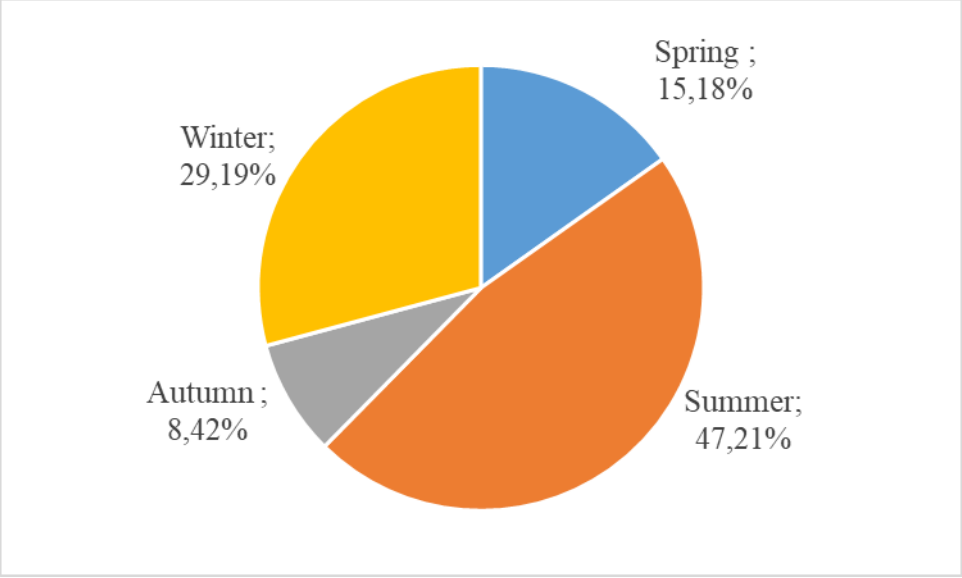

Figure 2. Seasonal Distribution of Oligochaeta in Büyükçekmece Dam Lake

Discussion

As a result of the study, 1976 individuals were detected in each m^2 of the lake. Two aquatic species of Oligochaetas, *L.hoffmeisteri* and *L.udekemianus* were detected in the lake. The detected species were observed in all seasons. The decrease in the predominance of Oligochaetas in spring and autumn can be attributed to the increase in water level due to the rainy seasons, and sampling could not be done completely from the lake.

When Büyükçekmece Lake is analyzed in terms of physicochemical data, it was observed that water temperature, pH, NO_2-N values are in 1st class water quality. DO and EC values were found to be between 1st and 2nd class water quality. NO_3-N values were not found at 2nd and 4th stations in all seasons. NO_2-N values were found to be in 1st and 2nd class water quality throughout the lake. NO_2-N value was found to be in the 4th quality in the winter season at station 3 and in the spring season at station 4 (TSWQR 2021; SKKY 2004).

Bayram and Kankal (2015) stated that one of the most important factors affecting DO concentration in surface waters is W.T. The increase in temperature decreases the solubility of oxygen in water. Based on this relationship, they reported that the amount of DO in cold water is higher than in warm water. In this case, DO concentration in surface waters increases in winter months when temperatures are low and decreases in summer months when temperatures are

high. In this study conducted in Büyükçekmece Dam Lake, it was determined that DO concentration was higher in winter and lower in summer. The graph of temperature and DO values determined during the seasons are plotted in Figure 3.

Koşal-Şahin (2006) reported that taxa such as *L.udekemianus, L.hoffmeisteri*, *Limnodrilus* sp., *Nais communis*, *Nais* sp., *Potamothrix hammoniensis*, *Psammoryctides albicola*, *Stylaria lacustris*, *Tubifex tubifex* were found. When our study is compared with this study, it is seen that there is a decrease in species diversity. Koşal-Şahin (2006) reported that 9 taxa were found in the lake. In this study, two species were found, only.

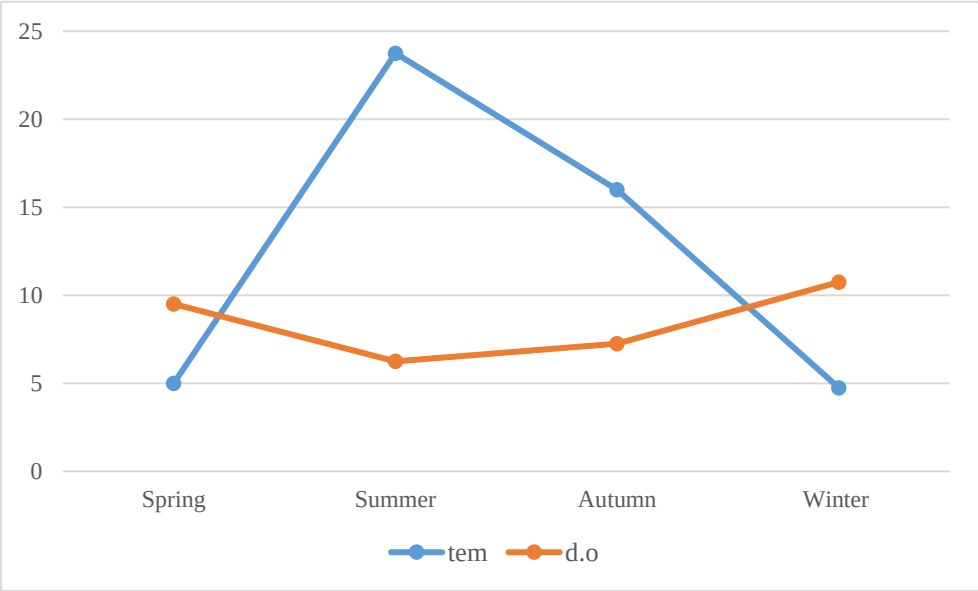

Figure 3. Temperature and dissolved oxygen graph of the lake

Koşal-Şahin (2006) reported that 939 per m^2 belonged to Oligochaeta in Büyükçekmece Lake. In this study, 1976 individuals were found in each m^2 of the lake. It was determined that the number of individuals per m^2 of Oligochaeta has doubled in the last 18 years. This may be because species that are indicators of pollution have adapted to the environment and proliferated, resulting in the disappearance of other species. The main impact of organic pollution in aquatic systems is seen on the community structure. Changes in the abundance and diversity of living organisms, especially with changing environmental conditions, occur in the form of an increase in the accumulation of organic matter on the substrates caused by the accumulation of wastes, which is preferred by some organisms. Accordingly, species that become dominant in an environment suppress other species, thus reducing species diversity (Kazancı et al.1997).

L. hoffmeisteri, one of the most common species in our study, is a highly pollution tolerant species and, together with other Tubificid species, is more frequently found in polluted habitats (Brinkhurst and Jamieson 1971; Timm 1999). It has been reported that *L. udekemianus* is a cosmopolitan species that can be found in many different environments, from oligotrophic habitats to habitats rich in organic matter (Timm 1970). In the study, the mean water temperature of the lake was found to be 13.4 ºC, the dissolved oxygen value was found to be 8.72 mg/L, the pH value was 7.19 and the salinity value was found 0.02 ppm. The electrical conductivity value of the lake was found 506 µS/cm and the secchi disk depth was 0.92 m.

Dorak (2019) reported the average water temperature of the lake as 16.3ºC and dissolved oxygen value as 9.5 mg/l. She found that the average pH value of the lake was 8.1 and the salinity value was 0.23 ppm. The electrical conductivity value of the lake was 473.1 µS/cm and the secchi disk depth was 0.8 m.

Arslan (2006) reported 1 potamodrilid, 4 aeolosomatids and 94 Oligochaeta species (1 lumbriculid, 1 haplotaxid, 46 naidids, 38 tubificids, 6 enchytraeids, 1 lumbricid and 1 criodrilid) from aquatic systems in different regions of Turkey. Information on the distribution of these species is described. Odabaşı et al. (2018) investigated the aquatic oligochaete fauna of the rivers in the Biga Peninsula and their seasonal variations. They reported that 33 taxa were identified as belonging to Oligochaeta. Their findings indicated that the pH and NO_3-N values of the streams fell within the 1st class

quality range, while the EC, DO and biological oxygen demand (BOD) values ranged between the 1st and 2nd class water quality levels. Fındık et al. (2019) conducted such a study in Damsa Dam Lake (Nevşehir). They reported 3 species of Oligochaeta; *Stylaria lacustris*, *Limnodrilus hoffmeisteri*, *Nais elinguis* species in the lake. They determined that the Oligochaetas were the most dominant group in the summer season. Yıldız and Balık (2006) determined the Oligochaeta fauna of Topçam Dam Lake. As a result of the research, they identified 11 Oligochaeta species. It was reported that *Limnodrilus hoffmesteri* was the dominant species in the lake and constituted 64.64% of the whole community. Yıldız et al. (2008) determined the macrobenthic fauna of Kemer reservoir. They found 10 taxa belonging to the Oligochaeta. They reported that 498 individuals were found in m^2 of the dam lake.

Albayrak et al. (2023) identified nine Oligochaeta taxa in their study of the Göksu stream. They reported that the DO values of the stream fell within the range of the 1st and 2nd classes, while the EC values are categorized in the 2nd class. Total phosphorus (TP) values are classified in the 3rd class, orthophosphate (o-PO_4) values in the 1st class, and ammonium nitrogen (NH_4-N) values were classified into the 2nd class.

As a result, two (*L.hoffmeiseri* and *L.udekemianus*) pollution indicator species of Oligochaeta were detected in the study conducted in Büyükçekmece dam lake for one year, seasonally. It was determined that Oligochaeta were represented by 1976 individuals in m^2. In the spring season at station 4 and in the winter season at station 3, NO_2-N variables decreased to 4th quality was determined.

It is recommended that the dam lake, which provides water to a large part of Istanbul, be examined in terms of various physicochemical, microbiological and toxicological parameters for all benthic macroinvertebrates and that these and similar studies be carried out at regular intervals.

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