Phytoplankton Composition and Water Quality of Kamil Abduş Lagoon (Tuzla Lake), Istanbul-Turkey

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Abstract

In this study, water quality and pollution status of Kamil Abduş Lagoon (Tuzla Lake), which is one of the special lagoons of Istanbul Metropolitan, were analyzed. For this purpose, phytoplankton composition, some physicochemical parameters and nutrient concentrations of the lake were investigated. Samples were collected at 3 sampling sites between February 2016 and January 2017. A total of 31 taxa, belonging to Bacillariophyta (12), Charophyta (1), Chlorophyta (4), Cryptophyta (1), Cyanobacteria (4), Euglenozoa (5) and Miozoa (4) were identified. Both of freshwater and marine species were recorded in the study area. The presence of mesotrophic and eutrophic species of phytoplankton indicated that the trophic structure of the lake is eutrophic. Also it is supported by high concentrations of chlorophyll-*a* and nutrients. Due to the lagoon is under treat by pollution it is need to be urgently protected.

Keywords: Phytoplankton, water pollution, physicochemical parameters, nutrients, Kamil Abduş Lagoon.

1. Introduction

They are unique and constitute very sensitive natural habitats for many life forms. In addition, they have great socio-economic importance in terms of providing opportunities for agriculture, aquaculture, fishing, tourism and recreation. Because of nutrient richness, lagoons are one of the most productive coastal ecosystems, hosting a wide variety of species. Increasing pollution levels resulting from growing population and industrialisation pose a significiant threat to water quality and aquatic life in lagoons (Kocatas, 2008; Kislalioglu and Berkes, 2001). Turkey is a coastal country surrounded by the sea on three sides and has a shoreline spanning about 7,816 km. There are 72 lagoon areas in Turkey (Kocatas, 2008). Kamil Abduş Lagoon is one of the lagoons which is placed in the Marmara Region. It is also known as Tuzla Fish Lake or Tuzla Bird Lake due to its rich bird and fish fauna especially before the introduction of industrial works into this area. It was stated that in earlier studies after the drought, most of the birds migrated, leaving only a few species which gathered in the central part of the dried lake. The aim of our study is to determine the pollution level and create consideration for taking necessary precautions against the ecological problems in this lake ecosystem.

2. Materials and Methods

2.1. Study Area

Kamil Abduş Lagoon which is located on the Anatolian side of Istanbul, near to the town Tuzla, was initially a bay changed into a lake due to redistribution and reaccumulation of the sediments of Aydınlı Creek in the front of the bay depression. The lake has an area of approximately 0.7 km^2; the average depth is 0.8 m in the winter and 0.6 m in the spring. The average water reserve of the lagoon is 500 000 m^3 (Figure 1). between terrestial and marine ecosystems, and are affected by physical, chemical and biological changes in both environments. Lagoon systems comprise approximately 13% of the earth's coastline. Coastal lagoons form a transition zone.

Figure 1. Map of Kamil Abduş Lagoon and sampling sites.

2.2 Sampling and Analyses

The study was carried out between February 2016 and January 2017 at three different sampling stations. Samples were taken montly from the surface with using Nansen bottles and were fixed with Lugol's iodine. Phytoplanktonic organisms were identified in reference to the literature, including several comprehensive reviews on the subject (Hustedt, 1930; Desikachary, 1959; Prescott, 1961; Prescott, 1964; Patrick & Reimer, 1966; Patrick & Reimer, 1975; Huber-Pestalozzi, 1975; Hustedt, 1985; Krammer & Lange-Bertalot, 1986; John *et al.*, 2003). Chlorophyll-*a* measurements were estimated according to Parsons and Strickland (1963). Water temperature, dissolved oxygen, pH, salinity and electrical conductivity were measured with the WTW Multi 340i /set made multiparameter in the field. Nitrite (NO_2), nitrate (NO_3) and orthophosphate (PO_4) concentrations of the water were determined at the laboratory, according to standard methods (Greenberg, 1995).

3. Results and Discussion

3.1. *Phytoplankton Composition*

During the study periyod, a total of 31 taxa, belonging to Bacillariophyta (12), Charophyta (1), Chlorophyta (4), Cryptophyta (1), Cyanobacteria (4), Euglenozoa (5) and Miozoa (4) were identified. Bacillariophyta was determined as the richest group in term of species numbers. The list of recorded taxa of phytoplankton was given in Table 1 and the percentage distribution of phytoplankton groups was showed in Figure 2.

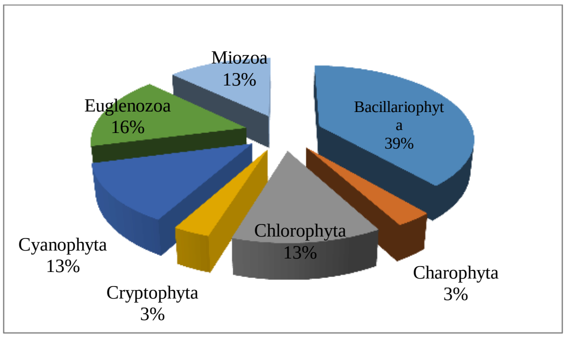

Figure 2. Percentage distribution of phytoplankton divisions.

Table 1. Recorded taxa of Kamil Abduş Lagoon.

DIVISIO: BACILLARIOPHYTA	**DIVISIO: CHAROPHYTA**
Order: Aulacoseirales	**Order: Desmidiales**
Aulacoseira italica (Ehrenberg) Simonsen	*Closterium acutum* Brébisson
Order: Bacillariales	**DIVISIO: CRYPTOPHYTA**
Nitzschia acicularis (Kützing) W.Smith	**Order: Cryptomonadales**
Order: Cocconeidales	*Cryptomonas ovata* Ehrenberg
Cocconeis placentula Ehrenberg	**DIVISIO: CYANOBACTERIA**
Order: Cymbellales	**Order: Chroococcales**
Cymbella affinis Kützing	*Microcystis aeruginosa* (Kützing) Kützing
Gomphonema truncatum Ehrenberg	**Order: Nostocales**
Order: Licmophorales	*Anabaena spiroides* Klebahn
Ulnaria acus (Kützing) Aboal	**Order: Oscillariotales**
Ulnaria ulna (Nitzsch) Compère	*Oscillatoria tenuis* C.Agadh ex Gomont
Order: Melosirales	**Order: Synechococccales**
Melosira varians C.Agardh	*Merismopedia glauca* (Ehrenberg) Kützing
Order: Naviculales	**DIVISIO: EUGLENOZOA**
Navicula cryptocephala Kützing	**Order: Euglenales**
Order:Rhopalodiales	*Euglena gracilis* G.A. Klebs
Epithemia sp.	*Euglena variabilis* G.A. Klebs
Order: Stephanodiscales	*Euglena viridis* (O.Müller) Ehrenberg
Cyclotella atomus Hustedt	*Phacus* sp.
Order:Thalassiophysales	*Trachelomonas hispida* (Perty) F. Stein
*Amphora ovalis (*Kützing) Kützing	**DIVISIO: MIOZOA**
DIVISIO:CHLOROPHYTA	**Order: Noctilucales**
Order:Clamydomonadales	*Noctiluca miliaris* Suriray, nom. inval.
Clamydomonas sp.	**Order: Peridiniales**

Order: Oedogoniales	*Peridinium bipes* Stein
Oedogonium sp.	**Order: Prorocentrales**
Order: Sphaeropleales	*Prorocentrum lima* (Ehrenberg) F.Stein
Ankistrodesmus falcatus (Corda) Ralfs	*Prorocentrum micans* Ehrenberg
Scenedesmus sp.	

Table 2. Some measured physicochemical parameters, nutrients and chlorophyll-*a* of the lagoon.

		Temp. (°C)	pH	Dis.O_2 (mg/L)	Sal. (‰)	Cond. mS/cm	Chl-*a* (μg/L)	NO_2 (mg/L)	NO_3 (mg/L)	PO_4 (mg/L)
Feb.16	St.1	11.9	8.17	10.79	24.5	39.7	0.46	0.015	0.417	0.031
	St.2	11.9	8.25	11.5	24.5	39.6	0.84	0.008	0.855	0.045
	St.3	13.6	8.6	10.66	21.1	34.2	11.4	0.053	2.463	0.045
Mar.16	St.1	11.03	8.39	8.39	25.4	40.9	2.01	0.008	0.125	0.04
	St.2	11.3	8.38	7.42	24.6	39.6	2.15	0.002	0.046	0.054
	St.3	11	8.62	9.66	18.4	30.4	20.1	0.052	1.618	0.111
Apr.06	St.1	18.8	8.39	8.65	24.1	58.4	1.36	0.041	0.035	0.049
	St.2	21.4	8.16	5.86	25.1	39.5	3.11	0.232	0.217	0.072
	St.3	19.5	7.9	3.1	23.2	37	21.5	0.925	0.39	0.147
May.16	St.1	24.3	8.61	6.19	21.5	34.3	0.71	0.018	0.041	0.035
	St.2	27.2	8.57	5.54	23.2	36.5	4.06	0.022	0.015	0.041
	St.3	30.6	8.63	6.02	17.1	27.7	22.9	0.018	1.591	0.054
Jun.16	St.1	29.4	8.81	5.05	23.4	36.9	6.99	0.071	0.038	0.057
	St.2	29.3	8.72	4.93	23.4	36.8	5.31	0.008	0.016	0.055
	St.3	29.7	8.38	3.23	21	33.3	33.5	0.039	0.049	0.777
Jul.16	St.1	27.6	8.62	4.16	23.8	37.3	1.93	0.002	0.031	0.051
	St.2	28.1	8.64	3.64	24.6	38.5	2.28	0.013	0.016	0.035
	St.3	28.6	9.22	7.03	23.1	36.2	16.1	0.009	0.012	1.057
Agu.16	St.1	28.8	8.5	5.33	23.3	36.7	0.71	0.005	0.028	0.062
	St.2	28.6	8.83	4.99	25.2	39.2	7.37	0.012	0.012	2.818
	St.3	27.9	8.89	4.11	25.2	39.3	34.2	0.014	0.007	0.547
Sep.16	St.1	21	7.82	5.7	23.6	37.8	2.71	0.004	0.044	0.068
	St.2	20.7	8.1	4.11	24.9	39.6	0.64	0.006	0.036	2.915
	St.3	20.8	8.44	7.61	22.9	36.8	166.6	0.006	0.035	0.112
Oct.16	St.1	17.8	7.93	6.45	24.2	38.4	5.78	0.007	0.025	0.075
	St.2	18.3	8.04	7.47	24	38.1	1.96	0.005	0.031	2.627
	St.3	17.9	7.85	4.7	21	34.2	64.5	0.039	0.071	0.142
Nov.16	St.1	14.7	8.12	6.7	23.8	38.2	1.88	0.007	0.025	0.043
	St.2	12.7	8.13	7.87	23.4	37.5	2.96	0.005	0.601	0.046
	St.3	13.1	8.6	12.17	17	28	349.2	0.0001	2.481	0.082
Dec.16	St.1	8.4	7.97	9.5	24.4	39.6	5.22	0.0161	0.069	2.651
	St.2	7.5	7.96	8.67	23.1	37.9	5.88	0.035	0.382	0.121
	St.3	8.6	7.09	0.93	4.2	7.74	8.45	2.431	0.436	3.087
Jan.17	St.1	7.1	8	8	24.4	39.6	5.22	0.0161	0.069	2.651
	St.2	7.4	8	9.41	23.1	37.9	5.88	0.035	0.382	0.121
	St.3	11	7.29	1.76	4.2	7.74	8.45	2.431	0.436	3.087

According to previous studies carried out in the freshwaters of Turkey, Bacillariophyta members were found to be the dominant group in terms of species number as in the presented study (Yilmaz and Aykulu, 2010; Yilmaz, 2013; Yilmaz, 2015). Bacillariophyta was represented by 12 taxon. It is stated that *Aulocoseira italica* and *Cyclotella atomus* of diatoms are found generally in vertical mixed mesotrophic small- medium lakes with tolerance to light deficiency and sensitive to a rise in pH. *Ulnaria acus* and *Nitzschia acicularis* of pennate diatoms are habitants of shallow enriched waters and streams with sensivity to nutrient deficiency. While *Gomphonema truncatum*, *Navicula cryptocephala* and *Ulnaria ulna* were usually present in mixed inorganically shallow lakes, *Melosira varians* is known as a lotic habitat member. Charaophyta was represented by a desmid *Closterium acutum*. It has tolerances to light and carbon deficiencies. Chlorophyta was represented by 4 species. A member of green algae *Ankistrodesmus falcatus* is recorded generally in shallow eutrophic and mesotrophic waters and it is sensitive to nutrient deficiency. *Scenedesmus* sp. of this division is sensitive to low light and presents in enriched ponds, lakes and streams. During the study *Chlamydomonas* sp. which indicates eutrophic aquatic systems, was recorded in high numbers especially in station 1 in February 2017. Species of this genus are widespread in freshwater but marine species are less common. Crytophyta was represented by *Cryptomonas ovata* which is presented in small enriched lakes. Cyanophyta was represented by 4 species. It is known that *Anabaena spiroides*, *Oscillatoria tenuis* and *Merismopedia galauca* of blue-green algae are indicated eutrophic conditions. Especially *Microcystis aeruginosa*, a toxic cyanobacteria, indicates organically and agricultural enriched eutrophic and also hypereutrophic waters. Euglenozoa was represented by 5 species. It was stated that species of *Euglena* genus are found commonly in shallow mesotrophic and organically polluted lakes. Miozoa was represented by 4 species which are found both in freshwaters and marine systems. It was expressed that these dinoflagellates are presented from oligotrophic to eutrophic waters in a wide range (Reynolds *et. al*, 2002; Padisak *et al*., 2009).

3.2. Pysicochemical Parameters and Chlorophyll-a

As a result of measurements, the minimum and maximum values of some physicochemical parameters and nutrients were as follows; water temperature (7.1- 30.6ºC), dissolved oxygen (0.93-12.17 mg/L), pH (7.29-9.22), salinity (4.2-25.4‰), electrical conductivity (7.74- 58.4 mS/cm), nitrite (0.0001-2.431 mg/L), nitrate (0.012-2.48 mg/L) and orthophosphate (0.031-2.915 mg/L). Measured chlorophyll-*a* concentrations varied between 0.46 µg/L and 349.2 µg/L. In this study, electrical conductivity values were higher than the standard limits (150-500 µS/cm) of the protocols assigned for protection of surface water sources against pollution (Uslu and Türkman,1997). According to the measured pH values, water of Kamil Abduş Lagoon is slightly alkaline (within normal limits) and is of class I and II water quality. During the study dissolved oxygen concentrations were measured in low levels. The minimum concentration of dissolved oxygen was measured in station 3 in December 2016. In general nitrite, nitrate and orthophosphate concentrations were determined in high levels. Chlorophyll- *a* distribution is an important indicator of pollution and primary production in surface waters. It was known that chlorophyll- *a* was used for determining the algal biomass in many investigations (Uslu and Türkman, 1987). In the present study, chlorophyll-*a* concentrations were estimated between 0.46 µg/L and 349.2 µg/L. Sokomoto (1966) was expressed that, chlorophyll-*a* concentrations between 5- 140 µg/L indicates eutrophic lakes (Cirk and Cirik, 1991). High levels of chlorophyll- *a* concentrations which shows hypereutrophic conditions, were measured in station 3 in summer and autmn in Kamil Abduş Lake.

4. Conclusion

The presence of mesotrophic and eutrophic species of phytoplankton indicated that the trophic structure of the lake is eutrophic. Also it is supported by measured high levels of chlorophyll-*a* and nutrients. Due to the lagoon is under treat by pollution, it is need to be protected according to the environmental regulations. Therefore detailed studies on phytoplankton including physicochemical parameters, heavy metal and nutrient concentrations, have to be carried out for controlling and monitoring the water quality in Kamil Abduş Lagoon.

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