

Report

Phytoplankton composition of Sazlidere Dam lake, Istanbul, Turkey

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Abstract: The phytoplankton composition of Sazlidere Dam lake was studied at 5 sampling sites between December 2003 - November 2005. A total of 67 taxa were recorded, representing Bacillariophyta (31), Chlorophyta (18), Cyanophyta (9), Chrysophyta (1), Cryptophyta (1), Dinophyta (3) and Euglenophyta (4). Bacillariophyta members constituted the dominant phytoplankton group in terms of species number. Nygaard's compound index value and composition of phytoplankton indicate that the trophic state of Sazlidere Dam lake was changing from oligotrophic to mesotrophic.

Keywords: phytoplankton, taxonomy, Sazlidere Dam lake, Turkey

INTRODUCTION

Water is essential for the survival of all organisms on the earth. About 97% of earth's water is found in the ocean, 2% is frozen as ice in the poles and the remaining 1% is available in the form of freshwater, which is used for daily needs, irrigation and industries [1]. Population growth, overurbanisation, integrated industry and increasing use of natural resources lead to water pollution problems in Turkey, as well as the rest of the world [2]. Access to clean and safe water has become more difficult because of the gradual decreases in available fresh water.

Phytoplankton are the primary producers in the food chain and they are very important organisms in aquatic systems. Phytoplankton species can be used as indicators of water quality, given their sensitivity and dynamic responses to changes in the surrounding environment [3]. According to the EU Water Framework Directive introduced in 2000, phytoplankton are one of the four biological elements suggested for assessing the ecological status and potential of surface waters in Europe [4, 5]. Taxonomic studies of phytoplankton are very effective in re-evaluation of the uses and stability of lakes. In particular, data on the algal flora of water sources are commonly used in the preservation, improvement and control of water quality. To date, few studies have been conducted to investigate the Sazlidere Dam lake and most of them are modelling studies. To our knowledge, this is the first report on the phytoplankton composition of Sazlidere Dam lake, one of

the drinking water resources of the Istanbul metropolitan area. The aim of the study is to determine the diversity of the phytoplanktonic algal flora of the Sazlidere reservoir.

STUDY AREA AND CLIMATE

Istanbul is located in the north-western part of Turkey and it extends both on European and Asian sides of the Bosphorus Strait. It is the only metropolis in the world that is situated on two continents. Its neighbours are the Black Sea in the north, Marmara Sea in the south, Kocaeli City in the east and Tekirdag City in the west. Istanbul has approximately 5100 km² of land area and a population of 13 million. In its long history, Istanbul served as a capital city of the Roman empire, the Byzantine empire, the Latin empire and the Ottoman empire. In addition to its rich history, high population and productive economy, Istanbul also has a wide variety of ecological features [6].

Istanbul is a kind of transition zone between the less rainy Mediterranean climate and the oceanic climate. In summer, less precipitation and high temperature are characteristic and the annual mean temperature is 14.5°C for the last two decades. Between May-September the temperature is generally above 30°C and between November-April it is rarely below 0°C. The total precipitation for Istanbul averages 640 mm per year. The rain regime is winter-autumn-spring-summer and the rain type is Central Mediterranean. The relative humidity is between 73-77% in the city, which decreases to 65-68% in summer despite the effect of the seas. The dominant wind in the city is the northeast-originated wind [7].

Sazlidere Dam is located in the Marmara region on the European peninsula of Istanbul, south-east of Lake Terkos (Durusu) and north-east of Lake Kucukcekmece (Figures 1-2). The dam is on the Sazlidere stream approximately 6 km from Lake Kucukcekmece. The reservoir aspect is 20 km east-west and 9 km north-south. The dam has a drainage area of 165 km² and average depth of 22.4 metres. It was completed in 1966 and is used to supply drinking and utility water, and as a sport fishing and recreational area. Sazlidere reservoir provides 55 million m³ of water per year to Istanbul [8].

SAMPLING AND PHYTOPLANKTON IDENTIFICATION

This study was carried out between December 2003 - November 2005 at 5 sampling stations (Figure 1) on a monthly basis. The first station was at the stream input; station 2 was located in the littoral of Sazlibosna settlement area; station 3 was at the shore of the stone quarries; station 4 was situated in front of a road channel and station 5 was located on the deepest part of the dam, which is close to the dam embankment (Figures 3-7). The locations of the sampling sites are given in Table 1.

Samples were taken both on the surface and vertically in Nansen bottles and fixed with Lugol's iodine [9]. Phytoplankton species were identified using several comprehensive reports on the subject [10-19]. The proportional representation of phytoplankton groups is used to determine the primary production of lakes. Of those, Nygaard's compound index [20] is determined by dividing the total number of species of Cyanophyceae, Chlorococcales, Centrales and Euglenaceae by the number of species of Desmidiaceae. Nygaard's compound index was used to determine the trophic state of Sazlidere Dam.

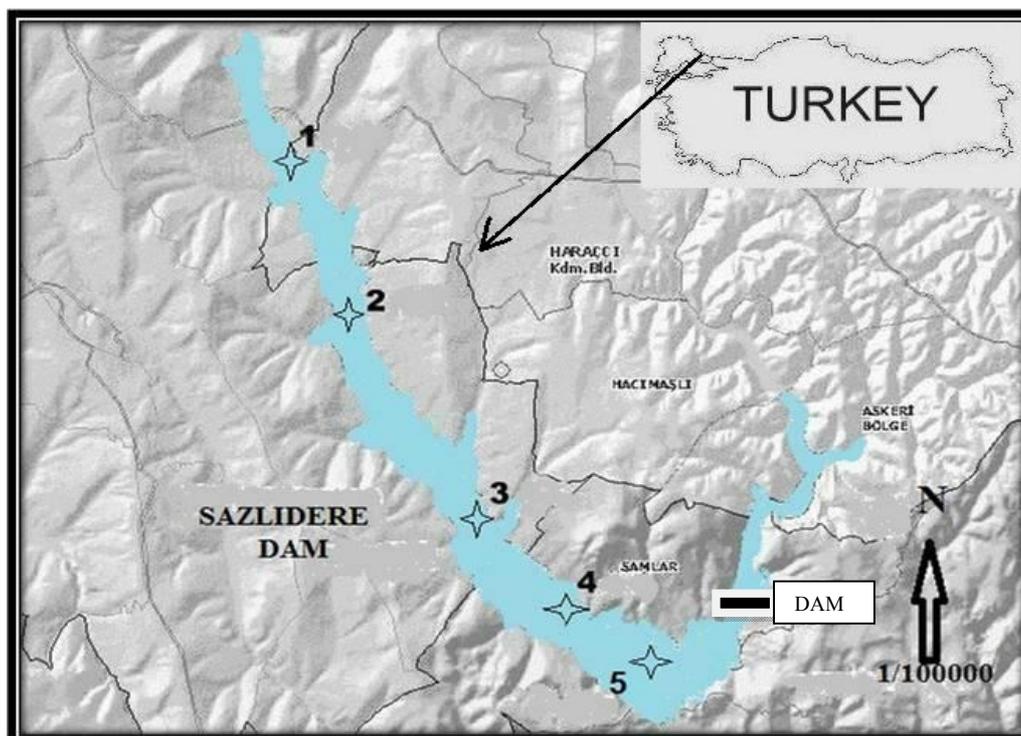


Figure 1. Map of Sazlidere Dam and sampling stations

Table 1. Locations of sampling stations

Station 1	N 41° 11 ' 31.4"	E 028° 38 ' 37.9"
Station 2	N 41° 09 ' 02.0"	E 028° 40 ' 16.2"
Station 3	N 41° 07 ' 57.9"	E 028° 41 ' 10.02"
Station 4	N 41° 07 ' 22.7"	E 028° 42 ' 08.2"
Station 5	N 41° 07 ' 08.09"	E 028° 42 ' 34.5"



Figure 2. Sazlidere Dam



Figure 3. Station 1



Figure 4. Station 2



Figure 5. Station 3



Figure 6. Station 4



Figure 7. Station 5

RESULTS AND DISCUSSION

A total of 67 phytoplankton taxa were identified. They belong to 7 divisions: Bacillariophyta (31 taxa), Chlorophyta (18 taxa), Cyanophyta (9 taxa), Euglenophyta (4 taxa), Dinophyta (3 taxa), Chrysophyta (1 taxon) and Cryptophyta (1 taxon). A list of the recorded taxa is given in Table 2 and the occurrence frequencies are given in Table 3. The major members of phytoplankton were Bacillariophyta, Chlorophyta and Cyanophyta and Bacillariophyta constituted the dominant phytoplankton group in terms of species numbers (48%). The distribution of phytoplankton groups by taxa (percentage) is shown in Figure 8.

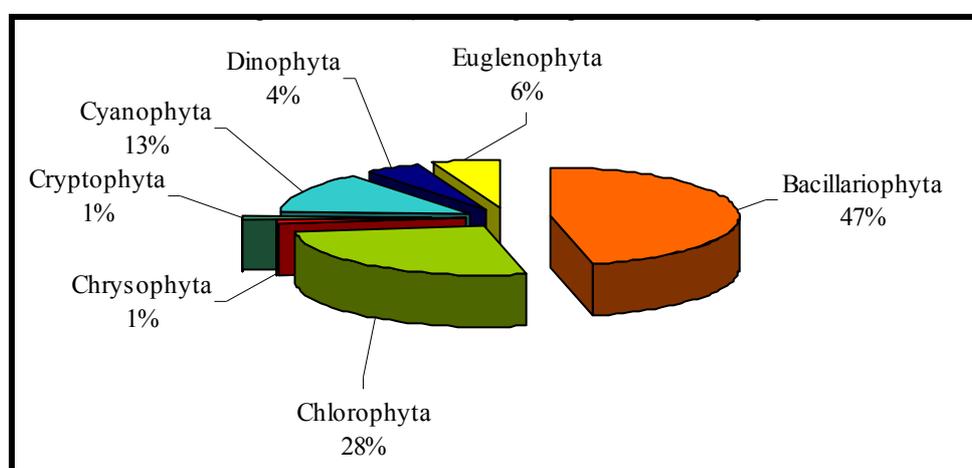


Figure 8. Sazlidere Dam phytoplankton diversity by division (percentage)

Table 2. List of recorded taxa**DIVISION BACILLARIOPHYTA****Order Centrales***Aulocoseira italica* (Ehr.) Simonsen*Cyclotella atomus* Hust.*Cyclotella ocellata* Pant.*Melosira varians* Ag.*Stephanodiscus astrea* Grun.**Order Pennales***Achnanthes lanceolata* (Breb.) Grun.*Amphora ovalis* Kütz.*Cocconeis placentula* Ehr.*Cymbella affinis* Kütz.*Cymbella tumida* (Breb.) Van Heurck*Cymbella prostrata* (Berkeley) Cl.*Diatoma vulgare* Bory*Diploneis elliptica* (Kütz.) Cl.*Fragilaria crotonensis* Kitton*Fragilaria pinnata* Ehr.*Gomphonema clavatum* Ehr.*Gomphonema truncatum* Ehr.*Navicula ambigua* Ehr.*Navicula cuspidata* (Kütz.) Kütz.*Nitzschia acicularis* (Kütz.) W. Sm.*Nitzschia linearis* (Ag.) W. Sm.*Nitzschia palea* (Kütz.) W. Sm.*Nitzschia panduriformis* Gregory*Nitzschia sigmoidea* (Nitzsch) W. Sm.*Pinnularia* sp.*Rhapholodia gibba* (Ehr.) O.Müll.*Rhoicosphenia* sp.*Surirella ovata* Breb.*Tabellaria* sp.*Ulnaria acus* (Kütz.) M. Aboal*Ulnaria ulna* (Nitzsch) P. Compere**DIVISION CHLOROPHYTA****Order Chlorococcales***Coelastrum microporum* (Naeg.) A. Braun*Kirchneriella* sp.*Monoraphidium falcatus* (Corda) Ralfs*Oocystis borgei* J.Snow*Pediastrum dublex* Meyen*Pediastrum simplex* Meyen*Scenedesmus communis* E.G.Hegewald*Scenedesmus dimorphus* (Turp.) Kütz.*Scenedesmus quadricauda* (Turp.) Breb.*Scenedesmus* sp.*Sphaerocystis planctonica* (Korshikov) Bourrelly*Tetraedron minimum* (A. Braun) Hansgirg**Order Desmidiiales***Closterium acutum* (Breb.) Ralfs*Cosmarium depressum* (Naeg.) P. Lundell*Cosmarium formosulum* Hofmann*Staurastrum crenulatum* (Naeg.) Delponte**Order Volvocales***Pandorina morum* (O.F.Müller)Bory**Order Zygnematales***Mougeotia* sp.**DIVISION CYANOPHYTA (CYANOBACTERIA)****Order Chroococcales***Chroococcus limneticus* Lemm.*Merismopedia glauca* (Ehr.) Naeg.*Microcystis aeruginosa* (Kütz.) Kütz.**Order Oscillatoriales***Oscillatoria tenuis* C. Agarth Gomont*Oscillatoria* sp.*Planktothrix rubescens* D.C.*Spirulina major* (Kütz.) Gomont**Order Nostocales***Anabaena flos-aquae* [(Lyngb.) Breb.] Bornet et

Flauhault

Aphanizomenon ovalisporum Forti.**DIVISION EUGLENOPHYTA****Order Euglenales***Euglena gracilis* G.A. Klebs*Phacus* sp.*Trachelomonas hispida* (Perty) F. Stein*Trachelomonas volvocina* Ehr.**DIVISION DINOPHYTA****Order Peridinales***Ceratium furca* (Ehr.) Claparède and Lachmann*Ceratium hirundinella* (O.F. Müller) Dujardin*Peridinium bipes* F. Stein**DIVISION CRYPTOPHYTA****Order Cryptomonadales***Cryptomonas ovata* Ehr.**DIVISION CHRYSOPHYTA****Order Chrysomonadales***Dinobryon sertularia* Ehr.

Table 3. Occurrence frequencies of phytoplankton in Sazlidere Dam (100-80% regularly present; 80-60% mostly present; 60-40% commonly present; 40-20% occasionally present; 20-1% rarely present)

OCCURRENCE (%)					
Total samples	20	20	20	18	20
Taxa	Station 1	Station 2	Station 3	Station 4	Station 5
BACILLARIOPHYTA					
Centrales					
<i>Cyclotella atomus</i>	61	60	90	90	70
<i>Cyclotella ocellata</i>	11	10	15	15	20
Pennales					
<i>Cymbella prostrata</i>	28	40	40	35	15
<i>Fragilaria crotonensis</i>	11	20	30	30	20
<i>Navicula cuspidata</i>	55	50	60	45	10
<i>Ulnaria acus</i>	39	15	30	20	15
<i>Ulnaria ulna</i>	33	55	55	55	40
CHLOROPHYTA					
Chlorococcales					
<i>Scenedesmus quadricauda</i>	28	35	2	30	35
CYANOPHYTA					
Oscillatoriales					
<i>Oscillatoria tenuis</i>	11	10	15	10	15
EUGLENOPHYTA					
Euglenales					
<i>Trachelomonas hispida</i>	17	10	15	20	10
DINOPHYTA					
Peridinales					
<i>Peridinium bipes</i>	6	25	25	25	30
CRYPTOPHYTA					
Cryptomonadales					
<i>Cryptomonas ovata</i>	55	70	75	65	60
CHRYSOPHYTA					
Chryomonadales					
<i>Dinobryon sertularia</i>	17	15	20	20	30

Bacillariophyta has been reported to be dominant in many algal studies in Turkish fresh waters [21-25]. The centric diatoms *Cyclotella atomus* and *Cyclotella ocellata*, which are typical components of oligotrophic lakes, were recorded in all seasons [26-27]. The benthic forms of the Order Pennales were based on wave-motion and wind exposure at the dam, as observed in previous studies at Lake Mogan, Lake Palandoken and Cakmak Dam lake [24, 28, 29]. It was reported that pennate diatoms were more abundant than centric diatoms in shallow lakes [28, 30]. *Ulnaria ulna*, a pennate diatom, is known to be characteristic of eutrophic lakes [31]. This species was also found to be dominant in Lake Hafik and Derbent Dam lake, which were oligotrophic [32, 33]. It was determined that the numbers of diatom taxa are higher in water samples taken in spring and summer. Generally, an increase in light and temperature leads to phytoplankton increase in spring. Diatoms, in particular, show greater abundance during this period [34].

Chlorophyta members are usually found widely and abundantly in mesotrophic and eutrophic lakes [27]. Furthermore, members of the Order Chlorococcales have been recorded in aquatic environments that are transitioning from oligotrophic to eutrophic character [27]. In this study *Sphaerocystis planctonica* and *Scenedesmus* species of the Order Chlorococcales were recorded mostly in autumn and winter samples.

Cyanophyta members usually prefer eutrophic environments [35]. *Oscillatoria tenuis* was found in all water samples. *Anabaena flos-aquae*, *Microcystis aeruginosa* and *Planktothrix rubescens* were recorded more in spring and summer samples than in other seasons.

Dinobryon sertularia (Chrysophyta) and *Euglena gracilis* (Euglenophyta) were recorded in all sampling stations. While *D. sertularia* is known to be characteristic of mesotrophic lakes [27], *E. gracilis* is found mostly in water with high levels of organic pollution [35].

When the vertical composition of the phytoplankton was examined, their individual numbers were found to decrease with increasing depth. As light penetration decreases with water depth, photosynthetic algae were found on and near the surface [34].

Nygaard's trophic state index can be a handy tool in determining the status of pollution in lakes. It involves only algal identification and the detailed analysis of physicochemical parameters can be omitted [20]. It was suggested by Rawson [36] that the numbers of species of certain groups present in phytoplankton would seem to have less ecological significance than the numbers of individuals of the dominant species [36]. A Nygaard compound index value less than 1 indicates oligotrophic conditions. Values of 1-2.5 indicate mesotrophic water; those of 3-5 indicate eutrophy and values of 5-20 show hyper-eutrophic conditions [20]. The compound index value was estimated to be 7.5 for Sazlidere Dam.

CONCLUSIONS

The algal flora of Sazlidere Dam did not have rich species variation except some dominant species. Phytoplankton of Sazlidere Dam consisted of centric and pennate diatoms, Chlorococcales members and blue-green algae. From Nygaard compound index value and the presence of eutrophic, mesotrophic and oligotrophic species, it was inferred that the trophic state of Sazlidere Dam lake was transitioning from oligotrophic to mesotrophic. Detailed ecological and limnological investigations should be continued at Sazlidere reservoir, which is an important source of drinking water for the Istanbul metropolitan area. The data obtained should provide a basis for determining the trophic state of the Sazlidere Dam water in order to manage and improve it.

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