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Phytoplankton composition of Hirfanlı Dam Lake (Kırşehir-Turkey)

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Abstract: The phytoplankton of the Hirfanlı dam lake was investigated monthly between August 2008 and July 2009. The samples were taken using plankton net with a pore diameter of 55 µm. A total of 69 taxa belonging to 6 divisions have been identified, including Bacillariophyta (32 taxa), Chlorophyta (18 taxa), Cyanobacteria (11 taxa), Euglenophyta (2 taxa), Charophyta (4 taxa), Miozoa (2 taxa). Seasonal distribution of phytoplankton was also investigated. Seasonal increase rate was determined higher in spring, summer, and autumn. Even though seasonal distribution of phytoplankton species varied, *Navicula* sp., *Cyclotella* sp., *Nitzschia* sp., *Gomphonema sp.*, and *Lyngbya* sp. were found as dominant.

Keywords: Phytoplankton, algae, Hirfanlı dam lake

Hirfanlı Baraj Gölü'nün fitoplankton kompozisyonu

Özet: Hirfanlı baraj gölü fitoplanktonu Ağustos 2008-Temmuz 2009 tarihleri arasında aylık olarak incelenmiştir. Örnekler 55 µm göz açıklığına sahip plankton ağı kullanılarak toplanmıştır. Bacillariophyta (32 takson), Chlorophyta (18 takson), Cyanobacteria (11 takson), Euglenophyta (2 takson), Charophyta (4 takson), Miozoa (2 takson) olmak üzere toplam 6 divizyoya dahil 69 takson teşhis edilmiştir. Fitoplanktonların mevsimsel dağılımı da incelenmiştir. Mevsimsel artış oranı ilkbahar, yaz ve sonbaharda daha yüksek olarak belirlenmiştir. Fitoplanktonların mevsimsel dağılımı değişmesine rağmen *Navicula* sp., *Cyclotella* sp., *Nitzschia* sp., *Gomphonema sp.*, ve *Lyngbya* sp. dominant olarak bulunmuştur.

Anahtar kelimeler: Fitoplankton, alg, Hirfanlı baraj gölü

1. Introduction

Hirfanlı dam is one of the dams located on the Kızılırmak River which originates from Karadag Spring in central Anatolia and flows to the Black Sea (Fig. 1). The altitude and reservoir area of dam lake are 856 m and 320 km^2. The mean depth and volume of the dam lake are 83 m and 7.63 x 10^9 m^3, and a mid-Anatolian land-type climate prevails in the area. Hirfanlı dam built in 1959 for the purposes of energy production and flood control (DSI 1973).

Several studies on the phytoplankton and zooplankton in Hirfanlı dam lake have been undertaken (Baykal and Açıkgöz 2004; Yiğit and Altındağ 2005; Baykal et al. 2006). Algae are primary producers of the aquatic environment and their periodic investigations are extremely important for aquatic life. Therefore, the aim of the present study was to examine phytoplankton compositions in the dam lake.

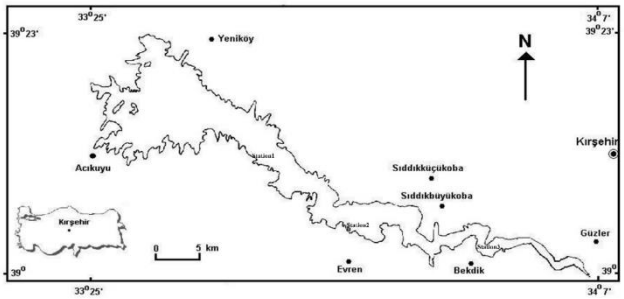

Fig. 1. Map of Hirfanlı dam lake

2. Materials and Method

Three stations were chosen in different areas of reservoir. The samples were taken from these stations each month between August 2008 and July 2009 vertically with 10 m intervals using plankton net with a pore diameter of 55 µm. Phytoplankton samples were placed in 250 ml dark bottles and fixed with 4% formaldehyde in the field. Identification of samples was performed on a light microscope. Diatoms were also analyzed using permanent preparations (APHA 1995). Phytoplankton species were identified according to (Round 1981; Round *et al*. 1990; Seckbach and Kociolek 2011; Kramer and Lange-Bertalot 1986, 1991a, 1991b; Huber– Pestalozzi, 1941, 1982; John *et al*. 2003; Komarek and Anagnostidis 2008; Bellinger and Sigee 2015). Taxonomy of algae was controlled with http://www.algaebase.org (M.D. Guiry 1996–2020) website.

Nitrogenous and phosphate compounds of water were measured in the spectrophotometer with the colorometric method, and standard methods have been applied for other parameters such as TH, PAL, MAL and PV analysis. SPC, TDS, SAL and TRB measurements were performed with YSI 6920 model Water Quality monitor, pH measurement was done with Sargent-Welch PBL model pH meter (Table 1).

3. Results

The pH of the dam lake shows slightly alkaline with its values between 7.8-8. Salinity rate varies between 0.63-0.71. While the conductivity in natural waters is between 20-180 µS/cm (Boyd 1988), it can be said that the conductivity in the dam lake is high (1255-1467 µS/cm). Dissolved oxygen values were within conventional values for reservoirs (7.8-10.3 mg/l) (Table 1). Some parameters for instance, temperature, dissolved oxygen concentration, nutrients and feeding pattern in the lake had important effects on the growth levels of phytoplankton (Baykal et al. 2006).

A total of 69 phytoplanktonic taxa was identified. Bacillariophyta comprised 46% (32 taxa) of the total taxa and were dominant in the phytoplankton. The remaining divisions were as follows: Chlorophyta 26% (18 taxa), Cyanobacteria 16% (11 taxa), Euglenophyta 3% (2 taxa), Charophyta 6% (4 taxa), Miozoa 3% (2 taxa). The list of phytoplankton is given in Table 2.

Species composition of this study is generally similar to Hirfanlı dam lake (Baykal and Açıkgöz 2004; Baykal et al. 2006), Altınapa dam lake (Yıldız 1986), Tercan dam lake (Altuner and Gürbüz 1996), Keban dam lake (Çetin and Şen 1997), Sarıyer dam lake (Atıcı 2002), Bafra Fish lakes (Gönülol and Çomak 1993), Asartepe dam lake (Atıcı and Obali 2010), Mamasin dam lake (Atıcı and Alas 2012) and Çaygören reservoir (Sevindik 2010).

The highest number of species was recorded in spring (63 taxa) and summer (55 taxa) while the lowest species richness was found in winter (34 taxa). Bacillariophyta was the dominant phytoplankton group showing the greatest species richness (32 taxa) with large contribution of Naviculales (8 taxa). Species numbers of Bacillariophyta were high in spring (29 taxa) and summer and autumn (27 taxa). Naviculales were mostly consisted of *Navicula*, *Gyrosigma*, *Caloneis* and *Pinnularia* species. *Navicula* and *Nitzschia* were dominant genus and they were both represented with 7 taxa. Baykal and Açıkgöz (2004) also reported that *Nitzschia* and *Navicula* species are abundant and widespread in Hirfanlı Dam Lake. *Navicula*, *Nitzschia*, *Cyclotella*, *Gomphonema*, *Fragilaria* and *Cymbella* were widely found especially in spring and summer. *Cyclotella ocellata* is the dominant diatom in lakes in Turkey (Baykal et al. 2006). *Cyclotella* species are thought biyoindicators of transient phase from oligotrophic to eutrophic conditions (Round 1956) while *Nitzschia palea* shows widespread development in eutrophic environments (Round 1981). Diatom diversity is high and abundant in Turkish freshwaters (Atıcı and Obali 2010).

The second dominant group was Chlorophyta (18 taxa) with large contribution of Sphaeropleales (9 taxa). Species numbers of Chlorophyta were high in spring (17 taxa) and summer (15 taxa). Sphaeropleales were mostly consisted of *Pediastrum*, *Scenedesmus* and *Ankistrodesmus* species. *Scenedesmus and Pediastrum* species were found in oligomesotrophic reservoirs in Turkey (İsbakan et al. 2002; Baykal and Açıkgöz 2004; Kıvrak and Gürbüz 2005).

Species richness of Cyanobacteria increased in summer with 11 taxa. With four species, Oscillatoriales has the most species. *Lyngbya*, *Microcystis*, *Oscillatoria* and *Anabaena* species were widespread in summer and spring months. According to Aysel (2005) *Anabaena* species were common in Turkey. Trifonova (1998) reported that Cyanobacteria species are significant planktons in summer and early autumn at eutrophic and mesotrophic lakes.

Charophyta was represented with 4 taxa of the order Desmidiales and Zygnematales. Gönülol and Çomak (1993) reported that Zygnematales species are common in eutrophic and mesotrophic lakes rather than oligotrophic lakes in Turkey though they were accepted as characteristic species of oligotrophic lakes (Hutchinson 1967).

Euglenophyta and Miozoa were each represented by 2 taxa. *Euglena* increased especially in autumn. *Ceratium hirundinella*, were widespread taxa in summer, spring and autumn. It was reported that *Ceratium hirundinella* is a common species in Hirfanlı dam lake (Baykal and Açıkgöz 2004; Baykal et al. 2006), have a wide distribution in Turkey (Aysel 2005) and prefers mesotrophic lakes (Rawson 1956).

Table 1. Some physico-chemical parameters of water

Parameters		July		October		February		May	
		Surface	4m	Surface	6m	Surface	4m	Surface	4m
pH		8	7.8	7.8	7.8	8	8	7.9	7.8
SPC (Specific Electrical Conductivity)	µS/cm	1303	1311	1356	1381	1458	1467	1255	1404
TDS (Total Dissolved Solids)	mg/l	846	854	881	893	951	950	802	898
SAL(Salinity)	ppt	0,65	0,64	0,69	0,70	0.71	0.71	0.64	0.65
o-PO_4-P (Ortho Phosphate Phosphorus)	mg/l	0,01	0.01	0,03	0.03	0,025	0.015	-	-
NO_2-N	mg/l	0,014	0.013	0,007	0.006	0,002	0.002	-	-
NO_3-N	mg/l	0,14	0.12	0,46	0.22	0,23	0.41	-	-
NH_3-N	mg/l	0,41	0.79	0,12	0.13	0,88	0.85	-	-
PV (Permanganate Value)	mg/l O_2	1,67	1.88	1,15	1.49	2,65	2.61	-	-
TRB (Turbidite)	NTU	0,4	5.2	0,7	0.5	-	-	-	-
DO (Dissolved Oxygen)	mg/l	8.4	7.8	9.1	8.7	10,3	10.1	9.5	9.2
T (Temperature)	°C	26,3	24.6	22	21,2	15.8	14,3	20	18.2
TH (Total Hardness)	mg/l ($CaCO_3$)	380	382	399	400	442	443	381	387
PAL (Phenoltalein Alkalinity)	mg/l ($CaCO_3$)	5	3	-	-	-	-	-	-
MAL (Total Alkalinity)	mg/l ($CaCO_3$)	106	108	101	102	121	122	97	100

Table 2. Phytoplankton composition of Hirfanlı dam lake

	Summer	Autumn	Winter	Spring
Divisio: CYANOBACTERIA				
Ordo: Chroococcales				
Chroococcus limneticus Lemmermann	+	+		+
Microcystis aeruginosa (Kützing) Kützing	+	+		+
Ordo: Synechococcales				
Merismopedia elegans A.Braun ex Kützing	+	+	+	+
M. punctata Meyen	+	+		+
Ordo: Oscillatoriales				
Lyngbya sp.	+	+	+	+
Oscillatoria planktonica Woll.	+	+	+	+
O. tenuis C. A. Agardh		+		+
Phormidium sp.				+
Ordo: Spirulinales				
Spirulina jenneri (Stizenberger ex Gomont) Geitler	+		+	+
Ordo: Nostocales				
Anabaena sp.	+	+		+
Nostoc sp.	+	+		+
Divisio: CHLOROPHYTA				
Ordo: Chaetophorales				
Stigeoclonium sp.	+	+	+	+
Ordo: Chlorellales				
Oocystis borgei J.W.Snow	+		+	+
O. crassa Wittrock in Wittrock & Nordstedt	+		+	+
O. pusilla Hansgirg	+	+		+
Ordo: Sphaeropleales				
Pediastrum dublex Meyen	+		+	+
P. tetras (Ehrenb.) Ralfs	+	+		+
Scenedesmus acutiformis Schroeder	+	+	+	+

S. ecornis (Ralfs) Chod.	+	+		+
S. quadricauda (Turp) Breb.	+	+	+	+
Scenedesmus sp.				+
Ankistrodesmus longissimus (Lemm.) Wille		+		+
A. mirabilis Korsch.	+	+		
Ankistrodesmus sp.	+	+		+
Tetraëdron minimum (A. Braun) Hansgirg		+		+
Ordo: Chlamydomonadales				
Chlamydomonas globosa Snow	+			+
Ordo: Ulotrichales				
Ulothrix variabilis Kuetzing	+	+		+
Ordo: Cladophorales				
Cladophora sp.	+			+
Ordo: Oedogoniales				
Oedogonium sp.	+			+
Divisio: EUGLENOPHYTA				
Ordo: Euglenida				
Euglena sp.	+	+		+
Phacus sp.				+
Divisio: BACILLARIOPHYTA				
Ordo: Cocconeidales				
Cocconeis pediculus Ehrenberg	+	+	+	+
Ordo: Bacillariales				
Nitzschia pusilla Grunow	+	+	+	+
N. fonticola Grunow	+	+		
N. fruticosa Hustedt	+	+		+
N. palea (Kützing) W. Smith	+	+		+
Ordo: Cymbellales				
Cymbella affinis Kützing	+		+	+
C. helvetica Kützing	+	+	+	+
C. microcephala Grunow in Van Heurck	+	+		+
C. prostrata (Berkeley) Cleve		+	+	+
Gomphonema sp.	+	+		+
Ordo: Fragilariales				
Diatoma vulgaris Bory	+	+	+	+
Diatoma sp.	+			+
Fragilaria virescens Ralfs	+	+	+	+
Synedra sp.	+	+	+	+
Ordo: Naviculales				
Gyrosigma acuminatum (Kützing) Rabenhorst	+		+	+
Navicula atomus (Kützing) Grunow	+	+	+	+
N. cuspidata (Kützing) Kützing	+	+		+
N. radiosa Kützing	+	+	+	+
Caloneis sp.	+	+		+
Pinnularia interrupta W. Smith	+	+	+	+
P. viridis (Nitzsch) Ehrenberg		+		+
Rhoicosphenia sp.	+		+	+
Ordo: Surirellales				
Cymatopleura sp.		+	+	
Surirella sp.	+	+	+	+
Ordo: Thalassiophysales				
Amphora ovalis (Kützing) Kützing	+	+	+	+
Ordo: Stephanodiscales				
Cyclotella meneghiniana Kützing	+	+	+	+
Cyclotella ocellata Pantocsek	+	+		+
Ordo: Melosirales				
Melosira varians Agardh.	+		+	+
Ordo: Mastogloiales				
Achnanthes conspicua A. Mayer		+	+	+
A. oblongella Oestrup	+	+	+	+
Ordo: Rhopalodiales				
Epithemia sp.	+	+	+	+
Rhopalodia sp.		+		
Divisio: CHAROPHYTA				
Ordo: Desmidiales				
Cosmarium sp.		+	+	+
Ordo: Zygnematales				

Zygnema sp.		+		+
Mougeotia sp.		+	+	
Spirogyra condensate (Vaucher) Dumortier	+	+	+	+
Divisio: MIOZOA				
Ordo: Gonyaulacales				
Ceratium hirundinella (O.F. Muller) Dujardin	+	+		+
Ordo: Noctilucales				
Noctiluca miliaris Suriray, nom. inval.	+	+		

4. Conclusion

The increase in the concentration of nutrients leads to irregularities in the quality and quantity of phytoplankton (Baykal et al. 2006). Variation of water temperature may cause changes in the chemical and biological composition of the dam lake. It is quite difficult to identify the trophic status of lake using only some indicator types. Although Hirfanlı dam lake shows the mesotrophic character, it is under the threat of eutrophication (Baykal et al. 2006) due to farming activities using nitrogenous fertilizer, dewatering and temperature variations. In euthrophic lakes, summer phytoplankton population is high due to increasing water temperature. Similarly to that, phytoplankton population is found higher in spring and summer in this study. The trophic status of the lake should be examined periodically in terms of the efficiency of the aquatic ecosystem.

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Conflict of interest disclosure:

There is no conflict of interest.

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