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A Study on Planktonic and Epipelic Algae Occurring in Karakaya Dam Lake (Elazığ, Türkiye)

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ABSTRACT

This study aimed to determine the species composition of two algal associations in Karakaya Dam Lake. For this purpose, monthly variations in species composition of phytoplankton and seasonally variations in epipelic algae occurring in the dam lake were studied between June 2010 and May 2011. Five stations were selected in Karakaya Dam Lake. A total of 38 algal taxa belonging to Bacillariophyta (27 taxa), Charophyta (2 taxa), Chlorophyta (3 taxa), Cyanobacteria (3 taxa), Miozoa (2 taxa) and Ochrophyta (1 taxon) were identified in the phytoplankton. The diatom genera *Cocconeis, Cymbella, Fragilaria, Nitzschia, Stauroneis* and *Surirella* were represented with two taxa in the phytoplankton. *Ceratium hirundinella* was noticed with its continuous occurrence in the phytoplankton throughout the year. A total of 25 algal taxa belonging to Bacillariophyta (21 taxa), Charophyta (1 taxon), Chlorophyta (2 taxa) and Cyanobacteria (1 taxon) were identified in the epipelon. Seasonal variations of algal species with respect to occurrence frequency and abundance were compared and discussed in relation to physical and chemical properties of the dam lake.

Keywords: Phytoplankton, epipelon, Karakaya Dam Lake, Elazığ, Türkiye

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Karakaya Baraj Gölü (Elazığ, Türkiye) Planktonik ve Epipelik Algleri Üzerine Bir Araştırma

Öz: Bu çalışma, Karakaya Baraj Gölü'ndeki iki alg topluluğunun tür kompozisyonunu belirlemeyi amaçlamıştır. Bu amaç doğrultusunda; Haziran 2010 ile Mayıs 2011 arasında gölde fitoplanktonik alg türlerinin ortaya çıkış ve bolluklarındaki değişimler aylık olarak incelenirken epipelik alglerdeki değişimler ise mevsimsel olarak incelenmiştir. Bu araştırma için Karakaya Baraj Gölü'nde beş istasyon seçilmiştir. Baraj gölü fitoplanktonunda Bacillariophyta (27 takson), Charophyta (2 takson), Chlorophyta (3 takson), Cyanobacteria (3 takson), Miozoa (2 takson) ve Ochrophyta'ya (1 takson) ait toplam 38 alg taksonu tespit edilmiştir. *Cocconeis, Cymbella, Fragilaria, Nitzschia, Stauroneis* ve *Surirella* cinsleri fitoplanktonda iki taksonla temsil edilmiştir. Tüm algler arasında *Ceratium hirundinella*, yıl boyunca fitoplanktonda sürekli bulunmasıyla dikkat çekici olmuştur. Karakaya Baraj Gölü epipelik alg topluluğunda Bacillariophyta (21 takson), Charophyta (1 takson), Chlorophyta (2 takson) ve Cyanobacteria'ya (1 takson) ait toplam 25 alg taksonu kaydedilmiştir. İstasyonlarda diyatomelerin ve diğer alg türlerinin ortaya çıkışlarındaki mevsimsel değişimler ve bollukları karşılaştırılmış ve baraj gölünün fiziksel ve kimyasal özellikleri ile ilişkili olarak tartışılmıştır.

Anahtar kelimeler: Fitoplankton, epipelon, Karakaya Baraj Gölü, Elazığ, Türkiye

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Introduction

The presence, absence or abundance of planktonic and benthic algal species in an aquatic ecosystem are based on certain ecological conditions. In fact, many external and internal factors affect the seasonal changes in species composition and biomass of algal communities in dam lakes. Seasonal/periodical fillings, discharge of wastewater and fluctuations in lake water level are considered to be major external factors changing physicochemical and biological characters of dam lakes (Geraldes and Boavida 1999) whilst water temperature, pH and concentrations of nutrients are commonly accepted to be the most significant internal parameters (Philips et

al. 2000). Thus it is significant to study phytoplankton and other algal communities to determine the changes in aquatic ecosystems since algae react to the physical and chemical changes most quickly occurring due to external factors in the structure of a lake ecosystem (Habib et al. 1997). Such reactive ability of algal species makes them? be used as one of the major indicators of environmental variables and trophic levels of lakes (Reynolds et al. 2002).

Studies on algae occurring in dam lakes and reservoirs have particularly received attention after 80's in Türkiye (Aykulu and Obalı 1981; Gönülol and Aykulu 1984; Yıldız 1985; Gönülol 1985a, 1985b; Altuner and Gürbüz 1996; Yazıcı and Gönülol 1994; Şipal et al. 1996; Gönülol and Obalı 1998; Çetin and Şen 1997,1998) Particularly floristic and ecological studies carried out on the phytoplankton of lakes have rapidly increased in numbers (Çetin and Yıldırım 2000; Gürbüz and Kıvrak 2003; Atıcı 2002; Albay and Akçaalan 2003; Çetin and Şen 2004; Baykal et al. 2004; Baykal and Açıkgöz 2004; Çetin 2004; Kıvrak and Gürbüz 2005; Sömek et al. 2005; Çetin and Şen 2006; Çelik and Ongun 2006; Aykulu et al. 2006; Pala 2007; Taş and Gönülol 2007; Ongun Sevindik 2010; Sönmez 2011; Atıcı and Alaş 2012; Öterler 2013; Tokatlı and Atıcı 2014; Atıcı et al. 2016; Sönmez et al. 2017; Atıcı et al. 2018; Tokatlı et al. 2020a, 2020b).

Karakaya is one of the largest dam lakes in Türkiye. The dam lake (or reservoir) was constructed in 1976-1987 and water retention was started in 1987. The reservoir has a surface area of 268 km^2 with a maximum (high from river bed) depth of 173 m. The total lake volume is 9580 hm^3 (DSİ 2019). The mean depth of the lake is determined as 35.7 m. The lake is mainly supported by Fırat River. The dam lake has a great significance for the region as it is commonly used for irrigation, energy production and fisheries purposes. The dam lake provides 102 hm^3 of potable water capacity per year. The cage fish culture has been performed intensively in Karakaya Dam Lake. There are 38 fish farms with the capacity of approximately 6.000 tonnes/year in the region. Through searching the literature, it was come across no detailed study engaged in seasonal variations of planktonic and benthic algae occurring in Karakaya Dam Lake. Therefore, the present research aimed to study the planktonic and epipelic algae occurring in Karakaya Dam Lake in relation to physico-chemical factors for a period of a year (Figure 1).

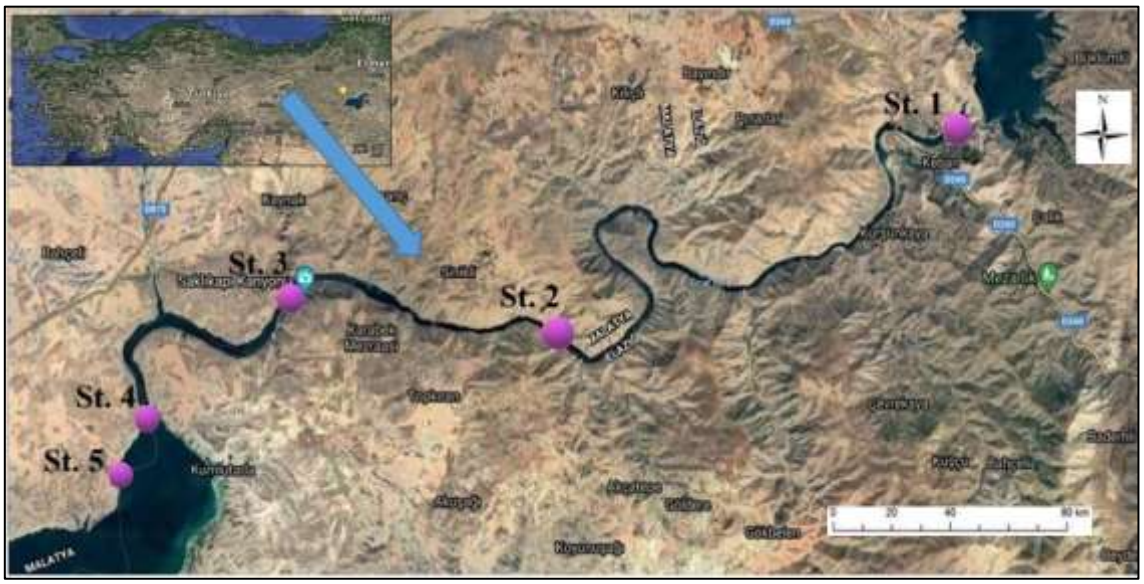

Figure 1. Location of sampling station and Karakaya Dam Lake

Materials and Methods

Karakaya Dam Lake, which is one of the most important rervoir of Türkiye, sample stations are located in the East Anatolia Region between the locality of 38.48127 – 38.43147 N and 38.43833 – 38.28149 E. Five stations were selected in Karakaya Dam Lake (Figure 1). Physical-chemical measurements and analyses were performed at different depths of stations (respectively mean depth 0-5-10 m). These depths are given in parenthesis after the number of each station. pH level was measured directly by using a pH meter (HACH HQ40 d), whilst a Secchi disk was used to measure water transparency. Chlorophyll-*a* was measured by fluorometric method in which the water sample was filtered through Whatman GF/C filter that was then treated with acetone (APHA 1995). The spectrophotometric method (Hach-Lange DR 6000 spectrophotometer) was employed for the analysis of sulfate, total

phosphorus and total nitrogen by using the suitable kits (Merck).

Phytoplankton sampling was carried out by using plankton net of the brand Hydro-Bios with pore of 55 µm. For epipelic algae, muddy sediment samples were collected and placed into plastic containers for laboratory observation.

To prepare permanent diatom slides, subsamples were taken in which acid solution was added to digest organic materials. The samples were boiled on a hot plate for 15 minute to expedite the digestion process. They were subsequently left to cool. Samples were neutralized by rinsing with distilled water and dried on coverslips that were mounted on glass slides with Entellan. For other algae temporary slides were prepared. Olympus CX21FS1 research microscope and Olympus CKX41 inverted microscope were employed for identification of species and counting algal cells respectively. The relative abundance method was applied for individual numbers of diatoms and results were expressed as "% organism" (Sladeckova 1962). At least 100-200 individuals based on the abundance of diatoms were observed and counted in each slide. Algal species were identified according to Krammer and Lange-Bertalot (1986, 1988, 1991a, 1991b) and John et al. (2003). Names of species are updated in accordance with Guiry and Guiry (2022).

Results

Changes in values of physicochemical parameters were given in Figures 2, 3, 4, 5, 6, 7 and 8.

The mean values of surface water temperature measured at stations were found to vary in the range of 8.4-30.3 ºC through the year (Figure 2).

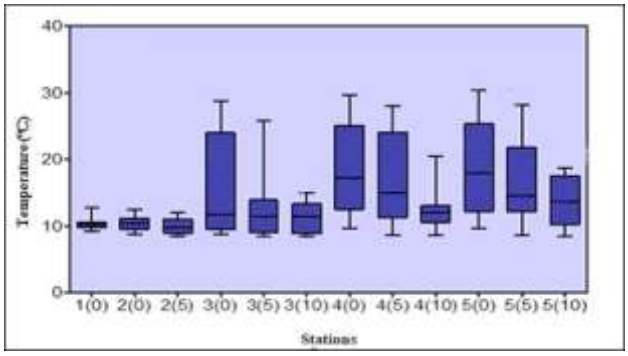

Figure 2. Variations of temperature values at stations

Values of pH at stations varied in the range of 8.1-8.73 (Figure 3). This simply shows that the dam lake has neutral and slightly alkaline water characteristic. pH values were slightly higher at station 4 than those recorded at other stations.

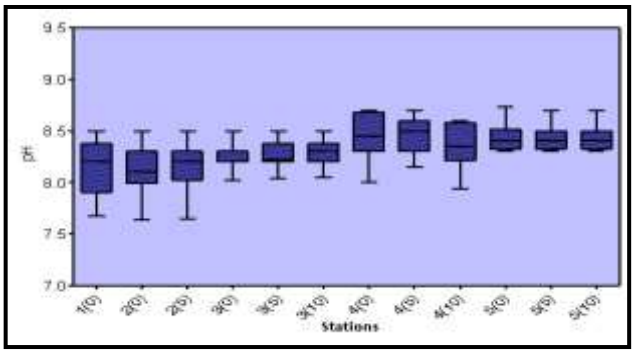

Figure 3. Variations of pH values at stations

Secchi disk depth at stations varied in the range of 2 m and 10.5 m (Figure 4). The figure shows that variations in Secchi disk depth between seasons and stations were considerable. The highest visibility (10.5 m) was recorded at Station 2 in July whilst the lowest visibility (2 m) was reached at stations 4 and 5 (Figure 4).

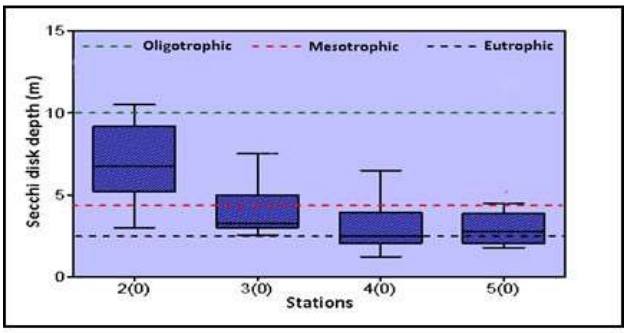

Figure 4. Secchi disk depth values (m) at stations

Chlorophyll-*a* was measured between 0.1-5.59 µg/L (Figure 5) The lowest concentration was determined at station 5 whilst the highest concentration was analysed at 5m depth at station 2.

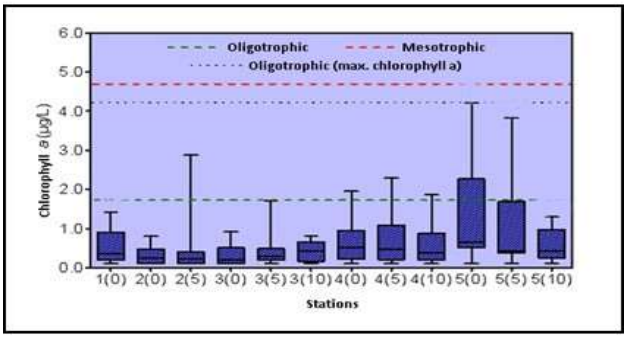

Figure 5. Variations of chlorophyll-*a* concentrations (µg/L) at stations

Variations in concentrations of plant nutrients were as follows; variations for sulfate (SO_4^{-2}) concentrations varied as 20.08-56-98 mg/L. Total phosphorus (TP) and total nitrogen (TN) concentrations varied between 0.01-0.08 mg/L and 0.67-0.91 mg/L respectively (Figure 6, 7 and 8).

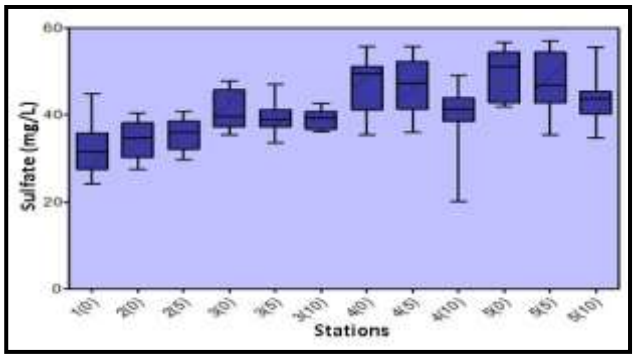

Figure 6. Variations of sulfate concentrations (mg/L) at stations

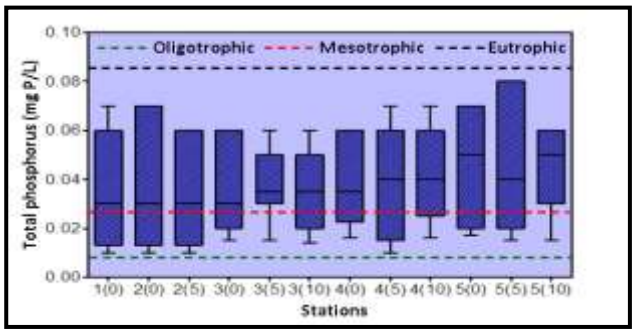

Figure 7. Variations of total phosphorus concentrations (mg P/L) at stations

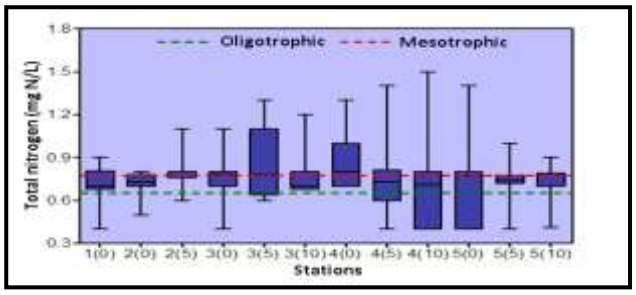

Figure 7. Variations of total nitrogen concentrations (mg N/L) at stations

Phytoplankton Community

A total of 38 algal taxa belonging to Bacillariophyta (27 taxa), Charophyta (2 taxa), Chlorophyta (3 taxa), Cyanobacteria (3 taxa), Miozoa (2 taxa) and Ochrophyta (1 taxon) were identified in the phytoplankton of Karakaya Dam Lake (Table 1). The diatom genera *Cocconeis*, *Cymbella*, *Fragilaria*, *Nitzschia*, *Stauroneis* and *Surirella* were represented with two taxa in the phytoplankton. Dinoflagellate *Ceratium hirundinella* was noticeable with its continuous occurrence in the phytoplankton throughout the year. *Asterionella formosa*, *Cocconeis pediculus*, *Cymbella affinis*, *Diatoma vulgaris*, *Fragilaria crotonensis*, *F. rumpens*, *Gyrosigma acuminatum*, *Melosira varians*, *Navicula cryptocephala*, *Nitzschia sigmoidea*, *Rhoicosphenia abbreviata* and *Ulnaria ulna* from Bacillariophyta and *Dolichospermum planctonicum* and *Oscillatoria limosa* from Cyanobacteria were also noticeable diatoms with respect to frequency of occurrence (Table 1, Figure 8). Contrary, *Cocconeis placentula* (April), *Craticula cuspidata* (March), *Cymbella cistula* (March), *Stauroneis anceps* (March), *S. construens* (April) and *Surirella ovalis* (September) were considered as rarely occurring algae as they were recorded in only one sample throughout the study. It is worth to mention that *Dinobryon divergens* was the only representative of Ochrophyta (Table 1).

The percentage participation of algal group is shown in Figure 9. As seen, Bacillariophyta constituted the main part of the phytoplankton in the lake. The percentage participation of other algal groups was low remaining under 8 %

Table 1. The list of algae recorded in the phytoplankton of Karakaya Dam Lake

Taxa	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
BACILLARIOPHYTA												
Achnanthidium minutissimum (Kützing) Czarnecki	-	-	-	+	-	-	-	+	-	-	-	-
Asterionella formosa Hassall	-	-	-	+	-	+	+	+	+	+	+	-
Aulacoseira granulata (Ehrenberg) Simonsen	-	-	-	-	-	-	-	-	-	+	+	-
Cyclotella meneghiniana Kützing	+	-	-	+	-	-	-	-	-	+	-	+
Cocconeis pediculus Ehrenberg	+	+	-	+	+	-	-	+	+	+	-	-
Cocconeis placentula Ehrenberg	-	-	-	-	-	-	-	-	-	-	+	-
Craticula cuspidata (Kutzıng) D.G.Mann	-	-	-	-	-	-	-	-	-	+	-	-
Ctenophora pulchella (Ralfs ex Kützing) D.M.Williams & Round	-	-	-	+	-	-	-	-	-	+	-	+

Table 1. Continued.

Taxa	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
BACILLARIOPHYTA												
Cymbella affinis Kützing	+	+	-	+	+	+	+	+	+	+	+	+
Cymbella cistula (Ehrenberg) O.Kirchner	-	-	-	-	-	-	-	-	-	+	-	-
Diatoma vulgaris Bory	+	+	+	+	+	+	+	-	+	+	+	+
*Epithemia gibba (*Ehrenberg) Kützing	-	-	-	+	-	-	-	-	-	+	+	-
Fragilaria crotonensis Kitton	+	+	-	-	-	+	+	+	+	+	+	+
Fragilaria rumpens (Kützing) G.W.F.Carlson	+	+	+	-	-	-	-	-	+	+	-	+
Gomphonema truncatum Ehrenberg	+	-	-	-	+	-	-	+	-	+	-	-
Gyrosigma acuminatum (Kützing) Rabenhorst	-	-	-	+	+	+	+	+	+	+	+	-
Halamphora veneta (Kützing) Levkov	-	-	-	+	-	-	-	+	-	+	-	+
Melosira varians C.Agardh	-	-	+	+	+	+	+	+	-	-	-	-
Navicula cryptocephala Kützing	-	+	+	-	+	+	-	+	+	+	+	+
Nitzschia intermedia Hantzsch	-	-	-	+	+	-	-	-	-	+	+	+
Nitzschia sigmoidea (Nitzsch) W.Smith	-	-	-	+	+	+	+	+	-	+	+	+
Rhoicosphenia abbreviata (C.Agardh) Lange-Bertalot	+	+	+	+	+	-	-	+	+	-	+	+
Stauroneis anceps Ehrenberg	-	-	-	-	-	-	-	-	-	+	-	-
Staurosira construens Ehrenberg	-	-	-	-	-	-	-		-	-	+	-
Surirella librile (Ehrenberg) Ehrenberg	-	-	-	-	-	-	-	-	+	+	-	-
Surirella ovalis Brébisson	-	-	-	+	-	-	-	-	-	-	-	-
Ulnaria ulna (Nitzsch) Compère	-	-	-	+	+	+	+	+	-	+	+	-
CHAROPHYTA												
Closterium aciculare T.West	+	+	-	-	-	-	-	-	+	-	-	-
Spirogyra gracilis Kützing	-	+	+	-	-	+	-	-	-	-	-	+
CHLOROPHYTA												
Microspora tumidula Hazen	+	+	-	-	-	-	-	-	+	-	-	-
Monactinus simplex (Meyen) Corda	+	+	-	-	-	+	+	-	-	-	-	+
Stigeoclonium tenue (C.Agardh) Kützing	-	+	-	-	+	+	-	-	-	-	-	-
CYANOBACTERIA												
Aphanizomenon flos-aquae Ralfs ex Bornet & Flahault	-	-	+	-	+	-	-	-	-	-	-	-
Dolichospermum planctonicum (Brunnthaler) Wacklin, L.Hoffmann & Komárek	-	+	-	+	+	+	+	-	-	+	+	+
Oscillatoria limosa C.Agardh ex Gomont	+	+	+	-	+	+	-	+	-	+	+	+
MIOZOA												
Ceratium hirundinella (O.F.Müller) Dujardin	+	+	+	+	+	+	+	+	+	+	+	+
Peridinium bipes F.Stein	-	-	-	+	-	-	-	-	-	-	+	-
OCHROPHYTA												
Dinobryon divergens O.E.Imhof	+	-	-	-	-	-	-	-	-	+	-	-

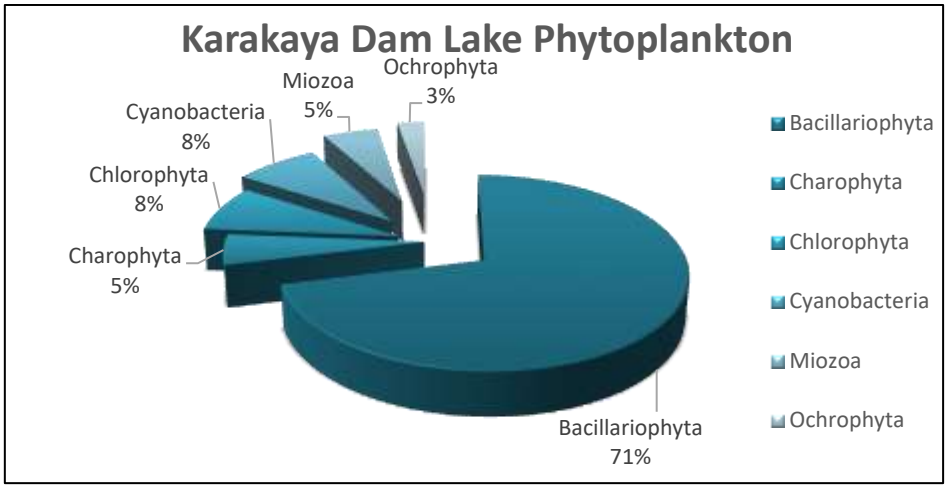

Figure 9. Percentage (%) distribution of phytoplanktonic algal groups in Karakaya Dam Lake

Epipelon Community

A total of 25 algal taxa belonging to Bacillariophyta (21 taxa), Charophyta (1 taxon), Chlorophyta (2 taxa) and Cyanobacteria (1 taxon) were identified in the epipelic association of Karakaya Dam Lake (Table 2). *C. pediculus, C. affinis, D. vulgaris, Gomphonema truncatum, N. cryptocephala* and *R. abbreviata* were observed in all seasons. Contrary, *C. cistula* was observed only in one season (spring) in the epipelon during the study. *Spirogyra gracilis* and *O. limosa* were the only representatives of Charophyta and Cyanobacteria respectively (Table 2).

Table 2. The list of algae recorded in the epipelon of Karakaya Dam Lake

Taxa	Summer	Autumn	Winter	Spring
BACILLARIOPHYTA				
Achnanthidium minutissimum (Kützing) Czarnecki	-	+	+	-
Asterionella formosa Hassall	-	+	+	+
Cocconeis pediculus Ehrenberg	+	+	+	+
Ctenophora pulchella (Ralfs ex Kützing) D.M.Williams & Round	-	+	-	+
Cyclotella meneghiniana Kützing	+	+	-	+
Cymbella affinis Kützing	+	+	+	+
Cymbella cistula (Ehrenberg) O.Kirchner	-	-	-	+
Diatoma vulgaris Bory	+	+	+	+
*Epithemia gibba (*Ehrenberg) Kützing	-	+	-	+
Fragilaria crotonensis Kitton	+	-	+	+
Fragilaria rumpens (Kützing) G.W.F.Carlson	+	-	+	+
Gomphonema truncatum Ehrenberg	+	+	+	+
Gyrosigma acuminatum (Kützing) Rabenhorst	-	+	+	+
Halamphora veneta (Kützing) Levkov	-	+	+	+
Melosira varians C.Agardh	+	+	+	-
Navicula cryptocephala Kützing	+	+	+	+
Nitzschia intermedia Hantzsch	-	+	-	+
Nitzschia sigmoidea (Nitzsch) W.Smith	-	+	+	+
Rhoicosphenia abbreviata (C.Agardh) Lange-Bertalot	+	+	+	+
Surirella librile (Ehrenberg) Ehrenberg	-	-	+	+
Ulnaria ulna (Nitzsch) Compère	-	+	+	+
CHAROPHYTA				
Spirogyra gracilis Kützing	+	-	-	+
CHLOROPHYTA				
Microspora tumidula Hazen	+	-	+	-
Stigeoclonium tenue (C.Agardh) Kützing	+	+	-	-
CYANOBACTERIA				
Oscillatoria limosa C.Agardh ex Gomont	-	+	-	+

The trophic level of the lakes reveals the basic ecological character of the ecosystem in question; It is also the most basic criterion in determining aquaculture strategies. In the trophic classification process, the annual average total phosphorus concentration and Secchi disk visibility findings of the Karakaya Dam Lake were used. Although there is no data covering all trophic levels given in Table 3, considering the terrace depths and phosphorus values of the lake, it can be said that the second station is oligotrophic and the other stations are mesotrophic according to the categories of OECD (1982) and Hakanson and Jansson (1983) possible.

Redfield (1934), in his studies, determined that the carbon: nitrogen: phosphorus (C: N: P) ratios of water and the carbon: nitrogen: phosphorus ratios in the phytoplankton are very similar to each other and these ratios (C: N: P) are 106: He gave it as 16:1. Based on this ratio and in accordance with Liebig's Law of Minimum, it was determined that phosphorus is the limiting element in the development of phytoplankton in Karakaya Dam Lake (Table 3).

Table 3. Characteristic properties of lakes in different trohic levels (OECD1982; Hakanson and Jansson1983).

Trophic Level	Secchi Disk Dept (m)	Clorophyll-a (µg/L)	Total-Phosphorus (mg/L)	Total-Nitrogen (mg/L)
Oligotrophic	>5	<2.5	<0.01	<0.35
Mesotrophic	3-6	2-8	0.008-0.025	0.3-0.5
Eutrophic	1-4	6-35	0.02-0.1	0.35-0.6
Hipertrophic	0-2	30-400	>0.08	>0.6
Karakaya Dam Lake	1.25–10.5	0.10-5.59	0.00-0.08	0.00-1.5

When it was looked at the fish species in the categories of OECD (1982) and Hakanson and Jansson (1983), the fact that the trout is not naturally found in the lake, but the vaccinated and escaped trout in the lake find a habitat in the lake, and the predominance of whitefish in the lake shows that the lake has a predominantly mesotrophic character.

In terms of maximum and mean chlorophyll a concentration, all sampling points were located in the oligotrophic border. It has tended to increase with the areas affected by fish farming facilities.

The difference between the low concentrations of the station representing the Keban outlet river area and the high concentrations of the station representing the Karakaya surface water was found to be statistically significant. However, other sampling points could not be distinguished as significant.

Discussion

Karakaya is one of the largest dam lakes in Türkiye. Phytoplankton and epipelic algae of the lake were studied for a period of a year in order to determine seasonal changes of species composition and abundance in both algal associations in relation to physical and chemical properties of the lake. Trophic status of the lake was also evaluated in terms of algal species and its physical-chemical characteristics.

Physicochemical data and recorded algae indicated that Karakaya Dam Lake shows both oligotrophic and mesotrophic lake characteristics. The lake could be included oligotrophic and mesotrophic lake category with respect to Secchi disk depth measured at stations (Nürnberg 1996; Vollenweider and Kerekes 1982). Maximum and mean chlorophyll-*a* concentrations also supported oligotrophic statue of Karakaya Dam Lake (Håkanson 1993). According to Thomann and Mueller (1987) if the total phosphorus concentration in the lake is <10 µg/L the lake should be considered as an oligotroph. If concentrations are 10-20 µg/L and >20 µg/L it should be placed in mesotrophic and eutrophic lake category respectively. Total phosphorus concentrations analyzed in dam lake water (0.01-0.08 mg P/L) clearly indicated that the studied part of Karakaya Dam Lake has oligotrophic lake characteristic. However, concentrations of total nitrogen (0.67-0.91 mg N/L) showed that the lake is on the border of oligotrophy-mesotrophy.

C. hirundinella was noticeable alga with its continuous occurrence in the phytoplankton throughout the study. *A. formosa, C. pediculus, C. affinis, D. vulgaris, F. crotonensis, G. acuminatum, N. cryptocephala, N. sigmoidea* and *R. abbreviata* (Bacillariophyta); *D. planctonicum* and *O. limosa* (Cyanobacteria) were also noticeable algae with their frequency of occurrence. Many studies have shown that these species are characteristic algae of mesotrophic lakes (Rawson 1956; Hutchinson 1967; Fogg et al. 1973; Round 1973; Wetzel 1983; Reynolds et al. 1993; Bellinger and Siegee 2010; Laplace-Treyture and Feret 2016). Thus, occurrence of these algae may support the view that the lake also shows mesotrophic characteristic in terms of algal evidence.

A total of 38 algal taxa belonging to Bacillariophyta (27 taxa), Charophyta (2 taxa),

Chlorophyta (3 taxa), Cyanobacteria (3 taxa), Miozoa (2 taxa) and Ochrophyta (1 taxon) were identified in the phytoplankton. The largest share of the phytoplankton belonged to Bacillariophyta (27 taxa) in Karakaya Dam Lake. The highest number of taxa (25) was found at in March, while the lowest number (9) was recorded in August. The diatom genera *Cocconeis, Cymbella, Fragilaria, Nitzschia, Stauroneis* and *Surirella* were represented with two taxa in the phytoplankton. *C. hirundinella* was noticed with its continuous occurrence in the phytoplankton throughout the year. *D. planctonicum* and *O. limosa* were observed in belonging to Cyanobactria in the phytoplankton. The species composition of the phytoplankton and epipelon of Karakaya Dam Lake showed similarities to those of many lakes and reservoirs in Türkiye (Çetin and Yıldırım 2000; Atıcı 2002; Çetin and Şen 2004; Kıvrak and Gürbüz 2005; Aykulu et al. 2006; Pala 2007; Taş and Gönülol 2007; Ongun Sevindik 2010; Sönmez 2011; Atıcı and Alaş 2012; Öterler 2013; Sönmez et al. 2017).

A total of 25 algal taxa belonging to Bacillariophyta (21 taxa), Charophyta (1 taxon), Chlorophyta (2 taxa) and Cyanobacteria (1 taxon) were identified in the epipelon. The largest share of the epipelon belonged to Bacillariophyta (25 taxa) in Karakaya Dam Lake. The highest number of taxa (21) was found at in spring, while the lowest number (13) was recorded in summer. The species composition and seasonal succession of the phytoplankton were almost similar at three stations during the study. The reasons for the similarities might be attributed to the similar environmental conditions at the stations. Seasonal values of almost all physicochemical parameters measured and analyzed showed similarities at stations. This may explain that in different parts of the same ecosystem, phytoplankton display similar growth characteristics under similar environmental conditions.

The increase both in species composition and algal individual numbers phytoplankton during the spring and autumn months in Karakaya Dam Lake were noticeable in the period of increasing water temperature. This finding may suggest that water temperature is one of the main factors affecting the species composition and abundance of planktonic algae in the dam lake. A strong relationship between phytoplankton composition and water temperature was also reported in some studies (Jaworska et al. 2014, Rakocevic 2012). However, it is difficult to mention any relations between phytoplankton growth and pH since high and low individual numbers were observed at similar pH levels in the present study. However, there was a noticeable correlation between the growth of phytoplankton and transparency in Karakaya Dam Lake since the larger populations of algae occurred during summer when transparency was high. In contrast low individual numbers coincided with low transparency in winter.

It is also hard to establish a relation between plant nutrients (TN and TP) and seasonal occurrence of phytoplankton species at stations. Although TN and TP concentrations were similar at stations seasonal occurrence of algal species varied from one station to another. Some species occurred at only one station and absent at others. Contrary, some species occurred at all stations. These findings suggest that occurrence of algal species in the Karakaya Dam Lake might be affected not only by the nutrients, but also by other factors. However, it was noticeable to observe that high chlorophyll a concentrations coincided with high amount of nitrogen and phosphorus in lake water.

The species diversity of Bacillariophyta was the highest in spring and autumn, and the lowest in winter and summer. *C. affinis* and *D. vulgaris*, which were reported to be found in eutrophic waters by Reynolds et al. 1994, were identified in Lake Karakaya in almost all seasons. According to these findings, it may be possible to express that *F. crotonensis, N. cryptocephala* and *R. abbreviata* may occur in mesotrophic as well as eutrophic lakes depending on the conditions.

G. acuminatum and N. sigmoidea is accepted by various authors as the characteristic indicator of both oligotrophic and mesotrophic lakes (Rawson 1956; Bellinger and Siegee 2010 and Laplace-Treyture and Feret 2016). It was also reported that *G. acuminatum and N. sigmoidea* strongly related to the trophic status of the lakes and announced to be the specific alga of oligotrophic lakes (Hutchinson 1967). In contrast, Wetzel (1983) reported that *G. acuminatum and N. sigmoidea* may be dominant in intermediate-sized eutrophic lakes. However, the present study is partly in harmony with these studies. Considering insistent occurrence of this diatom at three stations in the Karakaya Dam Lake, one may suggest that *G. acuminatum and N. sigmoidea* may incline to occur in lakes with various trophic status.

Occurrence of Ochrophyta species in Karakaya Dam Lake generally coincided with increasing temperature. However, occurrence of *D. divergens* with highly numbers was observed only in March when water temperature was already high. Studies (Reynolds et al. 1993 and Reynolds et al. 1994) revealed that phosphate and nitrate have an influence on the development of this species. Thus, *D. divergens* could have developed in Karakaya Dam Lake with the support of nitrate and phosphate that were always in sufficient concentrations to support the growth of plankton species.

D. planctonicum and *O. limosa* were only representatives of Cyanobacteria in Karakaya Dam Lake. Cyanobacteria species were observed mostly in summer and autumn. They were encountered with much fewer individual numbers in spring. Excessive Cyanobacteria development in summer may be explained by sufficient amount of nutrients and high water temperature (Round 1973; Reynolds et al. 1993 and Reynolds et al. 1994). Moreover, in cases where water movements are stable and lake is rich in nitrate, these species are known to reproduce rapidly (Fogg et al. 1973) Karakaya Dam Lake. *D. planctonicum and O. limosa* were recorded at all stations in all seasons.

It is important to determine the characteristics of the reservoirs, which have an important potential in terms of aquaculture and various study subjects, in terms of maximizing the evaluation of these water bodies that constitute the inland water wealth of our country. Such studies also provide the basis for the creation of databases related to our lakes.

Although fish farming in its current state does not seem to affect the water quality of the 10th Region of Karakaya Dam Lake in terms of nutrient salt forms; The increase in chlorophyll a determined at the Dam Lake station may represent the effect of fish farming on possible trophic level progression.

In order for a water source to be used in accordance with its purposes, it must be periodically monitored continuously. A managed monitoring program that fully evaluates the data will provide very useful information for environmental management.

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