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MEHMET NAZ

MUSTAFA TÜRKMEN

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Phytoplankton Biomass and Species Composition of Lake Gölbaşı (Hatay-Turkey)

Mehmet NAZ, Mustafa TÜRKMEN
Faculty of Fisheries, Mustafa Kemal University, Hatay - TURKEY

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Abstract: Seasonal distributions of phytoplanktonic organisms in Lake Gölbaşı were investigated in samples collected from 2 stations between May, 2001, and April, 2002. At each station, monthly sampling was performed from the surface water. The flora consisted of 41 taxa belonging to Bacillariophyta (24), Chlorophyta (12), Pyrrophyta (2), Cyanophyta (2) and Chrysophyta (1). During the 1-year study period, the most dominant group was Chrysophyta followed by Bacillariophyta, Chlorophyta, Cyanophyta and Pyrrophyta. The highest numbers of Chrysophyta were observed in both stations in May, 2001, January, 2002 and April, 2002. Bacillariophyta had the highest biomass in both stations, followed by Chrysophyta, Pyrrophyta, Chlorophyta and Cyanophyta. The monthly changes in diversity values were between 0.01 and 0.90. The lowest diversity value was observed in the first station in January, 2001. Lake Gölbaşı has mesotrophic characteristics due to the seasonal distribution of phytoplanktonic organisms. However, it will be necessary to conduct further physical and chemical analyses of the lake water to obtain more detailed information about the trophic status of the lake

Key Words: Phytoplankton, Seasonal distribution, Biomass, Diversity

Gölbaşı Gölü'nün Fitoplankton Biyoması ve Tür Kompozisyonu (Hatay-Türkiye)

Özet: Gölbaşı gölündeki fitoplanktonik organizmaların mevsimsel dağılımı iki istasyondan alınan örneklerde, Mayıs 2001-Nisan 2002 tarihleri arasında araştırılmıştır. İki istasyonun her birinden aylık örneklemeler yüzey suyundan yapılmıştır. Bu çalışmanın sonunda, flora Bacillariophyta (24), Chlorophyta (12), Pyrrophyta (2), Cyanophyta (2) ve Chrysophyta (1)'ya ait 41 taksondan oluşmuştur. Bir yıllık çalışma dönemi sonunda baskın grup Chrysophyta olmuştur. Bunu sırasıyla, Bacillariophyta, Chlorophyta, Cyanophyta ve Pyrrophyta izlemiştir. Chrysophyta'nın en yüksek sayıları Mayıs 2001 ve Ocak ve Nisan 2002'de gözlenmiştir. Bacillariophyta her iki istasyonda en yüksek biyomasa sahipti. Bunu sırasıyla Chrysophyta, Pyrrophyta, Chlorophyta ve Cyanophyta takip etmiştir. Diversite değerlerindeki aylık değişimler 0,01 ve 0,90 arasında oldu. En düşük diversite değeri Ocak 2002'de birinci istasyonda gözlendi. Gölbaşı gölü fitoplanktonik organizmaların mevsimsel dağılımlarından dolayı mezotrof karakter taşımaktadır.Ancak gölün tropik durumu hakkında daha detaylı bilgi almak için göl suyunun daha çok fiziksel ve kimyasal analizlerinin yürütülmesi gerekli olacaktır.

Anahtar Sözcükler: Fitoplankton, Mevsimsel dağılım, Biyomas, Diversite

Introduction

Algae are the major primary producers in many aquatic systems and are an important food source for other organisms.They exist in planktonic and benthic forms. Species composition and the seasonal variations of these forms in freshwater are dependent on the interactions between physical and chemical factors. Therefore, phytoplankton species and density fluctuate according to the seasons. It has been shown that many of these fluctuations, called seasonal successions, could result from the life activities of the previously existing phytoplanktons and zooplanktons, fishes and other organisms (1). The seasonal succession of the phytoplankton is a problem that has attracted the attention of algologists for a long time, but many of the studies on periodicity have been restricted to limited areas. Several studies have been conducted on the seasonal distribution of the phytoplankton species in Turkish lakes in recent years (2-6). Attempts have been made to explain the seasonal development of phytoplanktons in those lakes. However, there is inadequate information on the seasonal distribution of the freshwater phytoplanktons in Turkey. The aim of this study was to determine the biomass and examine the seasonal succession of phytoplanktonic organisms in Lake Gölbaşı. In addition, trophic status was determined according to the seasonal variations of the phytoplanktons.

Materials and Methods

Lake Gölbaşı, which is a natural lake, is fed by underground water sources located in various places. It is situated in the south of Turkey, 50 km from the city of Antakya (36° 29′ E, 36° 30′ N) (Figure 1). It has been used for irrigation purposes for cotton production in this region surrounded by agricultural land. Therefore, the water levels are lower in spring and summer than in other seasons.

The study was carried out between May, 2001 and April, 2002. Two sampling stations were selected. The water level of the first station was lower than that of the second station. During the study, horizontal samples were collected monthly from each sampling station for species identification using a plankton net with a 55 µm mesh size as recommended by Round (7). The samples were preserved in a 5% formaldehyde solution and then enumerated using an inverted microscope with a counting chamber (8). In the counting process, every colony and threadlike organism was considered an individual unit. Phytoplankton species were identified from the literature (9-12). The cell volume of each phytoplankton species was computed by applying average dimensions for each species from each sampling station. The volume of each phytoplankton species was calculated by using geometrical shapes according to the method described by Akbay (13). Biovolume (μ^3) was converted to biomass (mg/m^3) assuming a specific gravity of 1.0 for all phytoplanktons (14,15). Phytoplankton diversity was expressed by Simpson's index as defined by Washington (16).

Water quality parameters such as pH, dissolved oxygen and temperature were measured using a pH meter (Orion 420A) and an oxygenmeter (YSI Model 52).

Results

The monthly average water temperature varied from 11.0 °C to 32.2 °C. The highest and lowest temperatures were in August and December, respectively. The pH values fluctuated between 7.4 and 8.5. Dissolved oxygen concentration was between 5.5 and 10.5 mg/l. The average water depth varied from 8.0 m in winter to 0.4 m in summer during the study. The first station had a lower water depth in summer.

The flora consisted of 41 taxa belonging to Bacillariophyta (24), Chlorophyta (12), Pyrrophyta (2), Cyanophyta (2) and Chrysophyta (1). A list of the species is given in Table 1. The abundance rates of the total phytoplankton species varied according to the stations during the research period. The seasonal variations of the phytoplankton divisions are given in Table 2. The dominant group was Chrysophyta followed by Bacillariophyta, Chlorophyta, Cyanophyta and

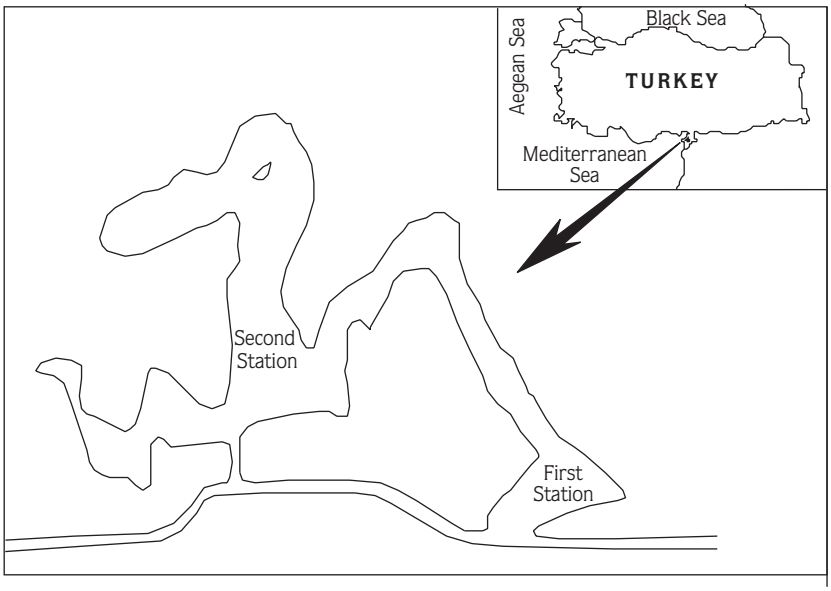

Figure 1. Map of Lake Gölbaşı.

Table 1. The monthly distribution of phytoplankton species in Lake Gölbaşı.

	M		J		J		A		S		O		N		D		J		F		M		A	
	2001							S	T	A	T	I	O	N	S								2002	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
CHLOROPHYTA																								
Chlorococcales																								
Coelastrum sp.			+														+	+						
Pediastrum bonyanum						+	+	+		+														
Pediastrum clathratum						+	+	+	+	+														
Pediastrum duplex						+	+	+	+	+	+	+	+	+	+	+							+	+
Pediastrum simplex											+	+	+	+	+	+	+	+	+	+	+	+	+	+
Pediastrum sp.	+	+	+	+	+			+																
Pediastrum tetras							+		+	+														
Scenedesmus sp.	+	+		+	+	+	+																+	+
Treubaria triapendiculata				+																				
Zygnemateles																								
Spirogyra sp.															+				+				+	+
Desmidiales				+																				
Closterium sp.	+																							
Tetrasporales																								
Sphaerocystis schroeteri				+																				
BACILLARIOPHYTA																								
Centrales																								
Melosira sp.				+		+						+	+		+	+							+	+
Stephanodiscus niagarae						+	+	+	+	+														
Cyclotella sp.														+									+	+
Pennales																								
Anomoeoneis sp.										+														
A. sphaerophora				+																				
Cymatopleura solea				+	+	+	+	+	+	+	+	+			+	+							+	+
Diatoma sp.												+	+	+	+	+	+	+	+	+	+	+	+	+
Nitzchia sp.	+		+	+	+	+	+				+		+	+	+	+	+	+	+				+	+
Gyrosıgma sp.	+	+	+	+	+	+	+		+	+	+	+	+	+	+	+	+	+	+	+		+	+	+
Cymbella sp.				+	+	+				+													+	+
Fragilaria sp.	+	+		+	+							+	+	+	+	+	+	+	+	+	+	+	+	+
Gamphonema sp.	+								+	+														
Synedra sp.	+	+		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Navicula sp.	+		+	+	+		+	+		+		+		+	+	+							+	+
Amphiprora alata					+																			
Cocconeis sp.	+		+	+	+						+	+	+						+	+		+	+	+
Cocconeis placentula							+		+	+														
Diatomella bolfouriana					+																			
Pinularia sp.			+	+	+	+		+		+													+	+
Caloneis amphisbaena					+					+														
Suriella robusta											+	+	+	+	+	+								
Surriella sp.		+	+	+	+	+	+	+	+	+	+						+	+	+	+	+	+		
Surriella striculata					+	+	+	+	+	+	+	+						+						
Campylodiscus clypeus				+		+	+	+	+															
PYRROPHYTA																								
Peridiniales																								
Peridinium sp.	+	+	+	+	+	+					+	+	+		+		+	+					+	+
Ceratıum sp.				+																				
CYANOPHYTA																								
Chroococcales																								
Merismopedia sp.			+	+	+	+		+		+	+	+	+	+	+	+							+	+
Gamphospheria sp.				+													+	+						
CHRYSOPHYTA																								
Chrysomonadales																								
Dinobryon sartularia	+	+	+	+									+	+	+	+	+	+					+	+

Table 2. The seasonal distribution of total phytoplankton divisions in Lake Gölbaşı (cells/m^3).

First Station (cells/m^3)												
DIVISION	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Chlorophyta	388	2300	2282	1681	2406	1026	460	513	124	36	18	583
Bacillariophyta	1945	1804	3539	3165	14013	1000	4424	1292	939	160	106	3627
Pyrrophyta	672	354	451	0	0	27	35	159	159	0	0	71
Cyanophyta	0	3963	1495	0	0	97	53	35	159	0	0	53
Chrysophyta	33723	71	0	0	0	0	18	88	25,3008	0	0	27,884
Second Station (cells/m^3)												
DIVISION	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Chlorophyta	1982	19108	4599	2093	1521	4016	778	229	70	35	35	547
Bacillariophyta	14,651	10,986	3221	1600	3397	5308	9978	1660	1148	194	246	3838
Pyrrophyta	1557	4458	230	0	0	124	0	0	88	0	0	35
Cyanophyta	0	26,751	2601	9	0	548	18	123	212	0	0	71
Chrysophyta	101,203	10,510	0	0	0	0	53	283	22,1161	0	0	23,974

Pyrrophyta. The seasonal variations in some dominant groups are shown in Figure 2. In the second station, the percentages of Bacillariophyta, Chlorophyta, Cyanophyta and Pyrrophyta were higher than those in the first station, except for Chrysophyta. The numbers of species in the second station were higher than those in the first station, although the percentage of Chrysophyta was lower compared to the first station. The biomass changes in phytoplankton divisions are presented in Table 3. Bacillariophyta had the highest biomass in both stations, followed by Chrysophyta, Pyrrophyta, Chlorophyta and Cyanophyta. Biomass changes are depicted in Figure 3. Diversity values ranged between 0.01 and 0.90. The highest diversity was 0.90 in the first station in February, 2002 and in the second station in March, 2002. The lowest value, 0.01, was observed in the first station in January, 2002. The monthly changes in the diversity index are shown in Figure 4.

Discussion

In summer, dissolved oxygen concentrations decreased due to high temperatures. Inversely, dissolved oxygen concentrations increased in winter due to lower temperatures. The change in the dissolved oxygen concentration can be attributed to the fluctuations in temperature. The average pH value was 8.03, indicating the alkaline character of the water body.

Seasonal differences were observed in the distribution of phytoplanktonic organisms. The species belonging to Bacillariophyta increased during the warmer months. In the months when the temperatures were low, the phytoplankton density was low, except for species belonging to Chrysophyta. Chrysophyta species usually start to grow towards the end of the fall due to their high dependency on temperature (17, 18). The effects of water temperature on phytoplanktons have been examined in many freshwater ecosystems and it was found that water temperature strongly regulates the seasonal distribution of phytoplanktons (19-21). The seasonal changes in water temperature considerably affected the seasonal variations in the phytoplanktons. In addition, such fluctuations in the amounts of phytoplanktons may be attributed to the seasonal variations in water levels between the 2 stations.

During the study, *Cyclotella*, belonging to Bacillariophyta, was rarely observed. *Cyclotella* was only observed in November, 2001 and April, 2002. As reported by various authors, the abundance of *Cyclotella* is closely related to the trophic status of lakes and many species of *Cyclotella* are typical in oligotrophic lakes (22-24). On the other hand, *Cyclotella* was also reported

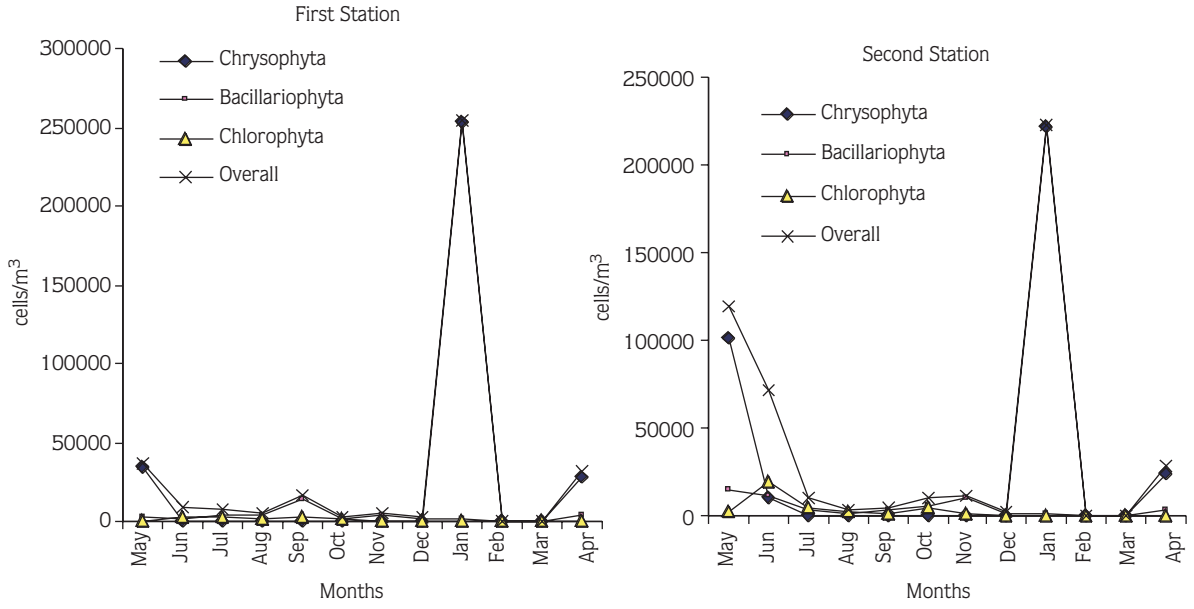

Figure 2. The seasonal variations in Chrysophyta, Bacillariophyta, Chlorophyta and overall phytoplankton populations in the stations (cells/m^3).

Table 3. The monthly changes in the biomass of phytoplankton divisions in Lake Gölbaşı (mg/m^3).

First Station (mg/m^3)												
DIVISION	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Chlorophyta	0.839	4.6	4.5	2.654	4.81	2.05	0.92	0.69	0.248	0.036	0.036	0.762
Bacillariophyta	2.26	43.45	126.4	88.91	444.07	34.21	6.69	8.9131	1.488	0.836	0.615	11.539
Pyrrophyta	13.44	7.08	9.02	0	0	0.54	0.7	3.18	3.18	0	0	1.42
Cyanophyta	0	0.39	0.15	0	0	0.001	0.005	0.0035	0.318	0	0	0.005
Chrysophyta	25.29	0.05	0	0	0	0	0.013	0.066	189.75	0	0	20.91
Second Station (mg /m^3)												
DIVISION	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Chlorophyta	0.003	37.29	9.092	2.594	3.042	8.032	1.556	0.458	0.14	0.07	0.07	0.72
Bacillariophyta	0.041	218.57	119.54	25.81	18.12	55.42	10.413	12.48	2.221	1.042	1.58	10.96
Pyrrophyta	0.02	93.93	4.6	0	0	2.48	0	0	1.76	0	0	0.7
Cyanophyta	0	6.91	0.26	0.001	0	0.0548	0.0018	0.012	0.424	0	0	0.007
Chrysophyta	75.9	7.88	0	0	0	0	0.04	0.212	165.87	0	0	17.98

among organisms belonging to the eutrophic lakes and reservoirs of Turkey (25-30).

Only the species *Dinobryon sertularia*, belonging to Chrysophyta, was observed during this study. This species was only detected in some months and the highest number was obtained in January, 2002. This species had the highest tolerance to low temperatures compared to the other species. These tolerance levels determine the dominance of different species within different seasons (31). In addition, *Dinobryon sertularia* is known from the literature to be potentially mixotrophic, exhibiting facultative bacterial feeding (32-34). The prevalence of

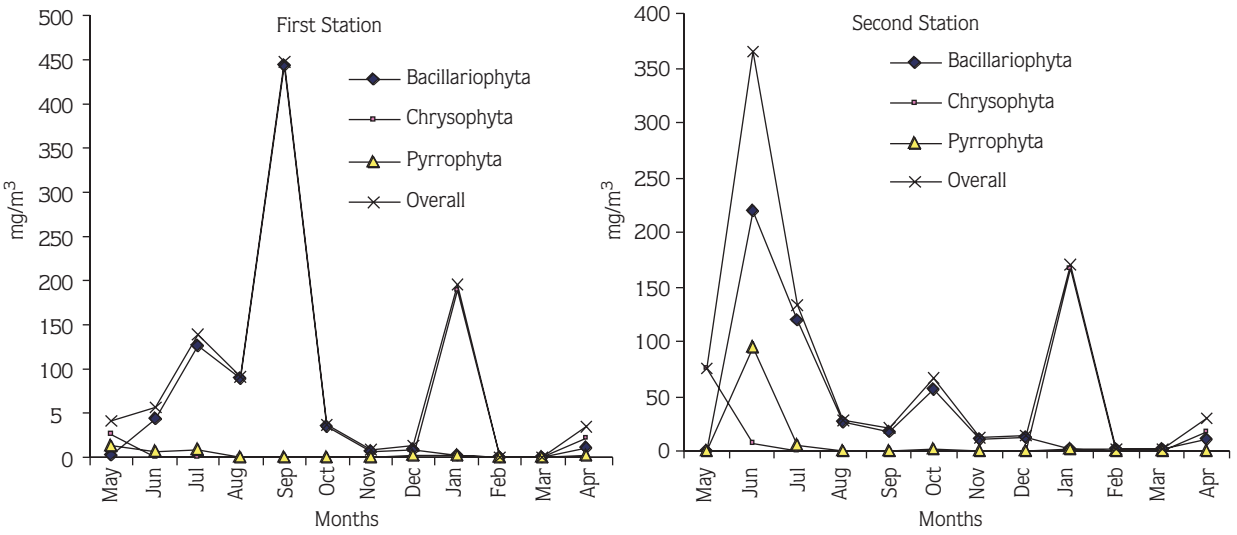

Figure 3. The monthly biomass changes in Bacillariophyta, Chrysophyta and Pyrrophyta and overall phytoplankton populations in the stations (mg/m^3).

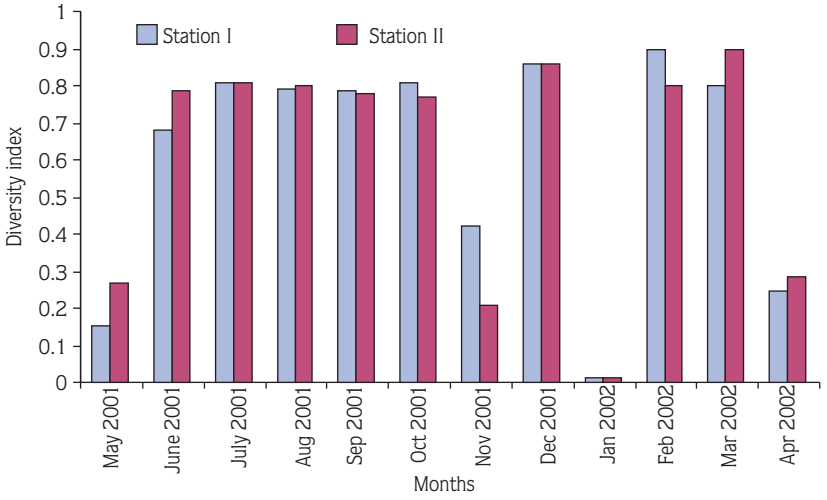

Figure 4. The monthly changes in Simpson's diversity index of phytoplankton species in the stations.

mixotrophic algae in oligotrophic environments is a well known phenomenon since mixotrophy is an optimal strategy when nutrients are low (34). Similar results were reported elsewhere (35). *Dinobryon sertularia* can also be found in mesotrophic lakes (36).

Members of Cyanophyta were observed to be more abundant in June and July, 2001, reaching their highest numbers in the second station in June, 2001. *Merismopedia* sp. and *Gamphospheria* sp, belonging to Cyanophyta, were rarely found, except in June and July, 2001. As reported for other lakes in Turkey (37), other members of Cyanophyta such as *Aphanizomenon flos-aqua*, *Anabaena* sp. and *Microcystis aeruginosa* were not found in the study, because, it is well documented that these algae usually prefer eutrophic lakes (37).

Members of Chlorophyta were found in the lake. In particularly, *Pediastrum bonyanum*, *Pediastrum clathratum*, *Pediastrum simplex*, *Pediastrum duplex*, *Pediastrum tetras* and *Pediastrum* sp. belonging to Chlorophyta were frequently observed during the study.

It has been reported that *Pediastrum* species are more common in eutrophic waters than in oligotrophic waters (23). On the other hand, these species are characteristic of mesotrophic lakes. In Lake Gölbaşı, members of Desmidiales (only *Closterium*) were only found in the first station in May, 2001. The members of Desmidiales are characteristic species of oligotrophic lakes, as reported by Hutchinson (23). These species usually prefer oligotrophic lakes, but it has been shown that of these species *Closterium* in particular is very common in eutrophic and mesotrophic lakes (38).

Two species of Pyrrophyta, were detected. These species were *Peridinium* and *Ceratium*. According to the results of this study, *Ceratium* was only observed in June, 2001, although *Peridinium* was found over a longer period. These species usually prefer eutrophic lakes, but it has been reported that they can also exist in mesotrophic lakes (23-39). The lowest diversity was found in January, 2002, followed by May, April and November, 2001. Such fluctuations in phytoplankton diversity can be attributed to the seasonal changes in the temperature and the water level of the lake. Since the lake is mainly used for irrigation for cotton production in this region, the water levels were lower in spring and summer than in the other seasons. Furthermore, as stated by Barone and Flores, water level variations affect predation patterns and consequently species diversity (40).

Many algal species are useful indicators of trophic conditions in lakes and rivers. Although we were not able to measure nutrient concentrations, we think that this study may provide valuable information with respect to later ecological studies of other lakes in Turkey. Our study revealed that Lake Gölbaşı had mesotrophic characteristics due to the seasonal distribution of phytoplanktonic organisms with trophic status. However, it will be necessary to carry out further physical and chemical analyses of the lake water to obtain more detailed information on trophic conditions.

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Corresponding author:
Mehmet NAZ
Faculty of Fisheries,
Mustafa Kemal University,
31040 Hatay - Turkey
E-mail: mnaz@mku.edu.tr

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