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Phytoplankton Community, Nutrients and Chlorophyll a in Lake Mogan (Turkey); with Comparison Between Current and Old Data

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Abstract

Seasonal changes in phytoplankton community structure, chlorophyll *a* and some physico-chemical features of Lake Mogan were studied during one-year period, from October 2005 to October 2006. The collected data were compared with the data in previous and recent studies. The nutrient concentrations in the lake were observed to increase with inputs of domestic wastewaters in to the lake in the last years. Chlorophyta and Cyanobacteria in the phytoplankton community in the lake were identified to be dominant together. *Merismopedia minima, Microcystis aeruginosa, Sphaerocystis schroeteri* and *Dictiyosphaerium pulchellum* were dominant during the warm period (May – October). Cyanobacterial blooms in the lake were observed in May, which is characteristic for eutrophic lakes in northern temperate region. Changes in phytoplankton community structure, Chl *a* peak and nutrient concentrations indicated that the trophic level of the lake is still eutrophic.

Keywords: Phytoplankton, physical-chemical parameters, eutrophication, trophic status, Mogan Lake, Turkey.

Mogan Gölü (Türkiye)'deki Fitoplankton Komunitesi, Besin Tuzları ve Klorofil a'nın Eski ve Yeni Durumlarının Karşılaştırılması

Özet

Mogan Gölü'nün fitoplankton kommunite yapısı, klorofil *a* ve fiziko-kimyasal özellikleri Ekim 2005 ve Ekim 2006 arasında bir yıl süreyle araştırılmıştır. Elde edilen veriler önceki araştırmalardan elde edilen verilerle karşılaştırılmıştır. Son yıllarda, göldeki besin tuzu konsantrasyonlarında evsel atıkların göle girişinden dolayı artış gözlenmiştir. Gölün fitoplankton komunitesinde Chlorophyta and Cyanobacteria'nın birlikte dominant olduğu belirlenmiştir. *Merismopedia minima, Microcystis aeruginosa, Sphaerocystis schroeteri* and *Dictiyosphaerium pulchellum* sıcak dönemde (Mayıs-Ekim) dominant olmuştur. Kuzey yarım kürenin ılıman bölgesindeki ötrofik göllerin karakteristiği olan Cyanobacteri patlaması Mayıs ayında gözlenmiştir. Fitoplankton komunite yapısındaki değişimler, klorofil *a* ve besin tuzu konsantrasyonları gölün hala ötrofik olduğunu göstermiştir.

Anahtar Kelimeler: Fitoplankton, fiziko-kimyasal parametreler, ötrofikasyon, trofik durum, Mogan Gölü, Türkiye.

Introduction

Planktonic organisms respond promptly to environmental changes and exhibit more conservative characteristics than physical and chemical variables changing in aquatic ecosystems (Nogueira, 2000). Therefore, the knowledge of the composition and abundance of phytoplankton organism constitutes an essential feature for the assessment of trophic status in lakes (Salmaso, 2002), and has been widely used as indicator of trophic status and water quality of lakes (Rawson, 1956; Wetzel, 1983; Trifonova, 1998; Reynolds *et al.*, 2002). The indicator properties of phytoplankton are determined by its species composition and quantitative parameters of developments, so the species composition, abundance, biomass and distribution of algae over water area are recorded completely (Yarushina et *al.*, 2003).

Composition and development of phytoplankton are deeply influenced by both short and long term environmental changes in the lake ecosystems. A comparison of recent research results with the results obtained several years ago may yield significant conclusions about the water quality and trophic status changes of lakes over time (Salmaso, 2002). Recently, the discharge of domestic, agricultural and industrial wastewater into aquatic ecosystems leads to increase amount of nutrients (particularly nitrogen and phosphorus) in lakes; consequently, an increase in the primary production, changes of the community structure of phytoplankton and phytoplankton blooms (especially Cyanobacteria) have been observed in aquatic ecosystems (Carpenter *et al*., 1999; Naselli-Flores and Barone, 2000; Vardaka *et.al*., 2005)

Lake Mogan has been affected by nutrient loading from various sources; consequently, eutrophication has been a major water quality problem in the lake for decades. The authors reported that restoration process is necessary for the lake (Altınbilek et *al*., 1995).

Hydrobiological characteristics of Lake Mogan were investigated by Tanyolaç and Karabatak (1974). Algal flora of littoral zone was studied by Obalı *et al*. (1989). A detailed study of seasonal variation of phytoplankton and physico-chemical characteristics of Lake Mogan had been carried out between 1975 and 1977 years by Obalı (1984), whereas Akbulut and Akbulut (2002) examined the plankton composition of the lake. Burnak and Beklioğlu (2000) described the situation of Lake Mogan as macrophyte-dominated clear water status. Mogan Lake was characterized as meso-eutrophic by Manav and Yerli 2008 but in the following years lake had shown a hypertrophic tendency (Mangıt and Yerli, 2010).

The aim of this work was to assess the current trophic status and seasonal dynamics of the phytoplankton together with the parameters of water quality of the Lake Mogan, and to compare available data.

Material and methods

Study Site

Lake Mogan is a shallow one (area 6.35 km^2), located 20 km south of Ankara (39º 47′ N; 32º 47′ E) within Gölbaşı. The lake has been primarily formed by tectonic activity. Its altitude is 972 m and its depth, on average, 2-2.5 m throughout length, reaching 3-4 m at its deepest point. The major inflows to Lake Mogan are Sukesen, Gölcük, Gölova and Tatlım brooks. The basin of Lake Mogan was reported to be a Specially Protected Area in 1990 (DSİ, 1993).

Sampling and Processing of Samples

The study of phytoplankton dynamics and physical and chemical features of the Lake Mogan carried out over one-year period, from October 2005 to October 2006. Five sampling stations were chosen to evaluate phytoplankton, chlorophyll *a* (Chl *a*) and water quality parameters (Figure 1). Water samples were taken from water surface using a Ruttner sampler and phytoplankton fixation was done immediately with Lugol iodine solution. Phytoplankton was identified and counted at 400x magnification using Hydro-Bios inverted microscope (Lund *et al*., 1958). Algal organisms were individual cells of single-celled species; and colonies of colonial algae (*Sphaerocystis, Dictyosphaerium, Botyrococcus* etc.). Identifying algal taxa were done according to Prescott (1982), Huber-Pestalozzi (1961), Komárek and Fott (1983), Krammer and Lange-Bertalot (1986; 1991a; 1991b, 1999), Round *et al*., 1990, Sims (1996), John *et al*. (2003). Recent systematic synonym and validity of the taxa were checked from the www.algaebase.org. (Guiry and Guiry, 2010).

The chlorophyll *a* (Chl *a*) concentrations, conductivity, water temperature, dissolved oxygen, pH, turbidity and total dissolved solid (TDS) were measured in situ using a 6600 model YSI multiprobe. Water transparency was determined by the Secchi disc with 20 cm diameter. Nutrient (NH_4-N, NO_2-N, NO_3-N and PO_4-P) concentrations of water were analyzed according to Standards Methods (Eaton *et al*., 1995).

Results and Discussion

Physical and Chemical Characteristics

Secchi depth varied between 0.40 and 2.50 m and measured as mean 1.16 m. Secchi depth values were much lower in early summer than in other seasons. The lowest values in early summer period were due to increasing amount of inorganic suspended solid inputs to the lake with rainfall during spring. However the mean Secchi depth level showed a gradual decrease according to that measured in the early study (Obalı, 1984). TDS concentrations showed less variation throughout the year and mean values ranged between 01 and 2.36 mg ml^{-1}. The lowest TDS mean value was measured in spring whereas highest value was observed in autumn. Turbidity was measured higher in spring than in other seasons. The seasonal mean turbidity values were measured as 10.64 NTU in autumn, 6.11 NTU in winter, 135 NTU in spring and 47.57 NTU in summer.

Water temperatures varied between 4.9 ^{o}C and 23.0 ^{o}C. Dissolved oxygen (DO) concentration means varied between 11.2 and 13.04 mg l^{-1} where minimum DO concentration was observed during the warm period. Conductivity values (EC) were generally high and varied between 2.27 mS cm^{-1} and, 3.01 mS cm^{-1} and highest values were observed in summer. High EC values in this period may be related to the increase of ionic concentrations due to increasing water temperature and the reduced water volume of the lake by means of evaporation. There was a gradual decrease in pH values towards to summer. Highest pH was measured as 9.25 in autumn and lowest value was 8.5 which was observed in summer. DO, pH and EC values in the present study were similar to that

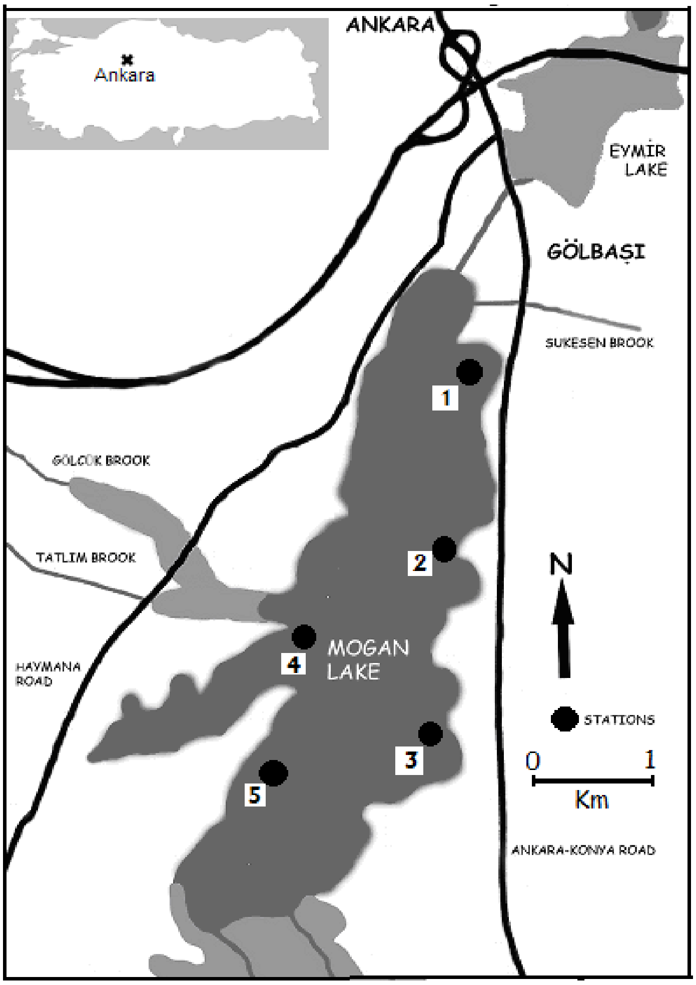

Figure 1. Study area and sampling stations (redrawn from Aldemir and Boşgelmez, 2005).

measured in the several studies (Obalı, 1984; Manav and Yerli, 2008). The average concentrations of the measured physico-chemical characteristics of Lake Mogan are listed in Table 1.

Ammonium (NH_4-N) concentrations were relatively high. Maximum ammonium concentrations were measured in spring and summer seasons which is thought to be caused by load of organic material and decomposition of this material. Maximum ammonium concentration was recorded in summer (0.773 mg l^{-1}) and minimum ammonium concentration was recorded (0.025 mg l^{-1}) in autumn. Nitrite (NO_2-N) concentrations were always very low during the study period. Maximum nitrite concentration was recorded as 0.03 mg l^{-1} in winter. Nitrate (NO_3-N) concentrations varied from between 0.09 and 0.90 mg l^{-1}. Ortho-phosphate (PO_4-P) concentrations ranged between 0.23 mg l^{-1} and 2.8 mg l^{-1}. In Lake Mogan, the remarkable feature was the relatively low nutrient concentrations in summer and autumn seasons, which can be explained by increased phytoplankton growth in spring and autumn with characteristic algal bloom consuming a major part of the nutrients.

A detailed study of seasonal variation of phytoplankton and physico-chemical characteristics of Lake Mogan had been carried out between 1975 and 1977 years by Obalı (1984). Mean nitrate and phosphate concentrations during those years were recorded as 0.26 mg l^{-1} and 0.18 mg l^{-1} respectively. The minimum and maximum amounts of ammonium, nitrite, nitrate and ortho-phosphate concentrations between 2001 and 2003 years by Manav and Yerli (2008) were recorded as 0.23 - 1.02 NH_4-N mg l^{-1}, 0.00 -0.09 NO_2-N mg l^{-1}, 0.00- 2.20 NO_3-N mg l^{-1} and 0.01 - 0.11 PO_4-P mg l^{-1} respectively. A gradual increase in nutrient concentration can be observed which can be related with inputs into the lake domestic wastewaters from its catchments in the last years. Nutrient concentrations and available biological data show that the trophic level according to OECD criteria (Ryding and Rast, 1989) in Lake Mogan is still continuing (Yerli *et al*., 2006).

Phytoplankton Composition and Seasonal Variations

A total of 88 taxa of phytoplankton assemblage were reported in Lake Mogan (Table 2). Bacillariophyta had the highest number of species (32), followed by Chlorophyta (27), Cyanobacteria (19), Streptophyta (5), Euglenophyta(3),

Table1. Some physical-chemical features of Lake Mogan in 2005-2006

Variable	Fall	Winter	Spring	Summer
Water Temperature (^oC)	8.39±0.45	5.36 ±0.40	13.17±0.64	21.93±0.84
Conductivity (ms cm^{-1})	2.50±0.22	2.27±0.14	2.39±0.05	3.01±0.07
Total Dissolved Solid (g l^{-1})	2.37±0.22	2.36±0.17	2.01±0.01	2.07±0.02
Dissolved Oxygen (mg ml^{-1})	11.64±0.39	12.84±0.98	13.04±0.80	11.20±1.64
pH	9.25±0. 08	9.04±0.10	8.60±0.01	8.50±0.02
Turbidity (NTU)	10.64±18.44	6.11±2.44	135.49±146.05	47.57±10.15
Secchi depth (m)	2.00±0.29	1.22±0.49	0.80±0.23	0.77±0.36
NH_4-N (mg l^{-1})	0.08±0.04	0.21±0.01	0.56±0.04	0.62±0.12
NO_2-N (mg l^{-1})	0.01±0.01	0.01±0.00	0.01±0.00	0.00±0.00
NO_3-N (mg l^{-1})	0.66±0.14	0.15±0.05	0.23±0.06	0.24±0.17
PO_4-P (mg l^{-1})	0.32±0.08	0.56±0.21	2.31±0.29	1.24±0.24

Table 2. The list of phytoplankton taxa from previous and present studies in Lake Mogan

TAXA	Aykulu *et al*., 1983	Present study
Bacillariophyta		
Amphora ovalis (Kütz.) Kütz.	+	
Amphora pediculus (Kütz.) Grunow		+
Campylodiscus hibernicus Ehrenb.		+
Cocconeis placentula Ehrenb.	+	+
Ctenophora pulchella (Ralfs ex Kützing) D.M.Williams & Round		+
Cyclotella meneghiniana Kütz.	+	+
Cyclotella ocellata Pant.	+	+
Cymbella affinis Kütz.	+	+
Diatoma tenue C.Agardh		+
Diatoma vulgare Bory	+	
Discostella glomerata (H.Bachmann) Houk & Klee	+	+
Encyonema silesiacum (Bleisch) D.G.Mann	+	
Entomoneis alata (Ehrenb.) Ehrenb		+
Epithemia adnata (Kütz.) Bréb.		+
Epithemia sorex Kütz.	+	+
Fragilaria tenera (W.Simith) Lange-Bert.		+
Gomphonema parvulum (Kütz.) Kütz.		+
Melosira varians Agardh	+	+
Navicula cryptocephala Kütz.	+	+
Navicula rhynchocephala Kütz.		+
Navicula salinarum Grunow		+
Navicula veneta Kütz.		+
Nitzschia palea (Kütz.) W. Smith	+	+
Nitzschia acicularis (Kütz.) W. Smith	+	
Nitzschia vermicularis (Kütz.) Hantzsch.		+
Pinnularia borealis Ehrenb.		+
Pinnularia microstauran (Ehrenb.) Cleve		+
Rhoicosphenia abbreviate (C. Agarth) Lange-Bert.	+	
Rhopalodia gibba (Ehrenb.) O. Müller		+
Stephanodiscus rotula (Kütz.) Hendey	+	
Surirella ovalis Bréb.	+	
Ulnaria ulna (Nitzsch) Compére	+	+
Chlorophyta		
Ankistrodesmus falcatus (Corda) Ralfs	+	+
Botyrococcus braunii Kütz.	+	+
Botyrococcus protuberans W. & G. S. West		+
Carteria sp.	+	
Characium sp.	+	
Chlamydomonas globosa Snow		+
Chlamydomonas pseudopertyi Pasch.		+
Chlamydomonas sp.	+	+
Chlorella ellipsoidea Gern.		+
Chlorella vulgaris Beij.		+
Coelastrum microporum Nägeli	+	
Crucigenia lauterbornii (Schmidle) Schmidle	+	+

Table 2. (continued)

TAXA	Aykulu *et al*., 1983	Present study
Chlorophyta		
Crucigenia quadrata Morr.	+	+
Dictyosphaerium pulchellum Wood	+	+
Gleocystis gigas (Kütz.) Lagerheim	+	
Kirchneriella sp.	+	
Monoraphidium irregulare (G. M. Smith) Kom.-Legn.		+
Oocystis parva W. & G. S. West	+	
Oocystis borgei Snow	+	+
Oocystis elliptica West	+	
Quadricula sp.	+	
Scenedesmus quadricauda (Turp.) Bréb.	+	+
Scenedesmus arcuatus (Lemm.) Lemm.	+	+
Scenedesmus ecornis (Ehrenb.) Chod.	+	+
Schroederia setigera (Schroed.) Lemm.	+	
Sphaerocystis schroeteri Chod.	+	+
Tetraedron minimum (A. Braun) Hansgirg		+
Streptophyta		
Closterium venus Kütz ex Ralfs	+	
Cosmarium sp.		+
Cosmarium wittrockii Lund.		+
Staurastrum gracile Ralfs ex Ralfs	+	+
Staurastrum muticum Bréb. ex Ralfs		+
Cyanobacteria		
Anabaena catenula Kütz ex Bornet& Flahault var. *affinis* (Lemm.) Geit.		+
Anabaena flos-aquae (Lyngbye) Bréb. ex Bornet & Flauhault		+
Anabaena sp.	+	
Anabaena spiroides Klebahn		+
Anabaenopsis elenkinii Miller		+
Aphanocapsa incerta (Lemm.) Cron.& Kom.	+	+
Chroococcus minimus (Keiss.) Lemm.		+
Chroococcus sp.	+	
Merismopedia glauca (Ehrenb.) Kütz.	+	
Merismopedia minima Beck		+
Merismopedia tenuissima Lemmerm.	+	+
Microcystis aeruginosa(Kütz.) Kütz.	+	+
Oscillatoria limosa C. Agardh		+
Oscillatoria tenuis C. Agardh		+
Phormidium formosum (Bory ex Gomont) Anognostidis & Komárek		+
Pseudanabaena limnetica (Lemm.) Komárek		+
Pseuduanabeana sp.		+
Spirulina major Kütz.		+
Spirulina nordstedtii Norstedt ex Gomont		+
Dinoflagellata		
Peridiniopsis borgei Lemmerm.		+
Euglenophyta		
Lepocinclis oxyuris (Schamarda) Marin & Melkonian	+	+
Euglena acus(O.F.Müller) Ehrenb.		+
Euglena polymorpha P.A. Dangeard		+
Cryptophyta		
Cryptomonas ovata Ehrenb.	+	

Dinoflagellata (1) and Cryptophyta (1). Bacillariophyta were represented by a large number of species, but most of them were pennate diatoms which are known as benthic organisms. The species of *Amphora*, *Cymbella*, *Cocconeis*, *Epithemia*, *Gomphonema*, *Navicula, Pinnularia*, *Rhopalodia* and *Surirella* usually exists in a benthic algal community (Round, 1984). The benthic algae could be carried to water column from sediment as a result of strong water mixing with wind affecting the surface of the sediment in the lake. One important aspect which can be observed in shallow lakes is frequent intermixing of benthic algal organisms and phytoplanktonic organisms. This situation was reported for Lake Mogan (Obalı *et. al.*, 1989) and Hafik Lake (Kılınç, 1998).

The composition of phytoplankton was found to be very similar in all stations. In the phytoplankton community, Cyanobacteria dominated with 48% in terms of density, and were followed by Chlorophyta with 41%, Bacillariophyta with 10%, Euglenophyta and Dinophyta with 1%. Cyanobacteria dominated in late spring, summer and autumn. Cyanobacteria, particularly *Merismopedia minima* peaked in late spring and comprised 70.7% of the total phytoplankton in May. However, their numbers showed a rapid decline and it had very low density in summer. *Microcystis aeruginosa* contributed considerably to the overall organism numbers and they constituted a significant part of the phytoplankton community during the summer and autumn seasons. Although *Merismopedia* sp. and *Microcystis aeruginosa* were observed in high densities in phytoplankton community during the study period but they were reported in low numbers in previous studies (Table 3), (Obalı, 1984).

Members of Chlorophyta dominated in spring, summer and autumn. *Chlamydomonas globosa* and *Chlamydomonas pseudopertyii* showed an increase in early spring and composed approximately 82.3% of phytoplankton density. *Chlamydomonas* sp. and *Carteria* sp. had been recorded as dominant in Lake Mogan during the spring in previous study (Table 3) (Obalı, 1984). An increase in the cell density coincided with the increasing water temperature value (mean 12 ^{o}C), high conductivity values and total dissolved solid concentrations. *Chlamydomonas* spp. has been widely found in eutrophic lakes and reservoirs (Trifonova, 1998; Temponeras *et al*., 2000). Garcia-Ferrer *et al*. (2003) explained that the populations of *Chlamydomonas* spp. might be supported by a mixotrophic metabolism in the lakes, where increase the concentrations of dissolved organic matter occur. *Dictiyosphaerium pulchellum* was observed frequently in April. *Sphaerocystis schroeteri* occurred in large quantities during summer and autumn seasons, and constituted a major part of phytoplankton density. *Oocystis elliptica* were subdominant in the phytoplankton community in summer. This species had been reported as a dominant species in summer and autumn seasons in previous studies (Table 3). (Obalı, 1984). *Sphaerocystis schroeteri* was observed in high numbers in early summer by Obalı, 1984 (Table 3), and was also recorded by showing highest density during the spring and early summer in Demirdöven Dam Reservoir of Turkey (Kıvrak and Gürbüz, 2005). Trifonova (1998) reported *Sphaerocystis* as to be found in high amounts during spring in temperate and subarctic lakes of north-western Russia. *Sphaerocystis* and *Oocystis* spp. are adapted to oligotrophy and mesotrophy (Hutchinson, 1967; Willen, 1992; Trifonova, 1998; Reynolds *et al*., 2002). Decreased nutrient concentrations, sufficient light density in summer seems to provide suitable growth conditions for these species. Many authors emphasized adequate

Table 3. The list of dominant phytoplankton taxa from previous and present studies in Lake Mogan

	2005 (present study)		2006			1975 (Obalı,1984)	1976 (Obalı, 1984)			1977 (Obalı, 1984)		
Dominant taxa	Autumn	Winter	Spring	Summer	Autumn	Autumn	Spring	Summer	Autumn	Spring	Summer	Autumn
Bacillariophyta												
Cyclotella meneghiniana				+		+	+	+				+
Ctenophora pulchella	+	+										
Discostella glomerata												+
Stephanodiscus rotula												+
Chlorophyta												
Botyrococcus braunii									+		+	
Carteria sp.							+			+		
Chlamydomonas globosa			+									
Chlamydomonas pseudopertyi			+									
Chlamydomonas sp.							+			+		
Crucigenia sp.									+			
Dictiyosphaerium pulchellum			+			+						
Oocystis elliptica				+								
Crucigenia quadrata								+				
Oocystis sp.								+	+			
Scenedesmus sp.								+				
Shroederia setigera										+	+	
Sphaerocystis schroeteri				+	+						+	
Tetraedron minimum	+											
Cyanobacteria												
Merismopedia minima			+	+								
Microcystis aeruginosa	+			+	+						+	
Microcystis sp.						+			+			
Dinoflagellata												
Peridiniopsis borgei	+											

light and water temperature as important factors affecting the growth the members of Chlorophyta (Temponeras et *al*., 2000; Çelik and Ongun, 2007).

Cyclotella meneghiniana (centric diatoms) and *Ctenophora pulchella* (pennat diatoms) from Bacillariophyta were observed highly in the phytoplankton community. *Ctenophora pulchella* dominated in late autumn and winter and comprised 56% of the total numbers of phytoplankton. *Cyclotella meneghiniana* showed a regular distribution during the study period and were recorded in high densities in summer months and early autumn. *Ctenophora* spp. are commonly found in well-mixed eutrophic lakes (Reynolds *et al*., 2002). *Cyclotella* spp. are characteristic indicators of oligotrophy in lakes and reservoirs (Hutchinson, 1967; Trifonova, 1998), and they have been reported as dominant in several oligotrophic and mesotrophic lakes and reservoirs of Turkey (Aykulu *et al*., 1983; Altuner, 1984; Gönülol and Obalı, 1998). Although *Cyclotella meneghiniana*, *Cyclotella glomerata* and *Stephanodiscus astrea* were reported high in summer and autumn by Obalı, 1984, *Ctenophora pulchella* had not been recorded as dominant in Lake Mogan during the spring (Table 3).

Peridiniopsis borgei (Dinoflagellata) became dominant together with *Microcystis aeroginosa* only in autumn of 2005. *Peridinium* spp, *Glenodinium* spp and *Peridiniopsis* spp. (Dinoflagellata) had been found widely in eutrophic and hypertrophic lakes of Russia and Norway (Trifonova, 1998; Brettum and Andersen, 2005). The other species identified in the lake were found in low densities in the phytoplankton community.

The phytoplankton in the Lake Mogan showed two seasonal peaks: one in definite spring and the second early autumn (Figure 2). This was the general pattern described for many temperate lakes (Hutchinson, 1967; Padisák *et al*., 1998), and was in accordance with growth of the phytoplankton in previous study (Obalı, 1984). *Merismopedia minima* bloomed in May and reached 39360 organisms in ml. During the late spring, suitable growth conditions for this species occurred as increased nutrient concentrations and water temperature. *Sphaerocystis schroeteri* and *Microcystis aeruginosa* performed the second peak in early autumn. The summer and autumn growth of *Microcystis aeruginosa* in eutrophic and hypertrophic lakes was reported to be characteristic by many authors (Naselli-Flores and Barone, 2000; Vardaka *et al*., 2005).

Sphaerocystis schroeteri seems to be adapted for growth in decreasing light density and nutrient concentrations during the summer and autumn seasons. Reynolds *et al*. (2002) stated that colonial Chlorophytes (e.g. *Botyrococcus* spp.) was tolerant to low nutrients and high turbidity. Turbidity, TDS and nutrients concentrations in the Lake Mogan may have provided the suitable environment for growth of these species summer and autumn seasons.

Chlorophyll *a* mean concentrations ranged between 2.28 and 17.86 µg $l^{-1}$was observed lowest during the late autumn, early winter and early spring (Figure 3). The highest Chl *a* concentrations were observed at the Station V which is located in the river inlet and affected by wastewater inputs. Seasonal variations of phytoplankton and Chl *a* concentrations generally shows a similar pattern (Fig 2 and 3). Based on the annual mean Chl *a* content, Lake Mogan can be classified as eutrophic (Ryding and Rast, 1989; Reckhow and Chapra, 1983). Chl *a* concentrations in this study was observed to be higher than those other studies (Obalı, 1984; Manav and Yerli, 2008).

Compared to previous studies, it is observed that the eutrophic level of the lake is still continuing. We observed a change from Chlorophyta assemblage to Cyanobacteria assemblage of the community structure of the phytoplankton in the lake. *Merismopedia minima* and *Microcystis aeruginosa* constituted a significant part of the phytoplankton community during the warm period (May – October). Cyanobacterial blooms were observed in the Lake in May, which was accepted as an indicator of eutrophy. This situation may be related to increasing nutrient concentrations by inputs into the lake the domestic wastewaters from its catchments in the last years. Chl *a* peak and nutrient concentrations indicated that the trophic level of the lake is progressing toward the hypertrophy. We hope that the presented data will be useful for future monitoring and evaluation of the trophic level of the lake.

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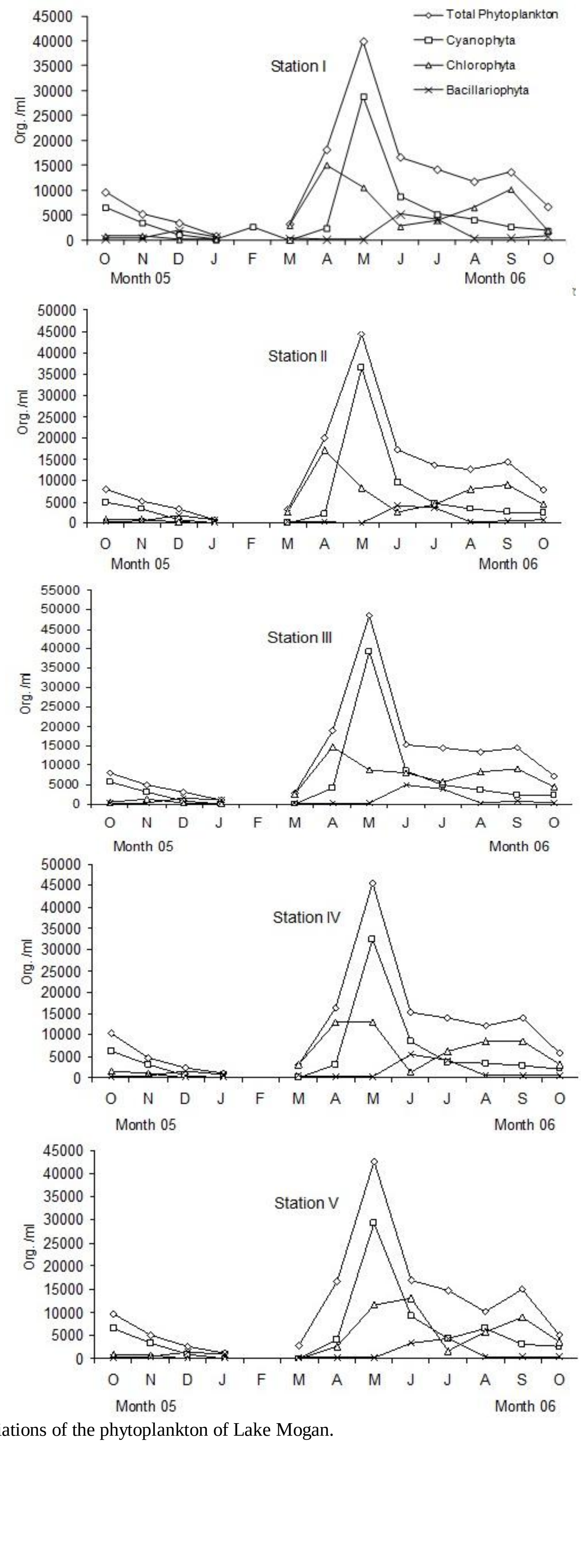

Figure2. Seasonal variations of the phytoplankton of Lake Mogan.

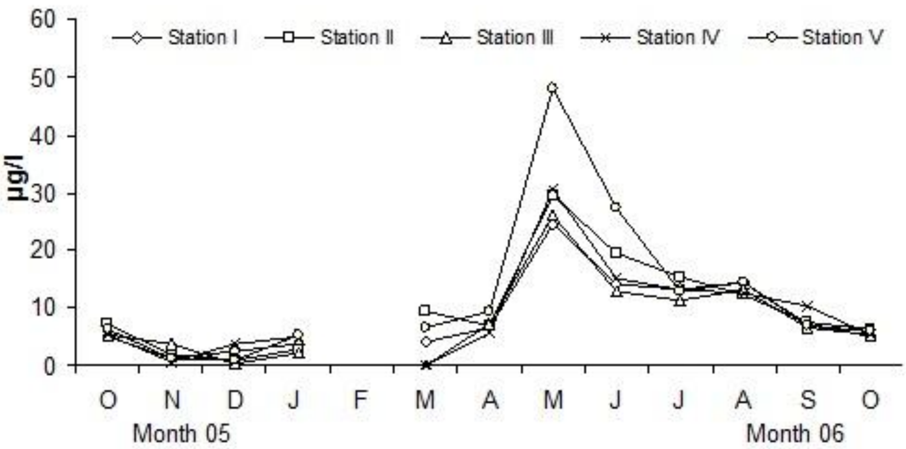

Figure 3. Seasonal variations of chlorophyll *a* concentration in Lake Mogan.

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