A Taxonomic Study on the Phytoplankton in the Littoral Zone of Karagöl Lake (Borçka-Artvin/Turkey)

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Abstract

The composition of phytoplankton community of Karagöl Lake was studied between April-October 2001 and April-October 2002. Thirty-two taxa (21 belonging to Bacillariophyta, 8 to Chlorophyta, 1 to Cyanophyta, 1 to Chrysophyta and 1 to Euglenophyta) were determined. Some physical factors, such as ice, light and temperature affected development of the phytoplankton community. In addition, wind and water current caused mixing between phytoplankton and benthic algae.

Key words: Phytoplankton, Littoral Zone, Taxonomy, Karagöl Lake, Turkey.

Introduction

Algae that form the source of food and oxygen for heterotrophic organisms in aquatic habitats, directly affect primary productivity by forming first circle of food chain. And also it is reported that the algae have a role in determining water pollution and cleaning waste water (Çolak and Kaya, 1988). In recent years, algal indicators are effective in checking and observing tools. If the chemical monitoring is limited, the use of diatoms in monitoring would be valuable in remote locations subject to the pronounced change (Jüttner *et al*., 1996).

Although Turkey has a great potential of inland waters relatively less is known about their algal flora. It is necessary to study the algal flora of Turkey as a part of the biological monitoring requested by the European Water Framework Directive, and also the investigation of the freshwater algal flora. However, algae might be used as the indicator of water quality (Soylu and Gönülol, 2003).

Apart from the work done by Şahin (Şahin and Gönülol, 1996), there are no published articles about phytoplankton in the lakes of the Eastern Black Sea Region of Turkey.

The present paper reveals the species composition of phytoplankton of Karagöl Lake.

Study Site

Karagöl Lake is located at latitude 41º 52' 30" N, and longitude 41º 52' 40" E, at an elevation of approximately 1465 ma.s.l. in the Natural Park in Artvin. The lake has a surface area of 10 hectares and maximum depth of 7 m. Two streams (Heba and Savgule Streams) flow into the lake. There is an outflow (Çosedinara Stream) (Figure 1). The climate of the region is generally cool and rainy in summer,

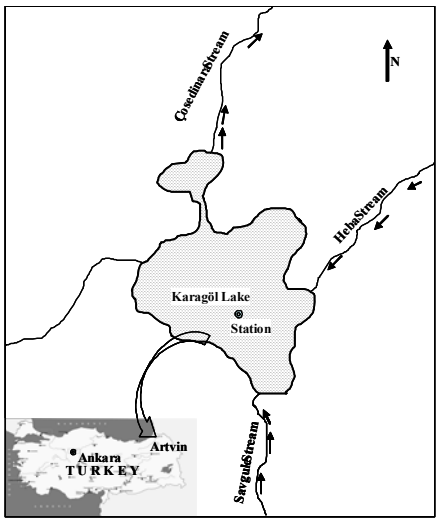

Figure 1. Map of Karagöl Lake.

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cold and snowy in winter (seasonal average temperature 14.4°C, highest temperature 42.4°C, lowest temperature -5.7°C and precipitation 708.3 mm) (Anonymous, 2002). Terrestrial vegetation is composed of trees, shrubs and herbs, including *Abies nordmanniana* (Stev.) Mattf., *Picea orientalis* (L.) Link, *Fagus orientalis* Lipsky, *Juglans regia* L., *Rhododendron ungernii* Trautv., *R. caucasicum* Pallas, *Rubus caucasicus* Focke (Anonymous, 1994). The lake is known for its natural beauty and is surrounded by a rich flora and fauna. Therefore, it is a well-know tourism location in Turkey.

Materials and Methods

In order to examine the phytoplankton community of Karagöl Lake one station was chosen at the littoral zone. Collections were made during the snow-free period from April-October 2001 to April-October 2002. The water samples were taken with plankton net (mesh size 50 µm) from surface water. Then the samples were fixed with 4% formaldehyde.

Water temperature and pH were measured *in situ* using a mercury thermometer and a WTW Digi 88 model pH meter, respectively. Dissolved oxygen concentration was measured according to the method described by Winkler (Yaramaz, 1988).

Taxonomic identifications were made according to Krammer and Lange-Bertalot (1986, 1988, 1991a, b), Patrick and Reimer (1966, 1975) and Prescott (1973). The main species of the phytoplankton were photographed using an Olympus BH-2 research microscope.

Results

Environmental Conditions

During the sampling period, water temperature varied from 5 to 21°C. The main surface water temperature was 13°C. pH fluctuated between 7.1 and 7.8 (mean 7.5), indicating alkaline character. Dissolved oxygen concentrations were measured between 8.5 and 12.3 mg L^{-1}.

Phytoplankton Composition

A total of 32 species of algae were recorded from Karagöl Lake. Bacillariophyceae was predominant, accounting for 21 taxa, followed by Chlorophyta with 8 taxa, Cyanophyta with 1 taxon, Chrysophyta with 1 taxon and Euglenophyta with 1 taxon. A list of taxa is given in the Table 1. Bacillariophyta is cited according to the systematic classification of Krammer-Lange-Bertalot.

Table 1. List of phytoplankton of Karagöl Lake.

Divisio: Bacillariophyceae	**Divisio:** Chlorophyta
Classis: Pennatibacillariophyceae	**Classis:** Chlorophyceae
Ordo : Pennales	**Ordo :** Chlorococcales
Cymatopleura solea (Breb. & Godey) W. Sm.	*Ankistrodesmus* sp.
Cymbella amphicephala Näegeli	*Crucigenia* sp.
C. cistula (Ehrenb. in Hemprich & Ehrenb.) Kirchn. in Cohn	*Lagerheimia* sp.
C. cuspidata Kütz.	*Oocystis* sp.
C. sinuata Gregory	*Scenedesmus* sp.
C. ventricosa C. Agardh.	**Classis:** Conjugatophyceae
Diatoma vulgare Bory.	**Ordo :** Desmidiales
Didyomosphenia geminata (Lyngb.) M. Schmidt.	*Micrasterias* sp.
Diploneis elliptica (Kütz.) Cleve	Ordo : Zygnemales
Fragilaria construens (Ehrenb.) Grunow	*Spirogyra* sp.
F. ulna (Nitzsch) Lange-Bert.	**Classis:** Oedogoniophyceae
Gomphonema constrictum Ehrenb.	**Ordo :** Oedogoniales
G. olivaceum (Lyngb.) Kütz.	*Bulbochaete* sp.
Gyrosigma acuminatum (Kütz.) Rabenh.	**Divisio:** Chrysophyta
Hannaea arcus (Ehrenb.) Patrick	**Classis :** Chrysophyceae
Navicula cryptocephala Kütz.	**Ordo :** Chrysomonadales
N. radiosa Kütz.	*Dinobryon* sp.
Nitzschia microcephala Grunow	**Divisio:** Cyanophyta
Pinnularia mesolepta (Ehrenb.) W. Sm.	**Classis :** Cyanophyceae
Rhoicosphenia abbreviata (C. Agardh) Lange-Bert.	**Ordo :** Hormogonales
Stauroneis anceps Ehrenb.	*Oscillatoria princeps* Vaucher
	Divisio: Euglenophta
	Classis: Euglenophyceae
	Ordo : Euglenales
	Phacus sp.

Discussion

The development of the phytoplankton community in Karagöl Lake was largely determined by some ecological factors. Ice was the main factor regulating the phytoplankton community. After the ice had melted, the wind and water current also influenced phytoplankton. There is no doubt, however, that the continuous light and temperature contributed substantially to the phytoplankton community. Photographs of some species are shown in Figure 2.

In Karagöl Lake, the taxa belonging to Bacillariophyceae were predominant and constituted 65.52% of the total taxa. The same result was observed in other lakes in Turkey (Şahin and Gönülol, 1996; Obalı, 1984; Gönülol and Obalı, 1986; Kılınç, 1998). Bacillariophyceae were only represented by members of Pennales in the phytoplankton of Karagöl Lake. The reason for this was that members of Pennales are bigger than members of Centrales which can escape from the plankton net holes. Members of Pennales are not actual species of phytoplankton. They were mixed with phytoplankton from streams and sediments and became the permanently existing organisms in phytoplankton throughout the examination period. This could be due to strong mixing detaching these algae because of lake being exposed to wind and water current. The same situation was observed in Uzungöl Lake in Turkey (Şahin and Gönülol, 1996), Mogan (Obalı, 1984), Karamık (Gönülol and Obalı, 1986) and Hafik (Kılınç, 1998). Hutchinson (1967) pointed out that species of *Cymatopleura*, *Cymbella*, *Navicula* and *Nitzschia*, which were common in phytoplanton of Karagöl Lake, are mainly benthic diatoms. *Cymbella* has the greatest diversity, including 5 species. Most of them have wide distribution throughout Turkey (Gönülol *et al.*, 1996; Çelekli, 2006). *Navicula cryptocephala* and *Fragilaria ulna*, which were found at moderate levels in Karagöl Lake, are known to have a broad distribution in Turkey (Gönülol *et al.*,

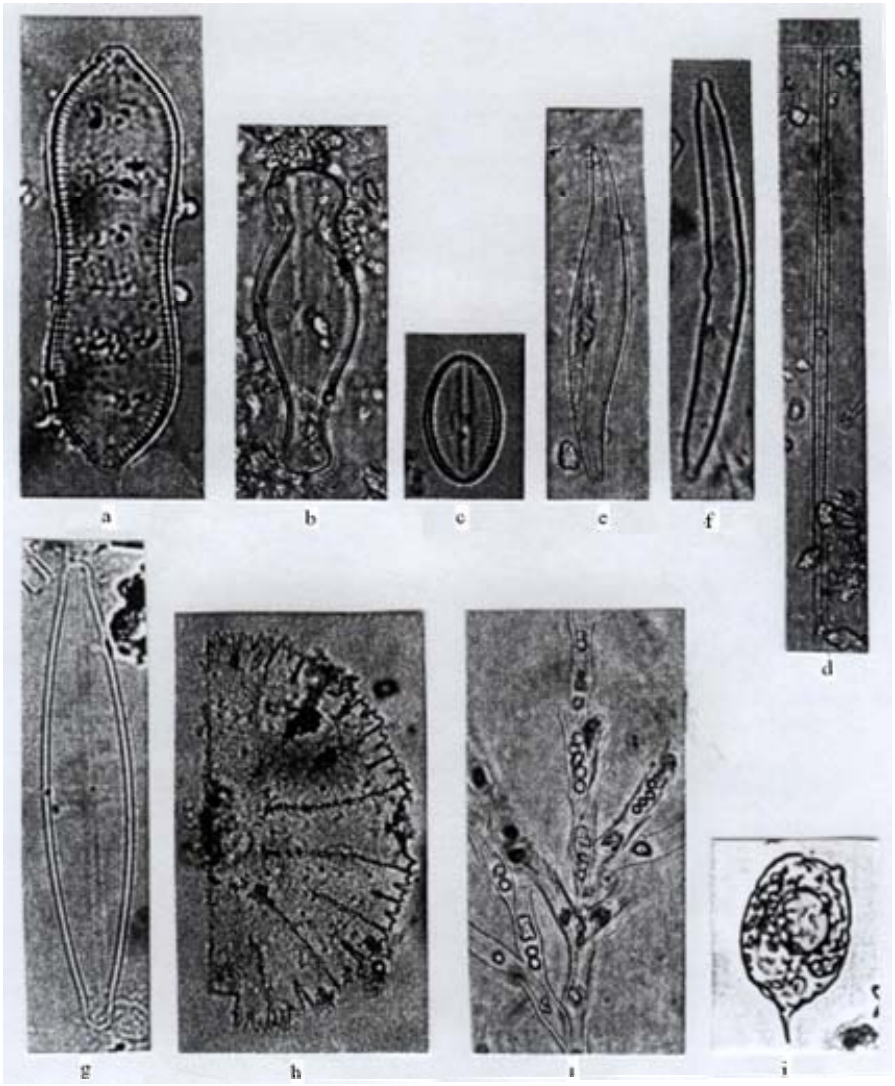

Figure 2. a-*Cymatopleura solea*, b-*Didymosphenia geminata*, c-*Diploneis elliptica*, d-*Fragilaria ulna*, e-*Gyrosigma acuminatum*, f-*Hannaea arcus*,g-*Stauroneis anceps*, h-*Micrasterias* sp., ı-*Dinobryon* sp., i-*Phacus* sp. (Scala: 10 µm).

1996) and Europe (Kitner and Poulickova, 2003).

Chlorophyta were represented by 8 taxa and constituted 25% of the total taxa. In literature, members of Chlorococcales are widespread in eutrophic lakes, but *Oocystis* species of this ordo have been mentioned to be oligotrophic (Hutchinson, 1967). In addition, the members of Desmidiales are also characteristic species of oligotrophic lakes (Hutchinson, 1967). The same situation was observed in Mogan Lake in Turkey (Obalı, 1984), Karamık (Gönülol and Obalı, 1986) and Hafik (Kılınç, 1998). These unicellular species were not important in the phyoplankton community of Karagöl Lake. Flamentous Chlorophyta were represented by two species, including *Bulbochaete* sp. and *Spirogyra* sp., which were sterile and could not be identified. These are mainly benthic species. We can say that the presence of these species in phytoplankton may be the result of wind affecting the lake.

Well known as "pioneer organisms", Cyanophyta are characteristically initial colonizers and are the dominant phytoplankton in such inhospitable habitats as recently filled volcanic craters, geothermal pools, alpine and boreal ponds, and highly polluted (either with organic and/or inorganic wastes) as well as in less extreme lake and river systems (Pearl, 1988). It has been well documented that as a group, Cyanophyta have a distinct preference for neutral to alkaline waters (King, 1970; Shapiro, 1973). However, Cyanophyta were represented by *Oscillatoria princeps* and comprised 3.12% of the phytoplankton in Karagöl Lake. The reasons for this were possibly being nutrient limitation other than physical effects.

Rawson (1956) reported that the members of Chrysophyta are characteristic species of oligotrophic lakes. In Karagöl Lake, Chrysophyta was represented by *Dinobryon* sp. and comprised 3.12% of the phytoplankton community. *Dinobryon* sp. was the mostly encountered species in the phytoplankton community in summer.

Euglenophyta members are known to be abundant in eutrophic waters and on sediments polluted with organic matter (Round, 1984). Euglenophyta were represented by *Phacus* sp. and comprised 3.12% of the phytoplankton community. *Phacus* sp. were not important in the phytoplankton community.

It is well known that phytoplankton composition and abundance is controlled by grazers as well as nutrients (Carvalho, 1994; Shapiro and Wright, 1984). Especially, *Keratella* sp. were the most common grazer during the summer months in Karagöl Lake.

The compound index indicates the trophic level of a lake (Nygaard, 1949). If the ratio is less than 1, the lake is accepted as being oligotrophic, whereas if it is greater than 3, the lake is accepted as being eutrophic. Nygaard (1949) pointed out that this index gives the most accurate result between June and August. Compound index value (Cyanophyceae + Chlorococcales + Centrales + Euglenales / Desmidiales) has been found to be 7 for Karagöl Lake, indicating that it is eutrophic. However, to be more precise it will be necessary to conduct a thorough physical and chemical analysis of the lake water.

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References

Anonymous. 2002. Çevre Bakanlığı Devlet Meteoroloji İşleri Genel Müdürlüğü Rasat Bilgisi No: 6936, Ankara.

Anonymous. 1994. Borçka (Artvin) Camili-Karagöl orman ekosistemlerini koruma ve geliştirme olanakları araştırması. Kırsal Çevre ve Ormancılık Sorunlarını Araştırma Derneği, Ankara.

Carvalho, L. 1994. Top-down control of phytoplankton in a shallow hypertrophic lake: Litle Mere (England). Hydrobiologia, 275/276: 53-63.

Çelekli, A. 2006. Net diatom (Bacillariophyceae) flora of Lake Gölköy (Bolu), Turk. J. of Bot., 30: 359-374.

Çolak, Ö. and Kaya, Z. 1988. Alglerin atık suların biyolojik arıtılmasında kullanılma olanakları, Doğa Bilim Dergisi, 12 (1): 18-29.

Gönülol, A. and Obalı, O. 1986. Phytoplankton of Karamık Lake (Afyon), Turkey. Commun. Fac. Sci. Univ. Ankara, Ser C (4): 105-128.

Gönülol, A., Öztürk, M. and Öztürk, M. 1996. A check-list of the freshwater algae of Turkey, Ondokuz Mayıs Üniversitesi, Fen-Edebiyat Fakültesi, Fen Dergisi, 7: 8-46.

Hutchinson, G.E. 1967. A treatise on limnology volume II introduction to lake biology and the limnoplankton. John Wiley & Sons. New York, London, Sydney, 570 pp.

Jüttner, I., Rothfritz, H. and Osmerod, S.J. 1996. Diatoms as indicators of river quality in the Nepalese Middle Hills with consideration of the effect of habitat specific sampling. Freshwater Biology, 36: 475-486.

Kılınç, S. 1998. A study in the seasonal variation of phytoplankton in Hafik Lake (Sivas, Turkey). Turk. J. of Bot., 22: 35-41.

King, D. 1970. The role of carbon in eutrophication. J. Wat. Poll. Con. Fed., 40: 2035-2501.

Kitner, M. and Poulickova, A. 2003. Littoral diatoms as indicators for the eutrophication of Shallow lakes, Hydrobiologia, 506-509: 519-524.

Krammer, K. and Lange-Bertalot, H. 1986. Subwasserflora von Mitteleuropa, Bacillariophyceae, Band 2/1, 1. Teil: Naviculaceae. Gustav Fischer Verlag. Stuttgart, 876 pp.

Krammer, K. and Lange-Bertalot, H. 1988. Subwasserflora von Mitteleuropa, Bacillariophyceae, Band 2/2,2. Teil: Bacillariaceae, Epithemiaceae, Surirellaceae. Gustav Fischer Verlag. Stuttgart, 536 pp.

Krammer, K. and Lange-Bertalot, H. 1991a. Subwasserflora von Mitteleuropa, Bacillariophyceae, Band 2/3, 3. Teil: Centrales, Fragilariaceae. Gustav Fischer Verlag. Stuttgart, 576 pp.

Krammer, K. and Lange-Bertalot, H. 1991b. Subwasserflora von Mitteleuropa, Bacillariophyceae, Band 2/4, 4. Teil: Achnanthaceae, Kritische Erganzungen zu Navicula (Lineolatae) und Gomphonema Gesamtliteraturverzeichnis. Gustav Fischer Verlag. Stuttgart, 437 pp.

Nygaard, G. 1949. Hydrological studies in some ponds and lakes Part 2:The quotient hypothesis and some new or little known phytoplankton organisms. Kgl. Danske-Vidensk, Stesk. Biol. Skrifter, 7(1): 1-293.

Obalı, O. 1984. Mogan Gölü fitoplanktonunun mevsimsel değişimi. Doğa Bil. Der., 8(1): 91-104.

Patrick, R. and Reimer, C.W. 1966. The diatoms of the United States I. Acad of Nat Sci of Philadelphia. Philadelphia, 213 pp.

Patrick, R. and Reimer, C.W. 1975. The diatoms of the United States II. Acad. of Nat. Sci. of Philadelphia. Philadelphia, 688 pp.

Pearl, H.W. 1988. Growth and reproductive strategies of freshwater blue-green algae (Cyanobacteria). Cambridge University Pres, Cambridge, 261-316.

Prescott, G.W. 1973. Algae of the Western Great Lakes Area.WC Brown Co Pub, Dubuque, 977 pp.

Rawson, D.S. 1956. Algal indicators of trophic lake types. Limnol. Oceanog., 1: 18-25.

Round, F.E. 1984. The ecology of algae. Cambridge University Pres, Cambridge, 653 pp.

Shapiro, J. 1973. Blue-green algae: Why they become dominant. Science 179: 382-384.

Shapiro, J. and Wright, D.I. 1984. Lake restoration by biomanipulation: Round Lake, Minnesota, the first two years. Freshwater Biol., 14: 371-383.

Soylu, E.N. and Gönülol, A. 2003. Phytoplankton and seasonal variations of the River Yeşilırmak, Amasya, Turkey, Turkish Journal of Fisheries and Aquatic Sciences, 3: 17-24.

Şahin, B. and Gönülol, A. 1996. Uzungöl'ün littoral bölge fitoplanktonu üzerinde taksonomik bir araştırma, XIII. Ulusal Biyoloji Kongresi, 17-20 Eylül, İstanbul: 488-496.

Yaramaz, Ö. 1988. Su kalitesi. Ege Üniv Su Ürün Yük Okulu. İzmir, 97 pp.