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A study on the phytoplankton of Lake Simenit, Turkey

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Résumé – **Etude du phytoplancton du lac Simenit, Turquie.** Le phytoplancton du lac de Simenit a été étudié de juin 2000 à 2001. Au total 167 taxons appartenant aux Cyanophyta, Bacillariophyta, Chlorophyta, Cryptophyta, Dinophyta, Euglenophyta et Xanthophyta ont été identifiés. Des efflorescences de *Chaetoceros, Cyclotella, Cocconeis, Scenedesmus, Anabaena, Euglena, Trachelomonas* ont été observées à certaines période. L'eau du lac est légèrement alcaline ; les variations de la dureté totale permettent de la classer dans la catégorie des eaux dures à très dures. La température et les nutriments ont influencé la composition du phytoplancton. Une classification hiérarchique a permis de comparer les stations.

Algues / phytoplancton / lac Simenit / classification hiérarchique

Abstract – The phytoplankton of Lake Simenit were studied from June 2000 to May 2001. A total of 167 taxa belonging to the Cyanophyta, Bacillariophyta, Chlorophyta, Cryptophyta, Dinophyta, Euglenophyta and Xanthophyta divisions were identified. Species belonging to the genera *Chaetoceros, Cyclotella, Cocconeis, Scenedesmus, Anabaena, Euglena* and *Trachelomonas* caused water blooms in certain months. The lake water was slightly alkaline and its hardness varied between hard and very hard. The water temperature and nutrient levels affected the composition of phytoplankton. Cluster analysis was applied to the phytoplankton composition. Stations were classified according to their similarity. The results of analysis support the results of the counting method.

Algae / Phytoplankton / Lake Simenit / Cluster analysis

INTRODUCTION

Algae play an important role in the ecological balance of aquatic ecosystems. The continuity of aquatic biota depends on the photosynthetic activity of these organisms. However, the quantity and quality of the algal flora is affected by many ecological factors. Because of their rapid growth and short, simple life cycles, algae are potential indicators of water quality. Since pollution may alter physiological tolerance in algae, resulting in community changes, *e.g.* green algae

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to blue-green algae dominance (Wetzel, 1975), any interactions between species and environmental changes must be experimentally verified (Cox, 1991). Additionally, the responses of algae species to pollutants may vary, and such variation must be documented (Bernard *et al.*, 1996).

Of the lakes in the Kızılırmak delta, located west of Samsun, the Bafra Fish Lakes (Balık Gölü, Uzungöl) (Gönülol & Çomak, 1992a, 1992b, 1993a, 1993b), Lake Karaboğaz (Arslan, 1998) and Lake Cernek (İşbakan *et al.*, 1998) have been examined for their floristic composition. The phytoplankton of Akgöl, one of the lakes in the Yeşilırmak delta, has also been examined (Şehirli, 1998).

Cluster analysis is one way of identifying homogeneous units and it indicates the degree of similarity in species composition between stations or at the same station over time. In recent years, cluster analyses have been used to classify similar groups of phytoplankton in European lakes, especially those in Italy and Sweden. Cluster analysis was applied to a phytoplankton community in northern Italy to determine similar algal groups (Salmaso, 1996). Morabito *et al.* (2001, 2002) performed cluster analyses using the Bray-Curtis similarity index on phytoplankton assemblages in Lago Maggiore and Lake Orta. Danilov & Ekelund (1999) applied cluster analysis to the assessment of the level of eutrophication in lakes in central Sweden. Four lakes in north-eastern Sweden were also classified on the basis of presence-absence of phytoplankton data. (Danilov & Ekelund, 2001).

There has been only one study in Turkey, in Lake Beyşehir, where similar stations based on phytoplankton were classified by cluster analysis (Oğuzkurt, 2001). There is an obvious need for more studies in Turkey.

The main purpose of this study was to determine the phytoplankton composition and ecological conditions of Lake Simenit and to classify similar stations by means of cluster analysis.

MATERIALS AND METHODS

Lake Simenit is a coastal lake near Terme, Samsun. It is located between 41° 16' north latitude and 36° 47' east longitude. Its area is 80 hectares and depth varies between 0.5-2 m (Anonymous, 1995). Lake Simenit reaches the sea through a very narrow channel, called Karaboğaz at its western end, and is linked to Akgöl through a channel at its southern end (Anonymous, 1989). The main vegetation in the lake is reed beds, herbs and trees, including *Alnus glutinosa* (Linnaeus) Gaertner subsp. *glutinosa*, *Ulmus glabra* Hudson and *Platanus orientalis* Linnaeus. The land is owned by the Turkish government and is managed by the National Parks Department. The main fish species in the lake are *Mugil cephalus* Linnaeus, *Mugil saliens* Risso, *Esox lusius* Linnaeus, *Carasius auratus gibelio* Bloch, *Tinca tinca* Linnaeus and *Abramis brama* Linnaeus.

Four stations were chosen to examine phytoplankton. The first station (st. 1) was located in the channel linking Akgöl to Lake Simenit. The second station (st. 2) was in the middle of the lake and in its deepest part. The third station (st. 3) was located in the area that first narrows and then enlarges northward. The fourth station (st. 4) was opposite the channel connecting the lake to the Black Sea . The channel is sometimes blocked by sand that is accumulated by waves. The geographical location of Lake Simenit and the sampling stations are shown in Fig. 1.

The samples were collected monthly from the surface at st. 1, 3 and 4 and from the surface and at 1 m depth at st. 2, using a 2 litre Hydro-Bios water

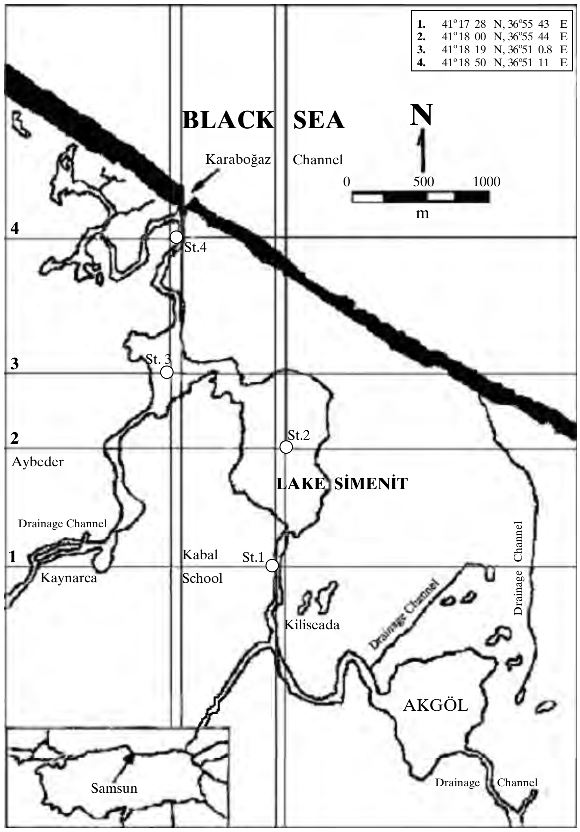


Fig. 1. The geographical location of Lake Simenit and the sampling stations.

sampler. The water samples were filtered using Whatman GF/A glass fibre filter paper with a pore size of 1.6 µm. The residue on the filter paper was used to identify all of the algae except Bacillariophyta. Bacillariophyta taxa were identified on permanent slides which were prepared according to the method of Round (1953). The algae were counted using an inverted microscope according to the method of Lund *et al.* (1958).

At the time of sampling, water temperature and dissolved oxygen were measured with a YSI 51B oxygenmeter and conductivity was measured with a PW 9529 conductivity meter at all stations. Other chemical analyses were performed according to the standard methods (Apha, Awwa, Wpcf 1992) at st. 2, in the middle of the lake and at st. 4, opposite the Karaboğaz channel.

Cluster analysis was performed according to the Bray and Curtis index by using the BioDiversity Professional 2 package programme. The similarity between samples was calculated using the Bray and Curtis index.

Algal species were identified by using John *et al.* (2003), Anagnostidis & Komarek (1988), Komarek & Anagnostidis (1999), Krammer & Lange-Bertalot, (1986, 1991a, 1991b, 1999), Huber-Pestalozzi (1955), Fott (1972), and Komarek & Fott (1983). All of the species were also checked on the *Algaebase* website (Guiry & Dhonncha, 2003).

RESULTS

Environmental Conditions

The water temperature, conductivity, and dissolved oxygen measurements at all stations are presented in Table 1 and chemical properties measured at st. 2 and 4 are shown in Tables 2 and 3.

Table 1. Temperature, conductivity and amount of dissolved oxygen at the sampling stations.

Stations	*Station 1*			*Station 2*			*Station 3*			*Station 4*		
Analyses / *Dates of sampling*	*Temperature (°C)*	*Conductivity (mS)*	*Dissolved oxygen (mg/l)*	*Temperature (°C)*	*Conductivity (mS)*	*Dissolved oxygen (mg/l)*	*Temperature (°C)*	*Conductivity (mS)*	*Dissolved oxygen (mg/l)*	*Temperature (°C)*	*Conductivity (mS)*	*Dissolved oxygen (mg/l)*
19 Sep. 2000	21.5	8.2	9.4	22.0	7.8	10.0	22.0	8.1	9.8	22.0	8.2	10.0
22 Oct. 2000	20.0	4.8	7.0	21.0	5.4	7.8	17.5	7.1	7.6	18.0	7.7	7.8
16 Nov. 2000	12.0	5.9	9.2	14.0	5.5	9.8	13.0	6.4	9.0	13.0	6.8	8.8
25 Dec. 2000	10.5	0.6	9.0	10.0	0.6	9.2	13.0	1.0	9.4	11.0	1.2	9.8
25 Jan. 2001	6.0	0.8	8.6	11.0	1.2	10.4	8.5	1.4	9.8	6.0	1.8	10.4
28 Feb. 2001	10.0	0.4	8.6	12.0	0.6	8.2	11.0	0.8	8.8	10.0	1.0	8.0
23 Mar. 2001	16.5	3.3	7.2	17.0	3.9	5.0	17.0	5.1	6.0	16.0	6.1	5.8
26 Apr. 2001	20.0	1.0	3.8	18.5	4.4	6.2	19.0	3.4	7.2	18.0	4.7	7.2
21 May.2001	25.0	0.4	5.0	24.5	4.6	5.4	24.0	4.8	5.2	24.5	4.4	3.6

Table 2. Some chemical analyses of the surface water of the lake at station 2.

Analyses / *Months*	*pH*	*Nitrite (NO_2-N) mg/l*	*Nitrate (NO_3-N) mg/l*	*Sulphate (SO_4) mg/l*	*Chloride (Cl) mg/l*	*Total hardness FS°*
19 Sep. 2000	7.65	0.19	0.22	207.36	20.28	113.60
22 Oct. 2000	7.97	0.00	0.10	606.72	14.79	78.00
16 Nov. 2000	8.16	0.01	0.00	529.92	101.41	74.40
25 Dec. 2000	8.65	0.08	1.15	660.48	10.14	82.00
25 Jan. 2001	8.37	0.19	0.11	216.96	22.82	30.80
28 Feb. 2001	7.85	0.12	0.00	174.72	1.41	26.00
23 Mar. 2001	8.26	0.04	0.11	405.12	67.61	58.40
26 Apr. 2001	8.05	0.00	0.00	310.14	20.30	40.13
21 May. 2001	8.72	0.21	0.00	240.00	83.38	35.60

Table 3. Some chemical analyses of the surface water of the lake at station 4.

Analyses / *Months*	*pH*	*Nitrite (NO_2-N) mg/l*	*Nitrate (NO_3-N) mg/l*	*Sulphate (SO_4) mg/l*	*Chloride (Cl) mg/l*	*Total hardness FS°*
19 Sep. 2000	7.86	0.00	0.00	211.20	5.60	94.00
22 Oct. 2000	8.10	0.00	0.00	737.28	19.72	94.00
16 Nov. 2000	8.39	0.00	0.00	618.24	121.69	84.80
25 Dec. 2000	8.56	0.10	1.13	491.52	16.34	60.80
25 Jan. 2001	8.51	0.01	0.00	385.92	34.65	50.00
28 Feb. 2001	7.80	0.03	0.36	205.44	2.25	29.60
23 Mar. 2001	8.30	0.00	0.14	520.32	104.23	78.80
26 Apr. 2001	8.10	0.00	0.00	380.90	40.12	50.21
21 May. 2001	8.50	0.17	0.00	301.44	70.70	44.40

Water temperature varied from 6 to 25°C. The conductivity of the lake water was measured at between 0.4 and 8.2 mS, and the amount of Cl was determined as 1.14-121.69 mg/l. The pH and hardness values varied between 7.65 and 8.75, and 34 and 113.6 FS°, respectively. Dissolved oxygen values varied between 3.6 and 10.4 mg/l. Nitrate (NO_3-N) values varied between 0.00 and 1.15 mg/l and the amount of nitrite (NO_2-N) varied between 0.00 and 0.21 mg/l. The sulphate (SO_4) values varied from 207.36 mg/l to 737.28 mg/l.

Phytoplankton Composition

In the phytoplankton of Lake Simenit, 167 taxa (Tab. 4) belonging to seven divisions were found. Of these, 70 belong to the Bacillariophyta, 38 to the Euglenophyta, 30 to the Chlorophyta, 24 to the Cyanophyta, 3 to the Dinophyta, 1 to the Cryptophyta and 2 to the Xanthophyta.

Bacillariophyta were dominant at all stations in June. *Cylotella glomerata* and *C. meneghiniana* were dominant at st. 1, 3 and 4. In July, while Euglenophyta were found to be dominant at st. 1, 2 and 3, Cyanophyta were dominant at st. 4. In August, Bacillariophyta were dominant at st. 1 and Euglenophyta were dominant at the other stations. *Cyclotella distinguenda* made up 24% of the total of 2057 cells/ml at st. 1 in August. *Trachelomonas oblonga*, *T. verrucosa*, *T. curta* were the dominant species, comprising 14.1-27.3% of the total organisms at st. 2, 3 and 4, in June, July and August.

Nitzchia reversa comprised 18.4-27.5% of the total organisms at all stations in September and October. *Chaetoceros ingolfianum* was the dominant organism, comprising 11-47% of the total organisms at all stations in October. In November, while *C. ingolfianum* was the dominant species at st. 2 and 3, *Nitzschia acicularis* was dominant at st. 4.

In December, while Euglenophyta were dominant at all stations, Cyanophyta were subdominant. *Colacium simplex* made up 12-54.5% of the total organisms. *Microcystis aeruginosa* was 6.9-13.5% of the total organisms at st. 1, at the surface of st. 2 and at st. 3. In January, 16.9-36.6% of the total organisms were *Colacium simplex* and 9.7-25.4% were *Trachelomonas pulcherrima* var. *minor.* In February, *T. pulcherrima var. minor* was 16% of the total 4952 cells/ml at st. 1, 44.6% of 5602 cells/ml at 1m depth at st. 2 and 17.8% of 1401 cells/ml at st. 4. At the surface of st. 2, *Fragilaria ulna* was dominant and *Stichococcus subtilis* was subdominant.

In March, *Scenedesmus communis* was the dominant organism, amounting to 22-33.8% of the total organisms at the stations. At st. 2 and 4, *S. obtusus* was the subdominant organism, while *F. ulna* and *Chroococcus dispersus* were subdominant organisms at st. 1 and 3, respectively. In April at st. 1, *Microspora stagnorum* was 28% of 4320 cells/ml and *S. communis* 12%. *Anabaena spiroides* was the dominant organism at the other stations. In May, the dominant organisms were *C. meneghiniana* at st. 1 and 4, *Euglena agilis* at the surface of st. 2 and *A. spiroides* at st. 3.

Monthly variations in the number of cells of species of Bacillariophyta, Euglenophyta, Cyanophyta and Chlorophyta are shown in Fig. 2 and monthly variations of some important species and genera are shown in Figs 3-4.

Cluster analysis was used to determine similar stations in Lake Simenit (Fig. 5). Stations fell into in two clusters. The first was formed by st. 1 and st. 2 with 60 % similarity. The second one was formed by st 3 and st 4 with 57 % similarity.

Photographs of some species are shown in Figs 6-28.

Table 4. The list of recorded taxa.

Divisio: CYANOPHYTA
Anabaena catenula (Kützing) Bornet *et* Flahault
Anabaena circinalis (Robenhorst) Bornet *et* Flahault
Anabaena flos-aquae (Lyngbye) Brébisson ex Bornet *et* Flahault
Anabaena fuellebornii Schmidle
Anabaena spiroides Klebahn
Anabaena zinserlingii Kossinskaja
Anabaenopsis arnoldii Aptekar
Anabaenopsis circularis (G.S.West) Woloszyńska *et* Miller
Anabaenopsis tanganyikae (G.S.West) Woloszyńska
Aphanizomenon aphanizomenoides (Forti) Hortobágyi *et* Komárek
Aphanizomenon flos-aquae (Linnaeus)Ralfs ex Bornet *et* Flahault
Aphanizomenon ovalisporum Forti
Aphanothece microscopica Nägeli
Chroococcus dispersus (Keissler) Lemmermann
Chroococcus minor (Kützing) Nägeli
Chroococcus pallidus (Nägeli) Nägeli
Chroococcus turgidus (Kützing) Nägeli
Cyanothece aeruginosa (Nägeli) Komárek
Limnothrix planctonica (Woloszyńska) Meffert
Merismopodia punctata Meyen
Microcystis aeruginosa (Kützing) Kützing
Microcystis flos-aquae (Wittrock) Kirchner
Spirulina major (Kützing) Gomont
Synechococcus sigmoideus (Moore *et* Carter) Komárek

Divisio: BACILLARIOPHYTA
Amphora commutata Grunow
Amphora ovalis Kützing
Amphora pediculus (Kützing) Grunow
Aulacoseira perglabra (Oestrup) Haworth
Chaetoceros borgei Lemmermann
Chaetoceros muelleri Lemmermann
Chaetoceros ingolfianus Ostenfeld
Cocconeis neodiminuta Krammer
Cocconeis disculus (Schumann) Cleve
Cocconeis pediculus Ehrenberg
Cocconeis placentula Ehrenberg
Cyclotella glomerata H.Bachmann
Cyclotella meneghiniana Kützing
Cyclotella distinguenda Hustedt
Cymbella affinis Kützing
Cymbella prostrata (Berkeley) Cleve
Cymbella turgida Gregory Cleve
Diatoma vulgaris Bory
Diploneis oculata (Brébisson) Cleve
Epithemia argus (Ehrenberg) Kützing
Eunotia proboscidea (Kützing) W.Smith
Eunotia sudetica O.Müller
Fragilaria berolinensis (Lemmermann.) Lange-Bertalot
Fragilaria biceps (Kützing) Lange-Bertalot
Fragilaria brevistriata Grunow
Fragilaria dilatata (Brebisson) Lange-Bertalot
Fragilaria fasciculata (C. Agardh) Lange-Bertalot
Fragilaria leptostauron (Ehrenberg) Hustedt var. *martyi* (Heribaud) Lange-Bertalot

Fragilaria pulchella (Ralfs. ex. Kützing) Lange-Bertalot
Fragilaria tenera (W. Smith) Lange-Bertalot
Fragilaria ulna (Nitzsch) Lange-Bertalot
Fragilaria virescens Ralfs
Frustulia creuzburgensis (Krasske) Hustedt
Gomphonema constrictum Ehrenberg
Gomphonema ventricosum Gregory
Gyrosigma attenuatum (Kützing) Rabenhorst
Melosira arctica (Ehrenberg) Dickie
Melosira lineata (Dillwyn) Agardh
Melosira varians C. Agardh
Meridion circulare (Greville) C.Agardh
Navicula capitata Ehrenberg var. *hungarica* (Grunow) Ross
Navicula cincta Ehrenberg
Navicula cryptotenella Lange-Bertalot
Navicula gallica (W.Smith) Lagerst. var. *laevissima* (Cleve) Lange-Bertalot
Navicula halophila (Grunow) Cleve
Navicula lateropunctata J.H.Wallace
Navicula notha Wallace
Navicula placentula (Ehrenberg) Kützing
Navicula protracta (Grunow) Cleve
Navicula pupula Kützing
Navicula rhynchocephala Kützing
Navicula secura Patrick
Navicula tripunctata (O.F.Müller) Bory
Navicula tuscula (Ehrenberg) Grunow
Navicula veneta Kützing
Navicula viridula (Kützing) Ehrenberg
Navicula vulpina Kützing
Nitzschia acicularis (Kützing) W.Smith
Nitzschia closterium (Ehrenberg) W.Smith
Nitzschia constricta (Kützing) Ralfs
Nitzschia reversa W.Smith
Rhizosolenia longiseta O.Zacharias
Rhoicosphenia abbreviata (C.Agardh) Lange-Bertalot
Rhopalodia gibba (Ehrenberg) O.Müller
Rhopalodia gibba var. *ventricosa* (Kützing) H. *et* M.Peragallo
Rhopalodia gibberula var. *producta* Grunow
Surriella angustata Kützing
Surirella linearis W. Smith
Thalassiosira weissflogii (Grunow) Fryxell *et* Halse
Tetracyclus glans (Ehrenberg) Mills

Divisio: CHLOROPHYTA
Actinastrum aciculare Playfair
Actinastrum hantzschii Lagerheim
Characium limneticum Lemmermann
Coelastrum microporum Nägeli
Coleochaete irregularis Pringsheim
Cosmarium laeve Rabenhorst
Crucigenia tetrapedia (Kirchner) W.West *et* G.S.West
Eremosphaera oocystoides Prescott
Kirchneriella irregularis (G.M.Smith) Korshikov
Microspora stagnorum (Kützing) Lagerheim
Pediastrum boryanum (Turpin) Meneghini
Pseudocharacium obtusum (A. Braun) Petry-Hesse
Rhizoclonium hieroglyphicum Kützing
Selenastrum gracile (Reinsch) Korshikov
Scenedesmus acuminatus (Lagerheim) Chodat
Scenedesmus arcuatus (Lemmermann) Lemmermann
Scenedesmus communis E.H.Hegewald
Scenedesmus dimorphus (Turpin) Kützing
Scenedesmus ellipticus Corda
Scenedesmus obtusus Meyen
Scenedesmus obliguus (Turpin) Kützing
Scenedesmus opoliensis P.G.Richter
Scenedesmus opoliensis var. *mononensis* Chodat
Scenedesmus perforatus Lemmermann.
Scenedesmus vesiculosus (Proskina) Péterfi
Spirogyra weberi Kützing
Stichococcus subtilis (Kützing) Klercker
Tetraedron minimum (A.Braun) Hansgirg
Tetraedron trigonum (Nägeli) Hansgirg
Westella linearis G.M.Smith

Divisio : CRYPTOPHYTA
Cryptomonas ovata Ehrenberg

Divisio: DINOPHYTA
Peridiniopsis penardiforme (Linde) Bourrelly
Peridinium cinctum (O.F.Müller) Ehrenberg
Peridinium inconspicuum Lemmermann.

Divisio: EUGLENOPHYTA
Colacium simplex Huber-Pestalozzi
Euglena agilis H.J.Carter
Euglena clara Skuja
Euglena lepocincloides Dreżepolski
Euglena oblonga F.Schmitz
Euglena oxyuris Schmarda
Euglena pseudoviridis Chadefaud
Euglena satelles Braslawska - Spectorowa
Euglena spathyrhyncha Skuja
Euglena stellata Mainx
Euglena tuberculata Swirenko
Lepocinclis acuta Prescott
Lepocinclis fusiformis (H.J.Carter) Lemmermann.
Lepocinclis playfairiana Deflandre
Lepocinclis radiata Chadefaud
Phacus caudatus K. Hübner
Phacus curvicauda Svirenko
Phacus longicauda (Ehrenberg) Dujardin
Phacus nordstedtii Lemmermann.
Phacus onyx Pochmann
Phacus orbicularis K.Hübner
Trachelomonas crebea Kell. var. *brevicollis* Prescott
Trachelomonas chlamydophora Nygaard
Trachelomonas curta A.M.Cunha
Trachelomonas dubia (Svirenko) Deflandre var. *minor* Deflandre
Trachelomonas dybowskii Dreżepolski
Trachelomonas hispida (Perty) F.Stein ex Deflandre
Trachelomonas hispida var. *punctata* Lemmermann
Trachelomonas intermedia P.A.Dangeard
Trachelomonas lismorensis Playfair
Trachelomonas lismorensis var. *oblonga* Playfair
Trachelomonas oblonga Lemmermann
Trachelomonas ovata Roll
Trachelomonas pulcherrima Playfair var. *minor* Playfair
Trachelomonas verrucosa A. Stokes
Trachelomonas volvocina Ehrenberg
Trachelomonas volvocina var. *papillata* Lemmermann
Trachelomonas volvocina var. *punctata* Playfair

Divisio: XANTHOPHYTA
Goniochloris mutica (A. Braun) Fott

DISCUSSION

The phytoplankton of Lake Simenit consisted of 167 taxa belonging to Cyanophyta, Bacillariophyta, Chlorophyta, Cryptophyta, Dinophyta, Euglenophyta and Xanthophyta. According to the number of species, Bacillariophyta-Euglenophyta were the most common.

In the lake, the lowest temperature was measured at st. 1 and 4 in January and the highest temperature was measured at st. 1 in May. Close to st. 4, the conductivity and the amount of Cl increased. St. 4 station was near the Karaboğaz channel, through which the lake reaches the sea, and therefore this increase may be attributed to the mixing of the freshwater of the lake with seawater.

According to its pH values, the lake was slightly alkaline. pH values vary between 6 and 9 in unpolluted lakes (Şişli, 1999). As to its hardness, the lake water was between hard and very hard (Yaramaz, 1992). The lower values of dissolved oxygen may have been caused by increasing temperature in May, and also by the absence of wind or fractionation of bloomed thread-like algae in April (Tanyolaç, 1993). NO_3-N values in Lake Simenit are similar to Lake Karaboğaz (Arslan, 1998) because they are linked to the sea. Arslan's study determined that nitrate can disappear over time from the surface of some very salty lakes and can be increased by organic pollution and flood waters. The higher NO_2-N values in March may have caused a bloom of thread-like algae in April. The SO_4 values in Lake Simenit which were between a few mg/l and several hundred mg/l (Şengül & Türkman, 1991) were measured 207.36 and 737.28 mg/l in this study.

Of the phytoplankton, the most common group of algae was Bacillariophyta, comprising 42% of the total taxa. Species of *Cyclotella* were present in all seasons. *Cyclotella* spp. are indicator species of transition to eutrophy (Round, 1956). *Cyclotella ocellata* was abundant in Akgöl (Şehirli, 1998), which has eutrophic features. According to Hindák & Hindákova (2002), this species was present in small and shallow water bodies in Slovakia. *C. distinguenda*, *C. meneghiniana* and species of *Melosira*, which are abundant in the study area, also exist in eutrophic waters (Hutchinson, 1967). *Chaetoceros* spp., which are characteristic of saline water, were also abundant in Lake Simenit. *Amphora pediculus*, *Cocconeis pediculus*, *Cyclotella meneghiniana*, *Eunotia sudetica*, *Navicula rhynchocephala*, *N. tripunctata*, *Nitzschia reversa*, *N. constricta*, *Surirella angusta* and *Fragilaria ulna* were recorded from both Lake Simenit and Lake Blagodatnoe (Medvedeva, 2001). *Amphora ovalis*, *Cyclotella meneghiniana*, *Navicula rhynchocephala*, *N. viridula* and *Nitzschia acicularis* exist in both Simenit Lake and Golubichnoe Lake (Medvedeva, 2001), and *Melosira varians* was also found in Lake Doïrani (Temponeras *et. al*., 2000). Most of these species are benthic. Benthic algae were abundant in the phytoplankton because Lake Simenit is shallow (1-2 m), with the bottom covered by aquatic plants and reeds. Similar situations were also reported in Turkey in the Bafra Fish Lakes (Gönülol & Çomak, 1992b), Lake Cernek (İşbakan *et al*., 1998) and Lake Karaboğaz (Arslan, 1998).

Euglenophyta was the subdominant group with 38 taxa. Euglenophyta are more abundant in polluted water and in water rich in organic matter (Round, 1956). Of the Euglenophyta, 39 taxa were identified in Bafra Fish Lakes (Gönülol & Çomak, 1993a), 27 in Akgöl (Şehirli, 1998), 12 in Karaboğaz (Arslan, 1998) and 11 in Cernek Lake (İşbakan *et al*., 1998). *Colacium simplex, Euglena agilis, Trachelomonas volvocina* and *T. crebea* var. *brevicollis* numbers increased to very

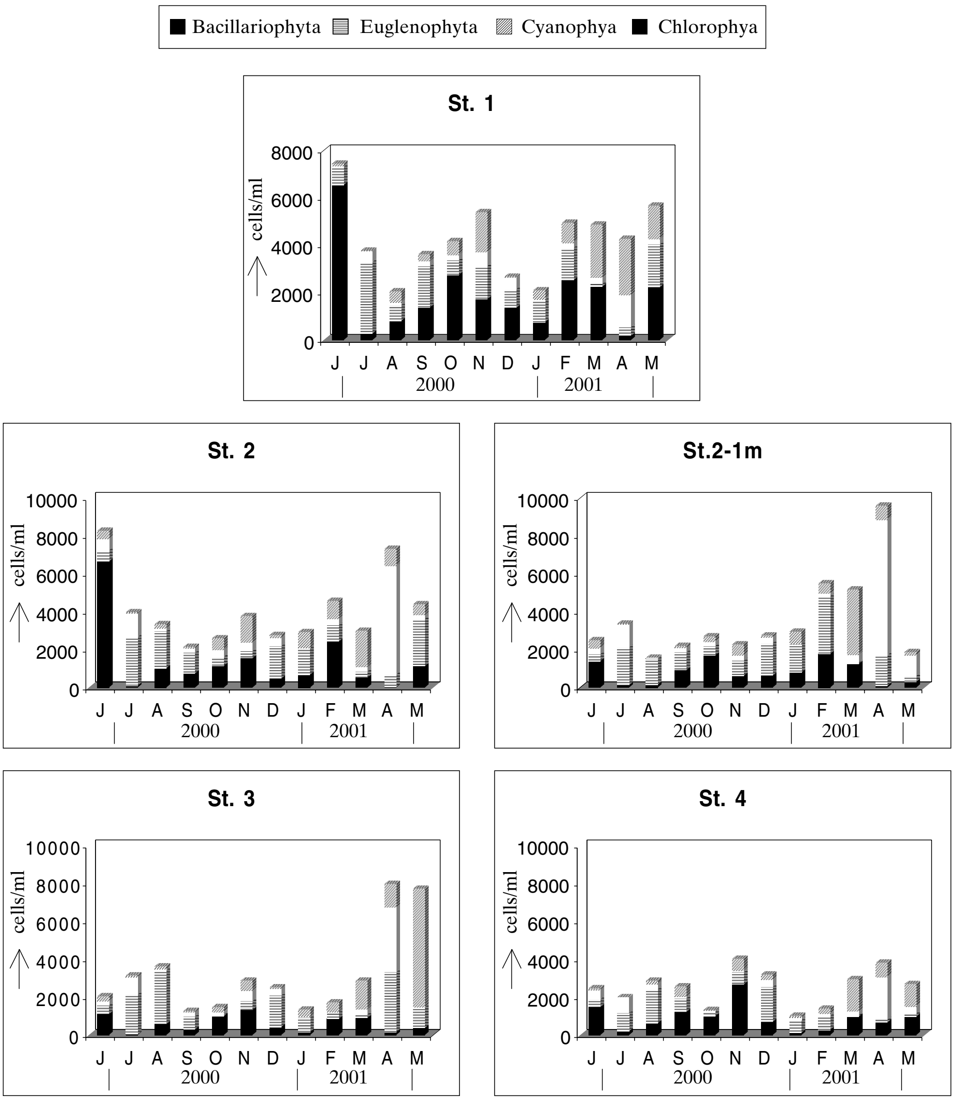


Fig. 2. Monthly variation according to numbers of species of Bacillariophyta, Euglenophyta, Cyanophyta and Chlorophyta at stations.

high levels in some months in Lake Simenit. Of these species, *T. volvocina* was also recorded in Puente Lakes (Domitrovic, 2003), and in Simenit Lake and Golubichnoe Lake (Medvedeva, 2001). *T. hispida* was also found in most of the shallow Bulgarian wetlands (Stoyneva, 2003).

In Lake Simenit, 30 species of Chlorophyta were found. Chlorophyta were the most common group of algae in Akgöl (Şehirli, 1998). *Scenedesmus communis* increased to very high levels in some months in Lake Simenit. Only one species of *Cosmarium* (*C. leave*) was identified in Lake Simenit. This species

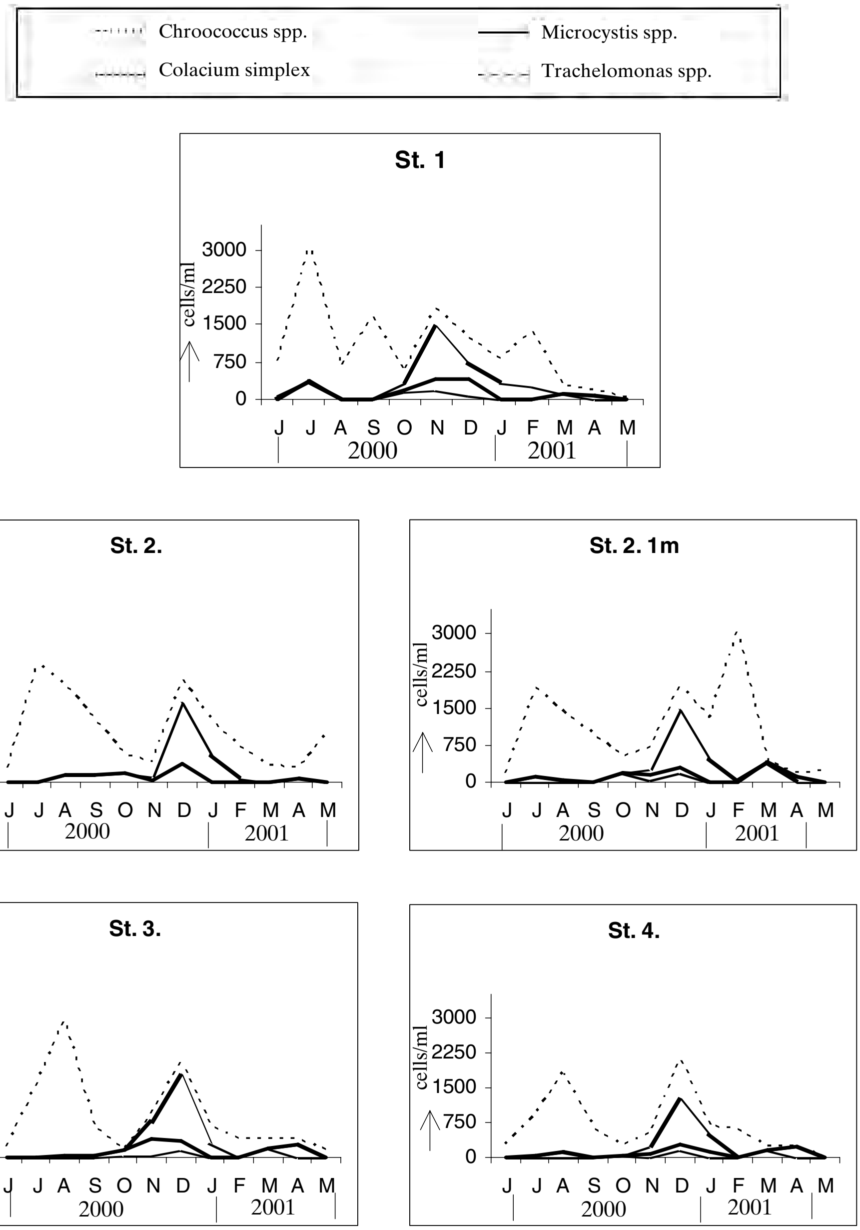


Fig. 3. Monthly variations of *Microcystis* spp., *Chroococcus* spp., from Cyanophyta and *Colacium simplex*, *Trachelomonas* spp. from Euglenophyta at stations.

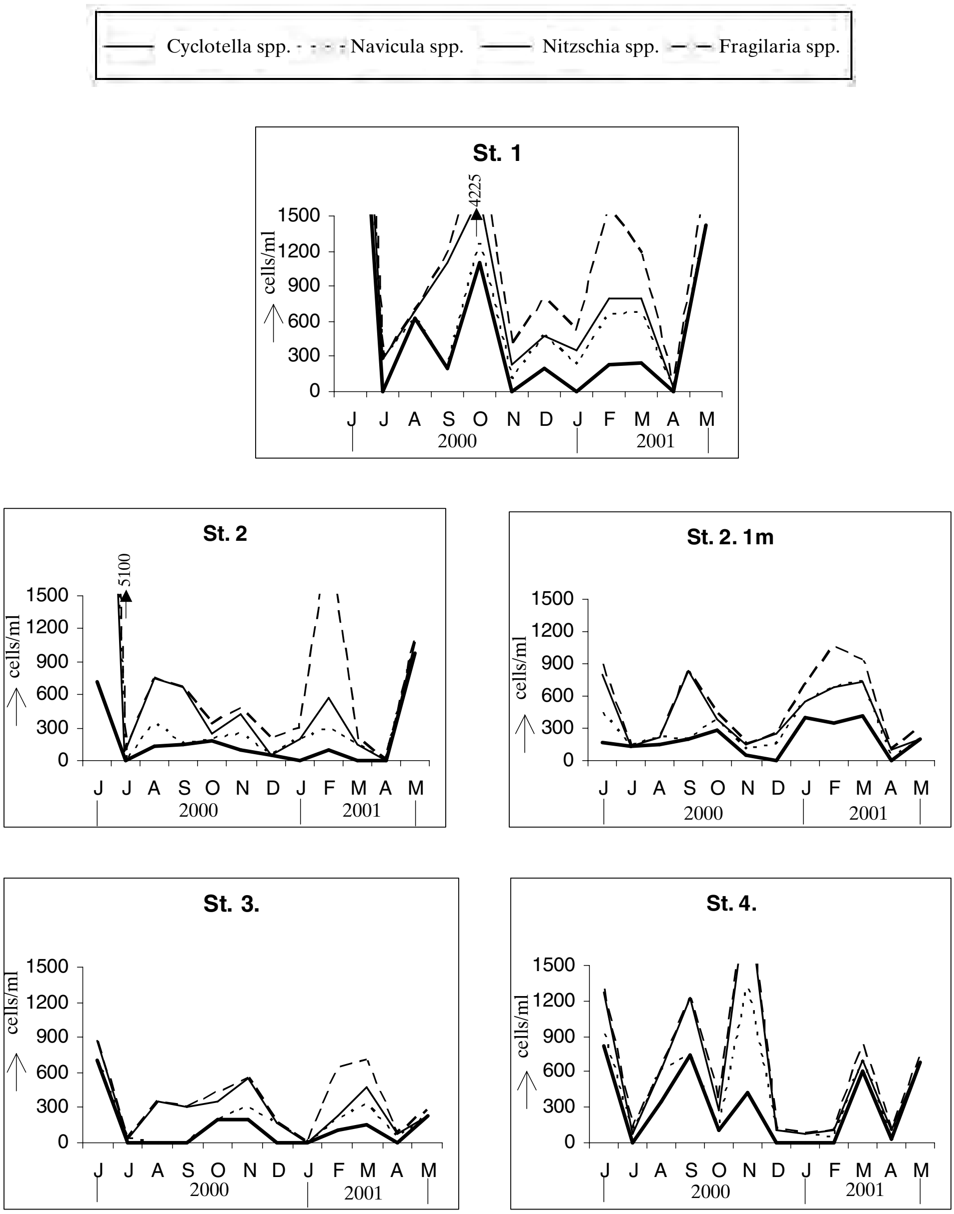


Fig. 4. Monthly variations *Cyclotella* spp., *Navicula* spp., *Nitzschia* spp. and *Fragilaria* spp. at stations.

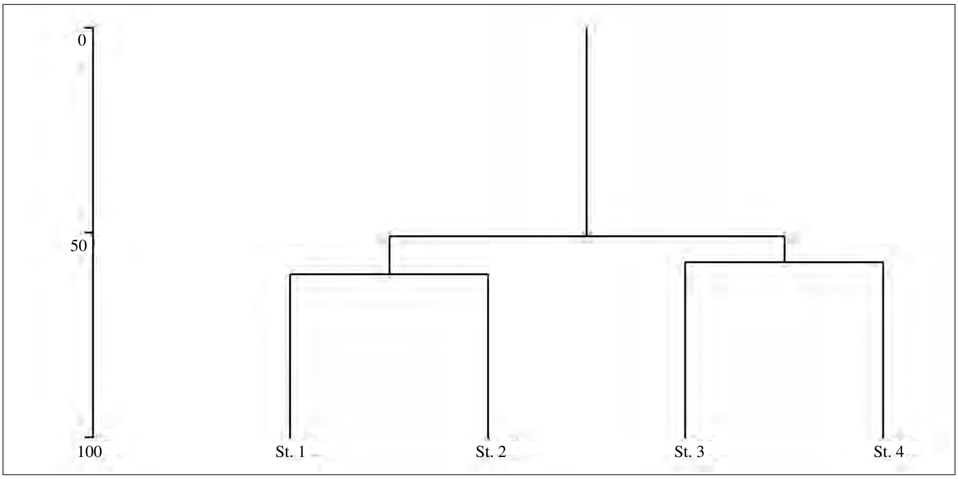


Fig. 5. Cluster analysis of sampling stations according to the calculation of Bray_Curtis similarity index in Lake Simenit.

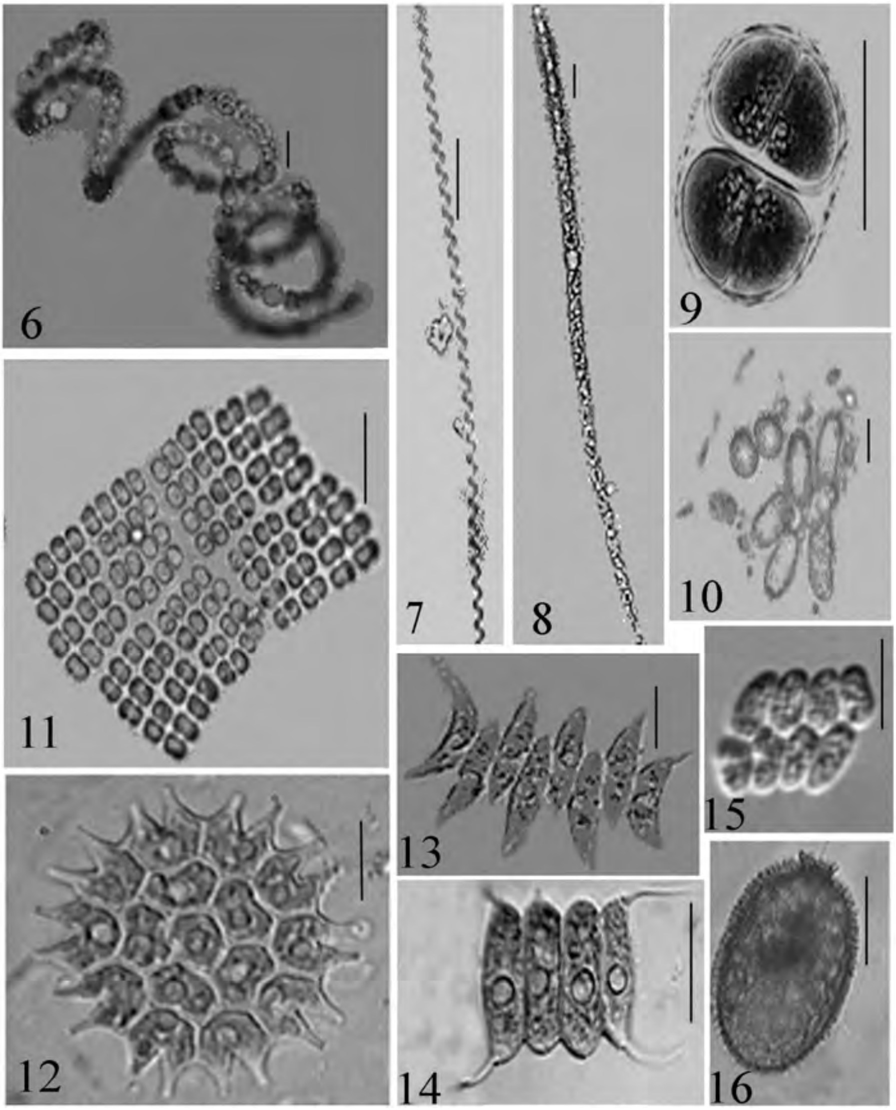
prefers calcareous waters at pH 6.6 to 9.4 (Krieger & Gerloff, 1969). *Coelastrum microporum*, *Kirchneriella lunaris* and *Scenedesmus communis* were recorded in both Lake Simenit and Lake Golubichnoe (Medvedeva, 2001). *Actinastrum hantzschii*, *Pediastrum boryanum*, *Scenedesmus acuminatus*, *S. communis*, *S. opoliensis* and *Tetraedron minimum* were also identified in Lake Doïrani (Temponeras *et. al.*, 2000).

Twenty four taxa belonging to the Cyanophyta were identified in Lake Simenit. It has been determined that members of Cyanophyta caused water bloom in Europe, North America and Anatolia's stagnant water (Prescott, 1973). In Lake Simenit, especially *Anabaena spiroides* and *Microcystis* spp. caused blooms in summer months. In Akgöl, blooms were caused by *A. spiroides* in July and *Limnothrix* spp. in autumn (Şehirli, 1998). On the other hand, in Lake Cernek, *M. aeruginosa*, *A. affinis* and *A. spiroides* caused blooms in summer (İşbakan *et al.*, 1998). *Anabaena spiroides*, *Aphonethece microscopica*, *Merismopedia punctata* and *Microcystis aeruginosa* were recorded in both Lake Simenit and Lake Golubichnoe (Medvedeva, 2001). *Microcystis aeruginosa* was found in Lake Simenit, Dourankoulak, Shabla and Ezerets (Stoyneva, 2003). *Aphanizomenon flos-aque* was also recorded in Shabla and Vaya (Stoyneva, 2003). *Anabaena spiroides*, *Microcystis aeruginosa* and *Aphanizomenon flos-aque* were dominant in shallow Bulgarian wetlands (Stoyneva, 2003).

Dinophyta was represented by 3 species, with two of these belonging to the genus *Peridinium*. *Peridinium* spp. were present at low levels during the year in Akgöl (Şehirli, 1998). *P. cinctum* is widespread in lakes in Turkey (Gönülol & Çomak, 1992b). This species can live in various habitats (Hutchinson, 1967).

Only one species from Cryptophyta (*Cryptomonas ovata*) was identified. This species was found in low numbers in some months. In Akgöl, *C. ovata* and *C. erosa* caused bloomed in October (Şehirli, 1998).

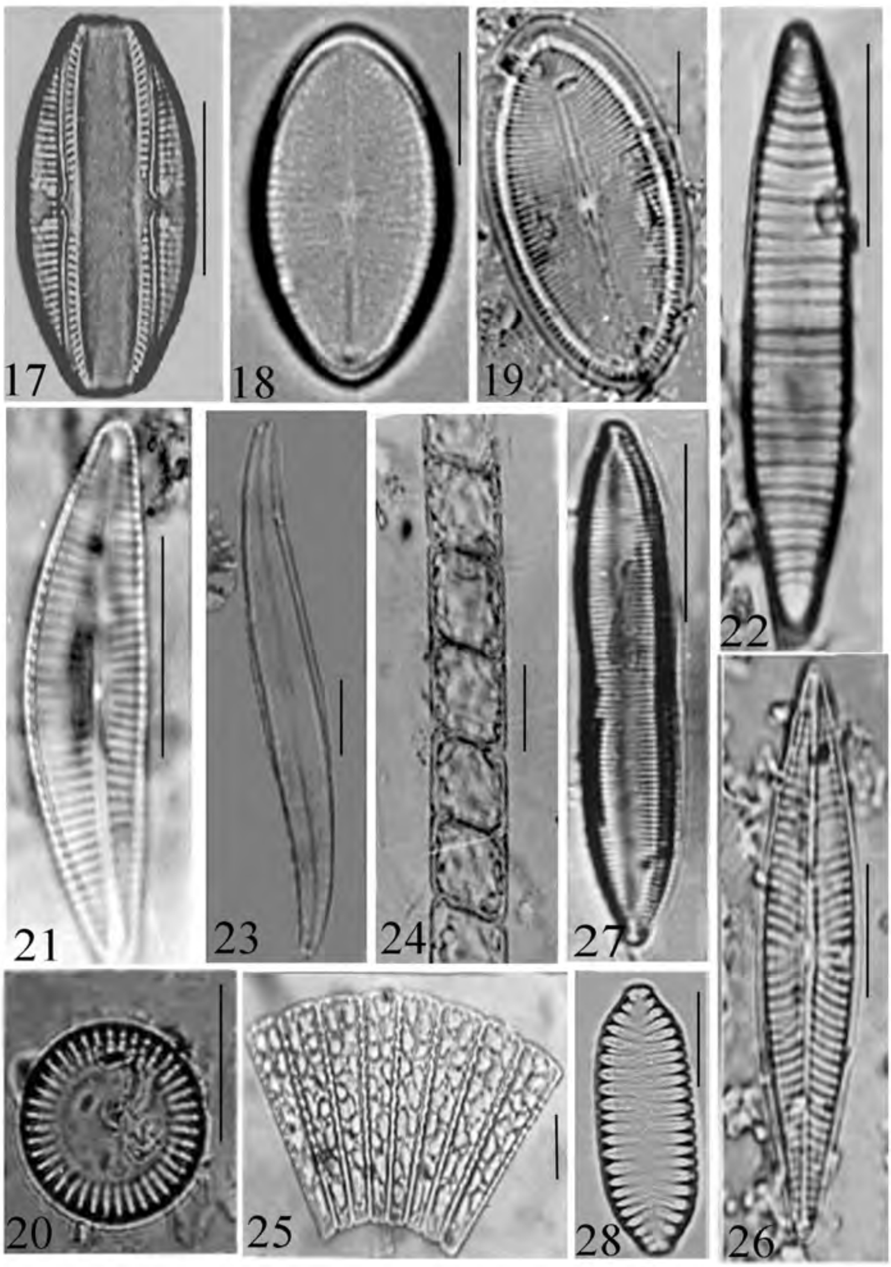
Xanthophyta was represented by only one species (*Goniocloris mutica*). This species is found in many lakes and slow-flowing rivers of Turkey.



Figs 6-16. **6.** *Anabaena spiroides*. **7.** *Spirulina major*. **8.** *Aphanizomenon flos-aquae*. **9.** *Chroococcus dimidiatus*. **10.** *Cyanothece aeruginosa*. **11.** *Merismopedia punctata*. **12.** *Pediastrum boryanum*. **13.** *Scenedesmus dimorphus*. **14.** *Scenedesmus communis*. **15.** *Scenedesmus ellipticus*. **16.** *Trachelomonas hispida*, Scales = 10 µm.

In Lake Simenit, according to the counting method's results, a similar distribution of phytoplankton was observed at st. 1 and st. 2. A similar distribution was also observed at st. 3 and st. 4. The cluster analysis results agree with the results of the counting method.

Lake Simenit is a shallow lake which has a wide vegetation belt surrounding it. Because of high levels of suspended material, the water



Figs 17-28. **17.** *Amphora ovalis*. **18.** *Cocconeis pediculus*. **19.** *Cocconeis placentula*. **20.** *Cyclotella meneghiniana*. **21.** *Cymbella prostrata*. **22.** *Diatoma vulgari*s. **23.** *Gyrosigma attenuatum*. **24.** *Melosira varians*. **25.** *Meridion circulare*. **26.** *Navicula crytocephala*. **27.** *Nitzschia constricta*. **28.** *Surirella angusta*. Scales = 10 μm.

transparency is low. The colour of the lake varies from brown-green to yellow-green through the year. The edges of the channels are covered with reeds and their bottoms are covered with aquatic plants, especially *Cladophora rivularis* (Linnaeus) Hoek and *Potamageton pectinatus* Linnaeus. Species of *Chaetoceros*, *Cyclotella*, *Cocconeis*, *Anabaena*, *Trachelomonas* and *Euglena* numbers increased to very high levels in certain months. These properties indicate Lake Simenit could be eutrophic.

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