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Planktonic Diatom (Bacillariophyta) Composition of Lake Kaz (Pazar, Tokat)

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Abstract: The composition, density, and seasonal variations of the planktonic diatoms of Lake Kaz were studied using samples taken from the surface and 1.0 m depths between May 2005 and April 2006. Some physical and chemical properties of the lake water were also determined. Planktonic algae communities were identified, with 143 belonging to *Bacillariophyta. Aulocoseira granulata, Aulocoseira italica, Cocconeis placentula, Cocconeis placentula* var. *euglypta, Cyclotella meneghiniana, Navicula radiosa*, and *Synedra ulna* from the *Bacillariophtya* were dominant. Seasonal variations in the planktonic flora were observed during that period. According to the chemical and physical analyses performed, the lake has low alkali soft water. The level of pollution is not very important, but if precautions are not taken the lake will become polluted, and, as a result, it will turn into a swamp.

Key Words: Planktonic diatoms, Lake Kaz, seasonal variations

Kaz Gölü (Pazar-Tokat) Planktonik Diyatom (Bacillariophyta) Kompozisyonu

Özet: Bu çalışmada, Kaz Gölü'nün planktonik diyatomelerinin kompozisyonu, yoğunluğu ve mevsimsel değişimleri yüzey ve 1 metre derinlikten alınan örneklerde Mayıs 2005 ile Nisan 2006 tarihleri arasında incelenmiştir. Ayrıca göl suyunun bazı fiziksel ve kimyasal parametreleri de ölçülmüştür. Planktonik alg topluluğunda *Bacillariophyta* 143 taksonla temsil edilmiştir. Toplulukta *Bacillariophyta*'dan *Aulocoseira granulata, Aulocoseira italica, Cocconeis placentula, Cocconeis placentula* var. *euglypta, Cyclotella meneghiniana, Navicula radiosa, Synedra ulna* dominant olarak bulunmuştur. Florada mevsimlere göre değişiklik gözlenmiştir. Yapılan fiziksel ve kimyasal analizlerde gölün hafif alkali, yumuşak su özelliğine sahip olduğu, kirliliğin önemli derecede olmadığı, ancak tedbir alınmazsa giderek kirlenerek, bataklığa dönme ihtimali olduğu gözlenmiştir.

Anahtar Sözcükler: Planktonik diyatomeler, Kaz Gölü, mevsimsel değişim

Introduction

The algae are the primary producers in water. They are not only the nutrition source of themselves and the other living things in the water, but they also cause increases in the dissolved oxygen rate. That is why phytoplankton are greatly affected by environmental pollution and changes in the water ecosystem. The algae play a major role in the determination of the biological productivity of the water. The composition, density, seasonal changes, and the ecological conditions like physical and chemical factors should be known for this reason. The water resources, which are of utmost importance for the survival of living things, have entered a rapid pollution process depending on human activity; household, industrial and agricultural wastes; and nitrates polluting the water through diffusion and drainage. Knowledge of the properties of the water and the physiological effects of the living things in the water is important to ensure their survival.

The number of studies on the algae flora of the lakes, ponds, and dam lakes of Turkey has recently increased. Turkey has a rich potential in respect of territorial waters.

Previous studies investigated systematic and ecological characteristics of algae in the natural lakes of Turkey (1-9).

This study aimed to determine the planktonic diatom composition and density of Lake Kaz, as well as the physical, chemical, and statistical properties of the water, and to make a contribution to the knowledge of the ecology and freshwater algae flora of Turkey over 12 months.

Materials and Methods

Lake Kaz is situated near Üzümören, which is located on the Pazar- Zile highway in the province of Tokat. It also covers the districts of Turhal and Pazar. It is situated at lat 40°15'00''- 40°22'30'' N, long 36°07'30''- 36°15'00'' E. The depth of the lake varies between 1 and 1.5 m. The surface area of the lake is 2293 ha (12). Lake Kaz is at an altitude of 540 m (10). No river feeds the lake. It is recorded that the lake is fed by an underground spring (11). Most of the lake was drained and converted into an agricultural area by opening dry channels by the State Hydraulic Works (DSİ) before the determination of the site as a wildlife protection site. It has been stated recently that Lake Kaz appears to be a marsh because of the decrease in the level of the water. This has been established from photographs taken from space (12) (Figures 1 and 2).

The lake has conserved the aquatic ecosystem balance, and offsets the natural freshwater ecosystem. The lake was almost entirely covered by reeds and a large marshy pasture encircles the lake. As no industrial facility exists near the lake, no environmental pollution occurs.

The planktonic diatom flora of Lake Kaz and certain physical and chemical properties of the lake water were analyzed by monthly samples taken from 3 different stations between May 2005 and April 2006 (Figure 3). Every month, water samples were taken from the depth of 1.5 m at 3 different stations at Lake Kaz to analyze the planktonic diatoms by 1-l plastic containers both from the surface and at a depth of 1 m. Such samples were taken the same day to the laboratory and 4% formaldehyde was put into each container after it was rinsed. The filtration of such organisms was performed thereafter. By using such a method, the water samples were passed through Whatman GF/A filtration paper in water jet pumps. Following this procedure, the water samples were put into separate petri dishes and the filtered water was poured over them in order to prevent them from drying.

For identification of *Bacillariophyta*, the cells must be purified from organic matter. Therefore, the H_2O_2 method was used. In this method, the water samples that were poured from petri dishes into test tubes were centrifuged and precipitated. The supernatant was poured off and precipitate was removed to another clean container. After adding 1 cm^3 of H_2O_2 the container was boiled for 30 min. After this step, for purifying from acids, distilled water was added to the samples and they were centrifuged at 3000 rpm for 5 min. This process was performed 5 times (13). Consequently, by using the *Bacillariophyta* species that were purified from the organic matter and only had silica cell walls, fixed slides were prepared and the species were identified.

The photographs of identified taxa were taken using a research microscope (Nikon) and the samples were coated in gold by sputter coating machine (SPI Supplies). After that, micrographs were taken by scanning electron microscope (SEM) (JEOL 5400).

After the fixed slides of diatoms were prepared, by counting at least 100 diatom shells in each slide, relative density values of species were calculated as percentages (14). However, as the flora was very poor during some

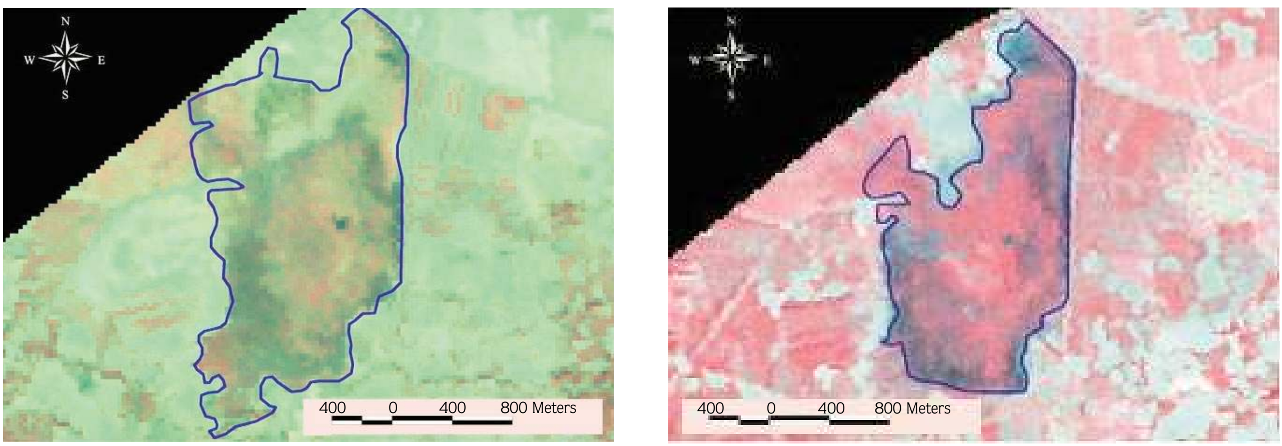


Figure 1. Photographs of Lake Kaz, which were taken from space in 1987 and 2002.

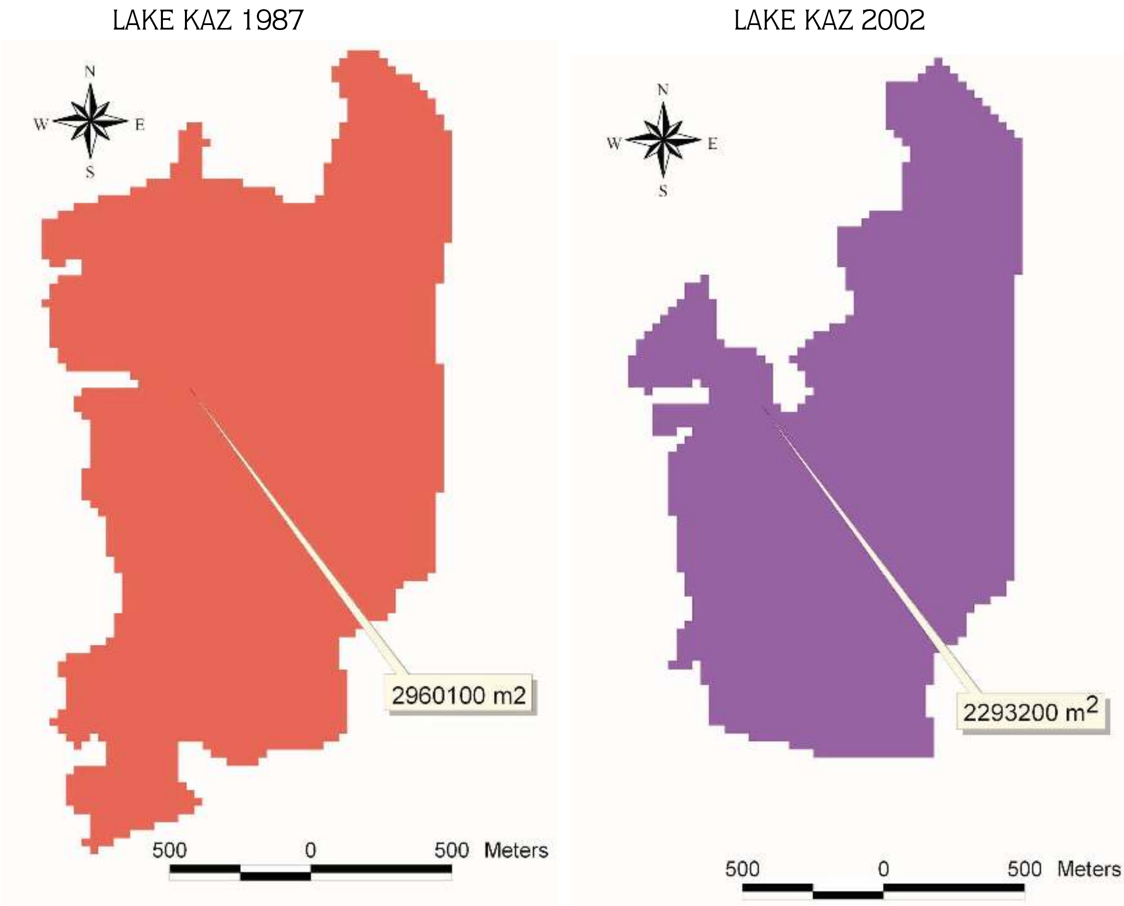


Figure 2. The variation in the area of Lake Kaz between 1987 and 2002.

periods, it was not always possible to count 100 diatom shells.

Considering the total number of planktonic diatomic organisms collected at the research stations, the diversity index involving the number of planktonic diatoms collected from the surface and 1.5 m depths of water was identified according to the Margalef index.

Relevant references were used in the identification of the algae (15-24).

Results

Physical and Chemical Parameters

The temperature in the study field varies between 8.6 and 29 °C at the surface, and between 10.2 and 28.7 °C at a depth of 1 m (Tables 1 and 2). The optimum temperature for the growth of algae is 25 °C (25). Particularly during the last month of spring, and in summer and autumn, the temperature of the water is very close to the optimum value. It was observed that major changes in the temperature of the water affected the diversity and density of the flora.

In general, the temperature of the water plays a larger role than altitude and latitude in the determination of the flora (26).

The amount of dissolved oxygen determined by the analyses conducted at Lake Kaz is 1.36-5.10 mg/l at the surface, while it varies between 1.87 and 5.15 mg/l at a depth of 1 m (Tables 3 and 4). The average value of the dissolved oxygen at Lake Kaz in general is 5 mg/l. However, the measurements obtained at the stations showed that the oxygen value was lower. Considering the existence of the populations living under normal circumstances in the lake, such a lower value arises from

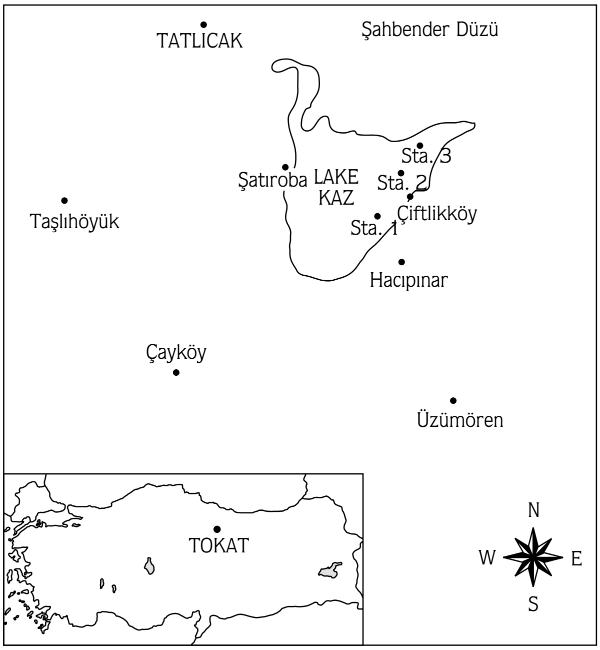


Figure 3. Map of the study area.

Table 1. Monthly surface temperature.

Months	Temperature (°C)		
	Station 1	Station 2	Station 3
May 2005	26.8	26.0	27.9
Jun 2005	24.0	25.5	24.8
Jul 2005	28.0	27.8	28.2
Aug 2005	26.7	28.2	29.0
Sep 2005	22.6	24.3	25.4
Oct 2005	21.5	22.8	23.0
Nov 2005	20.2	19.8	19.4
Dec 2005	16.7	16.8	15.2
Jan 2006	13.2	13.8	11.4
Feb 2006	11.6	9.9	8.6
Mar 2006	15.4	14.7	15.8
Apr 2006	16.1	17.1	17.5

Table 2. Monthly temperature at 1 m depth.

Months	Temperature (°C)		
	Station 1	Station 2	Station 3
May 2005	27	27.2	25.3
Jun 2005	25.8	26.3	25.3
Jul 2005	26.7	28.7	28.1
Aug 2005	27.7	27.7	28.0
Sep 2005	25.3	25.6	24.8
Oct 2005	22.4	23.4	21.5
Nov 2005	19.6	18.4	17.6
Dec 2005	15.8	14.3	13.8
Jan 2006	12.0	10.3	10.2
Feb 2006	12.5	11.2	10.5
Mar 2006	16.2	17.2	17.8
Apr 2006	18.1	18.5	18.3

Table 3. Monthly dissolved oxygen rate at the surface.

Months	Dissolved oxygen (mg/l)		
	Station 1	Station 2	Station 3
May 2005	3.94	3.93	3.74
Jun 2005	1.65	1.65	1.36
Jul 2005	2.76	4.33	2.31
Aug 2005	2.78	2.98	3.05
Sep 2005	2.86	3.01	2.89
Oct 2005	3.01	3.05	2.95
Nov 2005	3.12	4.05	4.40
Dec 2005	3.74	3.97	4.09
Jan 2006	4.36	3.89	3.82
Feb 2006	5.10	4.96	5.00
Mar 2006	3.85	3.09	3.51
Apr 2006	2.00	1.78	1.99

the locality where the values were obtained. The amount of dissolved oxygen varied depending on the temperature. In the summer, the amount of dissolved oxygen decreased depending on the increase in the temperature. This showed that the amount of dissolved oxygen at Lake Kaz and the temperature level have a negative relationship. The amount of dissolved oxygen increases under the effect of the pressure, current, and wind, and decreases as the salt level increases (27).

pH values in Lake Kaz were 7.22-8.35 at the surface and 6.77-8.52 at a depth of 1 m (Tables 5 and 6). The lake water should be soft alkaline (28).

The chemical analyses showed that the electrical induction of the water was on average 110.3 µmho/cm in

Table 4. Monthly dissolved oxygen rate at 1 m depth.

Months	Dissolved oxygen (mg/l)		
	Station 1	Station 2	Station 3
May 2005	4.00	3.83	4.76
Jun 2005	1.87	1.95	2.07
Jul 2005	3.31	3.04	2.74
Aug 2005	2.91	3.02	2.74
Sep 2005	3.07	3.12	3.05
Oct 2005	3.11	3.14	3.12
Nov 2005	3.25	4.17	4.52
Dec 2005	3.94	3.91	3.95
Jan 2006	4.63	3.61	3.37
Feb 2006	5.15	4.87	4.62
Mar 2006	3.68	3.05	3.58
Apr 2006	2.95	3.07	3.00

Table 5. Monthly surface pH levels.

Months	pH		
	Station 1	Station 2	Station 3
May 2005	7.59	7.62	7.71
Jun 2005	7.25	7.27	7.30
Jul 2005	7.49	7.51	7.56
Aug 2005	7.49	7.53	7.56
Sep 2005	7.47	7.50	7.52
Oct 2005	7.50	7.53	7.60
Nov 2005	7.61	7.62	7.55
Dec 2005	7.96	7.68	7.72
Jan 2006	8.35	7.75	7.90
Feb 2006	7.93	8.13	8.11
Mar 2006	7.80	7.64	7.66
Apr 2006	7.22	7.38	7.37

Table 6. Monthly pH levels at 1 m depth.

Months	pH		
	Station 1	Station 2	Station 3
May 2005	7.65	7.64	6.77
Jun 2005	7.37	7.38	7.36
Jul 2005	7.48	7.50	7.59
Aug 2005	7.52	7.53	7.60
Sep 2005	7.40	7.54	7.58
Oct 2005	7.52	7.58	7.64
Nov 2005	7.64	7.65	7.59
Dec 2005	8.01	7.62	7.76
Jan 2006	8.52	7.60	7.83
Feb 2006	7.89	7.92	8.04
Mar 2006	7.74	7.61	7.87
Apr 2006	7.41	7.51	7.59

Table 7. Monthly electrical induction rate of the lake.

Months	Electrical induction (μS/cm)		
	Station 1	Station 2	Station 3
May 2005	124.8	140.2	137.5
Jun 2005	157.4	164.0	161.6
Jul 2005	163.7	162.8	162.5
Aug 2005	179.9	180.6	181.6
Sep 2005	124.6	120.5	119.5
Oct 2005	122.2	125.4	124.6
Nov 2005	87.8	83.1	85.4
Dec 2005	118.8	121.8	124.5
Jan 2006	119.8	134.7	169.8
Feb 2006	230.0	128.0	120.0
Mar 2006	176.2	141.3	140.0
Apr 2006	92.3	116.4	119.7

autumn, 132.2 μmho/cm in spring, 140.7 μmho/cm in winter, and 168.2 μmho/cm in summer (Table 7).

Water samples were taken from 1 station during all 4 seasons, and at the end of the analysis anion and cation values were determined. The content of total Ca^{++} and Mg^{++} cations' value was determined as 6.17 meq/l (Table 8). Lake water was found in the moderately soft water class when these data were assessed in terms of French hardness. Despite the lake being very important for watering crops, in the chemical analysis performed previously the bottom water was found to be very salty (10).

The peak seasons in species diversity are summer and winter for surface water and spring and winter for 1.0 m depth.

The highest value for surface planktonic flora was obtained at station 1 in the winter. The highest diversity

Table 8. Results of the chemical analysis of the water.

	Summer	Autumn	Winter	Spring
CATIONS				
Na^{++} meq/l	1.53	0.58	0.65	1.84
K^{+} meq/l	0.04	0.06	0.06	0.07
$Ca^{++}Mg^{++}$meq/l	5.62	7.12	5.48	6.46
Total meq/l	7.19	7.76	6.18	8.37
ANIONS				
HCO_3^{-2} meq/l	6.60	9.48	5.70	7.46
Cl^{-2} meq/l	1.30	1.40	1.05	2.11
Total meq/l	7.90	10.88	6.75	9.57
Na % meq/l	21	7.5	10.5	21.9
pH	7.65	7.74	8.23	7.95
Boron mg/l	0.09	0.05	0.02	0.31
HCO_3^{-2} meq/l	6.60	9.48	5.7	7.46
Cl^{-2} meq/l	1.30	1.4	1.05	2.11
Sodium Adsorption Ratio	0.91	0.76	0.39	1.02
Alkaline class	A1	A1	A1	A1

of diatom species was also obtained in this season. In the spring, the highest value was obtained at station 3. There was a decrease in the diversity of diatom species at all 3 stations in the summer.

Regarding the diversity of planktonic diatom species at 1 m depth in Lake Kaz, the highest value was obtained in the summer at station 1. The lowest value was obtained in the summer also, at station 2. The diversity index rates obtained in the spring and summer were approximately equal (Table 9).

Monthly values of the most represented genera of diatoms are obtained by Tukey's test and shown in Figures 4-7.

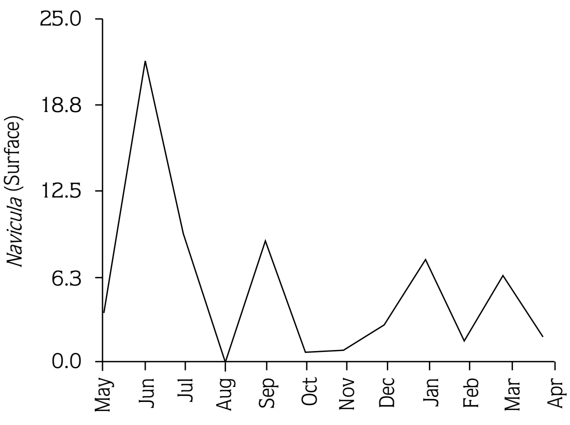
It was found that, with 143 taxa, *Bacillariophyta* was more dominant in the lake flora relative to the other phyla, at the rate of 67% (Table 10, Figures 8-14).

Discussion

It was found that the phylum *Bacillariophyta* was more dominant than the other phyla, at the rate of 67%. In the other studies performed in the lakes in Turkey the phylum *Bacillariophyta* was dominant too (6,7,29-37). In Lake Kaz it was found that population density of pennate diatoms was much greater than that of the centric diatoms. At the surface and 1.0 m depth *Cyclotella*

Table 9. Seasonal planktonic diatoms diversity index values for surface and 1 m depth.

	Spring		Summer		Autumn		Winter	
	Surface	1 m depth	Surface	1 m depth	Surface	1 m depth	Surface	1 m depth
Station 1	17.4	21.2	15.5	26.8	17.9	17.4	21.4	23.5
Station 2	15.8	18.5	11.6	16.9	13.8	19.6	16.0	22.8
Station 3	20.9	22.0	10.5	20.7	15.4	18.0	18.3	18.7



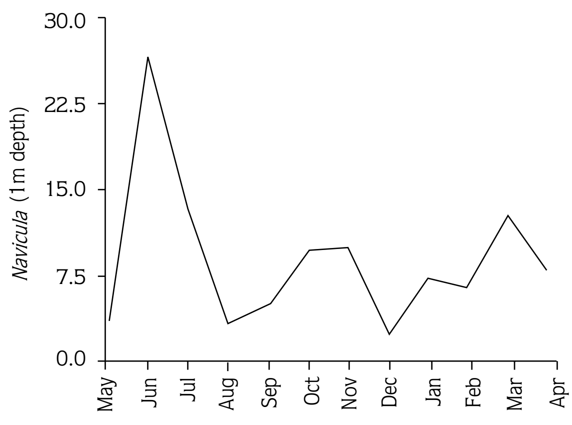


Figure 4. Monthly numbers of the genus *Navicula* at the surface and 1 m depth.

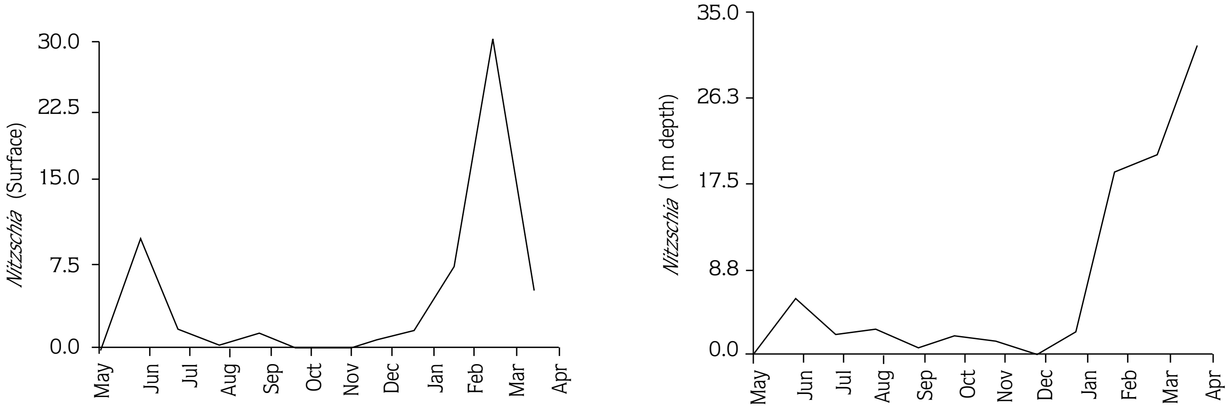


Figure 5. Monthly numbers of the genus *Nitzschia* at the surface and 1 m depth.

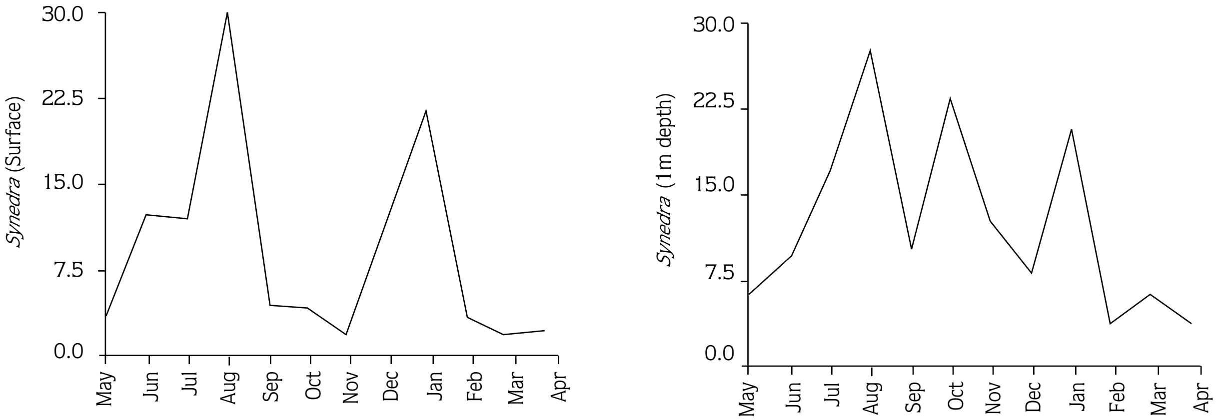


Figure 6. Monthly numbers of the genus *Synedra* at the surface and 1 m depth.

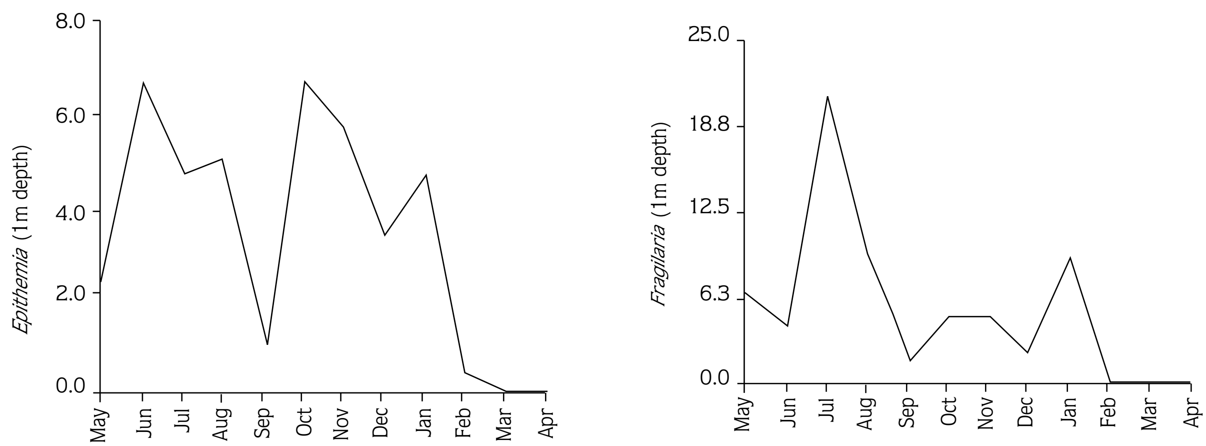


Figure 7. Monthly numbers of the genera *Epithema* and *Fragilaria* at 1 m depth.

Table 10. The lists of the determined species are given under their relevant stations.

	surface			1 m depths		
STATIONS BACILLARIOPHYTA	1	2	3	1	2	3
CENTRALES						
Coscinodiscaceae						
Cyclotella meneghiniana Kütz.	X	X	X	X	X	X
Cyclotella operculata (Ag.) Kütz.				X	X	
Aulocoseira granulata (Ehr.) Simonsen	X	X	X	X	X	X
Aulocoseira italica (Ehr.) Kütz.	X	X	X	X	X	X
Melosira distans (Ehr.) Kütz.	X	X	X	X		
Melosira varians C.A.Agardh	X	X	X	X	X	X
PENNALES						
Achnanthaceae						
Achanthes lanceolata (Breb.) Kütz.			X	X	X	X
Achanthes lanceolata var. *dubia* Grun.				X		
Cocconeis disculus Schum.				X		
Cocconeis pediculus Ehr.	X	X	X	X	X	X
Cocconeis placentula (Ehr.) Cl.	X	X	X	X	X	X
Cocconeis placentula var. *euglypta* (Ehr.) Cl.	X	X	X	X	X	X
Rhoicosphenia curvata (Kütz.) Grun.	X	X	X	X	X	X
Cymbellaceae						
Amphora delicatissima Krasske		X				
Amphora ovalis Kütz.	X	X	X	X	X	X
Amphora ovalis var. *pediculus* Kütz.		X		X	X	
Cymbella affinis Kütz.	X	X	X	X	X	X
Cymbella cistula (Hemprich) Grun.	X	X	X	X	X	X
Cymbella cistula var. *maculata* (Kütz.) Van Heurck				X		X
Cymbella cymbiformis (Ag. & Kütz.) Van Heurck	X	X		X	X	X
Cymbella gracilis (Rabh.) Cleve				X		
Cymbella helvetica Kütz.		X	X			
Cymbella sp.					X	X
Cymbella tumida (Breb.) Van Heurck	X					X
Cymbella ventricosa Kütz.	X	X	X	X	X	X
Gompocymbella anclyii (Cleve) Hust.					X	X
Epithemiaceae						
Epithemia adnata (Kütz.) Rabenhorst	X	X	X	X	X	X
Epithemia argus Kütz.	X	X	X	X	X	X
Epithemia sorex Kütz.	X	X	X	X	X	X
Epithemia turgida (Ehr.) Kütz.	X			X		X
Epithemia zebra (Ehr.) Kütz.	X	X	X	X	X	X
Epithemia zebra var. *porcellus* (Ehr.) Kütz.					X	X
Epithemia zebra var. *saxonica* (Kütz.) Grun.	X	X		X		
Rhopalodia gibba (Ehr.) O.Müller	X	X	X	X	X	X
Rhopalodia gibba var. *ventricosa* (Ehr.) Grun.	X	X	X	X	X	X
Rhopalodia gibberula (Ehr.) O.Müller	X	X	X	X	X	X
Rhopalodia gibberula var. *van Heurckii* O.Müller		X		X	X	X
Eunotiaceae						
Eunotia valida Hust.	X	X	X	X	X	X
Fragilariaceae						
Asterionella gracillima (Hantzsch) Heiberg				X		
Diatoma anceps (Ehr.) Grun.		X				

Table 10. (continued)

	surface			1 m depths		
STATIONS	1	2	3	1	2	3
Diatoma vulgare Bory		X			X	X
Diatoma vulgare var. *brevis* Grun.		X		X		
Diatoma vulgare var. *producta* Grun.	X	X	X	X	X	
Fragilaria bicapitata A.Mayer					X	
Fragilaria brevistriata Grun.	X		X	X	X	X
Fragilaria capucina (Rabh.) Grun.				X	X	
Fragilaria construens (Ehr.) Grun.	X	X	X	X	X	X
Fragilaria intermedia Grun.	X	X	X	X	X	X
Fragilaria pinnata Ehr.				X	X	X
Fragilaria vaucheriae (Kütz.) Petersen	X	X	X	X	X	X
Synedra acus Kütz.	X	X	X	X	X	X
Synedra affinis Kütz.	X	X				X
Synedra amphicephala Kütz.	X			X	X	X
Synedra capitata Ehr.		X	X	X	X	X
Synedra rumpens Kütz.	X	X	X	X	X	X
Synedra rumpens var. *familaris* (Kütz.) Grun.				X		
Synedra ulna (Nitzsch) Ehr.	X	X	X	X	X	X
Synedra ulna var. *aequalis* (Kütz.) Hust.	X					
Synedra ulna var. *amphirhynchus* (Ehr.) Grun.	X			X		
Synedra ulna var. *biceps* Kütz.	X	X	X	X	X	X
Synedra ulna var. *oxyrhynchus* (Kütz.) Van Heurck	X	X	X	X	X	X
Synedra vaucheriae Kütz.	X	X	X	X	X	X
Gomphonemaceae						
Gomphonema acuminatum Ehr.	X	X	X	X		X
Gomphonema acuminatum var. *coronata* (Ehr.) W.Smith	X					
Gomphonema acuminatum var. *trigonocephala* (Ehr.) Grun.			X			
Gomphonema angustatum (Kütz.) Rabh.	X		X			X
Gomphonema augur Ehr.			X			X
Gomphonema bohemicum Reichelt & Fricke	X	X	X	X	X	X
Gomphonema consector Hohn & Hellerm		X	X	X		X
Gomphonema constrictum Ehr.	X	X	X	X	X	
Gomphonema gracile Ehr.	X	X	X	X	X	X
Gomphonema longiceps Ehr.	X		X	X	X	X
Gomphonema olivaceum (Lyngbye) Kütz.	X	X		X	X	X
Gomphonema olivaceum var. *calcarea* Cleve			X			
Gomphonema parvulum (Kütz.) Grunow	X	X	X	X	X	X
Gomphonema sphaerophorum Ehr.	X		X			X
Gomphonema subclavatum (Grun.) Grun.			X			
Gomphonema truncatum Ehr					X	
Gomphonema truncatum var. *capitatum* Ehr.	X			X		
Gomphonema ventricosum Gregory				X	X	
Naviculaceae						
Anomoeoneis sphaerophora (Kütz.) Pfitzer	X	X	X	X	X	X
Caloneis amphisbaena (Bory) Cl.	X	X	X	X	X	X
Caloneis Schumanniana var. *biconstricta* Grun.			X			
Caloneis silicula (Ehr.) Cleve						X
Caloneis silicula var. *truncatula* Grun.						X
Gyrosigma acuminatum (Kütz.) Rabh.	X	X	X	X	X	X
Gyrosigma kützingii (Grun.) Cl.	X					X
Navicula bacillum (Ehr.)				X	X	X
Navicula cincta (Ehr.) Kütz.	X			X		
Navicula cryptocephala Kütz.	X	X	X	X	X	X
Navicula cryptocephala var. *intermedia* Grun.					X	

Table 10. (continued)

	surface			1 m depths		
STATIONS	1	2	3	1	2	3
Navicula cryptocephala var. *veneta* (Kütz.) Grun.				X	X	X
Navicula cuspidata Kütz.			X			X
Navicula dicephala (Ehr.) W.Smith	X					X
Navicula exigua (Gregory) O.Müller	X		X	X	X	X
Navicula gothlandica Grun.	X	X	X	X	X	
Navicula gracilioides A.Mayer					X	
Navicula gregaria Donk. Patr.			X	X	X	X
Navicula hungarica Grun.	X			X		
Navicula hungarica var. *capitata* (Ehr.) Cl.	X	X	X	X	X	X
Navicula longirostris (Hust.)	X					
Navicula minima Grun.	X	X		X	X	X
Navicula minima var. *atomoides* (Grun) Cl.			X			
Navicula protracta Grun.				X		
Navicula radiosa Kütz.	X	X	X	X	X	X
Navicula rostellata Kütz.	X	X	X	X	X	
Navicula salinarum Grun.						X
Navicula simplex Krasske			X	X	X	X
Navicula tuscula (Ehr.) Grun.				X		
Neidium affine (Ehr.) Cl.			X			
Neidium dubium (Ehr.) Cl.			X	X	X	X
Neidium dubium fo. *constricta* Hust.	X		X	X	X	X
Neidium productum (W.Smith) Cl.						X
Pinnularia divergens W.Smith			X	X		
Pinnularia fasciata (Lagerstedt) Hust.						X
Pinnularia globiceps Gregory			X	X	X	X
Pinnularia interrupta W.Smith	X			X		
Pinnularia microstauron (Ehr.) Cl.	X	X		X	X	X
Pinnularia virirdis (Nitzsch) Ehr.					X	
Nitzschiaceae						
Hantzschia amphioxys (Ehr.) Grun.					X	
Nitzschia acuta Hantzsch	X	X	X	X	X	X
Nitzschia amphibia Grun.	X	X	X	X	X	X
Nitzschia apiculata (Gregory) Grun.	X	X	X	X	X	X
Nitzschia gracilis Hantzsch	X					X
Nitzschia hungarica Grun	X	X	X	X	X	X
Nitzschia palea (Kütz.) W.Smith	X	X		X	X	
Nitzschia recta Hantzsch	X			X	X	X
Nitzschia romana Grun.				X	X	X
Nitzschia sigma (Kütz.) W.Smith	X	X		X	X	X
Nitzschia sigmoidea (Ehr.) W.Smith				X		
Nitzschia thermalis Kütz.	X			X		X
Nitzschia vermicularis (Kütz.) Grun.				X	X	X
Surirellaceae						
Cymatopleura angulata Greville						X
Cymatopleura elliptica (Breb.) W.Smith			X		X	
Cymatopleura elliptica var. *constricta* Grun.			X			
Cymatopleura solea (Breb.) W.Smith	X	X	X	X	X	X
Cymatopleura solea var. *regula* (Ehr.)	X		X	X	X	X
Surirella angustata Kütz.				X	X	X
Surirella delicatissima Lewis			X		X	
Surirella didyma Kütz.				X		
Surirella linearis W.Smith		X				
Surirella ovata Kütz.	X	X	X	X	X	X
Surirella patella Ehr.					X	
Surirella robusta Ehr.				X		X

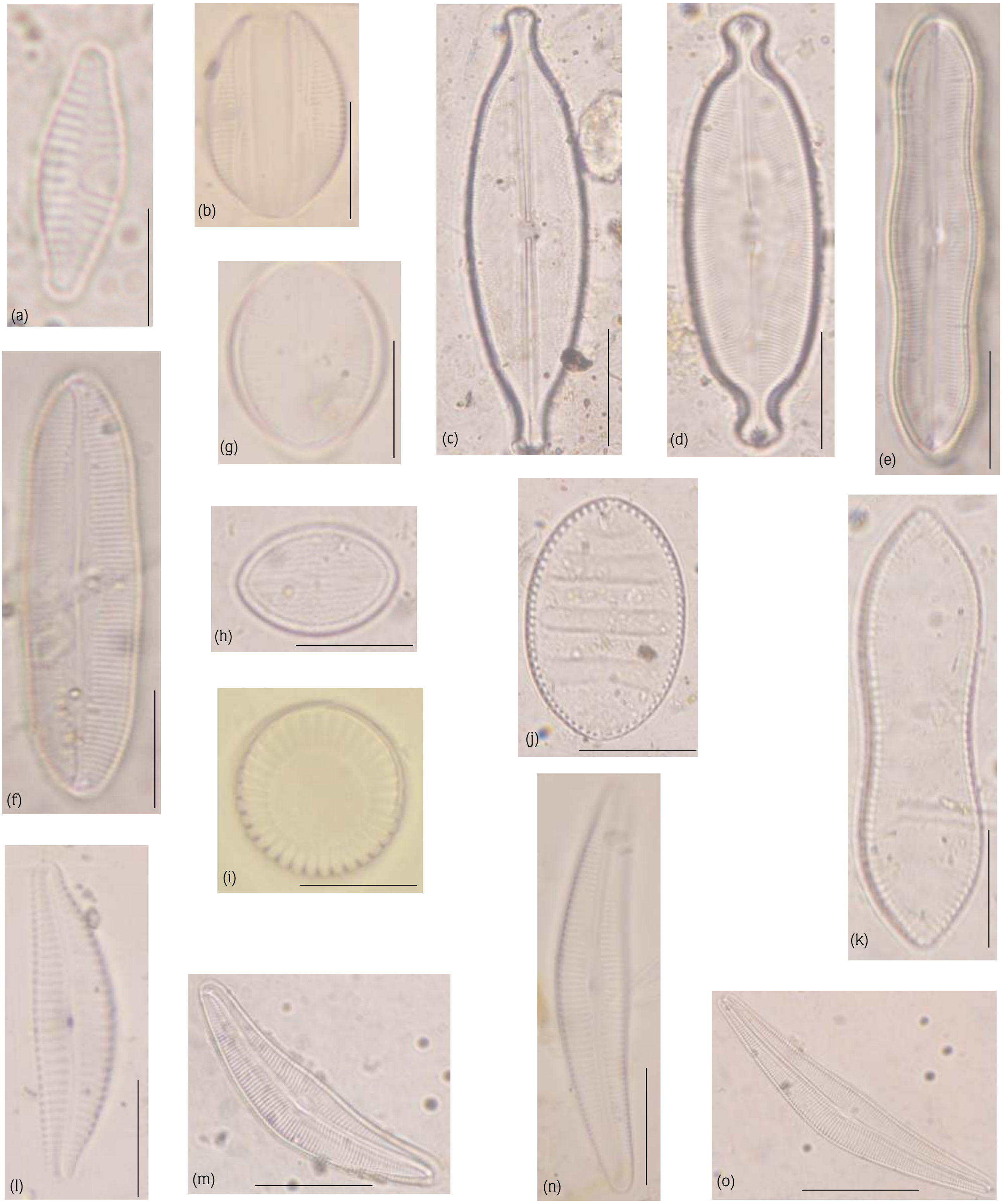


Figure 8. (a) *Achanthes lanceolata*, (b) *Amphora ovalis*, (c) *Anomoeoneis sphaerophora*, (d) *Caloneis amphisbaena*, (e) *Caloneis silicula*, (f) *Caloneis silicula* var. *truncutula*, (g) *Cocconeis pediculus*, (h) *Cocconeis placentula*, (i) *Cyclotella meneghiniana*, (j) *Cymatopleura elliptica*, (k) *Cymatopleura solea*, (l) *Cymbella affinis*, (m) *Cymbella cistula*, (n) *Cymbella cymbiformis*, (o) *Cymbella helvetica* (scale 10 µm).

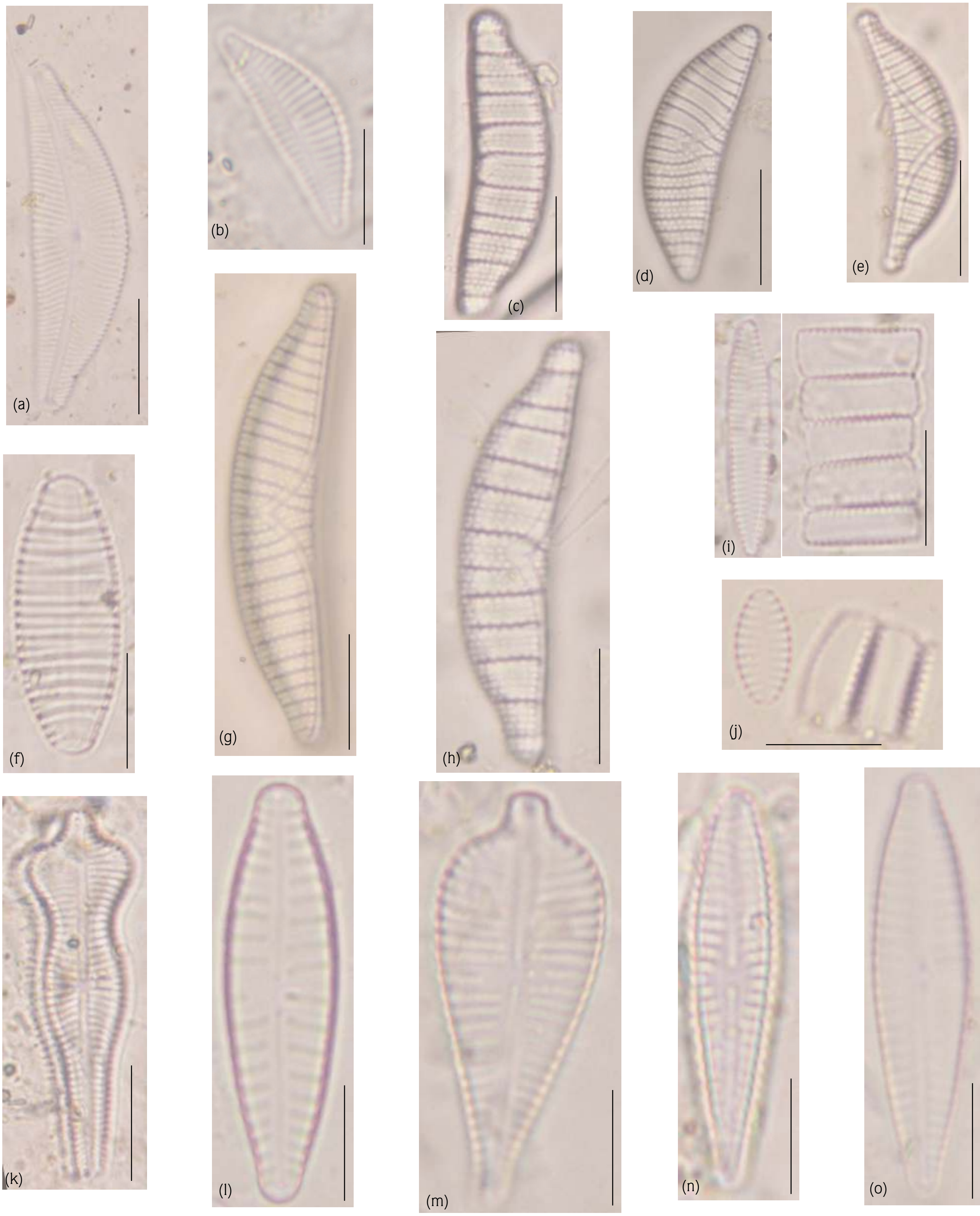


Figure 9. (a) *Cymbella tumida*, (b) *Cymbella ventricosa*, (c) *Epithemia adnata*, (d) *Epithemia argus*, (e) *Epithemia sorex*, (f) *Diatoma vulgare*, (g) *Epithemia turgida*, (h) *Epithemia zebra*, (i) *Fragilaria construens*, (j) *Fragilaria pinnata*, (k) *Gomphonema acuminatum* var. *coronata*, (l) *Gomphonema angustatum*, (m) *Gomphonema augur*, (n) *Gomphonema bohemicum*, (o) *Gomhonema consector* (scale 10 µm).

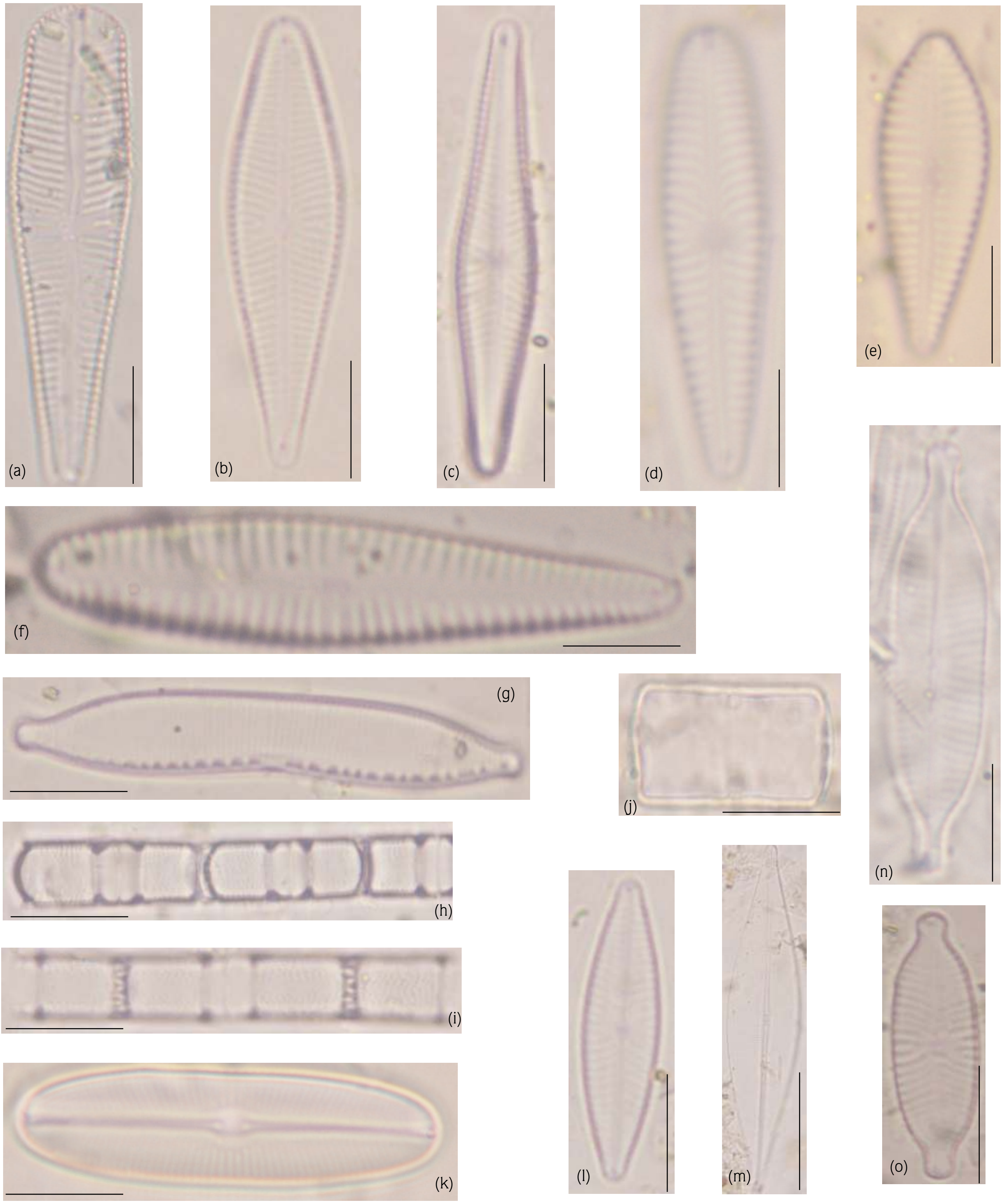


Figure 10. (a) *Gomphonema constrictum*, (b) *Gomphonema gracile*, (c) *Gomphonema longiceps*, (d) *Gomphonema olivaceum*, (e) *Gomphonema parvulum*, (f) *Gomphonema subclavatum*, (g) *Hantzschia amphioxys*, (h) *Aulocoseira granulata*, (i) *Aulocoseira italica*, (j) *Melosira varians*, (k) *Navicula bacillum*, (l) *Navicula cryptocephala*, (m) *Navicula cuspidata*, (n) *Navicula dicephala*, (o) *Navicula exigua* (scale 10 μm).

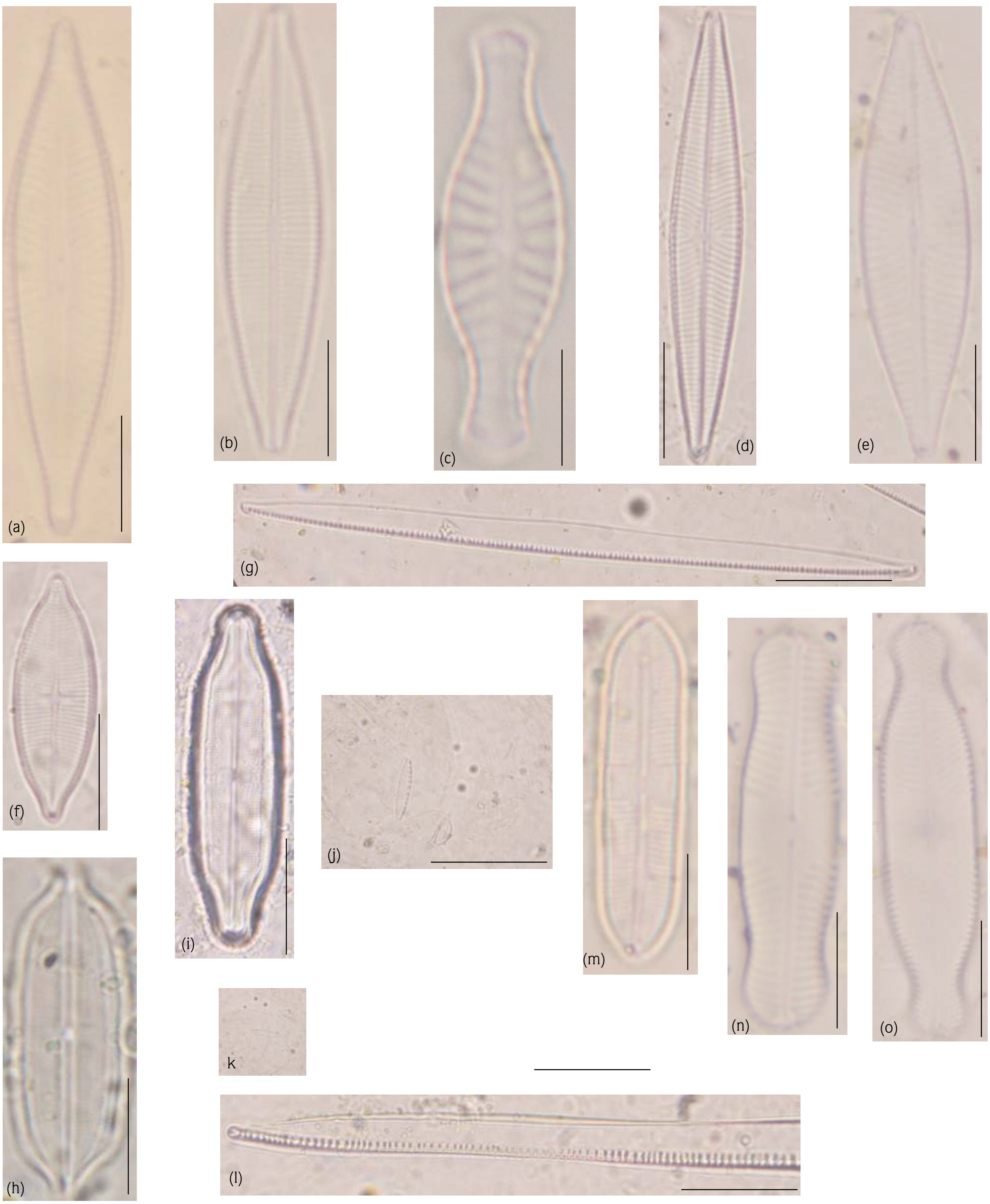


Figure 11. (a) *Navicula gothlandica*, (b) *Navicula gregaria*, (c) *Navicula hungarica* var. *capitata*, (d) *Navicula radiosa*, (e) *Navicula salinarum*, (f) *Navicula tuscula*, (g) *Nitzschia acuta*, (h) *Neidium dubium*, (i) *Neidium affine*, (j) *Nitzschia amphibia*, (k) *Nitzschia hungarica*, (l) *Nitzschia sigma*, (m) *Pinnularia fasciata*, (n) *Pinnularia globiceps*, (o) *Pinnularia interrupta* (scale 10 μm).

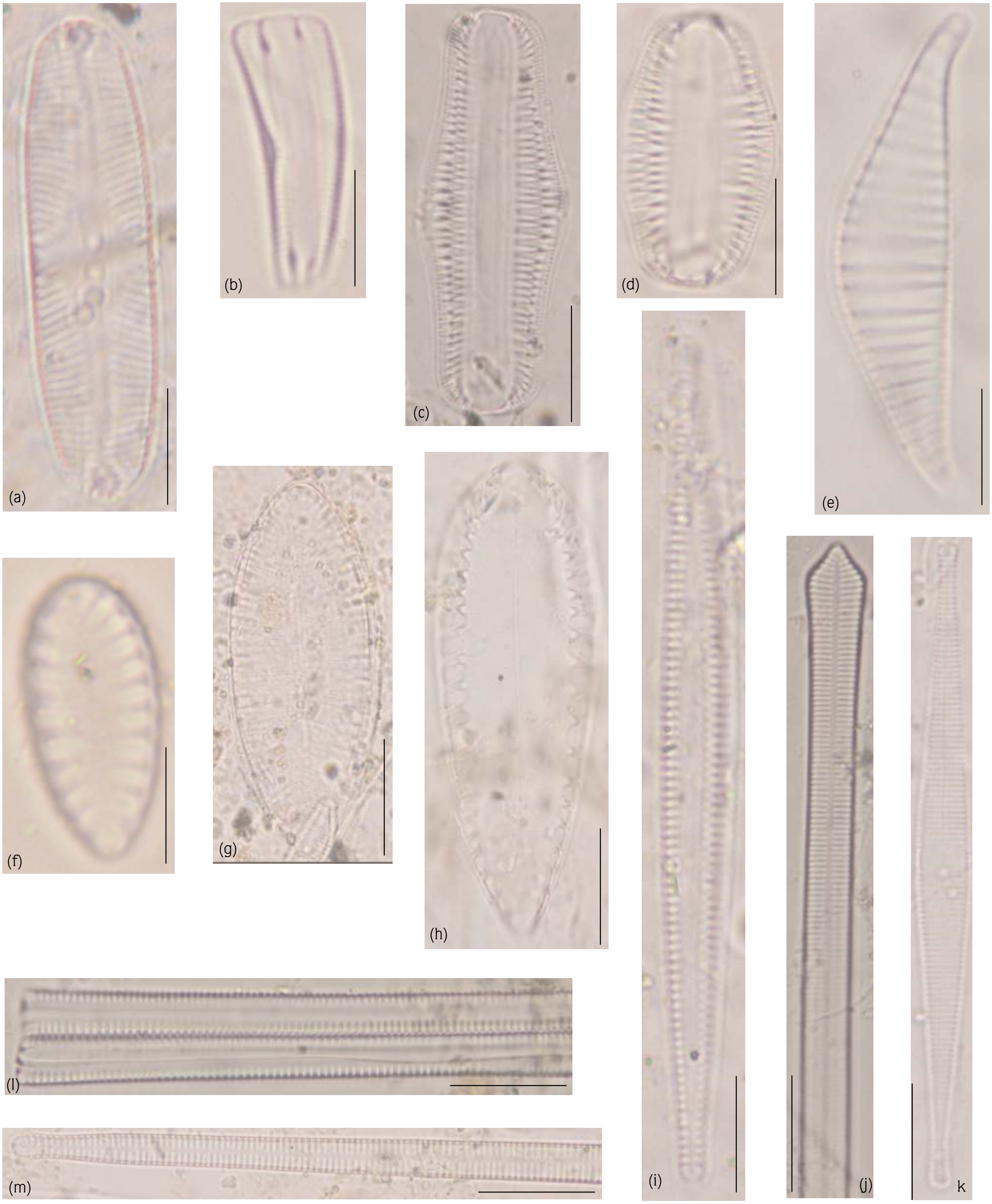


Figure 12. (a) *Pinnularia microstauron*, (b) *Rhoicosphenia curvata*, (c) *Rhopalodia gibba*, (d) *Rhopalodia gibba* var. *Ventricosa*, (e) *Rhopalodia gibberula*, (f) *Surirella ovata*, (g) *Surirella patella*, (h) *Surirella robusta*, (i) *Synedra affinis*, (j) *Synedra capitata*, (k) *Synedra rumpens*, (l) *Synedra ulna*, (m) *Synedra ulna* var. *biceps* (scale 10 µm).

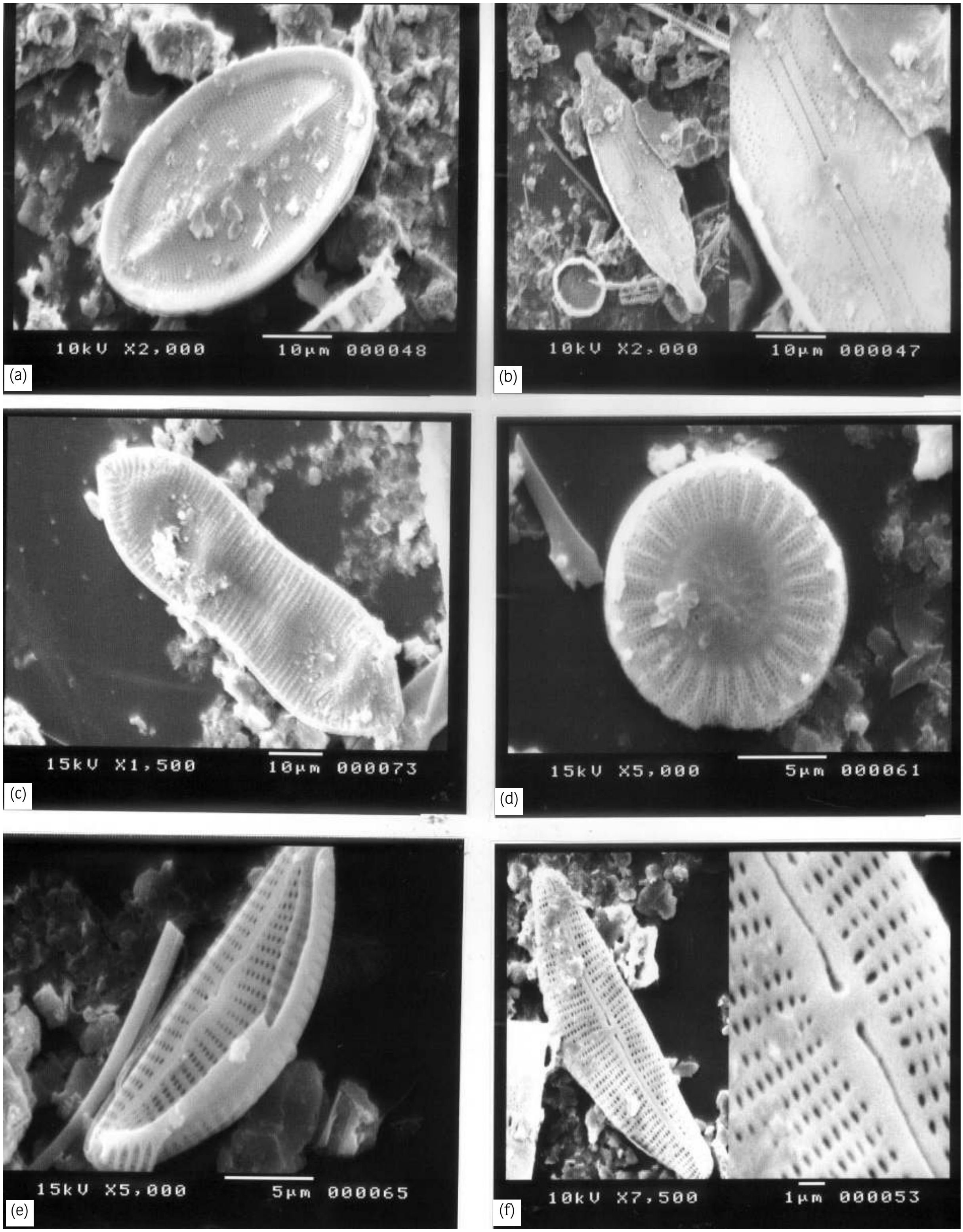


Figure 13. (a) *Cocconeis placentula*, (b) *Anomoeoneis sphaerophora*, (c) *Cymatopleura solea*, (d) *Cyclotella meneghiniana*, (e) *Cymbella ventricosa*, (f) *Cymbella affinis*.

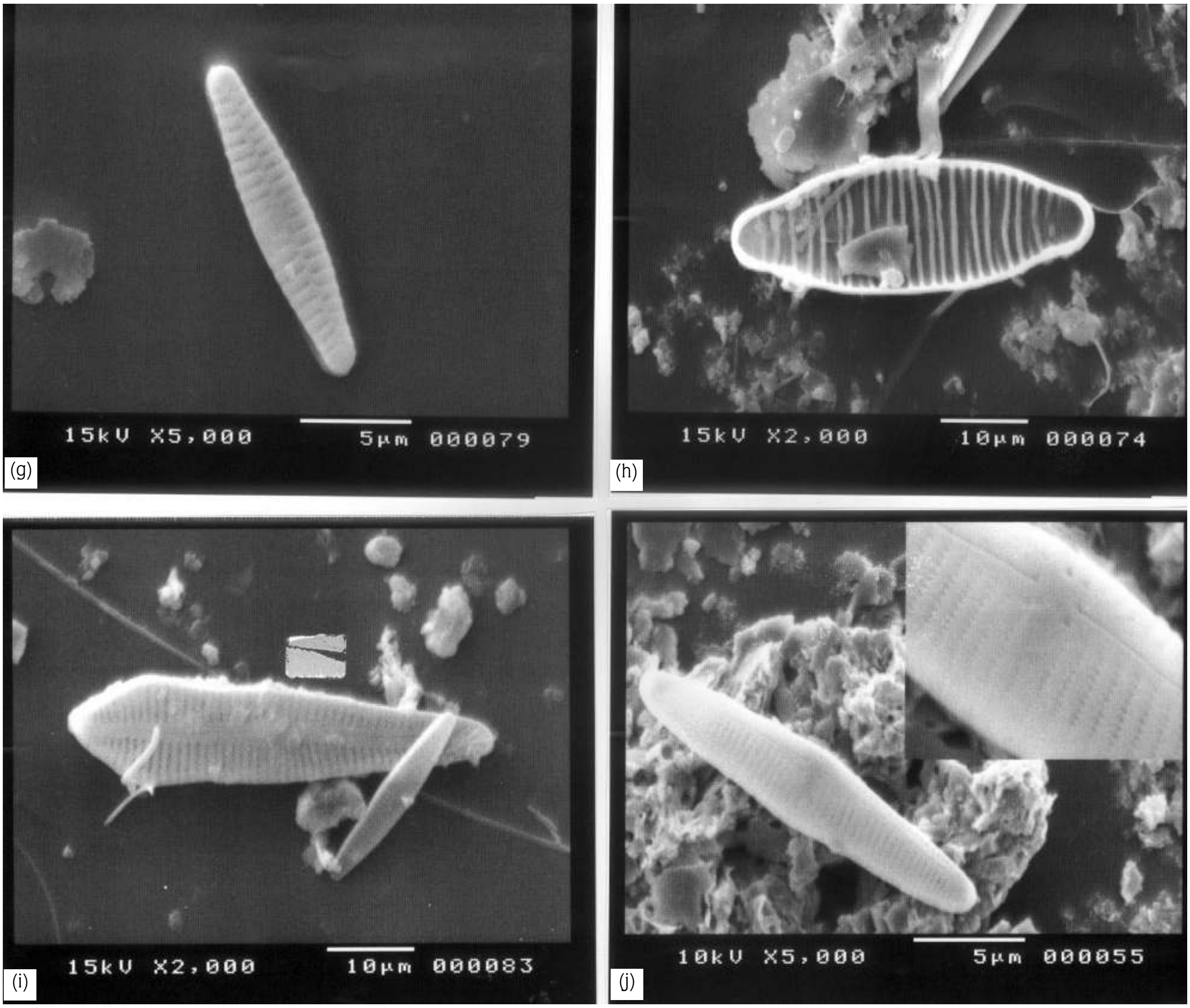


Figure 13. (continued)
(g) *Fragilaria intermedia*, (h) *Diatoma vulgare,* (i) *Gomphonema acuminatum* var. *trigonocephala*,
(j) *Gompocymbella anclyii* (scale 10 µm).

meneghiniana, *Aulocoseira granulata*, *Aulocoseira italica*, *Melosira varians*, *Cocconeis placentula*, *Navicula radiosa*, and *Synedra ulna* are dominant species that are seen during almost all seasons and at every station.

In Lake Kaz's surface water the *Navicula* (15), *Gomphonema* (14), *Synedra* (11), and *Nitzschia* (10) are the genera from *Bacillariophyta* represented by the most abundant species, whereas *Navicula* (21), *Gomphonema* (16), *Nitzschia* (12), *Synedra* (11), *Cymbella* (8), *Fragilaria* (7), and *Epithemia* (6) are the genera from *Bacillariophyta* represented by the most abundant species at 1.0 m depth.

Despite *Nitzschia*, *Gomphonema*, *Navicula*, and *Cymbella* preferring benthic (epipelic, epilithic, and epiphytic) habitats, they appear to be phytoplankton in this research. It is thought that because the lake is not very deep a large part of it is covered by reeds and contamination by benthic diatoms occurs in the planktonic habitat.

Round (38) stated that the *Fragilaria*, *Cocconeis*, *Gyrosigma*, *Caloneis*, *Navicula*, *Amphora*, *Cymbella*, *Nitzschia*, and *Cymatopleura* are common genera in calcareous water and they prefer neutral and alkali water. Nevertheless, this researcher defined the genera

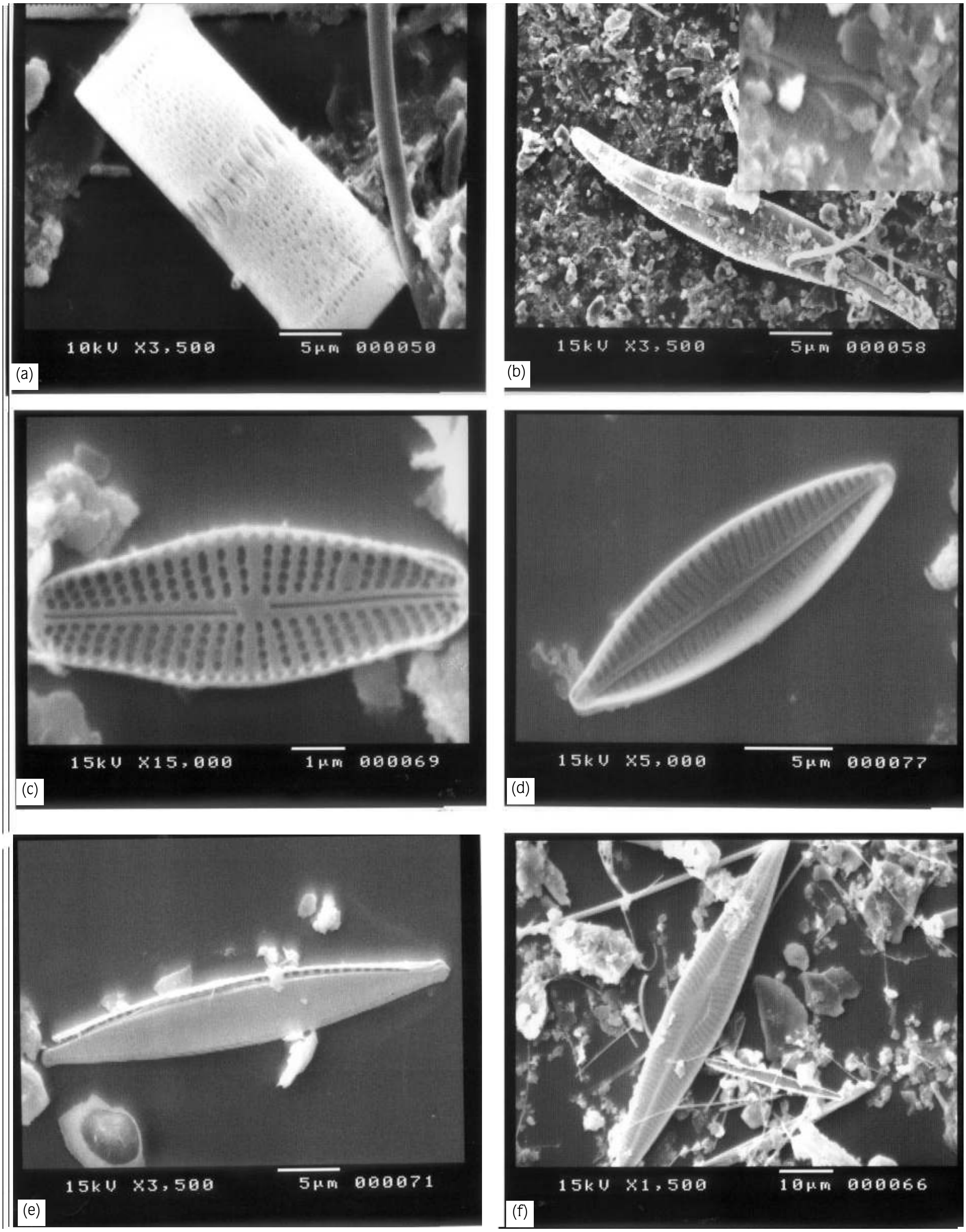


Figure 14. (a) *Aulocoseira italica*, (b) *Gyrosigma acuminatum*, (c) *Navicula minima*, (d) *Navicula cryptocephala*, (e) *Nitzschia palea*, (f) *Navicula radiosa.*

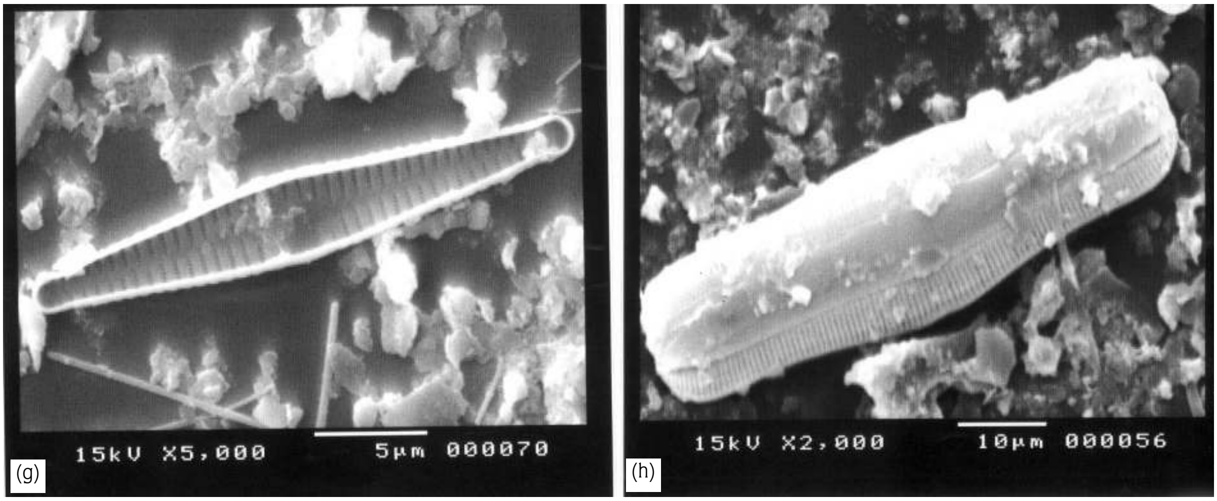


Figure 14. (continued)
(g) *Synedra vaucheriae*, (h) *Rhopalodia gibba* (scale 10 μm).

Pinnularia and *Neidium* distributed in unproductive lakes mostly as acidophyles. As a result of the species found and the chemical analysis done, it is determined that Lake Kaz's water is calcareous and it is low alkali. The genera *Pinnularia* and *Neidium* were encountered rarely in winter months.

Cylotella meneghiniana, which was determined to be the dominant species in Lake Kaz's surface water and especially at 1.0 m depth, was confirmed as dominant in Lake Mogan (2) and Palandöken Pond (39), while it was determined as secondarily dominant in Tercan (40) and Almus Dam Lakes (29). In Lake Borabay (30) it was defined as a permanently present species in epiphytic and epilithic habitats. *Aulocoseira granulata*, which was observed as one of the dominant species in Kaz Lake's surface water and at 1.0 m depths, is a secondarily abundant and common organism in Devegecidi Dam Lake (41). Its population increased in spring and autumn in Almus Dam Lake (29), whereas it was observed as a subdominant species in Suat Uğurlu Dam Lake during autumn and winter (42). *Melosira varians* was the dominant species in Almus Dam Lake as it was in Lake Kaz (29). It is recorded as permanently present and consistent in Porsuk Pond (43), most abundant in Bayındır Dam Lake (36), and the most common species in Çubuk-I Dam Lake (44), Altınapa Dam Lake (45), and Palandöken (Tekederesi) Pond (6).

In this study, *Cocconeis placentula* and *Cocconeis placentula* var. *euglypta* were observed among the dominant species. While *Cocconeis placentula* was widespread and dominant in epiphytic and epilytic habitats of Almus Dam Lake (29), they were dominant in every station in Demirdöven Dam Lake (37). They were found less frequently in Tercan Dam Lake (40). *Navicula* species, which were seen in nearly every season in Lake Kaz, were recorded as dominant species in other research carried out in Central Anatolia (46). The genus represented by the most abundant species is *Navicula*. *Navicula radiosa*, which was observed as the dominant species at the surface and 1.0 m depth, was determined as rarely present in Almus Dam Lake (29). It was determined as the most widespread species in an epipelic habitat in Uzungöl (5).

Synedra ulna, which was determined as the most dominant species in Kaz Lake, was the dominant species in Almus Dam Lake (28), Yedigöller and Abant Lake (34), Porsuk Pond (35), and Palandöken Pond (30) as well. It was among the permanently present species in an epiphytic habitat (47).

The genus *Gomphonema* ranks second in terms of abundant species. Few of these group members were encountered. *Nitzschia* species, which are abundant and common in Lake Kaz especially during autumn and winter, are usually found in warm water and in lakes tolerant to organic pollution (25). This group ranks third in terms of abundant species. The group represented by the most abundant species at 1.0 m depth is the genus

Cymbella. This genus is the most diverse group in Lake Borabay (30) and Lake Gölköy (9).

It is recorded that many of the *Fragilaria* species prefer places rich in nutrients and they are usually found in mesotrophic water (25,48). *Fragilaria vaucheriae*, which was found frequently in Lake Kaz during spring, was the dominant species in Porsuk Pond (32) and Palandöken Pond (39). *Fragilaria intermedia*, which is seen in Almus Dam in spring and autumn, is the dominant phytoplankton. It is a species present at Yedigöller and Lake Abant (7) in almost every month of the year.

Amphora ovalis, *Cocconeis placentula*, and *Navicula exigua* live in clean water and are known to be sensitive, and *Gomphonema parvulum*, *Melosira varians*, *Navicula cryptocephala*, *Nitzchia palea*, and *Surirella ovata*, which are adapted to polluted water, were recorded in the research area. The fact that *Cocconeis placentula* and *Melosira varians* were found at the same stations shows that pollution is not at important levels. However, the fact that *Gomphonema parvulum* was found in spring, *Navicula cryptocephala* in summer, and *Nitzchia palea* and *Surirella ovata* in winter shows that the pollution rates increase in some months of the respective seasons. The reason for this increase could be the bodily wastes of farm animals from neighboring villages and the pesticides used in the surrounding agricultural lands.

The high species diversity can be explained by the effect of nutritive salts on organism growth. It was observed that Lake Kaz is rich in diatoms species diversity, but a fully quantitative analysis was not performed on the subject. By considering only the relative abundance and empirical observations it can be concluded that the density of flora is low. Considering the other features determined in Lake Kaz, it appears that it is a mesotrophic lake that occurs by nutrient enrichment in some periods between eutrophic and oligotrophic conditions. At the same time, it is similar with regard to algae species diversity determined in other lakes.

At station 1, species diversity was observed in surface samples in the winter and at 1 m depth in the summer. At this station, the reason for the high species diversity in surface samples could be the contamination caused by the reeds on the surface. Furthermore, because the water is warm and still at this station, organic contamination could occur, and therefore it may positively affect the species diversity of the algae that are tolerant of contamination. At 1 m depth at the same station, greater species diversity could have resulted from the lake being too shallow, contamination of the lake by organic-rich sediments, and optimum ecological conditions in the summer. Additionally, increasing solar evaporation because of the high temperature during the summer leads to an increase in the ionization rate, which results in nutrient-rich water.

According to Round (49), especially for some diatom species, low alkali water increases viability. The low alkali characteristic of Lake Kaz usually creates a good growth medium for algae. Lund (47) reported that the increase in phytoplankton density in the late summer and in the autumn is more important than the rise in the spring. In the present study the increase in phytoplankton density occurred in the autumn and winter in surface water and at 1.0 m depth.

Ca^{++} and Mg^{++} cations' values (mg/l) were higher than those of the other ions. Many diatom species, especially *Synedra*, *Cymbella*, and *Navicula*, prefer water that is rich in calcium. When the (Na + K) / (Ca + Mg) ratio is smaller than 1.5 planktonic diatoms' density increases, because if this ratio is smaller the water is usually rich in silicate, nitrate, and carbonate (50). Values in Lake Kaz are consistent with this.

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