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Research Article

Diatoms *(Bacillariophyta)* in the Phytoplankton of Keban Reservoir and Their Seasonal Variations

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Abstract: The seasonal variations of planktonic diatoms occurring in the Keban and İçme regions of Keban Reservoir were investigated over a 2-year period (January 1991 - December 1992). A total of 104 diatom taxa were determined. *Cyclotella ocellata* Pantocksek, *C. kützingiana* Thwaites *(Centrales), Asterionella formosa* Hassall and *Fragilaria crotonensis* Kitton *(Pennales)* were the most conspicuous diatoms in terms of frequency of occurrence and numbers of individuals in the phytoplankton. The species composition and seasonal growth properties of the diatoms differed in the Keban and İçme regions of the lake. Although the quantity of diatoms tended to increase in all seasons, spring growth was more conspicuous in both regions. The seasonal growth of diatoms showed a clear relationship with the temperature and silica concentrations of the lake water.

Key Words: Diatom, Phytoplankton, Seasonal variation, Keban Dam Lake, Türkiye

Keban Baraj Gölü Fitoplanktonundaki Diyatomeler (*Bacillariophyta*) ve Mevsimsel Değişimleri

Özet: Bu çalışmada Keban Baraj Gölünün İçme ve Keban kesimlerinde fitoplanktonda ortaya çıkan diyatomeler Ocak 1991- Aralık 1992 tarihleri arasında incelenmiştir. Araştırma süresince planktonik diyatomelere ait 104 takson belirlenmiştir. Sentrik diyatomelerden *Cyclotella ocellata* Pantocksek, *C. kützingiana* Thwaites Pennate diyatomelerden ise *Asterionella formosa* Hassall ve *Fragilaria crotonensis* Kitton örneklerde bulunuş sıklıkları ve birey sayıları bakımından fitoplanktonda en önemli diyatomeler olmuşlardır. Diyatomelerin tür çeşitliliği, bulunuş sıklıkları ve mevsimsel çoğalma özellikleri Göl'ün Keban ve İçme bölgelerinde birbirinden farklı olmuştur. Diyatomeler her mevsimde çoğalabilmişlerse de ilkbahar çoğalmaları daha dikkat çekici olmuştur. Diyatomelerin mevsimsel çoğalmaları ile su sıcaklığı ve silisyum miktarı arasında bir ilişki gözlenmiştir.

Anahtar Sözcükler: Diyatome, Fitoplankton, Mevsimsel değişim, Keban Baraj Gölü, Türkiye

Introduction

This study was carried out in Keban Reservoir, which is the second largest man-made lake in Turkey after Atatürk Reservoir. The surface area and water capacity of the lake are 645 km^2 and 247 x 10^2 km^3, respectively. The lake has great significance in energy production and in its large potential for fisheries. The lake is also used for the irrigation of agricultural areas in the surrounding area.

There have been many studies carried out at Keban Reservoir. The majority of these studies are concerned with the limnological properties of the lake, whilst the other describe various aspects of pollution in the lake. The pollution studies cover; the relationship between O_2 consumption and organic wastes discharged by factories around the lake (1), the ratio of the degradation of synthetic detergents in the lake water (2), the effects of domestic waste on fish in the lake (3), the occurrence of eutrophication (4), phosphorus loading and the determination of eutrophication-discharge limit concentrations in the lake (5).

A limnological study by DSİ (6) the relationships between organelles and the meat efficiency of *Capoeta trutta* Heckel. (7), an investigation of the disgestive systems of *Capoeta trutta* (8) and age determination methods and the length-weight relations of fish in the

reservoir (9, 10, 11) are the main limnological studies carried out on the lake.

As can be understood from the literature above, there has been no detailed study of algae and their seasonal variations in Keban Reservoir. For this reason, diatoms and their seasonal variations in the phytoplankton of two different regions (Keban and İçme) of Keban Reservoir were investigated from January 1991 to December 1992.

Materials and Methods

Two regions were chosen in Keban Reservoir for this study. The first region includes the Ağın and Çemişgezek parts of Keban Reservoir and is referred to as the "Keban Region" in this study, while the second one is called "İçme Region" and includes the uluova part of the lake (Fig. 1). The Keban region does not appear to be suffering from the effects of pollutants since domestic wastes from nearby settlements are accumulated in fosseptics and there is no knowledge of any industrial waste discharged into this part of the lake. However, the "İçme Region" is already heavily polluted by many different sources, such as the sewage of Elazığ and drainage from agricultural land.

Diatoms and water samples from the Keban and İçme Regions were collected every month between January 1991 and December 1992. Phytoplankton samples were collected using a plankton net and Nansen water bottle for qualitative and quantitative examination (12). The diatoms were identified on permanent slides with the help of Germain (13), Grimes and Rushforth (14), Hustedt (15), Patrick and Reimer (16, 17). The phytoplankton was counted after preservation with Lugol iodine with an inverted microscope. The water temperature, oxygen concentration, pH and conductivity of the lake water were measured directly by means of a thermometer, oxygen meter, pH meter and conductivimeter, respectively. Sulphate, nitrate and silica concentrations were determined using spectrophotometric methods (18).

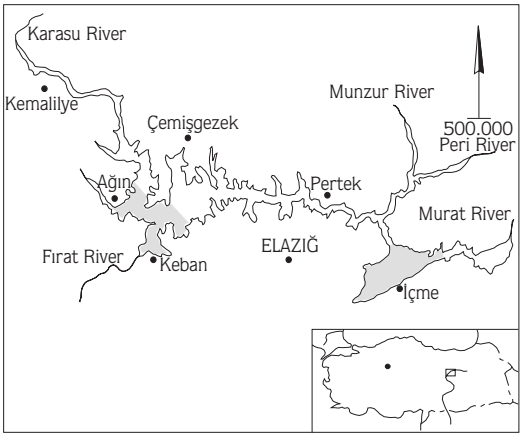

Figure 1. Map of the Keban Dam Lake showing the position of sampling stations

Results

The seasonal changes in physical and chemical parameters in the Keban and İçme regions of Keban Reservoir are presented in Tables 1 and 2.

Diatoms *(Bacillariophyta)* were the most important algae with respect to the number of species and population density in phytoplankton in the Keban and İçme regions. Taxa belonging to *Bacillariophyta* recorded in the phytoplankton of the regions studied and their distributional characteristics are presented in Table 3.

Seasonal development models of diatoms in the phytoplankton of the Keban region were similar in both years (1991-1992). In the first year, diatoms were recorded with a low level of individuals in winter. However their numbers started to increase by the beginning of spring and reached a maximum of 375 org/ml. in April. At this maximum the percentage proportions of the most common diatom species were as follows; *Cylotella ocellata* Pantocseck (40.45%), *Asterionella formosa* Hassall (36.32%) and *Navicula gracilis* Ehr. (9.9%).

Although the number of diatoms in the phytoplankton decreased suddenly in May, their numbers started to increase again by early summer and reached the highest level (223 org. / ml.) in the summer of July. *C. ocellata, C. kützingiana* Thwaites, *M. distans* (Ehr.) Kütz. and *N. cryptocephala* Kütz. were the dominant species in summer, constituting 43.5%, 37.2%, 10.3% and 9.0% of the total phytoplankton, respectively. The highest autumn growth (214 org/ml.) occurred in September during which the proportions of the major diatoms were as follows; *C. ocellata* (55.60%), *C. kützingiana* (31.3%), *C. affinis* Kütz. (14.3%), and *F. crotonensis* Kitton (7.0%) (Fig. 2).

(-) indicates no analysis.

Table 1. Seasonal variations in physical and chemical parameters in the Keban region of Keban Reservoir

	Water Temp.ºC	Secchi disk d.(m)	pH	Disol.O_2(mg./L.)	Conduct. (µmhos/cm.)	Total Hardn. (mg/L)	Ca++ (mg/L)	Mg++ (mg/L)	SiO_2 (mg/L)	NO3--N (mg/L)	SO4-2 (mg/L)
January 1991	1.0	2.20	8.10	17.30	390	120	40	4.37	-	-	-
February	2.3	2.70	8.10	21.40	365	130	43	5.56	-	-	-
March	3.3	2.49	8.00	14.35	370	130	42	6.07	-	-	-
April	8.2	1.62	8.20	14.20	400	145	36	12.15	-	-	-
May	15.7	1.41	8.10	10.40	405	160	37	16.40	-	-	-
June	15.0	1.35	7.95	13.60	415	140	40	9.72	-	-	-
July	16.2	1.78	8.00	11.40	310	175	40	17.01	-	-	-
August	21.1	2.05	8.10	6.85	345	180	35	22.47	-	-	-
September	20.0	2.40	7.95	6.50	375	160	38	15.79	-	-	-
October	15.4	2.27	8.00	9.86	350	165	39	16.40	9.60	0.04	-
November	15.1	2.06	8.00	10.55	320	130	39	7.89	12.15	0.00	-
December	5.2	1.37	8.15	14.65	375	125	37	7.89	13.40	0.00	-
January 1992	1.5	1.07	8.10	15.80	330	120	29	11.54	27.04	0.00	1.19
February	1.0	1.18	8.00	17.65	395	120	30	10.93	17.25	0.01	2.07
March	3.1	1.05	8.00	15.30	385	135	30	14.58	11.30	0.00	3.15
April	7.6	0.97	8.00	15.80	365	140	31	15.18	12.10	0.00	4.30
May	10.2	1.43	8.10	11.50	310	170	30	23.08	15.65	0.01	4.15
June	13.4	1.67	8.00	12.45	300	130	40	7.29	10.40	0.04	1.16
July	21.7	2.05	8.15	11.65	245	145	37	12.75	8.65	0.01	2.29
August	22.0	1.87	8.00	9.40	375	130	37	9.11	8.50	0.00	1.37
September	15.4	1.03	7.95	7.65	380	165	38	17.01	6.65	0.01	1.25
October	14.0	1.24	8.10	8.70	375	180	48	14.58	4.08	0.09	1.44
November	12.4	1.03	8.00	10.25	395	160	40	14.58	7.15	0.00	1.04
December	3.0	0.88	8.00	13.70	370	120	38	6.07	8.30	0.00	1.51

(-) indicates no analysis.

Table 2. Seasonal variations in physical and chemical parameters in the İçme region of Keban Reservoir

	Water Temp.ºC	Secchi disk d.	pH	Disol.O_2(mg/L)	Conduct. (µmhos/cm.)	Total Hardn. (mg/L)	Ca++ (mg/L)	Mg++ (mg/L)	SiO_2 (mg/L)	NO3--N (mg/L)	SO4-2 (mg/L)
January 1991	1.5	0.32	8.30	11.40	350	120	36	9.72	-	-	-
February	2.6	0.35	8.70	13.10	340	125	43	4.25	-	-	-
March	3.1	0.36	8.10	12.41	251	145	37	12.75	-	-	-
April	8.4	0.41	7.95	12.11	350	130	20	19.44	-	-	-
May	17.9	0.25	7.90	6.85	225	110	25	11.54	-	-	-
June	14.5	0.72	8.00	10.13	240	125	31	11.54	-	-	-
July	17.0	0.75	8.10	9.30	238	134	27	16.15	-	-	-
August	22.3	0.66	8.15	3.80	290	144	31	16.15	-	-	-
September	22.1	0.48	7.90	4.50	300	152	36	15.06	-	-	-
October	16.1	1.03	8.10	7.90	310	165	42	14.58	9.13	0.38	10.67
November	15.3	0.90	8.15	8.57	295	135	34	12.15	8.57	0.47	13.97
December	6.4	0.96	8.70	12.10	350	101	24	6.80	9.86	0.42	12.95
January 1992	1.0	0.87	8.10	11.35	345	117	22	15.06	9.63	0.32	11.40
February	1.0	0.98	8.80	14.60	335	120	33	9.11	7.68	0.44	10.96
March	2.8	1.20	8.30	14.00	270	135	38	9.72	6.76	0.47	10.78
April	8.7	0.75	8.20	13.70	320	140	37	11.54	9.40	0.65	11.50
May	18.5	0.80	8.00	7.65	310	105	36	3.64	15.55	0.47	14.37

June	19.7	0.87	8.10	8.10	275	120	30	10.93	26.66	0.34	15.97
July	21.6	1.00	7.95	8.60	260	120	28	12.15	9.30	0.55	9.97
August	22.3	1.70	8.00	4.85	300	135	33	12.75	6.86	0.42	10.05
September	18.4	1.96	8.00	6.20	290	140	34	13.36	11.86	0.40	12.98
October	15.3	1.97	7.95	7.60	300	170	36	19.44	9.60	0.38	11.67
November	13.5	1.78	8.00	9.65	280	140	37	11.54	7.15	0.48	10.04
December	5.0	0.97	8.80	11.70	320	170	38	18.72	9.56	0.09	9.88

Table 2. Contunied

Table 3. Diatom taxa recorded in the phytoplankton of the Keban and İçme regions of Keban Reservoir.

BACILLARIOPHYTA		
Centrales	Keban R.	İçme R.
Cyclotella comta (Ehr.) Kütz.	+	-
Cyclotella kützingiana Thwaites	+	+
Cyclotella meneghiniana Kützing	+	+
Cyclotella ocellata Pantocksek	+	+
Cyclotella stelligera Cleve et Grunow	-	+
Melosira ambigua O. Müller	+	+
Melosira distans (Ehr.) Kütz.	+	+
Melosira granulata (Ehr.) Ralfs.	-	+
Stephanodiscus astrea (Ehr.) Grun.	+	+
Stephanodiscus dubius (Fricke) Hustedt	-	+
Pennales		
Achnanthes gibberula Grun.	+	+
Achnanthes lanceolata Breb.	+	+
Achnanthes minutissima Kütz.	+	+
Amphora ovalis Kütz.	+	+
Amphora ovalis var. pediculus Kütz.	+	-
Amphora pediculus Kütz.	+	-
Amphora venata Kütz.	+	-
Asterionella formosa Hassall	+	+
Caloneis alpestris (Grunow) Cleve	-	+
Caloneis bacillum (Grun.) Mereschkowsky	+	+
Caloneis clevei (Lagst.) Cleve	-	+
Caloneis levisii Patr.	-	+
Caloneis schumanniana (Grun.) Cleve	-	+
Caloneis ventricosa (Her.) Meister	+	+
Cocconeis placentula Ehrenberg	+	-
Cymatopleura solea (de Breb.) W. Smith	+	+
Cymatopleura solea var. gracilis Grun.	+	-
Cymbella affinis Kütz.	+	+
Cymbella caespitosa (Kütz.) Grun.	+	-
Cymbella cistula (Hemrich) Grun.	+	-
Cymbella cistula var. maculata (Kütz.) V. Heu.	+	+
Cymbella cymbiformis (Agardin Kütz.) V. Heu.	+	+
Cymbella leptoceros (Her.) Grun.	+	-
Cymbella obtusiuscula (Kütz.) Grun.	+	+
Cymbella turgidula Grun.	-	+
Diatoma elongatum (Lyngb.) Agardh	+	-
Diatoma hiemala (Lyngbye) Hieberg	+	-
Diatoma vulgare Bory	+	-
Diploneis elliptica Kützing	+	-
Diploneis ovalis (Hilse) Cleve	+	-
Epithemia argus Kütz.	+	-
Epithemia sorex Kütz.	+	-
Epithemia turgida (Ehr.) Kütz.	+	-
Fragilaria crotonensis Kitton	+	+
Fragilaria rumpens (Küetz) Carl.	+	-
Gomphonema dichotomum Kütz.	+	-
Gomphonema lanceolatum Ehr.	+	-
Gomphonema olivaceum (Lyngbye) Kütz.	+	+
Gomphonema parvulum (Kütz.) Grun.	-	+
Gomphonema truncatum var. capitatum (Ehr.) Patr.	+	-
Gyrosigma attenuatum (Kütz.) Rabh.	+	-
Hantzschia amphioxys (Ehr.) Grun.	+	-
Navicula arenaria Donk.	+	-
Navicula capitata var. luneburgensis (Gr.) Pafr.	-	+
Navicula cincta (Ehr.) Kütz.	+	-
Navicula cincta var. heufleri Grunow	+	-
Navicula cryptocephala Kütz.	+	+
Navicula cryptocephala var. veneta (Kütz.) Gr.	+	+
Navicula cuspidata Kütz.	+	+
Navicula cuspidata var. heribaudi Peregallo	+	-
Navicula gracilis Ehr.	+	+
Navicula halophila (Grun.) Cleve	+	-
Navicula heufleri Grun.	-	+
Navicula pupula Kützing	+	+
Navicula radiosa Kütz.	+	-
Navicula radiosa var. tenella (Breb ex Kütz.) Gr.	+	+
Navicula rhyncocephala Kütz.	+	+
Navicula salinarum Grun.	+	-
Navicula tripunctata (O.F. Müell.) Bory.	+	+
Navicula tuscula (Ehr.) Grun.	+	-
Navicula virudula var. rostellata (Kütz.) Cleve	-	+
Neidium iridis var. amphigomphus (Ehr.) V. Heu.	+	-
Nitzschia amphibia Grun.	+	+
Nitzschia apiculata (Gregory) Grun.	-	+
Nitzschia clausii Hantzsch	+	-
Nitzschia dissipata (Kütz.) Grun.	+	-
Nitzschia gracilis Hantzsch.	+	+
Nitzschia hantschiana Rabh.	+	+
Nitzschia hungarica Grun.	+	-
Nitzschia linearis W. Smith	+	+
Nitzschia littoralis Grun.	-	+
Nitzschia navicularis (Brebisson) Grun.	-	+
Nitzschia obtusa W. Smith	-	+
Nitzschia palea (Kütz.) W. Smith	+	+
Nitzschia paleacea Grun.	-	+
Nitzschia romana Grun.	+	+
Nitzschia sigmoidea (Ehr.) W. Smith	+	+
Nitzschia stagnorum Rabh.	-	+
Nitzschia thermalis Küetzing	+	-
Nitzschia tryblionella Hantzsch	+	+
Nitzschia tryblionella var. levidensis (W. Smith) Gr.	-	+
Nitzschia umbonata (Ehr.) Lange Bertalot	+	-
Pinnularia brebissonii (Kütz.) Rabh.	-	+
Pinnularia viridis (Nitzsch.) Ehr.	-	+
Rhoicosphenia curvata (Kütz.) Grun.	+	+
Rhopalodia gibba var. ventricosa (Ehr.) Grun.	+	-
Rhopalodia gibberula (Ehr.) O. Müll.	+	+
Scolipleura peisonis Grun.	-	+

Table 3. Contunied

Stauroneis smithii Grun.	-	+
Surirella linearis W. Smith	-	+
Surirella ovata Kütz.	-	+
Surirella ovata var. pinnata W. Smith	-	+
Surirella robusta var. splendida (Ehr.) V. Heu.	-	+
Synedra ulna (Nitz.) Ehrenberg	+	+

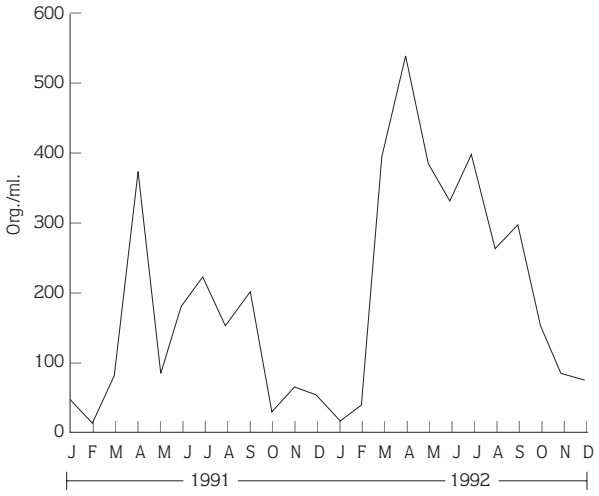

Figure 2. Seasonal variations in the total numbers of diatoms in the Phytoplankton of the Keban region.

The numbers of diatoms in the phytoplankton gradually decreased until the end of January (1992) but then started to increase again in spring. The diatoms reached their highest levels of spring in April, when their numbers reached 540 org./ml. The diatoms were quite rich in species composition during spring development and *A. formosa* (25.0%), *C. kützingiana* (23.5%), *C. ocellata* (17.96%), *F crotonensis* (16.48%), *S. astrea* (Ehr.) Grun. (10.0%), *N. linearis* W. Smith (2.4%), *N. palea* (Kütz.) W. Smith (2.4%), *N. sigmodiea* (Ehr.) W. Smith (1.3%) and *S. ovata* Kütz. (0.96%) were the major diatom taxa constituting a high proportion of the total phytoplankton. After the spring maximum levels, the numbers of diatoms started to decrease and this decrease continued until the end of the study (December, 1992).

C. ocellata, C. kützingiana and *F. crotonensis* were the most prominent diatoms with respect to the number of individuals, compared to the other diatom taxa in the phytoplankton of the Keban region of the lake.

C. ocellata was recorded each month in the phytoplankton of the Keban region, usually in significant numbers (Fig. 3). In the first year, the diatoms reached their highest levels (176 org./ml) in April. A decrease in the numbers of diatoms in June was followed by an increase in July (137 org./ml.). After the summer development, the numbers of *C. ocellata* first decreased rapidly and then started to increase, and this continued until September when it reached its highest level in the Autumn. The population of *C. ocellata* during winter (1992) remained poor. The spring maximum occurred in April, as in the previous year. A decrease in the numbers in May was followed by an increase in July when the diatoms reached their highest level (61 org./ml.) of the summer. The diatoms decreased in numbers rapidly between July and September, and slightly increased between October and November.

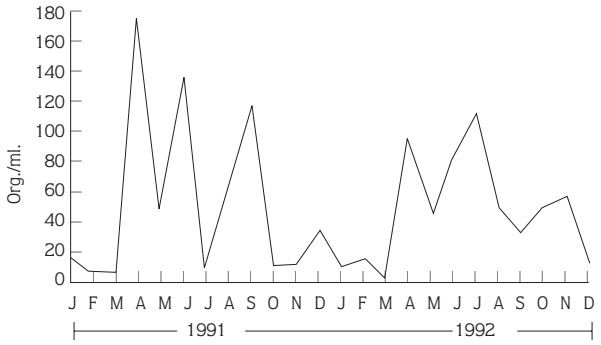

Figure 3. Seasonal changes in the numbers of *C. ocellata* in the Phytoplankton of the Keban region.

C. kützingiana was another significant constituent of the phytoplankton of the Keban region showing a regular seasonal development model. This species was insignificant in winter. The diatom started to increase in April but this increase was also insignificant. *C. kützingiana* showed better development in summer when it reached 183 org./ml. This was also the highest number recorded in the first year of the study. Although the species was present in samples between October (1991) and February (1992) its numbers were low. The number of diatoms started to increase towards the spring maximum in February and the maximum (127 org./ml.) occurred in April. The summer maximum of diatom levels occurred (179 org./ml.) in June, after which the numbers of diatoms started to decrease (Fig. 4).

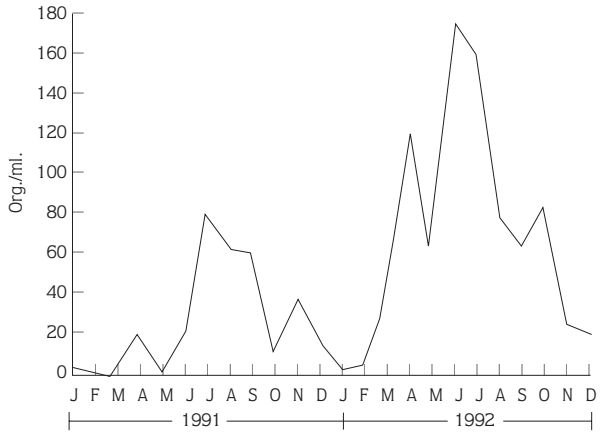

Figure 4. Seasonal changes in the numbers of *C. kützingiana* in the Phytoplankton of the Keban region.

F. crotonensis was another important constituent of the phytoplankton of the Keban region. Although This diatom was recorded almost throughout the study, only the spring development of the diatom was noticeable in the first year (Fig.5). In the second year, the diatom started to increase towards the spring maximum by the beginning of February and the maximum (97 org./ml.) occurred in May. The diatom decreased in numbers between May and August. The autumn development of the diatom continued until the maximum (139 org./ml.) occurred in September. This was also the highest number recorded for this diatom during the study. Decreasing numbers in October were followed by an increase in December.

The seasonal development models of the diatoms in the phytoplankton of the İçme region were similar in 1991 and 1992. The diatoms were quite low in number during the winter of 1991 (Fig.6) The spring maximum (501 org./ml.) occurred in April, when the proportions of individual diatom species were as follows; *C. kützingiana* (39.12 %), *C. ocellata* (25.54%), *S. astrea* (14.57%), *M. ambigua* O. Müller (12.97%) and *N. cryptocephala* (7.8%). The numbers of diatoms decreased in May and June but started to increase again in July (178 org./ml.). *C. küzingiana, C. ocellata* and *F. crotonensis* were the major diatom species during summer development, constituting 48.88%, 38.76% and 12.36% of the total summer phytoplankton, respectively. Autumn growth started in October and the maximum (302 org./ml.) occurred in the following month. At the time of the autumn maximum the proportions of the major diatoms were as follows; *C. ocellata* (28.8%), *N. cryptocephala* (22.85%) and *C. kützingiana* (17.88%).

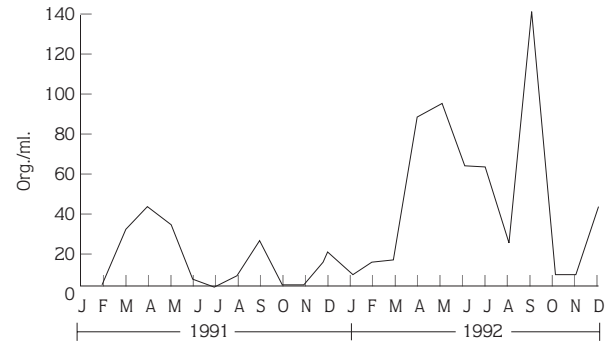

Figure 5. Seasonal changes in the numbers of *F. crotonensis* in the Phytoplankton of the Keban region.

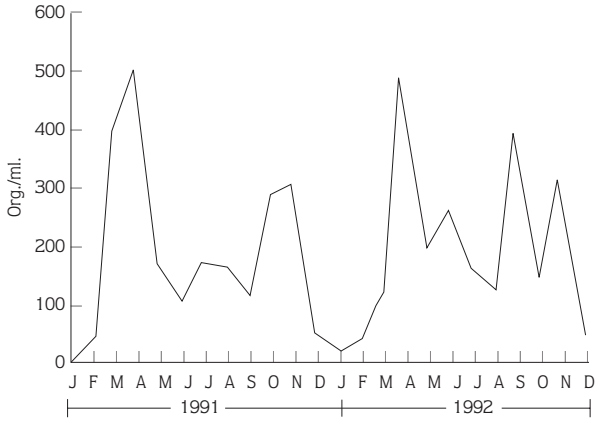

Figure 6. Seasonal variations in the total numbers of diatoms in the phytoplankton of the İçme region

The autumn growth of the diatoms was followed by a decrease which continued until January (1992). The diatoms started to increase by February and reached the spring maximum (482 org./ml.) in April. At the time of the spring maximum the proportions of diatoms were as follows; *C. ocellata* (26.14%), *C. kützigiana* (12.29%), *F. crotonensis* (15.14%), *S. astrea* (13.9%), *N. cryptocephala* (10.79%), *A. formosa* (7.05%), *C. meneghiniana* Kützing (3.53%), *N. tryblionella* Hantzsch (2.28%) and *N. gracilis* (1.88%).

The highest number of diatoms in the summer (252 org./ml.) was observed in June when *C. kützingiana* (74.21%) and *C. ocellata* (16.66%) con-

stituted the major proportion of total phytoplankton. However, the numbers of diatoms decreased in the following summer months. The diatoms reached the autumn maximum (393 org./ml.) in September (1992), when the proportions of individual species were recorded as follows; *N. cryptocephala* (59.03%), C. kützingiana (16.03%), and *C. ocellata (*7.38%), *C. ocellata, C. ocellata, C. kützingiana, F. crotonensis* and *N. cryptocephala* were the most significant diatoms in the phytoplankton of the İçme region of Keban Reservoir. *C. ocellata,* which was recorded every month, reached its spring maximum (128 org./ml.) in April (1991) (Fig. 7). The summer maximum of this diatom occurred (68 org./ml.) in July and the autumn maximum (87 org./ml.) in November. The seasonal development model of this diatom for 1992 shows similarities to that of the previous year. Although the spring maxima of both years were similar in size, the summer and autumn maxima recorded in 1992 were less significant than those recorded in 1991.

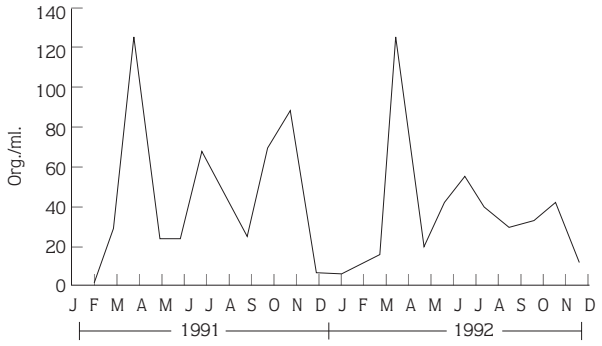

Figure 7. Seasonal changes in the numbers of *C. ocellata* in the Phytoplankton of the İçme region.

C. kützingiana was anorther important diatom with respect to frequency of occurrence and numbers of individuals in the İçme region. In the first year (1991), the spring maximum (196 org./ml.) of the diatom occurred in April (Fig. 8). A decrease in May was followed by an increase in July and the summer maximum (104 org./ml.) occurred in August (1991). Some autumn growth (69 org./ml.) was recorded in October. The spring development of the diatom in 1992 started by February and the maximum (127 org./ml.) was recorded in April. The highest number of the diatom (187 org./ml.) in the summer was observed in June.

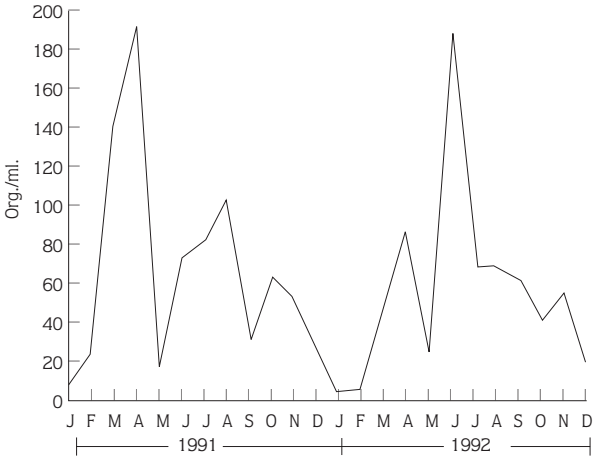

Figure 8. Seasonal changes in the numbers of *C. kützingiana* in the Phytoplankton of the İçme region.

One of the major diatoms of the phytoplankton of the İçme region was *N. cryptocephala,* whose seasonal developments were different from those of the other diatoms. In the first year two growth periods were observed one in spring (69 org./ml) and the other in autumn (Fig. 9). In the second year of the study, spring growth (42 org./ml.) occurred in April, after which the numbers of the diatom decreased until the end of summer. The diatom reached its highest number (232 org./ml.) in the phytoplankton of the İçme region during this study in September (1992).

Figure 9. Seasonal changes in the numbers of *N. cryptocephala* in the Phytoplankton of the İçme region.

Discussion

The diatoms in the phytoplankton of both the Keban and İçme regions were the most significant algae with respect to species composition and numbers of individuals. However, diatoms have often been reported as being the dominant algae in the phytoplankton of various natural Lakes (19-22) and reservoirs in Turkey (23-25).

The phytoplankton of the Keban and İçme regions showed similarities regarding the number of taxa. It has also been reported that pennate diatoms are richer in number of taxa than centric forms in many Turkish lakes (20, 21, 25). It is interesting that some diatom taxa were observed in only one of the Keban or İçme regions while some others were common in both regions of the lake. This may indicate that some diatom taxa require specific conditions while others do not. Of all the centric diatoms, *C. ocellata* and *C. kützingiana* were the most significant diatoms both with respect to frequency of occurrence and numbers of individuals in the phytoplankton of both regions, although centric diatoms were quite poor in number of taxa compared to pennate forms. *Cyclotella* spp. has also recorded as the dominant algae in the phytoplankton of various natural and artificial lakes in Turkey (20, 21, 22).

Melosira spp., like *Cyclotella* spp., were also recorded every month in Keban Reservoir. The finding in this study that centric diatoms seemed to be typical planktonic forms has also been noted in many algal studies (20, 21, 25).

Of the pennate diatoms, regarding the number of individuals only *F. crotonensis* was an important pennate member during this study. However, the numbers were lower than those of *Cyclotella* spp., although the diatom was present in most samples. This finding once again may show that major components of Bacillariophyta in the phytoplankton of Keban Reservoir are centric diatoms.

The diatoms showed their best growth in the phytoplankton of the Keban region of the lake during spring and summer months while low numbers were recorded in autumn and winter. Larger spring and smaller autumn growth has also been recorded in other Turkish Lakes (25). However, *C. ocellata* and *kützingiana* were more noticeable by their summer growth than that in spring and summer. This finding differs from studies in which the highest growth of diatoms was reported to be in spring (26, 27).

Diatoms in the phytoplankton of the İçme region showed good growth in spring, summer and autumn. However, spring. This was the period of the highest growth development model of the diatoms was different to that recorded in the phytoplankton of the Keban region.

The physical and chemical differences between the two regions of the lake could naturally have effects on the seasonal development of diatoms. Light is known to be one of the most important factors in the seasonal distribution of diatoms and this study supports this finding, since the diatoms showed their best growth in spring and summer in Keban Reservoir. There was a conspicuous relationship between the development of diatoms and water temperature in Keban Reservoir. Increasing temperatures encouraged the development of diatoms in this study. However, no relationship was observed between the development of diatoms and the pH levels of the water except that the numbers of *F. crotonensis* increased when the pH was high. Silica concentrations in the water always decreased when diatoms increased in number.

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