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Research Article

Planktonic Diatom (*Bacillariophyceae*) Flora of Sultan Sazlığı Marshes (Kayseri)

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Abstract: This paper describes the planktonic diatom flora of the Sultan Sazlığı marshes, Kayseri. Samples were collected systematically from the marshes over a period of 1.5 years from three stations. The diatom flora of Sultan Sazlığı is rich in terms of species and varieties, which are similar to those from many parts of Turkey. A total of 75 taxa of diatoms were identified. The diversity of species at freshwater stations was higher, than that of the brackish water station. Genera such as *Fragilaria* Lyngb., *Navicula*, *Gomphonema* Ehrenb., *Nitzschia* Hassall, *Epithemia* Bréb. ex Kütz. were dominant in species numbers.

Key Words: Sultan Sazlığı, Diatom, Plankton, Systematics

Sultan Sazlığı'nın (Kayseri) Planktonik Diyatom (*Bacillariophyceae*) Florası

Özet: Bu makalede Kayseri'de bulanan Sultan Sazlığının planktonik diyatom florası tanımlanmıştır. Örnekler, 1.5 yıldan fazla bir süre ile üç ayrı istasyondan sistematik olarak toplanmıştır. Sultan Sazlığının diyatom florası tür ve varyete düzeyinde zengindir ve Türkiye'nin bir çok bölgesi ile benzerlik göstermektedir. Toplam olarak 75 diyatom taksonu teşhis edilmiştir. Tatlısu istasyonlarındaki tür sayısının fazla olduğu görülmektedir. Acısu istasyonun diyatom florasının takson çeşitliliği daha küçük sayılardadır. *Fragilaria* Lyngb., *Navicula* Bory, *Gomphonema* Ehrenb., *Nitzschia* Hassall, *Epithemia* Bréb. ex Kütz. gibi bazı cinsler tür sayısı bakımından baskın olmuşlardır.

Anahtar Sözcükler: Sultan Sazlığı, Diyatom, Plankton, Sistematik

Introduction

Studies concerning the freshwater algae of Turkey are relatively recent, and those dealing with the inventory of such algae have not been completed. In recent years, studies on diatoms in Turkey have increased (Kashima et al., 1997; Şen et. al, 1994; Yıldız et al., 1994; Çetin & Şen, 1998; Yıldız & Özkıran, 1991; Akbulut & Yıldız, 2002; Şahin, 1991; Altuner & Pabuçcu, 1997; Morkoyunlu & Ertan, 1995; Yıldız, 1987; Yıldız & Özkıran, 1994; Altuner, 1988; Atıcı & Yıldız, 1996). Diatoms are the dominant group of algae in the wetlands of Turkey in terms of species diversity. Therefore, findings obtained from studies on diatoms will reflect the characteristics of the diatom flora of the area studied and provide information on the characteristics of freshwater environments. In this study, the planktonic *Bacillariophyceae* of the Sultan Sazlığı marshes are investigated.

Sultan Sazlığı is located in a 14000 ha basin between the towns of Develi, Yahyalı and Yeşilhisar towns in Kayseri province (Figure 1). Its surface area has changed greatly due to precipitation and agricultural activities over the past 20 years. The marshes lie 1170 m above sea level and their co-ordinates are 38° 20′ N-25° 17′ E. Sultan Sazlığı has two major distinct ecological habitats: freshwater and brackish water systems. The wetland has freshwater swamps on its north and south sides (salinity 1‰) and there is a moderately salty lake, Yay Lake, between the two (salinity 2-3‰). The average depths of Yay Lake and Sultan Sazlığı are 0.3 m and 1.5 m, respectively. Yay Lake, which is the biggest lake of the basin, is situated on the north side of the marsh. During the summer, as the water level of this lake gradually decreases, its salinity increases. To the north-east of Yay Lake is Kepir Sazlığı, which shows freshwater habitat characteristics. Due to agricultural activities, the water level of this area

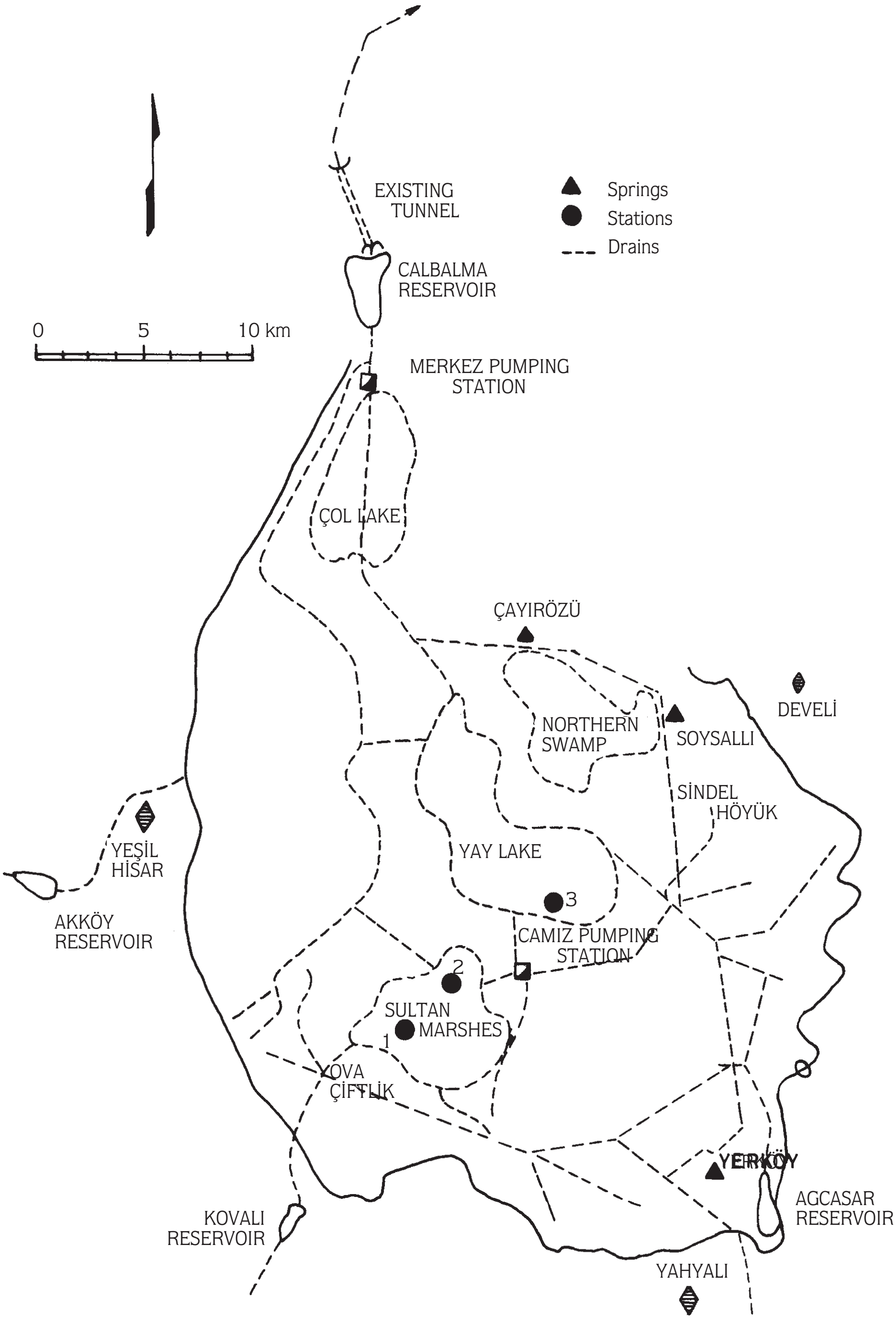

Figure 1. Study Area and Sampling Stations.

greatly decreases during summer, and sometimes it completely dries up. Çöl Lake, which is located the same basin, has salty water and its rate of salinity varies seasonally between 15 and 20‰. This lake generally remains dry for four or five months a year (Magnin and Yarar, 1997).

Sultan Sazlığı is one of the largest and most important wetland systems in Turkey. The system has some water regulation problems in terms of quality and quantity. Excess irrigation water carrying pesticides and fertilisers residnes is being channelled into the brackish and freshwater marshes.

Methods

Throughout the sampling period for all the stations the water of the lake was measured in terms of its physical features (temperature, dissolved oxygen, salinity, conductivity and pH). These parameters were measured using a portable WTW Multiline F-Set/3. Chemical parameters were determined using the methods described in the literature (APHA, 1985).

In order to investigate the planktonic *Bacillariophyceae* in Sultan Sazlığı, between August 1993 and October 1994 sampling studies were conducted every 20 days; the samples were taken from three different stations. Of these stations, two were in Sultan Sazlığı and the third one was in an area south of Yay Lake. The stations in Sultan Sazlığı were representative of the freshwater ecosystem and the other one represented the brackish water ecosystem (Figure 1).

The sampling of planktonic diatoms was carried out using a plankton net. These samples were taken from the surface water with a tow net of 20 cm mouth diameter and 55 µm nylon mesh size and then the collected samples were preserved in formalin solution (37% m/v, Merck). Diatom samples were boiled in a mixture of concentrated hydrochloric acid and nitric acid. The diatomaceous remains were then washed in distilled water until the frustules were acid-free. Permanent slides were prepared from the remains of diatoms using entellan (contains xylene, isomer mixture and alkylacrylates) for microscopic examination (Barber and Haworth, 1981). Photomicrographs were taken with Nikon Microflex photomicrographic equipment.

Results

Physical and Chemical Parameters

The pH value of the third station, which has a salty character, was very high (8.5-9.7), while the pH of the other two stations varied between 7.1 and 8.7. Dissolved oxygen concentrations appeared to vary seasonally, being greater than 5 mg/l over the winter and less than 4 mg/l over the summer . The minimum level recorded was 1.7 mg/l in June. High levels of dissolved oxygen, up to 9 mg/l, strongly correlated with a sharp increase in chlorophyll *a* levels. Sultan Sazlığı has freshwater swamps at the first and second stations (salinity between 0.5-2‰ in this study), Yay Lake (third station) has a moderately salty character (salinity between 1-14‰ in this study).

Nitrate-nitrogen had a seasonal pattern similar to that of dissolved oxygen, in the range 0.001 to 0.004 mg/l. Phosphorus values varied between 0.04 and 0.22 mg/l. Phosphorus and amonium-nitrogen concentrations were directly related to each other. Calcium, magnesium and sulphate ions were almost the same at the first and second stations (calcium 3-66.13 mg/l; magnesium 0.1-87.6 mg/l and sulphate 12.34-163.5 mg/l). At the third station, these values were higher than the other stations due to increased salinity (calcium 3.1-94.19 mg/l; magnesium 2.5-170.24 and sulphate 47.82-500 mg/l).

Systematic Account

Diatom taxa are given according to the systematic classification of Krammer & Lange-Bertalot 1986; 1988; 1991a; 1991b.

Descriptive information about each diatom collected from Sultan Sazlığı includes size range, costae and striae counts for all specimens. In addition, measurements from other related studies are given in brackets. All the measurements are given in micrometers (µm).

BACILLARIOPHYCEAE

PENNALES

Achnanthes Bory

A. brevipes C.Agardh var. intermedia Cleve (Figure 2.1)

Valve 43 µm (30-125 µm) in length and 12 µm (12-30 µm) in width, 10 (9-10) striae 10 µm (Husted, 1930 p. 210, Figure 310).

A. minutissima Kütz. (Figure 2.2-3)

Valve 18 µm and 23 µm (5-40 µm) in length and 5 µm (2-4 µm) in width, 25 (30-32) striae 10 µm (Patrick & Reimer 1966, p. 253-254, Figure 9-10).

Cocconeis Ehrenb.

C. placentula Ehrenb. var. placentula (Figure 2.4-5)

Valve 28 µm and 29 µm (11-50 µm) in length, 22 µm and 20 µm (8-30 µm) in width, 17 and 18 (17-24) striae 10 µm (Germain, 1981, p. 102, pl. 38, Figure 1-6).

Navicula Bory

N. laevissima Kütz. (Figure 2.6)

Valve 28 µm (20-70 µm) in length and 5.5 µm (6-11 µm) in width, 15 (15-20) striae 10 µm (Krammer & Lange-Bertalot, 1986, Figure 67: 6-13).

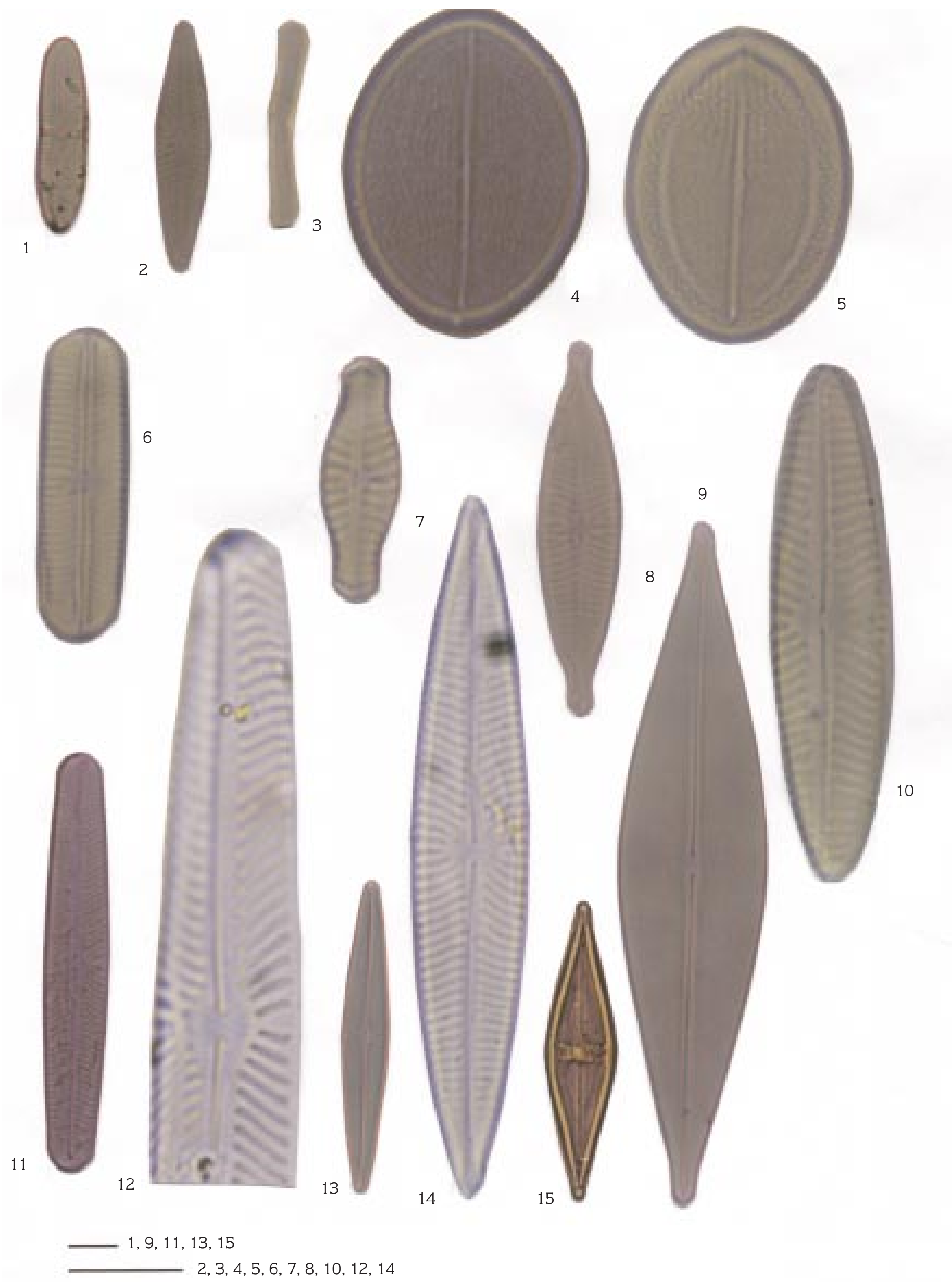

Figure 2. 1. *Achnanthes brevipes* var. *intermedia* 2.-3. *Achnanthes minutissima* 4.-5. *Cocconeis placentula* var. *placentula* 6. *Navicula laevissima* 7. *Navicula capitata* var. *hungarica* 8. *Navicula cryptocephala* 9. *Navicula cuspidata* 10. *Navicula cincta* 11.-12. *Navicula oblonga* 13.-14. *Navicula radiosa* 15. *Stauroneis nobilis* (Scales 10 μm).

N. capitata Ehrenb. var. **hungarica** (Grunow) Ross (Figure 2.7)

Valve 22 μm (30-40 μm) in length and 7 μm (6-8 μm) in width, 10 (10-13) striae 10 μm (Foged, 1982, p. 61, pl. XX, Figure 8).

N. cryptocephala Kütz. (Figure 2.8)

Valve 33 μm (20-40 μm) in length, 7 μm (5-7 μm) in width, 16 (16-18) striae 10 μm (Husted, 1930, p. 295, Figure 496).

N. cuspidata (Kütz.) Kütz. (Figure 2.9)

Valve 150 μm (50-170 μm) in length and 65 μm (17-37 μm) in width, 18 (11-19) striae 10 μm (Husted, 1930, p. 268, Figure 433).

N. cincta (Ehrenb.) Ralfs (Figure 2.10)

Valve 45 μm (10-42 μm) in length and 10 μm (4-8 μm) in width, 9 (8-17) striae 10 μm (Krammer & Lange-Bertalot, 1986, Figure 28: 8-15).

N. oblonga (Kütz.) Kütz. (Figure 2.11-12)

Valve 185 μm (70-220 μm) in length and 15 (13-24 μm) in width, 8 (6-8) striae 10 μm (Husted, 1930, p. 307, Figure 550).

N. radiosa Kütz. (Figure 2.13-14)

Valve 60 μm (40-120 μm) in length and 10.5 μm (10-19 μm) in width, 11 (10-12) striae 10 μm (Foged, 1982, p. 64, pl. XVII, Figure 1).

Stauroneis Ehrenb.

S. nobilis Schulm. (Figure 2.15)

Valve 66 μm (100-185 μm) in length and 16.2 μm (23-38 μm) in width, 12 (12-17) striae 10 μm (Krammer & Lange-Bertalot, 1986, Figure 87: 1,2).

Anomoeoneis Pfitzer

A. sphaerophora (Ehrenb.) Pfitzer (Figure 3.1)

Valve 64 μm (25-200 μm) in length and 16.5 μm (12-60 μm) in width, (13-20) striae 10 μm (Krammer & Lange-Bertalot, 1986, Figure 92: 1-5).

A. sphaerophora (Ehrenb.) Pfitzer var. **costata** (Kütz.) Schmidt (Figure 3.2-3)

Valve 90 μm in length and 22.5 μm in width (Krammer & Lange-Bertalot, 1986, Figure 92: 6).

Entomoneis Ehrenb.

E. alata (Ehrenb.) Ehrenb. (Figure 3.4)

Valve 61 μm (55-160 μm) in length and 29 μm (30-60 μm) in width, 25 (20-26) striae 10 μm (Krammer & Lange-Bertalot, 1986, Figure 203: 1-4).

Neidium Pfitzer

N. affine (Ehrenb.) Pfitzer (Figure 3.5)

Valve 72 μm (20-80 μm) in length and 19 μm (7-17 μm) in width, 25 (20-33) striae 10 μm (Krammer & Lange-Bertalot, 1986, Figure 103a: 4, 5; Figure 106: 8-10).

N. iridis (Ehrenb.) Cleve (Figure 3.6)

Valve 70 μm (37-300 μm) in length and 21 μm (15-40 μm) in width, 17 (12-18) striae 10 μm (Krammer & Lange-Bertalot, 1986, Figure 104: 1-4; Figure 105: 1).

Diploneis Ehrenb.

D. elliptica (Kütz.) Cleve (Figure 3.7)

Valve 39 (20-130 μm) in length and 21 μm (10-60 μm) in width, 12 (8-14) striae 10 μm (Krammer & Lange-Bertalot, 1986, Figure 108: 1-6).

Cymbella C.Agardh

C. affinis Kütz. (Figure 3.8)

Valve 34 μm (16-65 μm) in length and 9 μm (7-12 μm) in width, 13 (10-14) striae 10 μm (Krammer & Lange-Bertalot, 1986, Figure 125: 1-22).

C. asparea (Ehrenb.) Perag. (Figure 3.9)

Valve 165 μm (70-265 μm) in length and 45 μm (25-45 μm) in width, 8 (7-9) striae 10 μm (Krammer & Lange-Bertalot, 1986, Figure 131: 1-7; Germain, 1981, p. 280, pl. 102, Figures 1-4).

C. cistula (Ehrenb.) Kirschner (Figure 3.10)

Valve 64 μm (35-120 μm) in length and 23 μm (13-25 μm) in width, 9 (6-14) striae 10 μm (Krammer & Lange-Bertalot, 1986, Figure 127: 8-11; Germain, 1981, p. 282, pl. 103, Figures 1-11).

Amphora Ehrenb.

A. ovalis (Kütz.) Kütz. (Figure 3.11)

Valve 63 μm (20-140 μm) in length and 35 μm (17-63 μm) in width, 10 (10-13) striae 10 μm (Krammer & Lange-Bertalot, 1986, Figure 149: 1, 2; Figure 2: 7-9; Husted, 1930, p. 342, Figure 628).

A. commutata Grunow (Figure 3.12)

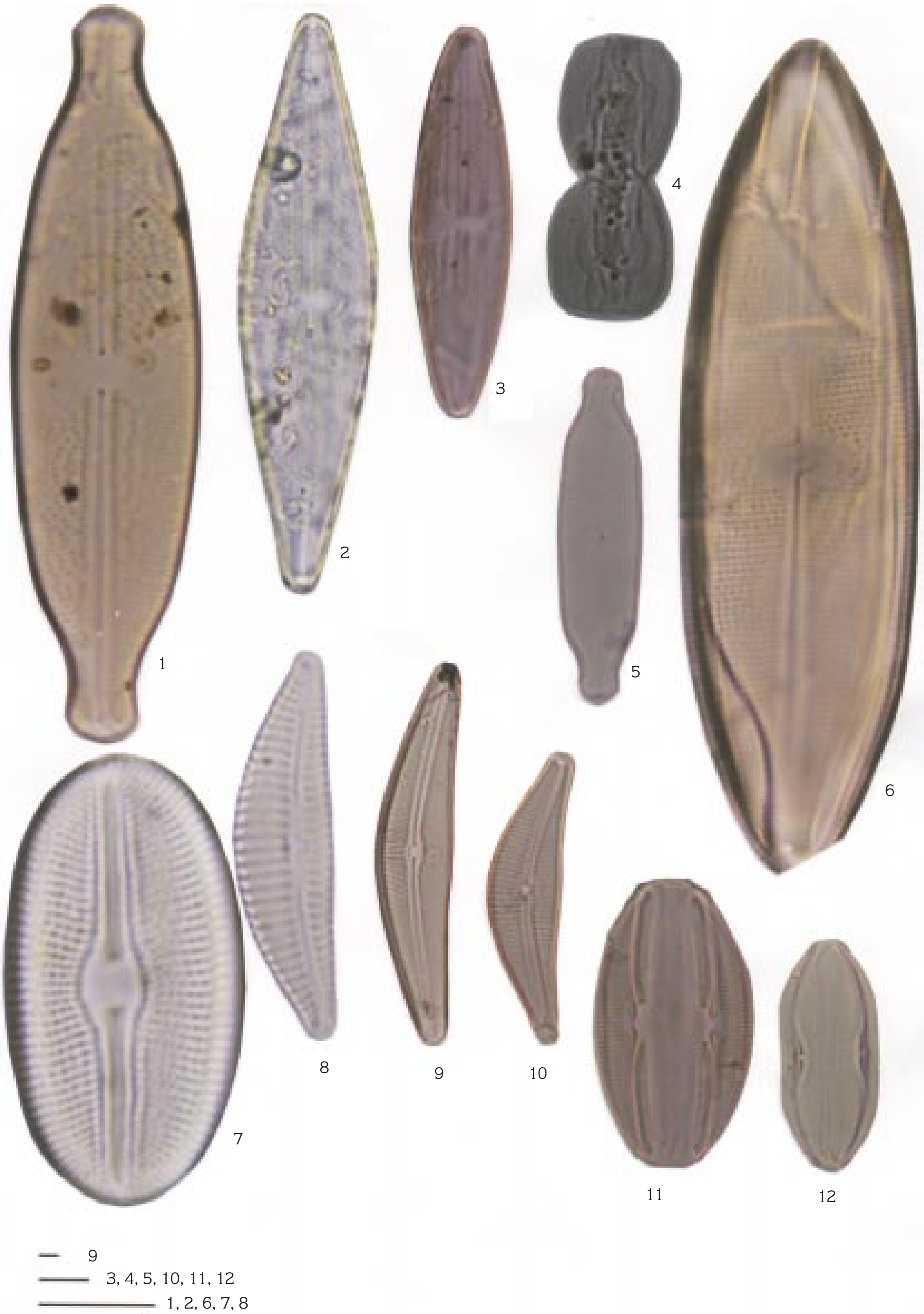

Figure 3. 1. *Anomoeneis sphaerophora* 2.-3. *Anomoeneis shaerophora* var. *costata* 4. *Entomoneis alata* 5. *Neidium affine* 6. *Neidium iridis* 7. *Diploneis elliptica* 8. *Cymbella affinis* 9. *Cymbella asparea* 10. *Cymbella cistula* 11. *Amphora ovalis* 12. *Amphora commutata* (Scales 10 µm).

Valve 50 µm (40-85 µm) in length and 15 µm (6-12 µm) in width, 11 (10-11) striae 10 µm (Krammer & Lange-Bertalot, 1986, Figure 152: 9-11; Germain, 1981, p. 296, Figures 3-4).

Gomphonema Ehrenb.

G. acuminatum Ehrenb. (Figure 4.1)

Valve 53 µm (20-120 µm) in length and 13 µm (5-17 µm) in width, 9 (8-13) striae 10 µm (Krammer & Lange-Bertalot, 1986, Figure 160: 1-13; Husted, 1930, p. 373, Figure 693).

G. gracile Ehrenb. (Figure 4.2)

Valve 44 µm (20-100 µm) in length and 10 µm (4-11 µm) in width, 13 (9-17) striae 10 µm (Krammer & Lange-Bertalot, 1986, Figure 156: 1-11; Husted, 1930, p. 376, Figure 697).

G. augur Ehrenb. var. **turris** (Ehrenb.) Lange-Bert. (Figure 4.3-4)

Valve 83 µm (35-130 µm) in length and 15 µm (12-20 µm) in width, 11 (7-11) striae 10 µm (Krammer & Lange-Bertalot, 1986, Figure 158: 1-6)

G. angustatum (Kütz.) Rabenh. (Figure 4.5)

Valve 29 µm (12-45 µm) in length and 6 µm (5-10 µm) in width, 14 (7-14) striae 10 µm (Krammer & Lange-Bertalot, 1986, Figure 155: 1-21; Husted, 1930 p. 371, Figure 693).

G. clavatum Ehrenb. (Figure 4.6)

Valve 31 µm (20-95 µm) in length and 11 µm (6-14 µm) in width, 18 (9-15) striae 10 µm (Krammer & Lange-Bertalot, 1986, Figure 163: 1-12).

G. parvalum (Kütz.) Kütz. (Figure 4.7-8)

Valve 25 µm ve 27 µm (10-36 µm) in length and 7 µm (4-8 µm) in width, 12 (7-20) striae 10 µm (Krammer & Lange-Bertalot, 1986, Figure 154: 1-25; Husted, 1930, p. 372, Figure 713a)

G. truncatum Ehrenb. (Figure 4.9-10)

Valve 23 µm ve 42 µm (13-75 µm) in length and 11 µm ve 9 µm (7-17 µm) in width, 14 ve 16 (9-12) striae 10 µm (Krammer & Lange-Bertalot, 1986, Figure 159: 11-18; Husted, 1930, p. 377, Figure 714).

Rhoicosphenia Grunow

R. abbreviata (C.Agardh) Lange-Bert. (Figure 4.11-12)

Valve 28 µm and 45 µm (12-75 µm) in length and 8 (4-8 µm) in width, (15-20) striae 10 µm (Krammer & Lange-Bertalot, 1986, Figure 91: 20-28; Husted, 1930, p. 211, Figure 311).

Caloneis Cleve

C. alpestris (Grunow) Cleve (Figure 4.13)

Valve 40 µm (45-92 µm) in length and 10 µm (6-15 µm) in width, 21 (19-24) striae 10 µm (Krammer & Lange-Bertalot, 1986, Figure 170: 3-7; Germain 1981, p. 238, pl. 86, Figure 19).

C. silicula (Ehrenb.) Cleve (Figure 4.14)

Valve 79 µm (13-120 µm) in length and 15 µm (5-20 µm) in width, 21 (15-20) striae 10 µm (Krammer & Lange-Bertalot, 1986, Figure 172: 1-13; Germain, 1981, p. 236, pl. 86, Figure 4-14).

Pinnularia Ehrenb.

P. borealis Ehrenb. (Figure 4.15)

Valve 36 µm (24-110 µm) in length and 10 µm (5-18 µm) in width, 6 (4-6) striae 10 µm (Krammer & Lange-Bertalot, 1986, Figure 177: 1-12; Figure 178: 7; Husted, 1930, p. 326, Figure 597).

P. gibba Ehrenb. (Figure 4.16)

Valve 133 µm (50-140 µm) in length and 19 µm (7-13 µm) in width, 9 (9-12) striae 10 µm (Krammer & Lange-Bertalot, 1986, Figure 189: 1-9; Figure 186: 1-3; Germain, 1981, p. 254, pl. 91, Figures 4-18).

P. microstauron (Ehrenb.) Cleve var. **brebissoni** (Kütz.) Mayer (Figure 4.17-18)

Valve 37 µm and 59 µm (20-65 µm) in length and 10 µm and 12 µm (7-11 µm) in width, 12 and 13 (10-13) striae 10 µm (Krammer & Lange-Bertalot, 1986, Figure 191: 7-9; Germain, 1981, p. 250, pl. 90, Figure 12-18).

P. viridis (Nitzsch.) Ehrenb. (Figure 4.19)

Valve 88 µm (50-170 µm) in length and 16 µm (10-30 µm) in width, 11 (6-12) striae 10 µm (Krammer & Lange-Bertalot, 1986, Figure 194: 1-4; Figure 195: 1-6; Germain, 1981, p. 260, pl. 95, Figure 1-6).

Mastogloia Thwaites

M. elliptica (C.Agardh) Cleve var. **danseii** (Thwaites) Cleve (Figure 5.1)

Valve 46 µm (20-51 µm) in length and 11 µm (11-15 µm) in width, 16 (16-18) striae 10 µm (Krammer &

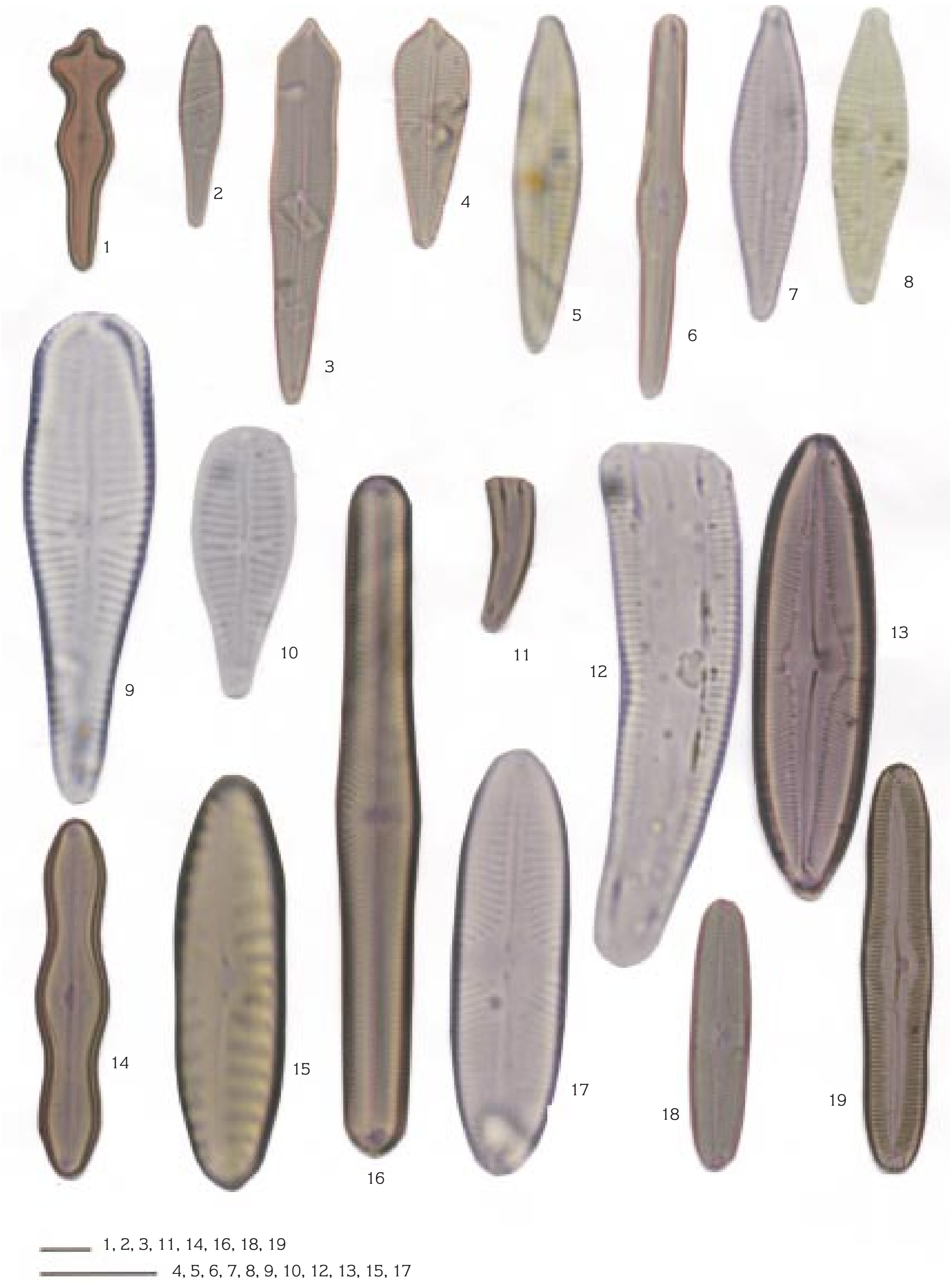

Figure 4. 1. *Gomphonema acuminatum* 2. *Gomphonema gracile* 3.-4. *Gomphonema augur* var. *turris* 5. *Gomphonema angustatum* 6. *Gomphonema clavatum* 7.-8. *Gomphonema parvalum* 9.-10. *Gomphonema truncatum* 11.-12. *Rhoicosphenia abbreviata* 13. *Caloneis alpestris* 14. *Caloneis silicula* 15. *Pinnularia borealis* 16. *Pinnularia gibba* 17.-18. *Pinnularia microstauron* var. *brebissoni* 19. *Pinnularia viridis* (Scales 10 µm).

Lange-Bertalot, 1986, Figure 202: 1-2; Patrick & Reimer, 1966, p. 300-301, pl. 20, Figure 20-23).

M. smithii Thwaites (Figure 5.2-3)

Valve 30 µm and 40 µm (25-48 µm) in length and 11 µm and 12 µm (8-13 µm) in width, 19 and 17 (15-18) striae 10 µm (Krammer & Lange-Bertalot, 1986, Figure 201: 1-9; Germain, 1981, p. 124, pl. 46, Figure 4).

Epithemia Bréb. ex Kütz.

E. adnata (Kütz.) Bréb. (Figure 5.4)

Valve 52 µm (45-60 µm) in length and 10 µm in width, 15 (14-15) striae 10 µm (Krammer & Lange-Bertalot, 1988, Figure 107: 1-11; Figure 108: 1-3; Germain, 1981, p. 316, pl. 116, Figures 11-14).

E. argus (Ehrenb.) Kütz. (Figure 5.5-6)

Valve 36 µm and 18 µm (20-130 µm) in length and 5 µm and 11 µm (4-18 µm) in width, 12 (10-12) striae 10 µm (Krammer & Lange-Bertalot, 1988, Figure 102: 1-9; Figure 103: 1-5; Germain, 1981, p. 318, pl. 117, Figure 1-6).

E. sorex Kütz. (Figure 5.7)

Valve 30 µm (8-70 µm) in length and 10 µm (6-16 µm) in width, 14 (10-15) striae 10 µm (Krammer & Lange-Bertalot, 1988, Figure 106: 1-14; Husted, 1930, p. 388, Figure 736).

E. turgida (Ehrenb.) Kütz. (Figure 5.8)

Valve 81 µm (45-200 µm) in length and 15 µm (13-35 µm) in width, 5 (3-5) costa and 9 (7-9) striae 10 µm (Krammer & Lange-Bertalot, 1988, Figure 108: 4-8; Figure 109: 1-7; Husted, 1930, p. 387, Figure 733).

E. turgida (Ehrenb.) Kütz. var. **granulata** (Ehrenb.) Brun (Figure 5.9)

Valve 81 µm (60-220 µm) in length and 9 µm (15-18 µm) in width, 13 (13-15) striae 10 µm (Krammer & Lange-Bertalot, 1988, Figure 108: 4-8; Van Heurck, 1962, p. 295, pl. 9, Figure 347).

Rhopaloida E.G.O.Müll.

R. gibba (Ehrenb.) E.G.O.Müll. (Figure 5.10-11)

Valve 149 µm and 50 µm (22-300 µm) in length and 19 µm and 21 µm (18-30 µm) in width, 8 and 8 (6-8) costae and (12-16) striae 10 µm (Krammer & Lange-Bertalot, 1988, Figure 110: 1; Figure 111: 1-13; Figure 111A: 1-7; Husted, 1930, p. 390, Figure 740).

R. operculata (C.Agardh) Håk. (Figure 5.12)

Valve 30 µm (18-52 µm) in length and 13 µm (12-26 µm) in width, 5 (3-6) costae and (16-18) striae 10 µm (Krammer & Lange-Bertalot, 1988, Figure 115: 9-12; Husted, 1930, p. 391, Figure 742).

Bacillaria Gmel.

B. paradoxa Gmel. (Figure 5.13)

Valve 69 µm (60-150 µm) in length and 6 µm (4-8 µm) in width, 4 (4-8) costae and 10 µm (20-25) striae 10 µm (Krammer & Lange-Bertalot, 1988, Figure 87: 4-12; Germain 1981, p. 326, pl. 123, Figures 1-2).

Nitzschia Hassall

N. amphibia Grunow (Figure 5.14)

Valve 21 µm (6-50 µm) in length and 5 µm (4-6 µm) in width, 8 (7-9) costae and 18 (13-18) striae 10 µm (Krammer & Lange-Bertalot, 1988, Figure 78: 13-26; Husted, 1930, p. 414, Figure 793).

N. constricta (Kütz.) Ralfs (Figure 5.15)

Valve 63 µm (20-58 µm) in length and 7 µm (4-9 µm) in width, 10 (8-11) costae and 17 (15-20) striae 10 µm (Krammer & Lange-Bertalot, 1988, Figure 35: 1-6; Germain, 1981, p. 336, pl. 127, Figure 171).

N. obtusa W.Sm. (Figure 5.16)

Valve 215 µm (120-350 µm) in length and 6 µm (7-13 µm) in width, (5-6) costae, (22-30) striae 10 µm (Krammer & Lange-Bertalot, 1988, Figure 17: 1, 2; Figure: 18: 1; Germain, 1981 p. 370, pl. 140, Figures 1-4).

N. palea (Kütz.) W.Sm. (Figure 5.17)

Valve 30 µm (15-70 µm) in length and 5 µm (2-5 µm) in width, 12 (9-17) costae and (28-40) striae 10 µm (Krammer & Lange-Bertalot, 1988, Figure 59: 1-24; Figure 60: 1-7; Germain, 1981, p. 350, pl. 132, Figures 1-11).

N. sigmoidae (Nitzsch) W.Sm. (Figure 5.18-19)

Valve 237 µm (150-500 µm) in length and 15 µm (8-15 µm) in width, 27 (21-27) striae 10 µm (Krammer & Lange-Bertalot, 1988, Figure 4: 1,2; Figure 5: 1-5; Husted, 1930, p. 419 Figure 810).

N. tryblionella Hantzsch (Figure 5.20)

Valve 98 µm (50-180 µm) in length and 19 µm (16-30 µm) in width, (5-9) costae, (30-35) striae 10 µm

Figure 5. 1. *Mastogloia elliptica* var. *danseii* 2.-3. *Mastogloia smithii* 4. *Epithemia adnata* 5.-6. *Epithemia argus* 7. *Epithemia sorex* 8. *Epithemia turgida* 9. *Epithemia turgida* var. *granulata* 10.-11. *Rhopalodia gibba* 12. *Rhopalodia operculata* 13. *Bacillaria paradoxa* 14. *Nitzschia amphibia* 15. *Nitzschia constricta* 16. *Nitzschia obtusa* 17. *Nitzschia palea* 18.-19. *Nitzschia sigmoidae* 20. *Nitzschia tryblionella* (Scales 10 mm).

(Krammer & Lange-Bertalot, 1988, Figure 27: 1-4; Germain, 1981, p. 389, pl. 125, Figures 3-5).

Hantzschia Grunow

H. amphioxys (Ehrenb.) Grunow (Figure 6.1)

Valve 41 µm (20-210 µm) in length and 8 µm (5-15 µm) in width, 7 (4-11) costae, (11-28) striae 10 µm (Krammer & Lange-Bertalot, 1988, Figure 88: 1-7; Husted, 1030, p. 394, Figure 747).

Cymatopleura W.Sm.

C. solea (Bréb.) W.Sm. (Figure 6.2)

Valve 113 µm (30-300 µm) in length and 23 µm (12-40 µm) in width, 8 (6-9) costae, (25-32) striae 10 µm (Krammer & Lange-Bertalot, 1988, Figure 116: 1-4; Figure 117: 1-5; Figure 118: 1-8; Figure 122: 4; Husted 1930, p. 426, 823a).

C. elliptica (Bréb.) W.Sm. (Figure 6.3)

Valve 93 µm (60-220 µm) in length and 53 µm (30-90 µm) in width, 5 (3-6) costae, (15-20) striae 10 µm (Krammer & Lange-Bertalot, 1988, Figure 119: 1-4; Figure 120: 1-6; Figure 121: 1-3; Figure 122: 3; Germain, 1981, p. 374, pl. 142, Figures 1-4).

Campylodiscus Ehrenb.

C. clypeus Ehrenb. (Figure 6.4)

Valve 100 µm (80-200 µm) in diameter and 20 (15-20) costae in 100 µm (Krammer & Lange-Bertalot, 1988, Figure 175: 3,4; Figure 177: 1-5; Germain 1981, p. 394, pl. 153, Figures 4-9).

Surirella Turpin

S. peisonis Pant. (Figure 6.5)

Valve 125 µm (60-120 µm) in length and 87 µm (40-70 µm) in width, 40 (34-40) striae 100 µm (Krammer & Lange-Bertalot, 1988, Figure 131: 1-3; Hustedt, 1930, p. 442, Figure 862).

Eunotia Ehrenb.

E. bilunaris (Ehrenb.) Mills (Figure 6.6)

Valve 100 µm (10-150 µm) in length and 4 µm (2-6 µm) in width, (11-28) striae 10 µm (Krammer & Lange-Bertalot, 1991a, Figure 138: 10-24; Germain, 1981, p. 94, pl., 32, Figures 7-10).

Diatoma Bory

D. tenuis C.Agardh (Figure 6.7)

Valve 58 µm (22-120 µm) in length and 4 µm (2-5 µm) in width, (6-10) striae 10 µm (Krammer & Lange-Bertalot, 1991a, Figure 96: 1-9,10; Husted, 1930, p. 127, Figure 111).

D. vulgaris Bory (Figure 6.8)

Valve 46 µm (8-75 µm) in length and 11 µm (7-18 µm) in width, (16-20) striae 10 µm (Krammer & Lange-Bertalot, 1991a, Figure 91: 2, 3; Figure 93: 1-12; Figure 94: 1-13; Figure 95: 1-7; Figure 97: 3-5; Germain, 1981, p. 52, pl. 14, Figures 1-3).

Fragilaria Lyngb.

F. capucina Demazieres (Figure 6.9)

Valve 90 µm (25-80 µm) in length and 4 µm (3-5 µm) in width, (13-15) striae 10 µm (Krammer & Lange-Bertalot, 1991a, Figure 108: 1-8; Husted, 1930, p. 141, Figure 137).

F. contruens (Ehrenb.) Grunow var. **contruens** (Figure 6.10)

Valve 15 µm (14-16 µm) in length and 10 µm (3-9 µm) in width, 14 (13-15) striae 10 µm (Krammer & Lange-Bertalot, 1991a, Figure 132: 1-5, 29; Figure 131: 5; Germain, 1981, p. 70, pl. 21, Figure 1-5).

F. contruens (Ehrenb.) Grunow var. **binodis** (Ehrenb.) Hust. (Figure 6.11)

Valve 14 µm (8-10 µm) in length and 5 µm (6-7 µm) in width, 15 striae 10 µm (Krammer & Lange-Bertalot, 1991a, Figure 132: 23-27; Sreenivasa & Duthie, 1973, p. 170, Figure 29).

F. contruens (Ehrenb.) Grunow var. **venter** (Ehrenb.) Hust. (Figure 6.12)

Valve 13 µm (5-9 µm) in length and 5 µm (3-6 µm) in width, 14 (14-16) striae 10 µm (Krammer & Lange-Bertalot, 1991a, Figure 132: 9-16, 28; Figure 131: 6; Patrick & Reimer 1966, p. 126, pl. 4, Figures 8-9).

F. pinnata Ehrenb. (Figure 6.13)

Valve 10 µm (3-35 µm) in length and 5 µm (2-8 µm) in width, 13 (5-12) striae 10 µm (Krammer & Lange-Bertalot, 1991a, Figure 112: 15, 16; Figure 117: 3; Figure 131: 3, 4; Husted, 1930, p. 142, Figure 141).

F. dilatata (Bréb.) Lange-Bert. (Figure 7.1-2)

Valve 207 µm (120-500 µm) in length and 10 µm (5-10 µm) in width, (6-11) striae 10 µm (Krammer &

Figure 6. 1. *Hantszchia amphioxys* 2. *Cymatopleura solea* 3. *Cymatopleura elliptica* 4. *Campylodiscus clypeus* 5. *Surirella peisonis* 6. *Eunotia bilunaris* 7. *Diatoma tenuis* 8. *Diatoma vulgaris* 9. *Fragilaria capucina* 10. *Fragilaria contruens* var. *contruens* 11. *Fragilaria contruens* var. *binodis* 12. *Fragilaria contruens* var. *venter* 13. *Fragilaria pinnata* (Scales 10 µm).

Lange-Bertalot, 1991a, Figure 123: 1-3; Germain, 1981 p. 74, pl. 23, Figures 1-2).

F. pulchella (Ralfs ex Kütz.) Lange-Bert. (Figure 7.3-4)

Valve 91 µm (20-200 µm) in length and, 6 µm (5-9 µm) in width, 9 (9-17) striae 10 µm (Krammer & Lange-Bertalot, 1991a, Figure 136: 1-7; Husted, 1930, p. 160, Figure 187).

F. ulna (Nitzsch) Lange-Bert. (Figure 7.5-6)

Valve 212 µm (27-600 µm) in length and 6 µm (2-9 µm) in width, 9 (7-15) striae 10 µm (Krammer & Lange-Bertalot, 1991a, Tafel 119-122; Husted, 1930, p. 151, Figure 158-159).

F. ulna (Nitzsch) Lange-Bert. var. ulna (Nitzsch) Lange-Bert. (Figure 7.7)

Valve 555 µm in length and 10 µm in width (Krammer & Lange-Bertalot, 1991a, Figure 122: 1-8)

F. ulna (Nitzsch) Lange-Bert. var. acus (Kütz.) Lange-Bert. (Figure 7.8)

Valve 330 µm in length and 8 µm in width (Krammer & Lange-Bertalot, 1991a, Figure 122: 11-13; Figure 119: 8; Germain, 1981, p. 78, Figures 1-2)

CENTRALES

Aulacoseria Thwaites

A. muzzanensis (Meister) Krammer (Figure 7.9)

Valve 28 (8-25 µm) in diameter, (11-13) striae 10 µm (Krammer & Lange-Bertalot, 1991a, Figure 20: 1-8).

A. ambigua (Grunow) Simonsen (Figure 7.10)

Valve 18 µm (4-17 µm) in diameter, (16-19) striae 10 µm (Krammer & Lange-Bertalot, 1991a, Figure 1: 5; Figure 2: 3; Figure 21: 1-16).

A. granulata (Ehrenb.) Simonsen (Figure 7.11)

Valve 6 µm (5-24 µm) in diameter, (10-15) striae 10 µm (Krammer & Lange-Bertalot, 1991a, Figure 16: 5; Figures 1, 17: 1-10; Figure 18: 1-14; Figure 19: 1-9; Husted, 1930, p. 85, Figure 41).

Cyclotella (Kütz.) Bréb.

C. meneghiniana Kütz. (Figure 7.12-14)

Valve 11 µm, 18 µm and 19 µm (5-43 µm) in diameter and 14, 11 and 10 (6-10) striae 10 µm (Krammer & Lange-Bertalot, 1991a, Figure 44: 1-10; Germain, 1981, p. 32, pl. 7, Figure 1-9).

C. ocellata Pant. (Figure 7.15-18)

Valve 10 µm, 17 µm, 9 µm and 9 µm (6-25 µm) in diameter and 18 and 16 (13-15) striae 10 µm (Krammer & Lange-Bertalot, 1991a, Figure 50: 1-11, 13, 14; Figure 51: 1-5; Germain 1981, p. 32, pl. 8, Figure 1-7).

Discussion

In this study, a total of 75 taxa from 29 genera were identified. Seventy taxa belong to the Pennales and Five taxa to the Centrales. The genera most commonly found were as follows: *Fragilaria* (10 taxa), *Navicula* (seven taxa), *Gomphonema* (seven taxa), *Nitzschia* (six taxa) and *Epithemia* (five taxa).

The diatom taxa found in Sultan Sazlığı mainly reflect the trophic state of the wetlands. Sultan Sazlığı has a eutrophic character. This was seen in the existence of the diatoms and their abundance. Many taxa regarded as indicators of eutrophic lakes were commonly found.

In Sultan Sazlığı, the species of diatoms belonging to the Pennales were dominant in terms of their richness and diversity, while there were fewer species of the Centrales. However, in Kutboğazı Dam Lake, Beytepe Pond and in Tortum Lake members of the Centrales were dominant (Aykulu & Gönülol, 1984; Ünal, 1980; Altuner, 1983). In Mogan Lake, members of the Centrales were less common, just as in Sultan Sazlığı (Akbulut & Yıldız, 2001)

Krammer & Lange-Bertalot (1991a) regard most species of *Synedra* Ehren. as a part of *Fragilaria*. They argue that these genera share common structural and ecological features, so they classified *Synedra* within *Fragilaria*.

Fragilaria ulna (Nitzsch) Lange-Bert. has been stated as *Synedra ulna* (Nitzsch) Ehrenb. in nearly all the studies conducted in Turkey. This genus was found in all of the three stations in Sultan Sazlığı. Many studies point to *F. ulna* as one of the most widely distributed taxa within *Bacillariophyceae* (Czarnecki & Blinn, 1978; Foged, 1981, 1982, 1985; Round, 1973; Hustedt, 1985). De Seve (1993) defines *F. ulna* (Nitzsch) Lange-Bert. var. *acus* (Kütz.) Lange-Bert. as an oligohalobous taxon and states that it grows at salinity levels less than 5‰. Rijtenbil et al. (1993) mentioned that *F. ulna* is found at a 5.2‰ salinity level. Miemi (1982) argued that this taxon is found under a 2‰ salinity level and cannot

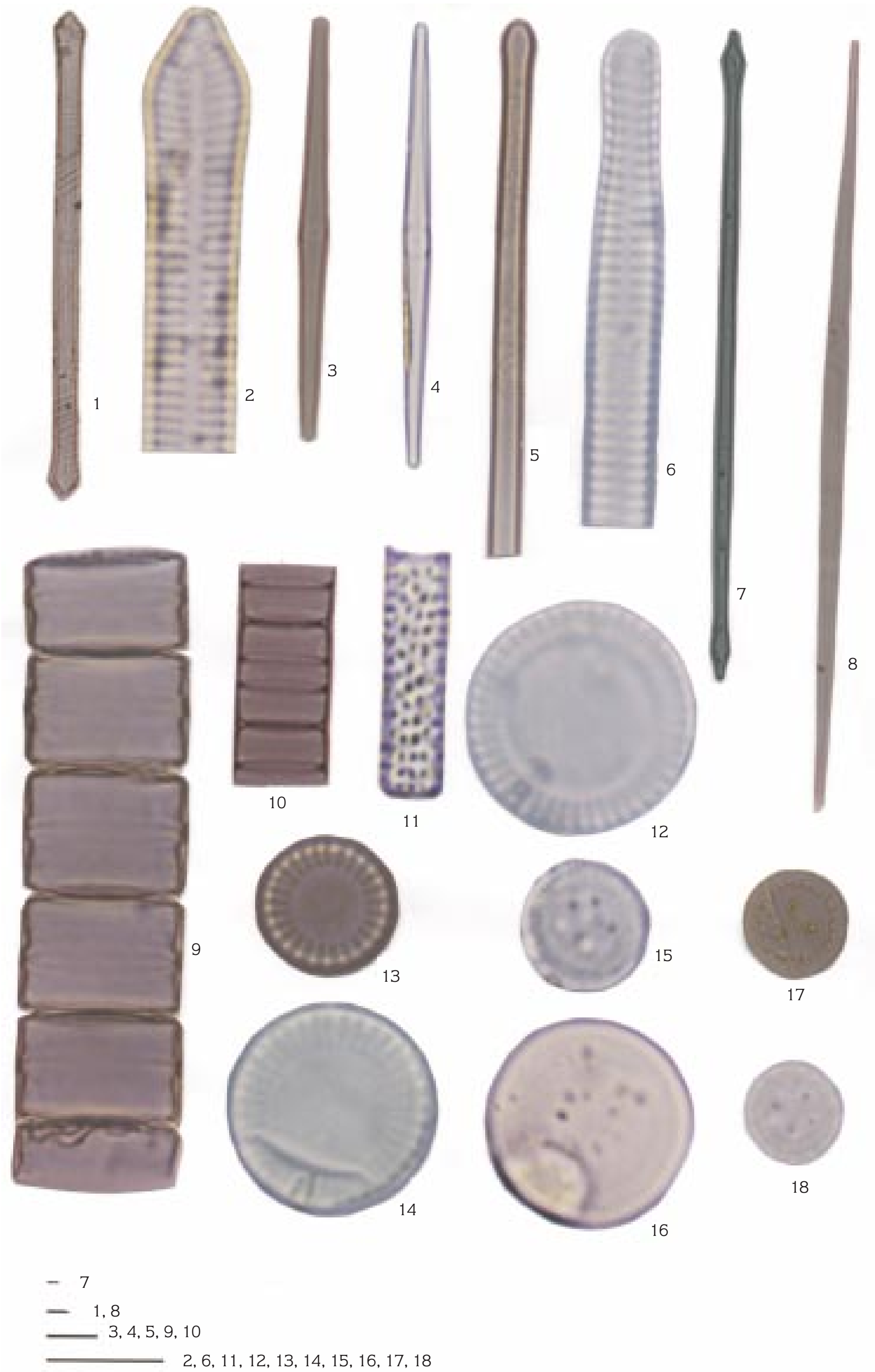

Figure 7. 1.-2. *Fragilaria dilatata* 3.-4. *Fragilaria pulchella* 5.-6. *Fragilaria ulna* 7. *Fragilaria ulna* var. *ulna* 8. *Fragilaria ulna* var. *acus* 9. *Aulacoseria muzzanensis* 10. *Aulacoseria ambigua* 11. *Aulacoseria granulata* 12.-14. *Cyclotella meneghiniana* 15.-18. *Cyclotella ocellata* (Scales 10 µm).

survive at higher levels. *F. ulna* var. *acus,* which is a variety of this genus, has been named *Synedra acus* Kütz. in nearly 22 locations in Turkey (Gönülol et al., 1996; Akbulut, 1999). The distribution of this genus is similar to that of *F. ulna* and it seems that it can be found not only in freshwater but also in brackish and saline water environments.

The seasonal change of *Bacillariophyceae* indicates that it increases during the second month of spring and the late summer period. The most abundant species among them is *F. ulna*, which is the most dominant species within the *Bacillariophyceae*. *F. ulna* is defined as a characteristic taxa of eutrophic lakes (Hutchinson, 1967; Reynolds, 1984).

Navicula is another dominant genus also seen in other wetlands of Turkey, and *Navicula radiosa* Kütz. and *Navicula cryptocephala* Kütz. are dominant in terms of quantity.

N. radiosa has been recorded in 36 wetlands (Akbulut, 1999; Gönülol et al., 1996; Kazancı et al., 1999). Although these areas have different ecological characteristics, *Navicula radiosa* has adapted to all these distinctive ecological features. Similarly, Cox (1996) states that this species is common and widely distributed. It is also known that it prefers environments with neutral pH and a medium level of electrical conductivity. Krammer & Lange-Bertalot (1985) argue that this species is mostly found in freshwater environments, but that it is oligahalobous and therefore may be seen also at higher salinity levels. In the study, *N. radiosa* was found both in freshwater and brackish water environments.

Navicula cryptocephala has a wide distribution in Turkey (Akbulut, 1999; Gönülol et al., 1996). It is seen in lakes, rivers and marshes and may be found in freshwater and brackish waters (Patrick & Reimer, 1966). It can live in waters with mild salinity (Czarnecki & Blinn, 1975). John (1993) defines this genus as alkaliphilous and it is thought to be an indicator of the eutrophic lakes (Şen et al., 1994; Round 1973).

Seven subgeneric taxa of *Gomphonema* were found in seven different taxa. Of these, two seem to be the most dominant.

Gomphonema parvalum (Kütz.) Kütz. is considered to be cosmopolitan (Foged, 1981; Krammer & Lange-Bertalot, 1986). However, there are different views regarding its appropriate living conditions. Hustedt (1985) argues that it lives in stagnant waters. Foged (1981, 1982, 1985) maintains that *G. parvalum* is an oligohalobic species. However, in this study, *G. parvalum* was found in all three study areas.

Gomphonema angustatum (Kütz.) Rabenh. has been recorded in six different places in Turkey. One of them is natural (Sapanca Lake), two are dam lakes (Bayındır and Tercan) and three are river systems (Aras, Karasu and Asi) (Temel, 1992; Gönülol, 1987; Altuner, 1994, 1998; Altuner & Gürbüz, 1991; Şen et al., 1997). Among these, Sapanca Lake has a partly eutrophic character, whereas the others have clean water features. Patrick & Reimer (1966) state that this genus is found in clean water environments. Its distribution in Turkey seems to support this assumption. However, the *G. angustatum* in this study was found at the first and second stations that have a eutrophic character. It is significant that this species was seen in highly polluted environments.

In this research, *Nitzschia* was represented by five taxa. The dominant samples of this genus are *N. sigmoidae* (Nitzsch) W.Sm., *N. tryblionella* Hantzsch and *N. constricta* (Kütz.) Ralfs.

N. sigmoidae is the most dominant species of *Nitzschia* in Turkey. In the study, it was found in all the study areas. Cox (1996) states that this species is widespread and cosmopolitan, and that it can be found in oligotrophic and eutrophic waters. He also maintains that this species may be seen in waters of mild salinity . Lowe (1974) argues that although *N. sigmoidae* is alkaliphilous, it has a wide ecological tolerance. The findings in this study regarding its distribution in the research area seem to support this view because *N. sigmoidae* was recorded in all environments such as freshwater, brackish water, saline water and in waters with high anions and cations. It was seen that this genus could occur in a variety of environments.

Hustedt (1985) states that *N. tryblionella* has a wide range of distribution and that it is mostly found in salty water environments. This species was recorded in all of our three stations.

Hustedt (1985) regards *N. constricta* as a freshwater form and states that it can be found in salty lakes. Lowe (1974) argues that this genus is common in waters with high salinity levels and that it tends to live in waters with a mesohaline character. Czarnecki & Blinn (1974) define this species as a salty and brackish water form, but it is also seen in freshwater environments. In this study, *N. constricta* was recorded in the first and second stations, which are freshwater environments, and it was also found at the third station, which has brackish water.

Epithemia was represented by five taxa in the study. *E. sorex* Kütz. and *E. argus* (Ehrenb.) Kütz. seemed to be the most dominant. *E. sorex* is the most densely distributed species of the *Epithemia* in Turkey (Gönülol et al., 1996; Akbulut, 1999). It is a cosmopolitan species and is said to be found in brackish water environments (Hustedt, 1985; Cox, 1996). It is seen in environments with high alkalinity and with mild and high electrical conductivity (Czarnecki & Blinn, 1978). Patrick & Reimer (1966) stated that this genus tends to occur at higher salinity levels. In the study *E. sorex* was found at all of the stations.

E. argus was also found at all the stations in this study. This species is seen in rivers, lakes, and ponds with mild and high electrical conductivity (Cox, 1996). *E. argus* has a wide range of distribution. The reason for its presence in all of our stations is that its ecological spectrum is very wide.

Two diatom samples found in the study area are new for Turkey: *Achnanthes brevipes* C.Agardh var. *intermedia* Cleve and *Rhopalodia operculata* (C.Agardh) Håk.

Krammer & Lange-Bertalot (1991b) state that *A. breviceps* var. *intermedia* is found in seaside areas, in eustuarine systems and in salty inland lakes. Furthermore, Vos & Wolf (1993) argue that it is a brackish water and sea organism. It was found only in the third station of our study area. This is in accordance with other observations in the literature because this station has brackish water. The taxon has never been recorded in any study previously performed in Turkey.

R. operculata is also a new record for Turkey. It was identified in the third station. This species is found in brackish waters in Central Europe (Krammer & Lange-Bertalot, 1988). Its existence at only the third station seemed to support these assumptions.

Conclusion

Taxonomical studies dealing with algae in Turkey should include photographs for better identification. If this were done, a photographical diatom flora of Turkey could be produced. In this study, a total of 75 planktonic diatom taxa were identificated and their photographs taken. These taxa are widely distributed in Turkey. However, *Achnanthes breviceps* var. *intermedia* and *Rhopalodia operculata* are new records for Turkish diatom flora.

References

Akbulut A (1999). Türkiye Tatlısu Algleri In: Demirsoy (ed.). *Genel ve Türkiye Zoocoğrafyası "Hayvan Coğrafyası"* 19: 513-637.

Akbulut A & Yıldız K (2001). Mogan Gölü Planktonik Bacillariophyta Üyeleri ve Dağılımları. *Gazi Üniv Fen Bil Enst Der* 14(4): 1081-1093.

Akbulut A & Yıldız K (2002). The Phytoplanktonic Diatoms of Çıldır Lake Ardahan. *Turk J Bot* 26: 55-75.

Altuner Z (1983). Tortum Gölü'nde Bir İstasyondan Alınan Fitoplanktonun Kalitatif ve Kantitatif Olarak İncelenmesi. *Doğa Bilim Der* 8(2): 162-182.

Altuner Z (1988). A Study of the Diatom Flora of the Aras River Turkey. *Nowa Hedwigia* 46: 255-263.

Altuner Z (1994). A Study on the Phytoplankton of the Tercan Dam Lake, Turkey. *Tr J Bot* 18: 443-450.

Altuner Z & Gürbüz H (1990). Karasu (Fırat) Nehri Epipelik Alg Florası Üzerinde Bir Araştırma. *X. Ulusal Biyoloji Kongresi Erzurum* 3: 193-203.

Altuner Z & Pabuçcu K (1997). Yeşilırmak Nehri (Tokat) Diyatom (Bacillariophyta) Florası. *XIII. Ulusal Biyoloji Kongresi* 4: 266-276.

APHA, AWNA & WPCF (1985). *Standard methods for the examination of water and wastewater.* Washington: American Public Health Association.

Atıcı T & Yıldız K (1996). Sakarya Nehri Diatomeleri. *Turk J Bot* 20: 119-134.

Aykulu G, Obalı O & Gönülol A (1983). Ankara Çevresindeki Bazı Göllerde Fitoplanktonun Yayılışı. *Doğa Bilim Der* 7: 277-287.

Barber HG, Haworth EY (1981). *A Guide to the Morphology of the Diatom Frustule*. London: Freshwater Biological Association Scientific Press.

Cox EJ (1996). *Identification of Freshwater Diatoms from Live Material*. London: Chapman and Hall.

Czernecki DB & Blinn DW (1978). *Diatoms of Colarado River*. Germany: J. Cramer.

Çetin AK & Şen B (1998). Diatoms (Bacillariophyta) in the Phytoplankton of Keban Reservoir and Their Seasonal Variations. *Turk J Bot* 22: 25-33.

De Sève MA (1993). Diatom Bloom in the Tidal Freshwater Zone of a Turbid and Shallow Eustuary, Rupert Bay (James Bay, Canada). *Hydrobiologia* 269/270: 225-233.

Foged N (1981). *Diatoms in Alaska.* Germany: J. Cramer.

Foged N (1982). *Diatoms in Bornholm, Denmark.* Germany: J. Cramer.

Foged N (1985). *Diatoms in Samos, a Greek Island in the Aegean, Diatoms in Kos and Kalymnos, Two Greek Islands in the Aegean.* Germany: J. Cramer.

Germain H (1981). *Flora Des Diatomeés, Diatomophycées.* Paris: Société Nouvelle Des Éditions Boubée.

Gönülol A (1987). Studies on the Benthic Algae of Bayındır Dam Lake. *Doğa Türk Bot Der* 11(1): 38-55.

Gönüol A, Öztürk M & Öztürk M (1996). A Check-list of the Freshwater Algae of Turkey (Türkiye Tatlısu Algleri). *Ondokuz Mayıs Üniv Fen-Ede Fak Fen Dergisi* 7(1): 8-46.

Husted F (1985). *The Pennat Diatoms a translation of HUSTEDT'S "DIE KIESELALGEN, 2. TEIL"* with supplement by Norman G. Jensen. Germany: Koeltz Scientific Books.

Hustedt F (1930). *Bacillariophyta (Diatomeae) Helf: 10 in Pacher. Die Süsswasser-Flora Mitteleuropas.* Stuttgart: Gustav Fischer Pub.

Hutchinson GE (1967). *A Treatise on Limnology, Vol II, Introduction to Lake Biology and the Limnoplankton.* New York: John Wiley Pub.

John J (1993). The Use of Diatoms in Monitoring the Development of Created Wetlands at a Sandmining Site in Western Australia. *Hydrobiologia* 269/270: 427-436.

Kashima K, Matsubana H, Kuzcuoğlu C & Karabıyıkoğlu M (1997). Diatom Assemblages from Inland Saline Lakes in the Central Part of Turkey-Their Application for Quantitative Reconstructions of Paleosalinity Changes during the Late Quaternary. *Japan Review Ano* 8: 235-249.

Kazancı N, Girgin S, Dügel M, Oğuzkurt D, Mutlu B, Dere Ş, Barlas M & Özçelik M, (1999). *Köyceğiz, Beyşehir, Eğirdir, Akşehir, Eber, Çorak, Kovada, Yarışlı, Bafa, Salda, Karataş, Çavuşcu Gölleri, Küçük ve Büyük Menderes Deltası, Güllük Sazlığı, Karamuk Bataklığı'nın Limnolojisi, Çevre Kalitesi ve Biyolojik Çeşitliliği.* Türkiye İç Suları Araştırmaları Dizisi: IV. Ankara: İmaj Yayınevi.

Krammer K & Lange-Bertalot H (1986). *Sußwasserflora von Mitteleuropa, Bacillariophyceae, Band 2/1, 1. Teil: Naviculaceae.* Stuttgart: Gustav Fischer Verlag.

Krammer K & Lange-Bertalot H (1988). *Sußwasserflora von Mitteleuropa, Bacillariophyceae, Band 2/2, 2. Teil: Bacillariaceae. Epithemiaceae, Surirellaceae*. Stuttgart: Gustav Fischer Verlag.

Krammer K & Lange-Bertalot H (1991a). *Sußwasserflora von Mitteleuropa, Bacillariophyceae, Band 2/3, 3. Teil: Centrales, Fragilariaceae*. Stuttgart: Gustav Fischer Verlag.

Krammer K & Lange-Bertalot H (1991b). *Sußwasserflora von Mitteleuropa, Bacillariophyceae, Band 2/4, 4. Teil: Achnanthaceae, Kritische Ergänzungen zu Navicula (Lineolatae) und Gomphonema Gesamtliteraturverzeichnis*. Stuttgart: Gustav Fischer Verlag.

Lowe B (1974). *Environmental Requirments and Pollution Tolerance of Freshwater Diatoms*. New York: USEPA.

Magnin G & Yarar M (1997). *Important Bird Areas in Turkey*. İstanbul: The Society for the Protection of Nature.

Niemi Å (1982). Dynamics of Phytoplankton in the Brackish-Water Inlet Pojoviken, Southern Coast of Finland. *Hydrobiologia* 86: 33-39.

Morkoyunlu A & Ertan ÖO (1995). Köprüçay Irmağı (Aksu Deresi)'nde Tespit Edilen Bazı Bacillariophyta Türleri. *S Üniv Eğirdir Su Ürünleri Fak Der* 4: 89-97.

Patrick R & Reimer CW (1966). *The Diatoms of the United States Volume1: Fragillariaceae, Eunotiaceae, Achnanthaceae, Naviculaceae.* Philadelphia: The Academy of National Science of Philadelphia.

Reynolds CS (1984). *The Ecology of Freshwater Phytoplankton.* Cambridge: Cambridge University Press.

Rijstenbil JW, Bakker C, Jackson RH, Merks AGA & de Visscher PRM (1993). Spatial and Temporal Variation in Community Composition and Photosynthetic Characteristics of Phytoplankton in the Upper Westerschelde Eustuary (Belgium, SW Netherlands). *Hydrobiologia* 269/270: 263-273.

Round FE (1973). *The Biology of the Algae.* London: Edward Arnold Pub.

Sreenivasa MR & Duthie HC (1973). Diatom Flora of the Grand River Ontario, Canada. *Hydrobiologia* 42: 161-224.

Şahin B 1(1992). Trabzon Yöresi Tatlısu Diyatom Florası Üzerinde Bir Araştırma. *Türk J Bot* 16: 104-116.

Şen B, Alp MT & Özrenk F (1997). Asi Nehri (Hatay)'nin Akdenize Döküldüğü Kesimdeki Diyatomlar (Bacillariophyta) Üzerine Bir Araştırma, *XIII. Ulusal Biyoloji Kongresi* İstanbul 5: 256-265.

Şen B, Yıldız K, Akbulut A & Atıcı T (1994). Karamuk Gölü Planktonundaki Bacillariophyta Üyeleri ve Su Kalitesinin Değerlendirilmesi. *XII. Ulusal Biyoloji Kongresi* Edirne 4: 166-172.

Temel M (1992). Sapanca Gölü Fitoplanktonu. *İ Üniv Su Ürünleri Der* 1: 25-40.

Ünal Ş (1984). Beytepe ve Alap Göletlerinde Fitoplanktonun Mevsimsel Değişimi. *Doğa Bil Der* 8(1): 121-137.

Van Heurck H (1896). *A Treatise on the Diatomaceae.* London: J. Cramer.

Vos PC & de Wolf H (1993). Diatoms as a Tool for Reconstructing Sedimentary Environments in Coastal Wetlands; Methodological Aspects. *Hydrobiologia* 269/270: 285-296.

Yıldız K (1987). Diatoms of the Porsuk River, Turkey. *Doğa Türk J Biol* 11(3): 162-182.

Yıldız K & Özkıran Ü (1991). Diatoms of Kızılırmak River. *Doğa - Tr. J. of Botany* 15: 166-188.

Yıldız K & Özkıran Ü (1994). Çubuk Çayı Diyatomları. *Tr. J. of Botany* 18: 313-329.

Yıldız K, Şen B, Atıcı T & Akbulut A (1994). Akşehir Gölü (Konya) Fitoplanktonundaki Diyatomlar. *XII. Ulusal Biyoloji Kongresi* Edirne 4: 173-179.