Turk J Bot
26 (2002) 55-75

Research Article

The Planktonic Diatoms of Lake Çıldır (Ardahan-Turkey)

Aydın AKBULUT
Hacettepe University, Faculty of Science, Department of Biology, Ankara - TURKEY

Kazım YILDIZ
Gazi University, Faculty of Education, Department of Biology, Ankara - TURKEY

Received: 21.06.2000
Accepted: 19.07.2001

Abstract: This paper describes the planktonic diatom flora of Lake Çıldır. Samples were collected monthly between May 1991 and September 1993 at three different stations. A total of 94 diatom taxa were identified. In the study period, the most dominant and abundant taxa were *Cyclotella meneghiniana* Kütz., *Aulacoseria granulata* (Ehrenb.) Simonsen, *Melosira varians* C.Agardh and *Navicula* Bory spp. The diatom flora of the lake is rich in species and varieties and is similar to that in other parts of Turkey.

Key Words: Diatom, Plankton, Lake Çıldır, Ardahan

Çıldır Gölü'nün Planktonik Diyatomeleri (Ardahan-Türkiye)

Özet: Bu çalışmada, Çıldır Gölü'nün planktonik diyatome florası tanımlanmaktadır. Örnekler, Mayıs 1991 ve Eylül 1993 tarihleri arasında aylık periyotlarla üç ayrı istasyondan toplanmıştır. Çıldır Gölü planktonik diyatome florasında 94 takson belirlenmiştir. Çalışma boyunca, *Cyclotella meneghiniana* Kütz., *Aulacoseria granulata* (Ehrenb.) Simonsen, *Melosira varians* C.Agardh ve *Navicula* Bory spp. taksonları bol ve baskın olarak bulunmuştur. Gölün diyatome florası tür çeşitliliği bakımından zengindir ve Türkiye'nin diğer bölgelerindeki çalışmalara benzerlik göstermektedir.

Anahtar Sözcükler: Diyatome, Plankton, Çıldır Gölü, Ardahan

Introduction

Lake Çıldır is located between the cities of Kars and Ardahan, which are in the northern part of East Anatolia (41° 00' north latitude and 43° 12' longitude). Lake Çıldır is a lava-set lake. This lake has an area of 124 km2 and maximum depth is more than 17 metres. Its altitute is 1959 m. The lake is narrow in the south and outflows from this join the Arpaçay River.

Diatoms are important components of most aquatic ecosystems and have been studied in some regions of Turkey. There are not enough studies on planktonic diatoms in Turkey. The studies about the algae in Turkey are generally not satisfactory and most of the studies deal with epiphytic, epilithic and epipelic diatoms in streams or lakes. The purpose of this paper is to describe the diatoms of Lake Çıldır, and is a contribution to the knowledge of the planktonic diatoms of Turkish lakes.

Sampling and Methods

To identify the chemical parameters and diatoms of the lake, water samples were taken monthly from three stations between May 1991 and September 1993 (Fig. 1). Physical parameters were measured and most chemical parameters were determined using methods described in Standard Methods For the Examination of Water and Wastewater (APHA, 1985).

Sampling of planktonic diatoms was carried out by 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%). Diatom samples were boiled in a mixture of concentrated hydrochloric acid and nitric acid. The diatomaceous remains were then washed in distilled water until acid free from frustules. Eventually slides were prepared from the remains of diatoms using entellan for microscopic

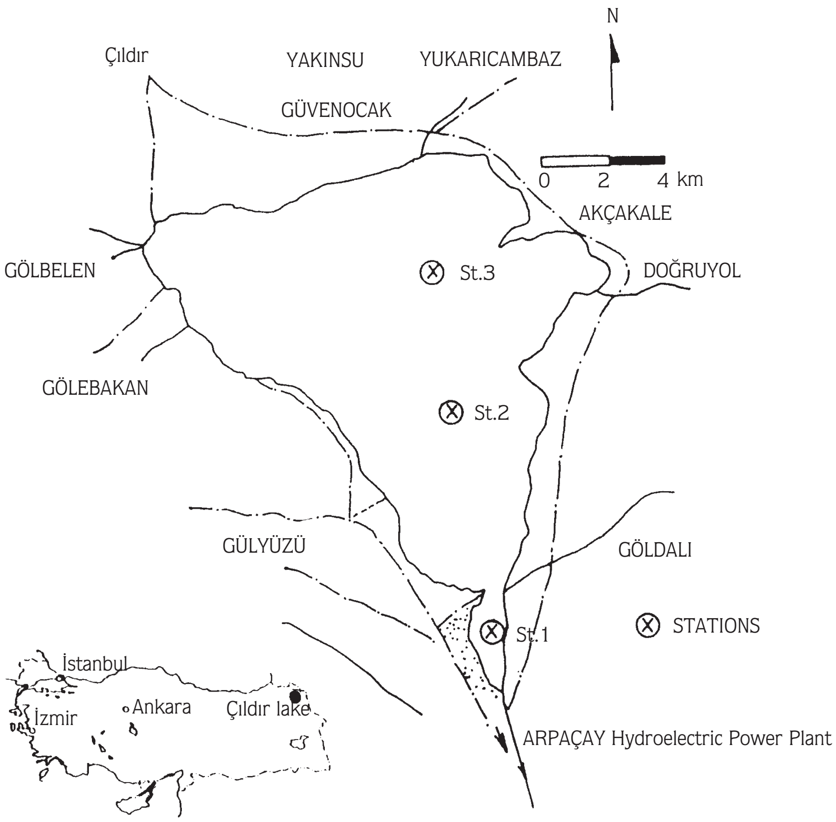

Figure 1. Study area and stanitons.

examination (Barber and Haworth, 1981). Photomicrographs were taken with Nikon Microflex photomicrographic equipment.

Results

Physical and Chemical Parameters

There is no wastewater loading or signs of eutrophication in the lake. According to physical and chemical parameters, the lake is oligotrophic. The physico-chemical features are as follows: Secchi depth 170-180 cm, conductivity 120-150 µS, pH 7.10-8.30, dissolved oxygen 8.4-13.4 mg/l, total P $_3$-10 mg/m^3 and total inorganic N 150-280 mg/m^3. These parameters were found to be similar at all sampling stations.

Systematic Account

In the following list of diatom taxa, the systematic classification of Round (1984) has been followed as far as possible.

The list is based on taxonomic criteria. The references cited for each species were the specific works used for identification of the species.

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

Melosira C.Agardh

M. varians C.Agardh (Figure 2.1)

(Hustedt (1930), p. 85, fig. 41), (Foged (1982), p. 104, pl. I, fig. 12), (Hadi et al., (1984), p. 544, pl. 8, fig. 131).

Valve 18 µm (8-35 µm) in diameter and 25 µm (9-23 µm) in length.

Aulacoseira Thwaites

A. granulata (Ehrenb.) Simonsen (Figure 2.2)

(Germain (1981), p. 24, pl. 3, fig. 1-6), (Foged (1982), p. 104, pl. I, fig. 15).

Valve 8 µm (7-21 µm) in diameter and 12 µm (5-20 µm) in length.

A. ambigua (Grunow) Simonsen (Figure 2.3)

(Germain (1981), p. 26, pl. 4, fig. 4,6,7), (Foged (1981), p. 190, pl. I, fig. 12).

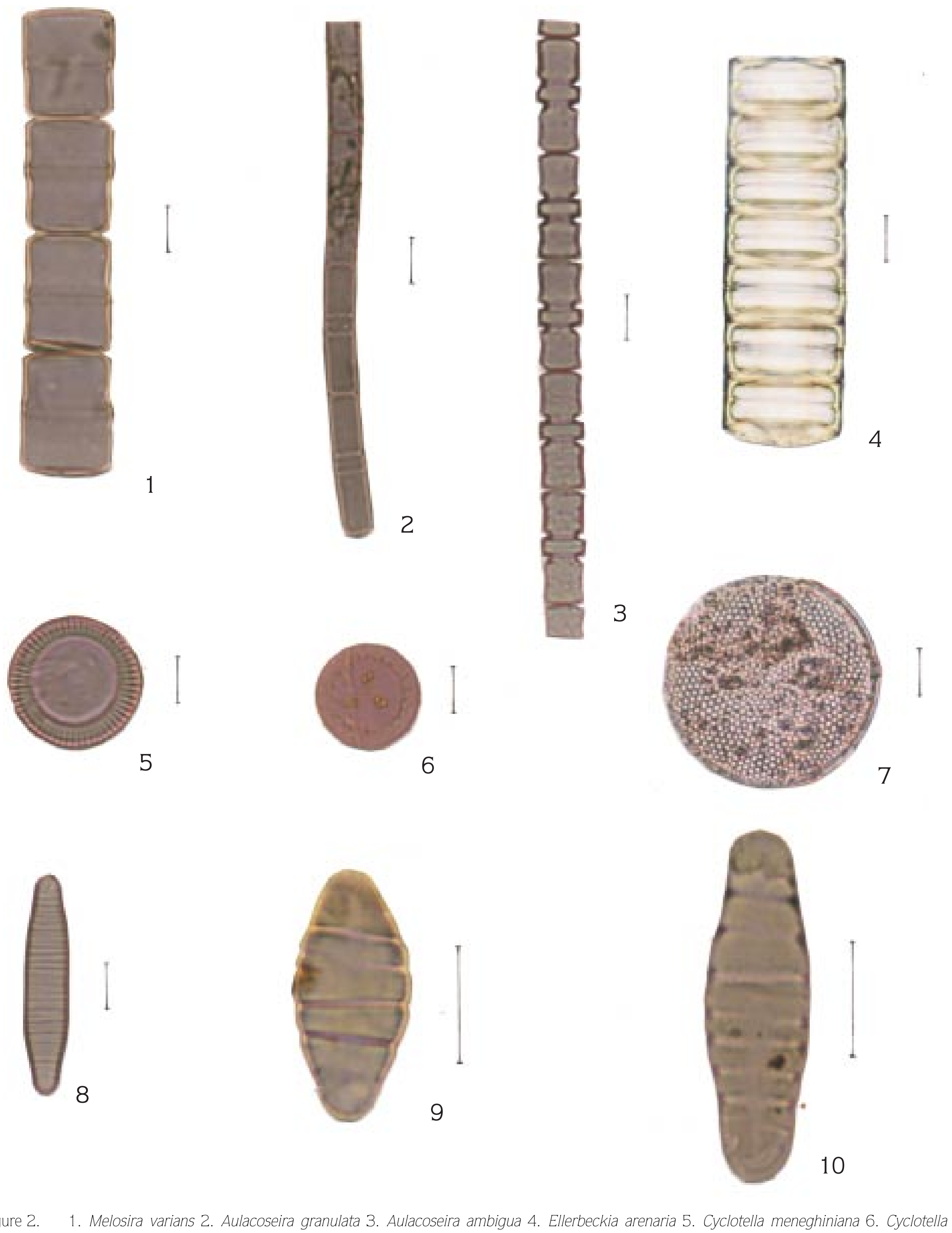

Figure 2. 1. *Melosira varians* 2. *Aulacoseira granulata* 3. *Aulacoseira ambigua* 4. *Ellerbeckia arenaria* 5. *Cyclotella meneghiniana* 6. *Cyclotella ocellata* 7. *Coscinodiscus* sp. 8. *Diatoma vulgare* 9. *Diatoma hiemale* var. *mesodon* 10. *Diatoma hiemale* (Scales 10 µm).

Valve 10 µm (4-15 µm) in diameter.

Ellerbeckia Crawford

E. arenaria (Moore) Crawford (Figure 2.4)

(Germain (1981), p. 28, pl. 5, fig. 1-3).

Valve 25 µm (20-140 µm) in diameter.

Cyclotella Kütz.

C. meneghiniana Kütz. (Figure 2.5)

(Germain (1981), p. 32, pl. 7, fig. 1-9), (Hustedt (1930), p. 99, fig. 67).

Valve 30 µm (8-30 µm) in diameter, 8 (8-9) striae in 10 µm.

C. ocellata Pantocsek (Figure 2.6)

(Germain (1981), p. 34, pl. 8, fig. 8-13), (Hustedt (1930), p. 101, fig. 68).

Valve 23 µm (6-20 µm) in diameter.

Coscinodiscus Ehrenb.

Coscinodiscus sp. (Figure 2.7)

Valve 47 µm in diameter.

Diatoma DC.

D. vulgare Bory (Figure 2.8)

(Hustedt (1930), p. 127, fig. 103), (Sreenivasa and Duthie (1973), p. 168, fig. 2-3).

Valve 50 µm (35-55 µm) in length and 10 µm (10-12 µm) in width, 7 (6-7) costae in 10 µm.

D. hiemale Heiberg (Figure 2.10)

(Foged (1981), p. 194, pl. III, fig. 12), (Sreenivasa and Duthie (1973), p. 168, fig. 21).

Valve 30 µm (30-43 µm) in length and 9 µm (9-11 µm) in width.

var. **mesodon** (Ehrenb.) Grunow (Figure 2.9)

(Patrick and Reimer (1966), Vol. 1, p. 108, pl. 2, fig. 8), (Foged (1981), p. 194, pl. III, fig. 13).

Valve 22 µm (15-22 µm) in length and 10-14 µm in width.

Opephora Petit

O. martyii Hérib. (Figure 3.1)

(Germain (1981), p. 58, pl. 17, fig. 1, 2), (Foged (1982), pl. II, fig. 19).

Valve 18 µm (5-60 µm) ind width, 9 (6-18) striae in 10 µm.

Meridion C.Agardh

M. circulare (Grev.) C.Agardh. (Figure 3.2)

(Hustedt (1930), p. 130, fig. 118).

Valve 31 µm (16-45 µm) in length and 5 µm (5-9 µm) in width.

Ceratoneis Ehrenb.

C. arcus Kütz. (Figure 3.3)

(Hustedt (1930), p. 134, fig. 122), (Foged (1981), p. 60, pl. V, fig. 16-17).

Valve 45 µm (50-150 µm) in length and 10 µm (5-8 µm) in width, 15 (15-18) striae in 10 µm.

Fragilaria Lyngb.

F. capucina Desm. (Figure 3.4)

(Germain (1981), p. 64, pl. 19, fig. 1-19), (Foged (1982), p. 110, pl. IV, fig. 10, 11).

Valve 78 µm (25-80 µm) in length and 4 µm (3-5 µm) in width, 13 (13-15) striae in 10 µm.

F. intermedia Grunow var. **littoralis** Grunow (Figure 3.5)

(Germain (1981), p. 68, pl. 20, fig. 11-12).

Valve 60 µm (15-63 µm) in length and 4 µm (2.5-4 µm) in width, 11-12 striae in 10 µm.

F. construens (Ehrenb.) Grunow

var. **binodis** (Ehrenb.) Grunow (Figure 3.6)

(Hustedt (1930), p. 141, fig. 137), (Germain (1981), p. 66, pl. 21, fig. 26-32).

Valve 14 µm (8-15 µm) in length and 5 µm (6-7 µm) in width.

var. **triundulata** Reichelt (Figure 3.7)

(Hustedt (1930), p. 141, fig. 136).

Valve 330 µm (30-50 µm) in length and 6µm (6 µm) in width.

F. pinnata Ehrenb. (Figure 3.8-9)

(Germain (1981), p. 72, pl. 21, fig. 44-52).

Valve 6 µm (3-30 µm) in length and 4.5 µm (2-6 µm) in width, 10 (10-12) striae in 10 µm.

Synedra Ehrenb.

S. capitata Ehrenb. (Figure 3.10)

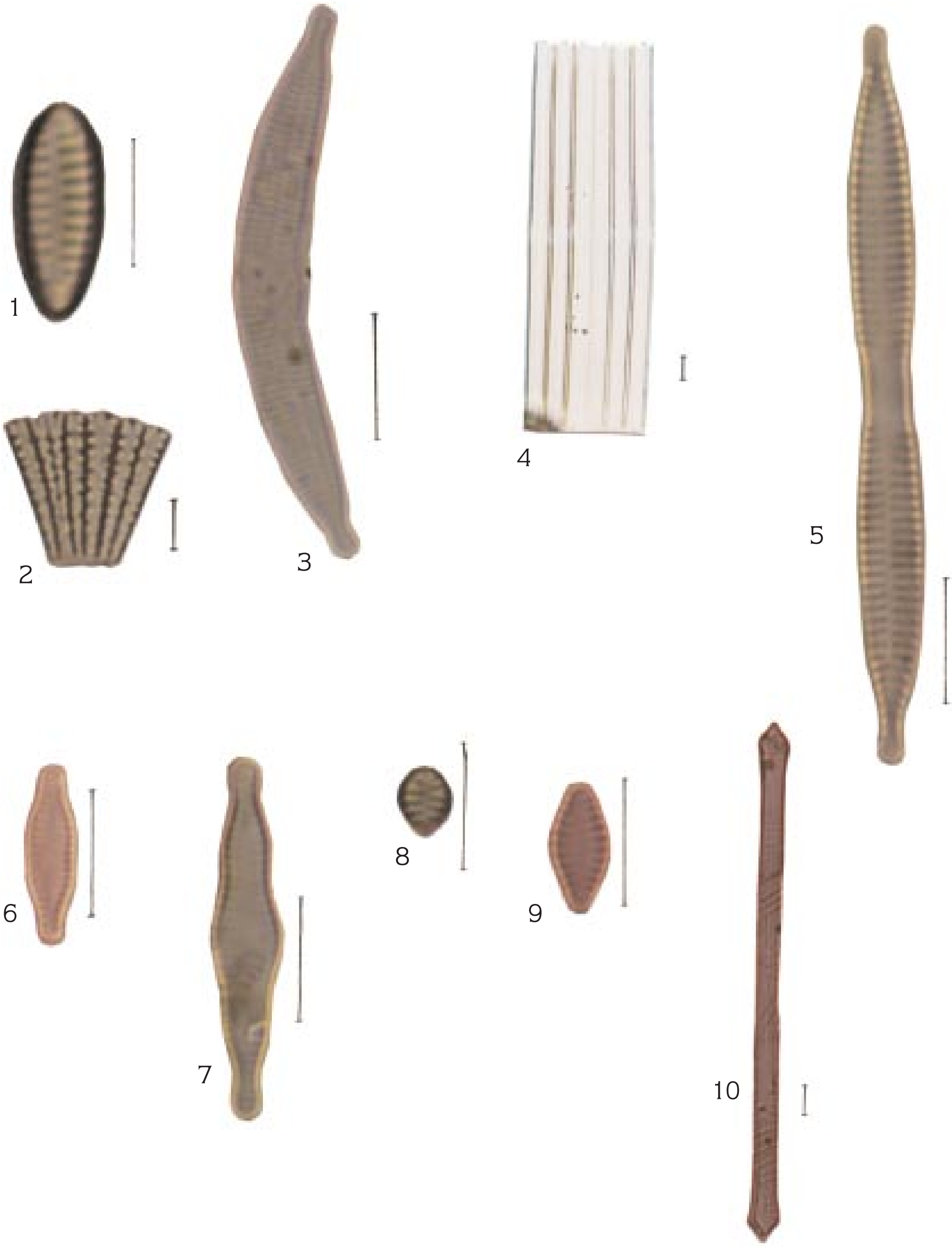

Figure 3. 1. *Opephora martyii* 2. *Meridion circulare* 3. *Ceratoneis arcus* 4. *Fragilaria capucina* 5. *Fragilaria intermedia* var. *littoralis* 6. *Fragilaria contruens* var. *binodis* 7. *Fragilaria contruens* var. *triundulata* 8-9. *Fragilaria pinnata* 10. *Synedra capitata* (Scales 10 µm).

(Hustedt (1930), p. 155, fig. 169), (Germain (1981), p. 74, pl. 23, fig. 1-2).

Valve 210 µm (100-300 µm) in length and 10 µm (7-8 µm) in width, 9 (8-11) striae in 10 µm.

S. ulna (Nitzsch) Ehrenb. (Figure 4.1)

(Hustedt (1930), p. 151, fig. 158-159), (Van-Heurck (1896), pl. 10, fig. 409).

Valve 300 µm (50-350 µm) in length and 6 µm (5-9 µm) in width, 10 (5-9) striae in 10 µm.

S. ulna var. spathulifera Grunow (Figure 4.2)

(Huber-Pestalozzi (1942), p. 459, fig. 543).

Valve 220 µm in length and 7.5 µm in width.

S. vaucheriae Kütz. (Figure 4.3)

(Hustedt (1930), p. 161, fig. 192), (Germain (1981), p. 80, pl. 28, fig. 1-21).

Valve 19 µm (7-40 µm) in length and 4 µm (4-5 µm) in width, 17 (12-16) striae in 10 µm.

S. rumpens Kütz. (Figure 4.4)

(Hustedt (1930), p. 156, fig. 175)

Valve 62 µm (27-70 µm) in length and 3 µm (2-3 µm) in width,, 18 (19-20) striae in 10 µm.

S. parasitica (W.Smith) (Figure 4.5)

(Hustedt (1930), p. 161, fig. 195), (Germain (1981), p. 82, pl. 28, fig. 22-30).

Valve 15 µm (10-30 µm) in length and 5 µm (3-5 µm) in width, 16 (16-19) striae in 10 µm.

Cocconeis Ehrenb.

C. scutellum Ehrenb. (Figure 4.6)

(Hustedt (1930), p. 191, fig. 267), (Foged (1982), p. 118, pl. VIII, fig. 4).

Valve 20 µm (20-60 µm) in length and 14 µm (12-40 µm) in width, 9 (10-12) striae in 10 µm.

C. placentula Ehrenb. (Figure 4.7)

(Hustedt (1930), p. 191, fig. 267), (Foged (1982), p. 118, pl. VIII, fig. 10).

Valve 20 µm (20-60 µm) in length and 13 µm (12-40 µm) in width, 10 (10-12) striae in 10 µm.

Rhoicosphenia Grunow

R. curvata (Kütz.) Grunow (Figure 4.8)

(Hustedt (1930), p. 211, fig. 311), (Foged (1982), p. 120, pl. IX, fig. 25-31).

Valve 34 µm (12-75 µm) in length and 8 µm (5-8 µm) in width, 14 striae in 10 µm.

Mastogloia Thwaites

M. recta Hustedt (Figure 4.9)

(Germain (1981), p. 124, pl. 45, fig. 8-11).

Valve 42 µm (22-50 µm) in length and 11 µm (6-9 µm) in width, 15 striae in 10 µm.

Gyrosigma Hassal

G. attenuatum (Kütz.) Rabenh. (Figure 4.10)

(Germain (1981), p. 132, pl. 49, fig. 1).

Valve 220 µm (150-200 µm) in length and 13 µm (18-25 µm) in width, 10 (10-12) striae in 10 µm.

Diploneis Ehrenb.

D. ovalis Kütz. (Figure 4.11)

(Hustedt (1930), p. 249, fig. 390), (Germain (1981), p. 148, pl. 55, fig. 1-8).

Valve 25 µm (10-50 µm) in length and 13 µm (7-20 µm) in width, 16 (11-14) striae in 10 µm.

Neidium Pfitzer

N. affine (Ehrenb.) Pfitzer var. amphirhynchus (Ehrenb.) Cleve (Figure 5.2)

(Hustedt (1930), p. 243, fig. 377), (Germain (1981), p. 148, pl. 57, fig. 1-4), (Foged (1982), p. 124, pl. XI, fig. 9).

Valve 83 µm in length and 17.5 µm in width.

N. iridis (Ehrenb.) Cleve (Figure 5.1)

(Hustedt (1930), p. 245, fig. 379), (Germain (1981), p. 148, pl. 57, fig. 1-4).

Valve 75 µm (45-200 µm) in length and 21 µm (13-30 µm) in width, 17 (16-18) striae in 10 µm.

Stauroneis Ehrenb.

S. acuta W.Smith (Figure 5.3)

(Hustedt (1930), p. 259, fig. 415), (Germain (1981), p. 158, pl. 60, fig. 20-22), (Foged (1982), p. 130, pl. XIV, fig. 1).

Valve 140 µm (80-100 µm) in length and 25 µm (15-40 µm) in width, 13 (12-15) striae in 10 µm.

S. phoenicenteron Ehrenb. (Figure 5.4)

(Hustedt (1930), p. 255, fig. 404), (Germain (1981), p. 156, fig. 1-6).

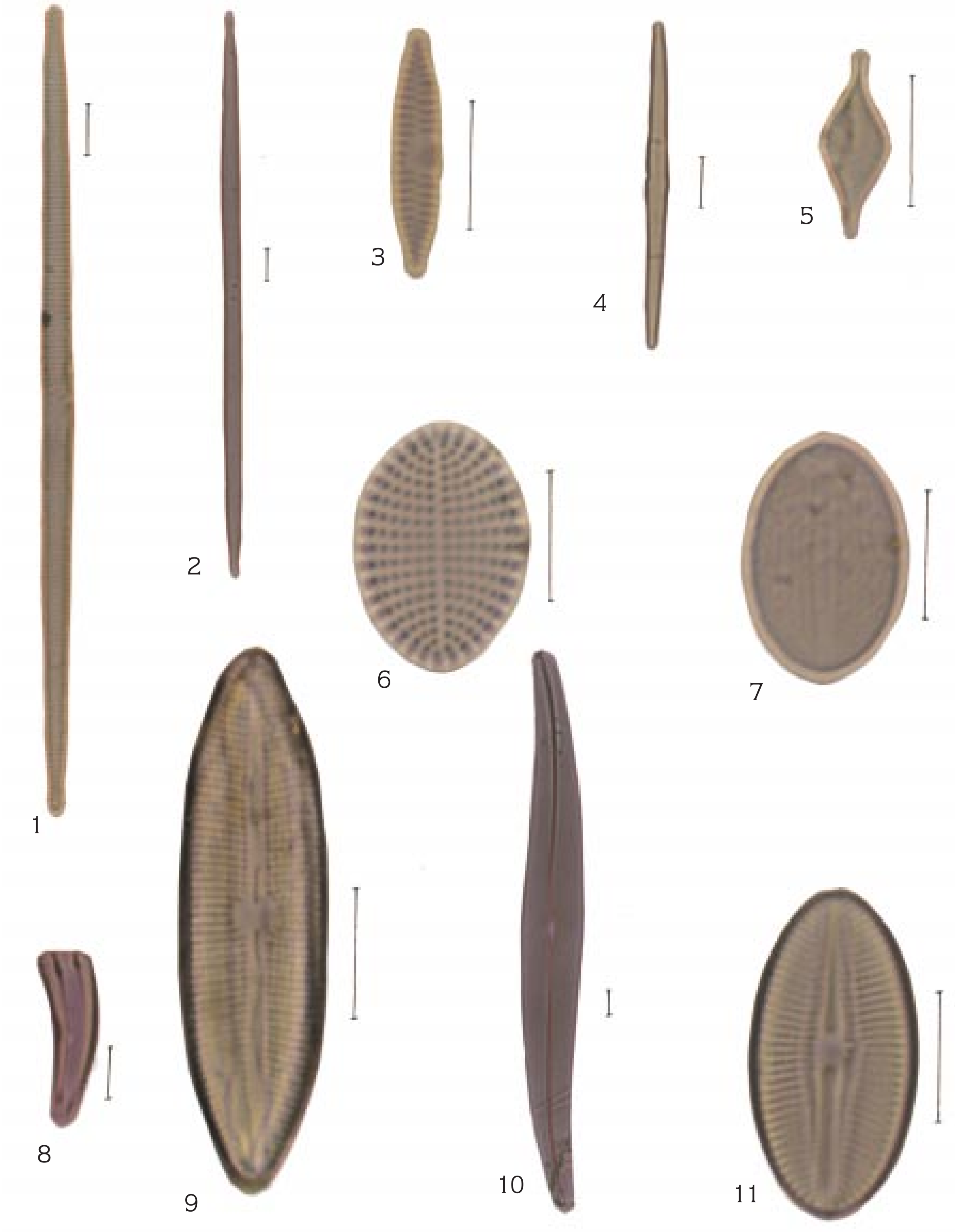

Figure 4. 1. *Synedra ulna* 2. *Synedra ulna* var. *spathulifera* 3. *Synedra vaucheriae* 4. *Synedra rumpens* 5. *Synedra parasitica* 6. *Cocconeis scutellum* 7. *Cocconeis placentula* 8. *Rhoicosphenia curvata* 9. *Mastogloia recta* 10. *Gyrosigma attenuatum* 11. *Diploneis ovalis* (Scales 10 µm).

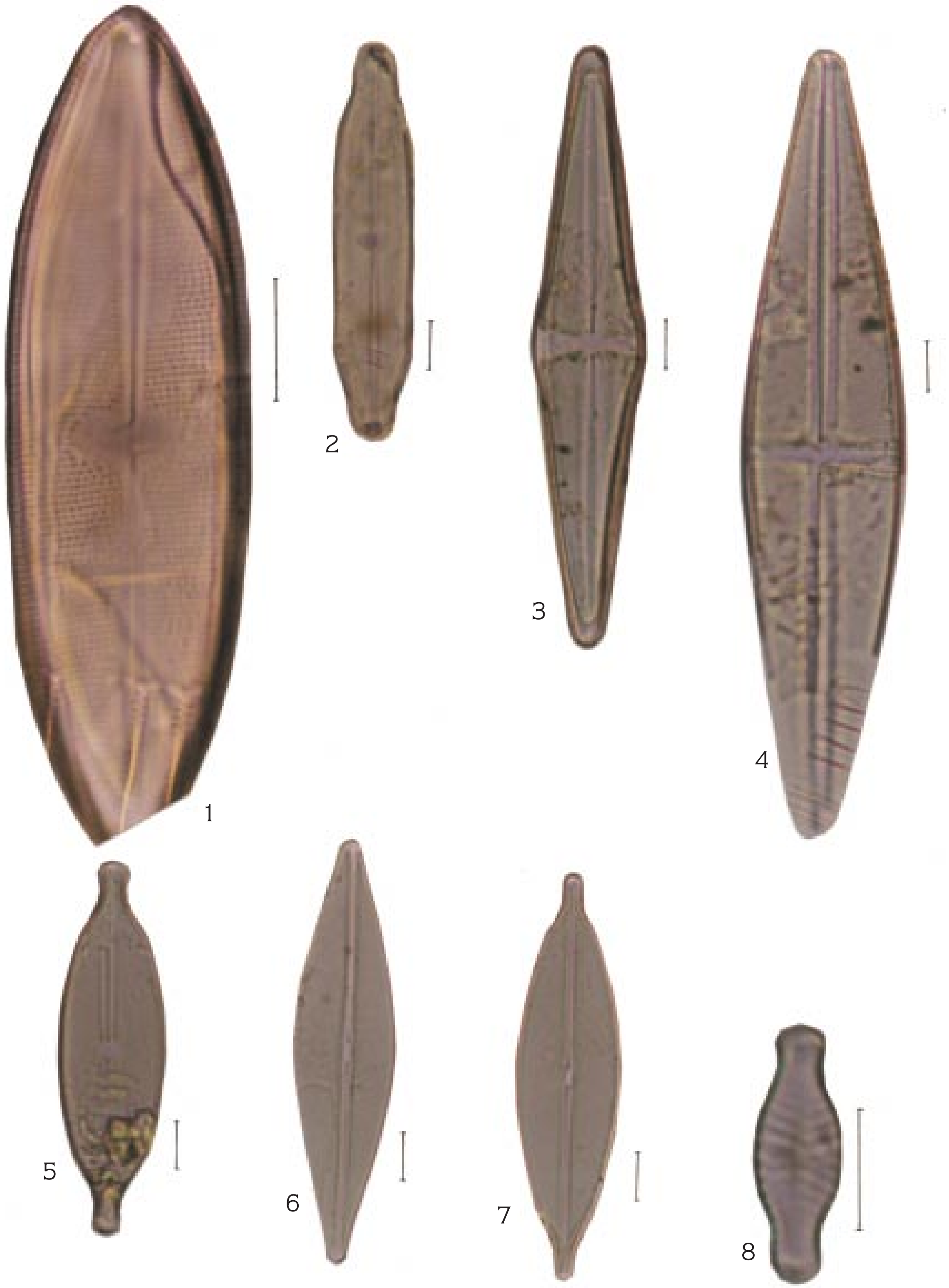

Figure 5. 1. *Neidium iridis* 2. *Neidium affine* var. *amphirhynchus* 3. *Stauroneis acuta* 4. *Stauroneis phoenicenteron* 5. *Anomoeoneis sphaerophora* 6. *Navicula cuspidata* 7. *Navicula cuspidata* var. *ambigua* 8. *Navicula hungarica* var. *capitata* (Scales 10 µm).

Valve 165 µm length , 34 µm width, 12-16 striae in 10 µm.

Anomoeoneis Pfitzer

A. sphaerophora (Ehrenb.) Pfitzer (Figure 5.5)

(Hustedt (1930), p. 262, fig. 422), (Foged (1982), p. 132, pl. XV, fig. 1).

Valve 78 µm (40-80 µm) in length and 22 µm (20-25 µm) in width, 15 (15-17) striae in 10 µm.

Navicula Bory

N. cuspidata Kütz. (Figure 5.6)

(Hustedt (1930), p. 268, fig. 433), (Sreenivasa and Duthie (1973), p. 191, fig. 113), (Foged (1982), p. 132, pl. XV, fig. 1).

Valve 88 µm (117-150 µm) in length and 21 µm (26-29 µm) in width, 9 (11-19) striae in 10 µm.

var. **ambigua** (Ehrenb.) Cleve (Figure 5.7)

(Hustedt (1930), p. 268, fig. 434), (Germain (1981), p. 168, pl. 63, fig. 2).

Valve 72 µm (30-70 µm) in length and 22 µm (12-18 µm) in width, 17 (18-19) striae in 10 µm.

N. hungarica Grunow var. **capitata** (Ehrenb.) Cleve (Figure 5.8)

(Hustedt (1930), p. 298, fig. 508), (Patrick and Reimer (1966), p. 536, pl. 52, fig. 1,2).

Valve 22 µm (20-25 µm) in length and 7 µm width.

N. menisculus Schum. (Figure 6.1)

(Germain (1981), p. 186, pl. 71, fig. 6), (Hustedt (1930), p. 301, fig. 517), (Foged (1981), p. 250, pl. XXXI, fig. 3).

Valve 27 µm (25-30 µm) in length and 10 µm (9-10 µm) in width, 12 (9-11) striae in 10 µm.

N. cryptocephala Kütz. (Figure 6.2)

(Germain (1981), p. 188, pl. 72, fig. 1-5), (Hustedt (1930), p. 295, fig. 496), (Patrick and Reimer (1966), p. 503, pl. 43, fig. 3).

Valve 28 µm (25-35 µm) in length and 7 µm (5-7 µm) in width, 15 (16-17) striae in 10 µm.

N. placentula (Ehrenb.) Kütz. var. **rostrata** A.Mayer (Figure 6.3)

(Germain (1981), p. 195, pl. 74, fig. 16), (Hustedt (1930), p. 304, fig. 533).

Valve 34 µm (30-70 µm) in length and 13 µm (14-28 µm) in width, 10 (6-9) striae in 10 µm.

N. reinhardtii Grunow (Figure 6.4)

(Germain (1981), p. 196, pl. 75, fig. 1-3), (Foged (1981), p. 250, fig. 4).

Valve 39 µm (35-70 µm) in length and 14 µm (7-20 µm) in width, 8 (7-9) striae in 10 µm.

N. gastrum Ehrenb. (Figure 6.5)

(Germain (1981), p. 196, pl. 76, fig. 2-5), (Foged (1981), p. 252, pl. XXXII, fig. 15), (Patrick and Reimer (1966), p. 518, pl. 49, fig. 14).

Valve 45 µm (25-60 µm) in length and 18 µm (9-20 µm) in width, 10 (8-13) striae in 10 µm.

N. scutelloides W.Smith (Figure 6.6)

(Hustedt (1930), p. 311, fig. 557), (Foged (1982), p. 142, pl. XX, fig. 14-15).

Valve 24 µm (10-30 µm) in length and 16 µm (8-20 µm) in width, 10 striae in 10 µm.

N. bacillum Ehrenb. (Figure 6.7)

(Germain (1981), p. 202, pl. 77, fig. 3-7), (Foged (1982), p. 140, pl. XIX, fig. 14-15).

Valve 39 µm (28-80 µm) in length and 10 µm (9-18 µm) in width, 16 (18-23) striae in 10 µm.

Caloneis Cleve

C. bacillum (Grunow) Mereschk. (Figure 6.8)

(Hustedt (1930), p. 236, fig. 360), (Germain (1981), p. 238, pl. 87, fig. 1-28).

Valve 53 µm (12-70 µm) in length and 8 µm (3-9 µm) in width, 15 (18-28) striae in 10 µm.

C. ventricosa (Ehrenb.) Meister (Figure 7.1)

(Germain (1981), p. 236, pl. 86, fig. 4-14), (Patrick and Reimer (1966), p. 583, pl. 54, fig. 3)

Valve 78 µm (40-105 µm) in length and 18 µm (10-15 µm) in width, 16 (16-19) striae in 10 µm.

Pinnularia Ehrenb.

P. biceps Gregory (Figure 7.2)

(Germain (1981), p. 245, pl. 89, fig. 1-6).

Valve 84 µm (30-105 µm) in length and 10 µm (10-16 µm) in width, 10 striae in 10 µm.

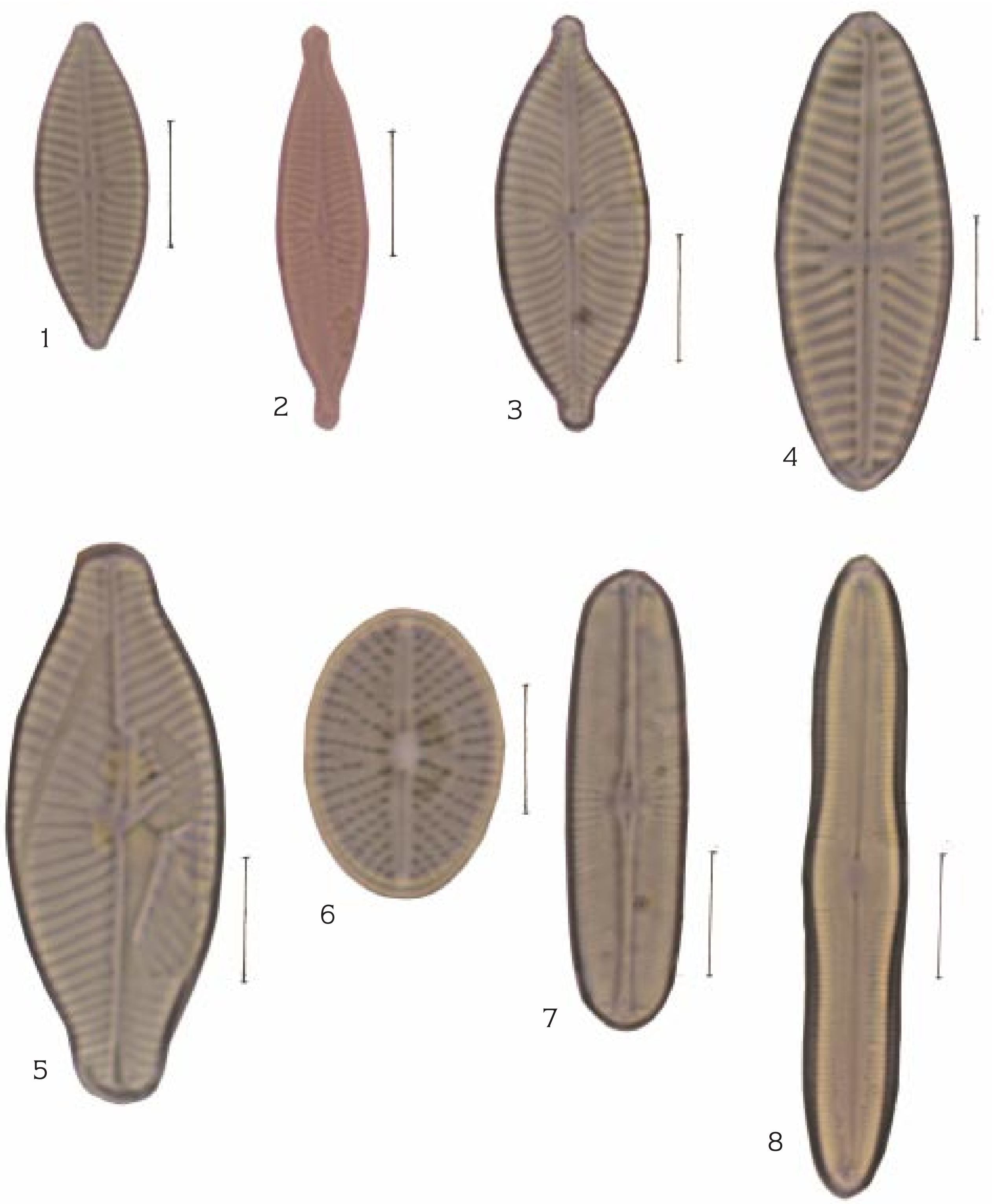

Figure 6. 1. *Navicula menisculus* 2. *Navicula cryptocephala* 3. *Navicula placentula* var. *rostrata* 4. *Navicula reinhardtii* 5. *Navicula gastrum* 6. *Navicula scutelloides* 7. *Navicula bacillum* 8. *Caloneis bacillum* (Scales 10 µm).

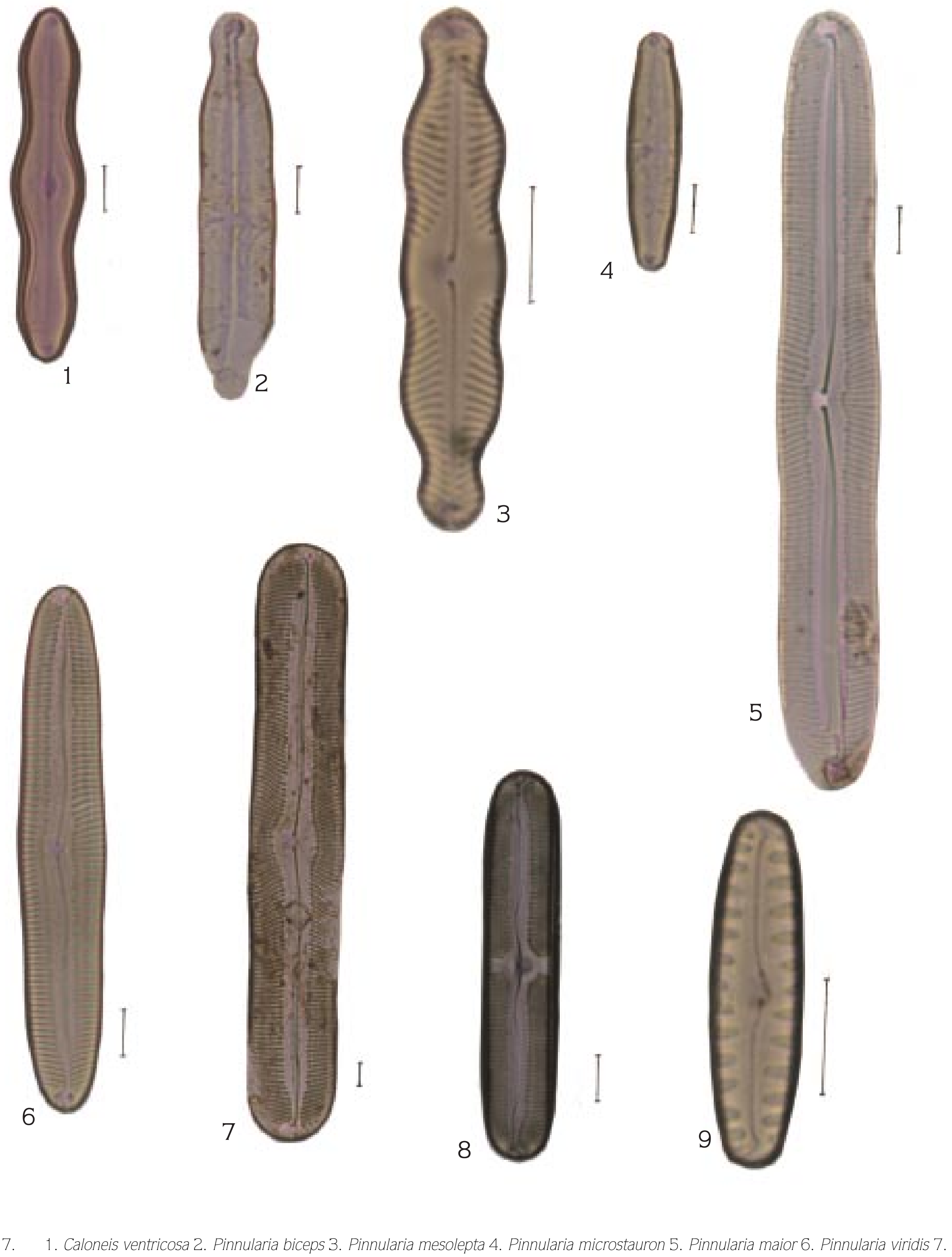

Figure 7. 1. *Caloneis ventricosa* 2. *Pinnularia biceps* 3. *Pinnularia mesolepta* 4. *Pinnularia microstauron* 5. *Pinnularia maior* 6. *Pinnularia viridis* 7. *Pinnularia nobilis* 8. *Pinnularia cardinalis* 9. *Pinnularia borealis* (Scales 10 µm).

P. mesolepta (Ehrenb.) W.Smith (Figure 7.3)

(Germain (1981), p. 241, pl. 88, fig. 7-10), (Hustedt (1930), p. 319, fig. 575a), (Patrick and Reimer (1966), p. 600, pl. 55, fig. 18).

Valve 45 µm (30-60 µm) in length and 9 µm (8-10 µm) in width, 11 (11-13) striae in 10 µm.

P. microstauron (Ehrenb.) Cleve (Figure 7.4)

(Germain (1981), p. 249, pl. 90, fig. 8-11), (Hustedt (1930), p. 320, fig. 582).

Valve 50 µm (60-90 µm) in length and 12 µm (9-11 µm) in width, 9 (9-10) striae in 10 µm.

P. maior (Kütz.) Cleve (Figure 7.5)

(Hustedt (1930), p. 331, fig. 614), (Germain (1981), p. 260, pl. 93, fig. 3).

Valve 170 µm (140-310 µm) in length and 23 µm (25-35 µm) in width, 8 (6-8) striae in 10 µm.

P. viridis (Nitzsch.) Ehr. (Figure 7.6)

(Germain (1981), p. 260, pl. 95, fig. 1-6), (Hustedt (1930), p. 334, fig. 617a).

Valve 113 µm (30-200 µm) in length and 19 µm (8-25 µm) in width, 9 (6-9) striae in 10 µm.

P. nobilis Ehr. (Figure 7.7)

(Germain (1981), p. 264, pl. 97, fig. 1-2), (Hustedt (1930), p. 337, fig. 619).

Valve 258 µm (20-350 µm) in length and 43 µm (35-50 µm) in width, 5 (4-5) striae in 10 µm.

P. cardinalis (Ehrenb.) W.Smith (Figure 7.8)

(Germain (1981), p. 266, pl. 97, fig. 7).

Valve 84 µm (80-320 µm) in length and 17 µm (17-45 µm) in width, 9 striae in 10 µm.

P. borealis Ehr. (Figure 7.9)

(Germain (1981), p. 270, pl. 98, fig. 1-8).

Valve 31 µm (30-70 µm) in length and 8 µm (7-15 µm) in width, 5 (5-7) striae in 10 µm.

Cymbella C.Agardh

C. *ehrenbergii* Kütz. (Figure 8.1-2)

(Germain (1981), p. 278, pl. 100, fig. 1), (Hustedt (1930), p. 356, fig. 356), (Foged (1982), p. 37, pl. XXX, fig, 3).

Valve 86-109 µm (50-220 µm) in length and 34-37 µm (19-50 µm) in width, 8-9 striae in 10 µm.

C. cuspidata Kütz. (Figure 8.3)

(Germain (1981), p. 277, pl. 100, fig. 3), (Hustedt (1930), p. 357, fig. 650).

Valve 98 µm (40-100 µm) in length and 38 µm (19-28 µm) in width, 5 striae in 10 µm.

C. lanceolata (Ehrenb.) Van Heurck (Figure 8.4)

(Hustedt (1930), p. 364, fig. 679), (Germain (1981), p. 278, pl. 101, fig. 1-2).

Valve 148 µm (70-210 µm) in length and 25 µm (22-34 µm) in width, 8 (8-10) striae in 10 µm.

C. cistula (Hemprich) Grunow (Figure 8.5)

(Germain (1981), p. 282, pl. 103, fig. 1-11), (Hustedt (1930), p. 363, fig. 676a).

Valve 65 µm (35-180 µm) in length and 16 µm (13-30 µm) in width, 9 (6-9) striae in 10 µm.

C. affinis Kütz. (Figure 8.6)

(Germain (1981), p. 282, pl. 104, fig. 1-11), (Hustedt (1930), p. 362, fig. 671).

Valve 48 µm (20-70 µm) in length and 16 (7-16 µm) in width, 9 (10-12) striae in 10 µm.

C. prostrata (Berkeley) Cleve (Figure 8.7)

(Germain (1981), p. 290, pl. 107, fig. 1-5), (Hustedt (1930), p. 357, fig. 659).

Valve 66 µm (40-100 µm) in length and 20 µm (15-20 µm) in width, 8 (7-10) striae in 10 µm.

C. ventricosa Kütz. (Figure 8.8)

(Germain (1981), p. 292, pl. 107, fig. 11-22), (Hustedt (1930), p. 359, fig. 661).

Valve 35 µm (8-40 µm) in length and 9 µm (5-10 µm) in width, 12 (10-18) striae in 10 µm.

Didymosphenia M.**Schmidt**

D. geminata (Lyngb.) M.Schmidt (Figure 8.9)

(Hustedt (1930), p. 367, fig. 682), (Foged (1981), p. 292, pl. LII, fig. 2).

Valve 115 µm (60-130 µm) in length and 42 µm (25-43 µm) in width, 10 striae in 10 µm.

Amphora Ehrenb.

A. ovalis Kütz. (Figure 8.10)

(Hustedt (1930), p. 342, fig. 628), (Germain (1981), p. 294, pl. 108, fig. 1-2).

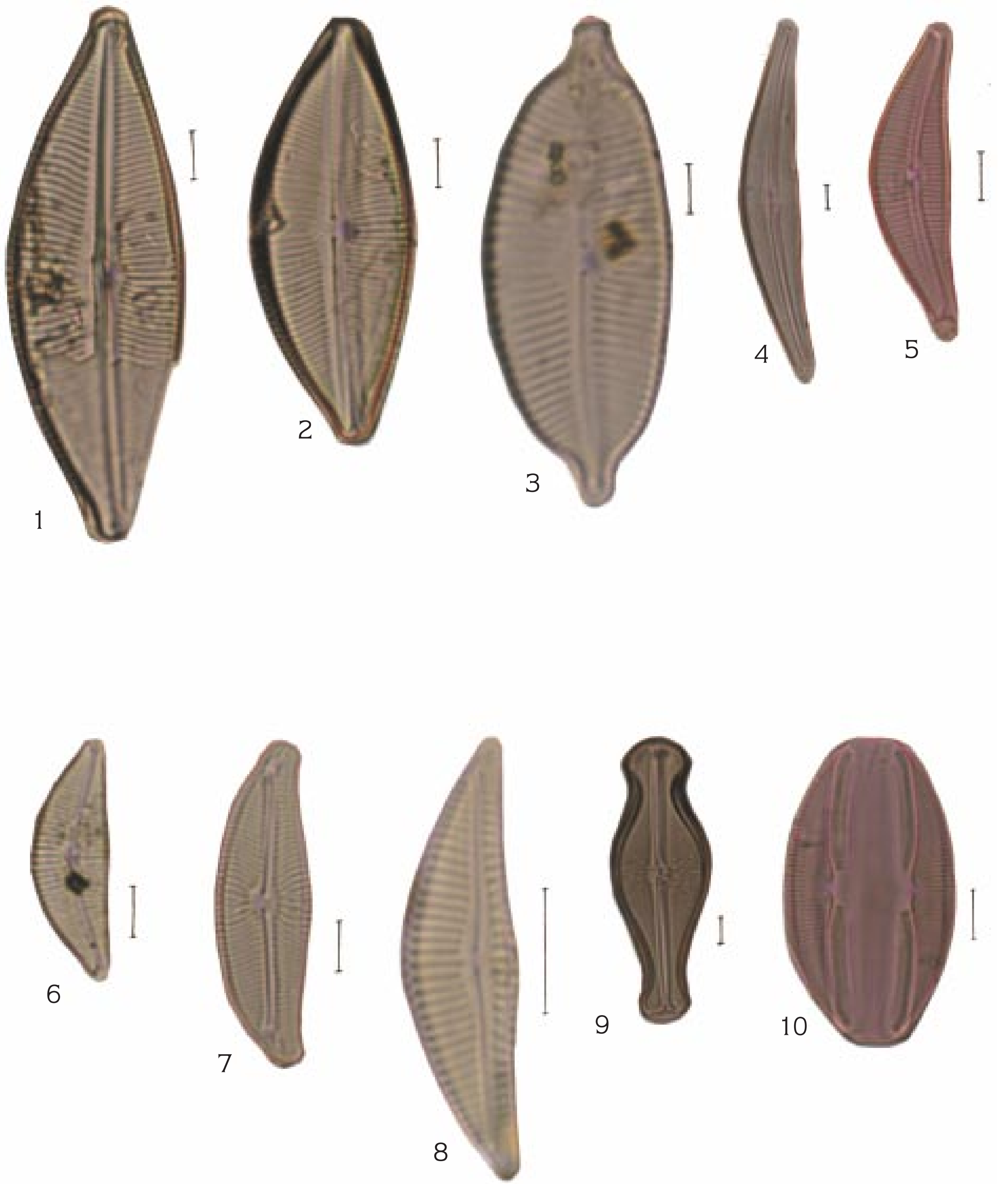

Figure 8. 1-2. *Cymbella ehrenbergii* 3. *Cymbella cuspidata* 4. *Cymbella lanceolata* 5. *Cymbella cistula* 6. *Cymbella affinis* 7. *Cymbella prostrata* 8. *Cymbella ventricosa* 9. *Didymosphenia geminata* 10. *Amphora ovalis* (Scales 10 µm).

Valve 42 µm (30-60 µm) in length and 34 µm (15-30 µm) in width, 10 (12-14) striae in 10 µm.

Gomphonema Ehrenb.

G. acuminatum Ehr. (Figure 9.1)

(Germain (1981), p. 300, pl. 110, fig. 1-9), (Hustedt (1930), p. 370, fig. 683).

Valve 45 µm (30-60 µm) in length and 10 µm (10-13 µm) in width, 11 (10-12) striae in 10 µm.

G. augur Ehrenb. var. **gautieri** Van Heurck (Figure 9.2)

(Hustedt (1930), p. 372, fig. 689).

Valve 54 µm in length and 13 µm in width, 13 striae in 10 µm.

G. constrictum Ehrenb. (Figure 9.3)

(Hustedt (1930), p. 377, fig. 714), (Germain (1981), p. 301, pl. 112, fig. 1-4).

Valve 39 µm (25-65 µm) in length and 14 µm (8-14 µm) in width, 12 (10-12) striae in 10 µm.

var. **capitata** (Ehrenb.) Cleve (Figure 9.4)

(Hustedt (1930), p. 377, fig. 715), (Germain (1981), p. 301, pl. 112, fig. 5-12).

Valve 50 µm (16-65 µm) in length and 12 µm (5-10 µm) in width.

G. intricatum Kütz. (Figure 9.5)

(Hustedt (1930), p. 375, fig. 697), (Foged (1982), p. 166, pl. XXXII, fig. 2).

Valve 65 µm (25-70 µm) in length and 8 µm (5-9 µm) in width, 9 (8-11) striae in 10 µm.

var. **dichotomiformis** Mayer (Figure 9.6)

(Foged (1981), p. 99, pl. LIV, fig. 10).

Valve 32 µm in length and 6 µm in width, 14 striae in 10 µm.

G. angustatum (Kütz.) Rabenhorst var. **producta** Grunow (Figure 9.7)

(Hustedt (1930), p. 373, fig. 693), (Germain (1981), p. 308, pl. 114, fig. 3).

Valve 22 µm (12-45 µm) in length and 6 µm (5-9 µm) in width, 14 (9-15) striae in 10 µm.

G. lanceolatum Ehrenb. (Figure 9.8)

(Hustedt (1930), p. 376, fig. 700), (Germain (1981), p. 302, pl. 11, fig. 4-5-6).

Valve 33 µm (27-70 µm) in length and 8 µm (7-10 µm) in width, 11 (12-13) striae in 10 µm.

Epithemia Brébissoni

E. zebra (Ehrenb.) Kütz.

var. **saxonica** (Kütz.) Grunow (Figure 9.9)

(Hustedt (1930), p. 384, fig. 729).

Valve 46 µm (30-150 µm) in length and 8 µm (7-14 µm) in width, 5 costae in 10 µm.

var. **porcellus** (Kütz.) Grunow (Figure 9.10)

(Hustedt (1930), p. 385, fig. 731), (Germain (1981), p. 316, pl. 116, fig. 8-9-10).

Valve 50 µm (45-60 µm) length and 9 µm width and 6 costae in 10 µm.

E. argus Kütz. (Figure10.1)

(Germain (1981), p. 318, pl. 117 fig. 1-6), (Foged (1981), p. 81, pl. LV, fig. 4-5).

Valve 41 µm (30-130 µm) in length and 10 µm (8-12 µm) in width, 5 costae in 10 µm.

E. turgida (Ehrenb.) Kütz. (Figure 10.3)

(Hustedt (1930), p. 387, fig. 733), (Foged (1981), p. 298, pl. LV, fig. 9).

Valve 52 µm in length and 6.5 µm in width, 10 striae in 10 µm.

var. **westermannii** (Ehrenb.) Grunow (Figure10.2)

(Foged (1981), p. 82, pl. LV, fig. 3 and 11).

Valve 45 µm (48-66 µm) in length and 15 µm (13-16 µm) in width, 5 striae in 10 µm.

var. **granulata** (Ehrenb.) Grunow (Figure 10.4)

(Hustedt (1930), p. 387, fig. 733).

Valve 82 µm (80-250 µm) in length and 13 µm (15-20 µm) in width, 9 striae in 10 µm.

Epithemia sp. (Figure 10.5)

Valve 85 µm in length and 10 µm in width.

E. sorex Kütz. (Figure 10.6)

(Germain (1981), p. 318, pl. 118, fig. 5-6).

Valve 32 µm (20-65 µm) in length and 8 µm (8-15 µm) in width, 6 (5-7) costae in 10 µm.

Rhopalodia O.Müller

R. gibba (Ehrenb.) O.Müller (Figure 10.7)

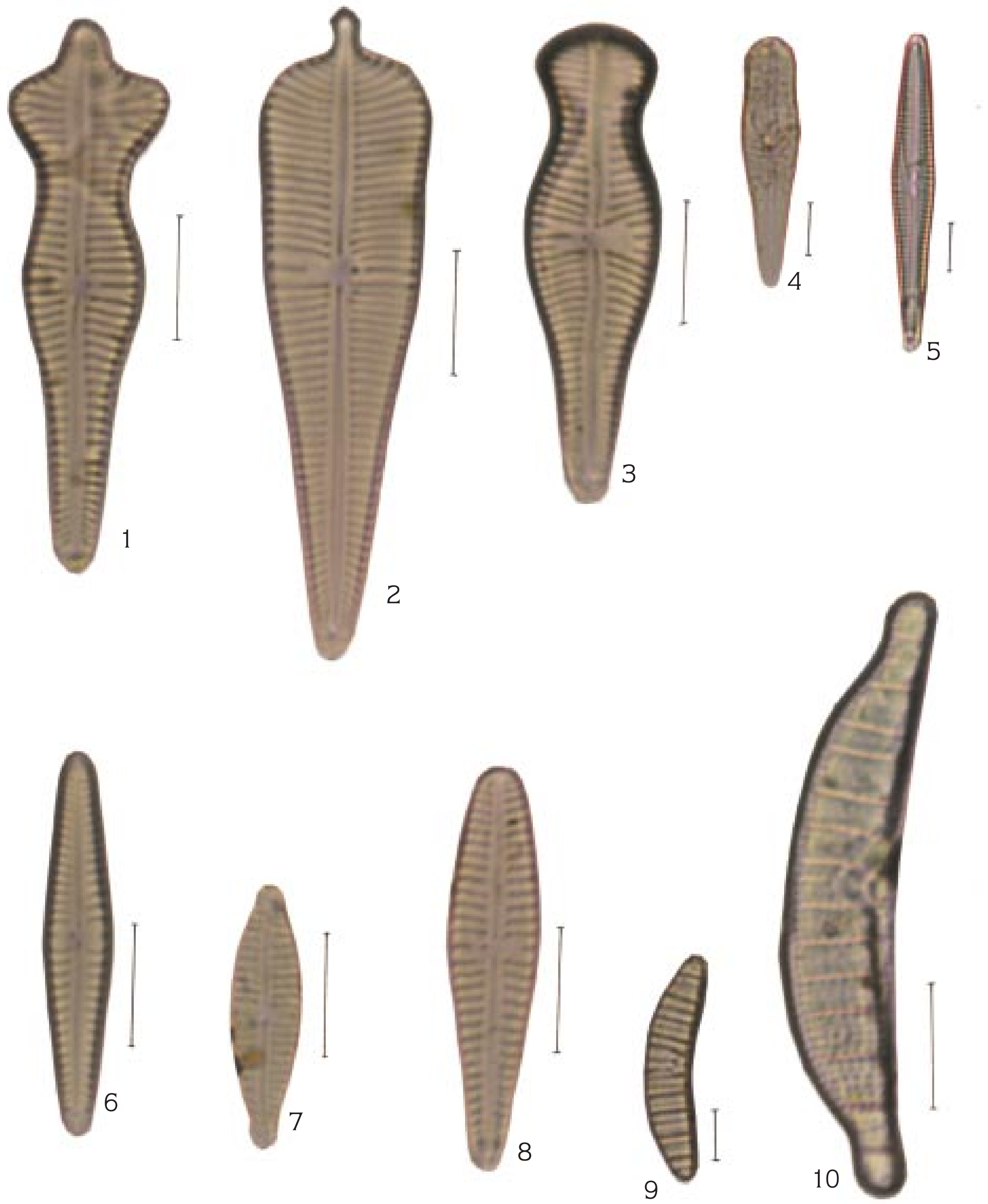

Figure 9. 1. *Gomphonema acuminatum* 2. *Gomphonema augur* var. *gautieri* 3. *Gomphonema constrictum* 4. *Gomphonema constrictum* var. *capitata* 5. *Gomphonema intricatum* 6. *Gomphonema intricatum* var. *dichotomiformis* 7. *Gomphonema angustatum* var. *producta* sp. 8. *Gomphonema lanceolatum* 9. *Epithemia zebra* var. *saxonica* 10. *Epithemia zebra var. porcellus* (Scales 10 µm).

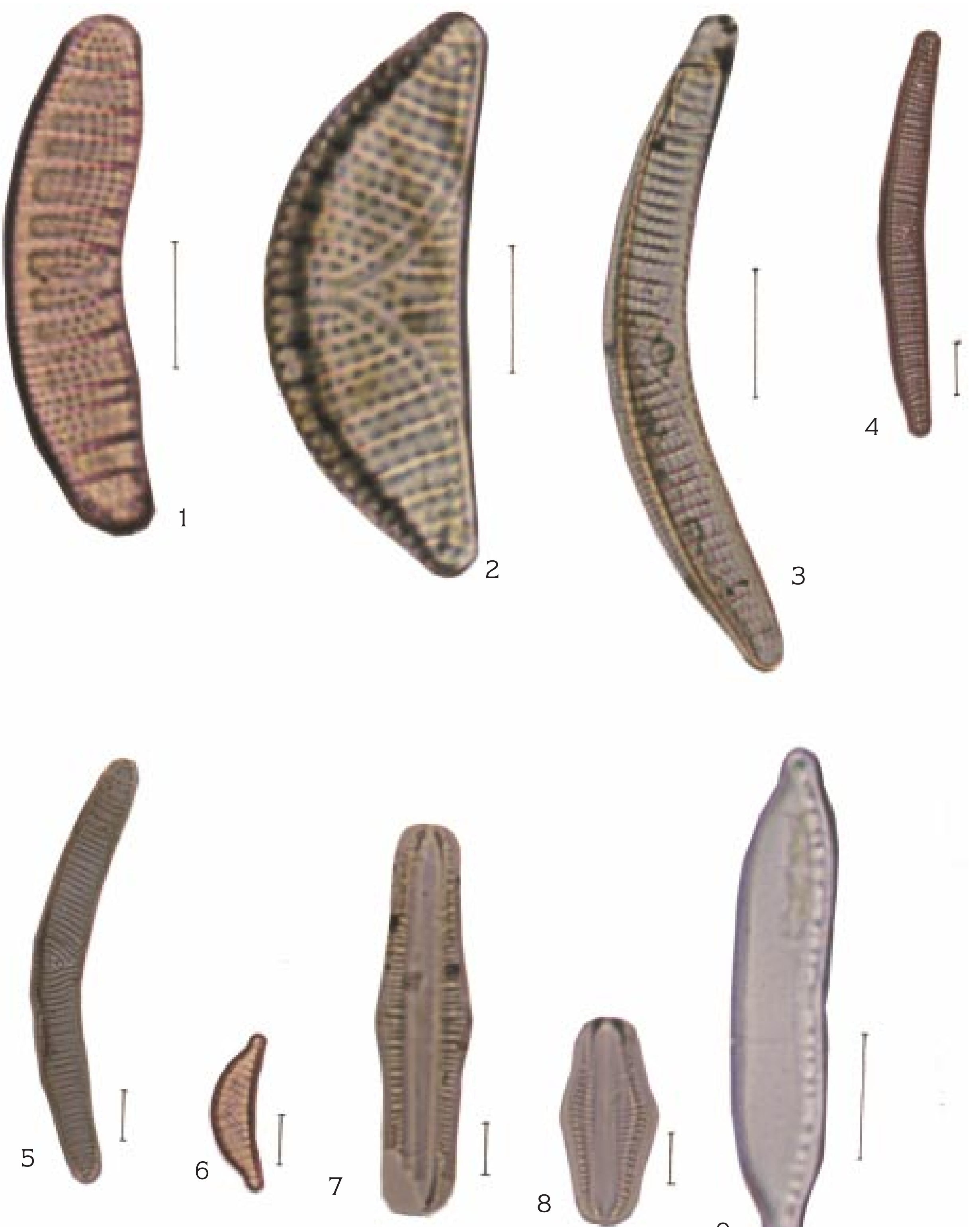

Figure 10. 1. *Epithemia argus* 2. *Epithemia turgida* var. *westermanni* 3. *Epithemia turgida* 4. *Epithemia turgida* var. *granulata* 5. *Epithemia* sp. 6. *Epithemia sorex* 7. *Rhopalodia gibba* 8. *Rhopalodia gibba* var. *ventricosa* 9. *Hantzschia amphioxyus* (Scales 10 µm).

(Germain (1981), p. 320, pl. 119, fig. 1), (Hustedt (1930), p. 390, fig. 740).

Valve 78 µm (40-300 µm) in length and 18 µm (18-30 µm) in width, 8 (6-8) costae in 10 µm.

var. **ventricosa** (Ehrenb.) Grunow (Figure 10.8)

(Hustedt (1930), p. 391, fig. 741), (Germain (1981), p. 320, pl. 119 fig. 2).

Valve 41 µm (40-45 µm) in length and 20 µm (17-20 µm) in width, 9 (8-9) striae in 10 µm.

Hantzschia Grunow

H. amphioxyus (Ehrenb.) Grunow (Figure 10.9)

(Hustedt (1930), p. 394, fig. 747), (Foged (1982), p. 170, pl. XXXIV, fig. 4-5).

Valve 40 µm (20-100 µm) in length and 8 µm (5-10 µm) in width, 8 (5-10) costae in 10 µm.

Nitzschia Hassal

N. amphibia (Kütz.) Grunow (Figure 11.1)

(Hustedt (1930), p. 414, fig. 793), (Germain (1981), p. 3458, pl. 135, fig. 32-37).

Valve 34 µm (12-50 µm) in length and 6 µm (8-14 µm) in width, 9 (7-9) costae in 10 µm.

N. sigmoidea (Ehrenb.) W.Smith (Figure 11.2)

(Hustedt (1930), p. 419, fig. 810).

Valve 235 µm (160-500 µm) in length and 15 µm (8-14 µm) in width, 23 (23-26) costae in 10 µm.

N. spectabilis (Ehrenb.) Ralfs. (Figure 11.3)

(Hustedt (1930), p. 419, fig. 809).

Valve 237 µm (150-450 µm) in length and 15 µm (10-15 µm) in width, 11costae in 10 µm.

Cymatopleura W.Smith

C. solea (Bréb.) W.Smith (Figure 11.4)

(Hustedt (1930), p. 425, fig. 823a), (Germain (1981), p. 374, pl. 141 fig. 1-8).

Valve 113 µm (30-300 µm) in length and 23 µm (12-40 µm) in width, 8 (6-9) wing canals in 10 µm.

C. elliptica (Bréb.) W.Smith (Figure 11.5)

(Hustedt (1930), p. 426, fig. 825).

Valve 69 µm (50-220 µm) in length and 56 µm (40-90 µm) in width, 4 (3-5) wing canals in 10 µm.

Surirella Turpin

S. biseriata Bréb. (Figure 11.6)

(Germain (1981), p. 38, pl. 145, fig. 1), (Huber-Pestalozzi (1942), p. 496, fig. 599).

Valve 170 µm (80-350 µm) in length and 33 µm (30-80 µm) in width, 3 wing canals in 10 µm.

S. turgida W.Smith (Figure 11.7)

(Hustedt (1930), p. 433, fig. 836), (Huber-Pestalozzi (1942), p. 497, 601).

Valve 157 µm (50-120 µm) in length and 70 µm (33-50 µm) in width, 3 wing canals in 10 µm.

S. robusta (Ehrenb.) var. **splendida** (Ehrenb.) Van Heurck (Figure 11.8)

(Germain (1981), p. 384, pl. 149, fig. 2-3), (Huber-Pestalozzi (1942), p. 509, fig. 620b, c).

Valve 155 µm (75-200 µm) in length and 57 µm (40-60 µm) in width, 2 wing canals in 10 µm.

S. capronii Bréb. (Figure 12.1)

(Germain (1981), p. 386, pl. 147, fig. 2), (Cleve-Euler (1952), p. 110, fig. 1537), (Huber-Pestalozzi (1942), p.513, pl. 625).

Valve 220 µm (120-350 µm) in length and 83 µm (55-125 µm) in width, 2 wing canals in 10 µm.

S. ovata Kütz. var. **pinnata** W.Smith (Figure 12.2)

(Hustedt (1930), p. 422, fig. 865), (Germain (1981), p. 390, pl. 152, fig. 10-14), (Sinnu and Lorins (1985), p. 318, pl. 21, fig. 192).

Valve 26 µm (30-45 µm) in length and 10 µm (10-12 µm) in width, 8 wing canals in 10 µm.

Campylodiscus Ehrenb.

C. noricus Ehrenb. ex. Kütz. var. **hibernica** (Ehrenb.) Grunow (Figure 12.3-4)

(Germain (1981), p. 394, pl. 153, fig. 4-9), (Huber-Pestalozzi (1942), p. 521, fig. 640).

Valve 100 µm (60-120 µm) in diameter, 2 wing canals in 10 µm.

Discussion

A total of 94 taxa belonging to 33 genera are presented in this paper. Most of the taxa collected from

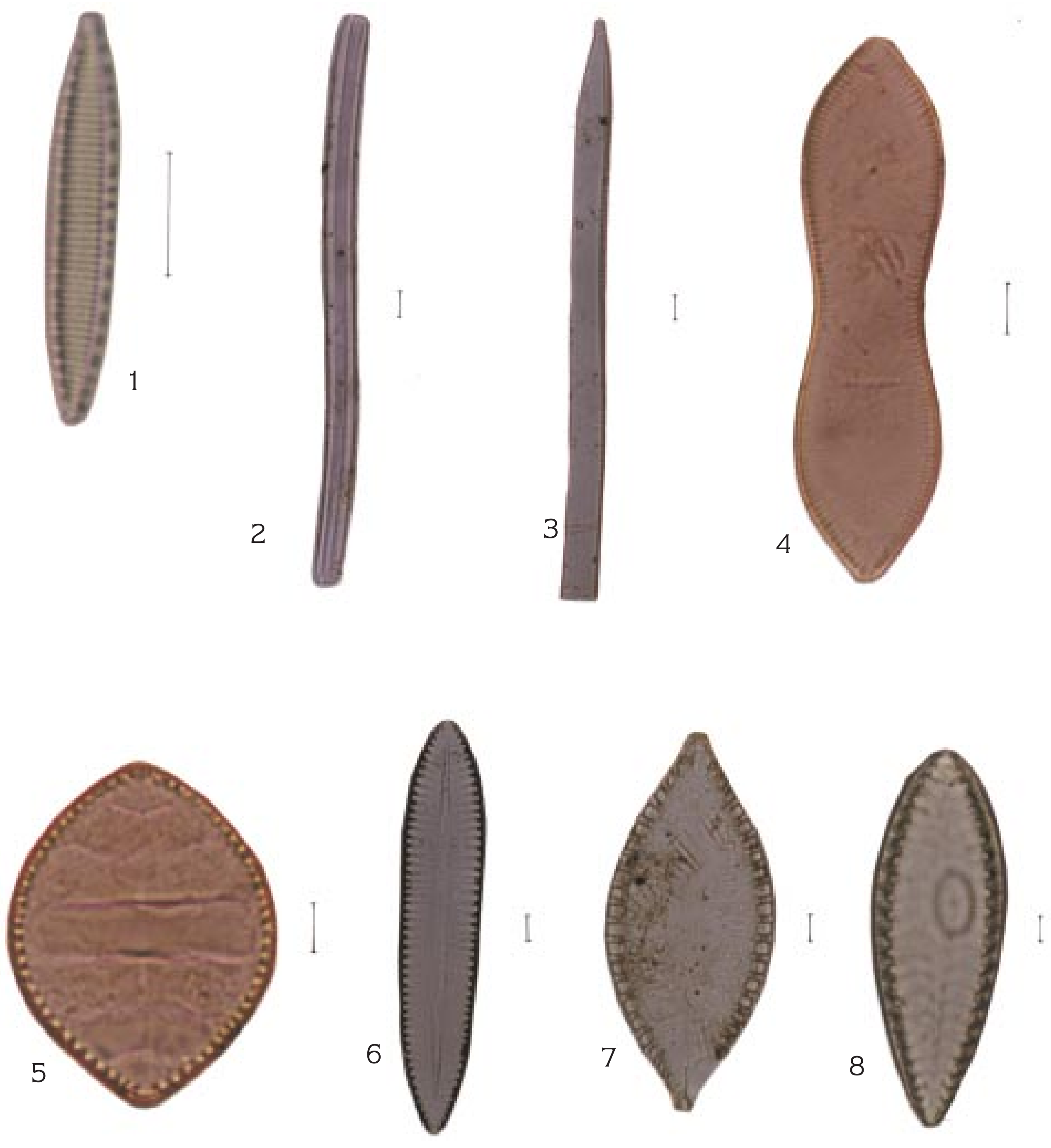

Figure 11. 1. *Nitzschia amphibia* 2. *Nitzschia sigmoidea* 3. *Nitzshia spectabilis* 4. *Cymatopleura solea* 5. *Cymatopleura elliptica* 6. *Surirella biseriata* 7. *Surirella turgida* 8. *Surirella robusta* var. *splendida* (Scales 10 µm).

Figure 12. 1. *Surirella capronii* Breb. 2. *Surirella ovata* var. *pinnata* W.Smith 3-4. *Campylodiscus noricus* var. *hibernica* (Ehr.) Grun. (Scales 10 µm).

Lake Çıldır have a cosmopolitan distribution. The results of our study were similar to those of other studies, conducted in other parts of Turkey (Gönülol et al., 1996).

The species belonging to the genera *Navicula*, *Pinnularia, Gomphonema* and *Epithemia* were found in high numbers. These species were followed by the species belonging to the genera *Cymbella, Synedra* and *Fragilaria*. Patrick and Reimer (1966) have remarked that all these genera have planktonic forms in freshwater. Benthic diatoms were also determined in plankton. The stations were 3-4 m deep and some benthic diatoms could have appeared in plankton due to different ecological factors such as wind and benthic macroinvertebrates.

Planktonic diatoms do not grow well in very low total phosphorus concentrations, < 2 µg/l (Hörnström et al., 1984). There is a large variation in the requirement of phosphorus but generally centric diatoms are considered more demanding than pennate species. The results of chemical analysis in Lake Çıldır show that centric diatoms increased in number in proportion to the increase in the total amount of phosphorus, especially in summer. We observed a linear correlation between total phosphorus and centric diatoms in Lake Çıldır. In particular, *Cyclotella meneghiniana*, *Melosira varians* and *Aulacoseira granulata* were found to abundant in Lake Çıldır when the levels of phosporus were high.

Cyclotella meneghiniana is a cosmopolitan alga that can live in very distinct environments (Rojo and Cobelas, 1994). *Cyclotella meneghiniana* was the dominant species at three stations during nearly all the sampling periods. Species of *Cyclotella* were dominant also in other investigated lakes and reservoirs of Turkey (Aykulu et al., 1983; Gönülol and Çomak, 1992; Şen et al., 1994). According to various authors, the abundance of *Cyclotella* is closely related to the trophic status of lakes, and many species of *Cyclotella* are typical in oligotrophic lakes (Thompson and Rhee, 1994; Hutchinson, 1967; Reynolds, 1984). Some authors classify some species as indicators of eutrophic lakes (Germain, 1981; Rosenström and Lepistö, 1996).

Melosira varians and *Aulacoseira granulata* were found to be abundant in summer. Petrova (1986) and Patrick and Reimer (1966) pointed out that these species have maximum growth in warm seasons. *Aulacoseira ambigua* and *Ellerbeckia arenaria* were found rarely in Lake Çıldır and in other Turkish lakes (Gönülol et al., 1996).

As noted above, the common diatoms of Lake Çıldır are also the most common and abundant species of Turkish lakes. But some species were found to be rare such as *Coscinodiscus* sp., *Opephora martyii, Didymosphenia geminata, Stauroneis acuta, Diatoma hiemale, Aulacoseira ambigua* and *Ellerbeckia arenaria*. The following taxa are new records for Turkey: *Cocconeis scutellum, Mastogloia recta, Navicula scutelloides, Pinnularia nobilis, P. cardinalis, Gomphonema augur var. gautieri, G. intricatum var. dichotomiformis* and *E. turgida var. granulata*.

Didymosphenia geminata was reported in studies of the Fırat River and Trabzon (Altuner and Gürbüz, 1994; Şahin, 1991). *Coscinodiscus* is generally distributed in brackish water (Patrick and Reimer, 1966), but this genus was determined in Lake Çıldır and some other lakes in Turkey. Demirhindi (1991) and Conk and Cirik (1991) found the planktonic forms of this genus in Lake Eğirdir, and Altuner and Gürbüz (1994) identified this genus in plankton of Tercan Dam Lake. *Stauroneis acuta* was recorded only in planktonic forms in the Seyhan River and Karagöl (Kandemir et al., 1994; Cirik and Cirik, 1990). Diatoma hiemale was found as plankton in Lake Tortum (Altuner, 1983). All these taxa are not widely distributed in the lakes above or Lake Çıldır.

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