

## Diatoms of the Mystery Lake, Taiwan (II)

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**ABSTRACT:** This study described 23 species of diatoms, belonging to five families and seven genera found in the Mystery Lake, a slightly acidic lake, located within a hardwood nature preserve in northeastern Taiwan. Of the species described, seven are new record to Taiwan. They are: *Cymbella cuspidata*, *Cymbella mongolica*, *Encyonema gracile*, *Gomphonema augur* var. *turris*, *Gomphonema clavatum*, *Brachysira steindorfiana*, *Luticola mutica* f. *intermedia*. *Brachysira* is a new genus to Taiwan. The fine structures of each species are described on the basis of observations under the scanning electron microscope.

**KEY WORD:** Diatoms, Mystery Lake, morphology, Nanao Nature Reserve.

### INTRODUCTION

Mystery Lake (E121°43', N24°26') is located within the Nanao Hardwood Nature Reserve, in northeastern Taiwan. The lake locates at an altitude of 1,100 m a.s.l. in a prevalent fog belt, and it covers an area of ca. 1.5 ha. It is a shallow lake, with depth less than 2 m, and it is in the late phase in its development. The forest surrounding the lake was comprised primarily of well-preserved hardwoods (Su *et al.*, 1988).

The siliceous cell walls of diatoms are usually well preserved in the sediments of lakes. Thus, they are commonly used as indicators for a variety of study purposes (Stockner, 1972; Davis, 1987; Whiting *et al.*, 1989; Whitmore, 1989; Schmidt and Simola, 1991; Stoermer and Smol, 1999). In Taiwan, diatoms have been used to study changes in the paleolimnological environment (Wu and Chang, 1996; Wu *et al.*, 1997; Chen and Wu, 1999).

Mystery Lake is virtually undisturbed by human activity, and as a result, diatoms are well preserved in its sediments. The data of diatom assemblages in the lake might provide important information for further elucidation of the environment surrounding this lake. In previous paper, we already have reported 36 taxa of diatoms in this lake (Wu and Wang, 2002). In the present study, we report another 23 species as a supplement to this record. This includes family Brachysiraceae, Cymbellaceae, Diadesmidaceae, Gomphonemataceae, and Stauroneidaceae (Table 1).

### MATERIALS AND METHODS

Six samples of surface-sediment from different localities of the lake were collected with a plastic pipe (6 cm in diameter). Samples from the uppermost 5 cm were taken for the treatment with an acid solution in the laboratory, as described by Chen and Wu (1999). A part of the acid treated samples was stored in the mixture of glycerol and formalin (3:1) in eppendorf tubes. The rest of samples were dehydrated through an alcohol series, and dried

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by the critical point dryer (Hitachi HCP-2). Dried diatoms were mounted on aluminum stubs and coated with gold by asputter coater (Edwards S150A). Coated stubs were viewed on a Zeiss DSM 950 SEM. The materials examined in this study were stored in the Phycological Laboratory, Institute of Botany, Academia Sinica, Taipei, Taiwan.

Table 1. Summaries of the diatom genera and their taxonomic positions described in the present article.

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Class BACILLARIOPHYCEAE Haekel 1878
Order Cymbellales Mann 1990
Family Cymbellaceae Greville 1833
<i>Cymbella</i> ; <i>Encyonema</i>
Family Gomphonemataceae Kützing 1844
<i>Gomphonema</i>
Order Naviculales Bessey 1907
Family Brachysiraceae Mann 1990
<i>Brachysira</i>
Family Diadesmidaceae Mann 1990
<i>Diadesmis</i> ; <i>Luticola</i>
Family Stauroneidaceae Mann 1990
<i>Stauroneis</i>

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## RESULTS

### Order Cymbellales Family Cymbellaceae Greville 1833

#### Key to genera

- 1a. Raphe lying along or near the midline of the valve, curved in strongly dorsiventral forms ..... *Cymbella*  
 1b. Raphe parallel to ventral margin ..... *Encyonema*

#### Genus *Cymbella* Agardh 1830

Valves almost naviculoid to strongly arcuate; ends rounded, rostrate or capitate. Raphe normally lying along or near the midline of the valve, curved in strongly dorsiventral forms. External raphe fissures often sinuous, proximal ends expanded pore-like or in hook pointing towards the dorsal margin; distal ends turned towards the dorsal margins. Central and axial area indistinct or variable in size and shape. Striae uniseriately punctate.

#### Key to species

- 1a. Valves with cuspidate ends ..... *C. cuspidata*  
 1b. Valves with bluntly to broadly rounded ends ..... 2  
 2a. Valves less than 75  $\mu\text{m}$  long in this study ..... 3  
 2b. Valves more than 185  $\mu\text{m}$  long in this study ..... *C. aspera*  
 3a. Valves with broadly rounded ends ..... 4  
 3b. Valves with bluntly rounded ends ..... 5  
 4a. Valves semi-elliptical with convex dorsal margin ..... *C. mongolica*  
 4b. Valve cymbiform with strongly convex dorsal margin ..... *C. tumida*  
 5a. Valves with slightly concave to straight ventral margins and more than 35  $\mu\text{m}$  long in this study  
 ..... *C. cymbiformis*  
 5b. Valves with slightly convex ventral margins and less than 30  $\mu\text{m}$  long in this study ..... *C. hustedtii*

1. *Cymbella aspera* (Ehrenberg) Peragallo, Güttinger, 1994, plate 2.05.14-21; Hadi *et al.*, 1984, p. 551, pl. 11, fig. 195; John, 1983, p. 145, pl. 60, fig. 7; Krammer, 1982, p.118-133, pl. 1058-1065; Krammer and Lange-Bertalot, 1986, p. 705, pl. 131, fig. 1.

Fig. 1. A & B

Synonym: *Cymbella asperum* Ehrenberg; *Cymbella gastroides* (Kütz.) Kützing.

Valves moderately dorsi-ventral; dorsal margin moderately arched, ventral margin almost straight; ends broadly rounded. Axial area linear, widening slightly at mid-valve. Central area shallow. Raphe lateral; proximal ends slightly hooked and rounded; distal ends curving dorsally. Striae uniseriately punctate, slightly radiate to parallel; puncta slit-like. Dimension: 25-27 × 188-190 μm, striae 9-10 in 10 μm.

2. *Cymbella cuspidata* Kützing, Krammer and Lange-Bertalot, 1986, p. 735, pl. 140, figs. 1-4; Patrick and Reimer, 1975, p. 89, pl. 6, fig. 2.

Fig. 4. D & F

Valves broadly linear-elliptical to sub-elliptical, moderately dorsi-ventral, tapering abruptly to cuspidate ends. Axial area linear, narrowing towards the ends. Central area ovoid to elliptical, more well-developed ventrally. Raphe lateral; proximal ends ventrally crochet-hooked. Central nodules large. Striae uniseriately punctate, radiate throughout; puncta slit-like. Dimension: 24-25 × 86-90 μm, striae 9-11 in 10 μm.

3. *Cymbella cymbiformis* Agardh, Güttinger, 1994, plate 2.05.14-4; Krammer, 1982, p.174-181, pl. 1086-1089; Krammer and Lange-Bertalot, 1986, p. 701, pl. 129, figs. 2-6.

Fig. 1. C-G

Valve cymbiform; dorsal margin smoothly convex; ventral margin slightly concave to straight, slightly centrally inflated; ends bluntly rounded. Axial area arched, narrowing towards the ends, median. Raphe arched; proximal fissures slightly sinuous towards the ventral margins; proximal ends rounded. Central area small containing a thickening on ventral side between nodules. Striae uniseriately punctate; ventral striae radiate near the middle valve, mostly parallel throughout rest of the valve; dorsal striae radiate. Dimension: 9-13 × 38-45 μm, striae 9-10 in 10 μm.

4. *Cymbella hustedtii* Krasske, Krammer and Lange-Bertalot, 1986, p. 723, pl. 140, figs. 9-17; Patrick and Reimer, 1975, p. 85, pl. 4, figs. 2a-3b.

Fig. 1. E & F

Valves slightly to moderately dorsi-ventral, ends bluntly rounded. Axial area linear. Central area inconspicuous. Raphe filiform, each branch slightly dorsally arched. Proximal raphe ends abrupt, somewhat ventrally angled. Distal raphe ends dorsally deflected. Striae uniseriately punctate, parallel, radiate near the ends. Dimension: 5-9 × 13-29 μm, striae 11-13 in 10 μm.

5. *Cymbella mongolica* Østrup, Cleve-Euler, 1955, p. 168, pl. 1259, fig. 1.

Fig. 1. I

Valves semi-elliptical; dorsal margin convex; ventral margins straight, centrally inflated; ends broadly rounded. Raphe median, arcuate; proximal ends closed; distal ends dorsally curved. Central area rounded. Striae uniseriately punctate, parallel or slightly radiate. Dimension: 12-13 × 47-48 μm, striae 9-10 in 10 μm.

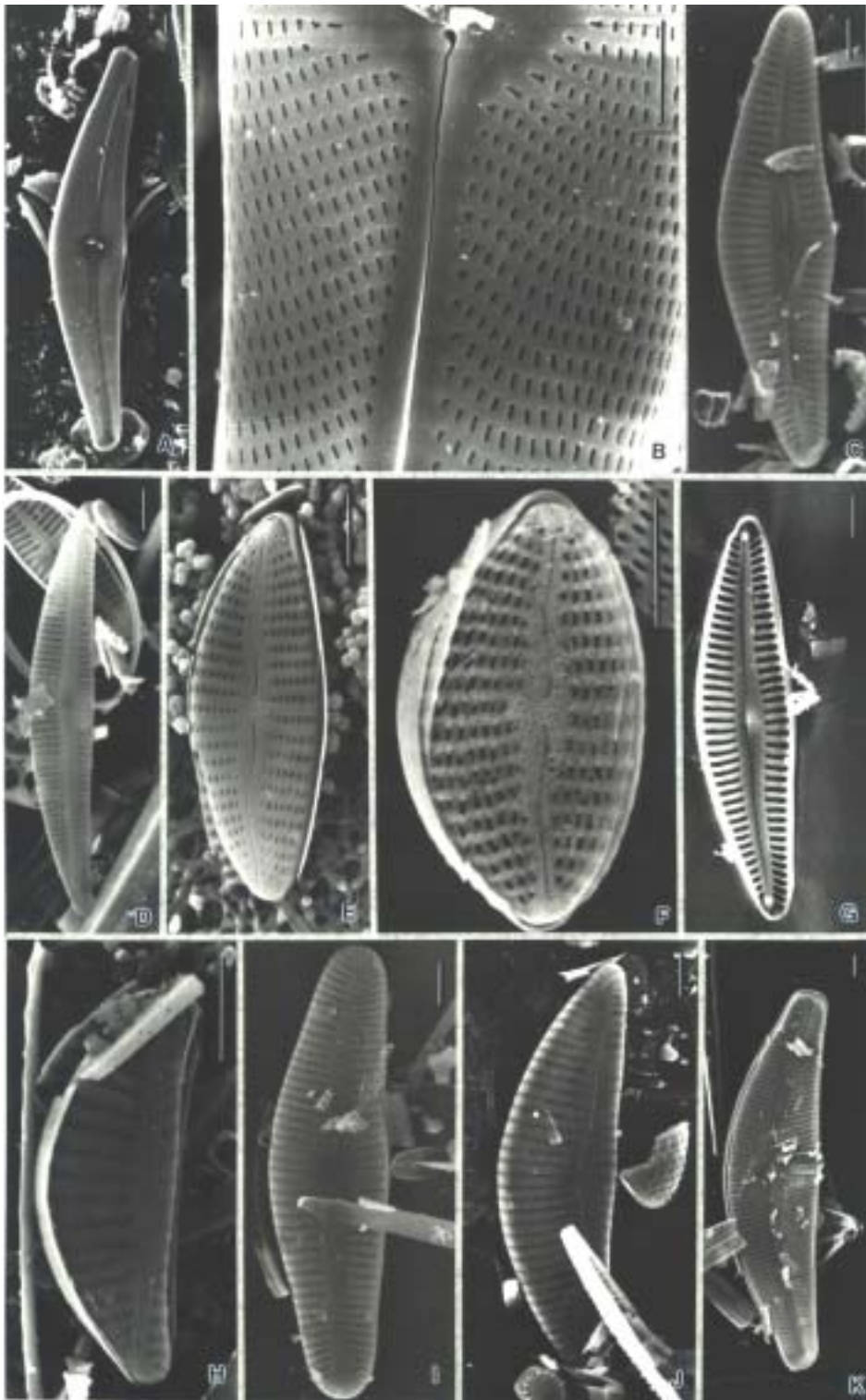


Fig. 1. A & B. *Cymbella aspera* (Ehrenberg) Peragallo. A. External valve. B. Part of the external valve showing slightly hooked and rounded proximal raphe ends and slit-like puncta. C. *Cymbella cymbiformis* Agardh external valve. D. *Encyonema gracile* Ehrenberg external valve. E & F. *Cymbella hustedtii* Krasske external valve. G. *Cymbella cymbiformis* Agardh internal valve. H. *Encyonema minutum* (Hilse es Rabenhorst) Mann external valve. I. *Cymbella mongolica* Østrup external valve. J. *Encyonema silesiaca* Mann external valve. K. *Cymbella tumida* (Brebisson) Van Heurck external valve. Bar = 4  $\mu$ m.

6. *Cymbella tumida* (Brebisson) van Heurck, Fungladda and Kaczmarska, 1983, p. 69, pl. 6, figs. 94-95; Güttinger, 1994, plate 2.05.14-16; Hadi *et al.*, 1984, p. 551, pl. 11, fig. 194; Krammer and Lange-Bertalot, 1986, p. 703, pl. 130, figs. 4-6. Fig. 1. K

Synonym: *Cymbella tumidum* Brebisson; *Cymbella stomatophora* Grunow.

Valve cymbiform; dorsal margin arcuate; ventral margin slightly concave, more or less gibbous; ends rounded truncate. Raphe median, gently arcuate; proximal ends ventrally rounded; distal ends dorsally reflexed. Axial area broad. Central area transversely rhomboidal. Striae uniseriately punctate, radiate; puncta perpendicular to the long axis. Dimension: 18-21 × 42-74 µm, striae 10-15 in 10 µm.

### Genus *Encyonema* Kützing 1833

Valves asymmetrical about the apical plane, the dorsal margin more convex than the ventral margin, the ventral margin maybe almost straight.; ends acutely or bluntly rounded, sometimes rostrate. Raphe system parallel to ventral margin. External raphe fissures slightly sinuous, proximal ends in expanded pores and deflected towards the dorsal margin; distal ends curved towards ventral margins. Internal proximal ends always visible, hooked towards the ventral side. Striae uniseriate punctate, puncta apically elongated.

### Key to species

- 1a. Valves often almost half-moon shaped; dorsal margins strongly convex, ventral margin straight, sometimes with ventrally deflected ends ..... 2  
 1b. Valves with weakly convex dorsal margins, ventral margin straight or weakly convex ..... *E. gracile*  
 2a. Valves more than 10 µm wide and 38 µm long, striae less than 11 in 10 µm ..... *E. silesiaca*  
 2b. Valves less than 7 µm wide and 14 µm long, striae more than 14 in 10 µm ..... *E. minutum*

1. *Encyonema gracile* Ehrenberg, Foged, 1979, p. 38, pl. 35, fig. 9; Güttinger, 1994, plate 2.05.14-12; Krammer, 1982, p. 102-113, pl. 1050-1055; Krammer and Lange-Bertalot, 1986, p. 683., pl. 120, figs. 1-16. Fig. 1. D

Synonym: *Cymbella gracilis* (Ehrenberg) Kützing; *Cymbella gracile* Ehrenberg; *Cymbella scotica* W. Smith; *Cymbella lunata* W. Smith.

Valve semi-lanceolate to semi-elliptical; dorsal margin smoothly convex; ventral margin straight or slightly concave; ends acutely rounded. Axial and central area arched, narrow, median. Raphe arched; distal fissures some distance removed from ends, proximal ends slightly turned towards the ventral margins. Striae uniseriately punctate; ventral striae radiate at middle valve, becoming parallel at ends; dorsal striae radiate. Dimension: 6-7 × 39-40 µm, striae 15-16 in 10 µm.

2. *Encyonema minutum* (Hilse et Rabenhorst) Mann, Güttinger, 1994, Plate 2.05.14-6; John, 1983, p. 145, pl. 60, fig. 8; Krammer, 1982, p. 54-63, pl. 1026-1030; Krammer and Lange-Bertalot, 1986, p. 681, pl. 119, figs. 1-13. Fig. 1. H

Synonym: *Cymbella minuta* Hilse et Rabenhorst; *Cymbella ventricosa* Kützing.

Valves semi-elliptical; dorsal margin convex; ventral margins straight; ends slightly produced. Axial area linear, parallel to the ventral margin. Central area small. Raphe fissures filiform; proximal ends dorsally deflected; distal ends ventrally deflected. Striae uniseriately

punctate, slightly radiate to parallel; both dorsal and ventral striae more closely arranged towards the ends. Dimension: 5-7 × 14-17 μm, striae 14-16 in 10 μm.

3. *Encyonema silesiaca* Mann, Güttinger, 1994, plate 2.05.14-5; Fungladda and Kaczmarska, 1983, p. 67, pl. 5, figs. 76 & 80; Krammer, 1982, p. 66-71, pl. 1032-1034; Krammer and Lange-Bertalot, 1986, p. 677, pl. 117, figs. 1-24. Fig. 1. J

Synonym: *Cymbella ventricosa* Kützing; *Cymbella minuta* var. *silesiaca* (Bleisch) Reimer. *Cymbella silesiaca* Bleisch.

Valves semi-elliptical; dorsal margin convex; ventral margins straight; ends acutely rounded. Axial area linear, parallel to the ventral margin. Central area small. Raphe fissures filiform; proximal ends dorsally deflected; distal ends ventrally deflected. Striae uniseriately punctate, slightly radiate to parallel; both dorsal and ventral striae more closely arranged towards the ends. Dimension: 10-11 × 38-39 μm, striae 10-11 in 10 μm.

Family Gomphonemataceae  
Genus *Gomphonema* Agardh 1824

Valves heteropolar, elliptical-clavate, linear-clavate, or lanceolate-clavate; foot pole narrow; head pole wider, sometimes rostrate or capitate; longitudinally symmetrical, transversely asymmetrical. Axial area straight, central. Central area of variable shape, in many taxa containing one or more isolated puncta or an evident terminal punctum of median stria. Striae uniseriately punctate.

Key to species

- 1a. Valves narrowly rhomboidal or narrowly lanceolate ..... 2  
 1b. Valves not narrowly rhomboidal or narrowly lanceolate ..... 3  
 2a. Head pole knob-like or capitate ..... *G. augur* var. *sphaerophorum*  
 2b. Head pole acute ..... *G. gracile*  
 3a. Axial and central area forming narrowly rhomboidal clear area ..... 4  
 3b. Axial and central area not forming narrowly rhomboidal clear area ..... 5  
 4a. Valves linear-lanceolate ..... *G. clevei*  
 4b. Valves clavate ..... *G. angustum*  
 5a. Raphe straight, filiform ..... 6  
 5b. Raphe sinuous, twice recurved ..... *G. truncatum*  
 6a. Valves less than 31 μm long in this study ..... 7  
 6b. Valves more than 45 μm long in this study ..... 8  
 7a. Head pole cuneate ..... *G. clavatum*  
 7b. Head pole rounded, rostrate, subrostrate or capitate ..... *G. parvulum*  
 8a. Head poles variously capitate, expanded near the apex, medianly with an acute terminal projection or somewhat cuneate apex ..... *G. acuminatum*  
 8b. Head pole cuneate or apiculate ..... 9  
 9a. Head pole cuneate ..... *G. augur* var. *augur*  
 9b. Head pole apiculate ..... *G. augur* var. *turris*

1. *Gomphonema acuminatum* Ehrenberg, Bateman and Rushforth, 1984, p. 69, pl. 11, figs. 155-156; Foged, 1979, p. 56, pl. 37, fig. 13; Foged, 1981, p. 95, pl. 52, figs. 6, 9; Güttinger, 1994, plate 2.05.24-1; John, 1983, p. 141, pl. 59, figs. 1-2; Krammer and Lange-Bertalot, 1986, p. 763, pl. 160, figs. 1-12. Fig. 2. A-C

Synonym: *Gomphonema brebissonii* Kützing.

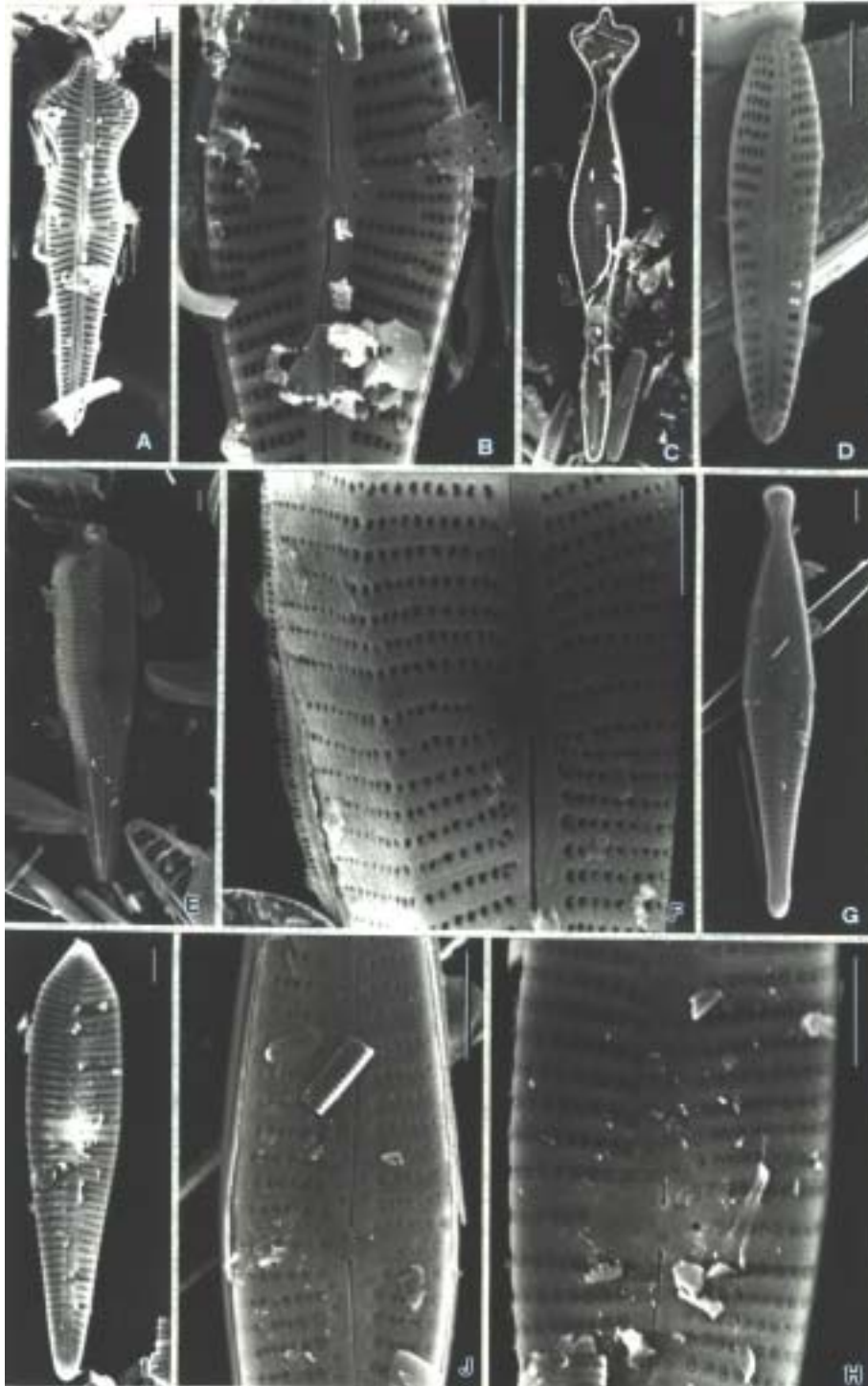


Fig. 2. A-C. *Gomphonema acuminatum* Ehrenberg. A. External valve. B. Part of the external valve showing reniform puncta, closed proximal raphe ends and slightly sinuous raphe. C. Internal valve. D. *Gomphonema angustum* Agardh external valve. E & F. *Gomphonema augur* Ehr. var. *augur*. E. External valve. F. Part of the external valve showing reniform or ovoid puncta, rounded proximal raphe ends and straight raphe. G & H. *Gomphonema augur* var. *sphaerophorum* (Ehr.) Grunow. G. External valve. H. Part of the external valve showing reniform puncta, rounded proximal raphe ends and straight raphe. I & J. *Gomphonema augur* var. *turris* (Ehr.) Lange-Bertalot. I. External valve. J. Part of the external valve showing reniform puncta, rounded proximal raphe ends and straight raphe. Bar = 4  $\mu$ m.

Valves clavate, expanded at the center; head poles variously capitate, expanded near the apex, medianly with an acute terminal projection or somewhat cuneate apex, wider than the central portion of valve, and with a deep subapical constriction; foot pole acutely rounded. Axial area linear. Central area circular, somewhat unilateral, containing a single isolated punctum on one side, usually terminated a short striae. Raphe slightly sinuous, proximal ends closed, distal ends hooked in the same direction. Striae uniseriately punctate, slightly radiate; puncta reniform. Dimension:  $10\text{-}4 \times 45\text{-}90 \mu\text{m}$ , striae 8-12 in  $10 \mu\text{m}$ .

2. *Gomphonema angustum* Agardh, Güttinger, 1994, plate 2.05.24-4; Krammer and Lange-Bertalot, 1986, p. 771, pl. 164, figs. 1-16. Fig. 2. D

Synonym: *Gomphonema intricatum* Kützing; *Gomphonema dichotomum* Kützing; *Gomphonema intricatum* var. *pumilum* Grunow; *Gomphonema bohemicum* Reichelt & Fricke; *Gomphonema fanensis* Maillard.

Valves clavate, hetropolar; head pole broadly rounded; foot pole acutely rounded, narrower than head pole. Axial and central area forming narrowly rhomboidal area. Raphe filiform; proximal ends rather close, rounded; distal ends ventrally deflected. Striae uniseriately punctate, slightly radiate; median striae widely separated; the midmost one side furnished with an isolated punctum; the opposite side with a quite shortened striae; puncta slit-like. Dimension:  $4\text{-}5 \times 18\text{-}20 \mu\text{m}$ , striae 14-15 in  $10 \mu\text{m}$ .

3. *Gomphonema augur* Ehrenberg var. *augur* Ehrenberg, De Oliveira and Steinita-Kannan, 1992, p. 545, pl. 6, fig. 94; Hadi *et al.*, 1984, p. 553, pl. 12, fig. 205; Krammer and Lange-Bertalot, 1986, p. 759, pl. 158, figs. 1-6. Fig. 2. E & F

Synonym: *Gomphonema turris* Ehrenberg; *Gomphonema acuminatum* var. *turris* (Ehrenberg) Wolle; *Gomphonema lanceolatum* var. *turris sensu* Hustedt.

Valves strongly clavate, with greatest breadth near the cuneate head pole, valves tapering towards the acutely rounded foot pole. Axial area linear. Raphe filiform; proximal ends simple, rounded; distal ends ventrally deflected. Central area formed by the median striae shortened at one side of the central nodule, and an isolated puncta on the other side ending. Striae uniseriately punctate, almost parallel at the central nodule, otherwise slightly radiate; puncta reinform or ovoid. Dimension:  $11\text{-}12 \times 65\text{-}66 \mu\text{m}$ , striae 8-9 in  $10 \mu\text{m}$ .

4. *Gomphonema augur* Ehrenberg var. *sphaerophorum* (Ehrenberg) Grunow, Krammer and Lange-Bertalot, 1986, p. 757, pl. 157, fig. 10. Fig. 2. G & H

Synonym: *Gomphonema sphaerophorum* Ehrenberg.

Valves narrowly rhomboidal or narrowly lanceolate, sharply narrowing towards a rounded and slightly subcapitate foot pole, and with a much wider knob-like or capitate head pole. Axial area narrowly linear. Raphe filiform; proximal ends simple, rounded; distal ends ventrally deflected. Central area formed by the median striae shortened on one side of the central nodule, and an isolated puncta at the other side ending. Central area with a small stigma opposite to the unilateral fascia. Striae uniseriately punctate, slightly radiate; puncta reinform. Dimension:  $7\text{-}9 \times 45\text{-}55 \mu\text{m}$ , striae 10-11 in  $10 \mu\text{m}$ .



5. *Gomphonema augur* Ehrenberg var. *turris* (Ehrenberg) Lange-Bertalot, Fungladda and Kaczmarska, 1983, p. 77, pl. 10, figs. 156-157; Krammer & Lange-Bertalot, 1986, p. 757, pl. 157, figs. 1-8. Fig. 2. I & J

Synonym: *Gomphonema apiculatum* Ehrenberg.

Valves somewhat obovate wedge-shaped, sharply attenuated from the broader head pole towards the foot pole; with broader apiculate head pole, foot pole acutely rounded. Axial area linear. Raphe filiform; proximal ends simple, rounded; distal ends ventrally deflected. Central area formed by the median striae shortened on one side of the central nodule, and an isolated puncta at the other side ending. Striae uniseriately punctate, almost parallel at the central nodule, otherwise slightly radiate; puncta reinform. Dimension: 11-13 × 52-55 μm, striae 9-10 in 10 μm.

6. *Gomphonema clavatum* Ehrenberg, Krammer and Lange-Bertalot, 1986, p. 769, pl. 163, figs. 1-12. Fig. 3. A

Synonym: *Gomphonema longiceps* Ehrenberg; *Gomphonema mustela* Ehrenberg; *Gomphonema montanum* Schumann; *Gomphonema subclavatum* (Grunow) Grunow; *Gomphonema commutatum* Grunow; *Gomphonema mexicanum* Grunow; *Gomphocymbella obliqua* (Grunow) O. Müller.

Valves clavate, tapering with concave margins towards acutely rounded foot pole, with cuneate head pole. Axial area narrow. Raphe filiform, proximal end simple. Central area formed by the median striae shortened on one side of the central nodule, and an isolated puncta at the other side ending. Striae uniseriately punctate, slightly radiate or parallel. Dimension: 6-8 × 28-31 μm, striae 13-15 in 10 μm.

7. *Gomphonema clevei* Fricke, Patrick and Reimer, 1975, p. 161, pl. 18, fig. 6. Fig. 3. G-J

Valves clavate, with broadly rounded, obtuse head pole, narrowing with slightly concave margins to narrower rounded foot pole, widest in the middle part of the valve. Axial and central area forming narrowly rhomboidal area. Striae uniseriately punctate, slightly radiate throughout most of the valve; puncta slit-like. A isolated punctum in the central area. Dimension: 4-6 × 18-34 μm, striae 11-15 in 10 μm.

8. *Gomphonema gracile* Ehrenberg, Bateman and Rushforth, 1984, p. 69, pl. 11, fig. 152; Foged, 1979, p. 58, pl. 37, fig. 11; Foged, 1981, p. 98, pl. 53, figs. 15-16, 18; Fungladda and Kaczmarska, 1983, p. 77, pl. 10, fig. 166; Gasse, 1986, p. 64, pl. 29, figs. 5-6, 12-13; Güttinger, 1994, plate 2.05.24-5; Hadi *et al.*, 1984, p. 551, pl. 11, fig. 201; Krammer and Lange-Bertalot, 1986, p. 755, pl. 156, figs. 1-11. Fig. 3. B & C

Synonym: *Gomphonema lanceolatum* Ehrenberg; *Gomphonema grunowii* Patrick.

Valves narrowly rhomboidal, barely heteropolar, very slightly asymmetrical to the transverse axis; head pole attenuated, foot pole acutely rounded. Axial area narrow. Central area small, somewhat rounded, unilateral. Raphe slightly sinuous, proximal ends rounded, distal ends hooked in the same direction. Striae uniseriately punctate, almost parallel; median striae widely separated; puncta slit-like; the midmost one side furnished with an isolated punctum; the opposite side with a quite shortened striae. Dimension: 7-15 × 45-56 μm, striae 15-16 in 10 μm.

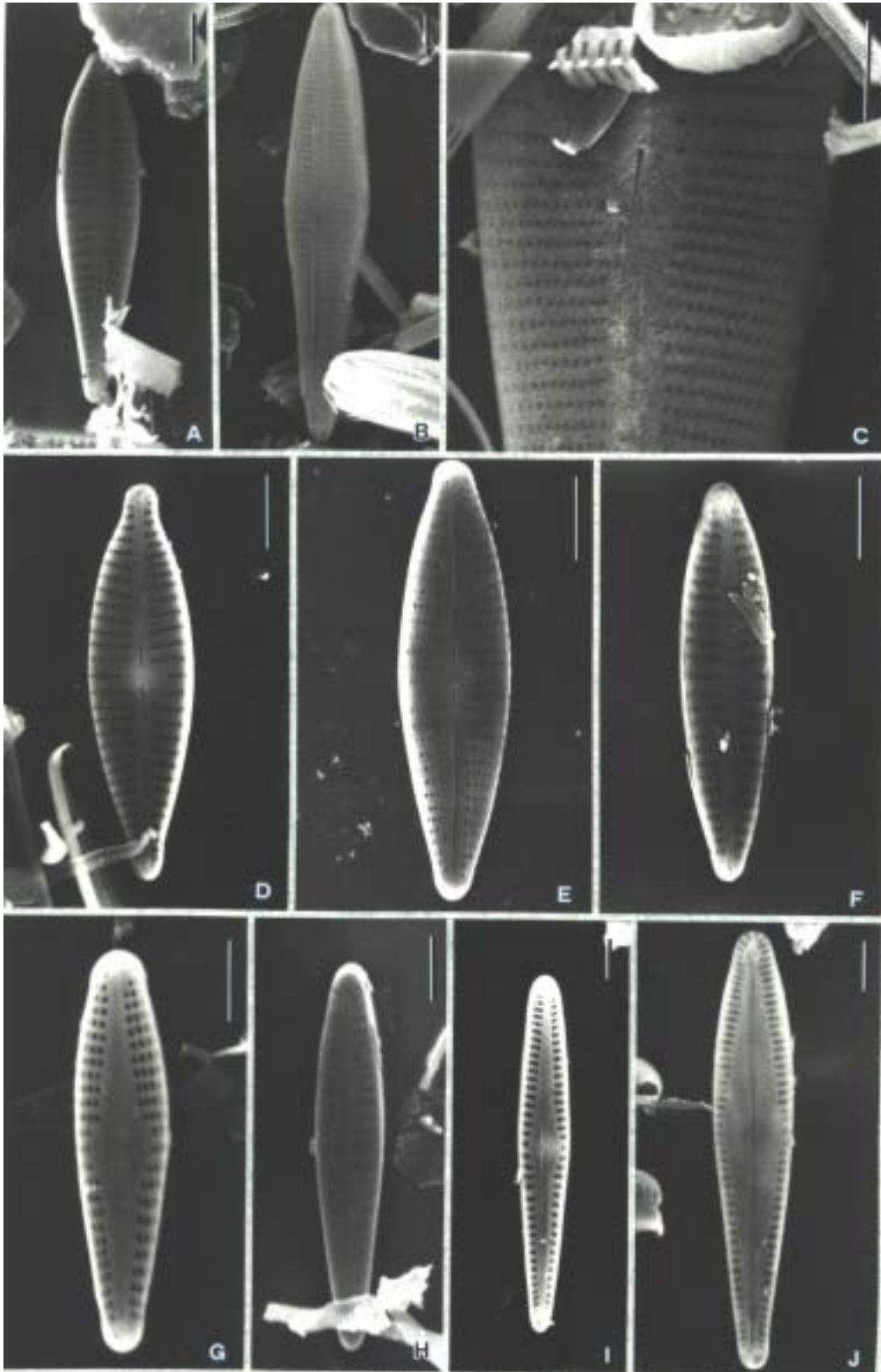


Fig. 3. A. *Gomphonema clavatum* Ehr. external valve. B & C. *Gomphonema gracile* Ehr. B. External valve. C. Part of the external valve showing rounded proximal raphe ends and slit-like puncta. D-F. *Gomphonema parvulum* (Kützing) Kützing external valve. G-J. *Gomphonema clevei* Fricke external valve. Bar = 4  $\mu$ m.

9. *Gomphonema parvulum* (Kützing) Kützing, Bateman and Rushforth, 1984, p. 71, pl. 12, figs. 162-163; Foged, 1979, p. 59, pl. 37, fig. 7; Gasse, 1986, p. 67, pl. 30, figs. 4-6, 8-10; Güttinger, 1994, plate 2.05.24-11; Hadi *et al.*, 1984, p.553, pl. 12, fig. 208; John, 1983, p. 142, pl. 59, figs. 7-9; Krammer and Lange-Bertalot, 1986, p. 751, pl. 154, figs. 1-25.

Fig. 3. D-F

Synonym: *Sphenella parvula* Kützing; *Gomphonema lagenula* Kützing; *Gomphonema micropus* Kützing.

Valves clavate, elliptical or lanceolate; with rounded, rostrate, subrostrate or capitate head poles, tapering quite sharply to narrowly rounded or rostrate foot poles. Axial area narrow. Raphe straight, proximal end simple, distal ends hooked in the same direction. Central area apparently unilateral, formed by a shortened median striae, the opposite median stria terminated in a distinct punctum. Striae uniseriately punctate, parallel or slightly radiate, central striae slightly widely arranged than the others; striae reinform. Dimension: 4-6 × 12-24 μm, triae 14-20 in 10 μm.

10. *Gomphonema truncatum* Ehrenberg, Fungladda and Kaczmarek, 1983, p. 77, pl. 10, figs. 164-165; Güttinger, 1994, plate 2.05.24-3; John, 1983, p. 143, pl. 59, figs. 10-11; Krammer and Lange-Bertalot, 1986, p. 761, pl. 159, figs. 11-18.

Fig. 4. A-C

Synonym.: *Gomphonema constrictum* Ehrenberg; *Gomphonema capitatum* Ehrenberg; *Gomphonema turgidum* Ehrenberg.

Valve clavate, heteropolar, constricted below the broad rounded head pole, occasionally lacking any valvar constriction before the apex, head pole never wider than the center of the valve, with attenuated narrow and rounded foot pole. Axial area linear. Raphe sinuous, twice recurved, proximal end rounded, distal end ventrally deflected. Central area irregular with the central striae short and long alternately arranged, a single isolated punctum present on one side of the central area. Striae uniseriately or biseriately punctate, slightly radiate, each puncta occluded by a single reniform vola. Dimension: 11-14 × 25-41 μm, striae 8-14 in 10 μm.

Order Naviculales  
Family Brachysiraceae  
Genus *Brachysira* Kützing 1836

Valves linear, lanceolate or rhombic; with bluntly rounded or capitate ends. Axial area narrow, sometimes expanded centrally. Raphe filiform. Striae uniseriately punctate, puncta transapically elongated.

1. *Brachysira steindorfiana* Moser, Lange-Bertalot et Metseltin, Moser *et al.*, 1998, p. 279, pl. 37, figs. 5-9.

Fig. 5. A

Valves lanceolate, symmetrical to longitudinal axis. asymmetrical to the transverse axis; ends subrostrate. Axial area linear, widening in the middle of the valve. Central area longitudinally elongated. Raphe straight, filiform; proximal ends straight, simple. Striae uniseriately punctate, nearly parallel in the middle, radiate towards the ends, puncta transapically elongated. Dimension: 5-6 × 23-25 μm, striae 30-32 in 10 μm.

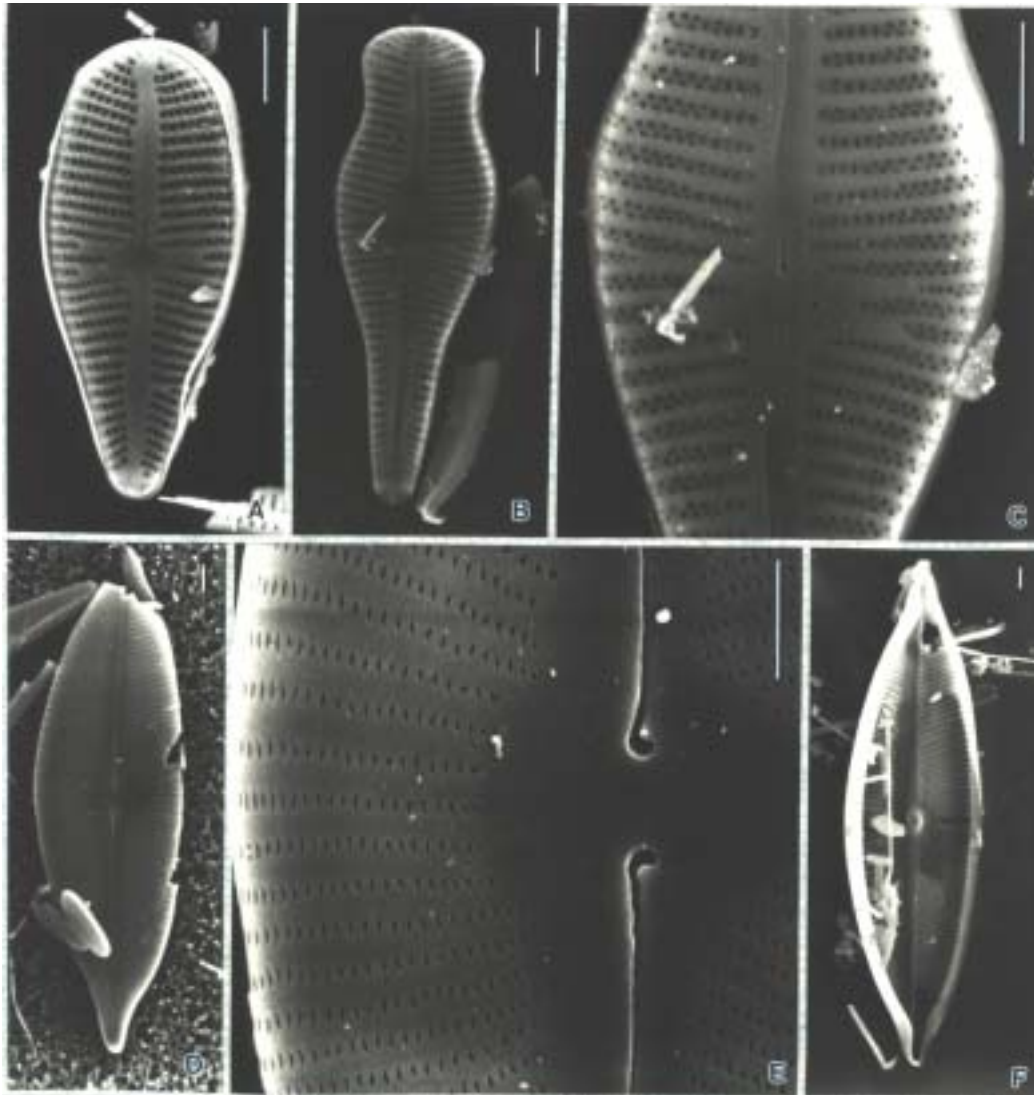


Fig. 4. A-C. *Gomphonema truncatum* Ehrenberg. A, B. External valve. C. Part of the external valve showing biseriately punctate striae and a single isolated punctum present on one side of the central area. D-F. *Cymbella cuspidata* Kützing raphid valve. D. External valve. E. Part of the external valve showing slit-like puncta and ventrally crochet-hooked proximal ends. F. Internal valve. Bar = 4 µm.

Family Diadesmidaceae

Key to genera

- 1a. Valves with stauroid central area ..... *Luticola*
- 1b. Valves without stauroid central area ..... *Diadesmis*

Genus *Diadesmis* Kützing 1844

Valves lanceolate, ends bluntly rounded. Axial and central areas forming a lanceolate clear space; the ends of the raphe at the central nodule often somewhat distant. Raphe sometimes filled in. Central raphe endings and external polar endings all simple or T-shaped. Striae uniseriate punctate, radiate at the ends.

1. *Diadesmis confervacea* Kützing, Krammer and Lange-Bertalot, 1986, p. 591, pl. 75, figs. 29-31; Gasse, 1986, p. 88, pl. 22, fig. 12; Patrick and Reimer, 1966, p. 555, pl. 45, fig. 9; Güttinger, 1994, plate 2.05.31-37. Fig. 5. B & C

Synonym: *Diadesmis peregrina* W. Smith; *Navicula confervacea* var. *hungarica* Grunow; *Navicula confervacea* (Kützing) Grunow; *Navicula confervacea* var. *peregrina* Grunow.

Valve lanceolate to broadly-lanceolate; ends rounded obtuse. Axial area near ends of the valve narrow; widening into a rhomboidal or lanceolate area extending over most of the valve. Central area not distinguished from the axial area. Raphe filled-in, proximal ends at the central nodule often simple, slightly broader than the raphe valve or slightly T-shaped, distal ends simple. Striae uniseriately punctate, radiate at the ends, puncta transapically elongated. Dimension: 5-8 × 18-22 μm, striae 22-30 in 10 μm.

#### Genus *Luticola* Mann 1990

Valve linear, lanceolate or elliptical; ends bluntly rounded to capitate. Raphe straight, digital ends curved in the same directions. Axial area narrow. Central area transversally expanded, penetrated on one side by a transverse stigma; on one side of the valve, opposite the stigma, the inner wall of the canal elaborated into a flap-like structure extending in towards the center of the valve. Striae uniseriately punctate, more or less radiate at the ends but not convergent.

1. *Luticola mutica* (Kützing) Mann f. *intermedia* Hustedt, Foged, 1979, p. 76, pl. 25, figs. 14, 16. Fig. 5. D

Synonym: *Navicula mutica* Kützing f. *intermedia* Hustedt.

Valve broadly lanceolate, widest in the center; ends bluntly rounded. Raphe straight, proximal ends simple; digital ends curved in the same directions. Axial area narrow. Central area transversally expanded, penetrated on one side by a transverse stigma; on one side of the valve, opposite the stigma, the inner wall of the canal elaborated into a flap-like structure which extending in towards the center of the valve; two distinct puncta alone present alongside the raphe in the central area. Striae uniseriate, transversely elongated punctate, more or less radiate at the ends, irregularly shortened at the central area. Dimension: 7-8 × 22-23 μm, striae 23-24 in 10 μm.

#### Family Stauroneidaceae Genus *Stauroneis* Ehrenberg 1843

Valves linear, linear-lanceolate to lanceolate, naviculoid; ends rostrate or capitate. Axial area and central area usually corresponding to stauros, stauros thickened internally, laterally expanded to the margins of the valve. Striae uniseriately punctate, mostly radiate to parallel, or convergent near the ends.

1. *Stauroneis tackei* (Hustedt) Krammer et Lange-Bertalot, Krammer and Lange-Bertalot, 1986, p. 623, pl. 91, figs. 12-13. Fig. 5. E & F

Synonym: *Stauroneis palustris* Hustedt; *Navicula tackei* Hustedt.

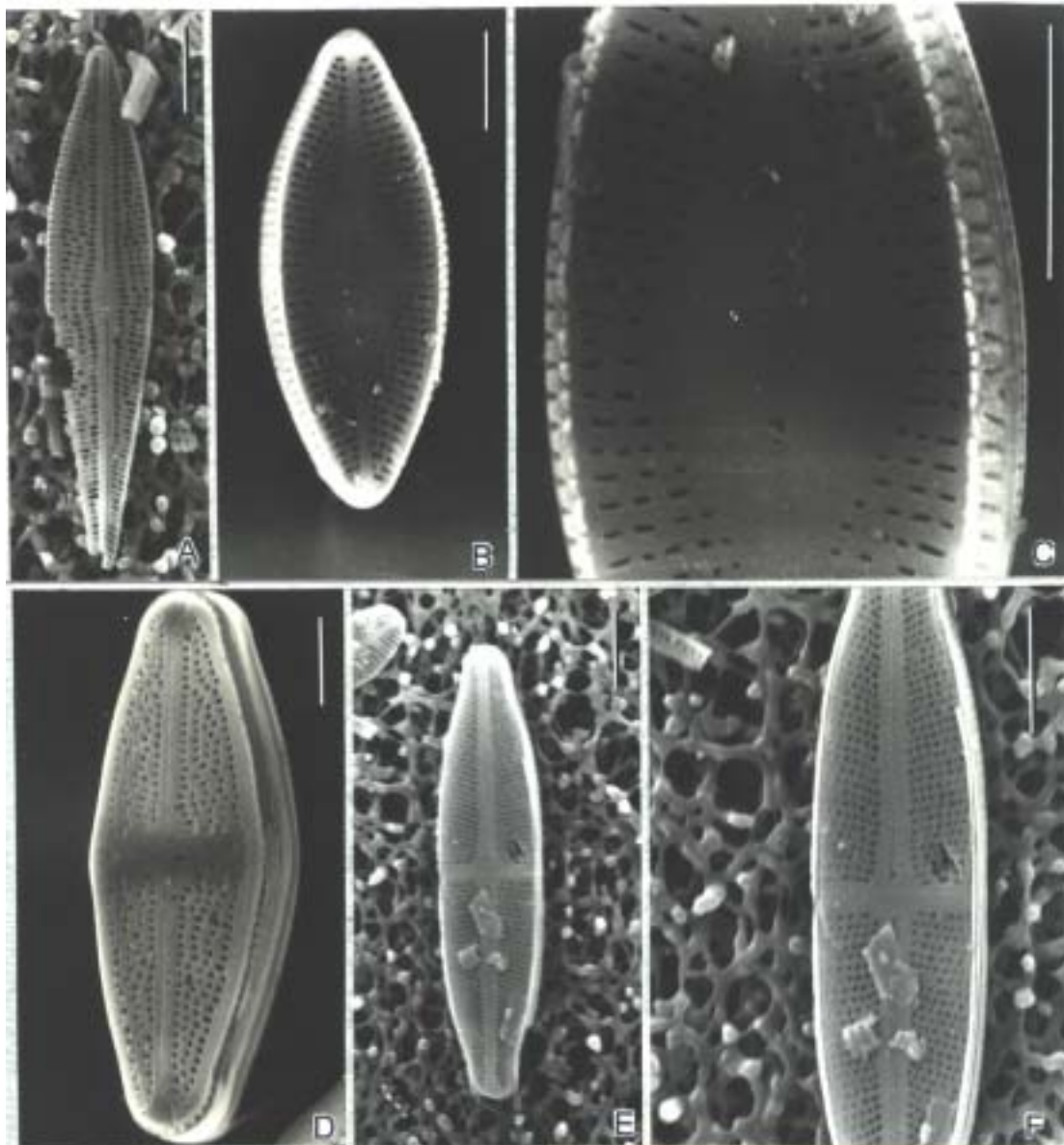


Fig. 5. A. *Brachysira steindorfiana* Moser, Lange-Bertalot et Metseltin external valve. B & C. *Diadesmis confervacea* Kützing. B. External valve. C. Part of the external valve showing transapically elongated puncta and slightly T-shaped proximal raphe ends. D. *Luticola mutica* (Kützing) Mann f. *intermedia* Hustedt external valve. E & F. *Stauroneis tackei* (Hustedt) Krammer & Lange-Bertalot. E. External valve. F. Part of the external valve showing transversely elongated puncta and rounded proximal raphe ends. Bar = 4  $\mu$ m.

Valves linear-elliptical with parallel to slightly convex sides; ends rostrate. Axial area linear, broad, widening at the ends. Raphe filiform, straight; proximal ends closed, rounded; distal ends hooking in the same direction. Central area transversely elongated, reaching towards the margins of the valves. Striae uniseriately punctate, radiate; puncta transversely elongated, striae pattern interrupted centrally by a internal thick stauros, stauros extended out from the almost equally thickening axial area. Dimension: 5-7  $\times$  25-27  $\mu$ m, striae 28-32 in 10  $\mu$ m.

## DISCUSSION

Mystery Lake is an oligotrophic, slightly acidic lake. The diatom assemblages found in this environment were characterized by very rich in those taxa belonging to Achnanthaceae, Eunotiaceae, Fragilariaceae, Cymbellaceae, Gomphonemataceae, Brachysiraceae, Diadesmidaceae, Stauroneidaceae, and Sellaphoraceae. Previous study had reported the first three families. In this article, we further described the other five families. Among them, genera such as *Diadesmis* and *Luticola* were formerly placed in *Navicula* (cf. Krammer and Lange-Bertalot, 1988). Either genus is easily separated from the other naviculoid diatoms by the combination of stria and raphe structure, valve shape and colonial habit.

*Cymbella* is a large and diverse genus. *Encyonema* was recognized by Krammer (1982) as a subgenus within *Cymbella*. However, Round *et al.* (1990) separated *Encyonema* at generic level by its ventral plastid, dorsal nucleus and the orientation of the raphe system. As a matter of fact, the orientation of the raphe systems are opposite in either genus. In this article, we adopted the opinion of Round *et al.* (1990).

Among 23 taxa described here, seven were new to the checklist of freshwater diatoms published in the past for Taiwan (cf. Wang and Chen, 2000). In addition, the genus *Brachysira* has never been reported in Taiwan. Therefore, it is a new record to Taiwan.

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## 台灣神祕湖的矽藻(II)

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### 摘 要

神祕湖位於台灣東北部南澳闊葉林保護區內，屬於中海拔略酸性的貧養湖。此湖中滋長豐富的矽藻種類，本文描述在湖積物出現之 23 種，分屬於 5 科 7 屬。其中有 7 種為台灣的新紀錄種，即 *Cymbella cuspidata*、*Cymbella mongolica*、*Encyonema gracile*、*Gomphonema augur* var. *turris*、*Gomphonema clavatum*、*Brachysira steindorfiana* 和 *Luticola mutica* f. *intermedia* 等。*Brachysira* 屬於台灣新記錄屬。本文主要係以掃描電子顯微鏡下觀察到的微細形態構造為依據。

關鍵詞：矽藻、神祕湖、形態、南澳自然保留區。

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