Diatom Research (1990) Vol. 5 (2), 351-366

STUDIES ON *EUNOTIA* SPECIES IN THE CLASSICAL "DEGERNÄS MATERIALS" HOUSED IN THE SWEDISH MUSEUM OF NATURAL HISTORY

Shigeki Mayama

Department of Biology, Tokyo Gakugei University, Koganei-shi, Tokyo 184, Japan

Hiromu Kobayasi

Tokyo Diatom Institute, Honcho 3-8-9-813, Koganei-shi, Tokyo 184, Japan

Ehrenberg established the genus *Eunotia* from Degernä Diatomite in 1837 and described eight species: *E. arcus, E. faba, E. diodon, E. triodon, E. diadema* and *E. serra*. In 1854 he added two more, *E. bactriana* and *E. hexaglyphis*. We have examined classical material labelled "Degernäs" housed in the Swedish Museum of Natural History, which contains 37 taxa, including 10 *Eunotia* species. The species we observed are extremely similar to those reported by Ehrenberg.

INTRODUCTION

Ehrenberg (1837) analyzed Degernä diatomite sent from Prof. Retzius in Stockholm and reported 22 taxa. In the paper he established a new genus *Eunotia* and described seven new species - *E. serra, E. diadema, E. pentodon, E. triodon, E. diodon, E. arcus*, and *E. faba* - based only on the dorsal morphology of their valves, but no figures were provided. In the following year he published "Die Infusionsthierchen als vollkommene Organismen" (1838) and here figures were presented. Ehrenberg gave two localities for each taxon - Degernfors (=Degernä) in Sweden and Kymmene Gård in Finland - except for *E. pentodon* and *E. serra*, for which he gave only Degernfors. For the other five species, he did not indicate from which material their figures were drawn. In the "Mikrogeologie" (Ehrenberg 1854, pl. 16/1), he gave only one locality, Degernfors, and he also described three other new species: *E. bactriana, E. hexaglyphis* and *E. quindenaria*. A re-analysis of the Degernä diatomite is clearly essential for determining the typification of the *Eunotia* species mentioned above. Unfortunately, however, although many Ehrenberg slides are housed in the Museum of Natural History, Berlin, nobody has yet reported discovering slides of Degernä diatomite.

We have analyzed three samples of diatomite labelled "Degernäs" which are housed in a herbarium of the Swedish museum of Natural History, Stockholm. Degernäs is the name of a locality in Degerfors, Sweden. The spellings of "Degernäs" and "Degerfors" are different from the names of the localities cited by Ehrenberg. Dr Hannelore Håkansson considers that the names quoted by Ehrenberg must have been misspelt, because she could not think of another locality in Sweden with a name similar to "Degernä or Degernfors" (personal communication). Our observations have revealed that the s

pecies complement in these diatomite samples is markedly similar to that reported in the "Mikrogeologie".

MATERIALS AND METHOD

The material examined was found among Cleve's collections, housed in the Swedish museum of Natural History, and consisted of three bottles of diatomite. The bottles were labelled as follows: "247 Degernäs, groft" (= our number K-6686); "247 Degernäs, fint" (= K-6687); "247 Degernäs, residus" (= K-6688). The diatomite was cleaned as described by Mayama & Kobayasi (1984) and mounted in Pleurax for light microscopy. The slides prepared were numbered as follows: H.K. 3082, from K-6686; H.K. 3083, from K-6687; H.K. 3084, from K-6688. After all the specimens on the prepared slides had been examined and identified, 600 valves encountered in H.K. 3082 were counted to calculate the relative abundance of each taxon. In this paper, relative abundances were indicated for all taxa appearing in the 600 valve count; taxa appearing only in the preliminary taxonomic survey are listed as "rare".

OBSERVATIONS AND DISCUSSION

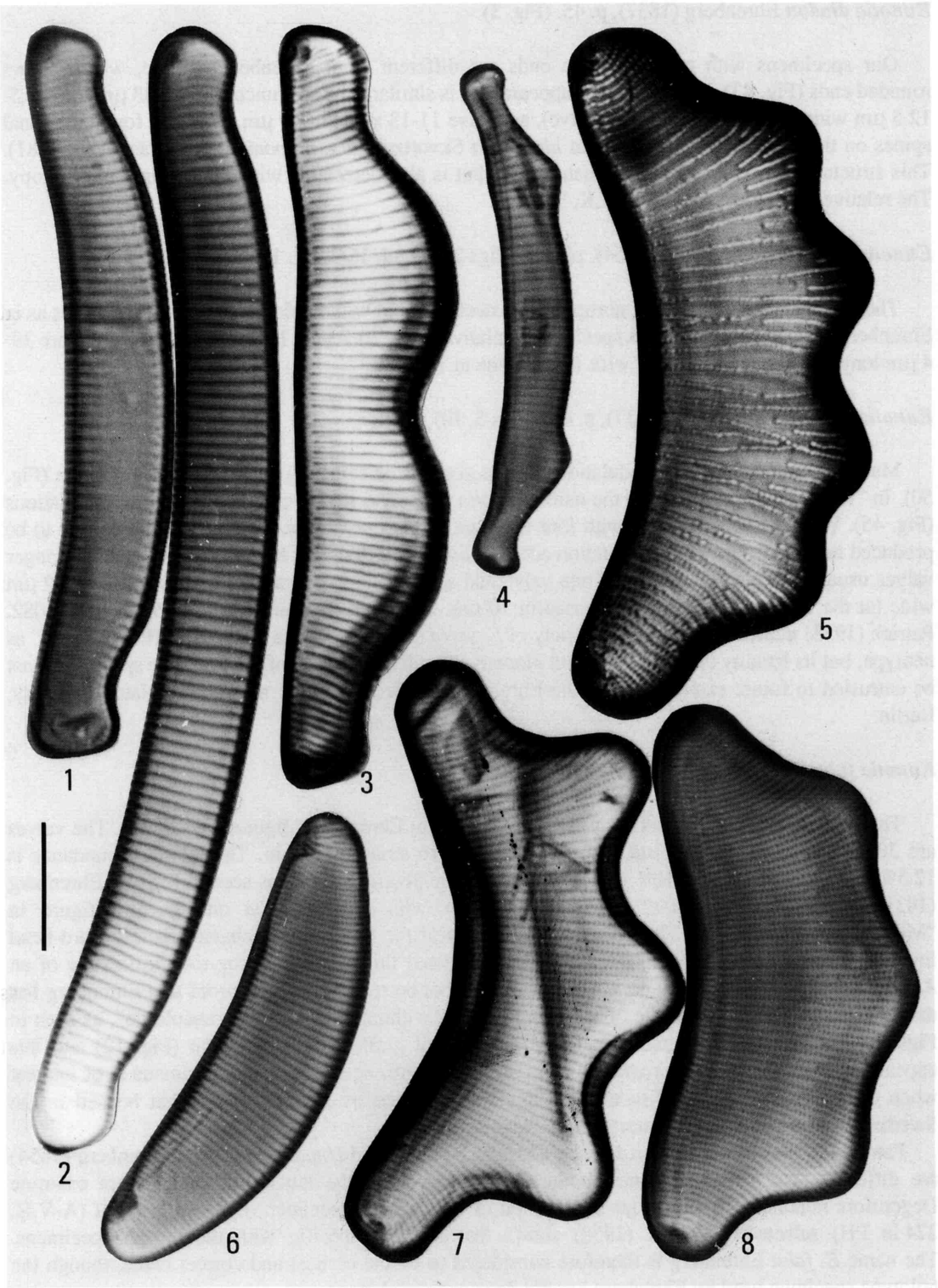
The three slides were extremely similar in this species complement and contained valves whose outlines resemble those shown in the figures in "Mikrogeologie" (Ehrenberg 1854). However, details of the figures are sometimes different from those of our specimens, and the names given by him are often different from those currently used.

Eunotia species

We identified ten *Eunotia* species from the Degernäs material. Nine of the species seem to correspond with *Eunotia* species drawn by Ehrenberg in "Mikrogeologie", although three of them are classified by him as species of *Himantidium*, *Synedra* and *Achnanthes*.

Eunotia arcus Ehrenberg (1837) p. 45. (Figs 1, 2)

This species was designated as the type species of the genus *Eunotia* by Boyer (1927). From our observations, the ventral margin is concave and the dorsal margin is convex, and they are almost parallel in the main body of the valve. The dorsal margin of the shorter specimens tends to be more constricted and bent back at the valve ends than that of the longer ones, as is also seen in Ehrenberg's "Mikrogeologie" (Figs 41, 42). This gives the appearance of a less ventrally concave and more dorsally convex margin in the short specimens. We found an initial valve paired with a first vegetative valve in SEM observation, but they had no constriction of the valve ends (Mayama & Kobayasi 1990). The length of the initial valve is 115 µm. The minimum valve length is 29 µm. In the valve centre the valve width is 6.5-10.5 µm and the striae density is about 11-14 in 10 µm. Ehrenberg (1854) classified this species in *Himantidium* (as *H. arcus*), but the material contains no filamentous colonies except for paired sibling cells just after cell division. This taxon is dominant in all slides observed and the relative abundance is 23.7% in H.K. 3082.



Figs 1-8. *Eunotia* species found in H.K. 3082, Degernäs. Scale bar = 10 µm. Figs 1, 2. *E. arcus*. Fig. 3. *E. diodon*. Fig. 4. *E. bactriana*. Fig. 5. *E. diadema*. Fig. 6. *E. faba*. Figs 7, 8. *E. triodon*.

Eunotia diodon Ehrenberg (1837), p. 45. (Fig. 3)

Our specimens with truncate valve ends are different from Ehrenberg's figure, which shows rounded ends (Fig. 43), but the general appearances is similar. The specimens are 63-43 μm long, 9.5-12.5 μm wide (in the widest part of valve), and have 11-13 striae in 10 μm. We have found marginal spines on the dorsal side as in *Eunotia nipponica* Skvortzow var. *nipponica* (Kobayasi *et al.* 1981). This structure can be noticed easily using SEM but is also detectable with careful light microscopy. The relative abundance is 4.8% in H.K. 3082.

Eunotia bactriana Ehrenberg (1854), pl. 16/1, figs 29-30; pl. 16/2, fig. 19 (Fig. 4)

The specimens have peculiar, abrupt dorsal swellings and without doubt are the same species as in Ehrenberg's figure (Fig. 44). This species was relatively rare (0.2 % in H.K. 3082). The valves are 39-4 μm long and about 5 μm wide, with 14-15 striae in 10 μm.

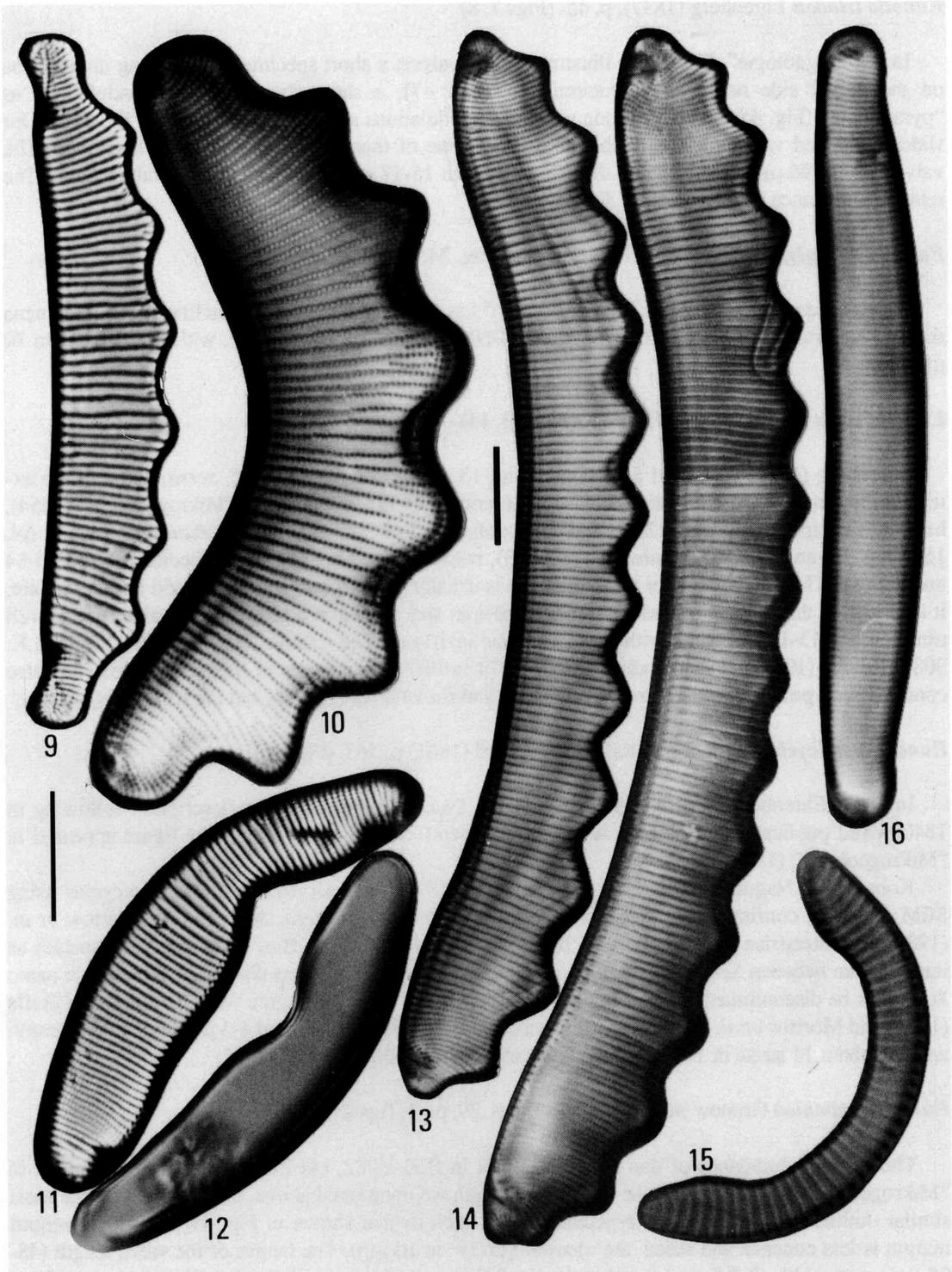
Eunotia diadema Ehrenberg (1837), p. 45. (Figs 5, 10)

Many specimens have six undulations on the dorsal side (Fig. 10) as in Ehrenberg's figure (Fig. 50). In "Mikrogeologie", he gave the name *Eunotia tetraodon* to the species having four undulations (Fig. 45). We did find specimens with four undulations but only rarely (Fig. 5), and these seem to be produced as a result of the size reduction accompanying cell division. In our observations, the longer valves usually have six undulations; one valve had seven. The valves are 53-62 μm long, 16-19 μm wide (at the widest part), with 9-11 striae in 10 μm. The relative abundance is 0.7% in H.K. 3082. Patrick (1958) treated this taxon as a variety of *E. serra* and designated a slide "A-V.H. 274 in PH" as neotype, but its locality is not Degernä but Norway. The determination of the true type specimen must be entrusted to future examination of the Ehrenberg's collection in the museum of Natural History, Berlin.

Eunotia faba Ehrenberg (1837), p. 45. (Figs 6, 11, 12)

The normal specimens observed were quite similar to Ehrenberg's figure (Figs 6, 46). The valves are 30-45 μm long, 7.5-10.5 μm wide, and have 12-16 striae in 10 μm. The relative abundance is 12.5% in H.K. 3082. About 10% ofthe specimens were aberrant forms, as seen in Fig. 11. Ehrenberg (1837) described *Achnanthes? inaequalis* together with *Eunotia faba* and gave a figure in "Mikrogeologie" (Fig. 51). The ventral valve margin of the former has a characteristic inward bend inwardly near the centre. Ehrenberg probably considered this as representing the girdle view of an *Achnanthes*. The figure shows no striae, but this cannot be recognized as a proof that Ehrenberg has drawn a girdle view, because he often showed valves without striae in "Mikrogeologie", as seen in Figs 44, 49, 52, etc. We sometimes found an aberrant girdle band of *E. faba* (Fig. 12) and this appearance resembles *A. inaequalis*. In any case, the occurrence of aberrant specimens is of interest when considering the possibility that the material observed by Ehrenberg and that housed in the Swedish museum of Natural History may be identical.

Patrick (1958) considered that *E. faba* Ehrenberg (1837) and *Himantidium faba* Ehrenberg (1854) are different taxa and gave a new name *E. vanheurckii* to the latter, but she did not examine Degernfors material. However, our observation of the neotype specimen of *E. vanheurckii* (A-V.H. 274 in PH) selected by Patrick (1958) shows that it is conspecific with the present specimens. The name *E. faba* Ehrenberg is therefore considered to be the earliest and correct name, though the holotype specimen used by Ehrenberg has not been examined by us.



Figs 9-15. *Eunotia* species found in H.K. 3082, Degernäs. Scale bars = 10 µm. (Long bar for Figs 9-12, 15, 16. Short bar for Figs 13, 14.) Fig. 9. *E. hexaglyphis*. Fig. 10. *E. diadema*. Figs 11, 12. *E. faba*. Fig. 11. Aberrant valve. Fig. 12. Aberrant girdle band. Figs 13, 14. *E. serra*. Fig. 15. *E. hemicyclus*. Fig. 16. *E. lapponica*.

Eunotia triodon Ehrenberg (1837), p. 45. (Figs 7, 8)

In "Mikrogeologie", Ehrenberg illustrated three valves: a short specimen with strong undulations on the dorsal side noted as "semicircularis" (Fig. 47), a short one with weak undulations as "pyramidata" (Fig. 48) and a long one with weak undulations as "depressa" (pl. 16/1. fig. 31b). Our slides contained various forms of this taxon and some of them are quite similar to his figure. The valves are 32-96 μm long and 13.5-20 μm wide, with 15-17 striae in 10 μm at the valve centre. The relative abundance is 9.2% in H.K. 3082.

Eunotia hexaglyphis Ehrenberg (1854), pl. 16/1, fig. 34; pl. 16/2, fig. 24. (Fig. 9)

Though the original figure in "Mikrogeologie" has no striae (Fig. 49), the outline of our specimens resembles Ehrenberg's figure. The valves are 54-60 μm long, 10-11 μm wide, with 12-16 striae in 10 μm. Rare.

Eunotia serra Ehrenberg (1837), p. 45. (Figs 13, 14)

Ehrenberg (1837) described a specimen with 13 dorsal undulations as *E. serra*, and later he extended the range of the undulation to 12-13 (Ehrenberg 1838). However, in "Mikrogeologie" (1854), he identified specimens with 12, 13 and 15 undulations as *E. serra* (Fig. 52), *Eunotia serrulata* (pl. 16/1, fig. 36) and *Eunotia quindenaria* (Fig. 53), respectively. We have found specimens with 10-14 undulations. Though the number of undulations is usually an even number and an odd number is rare, it is clear that the number of undulations decreases as size reduction proceeds. The valves are 96-128 μm long and 13-16 μm wide, with about 11 striae in 10 μm. The relative abundance is 0.2% in H.K. 3082. Patrick (1958) selected a slide "A-V.H. 274 in PH" as a neotype of this taxon. This slide also contains neotypes of *Eunotia serra* var. *diadema* and *Eunotia vanheurckii*, but the locality is Norway.

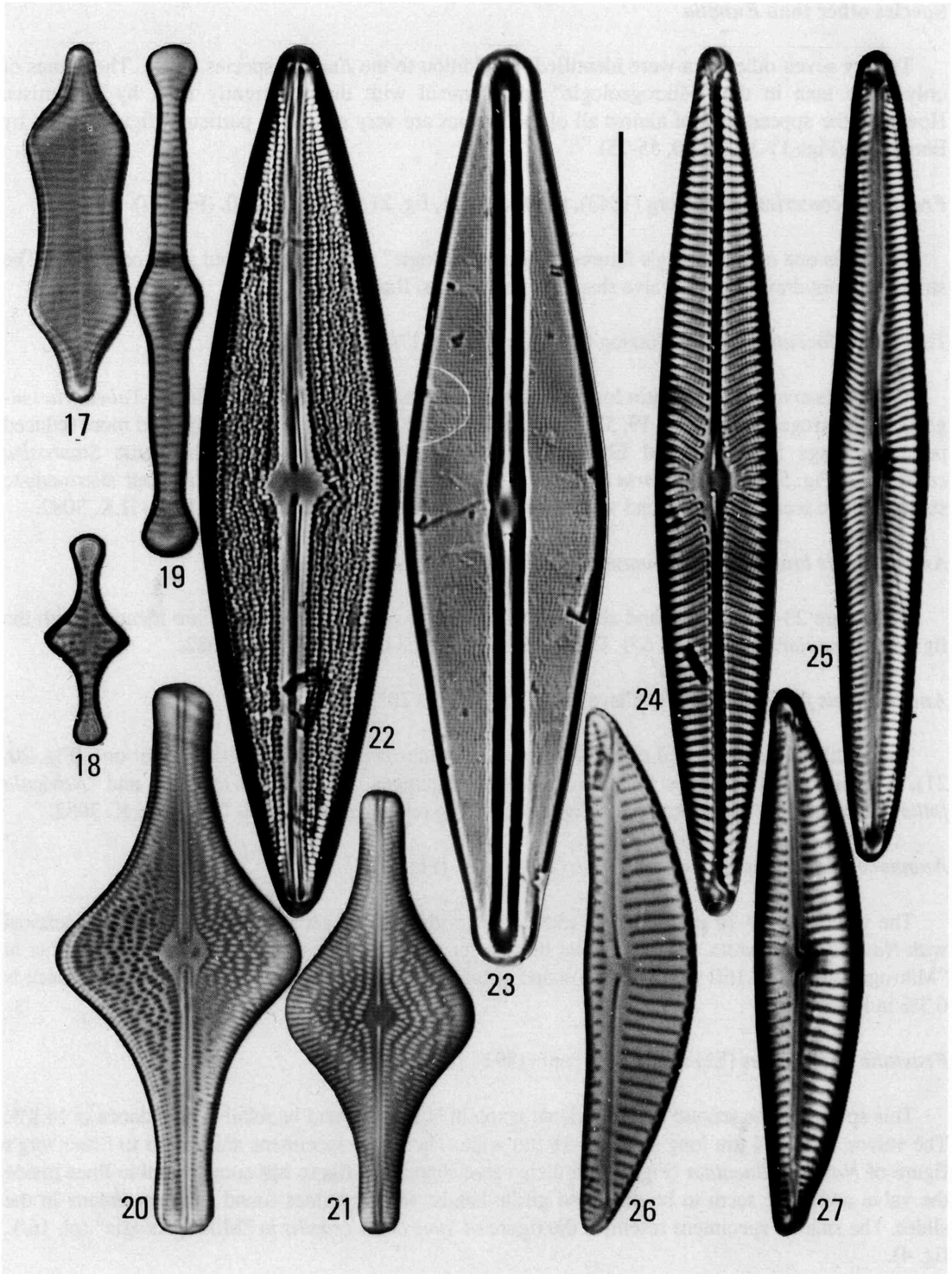
Eunotia hemicyclus (Ehrenberg) Ralfs in Pritchard (1861) p. 763. (Fig. 15).

In 1837, Ehrenberg published the name alone, *Synedra hemicyclus*, the description following in 1840. Valid publication of the epithet *hemicyclus* therefore dates from 1840. The figure appeared in "Mikrogeologie" (1854).

Kobayasi & Nagumo (1978) and Moss *et al.* (1978) have observed *Semiorbis hemicyclus* using SEM and have confirmed the presence of a raphe. *Eunotia catillifera*, described by Morrow *et al.* (1981), has interstriae with an unevenly developed transapical ridge. They considered this species as intermediate between *Semiorbis* and typical *Eunotia*, and suggested that the use of the generic name *Semiorbis* be discontinued. Comparing the structure of these taxa, we agree with the opinion of Ralfs (1861) and Morrow *et al.* The valves we observed were 35-55 μm long and 4-5 μm wide in the centre, and had about 11 striae in 10 μm. The relative abundance is 0.2% in H.K. 3082.

Eunotia lapponica Grunow in A. Cleve (1895), p. 29, pl. 1, figs 29-30. (Fig. 16)

The relative abundance of this species is 4.3% in H.K. 3082, but Ehrenberg did not record it in "Mikrogeologie". Of the species he did record, which we mentioned above, the species with the most similar outline is *Eunotia arcus*, especially forms such as that shown in Fig. 41, though its ventral margin is less concave and striae are denser (17-19 in 10 μm). The ranges of the valve length (48-85 μm) and width (7-8.5 μm) overlap those of *E. arcus*, and it is likely that Ehrenberg could not distinguish these two forms.



Figs 17-27. Species found in H.K. 3082, Degernäs. Scale bar = 10 µm. Fig. 17. *Fragilaria constricta*. Figs 18, 19. *Tabellaria flocculosa*. Figs 20, 21. *Anomoeoneis follis*. Fig. 22. *A. serians*. Fig. 23. *Frustulia rhomboides*. Fig. 24. *Navicula radiosa*. Fig. 25. *Cymbella amphioxys*. Fig. 26. *C. mesiana*. Fig. 27. *C. hebridica*.

Species other than *Eunotia*

Twenty seven other taxa were identified, in addition to the *Eunotia* species above. The names of only three taxa in the "Mikrogeologie" are identical with those currently used by diatomists. However, the appearances of almost all of the species are very similar to particular figures given by Ehrenberg (Figs 17-32, 36-40, 55-75).

Fragilaria constricta Ehrenberg (1843), p. 415, pl. 1/1, fig. 21; pl. 3/6, fig. 10. (Fig. 17)

Fig. 55 is one of Ehrenberg's figures in "Mikrogeologie" (pl. 16/1), labelled as *F. constricta*. The striae were not drawn but the valve shape resembles ours. Rare.

Tabellaria flocculosa (Roth) Kützing (1844), p. 127, pl. 17/21. (Figs 18, 19)

Valves observed are 15-40 μm long. Long valves resemble the figure identified as *Tabellaria vulgaris* in "Mikrogeologie" (Figs 19, 57). Short valves have abrupt central swellings and more reduced polar swellings (Fig. 18), and Ehrenberg presents similar figures under the name *Staurosira construens* (Fig. 56) and *Tabellaria biceps* in "Mikrogeologie" (pl. 16/1. fig. 21) and our intermediate size specimen seems to correspond well to the latter. The relative abundance is 0.7% in H.K. 3082.

Anomoeoneis brachysira (Brébisson) Grunow in Cleve (1895), p.7. (Fig. 29)

Valves are 23-32 μm long and about 7 μm wide. The valve size and shape are identical with the figure of *Pinnularia fulva* (Fig. 67). The relative abundance is 11.2% in H.K. 3082.

Anomoeoneis follis (Ehrenberg) Cleve (1895), p. 7. (Figs 20, 21)

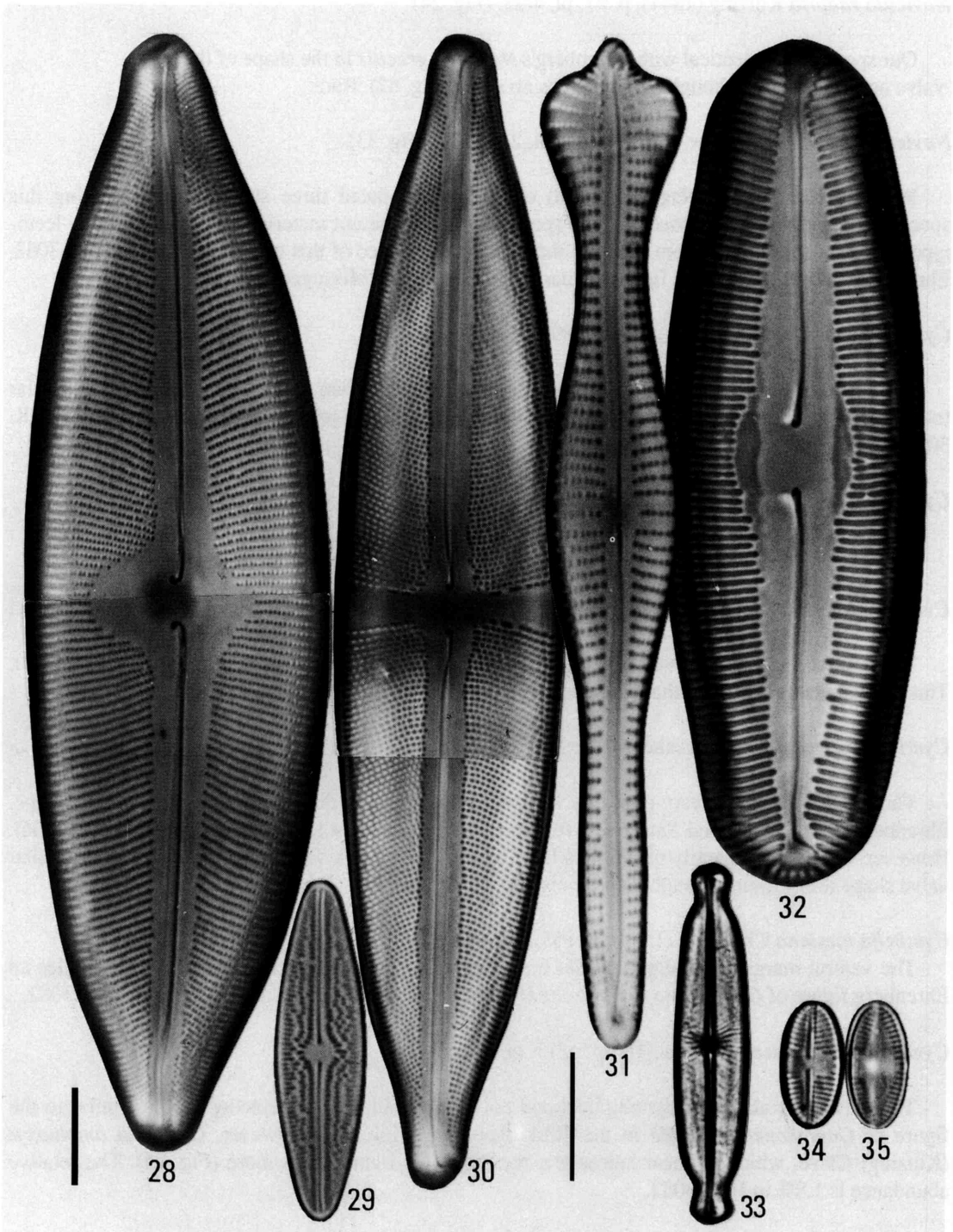
The width of the valve end of the shorter valve is narrower than that of the longer one (Fig. 20, 21). A similar relationship is found between the specimens of "*Navicula trochus*" and "*Navicula follis*" illustrated in "Mikrogeologie" (Figs 58, 59). The relative abundance is 0.2% in H.K. 3082.

Anomoeoneis serians (Brébisson) Cleve (1895), p. 7. (Fig. 22)

The valves are 49-70 μm long and 13.5-15 μm wide. The longer specimens seem to be identical with *Navicula punctulata* (Fig. 60) while the shorter ones resembles the figure of *Navicula fulva* in "Mikrogeologie" (pl. 16/1 fig. 2), in the shape of the valve and central area. The relative abundance is 6.3% in H.K. 3082.

Frustulia rhomboides (Ehrenberg) De Toni (1891), p. 277 (Fig. 23)

This species is the second most abundant taxon in H.K. 3082 and its relative abundance is 14.8%. The valves are 48-94 μm long and 11.5-18 μm wide. The larger specimens are similar to Ehrenberg's figure of *Navicula lineolata* (Fig. 61) in their valve shape. His figure has some rhombic lines inside the valve and these seem to be displaced girdle bands; we sometimes found such specimens in the slides. The smaller specimens resemble the figure of *Stauroneis gracilis* in "Mikrogeologie" (pl. 16/1. fig. 4).



Figs 28-35. Species found in H.K. 3082, Degernäs. Scale bars = 10 µm. (Long bar for Figs 29, 31-35. Short bar for Figs 28, 30.) Fig. 28. *Cymbella heteropleura*. Fig. 29. *Anomoeoneis brachysira*. Fig. 30. *Stauroneis phoenicenteron*. Fig. 31. *Gomphonema acuminatum*. Fig. 32. *Caloneis obtusa*. Fig. 33. *Navicula subtilissima*. Figs 34, 35. *Achnanthes marginulata* Fig. 34. Raphid valve. Fig. 35. Araphid valve.

Navicula radiosa Kützing (1844), p. 91, pl. 4/23. (Fig. 24)

Our specimen is identical with Ehrenberg's *Navicula gracilis* in the shape of the valve and central area, though his figure has no striae (Fig. 62). Rare.

Navicula subtilissima Cleve (1891), p. 37, pl. 2, fig. 35. (Fig. 33)

Recently Kobayasi & Nagumo (1988) clearly differentiated three similar taxa, including this species, using electron-microscopy. The specimens in the present material are identical to the lectotype specimen selected by them. Though the relative abundance of this species is 0.7% in H.K. 3082, Ehrenberg has not presented a figure similar to this species in "Mikrogeologie".

Cymbella amphioxys (Kützing) Cleve (1894), p. 164. (Fig. 25)

As is seen in Fig. 25, the valve has a less cymbelloid shape than usual. The valve shape is similar to the figure of Ehrenberg's *Gomphonema gracile* (Fig. 63). The relative abundance is 0.3% in H.K. 3082.

Cymbella gracilis (Ehrenberg) Kützing (1844), p. 79, pl. 6/9.

There is no figure similar to this species in Ehrenberg (1854, pl. 16/1). Rare.

Cymbella hebridica (Grunow) Cleve (1894), p. 169. (Fig. 27)

The ventral margin is convex but the valve shape is not so naviculoid as in *Cymbella amphioxys*. This appearance is similar to that of Ehrenberg's *Cocconema fusidium* (Fig. 65). Rare.

Cymbella heteropleura (Ehrenberg) Kützing (1844), p. 79. (Fig. 28)

Though this species is very rare, it is very noticeable because of its large size and peculiar shape. Ehrenberg (1854) described *Stauroneis inaequalis* originally as a large cymbelloid taxon (Fig. 66). However, his figure is clearly of a *Cymbella*. The *C. heteropleura* we observed shows a very similar valve shape to his figure, though he presents parallel striae. Rare.

Cymbella mesiana Cholnoky (1955), p. 160, figs 11-12. (Fig. 26)

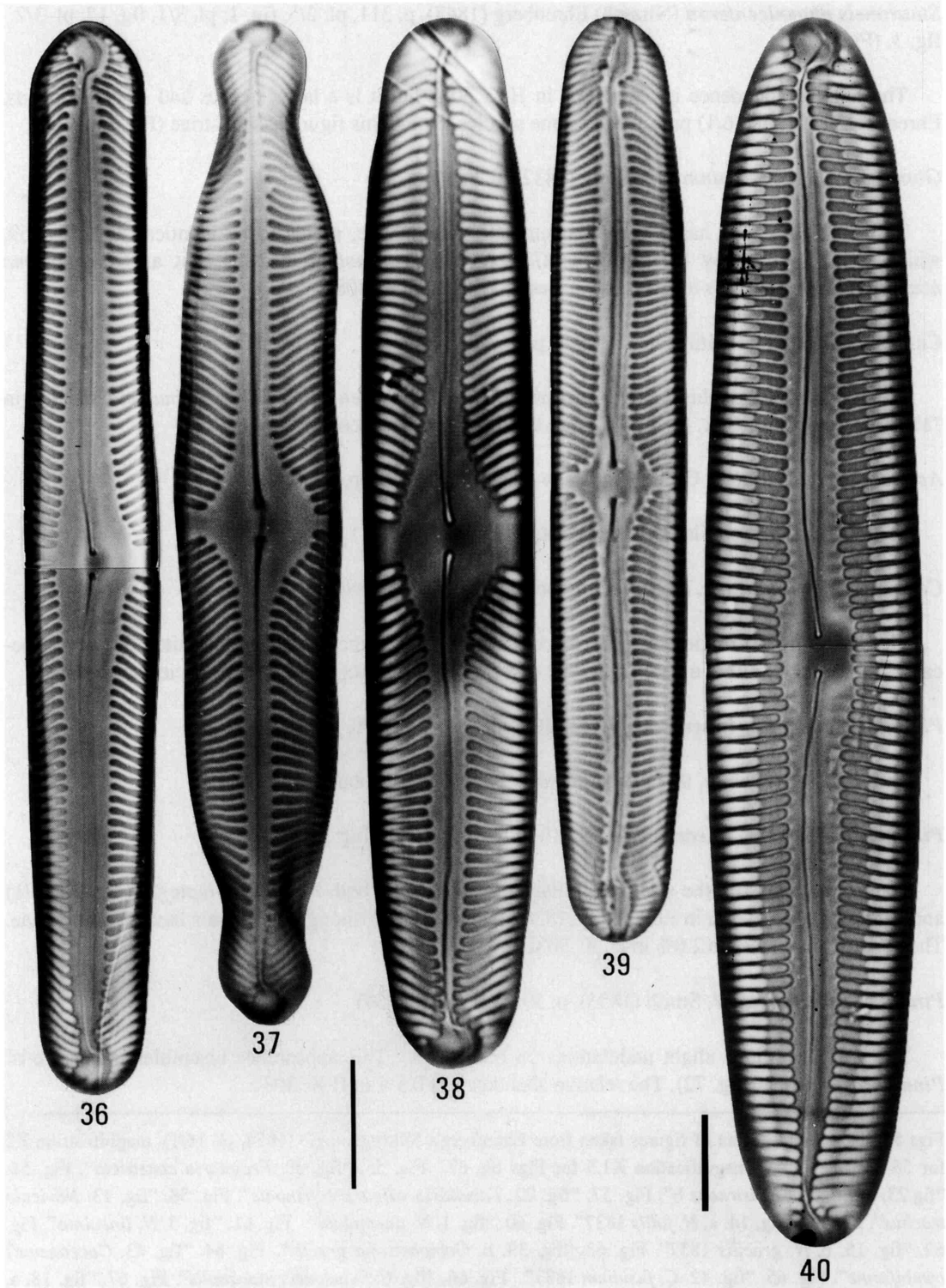
The ventral margin is straight and has a slight swelling in the centre. This species resembles an Ehrenberg figure of *Cocconema cymbiforme* (Fig. 64). The relative abundance is 0.7% in H.K. 3082.

Cymbella naviculacea Grunow (1881), p. 13, pl. 6/11.

The valves are almost linear-elliptical and not cymbelloid, the shape being a little similar to the figure of *Gomphonema gracile* in the "Mikrogeologie" (Fig. 63). However, *Cymbella amphioxys* (Kützing) Cleve, which is linear-lanceolate, resembles his figure much more (Fig. 25). The relative abundance is 1.8% in H.K. 3082.

Cymbella naviculiformis (Auerswald) Cleve (1894), p. 166.

This species resembles no figure in Ehrenberg (1854). Rare.



Figs 36-40. *Pinnularia* species found in H.K. 3082. Degernäs. Scale bars = 10 µm. (Long bar for Figs 37-39. Short bar for Figs 36, 40). Fig. 36. *P. gibba* var. *linearis*. Fig. 37. *P. interrupta*. Fig. 38. *P. microstauron*. Fig. 39. *P. stomatophora*. Fig. 40. *P. viridis*.

Stauroneis phoenicenteron (Nitzsch) Ehrenberg (1843), p. 311, pl. 2/5, fig. 1; pl. 3/1, fig. 17; pl. 3/2. fig. 3. (Fig. 30)

The relative abundance is only 0.3% in H.K. 3082 but it is a large species and so conspicuous. Ehrenberg (1854, pl. 16/1) presents the same species, though his figure has no striae (Fig. 68).

Gomphonema acuminatum Ehrenberg (1832), p. 88. (Fig. 31)

This species, which has a very characteristic valve shape, seems to be identical with Fig. 69, which was identified by Ehrenberg as *Gomphonema coronatum* in 1854, but as *Gomphonema acuminatum* in 1837. The relative abundance is 1.5% in H. K. 3082.

Caloneis obtusa (W. Smith) Cleve (1894), p. 54. (Fig. 32)

The valve shape of this taxon is similar to *Navicula semen* (Fig. 70) or *Pinnularia suecica*_in "Mikrogeologie" (pl. 16/1. fig. 12), though the latter figure has coarser striae. Rare.

Achnanthes marginulata Grunow in Cleve & Grunow (1880), p. 21. (Figs 34, 35)

There is no figure similar to this species in Ehrenberg (1854). Rare.

Cocconeis placentula **var.** ***lineata*** (Ehrenberg) Van Heurck (1880-1885), p. 133.

Ehrenberg (1837) reports an occurrence of *Cocconeis* in the Degernä diatomite. However, because of the lack of either a specific epithet or a figure, we cannot know which species he observed.

Pinnularia gibba **Ehrenberg var.** ***gibba*** (1844), p. 98, pl. 28/70.

This taxon is very rare, though var. *linearis* is a little more abundant.

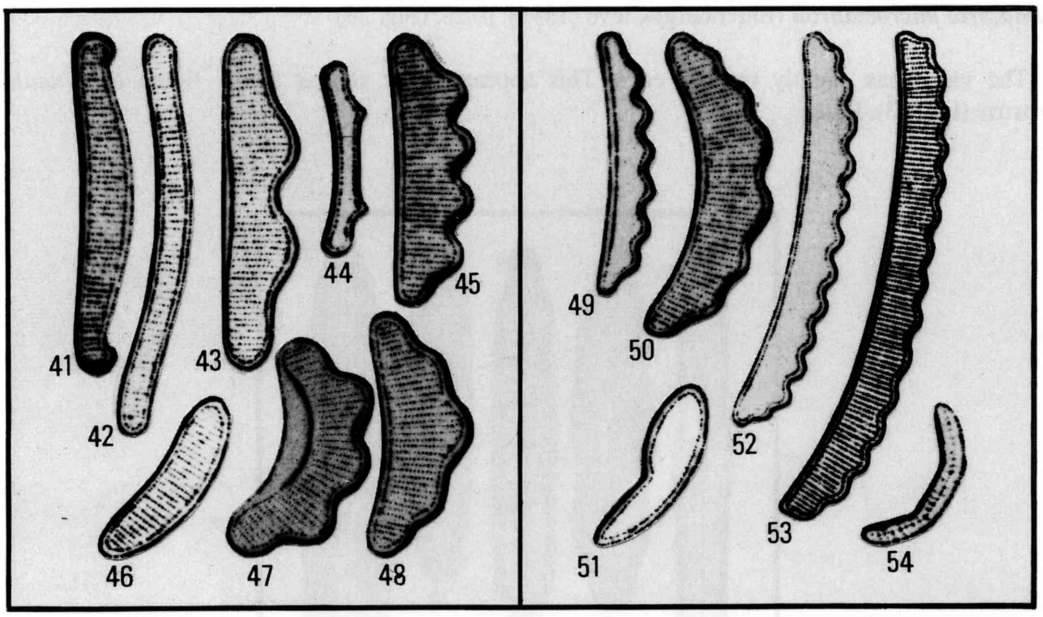
Pinnularia gibba **var.** ***linearis*** Hust. (1930), p. 327, fig. 604. (Fig. 36)

The valve shape and the size are similar to the figures of both *Pinnularia leptogongyla* (Fig. 71) and *Pinnularia macilenta* in Ehrenberg (1854, pl. 16/1, fig. 9), though his figures have parallel striae. The relative abundance is 2.0% in H. K. 3082.

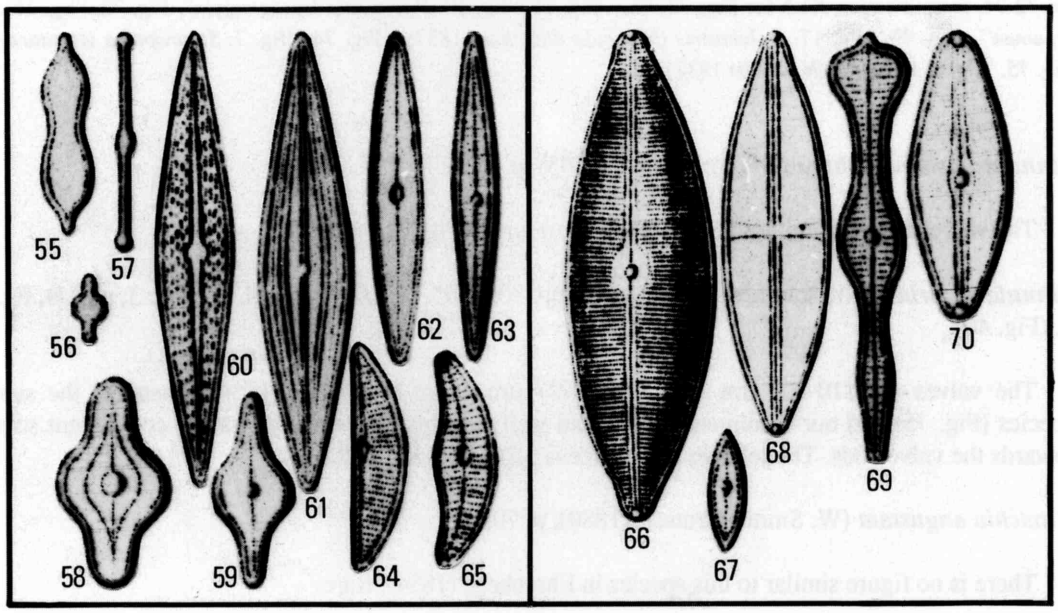
Pinnularia interrupta W. Smith (1853), p. 59. 19/184. (Fig. 37)

The valve has three slight undulations on both sides. This appearance resembles the figure of *Pinnularia legumen* (Fig. 72). The relative abundance is 0.5% in H.K. 3082.

Figs 55-70. Rearrangement of figures taken from Ehrenberg's Mikrogeologie (1854, pl. 16/1). magnification X2 for 55-65, 67, 69, 70. magnification X1.5 for Figs 66, 67. Fig. 55. "fig. 20. *Fragilaria constricta*". Fig. 56. "fig.23. *Staurosira construens* b". Fig. 57. "fig. 22. *Tabellaria vulgaris* b *trinodis*". Fig. 58. "fig. 13. *Navicula trochus*". Fig. 59. "fig. 14. a. *N. follis* 1837". Fig. 60. "fig. 1. *N. punctulata*". Fig. 61. "fig. 3. *N. lineolata*". Fig. 62. "fig. 15. b. *N. gracilis* 1837". Fig. 63. "fig. 39. b. *Gomphonema gracile*". Fig. 64. "fig. 43. *Cocconema*? *cymbiforme*". Fig. 65. "fig. 42. *C. fusidium* 1837". Fig. 66. "fig. 6. *Stauroneis inaequalis*". Fig. 67. "fig. 18. a. *Pinnularia fulva*". Fig. 68. "fig. 5. *S. phoenicenteron (N. phoenicenteron*_1837)". Fig. 69. "fig. 40. a. *G. coronatum*". Fig. 70. "fig. 11. *N. semen*?".

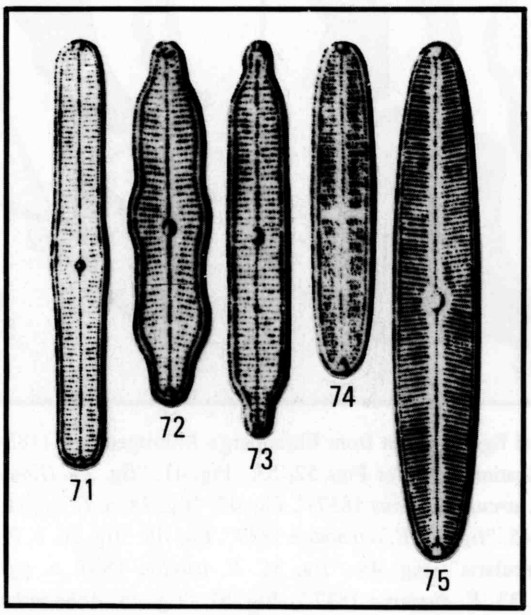


Figs 41-54. Rearrangement of figures taken from Ehrenberg's Mikrogeologie (1854, pl. 16/1). magnification X2 for Figs 41-51, 54. magnification X1.5 for Figs 52, 53. Fig. 41. "fig. 24. *Himantidium arcus (Eunotia arcus* 1837)". Fig. 42. "fig. 27. *H. arcus (E. arcus* 1837)". Fig. 43. "fig. 28. a. *E. zygodon (E. diodon* 1837)". Fig. 44. "fig. 30. *E. bactriana*". Fig. 45. "fig. 32. *E. tetraodon* 1837". Fig. 46. "fig. 26. b. *E. faba* 1837". Fig. 47. "fig. 31. *E. triodon* 1837. a. semicircularis". Fig. 48. "fig. 31. *E. triodon* 1837. c. pyramidata". Fig. 49. "fig. *E. hexaglyphis*". Fig. 50. "fig. 33. *E. diadema* 1837". Fig. 51. "fig. 45. *Achnanthes? inaequalis* 1837". Fig. 52. "fig. 35. a. *E. serra* 1837". Fig. 53. "fig. 37. *E. quindenaria*". Fig. 54. "fig. 38. a. *Synedra? hemicyclus* 1837".



Pinnularia microstauron (Ehrenberg) Cleve (1891), p. 28. (Fig. 38)

The valve has slightly rostrate ends. This appearance is similar to the figure of *Pinnularia birostris* (Fig. 73). Rare.



Figs 71-75. Rearrangement of figures taken from Ehrenberg's Mikrogeologie (1854, pl. 16/1). magnification X2 for 72-74. magnification X1.5 for Figs 71, 75. Fig. 71. "fig. 10. *Pinnularia leptogongyla*". Fig. 72. "fig. 16. *P. legumen*". Fig. 73. "fig. 17. *P. birostris* (*Navicula dicephala* 1837)". Fig. 74. "fig. 7. *Stauroptera isostauron*". Fig. 75. "fig. 8. *P. viridis* (*N. viridis* 1837)".

Pinnularia stomatophora (Grunow) Cleve (1895), p. 83. (Fig. 39)

The valve shape is similar to *Stauroptera isostauron* (Fig. 74). Rare.

Pinnularia viridis (Nitzsch) Ehrenberg (1843), pp. 305, 385, pl. 1/1, fig. 7; pl. 1/3, fig. 3; pl. 1/4, fig. 3. (Fig. 40)

The valves are 110-200 μm long and 21-27 μm wide. Ehrenberg (1854) illustrates the same species (Fig. 75) and our specimens correspond well with his figure except for the convergent striae towards the valve ends. The relative abundance is 3.2% in H.K. 3082.

Nitzschia angustata (W. Smith) Grunow (1880), p. 70.

There is no figure similar to this species in Ehrenberg (1854). Rare.

Overall, we identified a total of 37 taxa from the materials housed in the Swedish museum of Natural History. We consider that 28 of these taxa correspond to 39 taxa in "Mikrogeologie" (1854, pl. 16/1). Ehrenberg reported a total of 43 taxa from Degernfors diatomite but we could not find four of

them, namely *Cocconema leptoceros, Gallionella distans, Pyxidicula operculata*, and the brackish species *Achnanthes brevipes*. It is difficult now to appreciate the difficulties and limitations affecting Ehrenberg as he worked on the diatoms for the "Mikrogeologie", when microscopy was in its infancy. The fact that we observed specimens that are very similar to 39 of the 43 figures drawn by Ehrenberg is extraordinary. The diatomite sent to Ehrenberg was added to flour and the mixture used to bake bread during a flour shortage due to a bad crop in 1832 in Sweden. Therefore, there must have been a large quantity of diatomite originally. It seems possible that more of it is still preserved elsewhere. There is a high possibility that the materials we examined and Ehrenberg's materials are both portions from the same lump of diatomite. Our only regret is that the material we studied bears no indication of anyone's name or date. However, from this classical topotype material, nine well known *Eunotia* species described originally by Ehrenberg are clearly confirmed to be the same taxa as recognized by most authors today.

ACKNOWLEDGEMENTS

We wish to thank Dr. Thor-Biörn Engelmark and Dr. Nils Lundqvist of the Swedish Museum of Natural History for providing materials from Cleve's collections. We would also like to thank Dr. Hannelore Håkansson of the University of Lund for her kind response to our geographical and historical questions.

REFERENCES

BOYER, C. S. (1927). Synopsis of North American Diatomacea. *Proceedings of the Academy of Natural Sciences of Philadelphia*, **79**, supplement, part 2, 229-583

CHOLNOKY, B. J. (1955). Hydrobiologische Untersuchungen in Transvaal I. Vergleichung der herbstlichen Algengemein schaften in Rayton-vlei und Leeufontein. *Hydrobiologia*, **7**, 137-209

CLEVE, A. (1895). On recent freshwater diatoms from Lule Lappmark in Sweden. *Bihang till Kongliga Svenska vetenskapsakademiens handlingar*, **21**, Afd. III (2), 1-44

CLEVE, P. T. (1881). Färskvattens-Diatomaceer från Grønland och Argentinska Republiken. *Öfversigt af Kongliga vetenskapsakademiens Förhandlingar*, **38** (10), 3-13

CLEVE, P. T. (1891). The diatoms of Finland. *Acta Societatis pro fauna et flora fennica*, **8** (2), 1-68

CLEVE, P. T. (1894-1895). Synopsis of naviculoid diatoms. *Kongliga Svenska vetenskapsakademiens handlingar*, **26**, 1-194; **27**, 1-219

CLEVE, P. T. & GRUNOW, A. (1880). Beiträge zur Kenntniss der arctischen Diatomeen. *Kongliga Svenska vetenskapsakademiens handlingar*, **17** (2), 1-121

DE TONI, G. B. (1891). *Sylloge algarum omnium hucusque cognitarum*, **2**. Bacillarieae. sect. 1, Raphideae. 490 pp. T. Seminarii, Patavii

EHRENBERG, C. G. (1832). Über die Entwicklung und Lebensdauer der Infusions-thiere, nebst ferneren Beiträgen zu einer Vergleichung ihrer organischen Systeme. *Abhandlungen der königlichen Preussischen Akademie der Wissenschaften zu Berlin*, 1-154

EHRENBERG, C. G. (1837). Über ein aus fossilen Infusorien bestehendes, 1832 zu Brod verbackens Bergmehl von der Grenzen Lapplands in Schweden. *Bericht über die zur Bekanntmachung geeigneten Verhandlungen der Königlichen Preussischen Akademie der Wissenschaften zu Berlin*, 43-45

EHRENBERG, C. G. (1838). *Die Infusionsthierchen als vollkommene Organismen. Ein Blick in das tiefere organische Leben der Natur*. 548pp. L. Voss, Leipzig

EHRENBERG, C. G. (1840). Characteristik von 274 neuen Arten von Infusorien. *Bericht über die zur Bekanntmachung geeigneten Verhandlungen der Königlichen Preussischen Akademie der Wissenschaften Zu Berlin*, 197-219

EHRENBERG, C. G. (1843). Verbreitung und Einfluss des mikroskopischen Lenens in Süd- und Nord-Amerika. *Abhandlungen der königlichen Preussischen Akademie der Wissenschaften zu Berlin*, Theil 1, 291-445. pl. 1-4

EHRENBERG, C. G. (1854). *Mikrogeologie. Das Erden und felsen schaffende Wirken des unsichtbar kleinen selbstständigen Lebens auf der Erde*. 374 pp. 40 pls. L. Voss, Leipzig.

HUSTEDT, F. (1930). Bacillariophyta. In: *Die Süsswasser-Flora Mitteleuropas* (A. Pascher, ed.), **10** (2nd edition). Gustav Fischer, Jena.

KOBAYASI, H., ANDO, K. & NAGUMO, T. (1981). On some endemic species of the genus *Eunotia* in Japan. In: *Proceedings of the 6th Symposium on Recent and Fossil Diatoms*, (R. Ross, ed.), 93-114. O. Koeltz, Koenigstein

KOBAYASI, H. & NAGUMO, T. (1978). On the fine structure of the pennate diatom *Semiorbis hemicyclus* (Ehr.) Patr. *Japanese Journal of Phycology*, **26**, 171-175

KOBAYASI, H. & NAGUMO, T. (1988). Examination of the type materials of *Navicula subtilissima* Cleve (Bacillariophyceae). *Botanical magazine, Tokyo*, **101**, 239-253

KÜTZING, F. T. (1844). *Die kieselschaligen Bacillarien oder Diatomeen*. 152 pp. Nordhausen.

MAYAMA, S. & KOBAYASI, H. (1984). The separated distribution of the two varieties of *Achnanthes minutissima* Kuetz. according to the degree of river water pollution. *Japanese Journal of Limnology*, **45**, 304-312

MAYAMA, S. & KOBAYASI, H. (1990). Observations of *Eunotia arcus* Ehr., type species of the genus *Eunotia* (Bacillariophyceae). *Japanese Journal of Phycology* (in press)

MORROW, A. C., DEASON, T. R. & CLAYTON, D. (1981). A new species of the diatom genus *Eunotia*. *Journal of Phycology*, **17**, 265-270

MOSS, M. O., GIBBS, G., GRAY, V. & ROSS, R. (1978). The presence of a raphe in *Semiorbis hemicyclus* (Ehrenb.) R. Patr. *Bacillaria*, **1**, 137-150

PATRICK, R. (1958). Some nomenclatural problems and a new species and a new variety in the genus *Eunotia* (Bacillariophyceae). *Notulae Naturae*, **312**, 1-15

PRITCHARD, A. (1861). *A history of Infusoria, including the Desmidiaceae and Diatomaceae, British and foreign*, (4th edition). 968 pp. Whittaker & Co., London

SMITH, W. (1853). *Synopsis of the British Diatomaceae*, **1**, 89 pp. J. van Voorst, London

VAN HEURCK, H. (1880-1885). *Synopsis des Diatomees de Belgique*. Atlas, 132 pls. Ducaju & Cie., Anvers; Texte, 235 pp. m. Brouwers & Co., Anvers