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Eunotia sparsistriata sp. nov., a moss diatom from Mikura Island, Japan

by

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With 21 figures

In honour of Robert Ross on the occasion of his eightieth birthday

Abstract: A moss diatom, *Eunotia sparsistriata* has been newly described from Mikura Island (Mikura-jima), Japan. This species has very coarse transapical striae in the valve face, namely 4.5–8 in 10 μm, which is an unusual number in *Eunotia*. The detailed morphology of this species has been examined using a scanning electron microscope. This species is similar to *Eunotia biseriatoides* Kobayasi et al., but can be clearly differentiated by the coarseness of the areolae forming the transapical striae.

Introduction

In the past fifteen years, the Japanese moss diatoms have been researched vigorously by Ando (1977, 1978, 1979, 1981, 1982, 1985) and Kobayasi et al. (1981). In these studies, they recorded many *Eunotia* species from various localities. *Eunotia biseriatoides* Kobayasi, Ando et Nagumo was originally described in 1981 and considered to be an endemic species. This species is characterized by a low density of transapical striae, which is an unusual number in *Eunotia*.

Mikura Island (Mikura-jima) is a small island (ca 20.5 km^2) located in the Pacific Ocean (33° 52' N, 139° 36' E, ca 200 km south from the center of Tokyo). Although the diameter of the island is only 5 km, the highest altitude is 850 m. The lower area is warm, affected by an ocean current, and supports subtropical and warm-temperate plants; the higher area is cool, usually foggy, affected by strong winds, and is even covered with snow on some winter days. There has been no report regarding diatoms from this island yet.

Eunotia sparsistriata sp. nov. was found in moss diatom samples from Mikura Island. This species has a very coarse striation as seen in *Eunotia biseriatoides*. In this study, the morphology of *E. sparsistriata* is examined in detail.

Materials and methods

The materials of *Eunotia sparsistriata* were obtained from the following moss samples: K-6590 (sample number), moss moistened by an unnamed creek between Hariyama and Akazawa (altitude 380 m), Mikura Island (Mikura-jima), Tokyo, on 24 August 1987; K-6588, moss moistened by Shirokiya-Otsune-Somennagashi-no-Sawa (Shirokiya-Otsune-Somennagashi creek) (altitude 350 m), Mikura Island, Tokyo, on 24 August 1987. The material of *Eunotia biseriatoides* was obtained from moss sprayed by a waterfall: K-6942, moss, Kumaoshi Falls, Okayama Shinrin Park, Okayama Pref., Honshu Island (main island of Japan), on 15 October, 1988.

These moss materials were put in a vial with a small amount of water and were shaken well, and then the attached diatoms were removed from the moss surface, or they were subjected to ultrasonic vibrations to detach the diatoms from the moss surface. The cleaning methods for diatom cells are given in Mayama & Kobayasi (1984). Cleaned and dried diatom specimens were coated with Au-Pa on cover slips and were observed with scanning electron microscope (SEM, JEOL F15) at an accelerating voltage of 15 kV.

Description

Eunotia sparsistriata sp. nov. Figs 1–3, 6–19

Frustula rectangulata in aspectu cingulari. Valvae leviter arcuatae, margine ventrali leviter concava et margine dorsali conve, apicibus obtuse protractis et rotundatis, ca 39–91 µm longae, 9.5–13 µm latae. Striae transapicales parallelae in media parte valvae, 4.5–8 in 10 µm, prope apices leviter radiatae et densiores, usque ad 9–11 in 10 µm. Striae breves irregulariter insertae ad margine dorsali valvae. Cellulae in statu vivo, chloroplastis duobus elongatis et laminalibus.

Holotype: H.K.T.-99. This slide will be housed in the National Science Museum Tokyo, (TNS).
Type locality: unnamed creek between Hariyama and Akazawa, Mikura Island (Mikura-jima), Tokyo.

Frustules rectangular in girdle view. Valves slightly arcuate with slightly concave ventral margin and convex dorsal margin. Ends of the valves obtusely protracted and rounded, about 39–91 µm long and 9.5–13 µm wide. Transapical striae parallel in the middle, 4.5–8 in 10 µm, and 9–11 in 10 µm near the ends. Short striae irregularly inserted from the dorsal margin of the valve. Cells in living state with two elongated and laminated chloroplasts.

SEM observations and discussion

Externally, the valve face is corrugated and connects with the ventral mantle almost at a right angle (Figs 6, 7). The dorsal margin of the face is slightly rounded and connects

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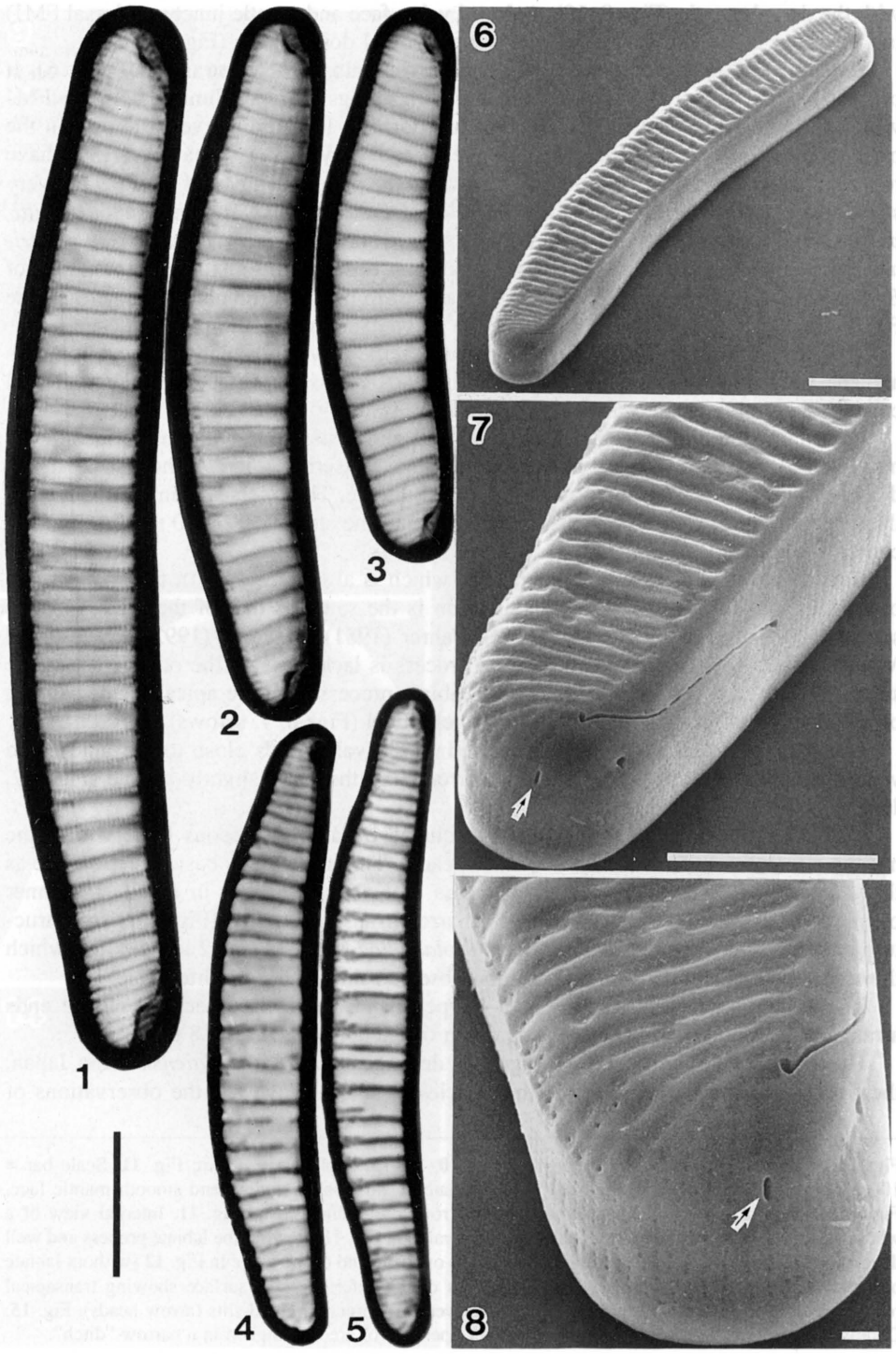
Figs 1–8. Figs **1–3, 6–8.** *Eunotia sparsistriata* sp. nov. Figs **4, 5.** *Eunotia biseriatoides* Kobayasi et al. Figs **1–7.** Scale bar = 10 µm; Fig. **8.** Scale bar = 1 µm. Figs **1–3.** Specimens showing the coarse striation regardless of the valve length. Fig. **2.** Holotype specimen. H.K.T.-99. unnamed creek between Hariyama and Akazawa, Mikura-jima, Tokyo. Figs **4, 5.** Specimens showing the similar striae density to *E. sparsistriata*. Fig. **6.** External oblique view of a whole valve showing a corrugated valve face. Fig. **7.** Enlargement of the valve in Fig. 6 showing the valve end with raphe branch, the longitudinal costa on the ventral valve face/mantle, (FMJ), and the outer opening of the labiate process (arrow). Fig. **8.** Details of the valve end showing the external polar raphe ending and the outer opening of the labiate process (arrow).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with the dorsal mantle (Figs 8, 10). A dorsal valve face and mantle juncture (dorsal FMJ) is sometimes heavily silicified to form a longitudinal dorsal costa (Figs 16, 18).

Externally, a pattern center, or a sternum, runs along the ventral FMJ (Fig. 6). It originates from both external polar raphe endings (Figs 6, 7) and unites with the FMJ within the raphe branch (Fig. 7) stretches and forms a longitudinal ventral costa in the main body (Fig. 6). Mayama (1992 in press) and Mayama & Kobayasi (1991) have reported that the locational relationships between the pattern center and the FMJ are very stable characteristics throughout the life cycles of *Eunotia arcus* Ehr. and *Eunotia multiplastidica* Mayama. In this study, I did not observe all vegetative valves of *E. sparsistriata* throughout the life cycle, because I could not observe any auxospore formation of *E. sparsistriata*. However, the locational relationship between the pattern center and the FMJ was stable regardless of the size of the valve examined.

The external polar raphe endings are located at the valve ends between the apical axis and the ventral side, and form prominent circular depressions (Figs 7, 8). The external central raphe endings are inflated and rounded (Fig. 9).

Externally, the interstriae are well developed and remarkably wide in the face of the main body (Figs 6–8, 10), and they sometimes have insertions of 1–3 short striae in the dorsal margin of the face and also in the dorsal mantle. The interstriae in the mantle are thinner than those of the face. The areolae forming the striae are 26–30 in 10 μm at the center of the face (Figs 14, 15).

Each valve has a single labiate process, which is always located in the apex of one of the poles as in Figs 11, 12. This situation is the same as that of the other *Eunotia* species observed by Moss et al. (1978), Wahrer (1981), Mayama (1992 in press) and Mayama & Kobayasi (1991). The labiate process is lacking from the other apex of the same valve (Fig. 13). The location of the labiate process is in the apical mantle almost on the apical axis, and the outer opening is elliptical (Figs 8, 7, arrows).

Internally, the helictoglossae are located in the valve ends close to the apical and ventral mantles, and the terminal areas surrounding them are slightly visible (Figs 12, 13).

The outer opening of each areola is occluded by a thin siliceous layer with some narrow circumferential slits (Fig. 14, arrowheads). This structure is basically the same as that of *Eunotia arcus* examined by Mayama & Kobayasi (1991) in detail. The inner openings of the areolae are aligned in the narrow transapical ditch (Fig. 15). This structure has also been observed in *Eunotia multiplastidica* Mayama (1992 in press), in which the stability of this characteristic has been observed throughout the life cycle.

The epicingulum is composed of 5–6 open bands, with the open and closed ends arranged alternately (Figs 16–19). The depth of the epitheca is 15–18 μm.

Hustedt (in A. Schmidt 1933) originally described *Eunotia sendaiensis* from Japan, the figures of which are similar to this species in shape. However, the observations of

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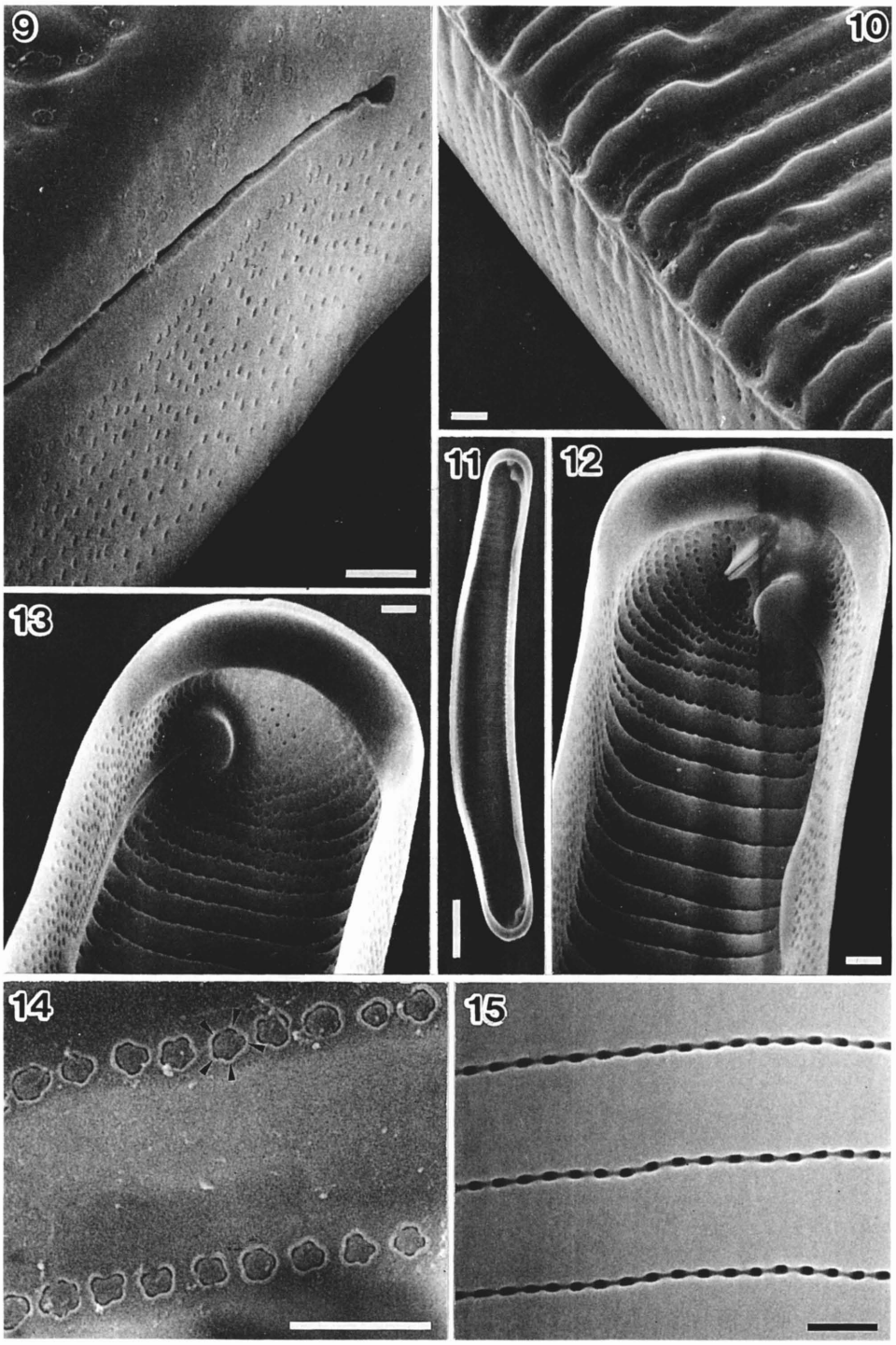
Figs 9–15. *Eunotia sparsistriata* sp. nov. Figs **9, 10, 12–15.** Scale bar = 1 μm; Fig. **11.** Scale bar = 10 μm. Fig. **9.** Details of the raphe showing an inflated central raphe ending and smooth mantle face. Fig. **10.** Details of the dorsal FMJ showing the narrow longitudinal costa. Fig. **11.** Internal view of a whole valve. Fig. **12.** Oblique view of the end of the valve in Fig. 11 showing the labiate process and well developed helictoglossa. Fig. **13.** Oblique view of the opposite end of the valve in Fig. **12** (without labiate process) showing the helictoglossa. Fig. **14.** Details of the external valve surface showing transapical rows of areolae each occluded by a thin siliceous layer with circumferential slits (arrow heads). Fig. **15.** Details of an internal valve face showing the inner openings of areolae aligned in a narrow "ditch".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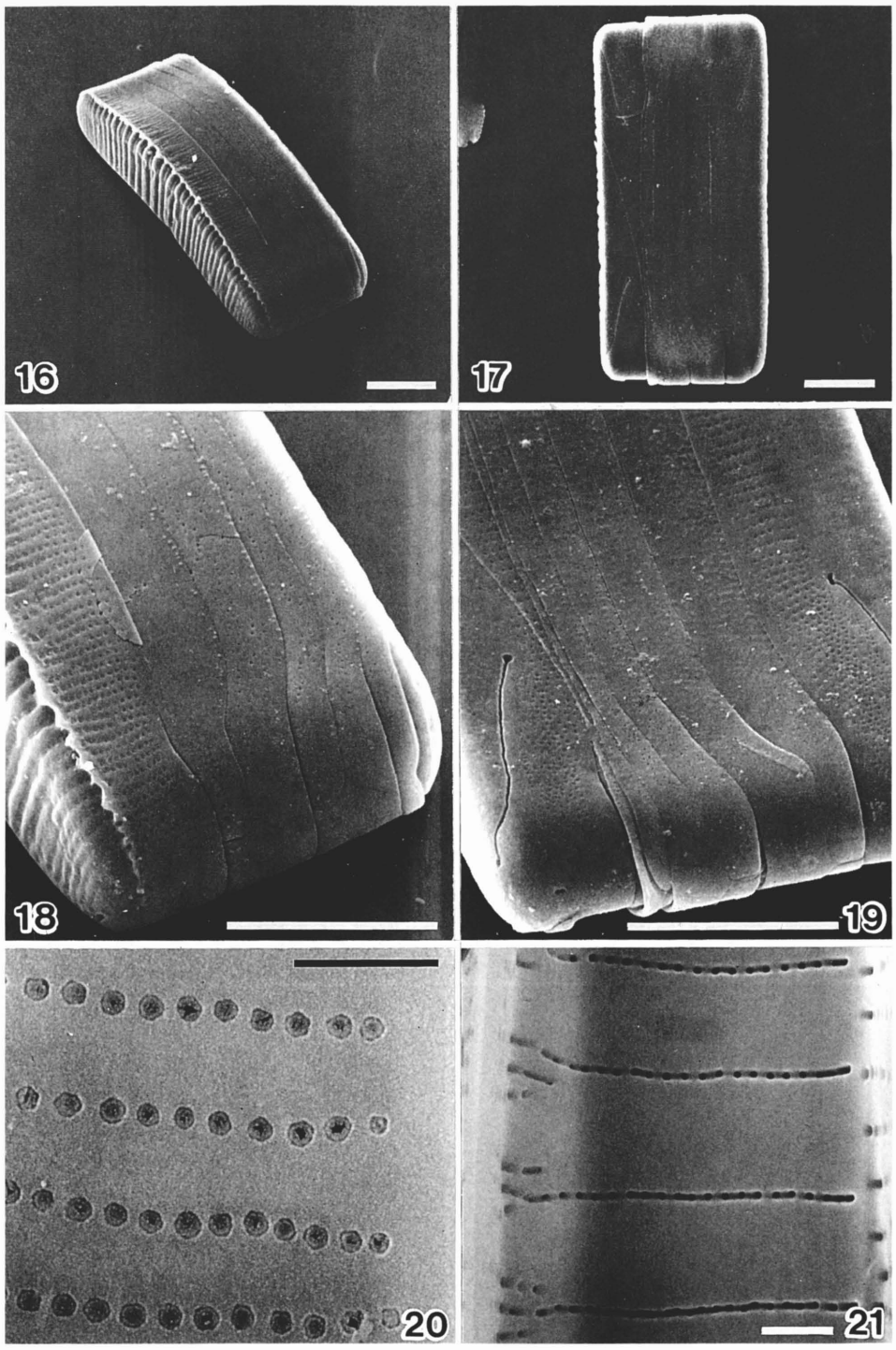
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the holotype slide (BRM), Hustedt coll. L3/38, Sendai by Simonsen (1987) and also by myself (in BRM) have clarified that *E. sendaiensis* has finer striation, namely 8.5–10 striae in 10 μm, and has terminal raphe endings located a bit distant from the apices, so that Hustedt's species is a different entity.

Eunotia biseriatoides H. Kobayasi et al. also has a similar striae density to *Eunotia sparsistriata*, i.e. 5–8 striae in 10 μm in the valve center, and its valve shape also resembles this species, though its valve width is narrower (Figs 4, 5). The two species can be clearly distinguished by the different density of the areolae forming the striae. *E. biseriatoides* has finer areolation, namely 40–45 in 10 μm (Figs 20, 21), and single areolae are scarcely recognizable under a light microscope (Figs 4, 5). On the other hand, the density of the areolae is 26–30 in 10 μm in *E. sparsistriata* (Figs 14, 15) and they are easily observed with a light microscope (Figs 1–3). The epitheca depth is also a useful characteristic for differentiation of the two species. Mayama & Kobayasi (1991) considered it a valuable characteristic for the taxonomy of *Eunotia*. The epitheca depth is 11–14 μm in *E. biseriatoides*, shallower than that of *E. sparsistriata*. However, in the other fine structures, *E. biseriatoides* shares many characteristics with *E. sparsistriata*, as seen in Kobayasi et al. (1981).

Eunotia biseriatoides is a moss diatom occurring in many places on Honshu Island (main island of Japan), but it has not been found on Mikura Island. However, *Eunotia sparsistriata* has been found only on Mikura Island. It is likely that *E. sparsistriata* is derived from the same ancient species as *E. biseriatoides* and speciation proceeded under the isolated condition of Mikura Island with its special environment.

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References

ANDO, K. (1977): Moss diatoms in Japan (1). – Bull. Jap. Soc. Phycol. **25**: 195–201.
– (1978): Moss diatoms in Japan (2). – Jap. J. Phycol. **26**: 125–130.
– (1979): Moss diatoms in Japan (3). – Jap. J. Phycol. **27**: 153–159.
– (1981): Moss diatoms in Japan (4). – Jap. J. Phycol. **29**: 201–207.
– (1982): Moss diatoms in Japan (5). – Jap. J. Phycol. **30**: 319–324.
– (1985): Moss diatoms in Japan (6). – Jap. J. Phycol. **33**: 143–148.

Figs 16–21. Figs. **16–19**. *Eunotia sparsistriata* sp. nov. Figs **20, 21**. *Eunotia biseriatoides* Kobayasi et al. Figs **16–19**. Scale bars = 10 μm; Figs **20, 21**. Scale bar = 1 μm. Fig. **16**. External oblique dorsal view of a whole frustule showing the heavily silicified FMJ, = dorsal longitudinal costa. Fig. **17**. External ventral view of the whole frustule showing its rectangular shape. Fig. **18**. Enlargement of the frustule in Fig. 16 showing the epicingulum composed of five open bands arranged with alternately open and closed ends at the apex. Fig. **19**. Enlargement of the end of the frustule in Fig. 17 showing the epicingulum composed of six open bands with alternately open and closed ends at the apex. Fig. **20**. Details of the external valve surface showing transapical rows of areolae occluded by a thin siliceous layer. Fig. **21**. Details of an internal valve face showing the inner openings of areolae aligned in a narrow "ditch".

KOBAYASI, H., K. ANDO & T. NAGUMO (1981): On some endemic species of the genus *Eunotia* in Japan. – In: ROSS, R. (ed.): Proceedings of the sixth symposium on recent and fossil diatoms. Budapest, 1980. – O. Koeltz, Koenigstein. Pp. 93–114.

MAYAMA, S. (1992 in press): Morphology of *Eunotia multiplastidica* sp. nov. (Bacillariophyceae) examined throughout the life cycle. – Korean J. Phycol. **7**.

MAYAMA, S. & H. KOBAYASI (1984): The separated distribution of the two varieties of *Achnanthes minutissima* Kuetz. according to the degree of river water pollution. – Jap. J. Limnol. **45**: 304–312.

– – (1991): Observations of *Eunotia arcus* Ehr., type species of the genus *Eunotia* (Bacillariophyceae). – Jap. J. Phycol. **39**: 131–141.

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

SCHMIDT, A. (1933): Atlas der Diatomaceen-Kunde. Taf. 381. – O.R. Reisland, Leipzig.

SIMONSEN, R. (1987): Atlas and catalogue of the diatom types of Friedrich Hustedt, Vol. 1. Catalogue, Vol. 2, Atlas. – J. Cramer, Berlin.

WAHRAR, R.J. (1981): Comparative valve morphology of selected species of *Eunotia* Ehr. (Bacillariophyceae). – Ph.D. thesis, Texas A & M University.