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UPPER CRETACEOUS DIATOMS FROM CENTRAL JAPAN

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This is the first report of the Upper Cretaceous (late Campanian to Maastrichtian age) diatoms from Japan. Diatoms were recovered from the Shoya Formation, which is exposed in the northwestern Kanto Mountains, 100 km northwest of Tokyo. In this region, the Shoya Formation consists of marine sedimentary rocks about 600 m thick, represented by alternating beds of sandstone and mudstone, which is overlain by about ten meters of diatom-bearing siliceous mudstone. The age of the floral assemblage is based on the presence of upper Campanian to lower Maastrichtian radiolarian fossils. It is difficult to identify these diatoms, because nearly all of the diatom specimens are poorly preserved as recrystallized quartz steinkerns. At least four morphologic types, types A to D are identified on the basis of their valve shape and poorly-preserved ornamentation.

Key words: Cretaceous, fossil diatom, lower Maastrichtian, Shoya Formation, upper Campanian.

INTRODUCTION

The geologic record of diatoms extends back at least to the Early Jurassic (Rothpletz 1896). Pre-Mesozoic diatoms have been reported by some researchers, but these are now regarded to be modern contaminations (Strelnikova 1974, Harwood & Gersonde 1990). Jousé (1978) cast doubt on whether the Jurassic occurrences are of diatoms, but there can be no doubt that the records from the Lower Cretaceous (Gersonde & Harwood 1990) of Antarctica are of diatoms. A review of Cretaceous diatoms was presented by Harwood & Nikoleav (1995).

Although Upper Cretaceous diatoms have been reported from marine deposits in many regions by different researchers (Fig. 1), little is known about Mesozoic diatoms from Japan. This is a result of their apparent scarcity, the instability of opal-A through time, and the limited number of diatomists looking at Cretaceous sediments. In fact, only one report of Cretaceous diatoms from Hokkaido is known (Sawamura 1979), but this report did not illustrate nor describe the fossils, and no locality was given.

This paper reports on the recovery of poorly-preserved diatoms from the Shoya Formation at the northernmost part of the Kanto Mountains in central Japan (Fig. 2).

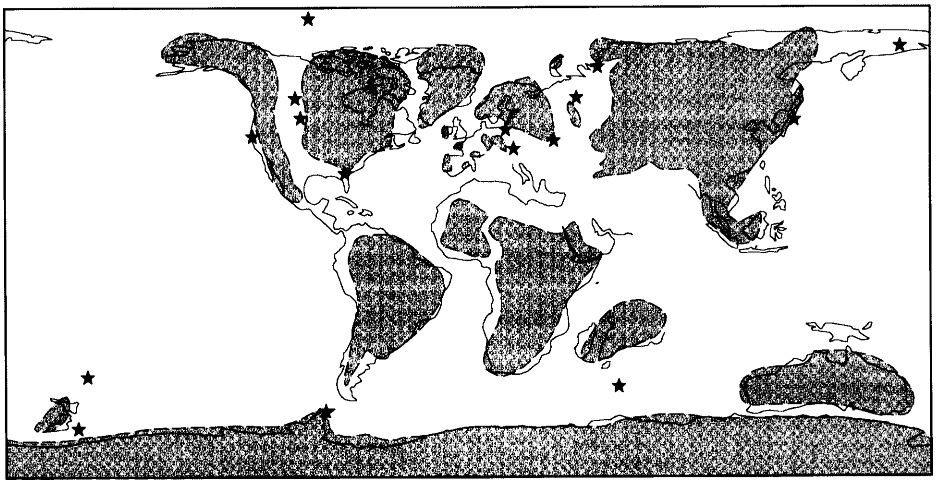

Fig. 1. Global distribution of Upper Cretaceous diatom-bearing deposits, represented by black stars. Data are from Hanna (1927, 1934), Schulz (1935), Deflandre (1941), Barker & Meakin (1944), Long *et al.* (1946), Jousé (1949, 1951), Weidmann (1964), Given & Wall (1971), Bukry (1974), Strelnikova (1965, 1966, 1974, 1975), Wall (1975), Hajós & Stradner (1975), Abbott (1978), Bergstresser & Krebs (1983), Harwood (1988), Ballance *et al.* (1989), and Dell'agnese & Clark (1994). This map has been synthesized from Smith *et al.* (1981, 1994).

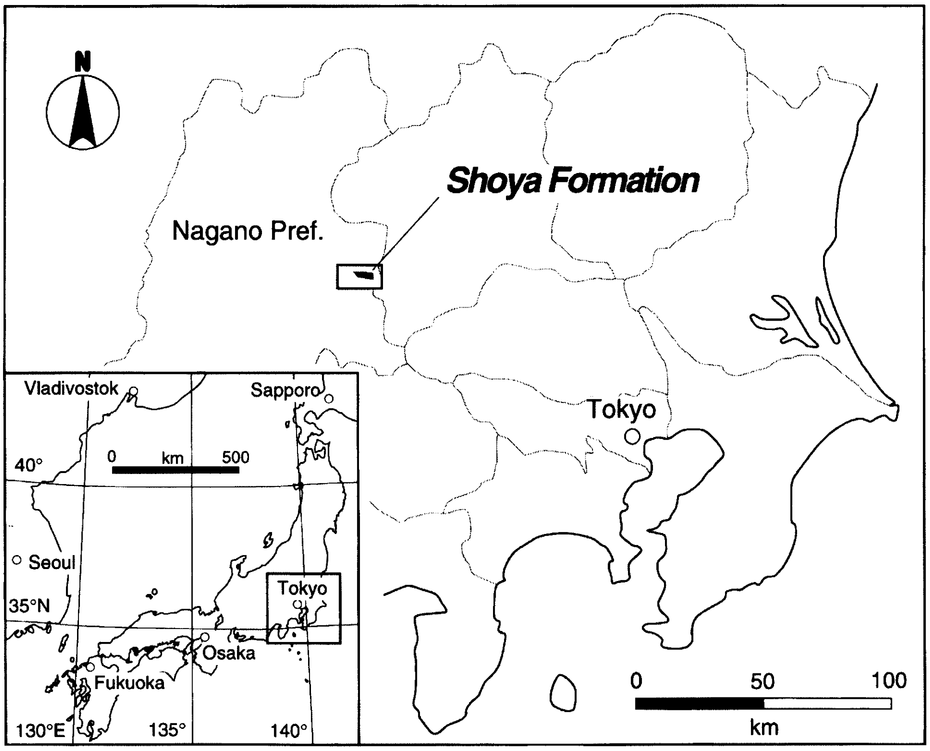

Fig. 2. Map showing the position of the Shoya Formation in central Japan. The inset corresponds to the limits of Fig. 3.

GEOLOGIC SETTING OF THE SHOYA FORMATION

The Shoya Formation (Watanabe 1958) is exposed in an area approximately 0.5 km wide and 4.5 km long in the northwestern Kanto Mountains, 100 km northwest of Tokyo (Figs 2, 3). It consists of three fining-upward cyclic sequences of marine sedimentary rocks about 600 m in total thickness and lacks hemipelagic or pelagic interbeds (Fig. 4). The lower and middle parts of each sequence are composed of poorly-sorted, black, medium- or fine-grained sandstone, which grade upward into well-sorted, bedded, dark-gray sandstone. The upper part of each sequence is composed of alternations of shale and sandstone with graded bedding, or dark-gray, siliceous shale. The siliceous shales frequently contain thin (several millimeters) layers of interbedded, greenish-gray, tuffaceous shale or tuff. Some sandstone units contain abundant, yet poorly preserved, molluscs, including *Spondylus japonicus*, *Cardium*(?), *Ostrea*, other pelecypods, brachiopods, and corals (Amano & Marui 1958).

The age of these sediments is based on the occurrence of well-preserved radiolarian fossils, which include *Amphipyndax tylotus*, *A. enesseffi*, *Lithomelissa heros*, *L. hoplites*, *Stichomitra livermorensis*, *Theocampe altamontensis*, *Dictyomitra* *lamellicostata* and others, from the *Amphipyndax tylotus* Zone (Foreman 1977, Sanfilippo & Riedel 1985), which ranges from late Campanian to early Maastrichtian (Takahashi & Ishii 1993).

MATERIALS AND METHODS

Thirty-eight samples were examined for diatoms, but only one yielded diatom remains (Fig. 4). The diatom-bearing sample collected at Otsuki Village in Nagano Prefecture
(36°12'54"N, 138°35'00"E) was from a dark-gray, siliceous shale in the uppermost part of the Shoya Formation.

The sample was broken into small pieces and washed in water. Collectively the pieces amounted to about 200 g and were identically treated under the following conditions.

The pieces were treated in a solution of approximately 5% hydrofluoric acid for around 24 hours and washed through 50-micron and 200-micron screens. The residue was dried and then divided into two parts for observation under a light microscope (LM) and a binocular microscope, in order to pick radiolarians and diatoms for scanning electron microscopy (SEM). The selected specimens were mounted, gold coated, and photographed with SEM.

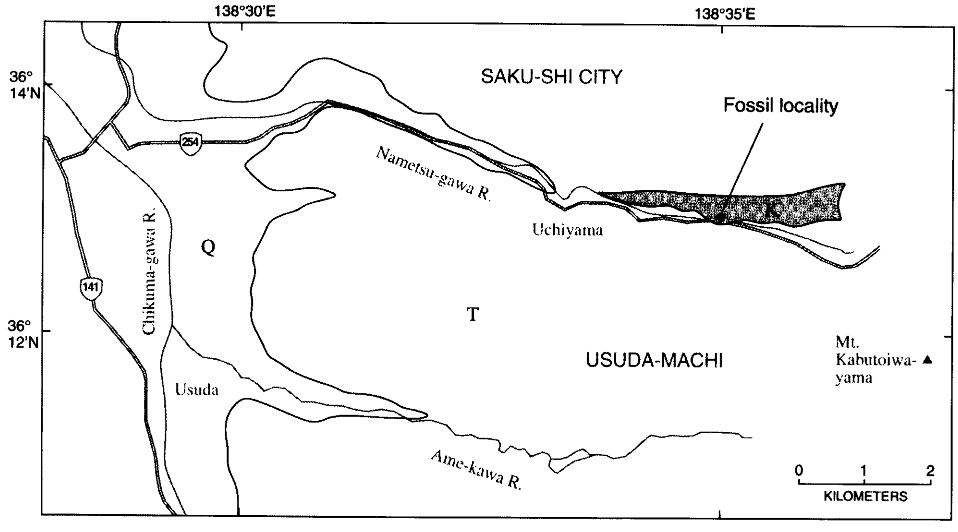

Fig. 3. Simplified geologic map showing the outcrop areas of the Shoya Formation and the fossil locality, including drainage and major roads. K: Cretaceous rocks (Shoya Formation), T: Tertiary rocks, Q: Quaternary deposits.

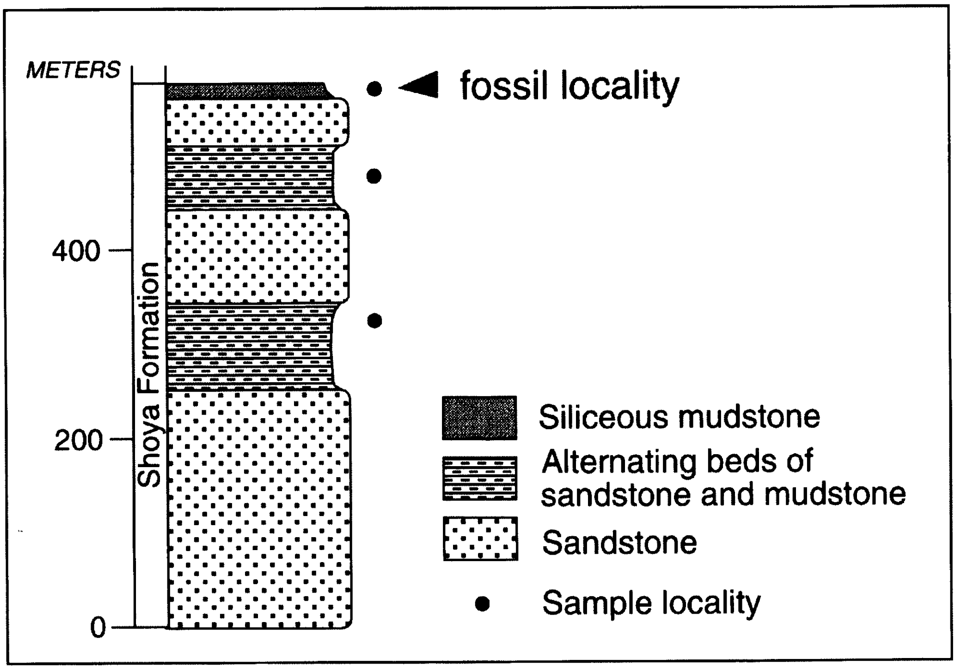

Fig. 4. Stratigraphic column of the Shoya Formation showing the position of the sample and fossil localities.

OBSERVATIONS AND DISCUSSION

All specimens were poorly-preserved, recrystallized as quartz steinkerns, where the fine structure of the frustules was not observed. The poor preservation rendered it difficult to assign these diatoms to generic rank, yet we were able to separate the assemblage into four different morphologic types based on valve shape and obscure ornamentation.

Type-A is tablet-like in shape (Fig. 5). The valve is circular, large (about 150 μm in diameter), and the valve face is convex without ornamentation. Although we could not observe the valve interior, LM observation clearly shows the constant thickness of the valve mantle (Fig. 6) as can be interpreted from this feature.

Type-A is the most common diatom in this floral assemblage. It is similar to the morphology of the genus *Coscinodiscus* illustrated from North America by Long *et al.* (1946), Given & Wall (1971), Wall (1975), Abbott (1978), and Bergstresser & Krebs (1983), and from Europe and Russia by Jousé (1949), Weidmann (1964), and Strelnikova (1974), although it could represent specimens of *Stellarima*, *Thalassiosiropsis* and other Upper Cretaceous genera.

Type-B is table- (Japanese chabudai-) like in frustule shape (Fig. 8). The valve is circular and concave, about 100 μm in diameter, with a raised ridge (quadrate form) on its external surface (Figs 9, 10) with a small, weak projection at each corner (Fig. 11).

Although the morphologic features of type-B resemble those of the genus *Aulacodiscus* reported by Long *et al.* (1946) and Strelnikova (1974), it differs from them by having a quadrate,
rather than a pentagonal raised ridge. Morphotype-G (Wall 1975) and Morphotype-2 (Bergstresser & Krebs 1983) are somewhat similar to type-B of this study, but both of them have more concave valves.

Type-C is triangular, with rounded and elevated apices (Fig. 12). Each side of the triangular valve is about 80 μm, and each corner has an elevation at an obtuse angle (Fig. 13). The valve has a central circular dome with a depressed center (Fig. 12). These features are similar to the genus *Sheshukovia, Trinacria*, and *Triceratium.*

Type-D is also probably classified into the genus *Sheshukovia* and *Trinacria.* The frustules are arcuate in shape, with a broad elevation at the center of the valve-face (arrow) and two massive short projections on the valve ends (Fig. 17). The valves are about 50 μm in length. LM observation shows the epi- and hypo-valves attached at the center of the girdle (Fig. 15).

The Upper Cretaceous diatom assemblage reported herein is comprised of a small number of poorly-preserved species. For this reason, the composition of the assemblage cannot, therefore, be correlated with the floral assemblages of other regions. Future micropaleontological studies, particularly on diatoms, may better define the Cretaceous paleoceanography of the world and paleoceanography of Japan.

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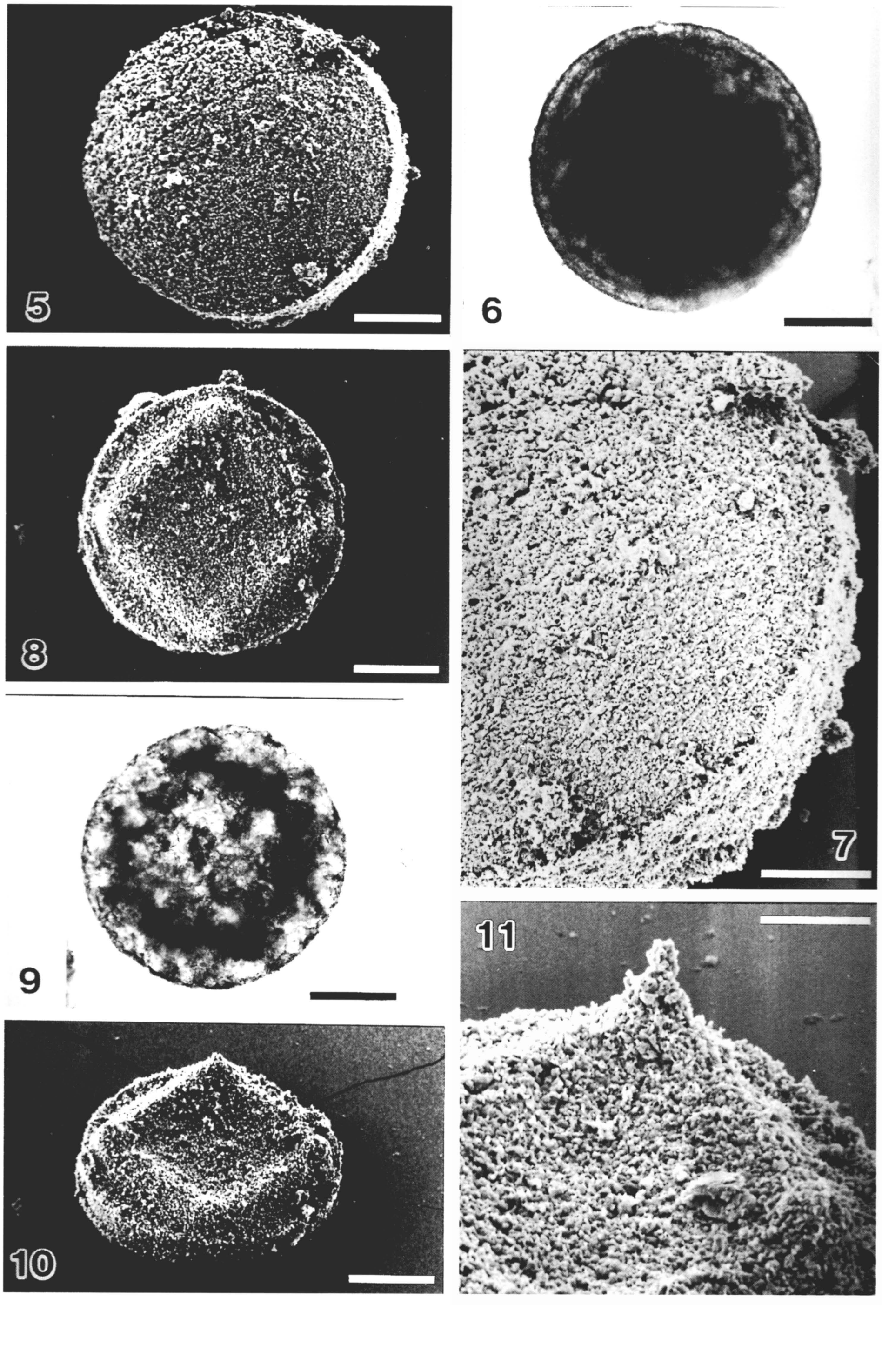
Figs 5-11. Scanning electron micrographs (SEM) and light micrographs (LM) of diatoms. Scale bars = 50 μm (Figs 5, 6, 8-10) or 10 μm (Figs 7, 11). Figs 5-7. Type-A. Fig. 5. External oblique view of the frustule. Fig. 6. LM photograph of the valve mantle showing clear rim, corresponding to the mantle thickness. Fig. 7. Enlargement of the valve surface. Figs 8-11. Type-B. Fig. 8. External view of the valve showing the concave center and the quadrate raised ridge with a projection at each corner. Fig. 9. Valve view showing quadrate raised ridge as a shadow in LM. Fig. 10. External oblique view of the valve. Fig. 11. Enlargement of one corner of the raised ridge showing the projection.

Figs 12-17. Scanning electron micrographs and transmitted light micrographs of diatoms. Scale bars = 25 μm (Figs 12, 14-16) or 10 μm (Figs 13, 17). Figs 12, 13. Type-C. Fig. 12. External oblique view of the valve. Fig. 13. Enlargement of a elevation. Figs 14-17. Type-D. Fig. 14. Oblique whole view of the frustule. Fig. 15. Girdle view of the frustule in LM. Fig. 16. Girdle view of the frustule showing the elevations at the center of the valves (arrows). Fig. 17. Enlargement of one of the massive, short projections on a valve end.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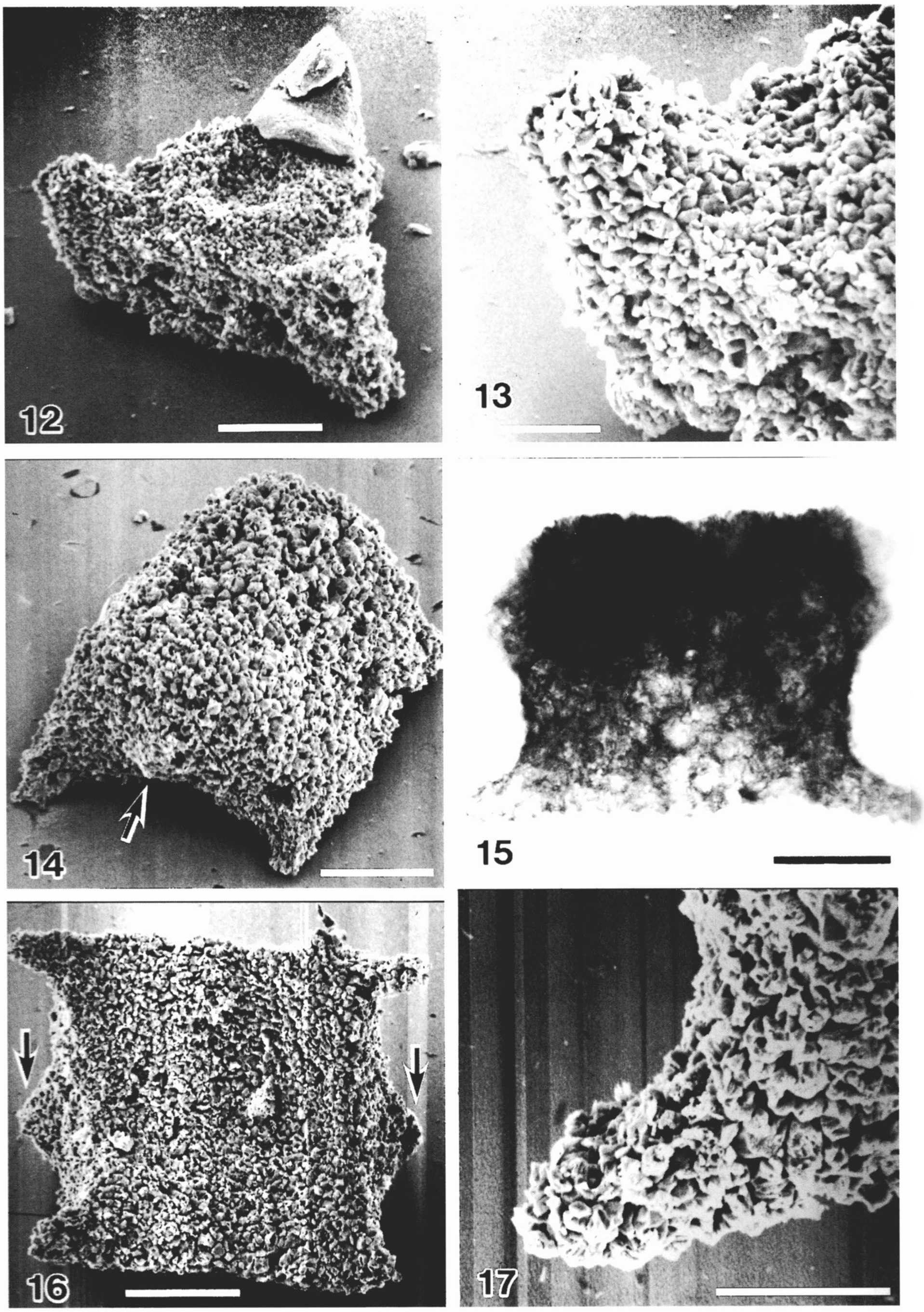
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