Zeitschrift: Eclogae Geologicae Helvetiae

Herausgeber: Schweizerische Geologische Gesellschaft

Band: 74 (1981)

Heft: 1

Artikel: Occurence of siliceous microfossils (diatoms, silicoflagellates and sponge spicules) in the Campanian Mishash Formation, southern Israel

Autor: Soudry, David / Moshkovitz, Shimon / Ehrlich, Aline

DOI: https://doi.org/10.5169/seals-165093

Eclogae geol. Helv.	Vol. 74/1	Pages 97-107	2 figures in the text and 2 plates	Basle, March 1981

Occurrence of siliceous microfossils (diatoms, silicoflagellates and sponge spicules) in the Campanian Mishash Formation, southern Israel[1])

By David Soudry, Shimon Moshkovitz and Aline Ehrlich[2])

ABSTRACT

Siliceous microfossils, mainly diatoms, were found for the first time in the Campanian cherty-phosphatic Mishash Formation (Negev, Israel). They occur in lenses of porcelanite and phosphate intraclasts. These findings suggest a biogenic supply of silica to the sediments. The very poor diversity of the diatom assemblages, sometimes very rich in specimens, indicate life in restricted marine environments.

Diatoms may explain the combined silica-phosphate occurrence in the Mishash Formation since phosphorite is known to be associated at present with diatomaceous oozes in some marine, near-shore environments.

RÉSUMÉ

Des microfossiles siliceux, surtout diatomées, ont été découverts dans des sédiments campaniens du Negev (Israël), dans des lentilles de porcelanite et dans des intraclastes de phosphate de la Formation Mishash. Leur présence suggère un apport de silice d'origine biogène à ces sédiments. La très faible diversité spécifique d'assemblages, par ailleurs riches en individus de diatomées, semble indiquer un milieu marin confiné. Les diatomées peuvent expliquer l'association silice-phosphate dans la Formation Mishash, puisque des sédiments phosphatés se forment de nos jours dans des boues à diatomées, dans certaines régions margino-littorales.

Introduction

Siliceous rocks are widespread in Israel in the Late Cretaceous (Campanian) Mishash Formation and in equivalent strata in adjacent countries. In the Negev of Southern Israel, these cherts and porcelanites are part of a shallow marine sequence with carbonates (chalks and limestones) and phosphorites. Many authors have dealt with their stratigraphy, petrology and paleoenvironment (Bartov et al. 1972, Bentor et al. 1960, Kolodny 1969, Nathan et al. 1979, Parnes 1965, Reiss 1962; Steinitz 1974, 1976 and Segev 1975). The Mishash sediments are considered to have been deposited on a flat shelf with local small elevated areas (Steinitz 1974). Their thickness varies from a few meters near the structural heights to some 130 m.

[1]) This work is a part of the Ph.D. Thesis of D. Soudry on the Depositional Environment of the Phosphatic Series in the En Yahav area (Project GSI 29637) which is now in preparation.

[2]) Geological Survey of Israel, Jerusalem.

The cherts and porcelanites formed by the partial or a total silica replacement of carbonate sediments (Kolodny, 1969). Some phosphate layers are also silicified to various degrees. The origin of these siliceous rocks, i.e. the mechanism of silica concentration, was for a long time controversial. Although a biogenic origin was suspected, no evidence whatsoever of siliceous microfossils had ever been found in these rocks. New investigations have revealed the presence of diatoms, silicoflagellates and sponge spicules, thus indicating a biogenic supply of silica to the sediments.

Provenance of material and description of the siliceous microfossils

The investigated material is from the En-Yahav area, near the Gevim High (Fig. 1). A geological section of the Mishash Formation is presented in Figure 2. Although siliceous layers occur throughout the section, siliceous microfossils were found only in the porcelanite unit. This unit consists of porcelanite layers, interbedded with partially silicified phosphorites and limy concretions. The microfossils are present in thin lenses of powdery porcelanite (up to 1 cm thick) intercalated within brown, thinly laminated and slightly phosphatic clays, and in partially silicified intraclasts in thick phosphorite layers.

In the powdery porcelanite lenses, the microfossils are usually rare and their degree of preservation decreases with induration of the sediments; in the phosphate intraclasts, they are locally abundant and well preserved. Part of the diatom frustules are opaline whereas others have been converted into chalcedony, without loosing their original microstructure.

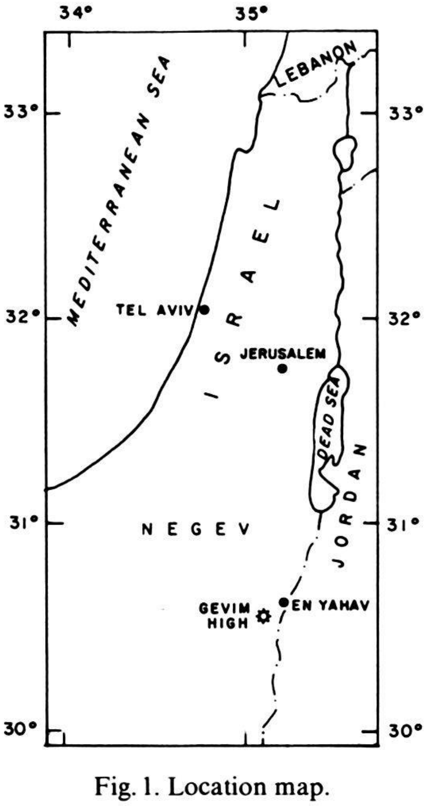


Fig. 1. Location map.

The porcelanite samples were crushed, and mounted slides by the usual water suspension method were prepared. Many samples were found to be barren. However, in microscopic examination, some show the presence of diatoms, silicoflagellates and sponge spicules. The diatoms are represented by *Coscinodiscus* sp., *Triceratium* sp. and *Hemiaulus* sp. Whereas the valves of *Coscinodiscus* show a thin, regular areolation (Pl. 1, Fig. 1), the specimens related to *Triceratium* and to *Hemiaulus* lack the original microstructure and were only identified on the basis of the general morphology (internal moulds?). The silicoflagellates are represented by a few,

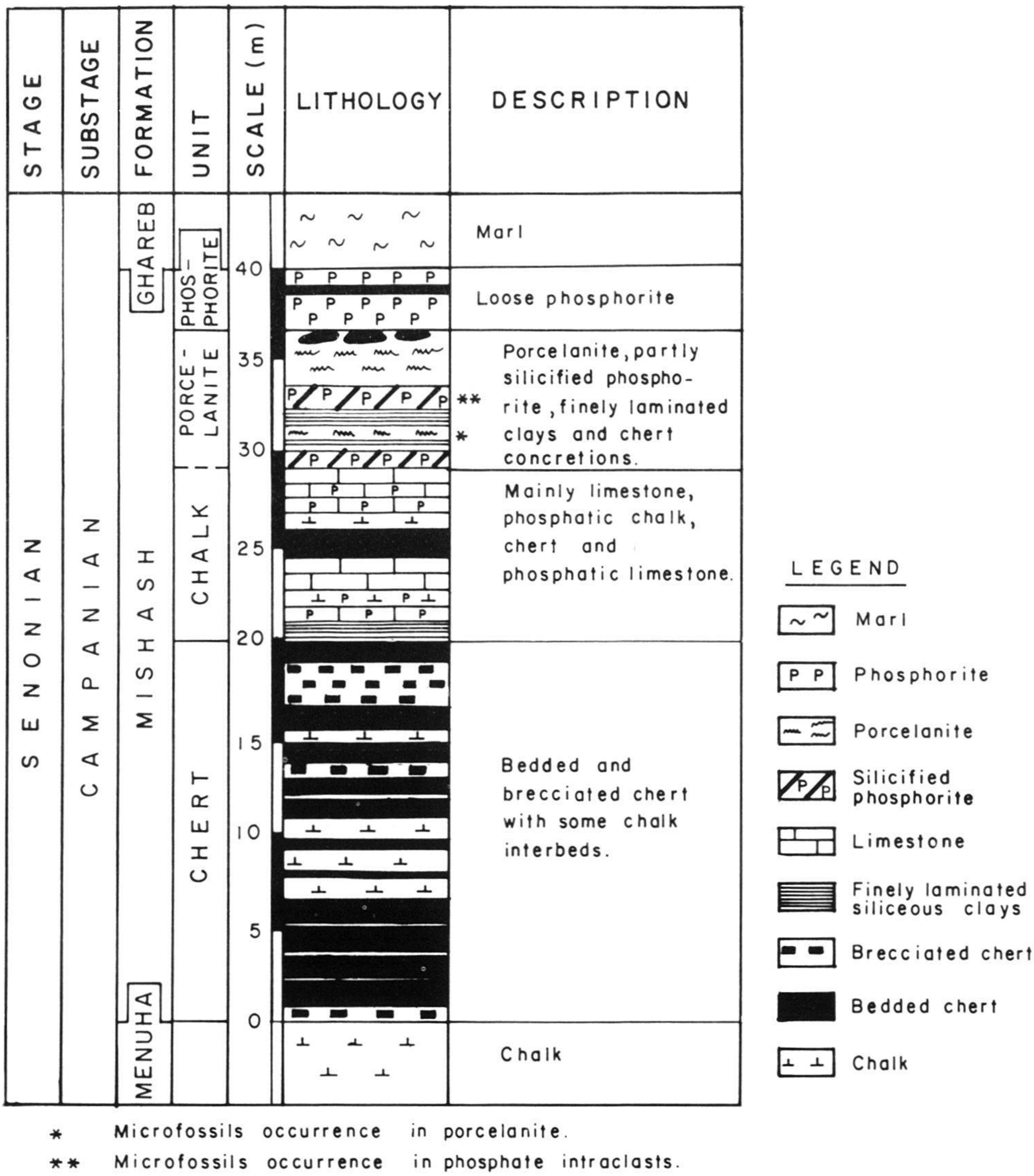


Fig. 2. Schematic columnar section of the Mishash Formation in the vicinity of the Gevim High.

broken specimens of *Lyramula furcula* (Pl. 2, Fig. 10–12). The sponge spicules are of different shapes and sizes (Pl. 2, Fig. 13–14).

The phosphate intraclast samples were studied from thin sections only since they are partly silicified and unsuitable for suspension slides. They contain in places abundant, well preserved, poorly diversified diatom assemblages, dominated by *Coscinodiscus* sp. and by *Stephanopyxis* spp. (Pl. 1, Fig. 8). The valves of the *Coscinodiscus* sp. are circular, convex and the frustules are elliptical in side view; their whole surface is ornamented by linear areolation. *Stephanopyxis* sp. 1 (Pl. 1, Fig. 2, 3, 5) differs from *Coscinodiscus* sp., by the higher convexity of the valves ($H = \frac{1}{2}D$); no spines were observed. *Stephanopyxis* sp. 2 (Pl. 1, Fig. 6, 7) is characterized by its elongated shape ($H > D$). Most of the specimens observed in the thin section contain an irregularly rounded, siliceous inner body, varying in size.

The assemblages recorded are marine. The poor diversity of the samples, which contain very abundant specimens, suggest a high productivity in a restricted environment.

There are only few reports concerning the distribution of siliceous microfossils in the world during the Late Cretaceous (Campanian–Maastrichtian). Diatoms were described from the Ural Mountains and California, where they locally form diatomites (Hanna 1927, Jousé 1949, 1977, Strelnikova 1974). Lately, new findings of siliceous microfossils were also reported from Site 275 (Leg 29 of the DSDP), south of New Zealand (Bukry 1975, Hajos & Stradner 1975, Perch-Nielsen 1975). The assemblages described from these areas are usually highly diversified and well preserved. A few diatoms have also been observed in Campanian phosphate coprolites from Egypt (Cayeux 1941).

Although our present findings contain only a small number of taxa, the relatively high frequency in the porcelanite samples of *Triceratium*. *Hemiaulus* and the presence of the index fossil *Lyramula furcula* considered significant in the silicoflagellate zonation of the Late Cretaceous (Bukry 1975) allow a stratigraphical correlation with other places.

Discussion

The presence of siliceous microfossils, mainly diatoms, points to a biogenic supply of silica to the Mishash sediments. This is in agreement with the conclusions of various authors concerning the silica origin in cherts and porcelanites (Dapples 1979, Ernst & Calvert 1969, Heath 1973, Lancelot 1973). According to Lancelot (1973), any input of silica (continental or marine) is immediately consumed by siliceous microorganisms. However, due to the high solubility of biogenic opal, mainly in diatoms, only rare occurrences of these microfossils are reported in siliceous Late Cretaceous rocks (Deflandre 1941, Hanna 1927, Strelnikova 1974). According to Lisitzin (1971), only 1–10% of the living oceanic diatoms reach the water-sediment interface after their death. In the Mishash siliceous sediments, because of the shallow water column (less than 20 m depth, Flexer 1971, Steinitz 1974), it may be assumed that a higher proportion of biogenic opal reached the sea bottom, thus contributing a large supply of silica to the sediments for the development of siliceous rocks. However, with regard to their preservation in the sediment, only a small fraction of the diatom frustules (0.05-0.15% of the total opal produced) withstands dissolution (HURD 1973). Biogenic opal dissolution is inhibited by the presence of certain cations (Ca^{2}, Al^{3}, Fe^{3}), which form an aluminosilicate protective film around the diatom test (HURD 1973, LEWIN 1961). This may explain the fact that the diatoms were found in the Mishash Formation mainly within those porcelanite lenses which are associated with clayey layers. On the other hand, the presence of abundant and well preserved diatoms in some phosphate intraclasts may possibly be related to the fossilizing capability of phosphate (CAYEUX 1939, 1955) and organic matter (SCHRADER 1971).

The occurrence of diatoms in the Mishash Formation may also explain the association silica-phosphate in these sediments, which is in fact typical of many phosphate deposits in the world. Present day forming phosphorites are known to be associated with diatomaceous oozes in continental margins of Peru, Chile and Southwest Africa, where upwelling currents prevail (BATURIN & BEZRUKOV 1979, BIRCH 1979, BURNETT 1977, PRICE & CALVERT 1978). The apparent ability of the diatoms to "fix" the P of the seawater (according to PERES & DEVEZE 1964, the organic C/P ratio is about 27) makes them, after their decay, one of the sources for phosphorus enrichment in sediments.

Acknowledgment

The authors are grateful to Mr. R. Bogoch of the Geological Survey of Israel, for critical reading of the manuscript.

REFERENCES

BARTOV, J., EYAL, Y., GARFUNKEL, Z., & STEINITZ, G. (1972): *Late Cretaceous and Tertiary stratigraphy and paleogeography of Southern Israel.* - Israel J. EArth Sci. *21*, 69-77.

BATURIN, G.N., & BEZRUKOV, P.L. (1979): *Phosphorites on the sea floor and their origin.* - Marine Geol. *31*, 317-332.

BENTOR, Y.K., & Coll. (1960): *Lexique Stratigraphique International (Asie)*, vol.III, fasc. 10C2, Israel. - CNRS, Paris.

BIRCH, G.F. (1979): *Phosphorite pellets and rock from the western continental margin and adjacent coastal terrace of South Africa.* - Marine Geol. *33*, 91-116.

BUKRY, D. (1975): *Silicoflagellate and coccolith stratigraphy.* - Init. Rep. Deep Sea Drill. Proj. *29*, 845-872.

BURNETT, W.C. (1977): *Geochemistry and origin of phosphorite deposits from off Peru and Chile* - Bull. Geol. Soc. Amer. *88*, 813-823.

CAYEUX, L. (1939, 1941, 1955): *Etudes des Gites Minéraux de la France, les Phosphates de Chaux Sedimentaires de France (France Metropolitaine et d'Outre Mer)* (3 vol.). - Impr. Nationale, Paris.

DAPPLES, E.C. (1979): *Silica as an agent of diagenesis.* In: LARSEN, G., & CHILINGAR (Ed.): *Diagenesis in Sediments and Sedimentary Rocks* (p.99-141). - Elsevier, New York.

DEFLANDRE, G. (1941): *Sur la présence de Diatomées dans certains silex creux turoniens et sur un nouveau mode de fossilisation de ces organismes.* - C.R. Acad. Sci. *213*, 878-880.

ERNST, W.G., & CALVERT, S.E. (1969): *An experimental study of the recrystallization of porcelanite and its bearing on the origin of some bedded cherts.* - Amer. J. Sci. *267-A*, 114-133.

FLEXER, A. (1971): *Late Cretaceous paleogeography of Northern Israel and its significance for Levant.* - Palaeogeogr. Palaeoclimatol. Palaeoecol. *10*, 293-316.

HAJOS, M., & STRADNER, H. (1975): *Late Cretaceous Archaeomonadaceae, Diatomaceae and Silicoflagellatae from the South Pacific Ocean.* - Init. Rep. Deep Sea Drill. Proj. *29*, 913-1009.

HANNA, G.D. (1927): *Cretaceous diatoms from California.* - Occas. Pap. Calif. Acad. Sci. *13*, 1-48.

HEATH, G.R. (1973): *Cherts from the Eastern Pacific.* Init. Rep. Deep Sea Drill. Proj. *16*, 609-613.

HURD, D.C. (1973): *Interactions of biogenic opal, sediment and sea water in the Central Equatorial Pacific.* - Geochim. cosmochim. Acta *37*, 2257-2282.

JOUSÉ, A.P. (1949): *Diatomovye mezozoiskih otlozhenij.* In: PROSHKINA-LAVRENKO, A.I.: *Diatomovyj Analiz.* - Gosgeolisdat, Leningrad, Moskow.

— (1977): *Atlas of microorganisms in bottom sediments of the oceans.* - Nauka, Moscow.

KOLODNY, Y. (1969): *Petrology of siliceous rocks in the Mishash Formation (Negev, Israel).* - J. sediment. Petrol. *39*, 165-175.

LANCELOT, Y. (1973): *Chert and silica diagenesis in sediments from the Central Pacific.* In: Init. Rep. Deep Sea Drill. Proj. *17*, 377-405.

LEWIN, J.C. (1961): *The dissolution of silica from diatoms walls.* - Geochim. cosmochim. Acta *21*, 182-198.

LISITZIN, A.P. (1971): *Distribution of siliceous microfossils in suspension and in bottom sediments.* In: FUNNEL, B.M., & RIEDEL, W.R. (Ed.): *The Micropalaeontology of Oceans* (p.223-230). - Cambridge Univ. Press.

NATHAN, Y., SHILONI, Y., RODED, R., GAL, I., & DEUTSCH, Y. (1979): *The geochemistry of the Northern and Central Negev phosphorites (Southern Israel).* - Bull. geol. Surv. Israel *73*, 1-41.

PERCH-NIELSEN, K. (1975): *Late Cretaceous to Pleistocene Archaeomonads, Ebridians, Endoskeletal dinoflagellates and other siliceous microfossils from the subantarctic Southwest Pacific.* - Init. Rep. Deep Sea Drill. Proj. *29*, 873-911.

PERES, J.M., & DEVEZE, L. (1964): *Oceanographie Biologique et Biologie Marine.* Tome 2: *La Vie Pelagique.* - Presses Univ. France, Paris.

PRICE, N.B., & CALVERT, S.E. (1978): *The geochemistry of phosphorites from the Namibian shelf.* - Chem. Geol. *23*, 151-170.

REISS, Z. (1962): *Stratigraphy and phosphate deposits in Israel.* - Bull. Geol. Surv. Israel *34*, 1-23.

SCHRADER, H.J. (1971): *Fecal pellets: Role in sedimentation of pelagic diatoms.* - Science *174*, 55-57.

SEGEV, A. (1975): *Porcellanite occurrences in the Hor Hahar area.* - Unpubl. M.Sci. Thesis, Hebrew Univ. Jerusalem.

STEINITZ, G. (1974): *The deformational structures in the Senonian bedded cherts of Israel.* - Ph.D. Thesis, Hebrew Univ., Jerusalem (in Hebrew, English summary).

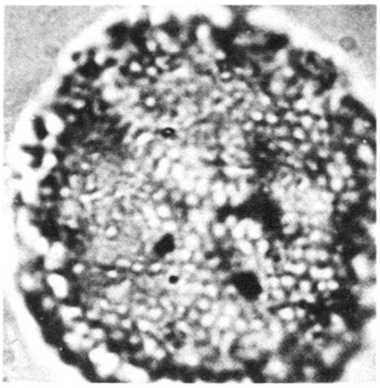
(1976): *Paleogeography of the Menuha and Mishash formations in the Eastern Ramon area, Southern Israel.* - Israel J. Earth Sci. *25*, 70-75.

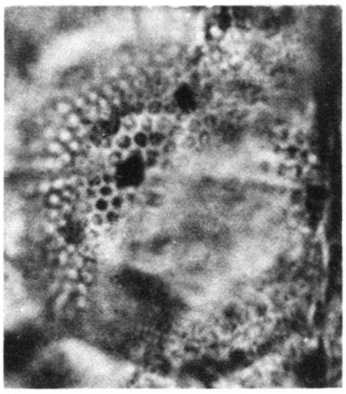
STRELNIKOVA, N.I. (1974): *Diatomej posdnovo miela* - Zap. Sibir, Moscow.

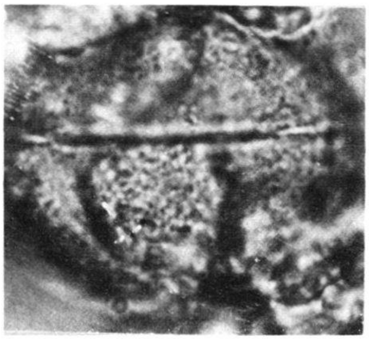
Plate 1

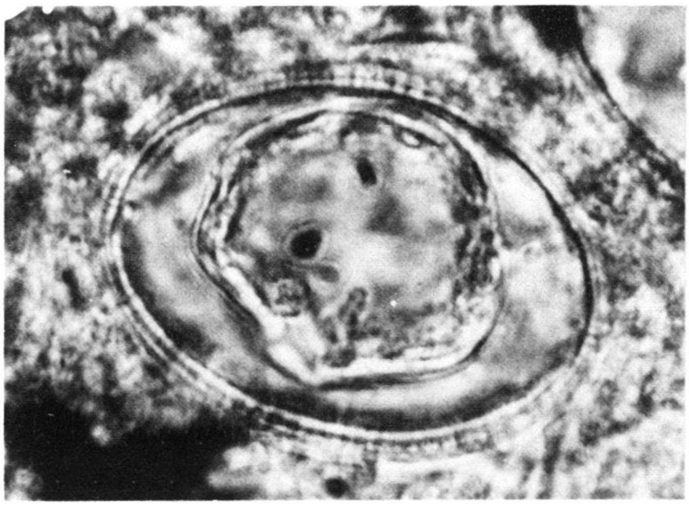
(All specimens were photographed from thin sections, except for Fig. 1; magnification of all figures × 1200, except for Fig. 8 × 200)

Fig. 1	*Coscinodiscus* sp., valve view, DS 1411.
Fig. 2, 3	*Stephanopyxis* sp. 1, side view, DS 832.
Fig. 4	*Coscinodiscus* sp., section of a frustule with irregular inner body, DS 832.
Fig. 5	*Stephanopyxis* sp. 1, section of a frustule with rounded inner body, DS 832.
Fig. 6	*Stephanopyxis* sp. 2, section of a frustule, DS 846.
Fig. 7	*Stephanopyxis* sp. 2, section of a frustule, DS 832.
Fig. 8	General view of a phosphate intraclast, with abundant *Coscinodiscus* and *Stephanopyxis*.


1

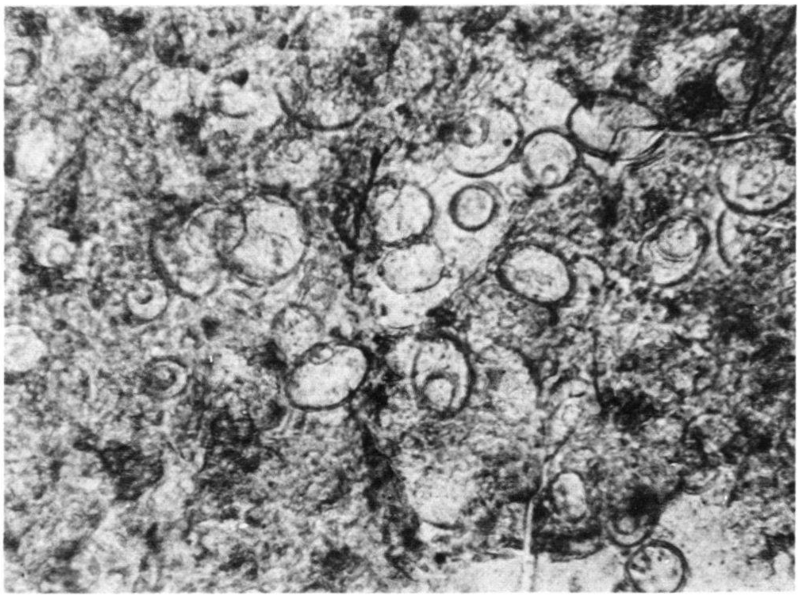

2


3


4


5


6


8

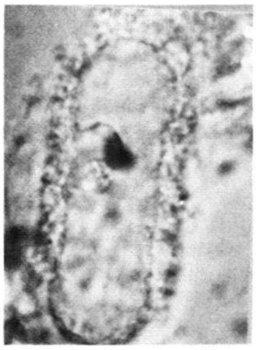
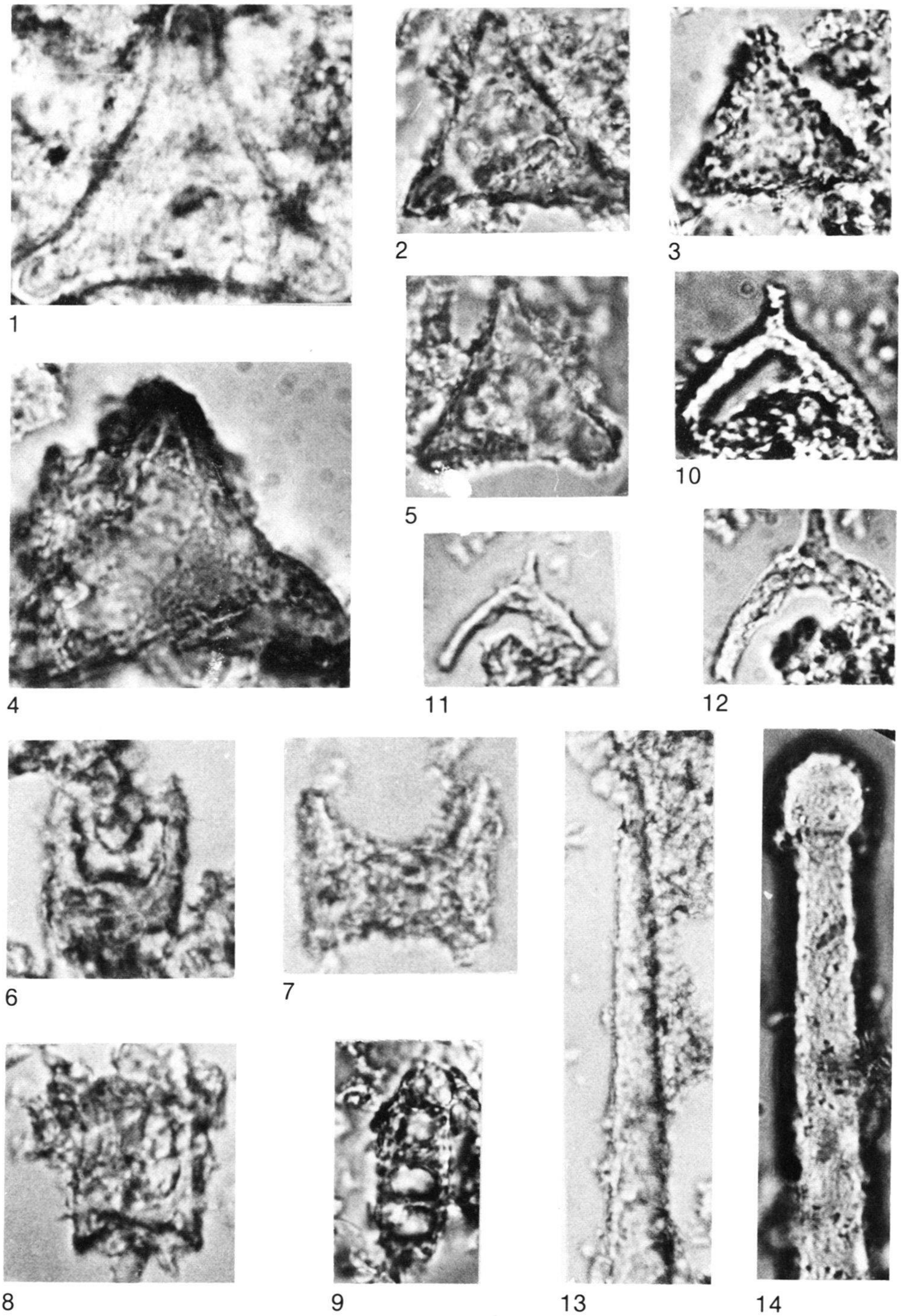

7

Plate 2

(Magnification of all figures $\times$ 1200; Fig. 1 photographed from a thin section)

Fig. 1	*Triceratium* sp., valve view, DS 832.
Fig. 2, 3, 5	*Triceratium* sp., valve view, DS 1411.
Fig. 4	*Triceratium* sp., valve view, DS 824 A.
Fig. 6–8	*Hemiaulus* sp., side view, DS 1411.
Fig. 9	*Hemiaulus* sp., valve view, DS 1411.
Fig. 10, 11	*Lyramula furcula* HANNA, DS 1411.
Fig. 12	*Lyramula furcula* HANNA, DS 824 A.
Fig. 13, 14	Sponge spicules, DS 1411.


1
2
3
4
5
6
7
8
9
10
11
12
13
14