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CALPIONELLID, RADIOLARIAN AND CALCAREOUS NANNOPLANKTON ASSOCIATION NEAR THE JURASSIC - CRETACEOUS BOUNDARY (HRUŠOVÉ SECTION, ČACHTICKÉ KARPATY MTS., WESTERN CARPATHIANS)

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Abstract: The article presents the results of a biostratigraphic study based on the distribution and joint occurrences of calpionellids, radiolarians and calcareous nannoplankton, in a time section around the Jurassic - Cretaceous boundary in the Hrušové section of the Čachtické Karpaty Mts. The results gained show that the boundaries of biozones established on the basis of studies of the above mentioned groups of micro- and nannoplankton are not synchronnous. The association of radiolarians (U.A.11) and calcareous nannoplankton (zone CC1 *Nannoconus steinmanii* occurs in the uppermost Tithonian, below the boundary of the calpionellid zones *Crassicollaria/Calpionella*, which in the conception of Remane et al. (1986) corresponds to the Tithonian - Berriasian boundary.

Key words: calpionellids, radiolarians, calcareous nannoplankton, Jurassic - Cretaceous boundary, Western Carpathians.

Introduction

The Hrušové section is found in the complex of Jurassic and Lower Cretaceous sediments of the Nedzov Nappe in the Čachtické Karpaty Mts., which Hanáček (in Salaj et al. 1987) classified as the Hrušové group.

It is situated 350 m east of the community of Hrušové (Fig. 1), and gives a stratigraphic sequence from the Lower Lias to the Valanginian (Kullmanová & Gašparíková 1983). A sequence of Lias, Dogger and Lower Malm is exposed in a small abandoned quarry. The Tithonian - Berriasian pelagic limestones, which are the subject of this study, occur in individual benches along a forest road (measurements on the section do not correspond to the real thickness of layers, but only to the distance of the taking of samples along this road) Fig. 2. The section is not exposed continuously, and it cannot be excluded that it is tectonically disturbed in the covered parts.

In this work, we have attempted to correlate the distribution and joint occurrence of calpionellids, radiolarians and calcareous nannoplankton, in a time section around the Jurassic - Cretaceous boundary.

The present understanding of the Jurassic - Cretaceous boundary on the basis of calpionellids, nannoplankton and radiolarian associations

Calpionellids have a dominant position in the spectrum of microfossils in the pelagic facies of the Upper Jurassic and Lower Cretaceous. Their mass occurrence rapid evolution and wide paleogeographic distribution including the whole Tethyan region makes from the calpionellid fauna an excellent marker for the fine biostratigraphic division.

The basis for forming the calpionellid scale originates from the work of Remane (1969), Le Hégarat & Remane (1968), Borza (1969), Allemann (1970), Catalano & Liguori (1971), and Farés & Lasnier (1971). Allemann et al. (1971) worked out the standard calpionellid biozonation for the Mediterranean province.

In 1973, at a colloquium in Lyons, it was proposed that the boundary of the Berriasian should be moved to the base of the ammonite zone *Berriasella jacobi*, so that the Jurassic/Cretaceous boundary would run between the calpionellid zones *Crassicollaria* and *Calpionella*. This variant was accepted in 1984, in Sümeg (Remane et al. 1986).

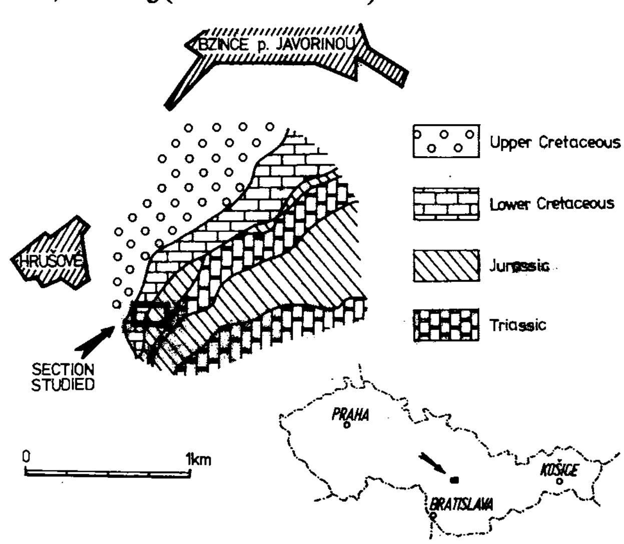


Fig. 1. Geological outline of the area of the Hrušové section.

The detailed nannoplankton biozonation is presented in the works of Thierstein (1975), Wind (1978), Cepek (1978) and Roth (1983). According to Roth (1983) and Manivit et al. (1986) the Tithonian - Berriasian boundary ran between the nannoplankton *Conusphaera mexicana* (Tithonian) and *Nannoconus colomii* Zones (Berriasian). Worsley (1971), Thierstein (1971) and Sissingh (1977) established at the proximity of the base of the *Calpionella* Zone, the Upper Tithonian *Nannoconus steinmannii* Zone.

Deres & Acheriteguy (1980) divided the uppermost Tithonian to Campanian into 11 nannocone zones, which they correlated with the 23 cocolitophorid zones of Sissingh (1977).

Weidich & Schairer (1990) proposed 6 nannocone zones for the Upper Jurassic and Lower Cretaceous, while placing the Jurassic - Cretaceous boundary between the *Dolomiticus* Zone (uppermost Tithonian) and the *Minor* Zone (base of the Berriasian to Lower Valanginian).

The radiolarian biozonation is presented in the works of Pessagno (1977a, 1977b), Baumgartner et al. (1980), Kocher (1981), Schaaf (1985).

Baumgartner (1984, 1987) gives the best worked out biozonation for the Tethyde region, which divides the Middle Jurassic to Lower Cretaceous (Bathonian to Hauterivian) into nine zones, on the basis of unitary associations. On the Jurassic - Cretaceous boundary, we find the most significant change at the base of Zone D, where new species of radiolarians occur in U.A. 11.

The unitary association (U.A. 11) has a wide geographical distribution, but its appearance is not synchronnous. Everywhere in the Fiume Bosso section (Umbria, Italy) U.A. 11 is found several metres below the boundary of calpionellid zones A and B, which is dated to the Tithonian - Berriasian boundary. In the Atlantic region (Blake Bahama Basin), U.A. 11 is found directly above samples assigned to Calpionella Zone B, which corresponds to the Lower Berriasian. In the Svinita section in Rumania, it was identified in samples of the Upper Berriasian, dated on the basis of ammonites and calpionellids (in Baumgartner 1984, 1987). The facts given show that U.A. 11 (Zone D) represents a stratigraphic interval of uppermost Tithonian to Upper Berriasian.

Micro- and nannoplankton associations near the Jurassic - Cretaceous boundary in the Hrušové section

Lower part of the Upper Tithonian

At the base of the section (75 m), in thin bedded pinkish micritic limestones, with a poor calcified radiolarian fauna, we find a weakly preserved calpionellid association, and a not very rich association of calcareous nannoplankton. The calpionellid fauna is formed by isolated specimens of *Tintinnopsella carpathica* (Murgeanu et Filipescu), small forms of *Calpionella* aff. *alpina* Lorenz, and a single specimen of *Tintinnopsella* cf. *remanei* Borza. The species mentioned indicate a partially preserved *Remanei* Subzone (Remane et al. 1986), which is characteristic of the lower part of the Upper Tithonian.

The nannoplankton association is formed by the species *Cyclagelosphaera margerelii* Nöel, *Ellipsagelosphaera* sp., *Ellipsagelosphaera fossacincta* Black, *Ellipsagelosphaera lucasii* Nöel, *Ellipsagelosphaera* cf. *ovata* (Bukry) Black, *Hexalithus* cf. *magharensis* Moshkovitz et Ehrlich, *Thoracosphaera* sp., *Watznaureria barnesae* (Black et Barnes) Perch-Nielsen.

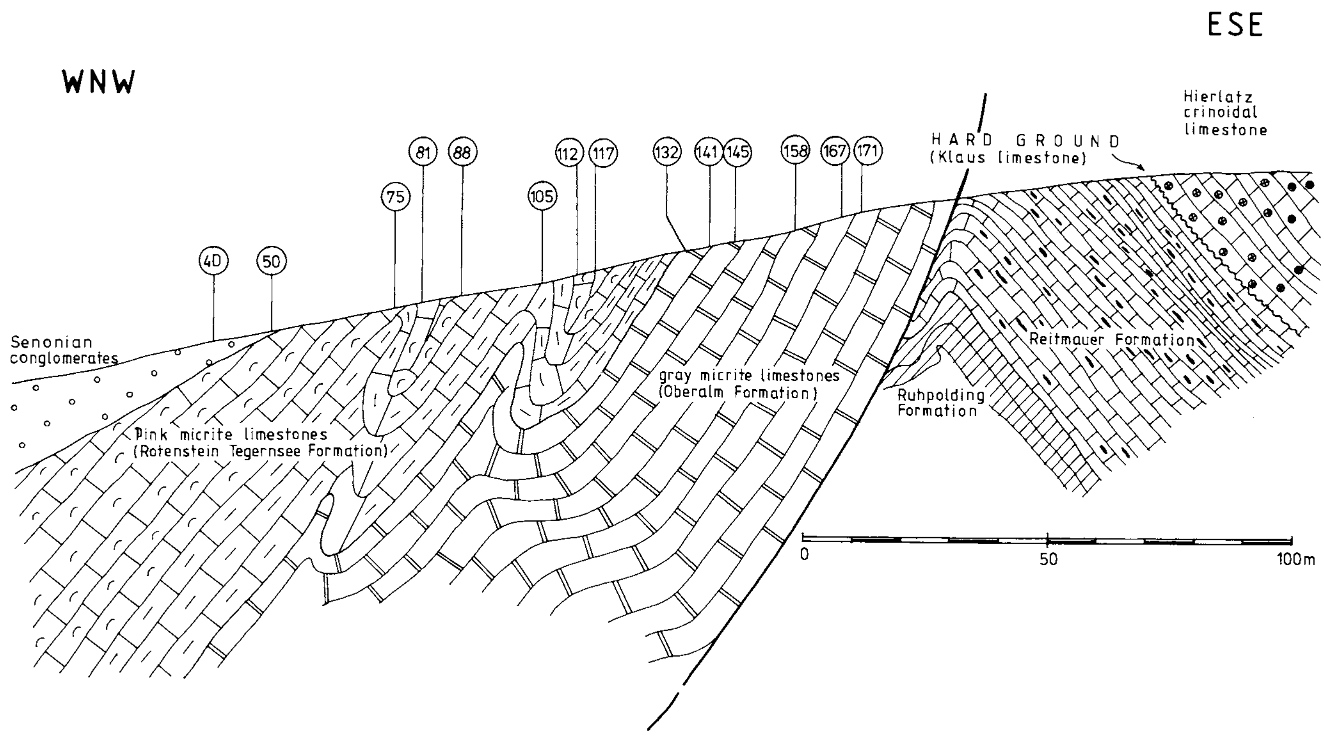


Fig. 2. Diagram of the taking of samples.

Upper part of the Upper Tithonian

The overlying horizon (81, 88, 105, 112 m) of micritic rosy limestones are accompanied by calcified and pyritized radiolarians, a poor nannoplankton association, and a richer calpionellid association. Isolated fragments of aptychi, small foraminifers *Spirillina* sp. and ostracods are found here. Clastic quartz of aleuritic size and hydroxide Fe are present in the mineral admixture. The calpionellid association is formed by large forms of *Calpionella alpina* Lorenz, small varieties of *Tintinnopsella carpathica* (Murg. et Fil.), *Crassicollaria intermedia* (Durand Delga), *Crassicollaria massutiniana* (Colom), and *Crassicollaria* sp. The association mentioned indicates the subzone *Intermedia* (Remane et al. 1986), which is characteristic of the upper part of the Upper Tithonian. The very poor association of nannoplankton, without stratigraphic value is almost consistent with the association from the underlying horizon (75 m), to which are added *Cyclagelosphaera rotaclypeata* Bukry (88 m), *Ellipsagelosphaera* cf. *ovata* (Bukry) Black (112 m) and *Zeugrhabdotus embergeri* (Nöel) Perch-Nielsen (81 m).

In horizon 117 m nannocones appear for the first time - *Nannoconus broennimannii* Trejo, *N.* aff. *colomii* (de Lapparent) Kamptner, *N. globulus* Brönnimann and *N. steinmannii* Kamptner. Among radiolarians in this horizon, apart from species with a wide stratigraphic range, species which indicate the occurrence of U.A. 11 were identified, with the species *Parvicingula cosmoconica* (Foreman), *Pseudodictyomitra depressa* Baumgartner, *Xitus spicularius* (Aliev),? *Pantanellium berriasianum* Baumgartner, and *Obesacapsula rusconensis* Baumgartner. The calpionellid association differs from the underlying horizon in that large forms of *Calpionella alpina* (*Calpionella* cf. *grandalpina* Nagy) have the most abundant occurrence.

Lower Berriasian

Horizon 132 m in the bedded pale grey micritic limestone facies of the Biancone type, is interesting not only for the change in lithofacies, but also for the change in associations of calpionellid microfauna. We date here the mass occurrence of small globular forms of *Calpionella alpina* Lorenz, described in the sense of Houša (1990) as true forms of *C. alpina*, which are typical of the base of the *Calpionella* Zone, at the base of the Berriasian. *Crassicollaria parvula* Remane, and *Tintinnopsella carpathica* (Murg. et Fil.), accompanied by globochaets are also present. The radiolarian association is unusually rich and includes species typical of zone U.A. 11, such as *Parvicingula cosmoconica* (Foreman), *Obesacapsula rusconensis* Baumgartner, *Archaeodictyomitra excellens* (Tan-Sin-Hok), *Alievum helenae* Schaaf, *Xitus spicularius* (Aliev), *Pseudodictyomitra depressa* Baumgartner. Calcareous nannoplankton is represented by the species *Nannoconus* cf. *globulus* Brönnimann, *N. steinmannii* Kamptner, *Nannoconus* sp., *Zeugrhabdotus embergeri* (Nöel) Perch-Nielsen, *Watznauria biporta* Bukry, *Hexalithus magharensis* Moshkovitz et Ehrlich.

The overlying horizon of micritic limestones of Biancone type (141 - 173 m) also contains a further calpionellid association of Lower Berriasian Zone B (*Calpionella*), but the radiolarian fauna is more diversified than in horizon 132 m. Apart from species with a wider stratigraphic range (*Acanthocirus dicranacanthos* (Squinabol), *Sethocapsa cetia* Foreman, *Triactoma echiodes* Foreman, *Mirifusus mediodilatatus minor* (Baumgartner), and those which are characteristic of U.A. 11, it also contains species which have so far been known in the literature from stages younger than the Berriasian. These are *Pseudodictyomitra lilyae* (Tan-Sin-Hók) and *Archaeodictyomitra nuda* Schaaf (158 m). Apart from *Ellipsagelosphaera* and *Cyclagelosphaera*, the nannofossils include *Zeugrhabdotus embergeri* (Nöel) Perch-Nielsen and *Rotelapillus laffittei* (Nöel) Nöel, the first occurrence of which is placed in the Lower Berriasian.

Horizons 167 and 173 m contain a rich association of radiolarians with significant species such as *Parvicingula cocmoconica* (Foreman), *Pseudodictyomitra depressa* Baumgartner, *Archaeodictyomitra excellens* (Tan-Sin-Hok), ? *Pantanellium berriasianum* Baumgartner, and also *Sethocapsa pseudouterculus* Aita, *S. kaminogoensis* Aita, *Podobursa polylophia* Foreman etc.

Conclusion

In the monotonous stratigraphic sequence of the Hrušové section, consisting of a formation of thin bedded pinkish limestones, and a formation of bedded pale limestones of the Biancone type, we distinguished the Upper Tithonian *Remanei* and *Intermedia* Subzones, and the Lower Berriasian *Calpionella alpina* Subzone We correlated these with the radiolarian zones (Baumgartner 1984, 1987) and the nannoplanktonic zones (Sissingh 1977).

In the Upper Tithonian horizons, on the basis of calpionellid fauna, we were able to distinguish the partially preserved *Intermedia* Subzone, accompanied by a nannoplankton association with dominant representation of *Ellipsagelosphaeraceae*. We did not succeed in identifying the radiolarian fauna, as a result of very poor preservation.

In horizon 117 m U.A. 11 radiolarian association (base of zone D, Baumgartner 1984) and a nannoplankton association, represented by nannocone CC1 Zone (Sissingh 1977) were found.

A mass occurrence of small globular forms of *Calpionella alpina* Lorenz, described by Houša (1990) as true *C. alpina* is characteristic of the base of the Berriasian.

Apart from radiolarians characteristic of U.A. 11, horizon 158 m also contains species known from stages later than Berriasian - *Pseudodictyomitra lilyae* (Tan-Sin-Hok) and *Archaeodictyomitra nuda* Schaaf.

The overlying horizon (161-173) is dated on the basis of calpionellids belonging to *C. alpina* Subzone.

The data obtained shows that the boundaries of the biozones (studied of associations of calpionellids, radiolarians and calcareous nannoplankton) are not synchronnous.

In the section we studied, U.A. 11 radiolarian association occurs below the boundary of the calpionellid zones A and B, in the uppermost Tithonian, just as in the Fiumo Bosso section (Umbria, Italy) in Baumgartner (1984).

Nannocones corresponding to CC1 Zone (*Nannoconus steinmannii*) appear in the association of calcareous nannoplankton occure together with U.A. 11 radiolarian association.

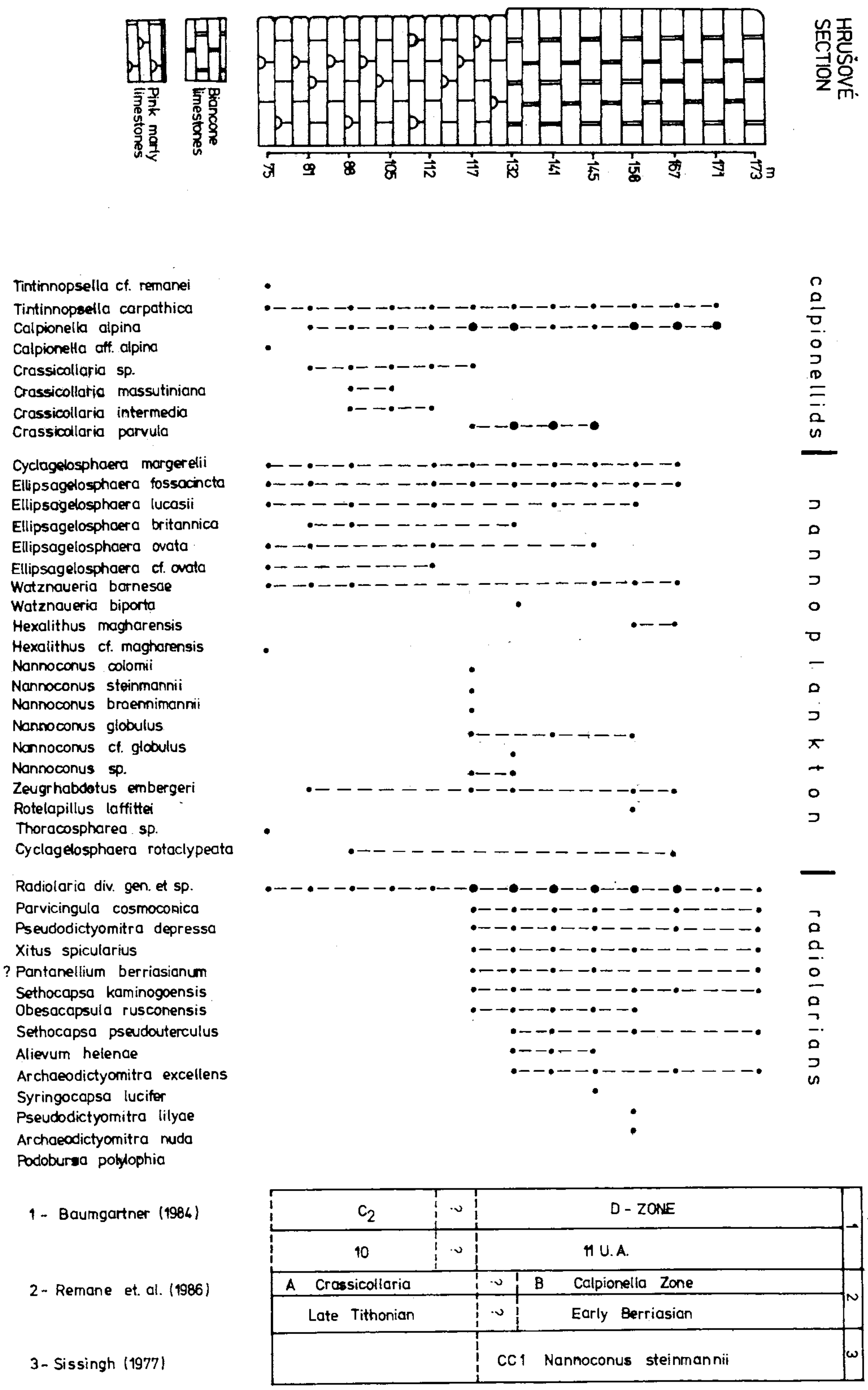


Fig. 3. The distribution of micro- and nannoplankton in the Hrušové section (schematized).

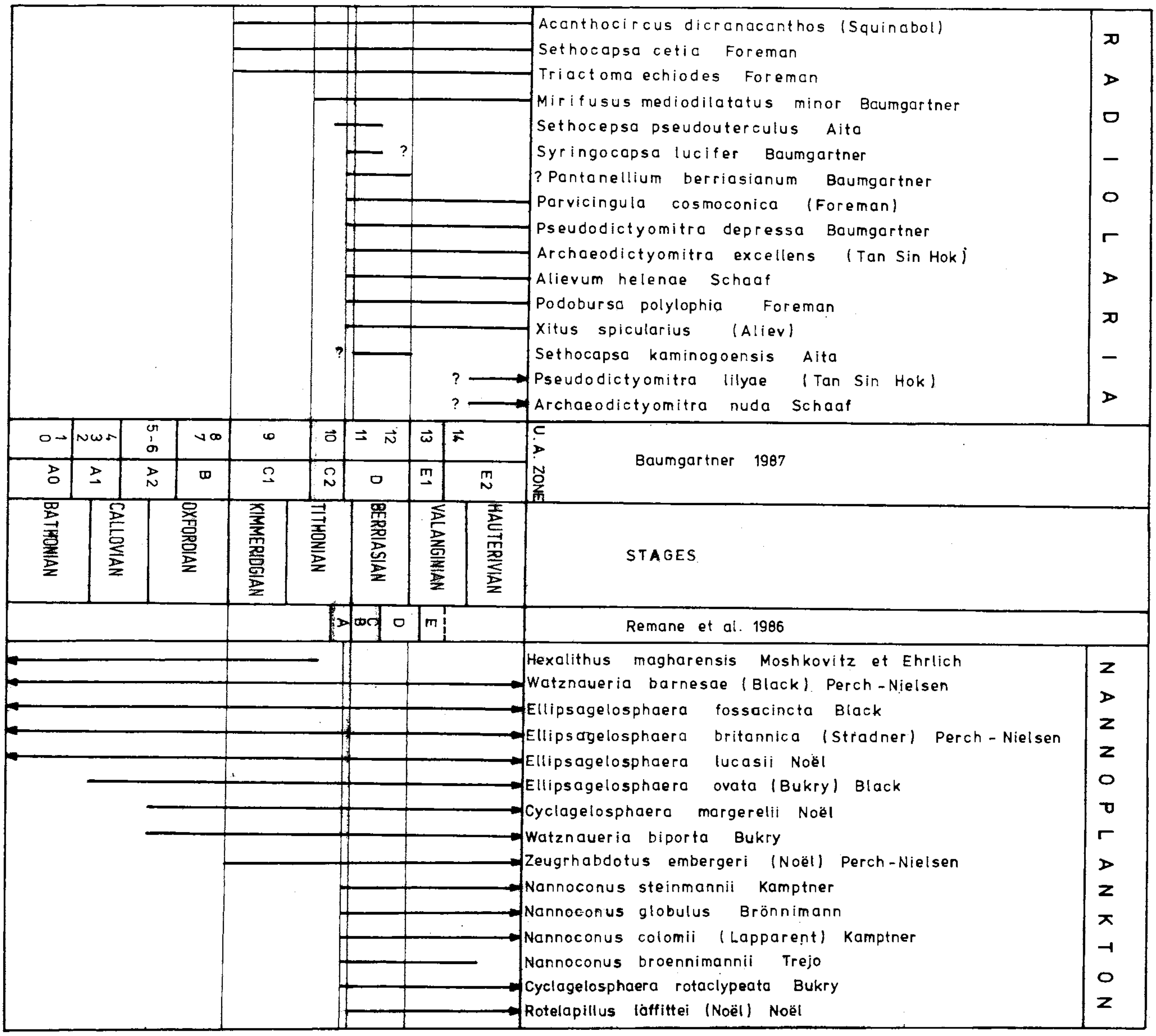
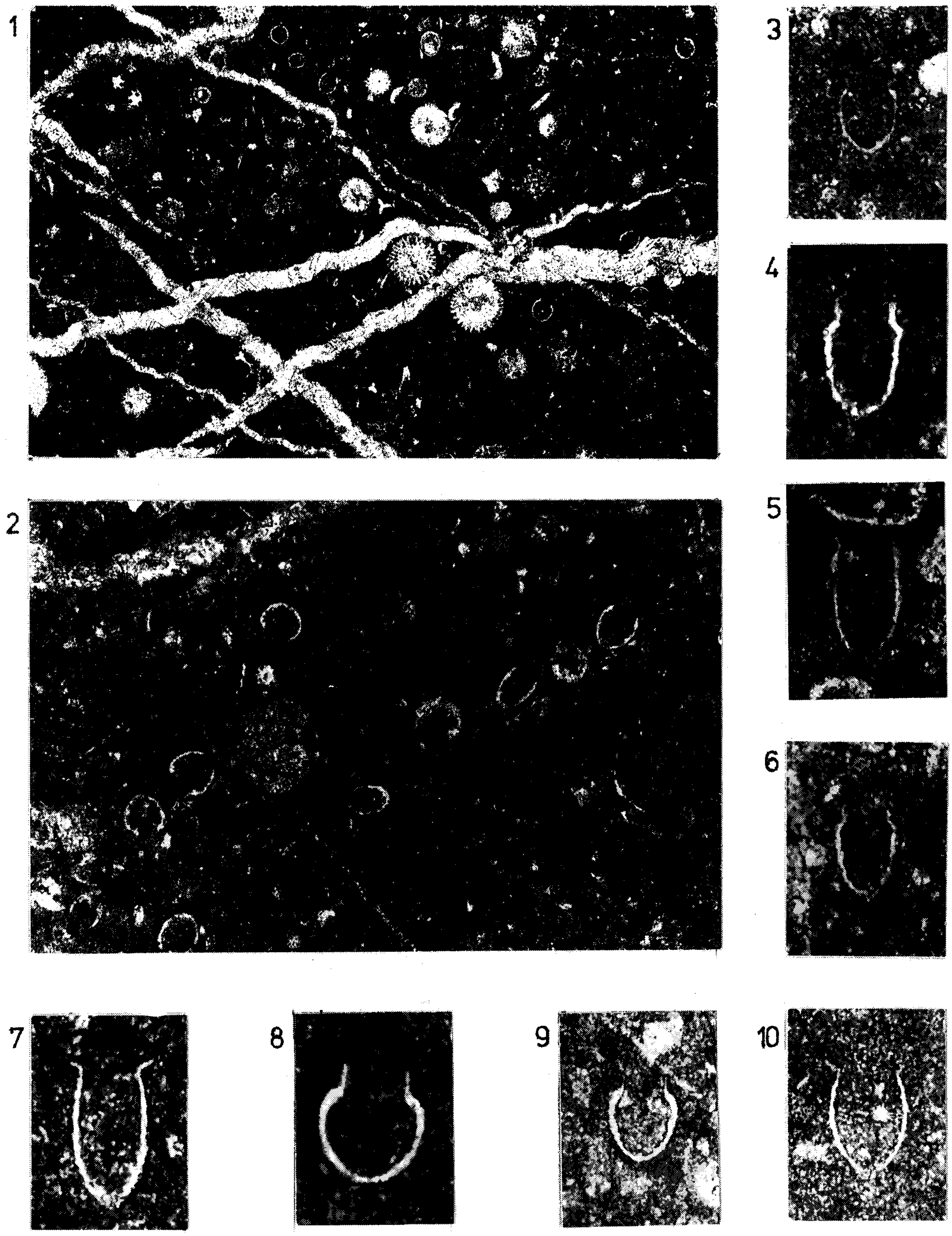


Fig. 4. Stratigraphic range of selected species of radiolarians and calcareous nannoplankton (Baumgartner 1984; Perch-Nielsen 1985).

Plate 1: Fig. 1 - radiolarian-calpionella microfacies, section 145 m (*C. alpina* Subzone), x 55. Fig. 2 - crassicollaria-calpionella microfacies, section 117 m (Intermedia Subzone), x 120. Fig. 3 - *Tintinnopsella* cf. *remanei* Borza, section 75 m (Remanei Subzone), x 265. Fig. 4 - *Crassicollaria massutiniana* (Colom), section 88 m, (Intermedia Subzone), x 265. Fig. 5 - *Crassicollaria intermedia* (Durand Delga), section 112 m(Intermedia Subzone), x 265. Fig. 6 - *Crassicollaria parvula* Remane, section 132 m (*C. alpina* Subzone), x 265. Fig. 7 - *Tintinnopsella carpathica* (Murg. et Fil.), section 167 m (*C. alpina* Subzone), x 265. Fig. 8 - *Calpionella alpina* Lorenz, section 112 m, (Intermedia Subzone), x 265. Fig. 9 - *Calpionella alpina* Lorenz, section 141 m (*C. alpina* Subzone), x 265. Fig. 10 - *Tintinnopsella carpathica* (Murg. et Fil.), section 112 m (Intermedia Subzone), x 265.

Plate 2: Figs. 1-3 - *Parvicingula cosmoconica* (Foreman), 1 - 3097, x 220, section 117 m; 2 - 2431, x 190, section 145 m; 3 - 1551, x 140, section 173 m. Figs. 4, 5.- *Xitus spicularius* (Aliev), 4 - 3095, x 225, section 117 m; 5 - 2151, x 210, section 145 m. Fig. 6 - *Mirifusus mediodilatatus minor* Baumgartner, - 2128, x 120, section 145 m. Fig. 7 - *Archaeodictyomitra excellens* (Tan Sin Hok) - 2116, x 130, section 173 m. Figs. 8-10 - *Obesacapsula rusconensis* Baumgartner, 8 - 2530, x 210, section 141 m; 9 - 2940, x 100, section 117 m; 10 - 1358, x 130, section 132 m.

Plate 3: Figs. 1-3 - *Alievum helenae* Schaaf, 1 - 2561, x 230, section 141 m; 2 - 2081, x 150, section 145 m; 3 - 2146, x 150, section 145 m. Fig. 4 - *Pseudodictyomitra lilyae* (Tan Sin Hok), - 1979, x 210, section 158 m. Fig. 5 - *Podobursa sp.* - 2124, x 100, section 145 m. Fig. 6 - *Podobursa polylophia* Foreman, - 1579, x 130, section 173 m. Fig. 7 - ?Pantanellium berriasianum Baumgartner, - 2897, x 230, section 117 m. Fig. 8 - *Triactoma echiodes* Foreman, -2118, x 110, section 145 m. Fig. 9 - *Acanthocircus dicranacanthos* (Squinabol), - 2533, x 110, section 141 m. Figs. 10, 11 - *Sethocapsa cetia* Foreman, 10 - 2112, x 90, section 173 m; 11 - 2432, x 110, section 145 m.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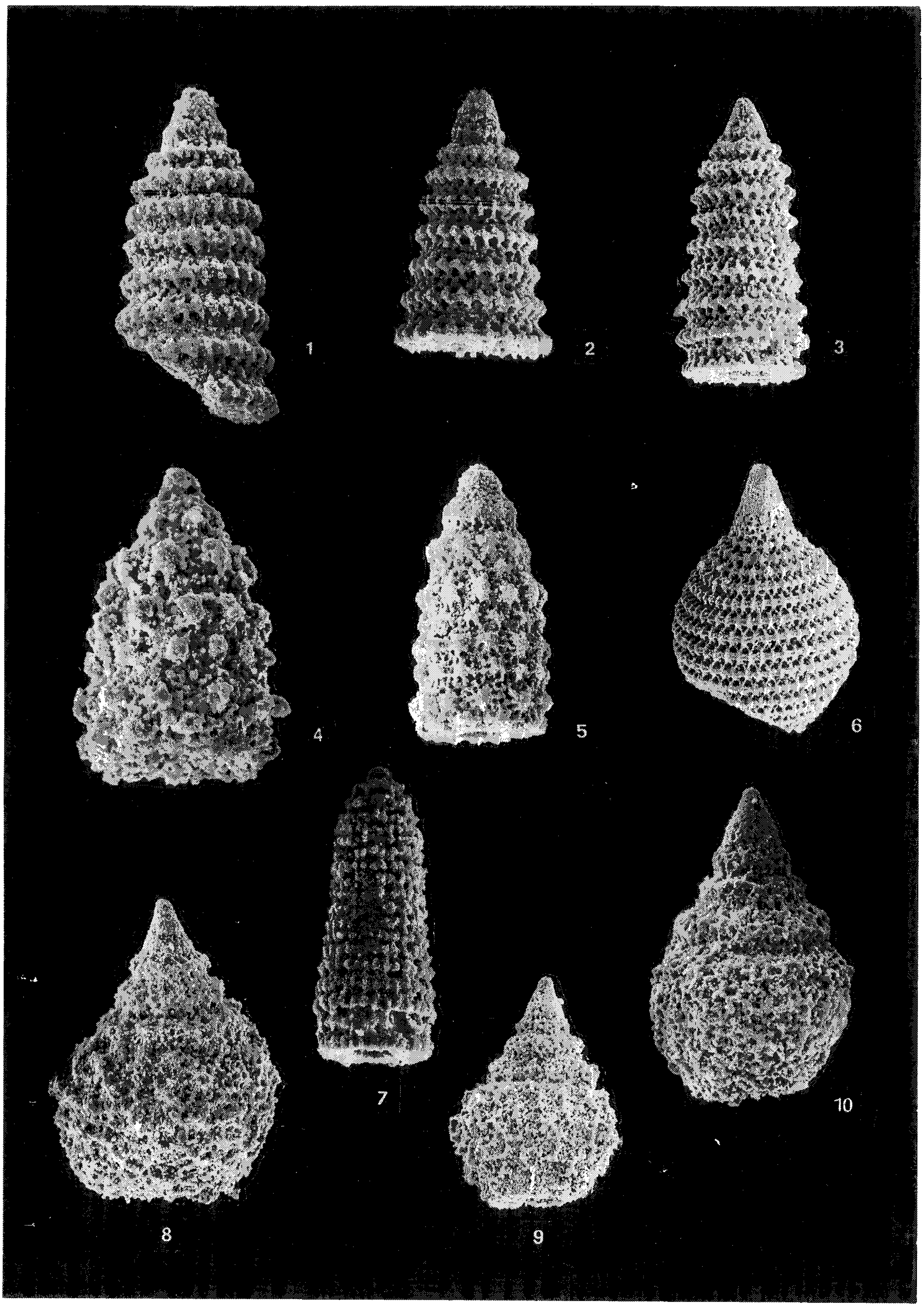
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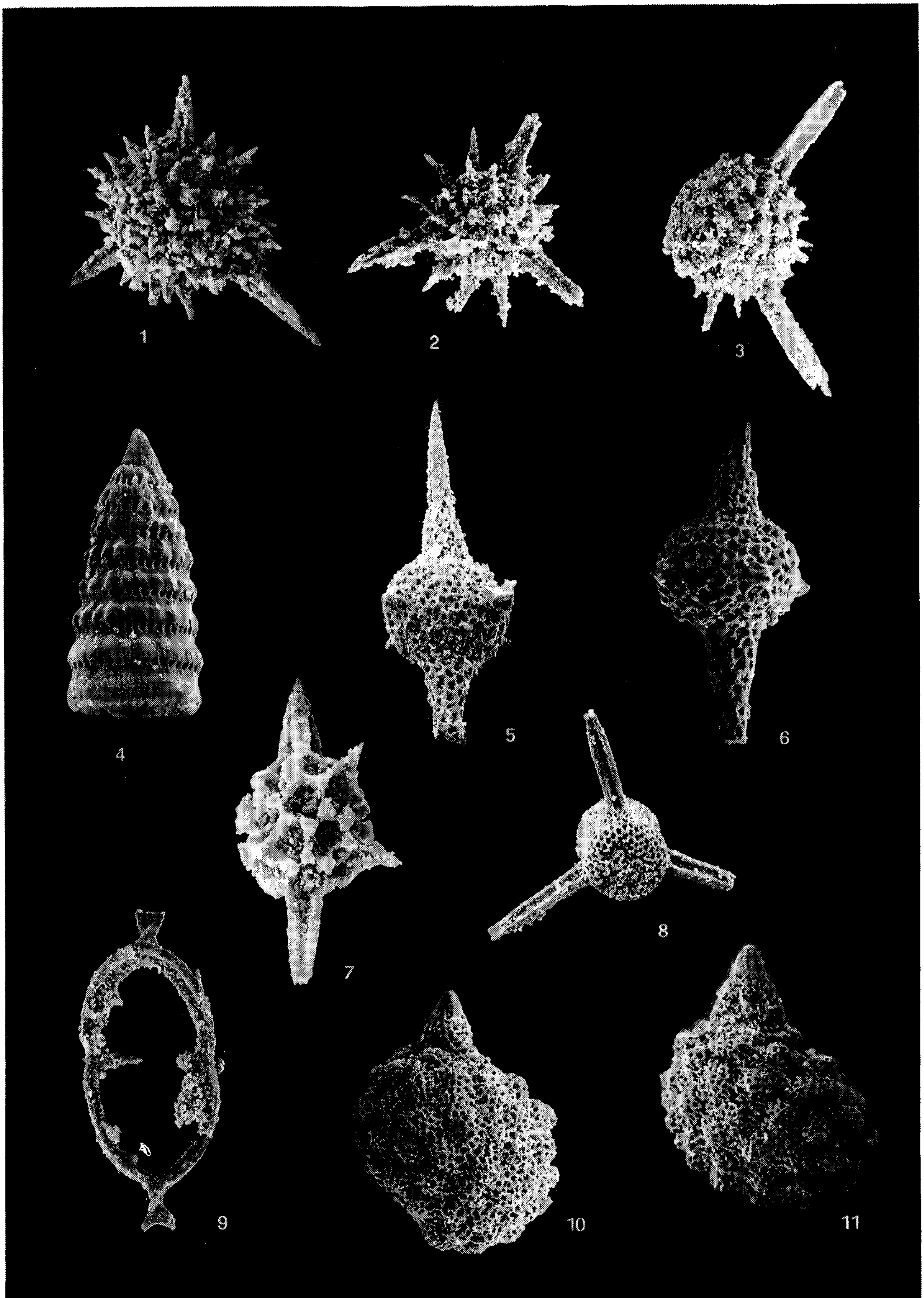

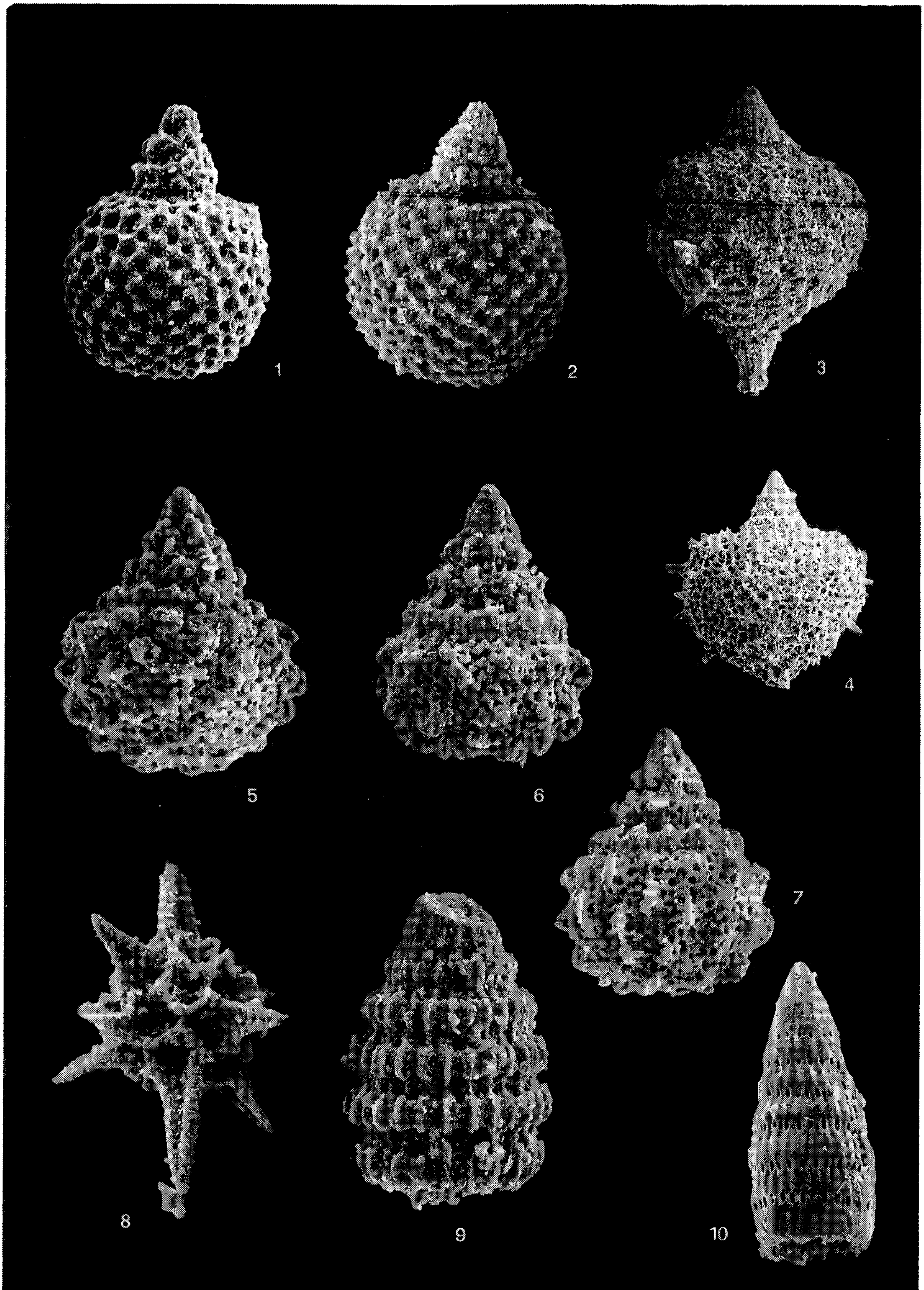

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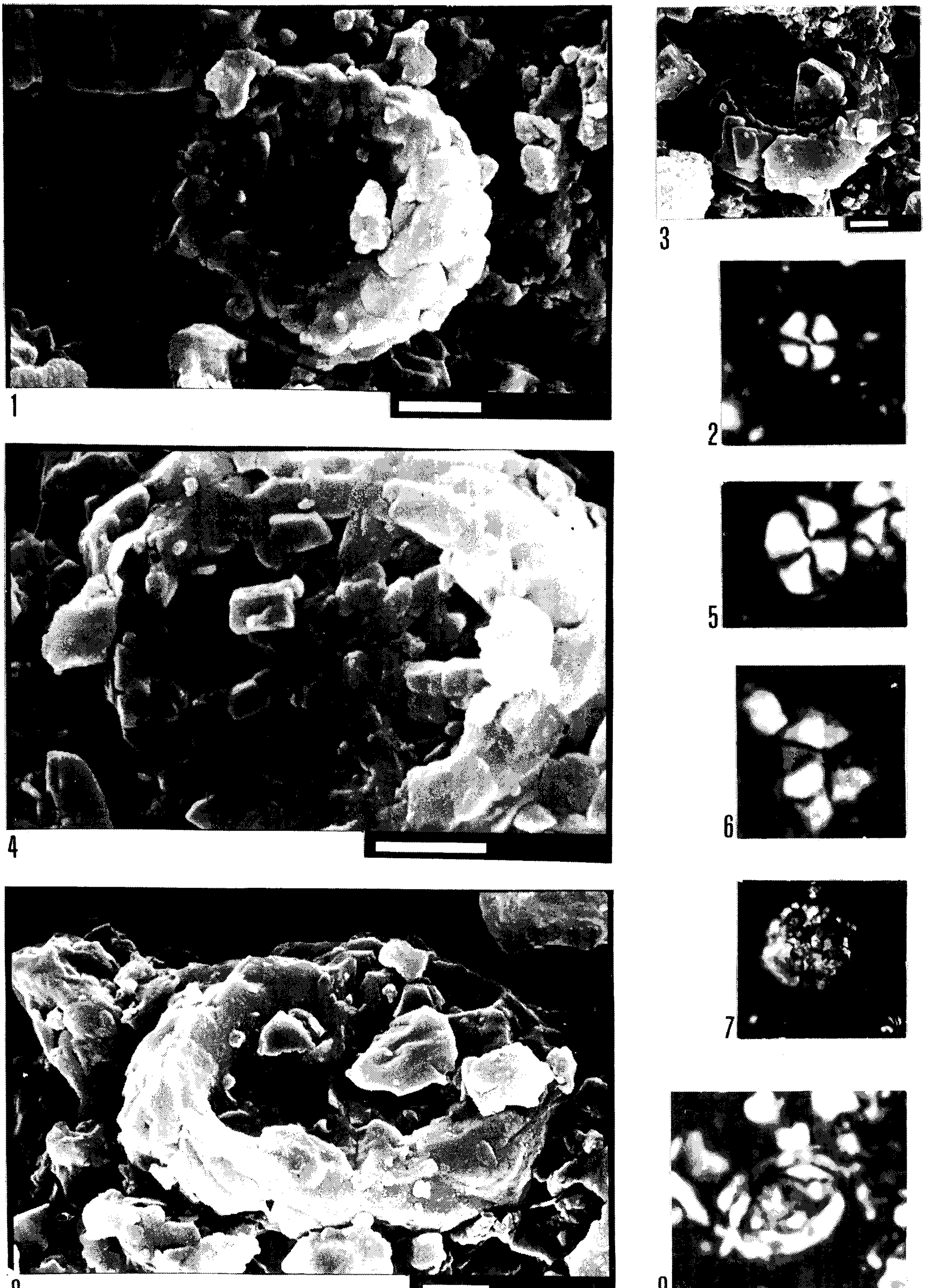

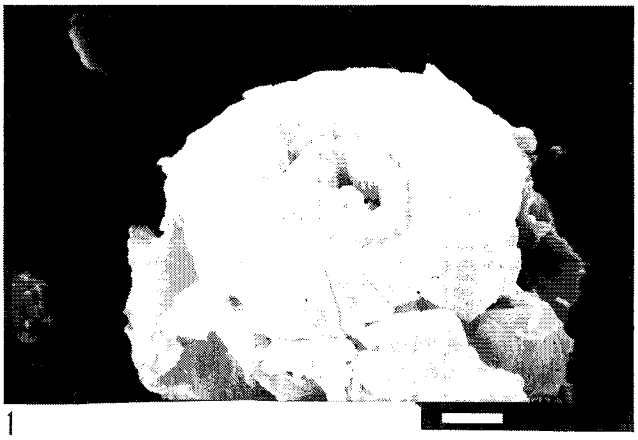

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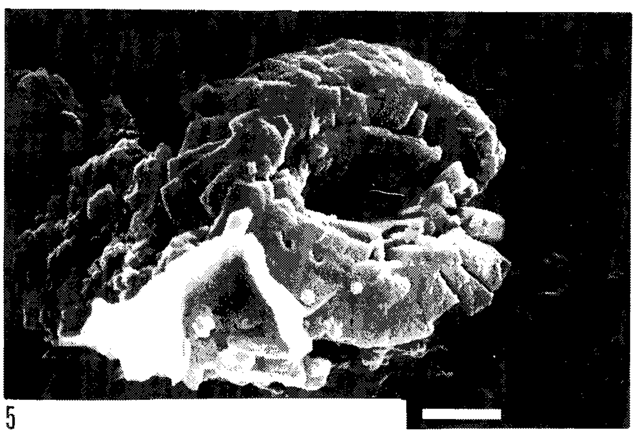

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Plate 6: Fig. 1 - *Watznaueria biporta* Bukry, section 132 m. Fig. 2 - *Nannoconus steinmannii* Kamptner, section 117 m, cross-pollarized light, x 2600. Fig. 3 - *Nannoconus steinmannii* Kamptner, section 117 m, transmitted light, x 2600. Fig. 4 - *Nannoconus globulus* Brönnimann, section 117 m, transmitted light, x 2600. Fig. 5 - *Ellipsagelosphaera* cf. *ovata* (Bukry) Black, section 112 m. Scale bar in figures indicates 1 m. SEM photographs made by Mr. Horák, Geological Inst. of D. Štúr.

Plate 4: Figs.1, 2 - *Sethocapsa pseudouterculus* Aita, 1 - 1067, x 220 m, section 173 m; 2 - 1311, x 220, section 132 m. Figs. 3, 4 - *Syringocapsa lucifer* Baumgartner, 3 - 2043, x 90; 4 - 2156, x 80, section 145 m. Figs. 5-7 - *Sethocapsa kaminogoensis* Aita, 5 - 3113, x 300, section 117 m; 6 - 1313, x 250, section 132 m; 7 - 1331, x 250, section 132 m. Fig.8 - ? *Pantanellium berriasianum* Baumgartner, - 2538, x 280, section 141 m. Fig. 9 - *Pseudodictyomitra depressa* Baumgartner, - 3101, x 300, section 117 m. Fig. 10 - *Archaeodictyomitra nuda* Schaaf, - 2026, x 300, section 158 m.

Plate 5: Fig. 1 - *Cyclagelosphaera margerelii* Nöel, section 81 m. Fig. 2 - *Cyclagelosphaera margerelii* Nöel, section 81 m, cross-pollarized light, x 2600. Fig. 3 - *Cyclagelosphaera rotaclypeata* Bukry, section 88 m. Fig. 4 - *Rotelapillus laffittei* (Nöel) Nöel, section 158 m. Fig. 5 - *Watznaueria barnesae* (Black et Barnes) Perch-Nielsen, section 81 m, cross-pollarized light, x 2600. Fig. 6 - *Hexalithus magharensis* Moshkovitz et Ehrlich, section 132 m, cross-pollarized light, x 2600. Fig. 7 - *Thoracosphaera* sp., section 75 m, cross-pollarized light, x 2600. Fig. 8 - *Zeugrhabdotus embergeri* (Nöel) Perch-Nielsen, section 167 m. Fig. 9 - *Zeugrhabdotus embergei* (Nöel) Perch-Nielsen, section 81 m, cross-pollarized light, x 2600.

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