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UPPERMOST MAASTRICHTIAN RADIOLARIA FROM THE MAGURA NAPPE DEPOSITS, CZECH OUTER CARPATHIANS

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Abstract: This paper starts a new series of investigation on the radiolarian faunas from the Upper Cretaceous–Paleogene deposits of the Magura Nappe (Outer Carpathians). Uppermost Maastrichtian Radiolaria from the flysch deposits of the Soláň Formation (Czech part of the Outer Carpathians) are described herein. The systematic description of nine species belonging to order Spumellaria and 37 species of Nassellaria is presented. One new family (Gongylothoracidae n.fam.) and two new species are described: *Gongylothorax maguraensis* n.sp. and *Lithocampe eminentis* n.sp. The assemblage analysed is dominated by nassellarians, which comprise 90 percent of all specimens investigated. The most common genera are *Theocapsomma, Amphipyndax*, *Dictyomitra* and *Gongylothorax*.

Abstrakt: Prezentowana praca rozpoczyna nowy cykl badań nad zespołami promienic występujących w utworach na granicy górnej kredy i paleogenu w jednostce magurskiej (w Karpatach Zewnętrznych). Opisano mastrychckie promienice z utworów fliszowych formacji solańskiej (czeska część Karpat Zewnętrznych). Przedstawiono opis systematyczny 9 gatunków należących do rzędu Spumellaria oraz 37 gatunków należących do rzędu Nassellaria. Opisano nową rodzinę (Gongylothoracidae n.fam.) oraz dwa nowe gatunki: *Gongylothorax maguraensis* n.sp. i *Lithocampe eminentis* n.sp. W badanym zespole dominują formy należące do rzędu Nassellaria, które stanowią 90% zespołu. Najliczniej są reprezentowane rodzaje: *Theocapsomma*, *Amphipyndax*, *Dictyomitra* oraz *Gongylothorax*.

Key words: Radiolaria, taxonomy, Maastrichtian, Magura Nappe, Czech Outer Carpathians.

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INTRODUCTION

Radiolarian faunas from the Cretaceous–Tertiary boundary interval have been a subject of systematic descriptions and stratigraphic studies of previous authors from different regions of the world.

In North America, Campbell and Clark (1944) started the investigations of the uppermost Cretaceous radiolarian fauna. These authors described a very diverse Campanian radiolarian association from California. Foreman (1968) presented the first study of radiolarians from the upper Maastrichtian and Cretaceous–Tertiary boundary deposits from the same region, and Pessagno (1976) established a Late Cretaceous radiolarian zonal scheme. Pessagno (1963) also recorded Campanian Radiolaria from the Puerto Rico region. Riedel and Sanfilippo (1970) recognised a Senonian radiolarian assemblage in the Caribbean region.

Late Cretaceous radiolarians from the Eastern Atlantic have been documented by Petrushevskaya and Kozlova (1972) and Foreman (1978).

In the Pacific region, Moore (1973) established a radiolarian biozonation in the Tithonian to Maastrichtian deposits. Dumitrică (1973) presented a Paleocene radiolarian assemblage from the Lord Howe Rise (South-East Pacific). Empson-Morin (1981) reported a Campanian radiolarian assemblage from the mid-Pacific mountains. The first studies of the Late Cretaceous to Paleogene Radiolaria and the radiolarian changes across the Cretaceous–Tertiary boundary from New Zealand were presented by Hollis (1993, 1996, 1997). Upper Cretaceous and Paleogene radiolarian faunas have been described from Japan by many authors (i.e., Taketani, 1982; Iwata & Tajika, 1986; Aita *et al.*, 1997).

In the Indian Ocean region, Riedel and Sanfilippo (1974) reported several Late Cretaceous Radiolaria (the Madagascar region).

In the Antarctic region, Ling and Lazarus (1990) recorded Cretaceous radiolarians from the Weddell Sea.

In Asia, Lipman (1960) was the first who described

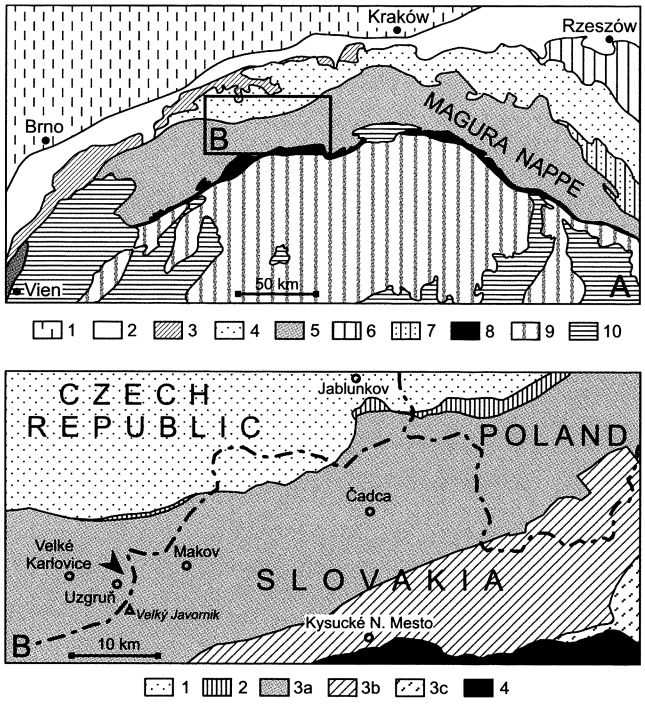

Fig. 1. Location map of the study area. **A.** Position of the Magura Nappe within the Carpathians; *1* – Forecarpathian platform, *2* – Carpathian Foredeep, *3* – Sub-Silesian Nappe, *4* – Silesian Nappe, *5* – Magura Nappe, *6* – Skole Nappe, *7* – Dukla Nappe, *8* – Pieniny Klippen Belt, *9* – undivided Inner Carpathian units, *10* – Neogene cover. **B.** Detailed map (after Żytko, *et al.*, (1988) – simplified) showing distribution of examined section (black arrow); *1* – Silesian Unit, *2* – Fore Magura Unit, *3* – Magura Unit: *a* – Rača subunit, *b* – Bystrica subunit, *c* – Krynica subunit, *4* – Pieniny Klippen Belt

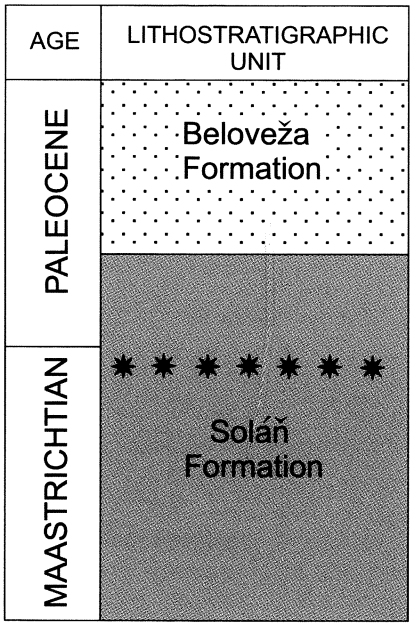

Fig. 2 Stratigraphic column of the upper Maastrichtian through Paleocene flysch deposits of the Rača subunit (after Bubik *et al.* (1999) – simplified). Radiolarian "horizon" marked by black stars

Cretaceous Radiolaria from the Western Siberian Lowland. Kozlova and Gorbovetz (1966) described a number of Radiolaria from the Upper Cretaceous deposits of the same area.

In Europe, Zittel (1876), Cayeux (1897) and Hill (1912) presented radiolarian occurrences in the European Upper Cretaceous Chalk. Górka (1989) described Upper Cretaceous Radiolaria from extra-Carpathians territory of Poland. Upper Cretaceous–Paleocene radiolarian fauna from the Mediterranean region were described first by Squinabol (1903, 1904).

Despite these numerous investigations of the uppermost Cretaceous radiolarian assemblages, which began towards the end of the 19th century, radiolarians have not been described from Carpathians deposits up to now.

Upper Cretaceous–Paleocene deposits of the Magura Nappe (Western Carpathians) have been a subject of lithological and biostratigraphical studies by many scientists in the Czech, Slovak and in the Polish part of this unit. During these investigations radiolarians have been noted within these deposits, but there has been no systematic description of this microfauna. The radiolarian assemblage presented herein has been used the first time for the biostratigraphy and palaeoecological interpretation of the Upper Cretaceous–Paleocene deposits of the Rača subunit (Magura Nappe) by Bubik *et al.* (1997, 1999).

The present paper is a first attempt of systematic description of the uppermost Maastrichtian radiolarian assemblage from the Czech part of the Magura Unit.

GEOLOGICAL SETTING

The Magura Nappe is the largest and innermost of the Tertiary thrust-sheets of the Outer Carpathians. The exposed part of the Magura sequence is represented by Mid-Cretaceous through Oligocene flysch deposits. Four tectono-facies zones have been distinguished in the Polish part of the Magura Nappe (Książkiewicz, 1948; Świdziński, 1953; Sikora & Żytko, 1959; Węcławik, 1969; Koszarski *et al.*, 1974; Żytko *et al.*, 1988). These are, from north to south: the Siary, the Rača, the Bystrica and the Krynica subunits. This scheme is correlatable with that of the Czech Outer Carpathians. The described radiolarian assemblage has been found within the Soláň Formation belonging to the Rača subunit in the Czech part of the Magura Nappe (Bubik *et al.*, 1997, 1999).

The outcrop is located in the vicinity of Uzgruň settlement, close to the Czech/Slovak border (Fig. 1). The Soláň Formation (Maastrichtian–Paleocene) is represented in its lower part by thin-bedded flysch deposits (Fig. 2), predominantly consisting of dark-grey calcareous silty claystones and grey-green non-calcareous claystones with thin intercalations of dark-grey silty sandstones and siltstones (Bubik *et al.*, 1997, 1999). The abundant radiolarian faunas are present within the layers of dark-grey silty claystones. The upper part of the Soláň Formation consists of thicker and more frequent sandstone beds. These deposits are completely non-calcareous.

The Soláň Formation corresponds to the upper Senonian through Paleocene part of the Inoceramian beds in the

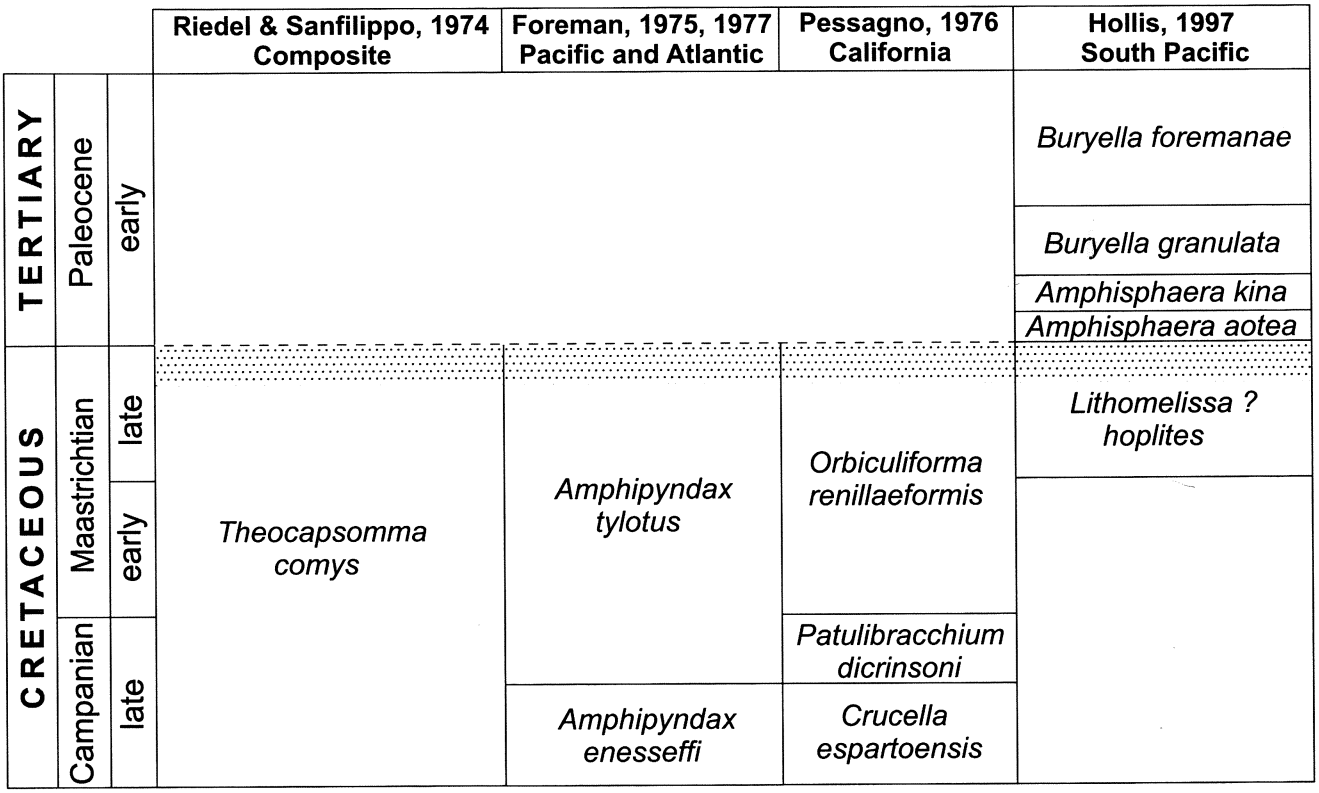

Fig. 3. Correlation of the previous published radiolarian zonal schemes for the deposits around the Cretaceous–Tertiary boundary. Dashed lines indicate uncertain position of zonal boundaries. Dotted field indicates range of radiolarian association investigated

Polish part of the Magura Nappe. A similar radiolarian association of latest Maastrichtian age has been found within the Inoceramian beds located at Szymbark in the stream-bed of the Ropa river (author's unpublished materials). The Inoceramian beds at the Szymbark locality consist of dark-grey and greenish shaly silts and argilaceous shales, alternated with thin- and medium-bedded, calcareous, laminated, micaceous sandstones with some thick-bedded sandstone intercalations. This "horizon" rich in radiolarians, might form a useful biotic marker for correlation of the Czech and the Polish lithostratigraphic units around the Cretaceous–Tertiary boundary.

METHODS

The samples for micropalaeontological purposes were collected by Dr. M. Bubik (Czech Geological Survey, Brno) during his field studies. The samples were taken in the section every 20 to 80 cm (depending on changes of lithology and quality of exposure), especially near lithological boundaries (for detail description and lithological column see Bubik *et al.*, 1999).

AGE ASSIGNMENT

The radiolarian assemblage presented below consists of well preserved, pyritised Radiolaria, which have been found in the dark-grey silty claystones. The presence of organic matter and clay minerals in the bottom sediments can result in excellent preservation of radiolarian skeletons. The radiolarian association comprises nine species belonging to order Spumellaria and 37 species of Nassellaria. The nassellarians dominate in numbers of specimens and taxa. They consist of 90 percent of all specimens found. The most characteristic genera are *Amphipyndax*, *Dictyomitra*, *Gongylothorax* and *Theocapsomma*. The spumellarians are represented predominantly by species belonging to the family Pseudoaulophacidae (genera: *Pseudoaulophacus*, *Patellula*). The fauna described has a character of low latitude radiolarian association.

The age of the Soláň Formation deposits in the investigated profile has been assigned as late Maastrichtian–Paleocene based on calcareous nannofossils, foraminifers and radiolarians (Bubik *et al.*, 1997, 1999).

The late Maastrichtian age of these deposits has been assigned mainly based on the abundant and well-preserved calcareous nannofossils (Švabenicka in Bubik *et al.*, 1999). There have been determined the *Micula murus* local zone, corresponded to the CC25c Zone (*sensu* Sisingh, 1977; Perch-Nielsen, 1985) as well as the *Nephrolithus frequens* and *Micula prinsii* local zones, both corresponded to the CC26 Zone. The Paleocene age has been assigned based on autochtonous agglutinated foraminifers (*Rzehakina fissistomata* Zone; Bubik *et al.*, 1997, 1999).

The abundant radiolarian assemblage has been found within several meters of the deposits belonging to the Cretaceous–Tertiary (K/T) transitional interval: between the last occurrence of stratigraphically important nannofossils and

the first appearance of the Paleocene agglutinated foraminifer, *Rzehakina fissistomata*. The age of the radiolarian assemblage has been assigned based on correlation with the radiolarian zonal schemes of previous authors (Foreman, 1975, 1977; Riedel & Sanfilippo, 1974; Pessagno, 1976; Hollis, 1997) (Fig. 3). The assemblage investigated can be correlated with the upper Campanian to Maastrichtian *Amphipyndax tylotus* radiolarian Zone of Foreman (1977) based on the presence of the index species and *Afens liriodes* which co-occur with *Siphocampe bassilis*, *Siphocampe daseia*, *Stichomitra grandis* (= *Stichomitra asymbatos*), *Theocapsomma teren* and *Theocapsomma comys*, described also by Foreman (1968) from upper Maastrichtian deposits in California.

The assemblage studied is also similar to those of Riedel and Sanfilippo (1974), and can be correlated with the *Theocapsomma comys* Zone of Riedel and Sanfilippo (1974) of approximately Maastrichtian age, based on the co-occurrence of the index species with *Stichomitra grandis* (= *S. asymbatos*), *Amphipyndax stocki*, *Afens liriodes* and *Amphipyndax pseudoconulus*.

The presence of *Orbiculiforma renillaeformis* together with the above mentioned radiolarian species allows correlation with the Maastrichtian *Orbiculiforma renillaeformis* interval Zone proposed by Pessagno (1976) for the California Coastal Ranges.

The comparison of the investigated radiolarian assemblage with mentioned above zonal schemes allows to assign its age as the Maastrichtian, but do not allow precise determination of the position of Cretaceous–Tertiary boundary within the profile investigated. This problem might be discussed based on the radiolarian zonation proposed by Hollis (1997) for the uppermost Cretaceous to Paleocene deposits from the New Zealand region. In his monograph Hollis (1997) revised the previous radiolarian biozonation for the New Zealand region (Hollis, 1993). He proposed the *Lithomelissa* ? *hoplites* radiolarian Interval Zone (RK9) for the upper Campanian to uppermost Maastrichtian, and for those parts of the Cretaceous–Tertiary boundary interval deposits which lack *Amphisphaera aotea* – the first species providing evidence of earliest Paleocene. The assemblage investigated corresponds to this zone by the presence of *Orbiculiforma ranillaeformis*, the first appearance of which defines the lower boundary of the zone. The radiolarian species that occur within the RK9 Zone (Hollis, 1993, 1997) are similar to the radiolarian association from the Magura Nappe deposits. Both associations contain *Stichomitra carnegiense*, *S. grandis*, *S. bertrandi*, *Amphipyndax stocki*, *Myllocercion acineton*, *Dictyomitra lamellicostata*, *D. multicostata*. The species *Amphisphaera aotea* is not present in the assemblage investigated. Moreover the nassellarians dominate within the association in number of specimens as well as in number of taxa. The characteristic change of faunal character from nassellarians to spumellarians dominance which also coincides with the top of the *Lithomelisa* ? *hoplites* Zone of Hollis (1997) does not occur in the association investigated. Based on these facts the age of the radiolarian assemblage from the Magura Nappe is assigned to the latest Maastrichtian.

SYSTEMATIC PALEONTOLOGY

Systematic schemes of Hollis (1997), Foreman (1968), Pessagno (1976) and O'Dogherty (1994) have been used to classify specimens described in this paper. The types of all species are currently housed in the author's collection (Institute of Geological Sciences, Jagiellonian University). All species (Figs 4–12) are described in family alphabetical order.

Order SPUMELLARIA Ehrenberg, 1875
Family ACTINOMMIDAE Haeckel, 1862, emend. Riedel, 1967b

Genus *Lithomespilus* Haeckel, 1881, emend. Hollis, 1997
Type species *Lithomespilus phloginus* Haeckel, 1887

Lithomespilus coronatus (Squinabol)
Fig. 4 A

1904. *Lithomespilus coronatus* Squinabol: p. 198, pl. 4, fig. 7.
1997. *Lithomespilus coronatus* Squinabol: Hollis, p. 37, pl. 4, figs 1-3.

Diagnosis: Test ellipsoidal with several three-bladed spines at each pole. Cortical shell with numerous, small, circular pores. An irregular medullar shell may be present.
Material: Only two specimens with broken spines have been found in the material investigated.

Genus *Prunocarpus* Haeckel, 1887
Type species *Prunocarpus datura* Haeckel, 1887

Prunocarpus sp.
Fig. 4 B

Diagnosis: Test ellipsoidal with numerous pyramidal spines distributed regularly around the test. Pores of cortical shell circular.
Material: Only two specimens have been found in the material investigated.
Remarks: Specimens very similar to these described by Hollis (1997).

Family PORODISCIDAE Haeckel, 1881, emend. Kozlova in Petrushevskaya & Kozlova, 1972

Genus *Tholodiscus* Kozlova in Petrushevskaya & Kozlova, 1972
Type species *Stylodictya ocellata* Ehrenberg, 1875

Tholodiscus cf. *ocellatus* (Ehrenberg)
Fig. 4 C

1875. *Stylodictya ocellata* Ehrenberg: pl. 23, fig. 7.
1997. *Tholodiscus* cf. *ocellatus* (Ehrenberg): Hollis, p. 54, pl. 11, figs 4-8.

Diagnosis: Test discoidal, circular to subquadrangular in outline, flattened, with four radial spines protruding out from the test periphery. Chambers arranged in bands, which form a spiral of up to seven whorls. Pores of the test small, circular.
Material: Ten specimens have been found in the material investigated.
Remarks: Only well preserved specimens have spines visible on the test periphery.

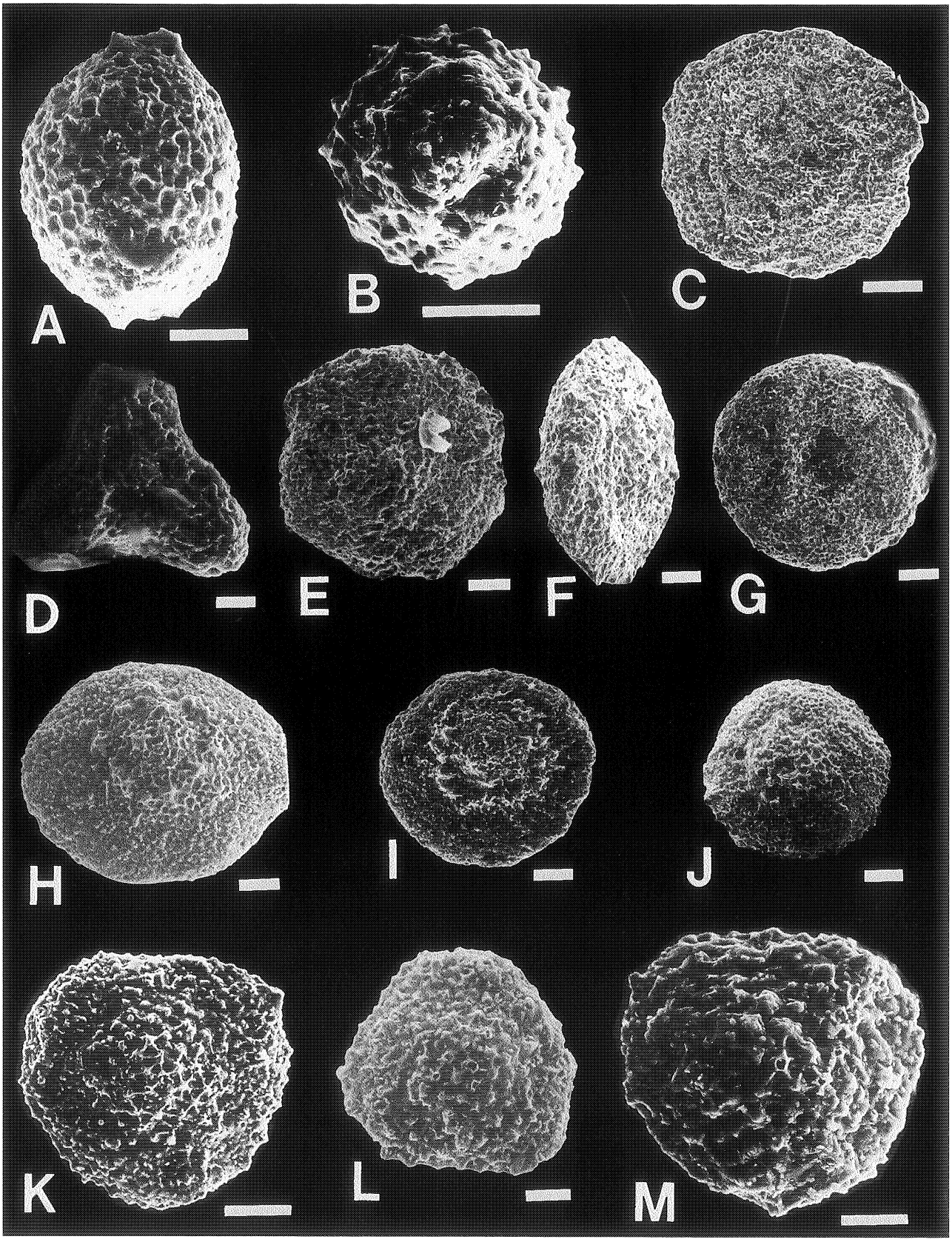

Fig. 4. SEM micrographs of Spumellaria. **A.** *Lithomespilus coronatus* (Squinabol), **B.** *Prunocarpus* sp., **C.** *Tholodiscus* cf. *ocellatus* (Ehrenberg), **D.** *Spongotripus* sp., **E.** *Orbiculiforma renillaeformis* (Campbell & Clark), **F.** *Pseudoaulophacus lenticulatus* (White), **G.** *Orbiculiforma sacramentoensis* Pessagno, **H, I.** *Patellula planoconvexa* (Pessagno), **J.** *Pseudoaulophacus lenticulatus* (White), **K-M.** *Pseudoaulophacus floresensis* Pessagno. Length of scale bar – 100 μm

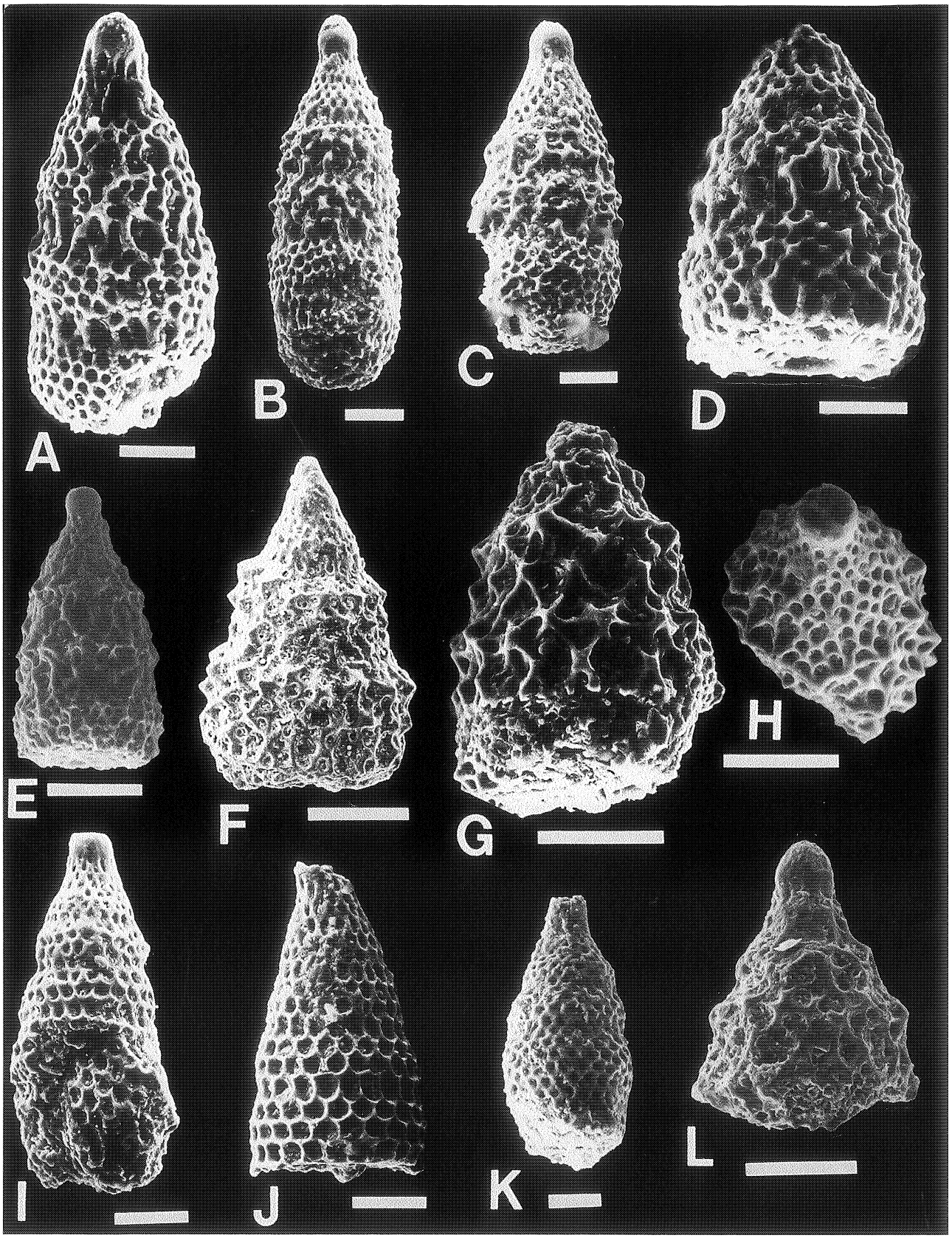

Fig. 5. SEM micrographs of Nassellaria. **A-D.** *Amphipyndax tylotus* Foreman, **E-H.** *Amphipyndax pseudoconulus* (Pessagno), **I-K.** *Amphipyndax stocki* (Campbell & Clark), **L.** *Amphipyndax pseudoconulus* (Pessagno). Length of scale bar – 100 μm

Family PSEUDOAULOPHACIDAE Riedel, 1967a

Genus *Patellula* Kozlova, in Petrushevskaya & Kozlova, 1972
Type species *Stylospongia planoconvexa* Pessagno, 1963

Patellula planoconvexa (Pessagno)
Fig. 4 H, I

1963. *Stylospongia planoconvexa* Pessagno: p. 199, pl. 3, figs 4-6; pl. 6, fig. 1.
1979. *Patellula planoconvexa* (Pessagno): Nakaseko *et al.*, p. 21, pl. 8, fig. 1.
1981. *Patellula planoconvexa* (Pessagno): Nakaseko & Nishimura, p. 157, pl. 2, fig. 8.

Diagnosis: Test circular in equatorial cross-section, plano-convex. Convex surface with centrally located raised area covered by nodes. Opposite surface flat. Meshwork comprises tetragonal to hexagonal pore frames. Test possesses approximately 20 spines, which radiate from the equatorial plane.
Material: Ten specimens have been found in the material investigated.

Genus *Pseudoaulophacus* Pessagno, 1963
Type species *Pseudoaulophacus floresensis* Pessagno, 1963

Pseudoaulophacus floresensis Pessagno
Fig. 4 K-M

1963. *Pseudoaulophacus floresensis* Pessagno: p. 200, pl. 2, figs 2, 5; pl. 4, fig. 6; pl. 7, figs 1, 5.
1976. *Pseudoaulophacus floresensis* Pessagno: Pessagno, p. 28, pl. 9, fig. 6.
1985. *Pseudoaulophacus floresensis* Pessagno: Sanfilippo & Riedel, p. 595, figs 6.3a-b.
1989. *Pseudoaulophacus floresensis* Pessagno: Górka, p. 336, pl. 10, fig. 6.

Diagnosis: Test sub-triangular with three spines at corners. Spines circular in cross-section. Tholi diameter usually occupies half of the disk or more. Meshwork of tholi comprised larger and more massive pore frames than the remainder of the test.
Material: Fifteen specimens have been found in the material investigated.
Remarks: The spines at the test corners are usually broken.

Pseudoaulophacus lenticulatus (White)
Fig. 4 F, J

1928. *Baculogypsina* (?) *lenticulata* White: p. 306, pl. 41, figs 9, 11.
1962. *Aulophacus lenticulatus* (White): Pessagno, p. 364, pl. 6, figs 1, 2.
1963. *Pseudoaulophacus lenticulatus* (White): Pessagno, p. 202, pl. 2, figs 8, 9.

Diagnosis: Test circular in outline with centrally located tholi, which occupies about a third to a half of the disc diameter. Meshwork of tholi comprised larger and more massive pore frames than the remainder of the test. Test possesses approximately 12 short spines, circular in cross-section.
Material: Fifteen specimens have been found in the material investigated.

Family SPONGODISCIDAE Haeckel, 1862, emend. Riedel, 1967b, emend. Hollis, 1997

Genus *Orbiculiforma* Pessagno, 1973
Type species *Orbiculiforma quadrata* Pessagno, 1973

Orbiculiforma renillaeformis (Campbell & Clark)
Fig. 4 E

1944. *Spongodiscus renillaeformis* Campbell & Clark: p. 18, pl. 6, figs 5-6.
1976. *Orbiculiforma renillaeformis* (Campbell & Clark): Pessagno, p. 36, pl. 11, fig. 11.
1997. *Orbiculiforma renillaeformis* s.s. (Campbell & Clark): Hollis, p. 50, pl. 9, figs 4-7.

Diagnosis: Test disc-shaped, flat, circular in outline, with a v-shaped marginal notch. Central area wide. Meshwork spongy, coarse, with pores of different shapes.
Material: Five specimens have been found in the material investigated.
Remarks: Marginal spines along notch usually broken.

Orbiculiforma sacramentoensis Pessagno
Fig. 4 G

1976. *Orbiculiforma sacramentoensis* Pessagno: p. 36, pl. 11, fig. 8.

Diagnosis: Test circular to hexagonal in outline, with six short spines at periphery. Central depression narrow, with diameter about 1/3 of the tests. Meshwork with small, circular pores.
Remarks: Spines usually broken in the species investigated.
Material: Two specimens have been found in the material investigated.

Genus *Spongotripus* Haeckel, 1881
Type species *Spongotripus regularis* Haeckel, 1887

Spongotripus sp.
Fig. 4 D

1997. *Spongotripus* spp.: Hollis, p. 52, pl. 9, figs 8-10.

Material: Two specimens have been found in the material investigated.
Remarks: Forms included here with spongy tests, trilobate in outline with three spine, which are usually broken because of poor preservation of specimens. Pores visible on the surface of the test circular to elliptical, vary in size.

Order NASSELLARIA Ehrenberg, 1875
Family AMPHIPYNDACIDAE Riedel, 1967a

Genus *Amphipyndax* Foreman, 1966
Type species *Lithostrobus pseudoconulus* Pessagno, 1963

Amphipyndax pseudoconulus (Pessagno)
Fig. 5 E-H, L

1963. *Lithostrobus pseudoconulus* Pessagno: p. 210, pl. 1, fig. 8; pl. 5, figs 6, 8.
1963. *Lithostrobus punctulatus* Pessagno: pl. 5, figs 4, 5.
1978. *Amphipyndax enesseffi* Foreman: Foreman, p. 745, pl. 4, fig. 3.
1982. *Amphipyndax pseudoconulus* (Pessagno): Empson-Morin, p. 510, pl. 1, fig. 5; pl. 2, figs 1-5, 9, 10, 12.

1988. *Amphipyndax pseudoconulus* (Pessagno): Thurow, p. 397, pl. 1, fig. 8.

Diagnosis: Test multi-segmented, conical. Cephalis imperforate, divided into two chambers by a transverse septum. Outer layer of a meshwork consists of well developed nodes interconnecting by bars.
Material: Twenty five specimens have been found in the material investigated.

Amphipyndax stocki (Campbell & Clark)
Fig. 5 I-K, Fig. 6 A-E

1944. *Stichocapsa* (?) *stocki* Campbell & Clark: p. 44, pl. 8, figs 31-33.
1968. *Amphipyndax stocki* (Campbell & Clark): Foreman, p. 78, pl. 8, figs 12a-c.
1994. *Stichomitra stocki* (Campbell & Clark): O'Dogherty, p. 147, pl. 18, figs 9-15.
1997. *Amphipyndax stocki* (Campbell & Clark) group: Hollis, p. 66, pl. 15, figs 5-11.

Diagnosis: Test multi-segmented with about five to seven chambers. Cephalis spherical to knob-like. The first two or three chambers trapezoidal, remaining chambers cylindrical in some cases weakly constricted distally. Strictures between chambers invisible or slightly marked externally. Test thick-walled with circular or sub-circular pores arranged alternating in horizontal rows.
Material: Fifty six specimens have been found in the material investigated.

Amphipyndax tylotus Foreman
Fig. 5 A-D

1978. *Amphipyndax tylotus* Foreman: p. 745, pl. 4, figs 1, 2.
1981. *Amphipyndax tylotus* Foreman: Nakaseko & Nishimura, pl. 17, fig. 13.
1982. *Amphipyndax tylotus* Foreman: Empson-Morin, p. 512, pl. 3, figs 1-7.

Diagnosis: Test multi-segmented, conical in the upper part and becoming sub-cylindrical distally. Outer layer of a meshwork is characterised by an irregular network of interconnecting bars.
Material: Fifteen specimens have been found in the material investigated.

Family ARCHAEODICTYOMITRIDAE Pessagno, 1976; emend. Pessagno, 1977

Genus Dictyomitra Zittel, 1876, emend. Pessagno, 1976
Type species *Dictyomitra multicostata* Zittel, 1876

Dictyomitra aff. *rhadina* Foreman
Fig. 7 A-C

1968. *Dictyomitra* aff. *rhadina* Foreman: p. 66, pl. 7, figs 5a-b.
1997. *Dictyomitra* aff. *rhadina* Foreman: Hollis, p. 69, pl. 16, figs 17-20.

Diagnosis: Test conical to slender, consists of six to seven chambers. Ten to fourteen moderately massive costae are on the visible side of the last chamber.
Material: Seventeen specimens have been found in the material investigated.

Dictyomitra koslovae Foreman
Fig. 7 F

1975. *Dictyomitra koslovae* Foreman: p. 614, pl. 7, fig. 4.
non 1978. *Dictyomitra koslovae* Foreman: Foreman, p. 746, pl. 4, fig. 10.
1978. *Dictyomitra duodecimcostata duodecimcostata* (Squinabol): Foreman, p. 746, pl. 4, figs 8-9.

Diagnosis: Test multi-segmented conical, with fourth or fifth segment distinctly prominent in relation to the outlines of the segments immediately above and below. Test possesses 9-12 massive costae on the visible side.
Material: Fifteen specimens have been found in the material investigated.

Dictyomitra lamellicostata Foreman
Fig. 7 G-H, L

1968. *Dictyomitra lamellicostata* Foreman: p. 65, pl. 7, figs 8a-b.
1985. *Archaeodictyomitra lamellicostata* (Foreman): Sanfilippo & Riedel; p. 599, figs 7.5a-d.

Diagnosis: Specimens with about nine to fourteen blade-like, massive costae on the widest visible part of the test. Some of the costae (every other or each third) are present also on cephalis and thorax.
Material: Ten specimens have been found in the material investigated.
Remarks: The forms found here differ from those illustrated by Sanfilippo and Riedel (1985) by having less costae on the visible part of the test and having slightly marked constrictions on segmental divisions.

Dictyomitra multicostata Zittel
Fig. 7 I-K

1876. *Dictyomitra multicostata* Zittel: p. 81, pl. 2, figs 2-4.
1944. *Dictyomitra (Dictyomitroma) multicostata* Zittel: Campbell & Clark, p. 39, pl. 8, figs 22-24, 29, 35, 42.
1976. *Dictyomitra multicostata* Zittel: Pessagno, p. 52, pl. 14, figs 4-9.
1990. *Dictyomitra multicostata* Zittel: Ling & Lazarus, p. 356, pl. 2, fig. 4.
1994. *Dictyomitra multicostata* Zittel: O'Dogherty, p. 82, pl. 4, figs 17-19.
1997. *Dictyomitra multicostata* Zittel: Hollis, p. 69. pl. 16, figs 6-10.

Diagnosis: Test conical or sub-cylindrical distally, with seven to fifteen segments regularly increase in length. Nine to fifteen costae on the visible side of the test separate by single row of pores. Pores bigger and best visible on strictures between chambers.
Material: Fifteen specimens have been found in the material investigated.
Remarks: Specimens closely related to those described and illustrated by Campbell and Clark (1944).

Dictyomitra sp.
Fig. 7 D, E

Diagnosis: Test multi-segmented with seven to nine chambers regularly increase both in width and height. Ten to twelve massive costae on the visible part of the test. Intercostal depressions wide with a single row of pores. Aperture usually possess a perystome.
Material: Five specimens have been found in the material investigated.
Remarks: One specimen with twisted costae in the apical part of the test.

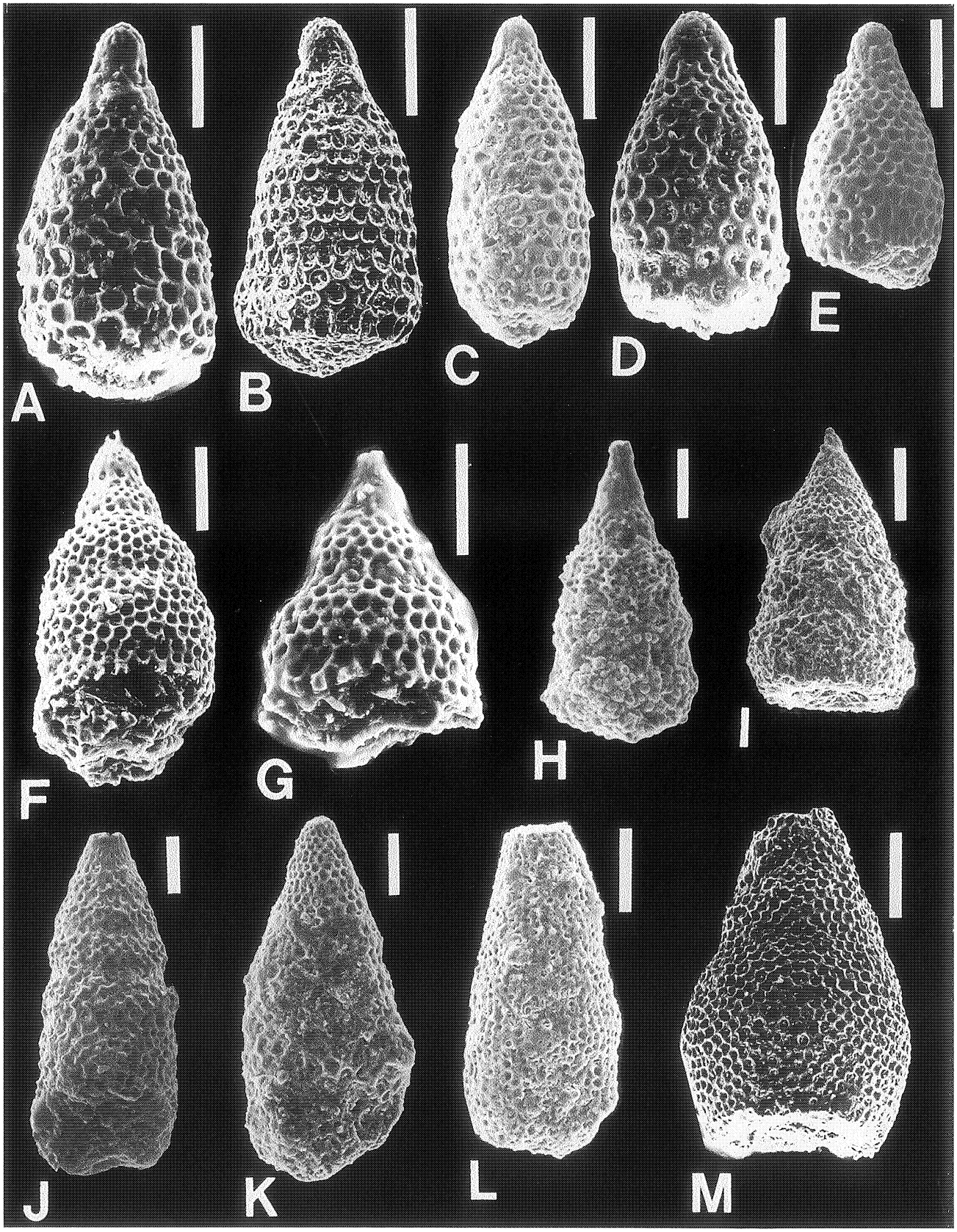

Fig. 6. SEM micrographs of Nassellaria. **A-E.** *Amphipyndax stocki* (Campbell & Clark), **F-G.** *Stichomitra carnegiense* (Campbell & Clark), **H-I.** *Stichomitra grandis* (Campbell & Clark), **J-K.** *Stichomitra bertrandi* Cayeux, **L-M.** *Stichomitra* cf. *bertrandi* Cayeux. Length of scale bar – 100 μm

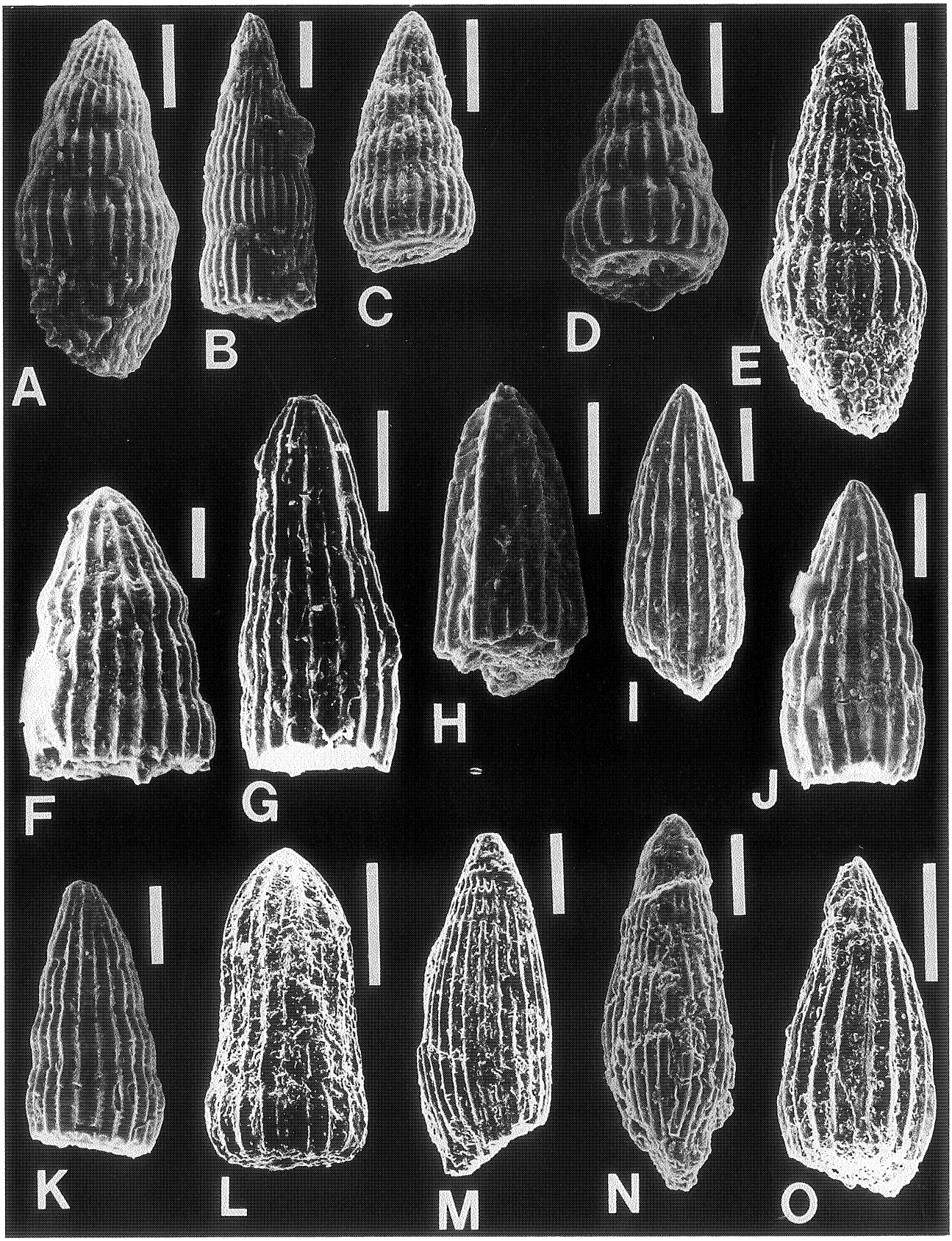

Fig. 7. SEM micrographs of Nassellaria. **A-C.** *Dictyomitra* aff. *rhadina* Foreman, **D-E.** *Dictyomitra* sp., **F.** *Dictyomitra koslovae* Foreman, **G-H.** *Dictyomitra lamellicostata* Foreman, **I-K.** *Dictyomitra multicostata* Zittel, **L.** *Dictyomitra lamellicostata* Foreman, **M-O.** *Thanarla thiensis* (Tan). Length of scale bar – 100 μm

Genus *Thanarla* Pessagno, 1977
Type species *Phormocyrtis veneta* Squinabol, 1903

Thanarla thiensis (Tan)
Fig. 7 M-O

1927. *Eucyrtidium Thiensis* Tan: p. 59, pl. 11, fig. 95.

Diagnosis: Test multi-segmented, spindle-shaped, with six to seven chambers. Proximal portion of the test conical with massive uppermost part possesses few pores. Constrictions weakly developed, do not occur at segmental divisions. Distal part of the test slightly inflated, inverted conical in the lower part, with narrow aperture. Test possesses ten to twelve costae in lateral view. Pores are situated in single rows between adjacent costae.
Material: Fifteen specimens have been found in the material investigated.

Family ARTOSTROBIIDAE Riedel, 1967

Genus *Siphocampe* Haeckel, 1881
Type species *Siphocampe annulosa* Haeckel, 1887

Siphocampe bassilis (Foreman)
Fig. 12 A

1968. *Theocampe bassilis* Foreman: p. 50, pl. 6, fig. 10.
1978. *Theocampe bassilis* Foreman: Foreman, p. 745, pl. 5, fig. 25.
1985. *Siphocampe bassilis* (Foreman): Sanfilippo & Riedel, p. 602, fig. 9.1.

Diagnosis: Test narrow, elongate consists of three segments. Cephalis bears a horizontal tube. Cephalis and thorax together conical. Abdomen long, sub-cylindrical, with sub-circular pores, set in seven widely spaced transverse rows.
Material: Only a single partly broken specimen has been found in the material investigated.

Siphocampe daseia (Foreman)
Fig. 12 B-E

1968. *Theocampe daseia* Foreman: p. 48, pl. 6, figs 9a-b.
1978. *Theocampe daseia* Foreman: Foreman, p. 745, pl. 5, fig. 26.
1985. *Siphocampe daseia* (Foreman): Sanfilippo & Riedel, p. 604, figs 9.3a, b.

Diagnosis: Test of three segments. Cephalis and thorax together conical, thick-walled. Cephalis bears a horizontal tube and a short apical horn. Abdomen smooth, thin-walled, narrows distally. Pores of cephalis scarce. Thoracic pores circular to sub-circular set in hexagonal frames. Pores of abdomen circular set in four to six widely spaced transverse rows.
Material: Six specimens have been found in the material investigated.

Family CARPOCANIIDAE Haeckel, 1881

Genus *Myllocercion* Foreman, 1968
Type species *Myllocercion acineton* Foreman, 1968

Myllocercion acineton Foreman
Fig. 8 E-G

1968. *Myllocercion acineton* Foreman: p. 37, pl. 5, figs 11a, b.
1973. *Myllocercion* sp.: Dumitrică, p. 789, pl. 2, fig. 5; pl. 5, figs 8-9; pl. 8, fig. 1.
1978. *Myllocercion acineton* Foreman: Foreman, p. 747, pl. 5, fig. 8.
1981. *Schadelfusslerus* sp. aff. *S. echtus* Empson-Morin: Empson-Morin, p. 278, pl. 10, fig. 4a-d.
1985. *Myllocercion acineton* Foreman: Sanfilippo & Riedel, p. 620, figs 14.1a-d.
1997. *Myllocercion acineton* Foreman: Hollis, p. 62, pl. 14, fig. 7-11.

Diagnosis: Test inflated, fusiform, consists of three segments. Cephalis spheroidal, partly submerged in thorax, hemispherical to conical in lateral view, massive or sparsely porous with ribs converging apically. Thorax inflated conical to globose with pores longitudinally aligned. Three broad, lamellar feet projecting from the base of thorax, and form ribs within abdominal wall. Abdomen (when completely developed) rounded-triangular to inverted conical in transverse cross-section with narrow circular aperture. Wall of abdomen thin with small circular pores irregularly distributed over a smooth surface.
Material: Ten specimens have been found in the material investigated.
Remarks: The presence of an abdomen might be rather a function of test's preservation or ecological features, and could not be a feature for species division. The feet projecting from the base of thorax suggest the possibility of abdomen presence. *Schadelfusslerus echtus* Empson-Morin differs from by having cephalis spherical in outer cross-section, with well-developed pores and without so well visible ribs on it, as well as by having lamellar feet smooth, without scalloped edges.

Genus *Theocapsomma* Haeckel, 1887
Type species *Theocapsa (Theocapsomma) linnaei* Haeckel, 1887

Theocapsomma amphora (Campbell & Clark)
Fig. 9 J-K

1944. *Theocapsa (Theocapsomma) amphora* Campbell & Clark: p. 35, pl. 7, figs 30, 31.
1944. *Tricolocapsa (Tricolocapsium) granti* Campbell & Clark: Campbell & Clark, p. 35, pl. 7, figs 37, 38.
1968. *Theocapsomma amphora* (Campbell & Clark): Foreman, p. 31, pl. 4, figs 9a-c.
? 1972. *Theocapsomma* sp. A gr.: Petrushevskaya & Kozlova, p. 536, pl. 7, fig. 11; pl. 22, figs 4, 6.
1972. *Theocapsomma* sp. B: Petrushevskaya & Kozlova, p. 536, pl. 7, figs 4, 5.
1973. *Theocapsomma* sp.: Dumitrică, p. 789, pl. 2, figs 6, 7.
1997. *Theocapsomma amphora* (Campbell & Clark): Hollis, p. 64, pl. 15, figs 1, 2.

Diagnosis: Test consists of three segments. Cephalis small, partly or completely enclosed in the thick thoracic wall, sometimes may bear a short apical horn. Thorax hemispherical, with circular poses set in hexagonal to sub-circular frames, arranged vertically. Abdomen vary in size and shape, aperture small, circular. Pores of the abdomen usually larger than those of the thorax, circular, also set in hexagonal to sub-circular frames.
Material: Ten specimens have been found in the material investigated.
Remarks: The specimens presented followed the emended definition of this species by Foreman (1968).

Theocapsomma ancus Foreman
Fig. 9 E, F

1968. *Theocapsomma ancus* Foreman: p. 32, pl. 4, fig. 3.
1970. *Diacanthocapsa* cf. *ancus* Foreman: Dumitrică, p. 64, pl. 6,

fig. 35a-b; pl. 7, fig. 40; pl. 20, fig. 125.

Diagnosis: Test ovate, three-segmented. Cephalis small, poreless. Thorax conical, abdomen inversely conical with small, circular aperture. Pores of thorax and abdomen irregularly arranged.

Theocapsomma comys Foreman
Fig. 9 A-D

1944. *Dictyocephalus (Dictyocryphalus)* (?) *legumen* Campbell & Clark: p. 28, pl. 7, figs 12-14.
1968. *Theocapsomma comys* group Foreman: Foreman, p. 29, pl. 4, fig. 2a-c.
1974. *Theocapsomma comys* Foreman: Riedel & Sanfilippo, p. 40, pl. 10, fig. 8.
1978. *Theocapsomma comys* group Foreman: Foreman, p. 748, pl. 5, figs 11, 12.
1985. *Theocapsomma comys* group Foreman: Sanfilippo & Riedel, p. 623, fig. 14.4a-d.

Diagnosis: Test sub-cylindrical, consists of three segments. Cephalis merged into thoracic wall. Lumbar stricture is not expressed externally. Abdomen sub-cylindrical, narrowed distally. Pores of thorax and abdomen uniform circular, regularly arranged, set in polygonal frames which form longitudinal ridges.
Material: Fifteen specimens have been found in the material investigated.
Remarks: Only forms with completely or partly broken abdomen have been found in the material investigated.

Theocapsomma sp. aff. *T. comys* Foreman
Fig. 9 G

1978. *Theocapsomma* sp. aff. *T. comys* Foreman: p. 748, pl. 5, fig. 7.

Description: Test tri-segmented, elongate, without apical horn and sutural pore. Cephalis completely enclosed into thoracic wall. Thorax hemispherical to bluntly conical. Abdomen with the same shape as thorax (or much sub-cylindrical) but inverted. Abdomen never complete. Thorax and abdomen possessing very large, spherical to oval pores, arranged longitudinally (about five to six in the visible side of the test). They are set in frames, the vertical ridges of which create the longitudinal costae throughout the test. Test usually brakes along the lumbar stricture.
Material: Ten specimens have been found in the material investigated.
Remarks: Species differs from another species belonging to the genus *Theocapsomma* by having large pores of thorax and abdomen.

Theocapsomma teren Foreman
Fig. 10 A-F

1968. *Theocapsomma teren* Foreman: p. 32, pl. 4, fig. 4.

Diagnosis: Tri-segmented nassellarians with test elliptical to spindle-shaped of unsymmetrical, sickle-shaped. Cephalis small, poreless, spherical to conical. Thorax and abdomen with small circular pores in hexagonal pore frames. Costae slightly marked or absent. Lumbar stricture may be slightly marked or not. Test lacking sutural pore and possessing constricted aperture. The most external cover of the test if present, thin, smooth, with small, arranged longitudinally, rounded pores, elongate in the apical part of the test.
Material: Twenty five specimens have been found in the material investigated.

Theocapsomma sp. A
Fig. 9 H-I

Description: Test tri-segmented, elongate, without sutural pore. Cephalis small, conical, straight or unsymmetrical, massive, partly enclose into the thorax. Thorax hemispherical to rounded trapezoidal in outer shape. Lumbar stricture slightly expressed externally. Abdomen of the same shape or longer to sub-cylindrical. Thorax and abdomen having longitudinally arranged, moderately in size, circular to oval pores. Each two rows of single pores are separate by costae, which are arranged tangential throughout the test and wedging out apically and distally. Some specimens with straight costae.
Material: Three specimens have been found in the material investigated.
Remarks: Spesies differs from *T. comys* by having tangential arranged costae.

Theocapsomma sp. B
Fig. 10 G

Material: Two specimens have been found in the material investigated.
Remarks: Only incomplete specimens have been found in the material investigated. Forms closely related to Nassellaria gen. and sp. indet. illustrated by Wakita *et al.* (1994: fig. 5 (13-14)). These forms probably have tests tri-segmented with outer shape as in genus. Cephalis almost completely enclose into the thorax. Test with massive costae throughout.

Theocapsomma sp. C
Fig. 10 H-I

Material: Two specimens have been found in the material investigated.
Remarks: Specimens very similar to *Theocapsomma* sp. presented by Dumitrică (1973), but lacking the abdomen.

Genus *Turbocapsula* O'Dogherty, 1994
Type species *Tricapsula costata* Wu, 1986

Turbocapsula sp.
Fig. 11 A-B

Description: Tri-segmented thick-walled nassellarians with test ellipsoidal in outer shape. Cephalis small, without apical horn, spherical, slightly encase into the thorax. Abdomen large, inflated with circular pores arranged longitudinally. Each row of pores is separate by moderately thick costae build up on vertical side of the pore-frames. Costae (about 16 to 20 in the visible side of the test) wedging out apically and distally. Test without sutural pore and possessing a constricted circular aperture (occasionally closed antapically). Collar and lumbar strictures is not defined externally.
Material: Five specimens have been found in the material investigated.
Remarks: Forms belonging to the genus *Turbocapsula* have been described first by O'Dogherty (1994) from Aptian deposits. Specimens presented herein differ from those of O'Dogherty by lacking any visible changing of contour in the proximal part of the test.

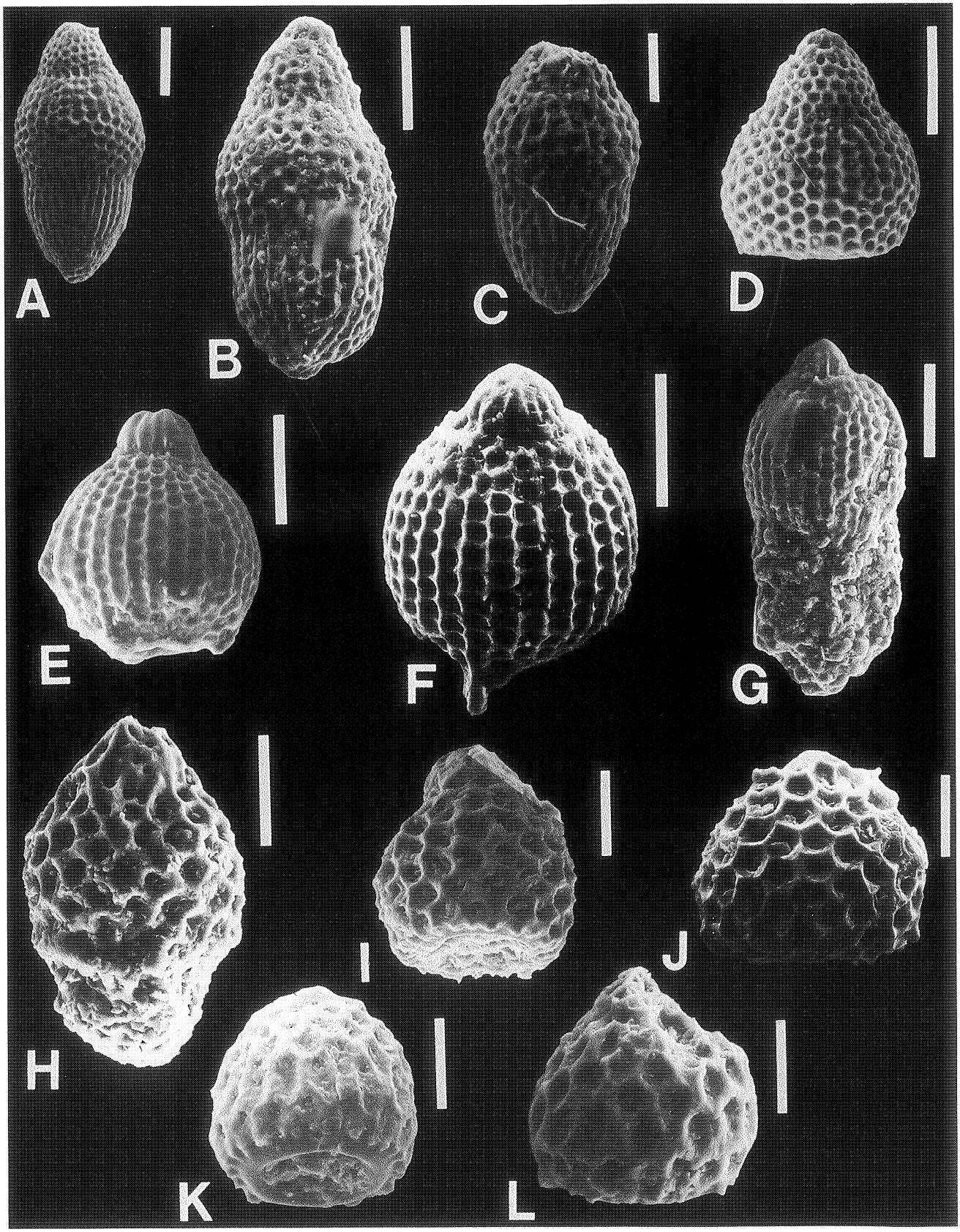

Fig. 8. SEM micrographs of Nassellaria. **A-D.** *Lithocampe eminentis* n.sp.; A – holotype, U19-701, **E-G.** *Myllocercion acineton* Foreman, **H-L.** *Rhopalosyringium magnificum* Campbell & Clark. Length of scale bar – 100 μm

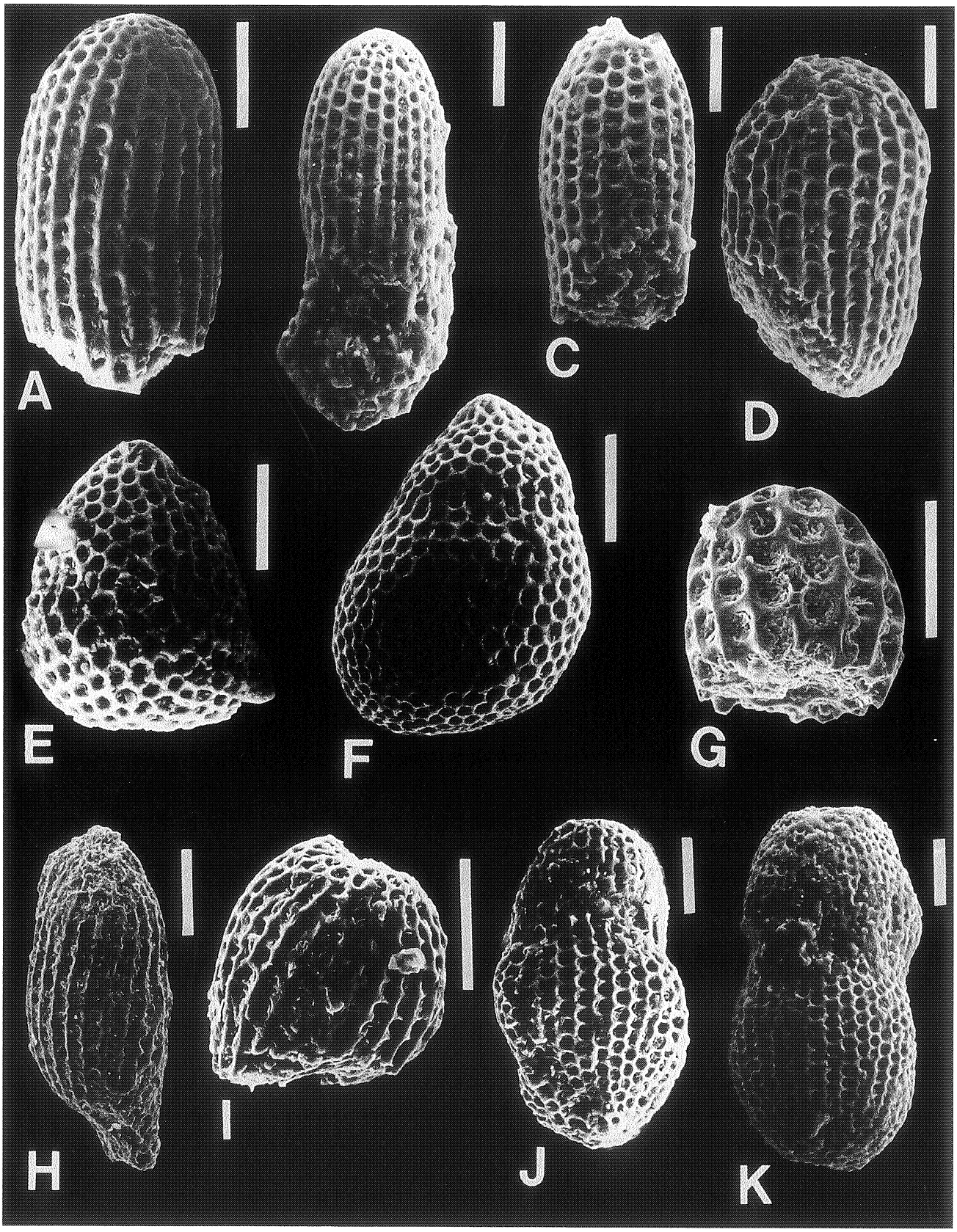

Fig. 9. SEM micrographs of Nassellaria. **A-D.** *Theocapsomma comys* Foreman, **E-F.** *Theocapsomma ancus* Foreman, **G.** *Theocapsomma* sp. aff. *T. comys* Foreman, **H-I.** *Theocapsomma* sp. A, **J-K.** *Theocapsomma amphora* (Campbell & Clark). Length of scale bar – 100 μm

Genus *Cryptocapsa* Haeckel, 1881
Type species *Cryptocapsa tricyclia* Rüst, 1885

? *Cryptocapsa axios* Foreman
Fig. 10 J-L

1968. ? *Cryptocapsa axios* Foreman: p. 18, pl. 2, fig. 5.

Material: Seven specimens have been found in the material investigated.
Diagnosis: Ovate test of two segments. Cephalis completely encased in thorax. Thorax with small circular aperture. Thoracic pores circular, arranged quincuncially in longitudinal rows.

Family EUCYRTIDIIDAE Ehrenberg, 1847

Genus *Cyrtocapsa* Haeckel, 1881
Type species *Cyrtocapsa ovalis* Rüst, 1885

Cyrtocapsa campi Campbell & Clark
Fig. 10 M

1944. *Cyrtocapsa campi* Campbell & Clark: p. 43, pl. 8, figs 14-17, 20.
1968. *Stichomitra* ? *campi* (Campbell & Clark): Foreman, p. 75, pl. 8, fig. 3a-c.
1997. *Cyrtocapsa campi* Campbell & Clark: Hollis, p. 75, pl. 20, figs 10-13.

Diagnosis: Test fusiform, consists of four to eight segments. Cephalis small with a short apical horn. The last segment hemispherical with aperture rarely with a short neck. Strictures are absent or weakly developed.
Material: Three specimens have been found in the material investigated.

Cyrtocapsa sp.
Fig. 11 C

Diagnosis: Fusiform, slightly lobate test of five chambers. Cephalis small, circular. Final segment hemispherical with small circular aperture. Pores arranged quincuncially.
Material: One specimen has been found in the material investigated.

Genus *Lithocampe* Ehrenberg, 1838
Type species *Lithocampe radicula* Ehrenberg, 1838

Lithocampe eminentis n.sp.
Fig. 8 A-D

? 1974. Theopheridae Gen. et sp. indet.: Riedel & Sanfilippo, pl. 15, figs 6-10.

Holotype: Specimen no. U19-701 (Fig. 8 A).
Etymology: Latin adjective *eminens* (*-tis*), meaning: to be conspicuous.
Material: Four specimens have been found in the material investigated.
Type-locality: Užgruň settlement, close to the Czech/Slovak border, Czech part of the Outer Carpathians.
Type-level: Soláň Formation, Rača subunit, Magura Unit, sample U-19.
Description: Tetra-segmented nassellarians spindle-shaped in general outline. Strictures between chambers are well visible externally. Cephalis small, spherical, slightly encased into the thorax. Thorax hemispherical, abdomen inflated, almost twice bigger than thorax. Pores of thorax and abdomen circular, arranged quincuncially, set in hexagonal pore frames. First three segments comprising more than half of total length. Post-abdominal chamber inverted-conical to hemispherical, with circular pores setting within the frames, which form longitudinal costae wedging out apically and antapically. Aperture circular, constricted.
Measurements (µm): Holotype length = 400, Holotype maximum width = 190.
Stratigraphic distribution: uppermost Maastrichtian.
Deposition of types: Institute of Geological Sciences, Jagiellonian University, author's collection. Holotype = 1-99-U19-701, paratypes = 2-99-U19-702, 3-99-U19-703, 4-99-U19-704.

Genus *Stichomitra* Cayeux, 1897
Type species *Stichomitra bertrandi* Cayeux, 1897

Stichomitra bertrandi Cayeux
Fig. 6 J-K

1897. *Stichomitra bertrandi* Cayeux: p. 204, pl. 8, fig. 69.
1968. *Stichomitra compsa* Foreman: Foreman, p. 72, pl. 8, fig. 8a-b.
1997. *Stichomitra bertrandi* Cayeux: Hollis, p. 77, pl. 20, figs 6-9.

Diagnosis: Test conical, consists of six to eleven segments. Cephalis sparsely perforate, spheroidal. Thorax inflated, abdomen and post-abdominal chambers moderately inflated, sub-cylindrical to sub-trapezoidal in outline. Pores on thorax and subsequent segments arranged quincuncially.
Material: Ten specimens have been found in the material investigated.

Stichomitra cf. *bertrandi* Cayeux
Fig. 6 L-M

Remarks: Forms differ from *S. bertrandi* by having slightly developed strictures. Some of them with the last but one segment more inflated than others.
Material: Five specimens have been found in the material investigated.

Stichomitra carnegiense (Campbell & Clark)
Fig. 6 F-G

1944. *Eucyrtidium (Eucyrtis) carnegiense* Campbell & Clark: p. 42, pl. 8, figs 36-37.
1973. *Stichomitra* sp. A: Dumitrică, p. 789, pl. 3, figs 9-10; pl. 8, fig. 5.
1982. *Stichomitra warzigita* (Empson-Morin): Taketani, p. 56, pl. 3, figs 10a-b; pl. 11, fig. 9.
1997. *Stichomitra carnegiense* (Campbell & Clark): Hollis, p. 78, pl. 19, figs 7-12.

Diagnosis: Test consists of six to nine segments. Cephalis with short, conical apical horn. Thorax inflated, abdomen and post-abdominal chambers increase regularly in size. Test may tends to be cylindrical distally. Pores circular, arranged quincuncially.
Material: Six specimens have been found in the material investigated.

Stichomitra grandis (Campbell & Clark)
Fig. 6 H-I

1944. *Cyrtophormis (Acanthocyrtis) grandis* Campbell & Clark: p. 38, pl. 8, figs 18, 39.
1968. *Stichomitra asymbatos* Foreman: Foreman, p. 73, pl. 8, figs 10a-c.
1972. *Stichocapsa asymbatos* (Foreman): Petrushevskaya & Ko-

zlova, p. 546, pl. 8, figs 1-3.
1974. *Stichomitra asymbatos* Foreman: Riedel & Sanfilippo, p. 780, pl. 10, fig. 1.
1982. *Stichomitra asymbatos* Foreman: Taketani, p. 54, pl. 4, fig. 13; pl. 11, figs 3-4.
1986. *Xitus* ? *asymbatos* (Foreman): Iwata & Tajika, pl. 2, figs 11-12; pl. 3, figs 1-2.
1997. *Stichomitra grandis* (Campbell & Clark): Hollis, p. 78, pl. 19, figs 1-4.
1997. *Stichomitra grandis* ? (Campbell & Clark): Hollis, p. 78, pl. 19, figs 5-6.

Diagnosis: Test multi-segmented. Cephalis with a few circular pores bearing sturdy apical horn. Each post-thoracic chambers with circumferential ridges passes hexagonal close-packed layer which form nodes (more than five in the visible side of the test).
Material: Ten specimens have been found in the material investigated.

Family GONGYLOTHORACIDAE nov. fam.

Type genus *Gongylothorax* Foreman, 1968, emend. Dumitrică, 1970

Diagnosis: This family includes dicyrtid nassellarians with cephalis partly or complete depressed into the thoracic cavity. Thorax large, inflated, spherical, subspherical or discoidal. Last segment with or without aperture.

Genus *Gongylothorax* Foreman, 1968, emend. Dumitrică, 1970
Type species *Gongylothorax verbeeki* (Tan) *sensu* Foreman, 1968

Gongylothorax maguraensis n.sp.
Fig. 11 E-F, H-I

non 1927. *Dicolocapsa exquista* Tan: p. 44, pl. 8, fig. 43.
non 1927. *Dicolocapsa Verbeeki* Tan: p. 44, pl. 8, figs 40-41.
1968. *Gongylothorax verbeeki* (Tan Sin Hok): Foreman, p. 20, pl. 2, fig. 8a-c.
1970. *Gongylothorax verbeeki* (Tan Sin Hok): Dumitrică, p. 57, pl. 1, fig. 6a-b; pl. 2, figs 7-10.
1972. *Gongylothorax* sp. aff. *G. verbeeki* (Tan Sin Hok): Petrushevskaya & Kozlova, p. 541, pl. 7, figs 18, 19.
1973. *Gongylothorax verbeeki* (Tan Sin Hok): Foreman, p. 429, pl. 13, fig. 4.
1975. *Gongylothorax verbeeki* (Tan Sin Hok): Dumitrică, text-fig. 2.20.
non 1981. *Gongylothorax verbeeki* (Tan Sin Hok): Schaaf, p. 434, pl.1 fig. 1a-b; pl. 9, fig. 9a-b.
1982. *Gongylothorax verbeeki* (Tan Sin Hok): Wu & Li, p. 66, pl. 1, fig. 10.
? 1989. *Gongylothorax verbeeki* (Tan Sin Hok): Tumanda, p. 37, pl. 8, fig. 18.
non 1994. *Hiscocapsa verbeeki* (Tan): O'Dogherty, p. 199, pl. 31, figs 1-6.

Holotype: Specimen no. U19-594 (Fig. 11 I).
Etymology: Species name derives from the name of the Magura Nappe.
Material: Thirty specimens have been found in the material investigated.
Type-locality: Užgruň settlement, close to the Czech / Slovak border, Czech part of the Outer Carpathians.
Type-level: Soláň Formation, Rača subunit, Magura Nappe, sample U-19.

Description: Dicyrtid with cephalis small, spherical, poreless, partly hidden in the thoracic wall and cavity. Thorax large, spherical or subspherical, with rough surface composed of hexagonal pore frames with single, small pore in each frame. Aperture constricted, having smooth, rarely protruding rim.
Remarks: Since Tan (1927) described a new species *Dicolocapsa verbeeki* from Lower Cretaceous deposits of Rotti Island (Moluccas, East Indian Ocean), many authors assigned to this nominal species also some Late Cretaceous forms (e.i. Foreman, 1968; Dumitrică, 1970). In 1994 O'Dogherty excluded the forms described as "*verbeeki*" from those forms which are of Late Cretaceous age and possess a true cryptothoracic stage. He described as *Hiscocapsa verbeeki* (Tan) only those Early Cretaceous tricyrtids, with thorax party or completely depressed in a large abdomen, and sutural pores situated near the junction between the cephalis and thorax. I propose here a new species name for those dicyrtids forms that have been previously assigned as *G. verbeeki* (according to Tan's lectotype of *Dicolocapsa verbeeki*) and have been excluded from the species *Hiscocapsa verbeeki* (Tan) described by O'Dogherty (1994) as tricyrtid forms from the Early Cretaceous.
Measurements (μm): Holotype length = 243, Holotype and paratypes width = 286-234.
Stratigraphic distribution: uppermost Maastrichtian.
Deposition of types: Institute of Geological Sciences, Jagiellonian University, authors collection. Holotype = 5-99-U19-594, paratypes = 6-99-U19-524, 7-99-U19-525, 8-99-U19-526.

Family NEOSCIADIOCAPSIDAE Pessagno, 1969a

Genus *Dictyodedalus* O'Dogherty, 1994
Type species *Dictyodedalus hesperis* O'Dogherty, 1994

Dictyodedalus cretaceus (Taketani)
Fig. 12 L

1982. *Cornutella cretacea* Taketani: p. 65, pl. 6, fig. 5a, b, pl. 13, fig. 9.
1994. *Dictyodedalus cretaceus* (Taketani): O'Dogherty, p. 237, pl. 41, figs 13-14.

Diagnosis: Test dicyrtid, conical. Cephalis small, poreless, bearing a short apical horn. Thorax conical, open distally, without longitudinal costae. Pores of thorax circular to oval, setting within hexagonal frames, varying with their diameter but generally becoming bigger toward the antapical side of the test.
Material: Six specimens have been found in the material investigated.
Remarks: The specimens found here are always with the most apical and antapical parts of the test broken off. Some specimens with small nodes seated randomly on the cephalis.

Family PLAGIACANTHIIDAE Hertwig, 1879

Genus *Lithomelissa* Ehrenberg, 1847
Type species *Lithomelissa microptera* Ehrenberg, 1854

Lithomelissa ? *aitai* Hollis
Fig. 12 F

1997. *Lithomelissa* ? *aitai* Hollis: p. 56, pl. 12, figs 5-8.

Diagnosis: Test conical, consists of two segments. Cephalis hemispherical, moderately large. Apical bar projects outside as a conical apical horn. Thorax conical. Pores of cephalis and thorax circular to sub-circular, arranged quincuncially to irregularly.
Material: Two specimens have been found in the material investigated.

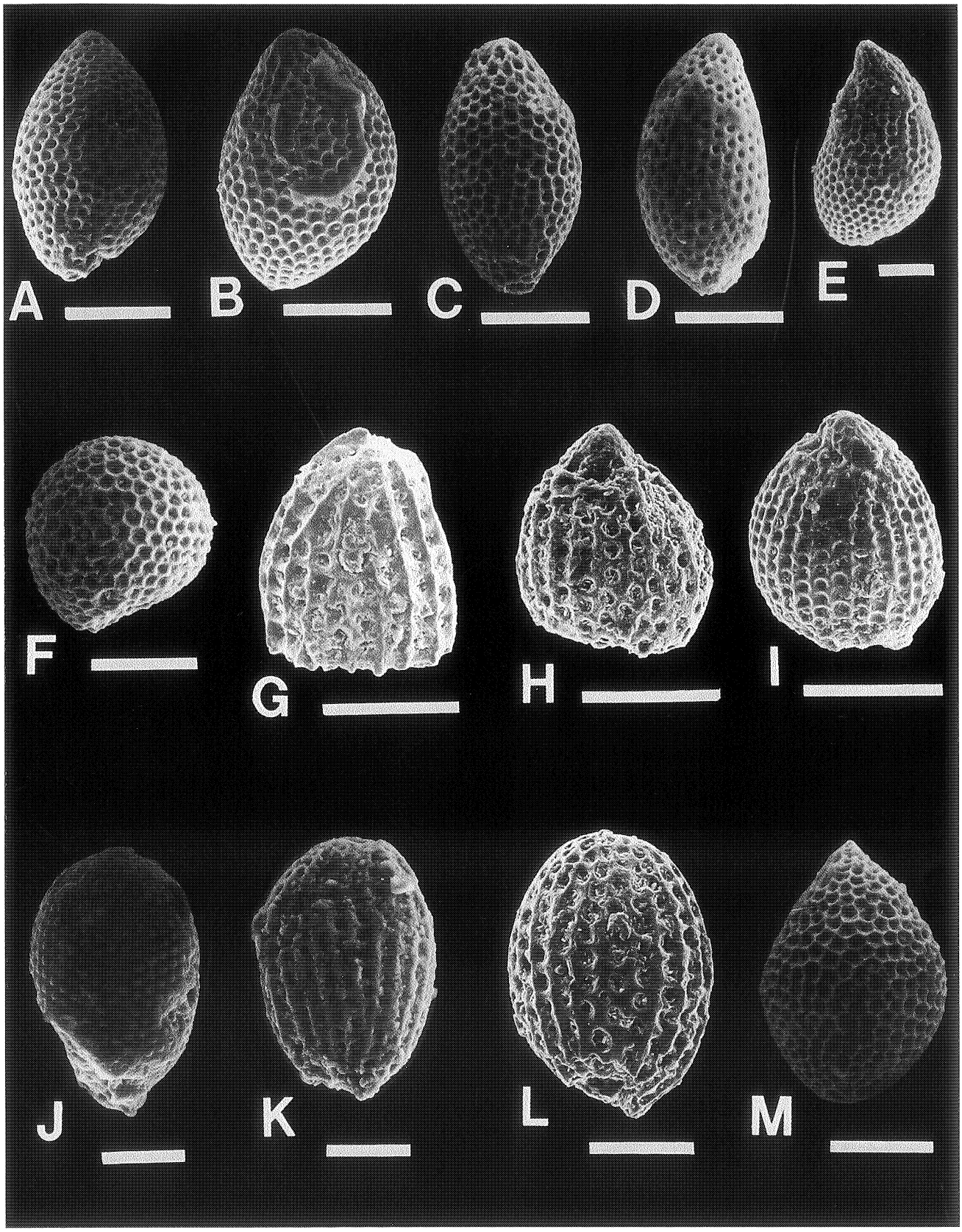

Fig. 10. SEM micrographs of Nassellaria. **A-F.** *Theocapsomma teren* Foreman, **G.** *Theocapsomma* sp. B, **H-I.** *Theocapsomma* sp. C, **J-L.** ?*Cryptocapsa axios* Foreman, **M.** *Cyrtocapsa campi* Campbell & Clark. Length of scale bar – 100 μm

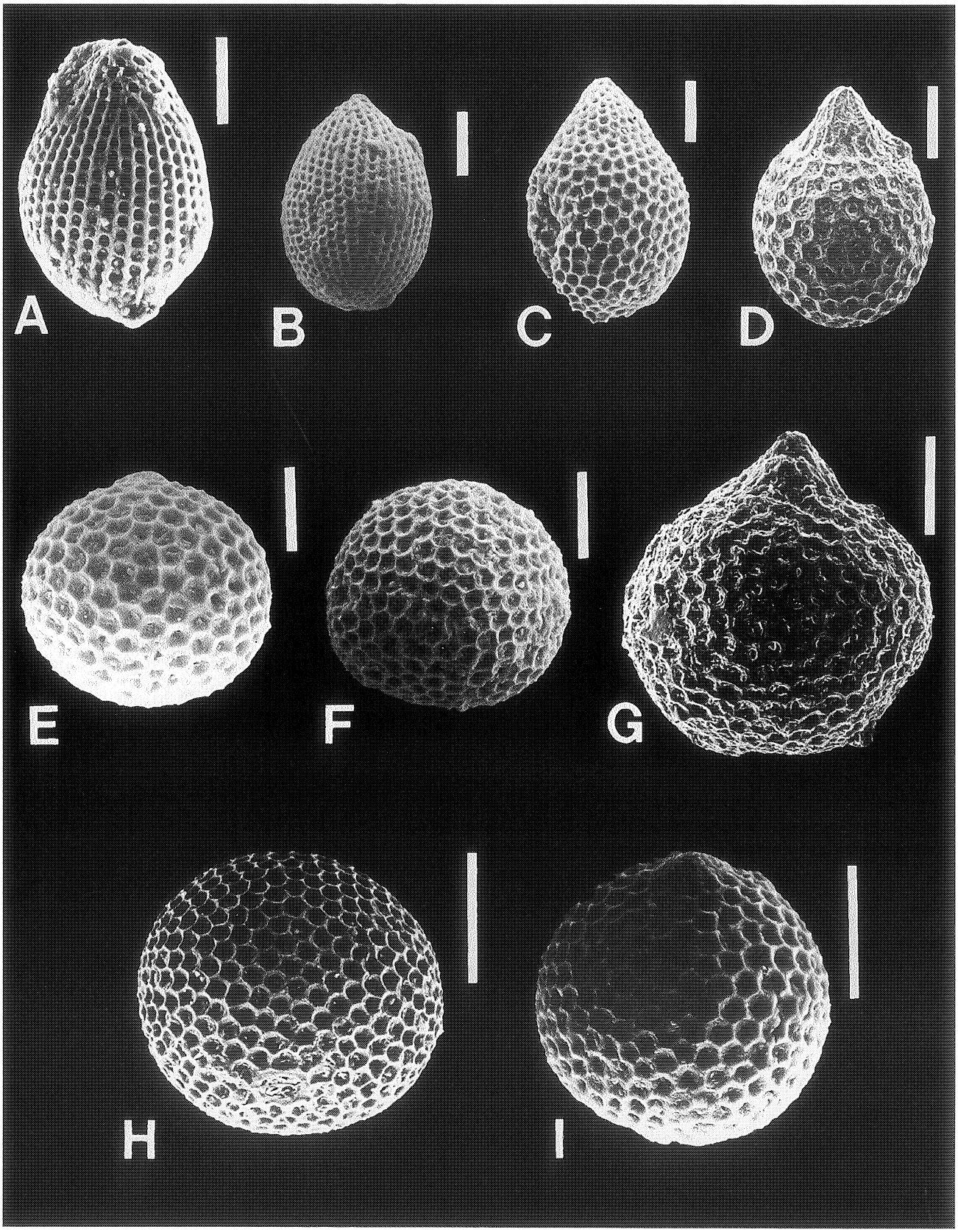

Fig. 11. SEM micrographs of Nassellaria. **A-B.** *Turbocapsula* sp., **C.** *Cyrtocapsa* sp., **D,** *Cryptamphorella conara* (Foreman), **E-F.** *Gongylothorax maguraensis* n.sp., **G.** *Cryptamphorella conara* (Foreman), **H-I.** *Gongylothorax maguraensis* n.sp.; I. holotype, U19-594. Length of scale bar – 100 μm

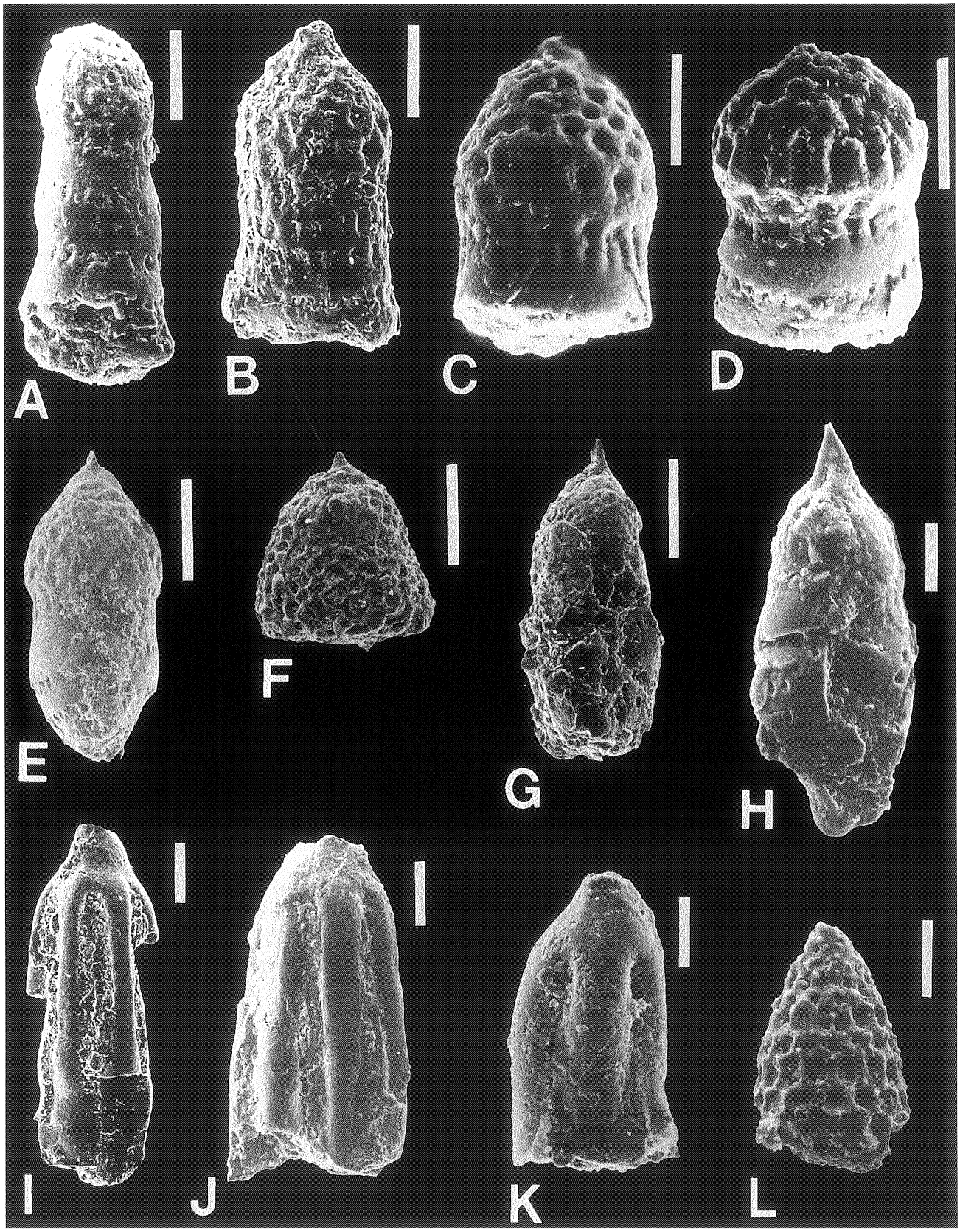

Fig. 12. SEM micrographs of Nassellaria. **A.** *Siphocampe bassilis* (Foreman), **B-E.** *Siphocampe daseia* (Foreman), **F.** *Lithomelissa* ?*aitai* Hollis, **G-H.** *Lithomelissa* cf. *heros* Campbell & Clark, **I-K.** *Afens liriodes* Riedel & Sanfilippo, **L.** *Dictyodedalus cretaceus* (Taketani). Length of scale bar – 100 μm

Remarks: Specimens found in the material investigated closely related to *Lithomelissa* ? *aitai* described by Hollis (1997) from the New Zealand.

Lithomelissa cf. *heros* Campbell & Clark
Fig. 12 G-H

1944. *Lithomelissa heros* Campbell & Clark: p. 25, pl. 7, fig. 23.
1973. *Lithomelissa* ? sp.: Dumitrică, p. 788, pl. 2, fig. 2, pl. 4, fig. 6.
1997. *Lithomelissa* cf. *heros* Campbell & Clark: Hollis, p. 55, pl. 12, figs 9-11.

Diagnosis: Test of two segments. Cephalis large, hemispherical, occasionally with a few circular pores. Apical bar forms a central columella that extends upward as an apical horn. Thorax slightly inflated in medial part, narrow distally. Pores of thorax small, variable in size and shape, irregularly spaced.
Material: Three specimens have been found in the material investigated.
Remarks: This form is very similar to *L. heros* described by Campbell and Clark (1944), differing only by the lack of lateral spines.

Family RHOPALOSYRINGIIDAE Empson-Morin, 1981

Genus *Rhopalosyringium* Campbell & Clark, 1944
Type species *Rhopalosyringium magnificum* Campbell & Clark, 1944

Rhopalosyringium magnificum Campbell & Clark
Fig. 8 H-L

1944. *Rhopalosyringium magnificum* Campbell & Clark: p. 30, pl. 7, figs 16, 17.
1968. *Rhopalosyringium* (?) *magnificum* Campbell & Clark: Foreman, p. 55, pl. 5, fig. 8.
1981. *Rhopalosyringium magnificum* Campbell & Clark: Empson-Morin, p. 265, pl. 8, figs 1A-D.

Diagnosis: Test consists of two segments. Cephalis hemispherical, with apical horn. Thorax subspherical to asymmetrical, usually with apertural ring. Pores of thorax vary in shape from circular to irregular, set in usually pentagonal frames. Test may terminate in an open tube.
Material: Fifteen specimens have been found in the material investigated.
Remarks: Only incomplete specimens usually with broken apical horns have been found. Only a few forms having the terminal tube.

Family WILLIRIEDELLIDAE Dumitrică, 1970

Genus *Cryptamphorella* Dumitrică, 1970
Type species *Hemicryptocapsa conara* Foreman, 1968

Cryptamphorella conara (Foreman)
Fig. 11 D, G

1968. *Hemicryptocapsa conara* Foreman: p. 35. pl. 4, fig. 11a-b.
1970. *Cryptamphorella conara* (Foreman): Dumitrică, p. 80, pl. 11, fig. 66a-c.

Diagnosis: Test three-segmented, subspherical in outer shape. Cephalis small, poreless. Thorax poreless, half depressed into the abdominal cavity. Abdomen large, spherical, with pores regularly arranged, and with oval sutural pore.
Material: Ten specimens have been found in the material investigated.

NASSELLARIA INCERTAE SEDIS

Genus *Afens* Riedel & Sanfilippo, 1974
Type species *Afens liriodes* Riedel & Sanfilippo, 1974

Afens liriodes Riedel & Sanfilippo
Fig. 12 I-K

1973. Incert. sed. sp. A: Moore, p. 830, pl. 13, figs 1-3.
1974. *Afens liriodes* Riedel & Sanfilippo: p. 775, pl. 11, fig. 11; pl. 13, figs 14-16.
1978. *Afens liriodes* Riedel & Sanfilippo: Foreman, p. 750, pl. 5, fig. 24.
1981. *Afens liriodes* Riedel & Sanfilippo: Kling, p. 548, pl. 1, figs 23, 24; pl. 3, figs 5, 6.
1985. *Afens liriodes* Riedel & Sanfilippo: Sanfilippo & Riedel, p. 624, fig. 13.3a-c.
1988. *Afens liriodes* Riedel & Sanfilippo: Thurow, p. 396, pl. 2, fig. 1.
1994. *Afens liriodes* Riedel & Sanfilippo: Goričan, p. 60, pl. 26, figs 1, 2.
1994. *Afens liriodes* Riedel & Sanfilippo: O'Dogherty, p. 246, pl. 42, figs 23-26.

Diagnosis: Test siliceous, calyx-like, possess a cylindrical stem and four to six sub-parallel lamellae.
Material: Fifteen specimens have been found in the material investigated.
Remarks: Only skeletons with a broken stem and incomplete lamellae have been found in the material investigated. The uppermost Cretaceous forms seem to have about four to six lamellae which are more massive then in *A. liriodes* described from Turonian deposits (see Thurow, 1988; O'Dogherty, 1994).

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Streszczenie

PROMIENICE Z UTWORÓW GÓRNEGO MASTRYCHTU JEDNOSTKI MAGURSKIEJ, CZESKA CZĘŚĆ KARPAT ZEWNĘTRZNYCH

Marta Bąk

W osadach formacji solańskiej należącej do strefy raczańskiej jednostki magurskiej w Czechach znaleziono bogaty zespół radiolarii reprezentowany przez 46 gatunków, należących do 25 rodzajów w obrębie 14 rodzin. Przedmiotem badań były odsłonięcia tej formacji zlokalizowane w miejscowości Užgruň, w pobliżu czesko-słowackiej granicy państwowej (Fig. 1).

Formację solańską tworzą górnokredowo-paleoceńskie osady drobno i średnio-rytmicznego fliszu (Fig. 2). Są to głównie szare, ciemnoszare i czarne łupki ilaste lub margliste z przeławiceniami cienkich wkładek mułowców i piaskowców, które występują w dolnej części formacji. Górna część formacji obejmuje kompleks łupkowy z grubszymi wkładkami piaskowców.

Opisany zespół radiolarii stanowią okazy bardzo dobrze zachowane (Fig. 4–11). Wszystkie szkieleciki są spirytyzowane. W zespole najliczniej reprezentowane są radiolarie należące do rzędu Nassellaria. Stanowią one 90% wszystkich okazów. Nassellarie przeważają w zespole również pod względem liczby występujących gatunków i rodzajów. Najliczniej reprezentowany jest rodzaj *Theocapsomma*. Należą tu m.in. takie gatunki jak *Theocapsomma amphora* (Campbell & Clark), *T. ancus* Foreman, *T. comys* Foreman, *Theocapsomma* sp. aff. *T. comys* Foreman oraz *T. teren* Foreman. Licznie występują także formy należące do gatunków: *Dictyomitra koslovae* Foreman, *D. lamellicostata* Foreman, *D. multicostata* Zittel, *Dictyomitra* aff. *rhadina* Foreman, *Amphipyndax pseudoconulus* (Pessagno), *A. stocki* (Campbell & Clark), *A. tylotus* Foreman oraz *Rhopalosyringium magnificum* Campbell & Clark. Mniej licznie reprezentowane są w zespole gatunki: *Thanarla thiensis* (Tan), *Siphocampe bassilis* (Foreman), *S. daseia* (Foreman), *Myllocercion acineton* Foreman), *Cyrtocapsa campi* Campbell & Clark, *Stichomitra bertrandi* Cayeux, *Stichomitra* cf. *bertrandi* Cayeux, *S. carnegiense* (Campbell & Clark), *S. grandis* (Campbell & Clark), *Dictyodedalus cretaceus* (Taketani), *Lithomelissa* ? *aitai* Hollis, *Lithomelissa* cf. *heros* Campbell & Clark oraz *Cryptamphorella conara* (Foreman). Dwa gatunki wyróżniono jako nowe. Są to: *Lithocampe eminentis* n.sp. i *Gongylothorax maguraensis* n.sp. Ostatni z nich należy do nowo wyróżnionej rodziny Gongylothoracidae n.fam.

Spumellarie w badanym zespole są nieliczne. Stanowią jedynie 10% wszystkich okazów. Najliczniej reprezentowany jest gatunek *Pseudoaulophacus floresensis* Pessagno oraz *P. lenticulatus* (White). Wśród spumellarii oznaczono ponadto taksony: *Lithomespilus coronatus* (Squinabol), *Tholodiscus* cf. *ocellatus* (Ehrenberg), *Patellula planoconvexa* (Pessagno), *Orbiculiforma renillaeformis* (Campbell & Clark), *O. sacramentoensis* Pessagno oraz *Spongotripus* sp.

Wiek osadów formacji solańskiej w badanym profilu został określony na podstawie nanoplanktonu wapiennego, otwornic aglutynujących oraz radiolarii (Bubik *et al.*, 1997, 1999). Na późny mastrycht wskazuje zespół nanoplanktonu wapiennego. Reprezentuje on poziom *Micula murus* (Švabenicks in Bubik *et al.*, 1999), odpowiadający zone CC25c (*sensu* Sisingh, 1977; Perch- Nielsen, 1985) oraz poziomy *Nephrolithus frequens* i

Micula prinsii, odpowiadające zonie CC26. Paleoceński wiek górnej części kompleksu został ustalony poprzez pierwsze pojawienie się w osadach otwornic aglutynu- jących z gatunku *Rzehakina fissistomata*, definiujących poziom *Rzehakina fissistomata*.

Opisany poziom z bogatą fauną radiolariową został znaleziony w kilkumetrowym odcinku osadów przejściowych pomiędzy ostatnim pojawieniem się nanoplanktonu wapiennego pozwalającego na pewne określenie wieku osadów (późny mastrycht) a pierwszym pojawieniem się paleoceńskiej otwornicy aglutynującej *Rzehakina fissistomata*. Dominacja form kredowych należących do Nassellaria przy braku wczesnopaleoceńskiego gatunku *Amphisphaera aotea* wskazuje na późnomastrychcki wiek osadów w pobliżu granicy kredy i trzeciorzędu.