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NEW BIOSTRATIGRAPHIC RESULTS IN THE MELIATICUM IN ITS TYPE AREA AROUND MELIATA VILLAGE (SLOVAKIA) AND THEIR TECTONIC AND PALEOGEOGRAPHIC SIGNIFICANCE

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With 2 figures and 6 plates

Abstract:
New radiolarian data show that the Meliaticum consists mostly of Middle Jurassic siliciclastic flysch (Bathonian-Callovian distal turbidites overlain by an Early Oxfordian coarsening upwards sequence). Triassic rocks of the oceanic Meliaticum sequence (e.g. dismembered ophiolites, Anisian red pelagic limestones, Ladinian-Cordevolian red ribbon radiolarites, Late Triassic dark and variegated radiolarites and grey cherty limestones) form blocks, olistoliths or melanges within the Middle Jurassic turbidites and olistostromes. Early Anisian light coloured recrystallized limestones and Scythian limestones, marls and shales of a pre-rift sequence are likewise blocks within Middle Jurassic flysch. Melanges are often present. The Meliaticum in its type area is a Middle Jurassic to Lower Oxfordian accretionary complex. This is also the case for all other occurrences of the Meliaticum in the Western Carpathians and Eastern Alps except for Meliaticum remnants from salinar melanges in Late Permian hypersaline rocks at the base of higher nappes, in which parts of an accretionary complex have been involved during thrusting of nappes.
The geological evolution of the Meliaticum excludes a connection of the Meliata Ocean and its slopes and outer shelves with the Vardar Zone and originally more southernly oceans and their slopes and outer shelves. The South Tethyan oceans and their slopes and shelves are characterized by dominantly andesitic Scythian to Ladinian volcanism and Late Triassic and Jurassic sea-floor spreading. Their final closing was in post-Jurassic time. The Middle Anisian to Jurassic development of the Cimmerian Ocean (= Paleo-Tethys sensu Şengör, 1984) is identical to the development in the Meliata Ocean. Therefore, only a connection with this ocean is possible.

Zusammenfassung:
Neue Radiolarien-Daten haben gezeigt, daß das Meliaticum überwiegend aus mitteljurassischen siliziklastischem Flysch (distale Turbidite des Bath-Callov, überlagert durch eine coarsening upwards-Folge) besteht. Triassische Gesteine der ozeanischen Meliaticum-Abfolge (tektonisch zerstückelte Ophiolite, anisische rote pelagische Kalke, ladinische bis cordevolische rote dünnschichtige Radiolarite, obertriassische dunkle und bunte Radiolarite und graue Hornsteinkalke) sind Blöcke, Olistolithe oder Melangen innerhalb der mitteljurassischen Turbidite und Olistostrome. Unteranisische helle, rekristallisierte Kalke und skythische Kalke, Mergel und Schiefer der pre-Rift-Abfolge sind ebenfalls Blöcke innerhalb des mitteljurassischen Flysch. Chaotische Melangen kommen häufig vor. Das Meliaticum ist in seinem Typusgebiet ein mitteljurassischer bis unteroxfordischer Akkretionskomplex. Das ist auch in allen anderen Vorkommen von Meliaticum in den Westkarpaten und Ostalpen der Fall außer jenen Resten von Meliaticum in Salinar-Melangen in oberpermischen Salinargesteinen an der Basis höherer Deckeneinheiten, in die Teile des Akkrektionskomplexes während der Deckenüberschiebung gelangten.
Die geologische Evolution des Meliaticums schließt eine Verbindung des Meliata-Ozeans, seines Kontinentalabhanges und äußeren Schelfs mit dem Vardar-Ozean und ursprünglich noch weiter südlich gelegener Ozeanbecken, deren Kontinentalabhänge sowie äußere Schelfe aus. Die südtethyalen Ozeanbecken und ihre Kontinentalabhänge und Schelfe sind durch oberskythischen bis ladinischen andesitischen Vulkanismus und obertriassisches bis jurassisches sea-floor spreading gekennzeichnet. Ihre endgültige Schließung war in nach-jurassischer Zeit. Die mittelanisische bis jurassische Entwicklung des Cimmerischen Ozeans (= Paläotethys im Sinne von Şengör, 1984) ist identisch mit jener des Meliata-Ozeans. Daher ist nur eine Verbindung mit diesem Ozean möglich.

1. Introduction

For a long time the Meliata "Series" (ČEKALOVÁ, 1954) was regarded as a Late Permian to basal Scythian unit at the base of an assumed autochthonous/parautochthonous Gemeric Triassic (ANDRUSOV, 1959, BYSTRICKÝ, 1964, 1973, ILAVSKÁ, 1965, BORZA, 1966, and in BYSTRICKÝ, 1973, MAHEL' et al., 1968). KOZUR & MOCK (1973 a, b) found for the first time rich Middle and Late Triassic conodont faunas from the slightly metamorphic Meliaticum in its Meliata type locality (Slovakia). They recognized Pelsonian to Late Triassic deep-water rocks (reddish pelagic Pelsonian limestones, red Ladinian radiolarites, Carnian cherty limestones, Late Norian pelagic limestones). This evidence has changed the geologic interpretation of the "parautochthonous" Gemeric Triassic above the Meliaticum (Silica Nappe, KOZUR & MOCK, 1973 a, b).

Dismembered ophiolites (e.g. serpentinites, pillow lavas) of Ladinian to Cordevolian age (subordinately also of Middle and Late Anisian age), known from adjacent outcrops and other areas with rocks of the Meliaticum, indicate the presence of oceanic Triassic in this unit. The recognition of a Triassic oceanic development in the Western Carpathians has totally changed the former paleogeographic and tectonic models of the Inner Western Carpathians. The Meliata Ocean was involved in the plate tectonic interpretation of the Western Carpathians and has played a decisive role in all paleogeographic and tectonic reconstructions in the Western Carpathians (HORVÁTH et al., 1977, CHANNELL et al., 1979, KOZUR, 1979, 1984, 1989 b, 1990 b, c, 1991 a, b, KOVÁCS, 1982, 1984, HOVORKA et al., 1984, MAHEL', 1986, KOZUR & MOCK, 1987 a, 1988). KOZUR (1989 b, 1990 b, c, 1991 a, b), MANDL & ONDREJIČKOVÁ (1991), KOZUR & MOSTLER (1992) and MANDL (1992) recognized remnants of the Meliata Ocean in the Eastern Alps and KOZUR (1991 a, b) presented the first synthesis of the Triassic-Jurassic development of the Meliata Ocean (as embayment of the Cimmerian Ocean) in the Western Carpathians and Eastern Alps from its opening in the late Early Anisian until its final closing in the Early Oxfordian.

After the first dating by KOZUR & MOCK (1973 a, b), the Triassic age of the oceanic sequence was confirmed in many outcrops of the Meliaticum of the Western Carpathians (e.g. MOCK, 1980, DUMITRICĂ & MELLO, 1982, BAJANÍK et al., 1984). Despite intensive investigations, the dominant Jurassic rocks have been dated only by KOZUR & MOCK (1985). There are two reasons for this late discovery of Jurassic:

(1) The rocks of the Meliaticum are predominantly soft Middle Jurassic turbidites (e. g. graded siltstones, claystones with very few thin radiolarites). The Triassic consists of hard rocks resistant to weathering (e.g. pillow lavas, thick radiolarite sequences, cherty limestones). Moreover, parts of the Triassic rocks have been exploited (astbestos-bearing serpentinites of the huge Dobsiná quarry or quarries in Triassic pillow lavas and limestones) and are (or were) therefore also well exposed. The Jurassic beds are mostly poorly exposed and even in areas with nearly exclusively Jurassic rocks, often only a few blocks or klippen of hard Triassic rocks are exposed and bolders of Triassic rocks can be found (e.g. around Držkovce W of the Meliata type area).

(2) The biostratigraphic age determinations in the beginning were based on conodonts and in all Jurassic rocks these stratigraphically important fossils are missing. DUMITRICĂ & MELLO (1982), who used radiolarians for dating rocks of the Meliaticum, did not find Jurassic radiolarians for reasons mentioned under (1).

In the past 10 years, radiolarians of the slightly metamorphic (HP/LT metamorphosis, maximally until blueschist facies) Meliaticum have been studied in detail by the present authors. From these investigations it was found that both in the Western Carpathians and in the Eastern Alps the Meliaticum consists of a Jurassic accretionary complex, while Triassic rocks are always blocks or olistoliths in Jurassic turbidites (flysch), olistostromes, or in melanges (KOZUR, 1991 a, b, KOZUR & MOSTLER, 1992). The Meliaticum occurs also at the base of overlying nappes, mainly as blocks in Permian hypersaline rocks at the thrust plane of the southern Inner Western Carpathian nappes.

According to previous mapping (BAJANÍK et al., 1984), the Meliata type area appeared to be an exception. Thick pre-rift sequences of Scythian and Early Anisian ages were overlain by a Triassic suboceanic sequence below thick Jurassic beds. However, our radiolarian data have shown that the Triassic of the Meliata type locality also consists of large blocks and olistoliths in Bathonian to Callovian turbidites and olistostromes. Also, most occurrences of the Lower Triassic "pre-rift sequence" are in reality Middle Jurassic to Lower Oxfordian oceanic flysch sediments of the Meliaticum and therefore belong to the oceanic sequence.

2. Methods

Radiolarians have been dissolved by fluoritic acid from thin chert intercalation of turbidites or from silicified turbidites. Because all investigated rocks are slightly metamorphosed, the preservation of the radiolarians is often bad or the radiolarians cannot be dissolved from the rocks. Therefore numerous small samples have been solved, from which some (about 10%) contain determinable radiolarians of poor to moderate preservation.

3. Observations and results

Samples that contained determinable radiolarians are listed below. The location of the investigated outcrops is shown in fig. 1. The sampling points of radiolarian-bearing Jurassic samples in the Meliata type locality are shown in fig. 2.

Meliata type locality NW of Meliata village (locality E)

Sample M 7
2–3 cm of thin gray to dark-gray radiolarite within greenish-gray, hard, shaly-silty turbidites that contain muscovite. The radiolarian fauna is rather

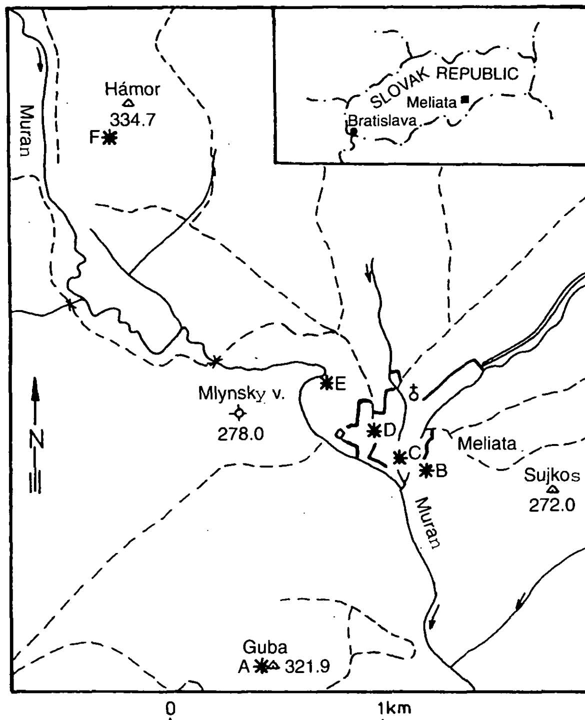

Fig. 1: Locality map around the village Meliata in Slovakia.

rich, moderately preserved. The following species have been determined:

***Archaeodictyomitra exigua* BLOME**
Archaeodictyomitra sp.
Canoptum ? *kamoensis* (MIZUTANI & KIDO)
Eoxitus sp. aff. *hungaricus* KOZUR
Eucyrtidellum semifactum NAGAI & MIZUTANI
Eucyrtidellum unumaense (YAO)
Praezhamoidellum convexa (YAO)
Protunuma cf. *turbo* MATSUOKA
Semihsuum cf. brevicostatum (OŽVOLDOVÁ)
"*Stichocapsa*" *robusta* MATSUOKA
Striatojaponocapsa conexa (MATSUOKA)
"*Stylocapsa oblongula*" KOCHER
Age: Early Callovian.

Sample M 7 G
3 cm of thin dark gray radiolarite in greenish-gray turbidites with thin black siliceous shale layers. The radiolarian fauna is rather poor, moderately to badly preserved.
Eucyrtidellum pustulatum BAUMGARTNER
Praezhamoidellum sp. aff. *yaoi* KOZUR

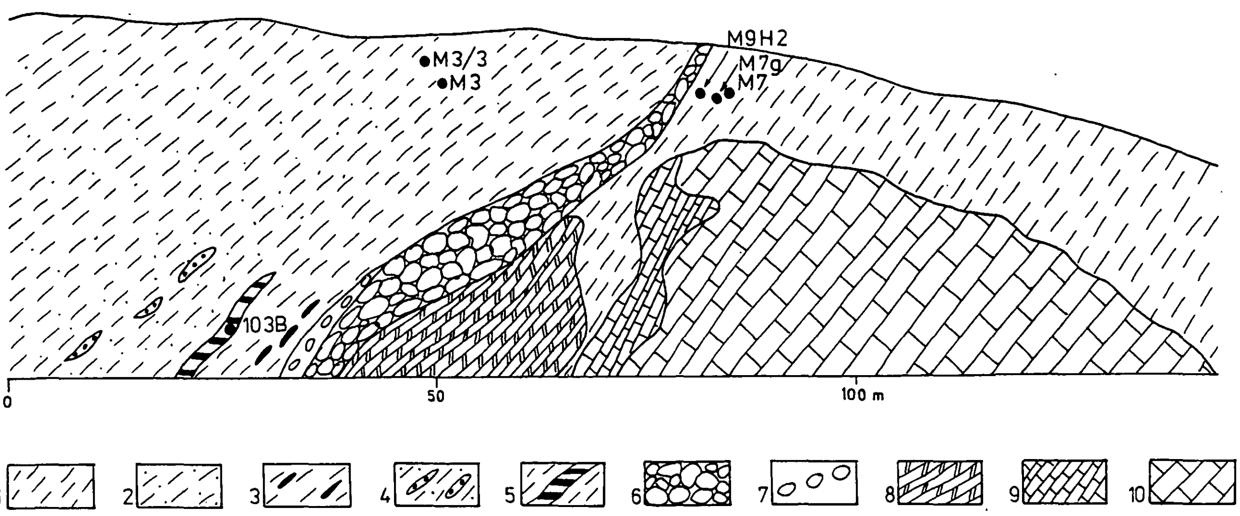

Fig 2: Meliata type section (locality E of fig. 1) with the position of the described radiolarian-bearing samples.
1: Greenish-gray distal turbidites (shales, siltstones with few radiolarite intercalations) of Bathonian to Callovian age.
2: Proximal turbidites (shales, siltstones, sandstones, conglomerates) of Late Callovian to Early Oxfordian age.
3: Olistoliths of pelagic dark Liassic limestones within the Bathonian-Callovian turbidites.
4: Conglomeratic bodies within the proximal turbidites.
5: Larger radiolarite intercalation at the boundary between the distal and proximal turbidites.
6: Nearly matrix-free olistostrome of Carnian dark, cherty limestone olistoliths.
7: Light-gray Late Norian limestone olistoliths within the Bathonian-Callovian turbidites.
8: Red ribbon radiolarites of Ladinian age.
9: Pelagic Pelsonian reddish limestones that penetrate in numerous fissure fillings in the underlying platform carbonates.
10: White, recrystallized Early Anisian shallow-water limestones of the pre-rift sequence.

"*Stichocapsa*" *robusta* MATSUOKA
Striatojaponocapsa conexa (MATSUOKA)
Williriedellum sp. A MATSUOKA, 1983
Age: Early Callovian.

Sample M9 H2
2–3 cm of thin gray radiolarite as an olistolith in greenish-gray turbidites, with thin black siliceous shale layers. Poorly preserved radiolarian fauna.
Striatojaponocapsa conexa (MATSUOKA)
Striatojaponocapsa plicarum (YAO)
Williriedellum sp. B
Age: Bathonian.

Sample M 3
Light gray radiolarite within greenish-gray, carbonate-free shaly-silty turbidites. Rich, moderately preserved radiolarian fauna.
Archaeodictyomitra sp.
Praezhamoidellum convexum (YAO)
Praezhamoidellum sp.
Protunuma sp.
Pseudodictyomitrella hexagonata (HEITZER)
Semihsuum brevicostatum (OŽVOLDOVÁ)
Semihsuum maxwelli (PESSAGNO)
"*Stichocapsa*" *robusta* MATSUOKA
Striatojaponocapsa conexa (MATSUOKA)
Striatojaponocapsa plicarum (YAO)
"*Stylocapsa oblongula*" KOCHER
Diacanthocapsa cordis (KOCHER)
Williriedellum sp. A MATSUOKA, 1983
Age: Early Callovian.

Sample M 3/3
Light gray radiolarite within greenish-gray, carbonate-free shaly-silty turbidites. Rich, moderately preserved radiolarian fauna.
Canoptum ? *kamoensis* (MIZUTANI & KIDO)
Eoxitus ? *dhimenaensis* (BAUMGARTNER)
Eucyrtidellum pustulatum (BAUMGARTNER)
Obesacapsula morroensis PESSAGNO
Ristola sp.

Semihsuum brevicostatum (OŽVOLDOVÁ)
Semihsuum maxwelli (PESSAGNO)
Semihsuum sp.
"*Stichocapsa*" *robusta* MATSUOKA
Striatojaponocapsa conexa (MATSUOKA)
"*Stylocapsa oblongula*" KOCHER
Age: Early Callovian.

Sample M 103 B
Basal part of dark gray, 1.30 m thick bedded radiolarites directly below the coarsening upwards sequence. Rich, moderately preserved radiolarian fauna.
Archaeodictyomitra rigida PESSAGNO
Archaeospongoprunum imlayi PESSAGNO
Cinguloturris carpatica DUMITRICĂ
Eoxitus ? dhimenaensis (BAUMGARTNER)
Eucyrtidellum unumaense (YAO)
Eucyrtidellum cf. *ptyctum* (RIEDEL & SANFILIPPO)
Quarticella ? sp.
Praewilliriedellum cf. *cephalospinosum* KOZUR
Praezhamoidellum sp.
Pseudodictyomitrella hexagonata (HEITZER)
Ristola altissima (RÜST)
Semihsuum brevicostatum (OŽVOLDOVÁ)
Semihsuum sourdoughense PESSAGNO, BLOME & HULL
"*Stichocapsa*" *robusta* MATSUOKA
Striatojaponocapsa conexa (MATSUOKA)
"*Stylocapsa oblongula*" KOCHER
Diacanthocapsa cordis (KOCHER)
Age: Upper half of Callovian.

Sample Me 37
The radiolarian fauna of this sample was described by KOZUR & MOCK (1985). It comes from the top of the above mentioned 1.30 m thick radiolarite. The moderately preserved radiolarian fauna contains the following species (in brackets the former assignments by KOZUR & MOCK, 1985, if they were different from the present taxonomic assignment):
Archaeospongoprunum imlayi PESSAGNO
Cinguloturris cf. *carpatica* DUMITRICĂ
Pseudoeucyrtis sp. J CONTI & MARCUCCI [*Eucyrtis micropora* (SQUINABOL) sensu BAUMGARTNER et al., 1980]
Pseudoeucyrtis n. sp. [*Eucyrtis* n. sp.]
Hemicryptocapsa sp.
Paronaella sp. 1
Paronaella sp. 2
Podobursa cf. *triacantha* (FISCHLI)
Tetratrabs sp.
Tritrabs sp. 1
Tritrabs sp. 2
Urocyrtis sp.
Age: Late Callovian-Early Oxfordian.

Locality D (Meliata village, near the Protestantic church)

Samples M 1B, M 1C, M1 F
Gray radiolarites, olistoliths in greenish-gray, shaly-silty carbonate-free turbidites with manganese-oxid layers or nodules. Sequence so far regarded as Early Triassic (Werfen Beds). Very badly preserved radiolarians, mostly undeterminable.
Praezhamoidellum sp.
Striatojaponocapsa plicarum (YAO)
Age: Bajocian-Callovian.

Locality C (Meliata village, behind house No. 72)

Sample M 2 D1
2 cm of thin gray radiolarites in greenish-gray, shaly-silty carbonate-free turbidites. The sequence was so far regarded as Early Triassic (Werfen Beds). The radiolarians are poorly preserved. The species are mostly undeterminable, genera partly determinable.
Striatojaponocapsa plicarum (YAO)
Tetracapsa sp. aff. *tetragona* (MATSUOKA)
Age: Bathonian

Locality B (Meliata, 400 m SSE of the Catholic church)

Sample M 13 N
Gray thin-bedded radiolarite with reddish stripes within greenish-gray, carbonate-free shaly-silty

turbidites, until now mapped as Lower Triassic (Werfen Beds). Rich, but badly preserved radiolarian fauna.
Eucyrtidellum unumaense (YAO)
Lupherium ? sp. (cf. Nassellaria in NAGAI & MIZUTANI, 1992, pl. 6, fig. 5)
Praezhamoidellum cf. *yaoi* KOZUR
Striatojaponocapsa conexa (MATSUOKA)
"*Stylocapsa oblongula*" KOCHER
Tetracapsa sp.
Age: (Early) Callovian.

Locality A (Guba, 1 km SW of the village)

Sample G 6
Thin, gray radiolarite in gray, partly graded, carbonate-free shaly-silty turbidites, until now regarded as Early Triassic (Werfen Beds).
Acanthocircus variabilis (SQUINABOL)
Angulobracchia sp.
Archaeodictyomitra rigida PESSAGNO
Archicapsa sp.
Cinguloturris carpatica DUMITRICĂ
Eoxitus ? *dhimenaensis* (BAUMGARTNER)
Eoxitus cf. *hungaricus* KOZUR
Eucyrtidellum ptyctum (RIEDEL & SANFILIPPO)
Praezhamoidellum convexus (YAO)
Protunuma cf. *costata* (HEITZER)
Protunuma ochiensis MATSUOKA
Protunuma ? sp. A
Semihsuum maxwelli (PESSAGNO)
Semihsuum ex gr. *maxwelli* (PESSAGNO)
Tetracapsa leiostraca (FOREMAN)
Spongocapsula palmerae PESSAGNO
Striatojaponocapsa conexa (MATSUOKA)
Unuma latusicostata (AITA)
Age: Upper part of Callovian.

Locality F (Hámor, 2 km NW of the village)

Sample H-22108
Gray radiolarite (olistolith ?) in greenish-gray, carbonate-free, shaly-silty turbidites, until now regarded as Lower Triassic (Werfen Beds). Rich, moderately preserved radiolarian fauna.
Archaeodictyomitra sp.
Eoxitus hungaricus KOZUR
Eucyrtidellum unumaense (YAO)
Praezhamoidellum buekkense KOZUR
Praewilliriedellum n. sp. (= "*Tricolocapsa*" sp. cf. "*T.*" *parvipora* TAN sensu YAO, 1979)
Praezhamoidellum sp.
Protunuma sp.
Pseudodictyomitrella wallacheri GRILL & KOZUR
"*Stichocapsa*" sp. A
Striatojaponocapsa plicarum (YAO)
Age: Late Bajocian or Early Bathonian.

Sample H-22109
Gray radiolarite in greenish-gray, carbonate-free, shaly-silty turbidites, until now regarded as Lower Triassic (Werfen Beds). Poorly preserved radiolarian fauna.
Eoxitus ? *dhimenaensis* (BAUMGARTNER)
Praezhamoidellum convexus (YAO)
"*Stichocapsa*" sp. B
Age: Bajocian-Callovian.

Sample H-22092
Variegated (greenish, gray and reddish) radiolarite within greenish-gray, carbonate-free, shaly-silty turbidites, until now regarded as Lower Triassic (Werfen Beds). Poorly preserved radiolarian fauna from which only two species could be determined.
Cinguloturris carpatica DUMITRICĂ
Striatojaponocapsa plicarum (YAO)
Age: Callovian.

4. Discussion

(1) Taxonomic problems

The Jurassic radiolarian species are in general well defined, but some of them are junior synonyms of species established partly more than 100 years ago. Some generic assignments of the Jurassic radiolarians are problematic because the rules of the ICZN are not followed in several cases. Partly junior synonyms are used and partly Jurassic species are assigned to genera with Cenozoic type species that belong even to other families. These taxonomic questions do not influence the stratigraphic evaluation. Largely used, but incorrect generic assignments are indicated by generic names in quotation marks. A species in quotation marks indicates that it is a junior synonym of a formerly described species.

Only two examples are briefly discussed. *Tricolocapsa* HAECKEL, 1882, with the type species *T. theophrasti* HAECKEL, 1887, is a Tertiary to Recent tricyrtid genus, in which the thorax is larger then the other two segments. The abdomen is cylindrical or inverse conical. The Jurassic species, placed by YAO (1979) into *Tricolocapsa*, like "*Tricolocapsa*" *plicarum* YAO, display a big inflated abdomen that is by far larger than the cephalothorax. These forms do not belong to the same family as the Cenozoic *Tricolocapsa*. KOZUR (1984) introduced several genera for these forms, like *Striatojaponocapsa* KOZUR and *Praezhamoidellum*. TAKEMURA (1986) assigned these forms again to *Tricolocapsa*, disregarding the scope of this genus defined by its Recent type species. After this paper *Tricolocapsa* is again used in most papers for Jurassic species (e.g. GORIČAN, 1994) despite the fact that a genus is defined by its type species. Only PESSAGNO et al. (1993) separated a part of the Jurassic species, erroneously assigned to *Tricolocapsa* HAECKEL, to the genus *Quarkus* PESSAGNO, BLOME & HULL, 1993, that is, however, a junior synonym of *Praezhamoidellum* KOZUR, 1984.

GORIČAN (1994) regarded *Eucyrtidellum pustulatum* BAUMGARTNER as a junior synonym of *E. unumaense* (YAO). However, in well preserved radiolarian faunas of the *Unuma echinatus* Zone (Aalenian-Bajocian) of Hungary only *E. unumaense*, but no *E. pustulatum* have been found. In well dated Late Bathonian (NAGAI & MIZUTANI, 1992) and younger radiolarian faunas, *U. pustulatum* is common and co-occurs with *U. unumaense*. Because of the considerably different appearance of *E. unumaense* and *E. pustulatum* both species are separated, as in BAUMGARTNER (1984).

(2) Discussion of the biostratigraphic assignments

Middle Jurassic age is easily to recognize even in badly preserved radiolarian faunas. Only Toarcian and (Early) Oxfordian faunas are similar to the Middle Jurassic radiolarian faunas. Often radiolarians are the only stratigraphically important fossils present in investigated rocks (especially in radiolarites). The exact assignment of Middle Jurassic radiolarian faunas to stages or substages is therefore difficult, because only a part of the radiolarian faunas is well dated by other stratigraphically important fossils.

KOZUR (1984) assigned a radiolarian association of the *Unuma echinatus* Zone (with the index species) from the Bükk Mts. to the Bajocian (first evidence of Jurassic in the Bükk Mts.), because it contains *Hsuum mirabundum* (PESSAGNO & WHALEN) and *Lupherium officerense* PESSAGNO & WHALEN. Both species are well dated by ammonoids of the *Otoites sauzei* Zone (Lower part of Middle Bajocian) in Oregon (PESSAGNO & WHALEN, 1982). BAUMGARTNER (1984) placed the Tethyan *Unuma echinatus* fauna into the Bathonian (with an assumed disappearence of *U. echinatus* at the top of the Bathonian). GRILL & KOZUR (1986) divided the *U. echinatus* Zone into two subzones and placed the lower subzone (*Lupherium officerense* Subzone) in the Aalenian to the basal part of the Middle Bajocian, and the upper Subzone (*Yaocapsa mastoidea* Subzone) in the Middle and Late Bajocian. The Bajocian age of the *Unuma echinatus* fauna was confirmed by ammonoids in the Subbetic Jurassic (Betic Cordillera, Spain) (O'DOGHERTY et al., 1989). Surprisingly, CSONTOS et al. (1991) placed the "*Tricolocapsa*" *plicarum* (= *Unuma echinatus*) Zone into the Bathonian-Callovian. But they presented no new data for the correlation of the radiolarian faunas with the Middle Jurassic time-scale, because in the Bükk Mts. radiolarians are the only stratigraphic important fossils of Jurassic age. The newest range data of *Unuma echinatus* ICHIKAWA & YAO were published by GORIČAN (1994). Again, an Aalenian to Bajocian age was indicated for this stratigraphically important species.

Only one sample, H-22108, contains a fauna, similar to that of the upper *Unuma echinatus* Zone. *Pseudodictyomitrella wallacheri, Praezhamoidellum buekkense* and *Praewilliriedellum* n. sp. are so far only known from the *Unuma echinatus* Zone. However, the zonal and subzonal index species *U. echinatus* and *Yaocapsa mastoidea*, are missing and well dated Early Bathonian faunas are practically unknown. Therefore, the age of the sample is Late Bajocian or Early Bathonian.

Within the Late Bathoian-Callovian interval several distinct radiolarian associations are known, but their exact correlation with the Middle Jurassic stages and substages is still difficult. Up to the Middle Callovian, *Eucyrtidellum ptyctum* is still missing (YAMAMOTO et al., 1985), whereas this species is common in Late Callovian and younger faunas. This is also confirmed by BAUMGARTNER (1987), who found *Mirifusus guadalupensis* PESSAGNO directly above beds with Early and Middle Callovian ammonites. *E. ptyctum* begins, according to GORIČAN (1994), together with *M. guadalupensis*, but according to BAUMGARTNER (1984, 1987) a little later than this species. Therefore, according to all the available data, *E. ptyctum* begins in the upper half of the Callovian. A Late Callovian age for the first appearance of this species is also confirmed by GORIČAN (1994).

Sample G 6 (Guba) and M 103 B (Meliata type locality, in the basal part of the uppermost radiolarite intercalation at the top of the turbidites) with *E. ptyctum* are, therefore, not older than Late Callovian. For sample G 6 a Late Callovian lower age assignment is also indicated by *Protunuma ochiensis* that begins nearly in that level or a little below. A post-Callovian age is excluded by the presence of "*Stylocapsa oblongula*" and *Striatojaponocapsa conexa*, which end at the top of the Callovian. Moreover, all common (Early) Oxfordian guide-forms, such as *Homoeoparonaella argolidensis* BAUMGARTNER, *Mirifusus chenodes* (RENZ), *Paronaella broennimanni* PESSAGNO, *Paronaella mulleri* PESSAGNO, *Emiluvia orea* BAUMGARTNER, *Williriedellum carpathicum* DUMITRICĂ etc. are absent. A post-Callovian age additionally is excluded by the presence of *Protunuma ochiensis*, *Striatojaponocapsa plicarum*, *Unuma latusicostata* (all sample G 6) and "*Stichocapsa*" *robusta* (sample M 103 B), which all end at the top of the Callovian.

Samples without *E. ptyctum* and *Protunuma ochiensis*, but with *Obesacapsula morroensis*, "*Stylocapsa oblongula*", "*Stichocapsa*" *robusta* and *Cinguloturris carpatica* or at least one of these species are placed in the lower half of Callovian, because these species are at least in Europe unknown before the Callovian. This can be only applied for radiolarian-rich samples (M 7, M 7G, M 3, M 3/3). Poor samples with the above mentioned Callovian species, but without *E. ptyctum* and *P. ochiensis* can be only assigned to the Callovian, because in such samples the absence of Late Callovian species cannot be stratigraphically evaluated (samples M 13 N, H 22092).

Samples with *Striatojaponocapsa conexa* or *Tetracapsa* sp. aff. *tetragona* and common *Striatojaponocapsa plicarum*, but without Callovian guide-forms are placed in the Bathonian (sample M2 D1, M9 H2). Unfortunately, these samples yielded poor or badly preserved radiolarians. For this reason, a Callovian age cannot be totally excluded, but common *S. plicarum* indicates rather Bathonian than Callovian age. *Tetracapsa tetragona* is restricted to a rather narrow interval within the Bathonian, but the specimens in sample M2 D1 are too badly preserved for exact determination.

Samples with long-ranging Middle Jurassic species can be only assigned to the Bajocian-Callovian (samples H 22109, M 1B, M 1C, M 1F).

The only sample, which is probably Early Oxfordian in age, was taken immediately below the coarsening-upwards sequence. *Podobursa triacantha* is so far unknown from pre-Oxfordian beds.

(3) Tectonic and paleogeographic evaluation

Most of the investigated turbidites were erroneously mapped as shallow-water Early Triassic Werfen Beds also after recognition of the Middle and Late Triassic oceanic sequence of the Meliaticum (BAJANÍK et al., 1984). Only the Late Callovian-Early Oxfordian radiolarites just below a coarsening-upwards sequence were at first placed in the Middle Carnian (KOZUR & MOCK, 1973 a, b), but later in the Jurassic (KOZUR & MOCK, 1985). Definite Lower Triassic shallow-water sediments (i.e. limestones, marls) with foraminifers are only rarely present (e.g. near the Catholic church in the northeastern part of Meliata village, KOZUR & MOCK, in prep.). They are blocks of the pre-rift sequence within the Middle Jurassic turbidites.

Also in all other occurrences of the Meliaticum in the Western Carpathians, the Middle Jurassic turbidites clearly dominate and were mapped as Early Triassic Werfen Beds by BAJANÍK et al. (1984), as in the Meliata type area. In the Eastern Alps, most of the sedimentary Meliaticum consists of Middle Jurassic turbidites with a coarsening-upwards sequence at the top (KOZUR & MOSTLER, 1992). Also in this area, these slightly metamorphic turbidites have been mapped as Early Triassic Werfen Beds, but partly as Early Paleozoic (see historical review in KOZUR & MOSTLER, 1992).

The largely Middle Jurassic age (Bathonian-Callovian flysch) of the Meliaticum in the Western Carpathians and Eastern Alps is shown in different papers (e.g. KOZUR, 1991 a, b, KOZUR & MOSTLER, 1992, MANDL, 1992). KOVÁCS (1993), however, totally ignored these results in a selective compilation about the connection of the Meliaticum with other oceans toward the E–SE. He even stated that the Kotel and Strandzha Zones have no Alpine-type Jurassic (according to his opinion similar from the Alps to China !) because of the presence of Early-Middle Jurassic flysch with blocks of pelagic Triassic (PEYBERNES et al., 1989). With this „argument“ he supported his view that the Meliaticum cannot be connected with the Kotel and Strandzha Zones. But in reality the Early-Middle Jurassic flysch of the Kotel Zone with blocks of pelagic Triassic is an important argument for connection of the Meliaticum and its marginal parts with the Strandzha and Kotel Zones. According to the above mentioned „argument“ of KOVÁCS (1993) the Meliaticum as the decisive unit of the Western Carpathians and Eastern Alps would not have an Alpine-type Jurassic !

The connection of the Kotel and Strandzha Zones with the Meliaticum and its slope and outer shelf was assumed by all previous authors that have discussed its paleogeographic position (KOZUR & MOCK, 1987 a, 1988, TOLLMANN, 1988, GOCHEV, 1991, KOZUR, 1991 a, b). Different opinions were only expressed about the assumed root zone. According to TOLLMANN (1988) the Kotel Zone and the Transylvanides represent the only remnants of the „northern belt of the Vardar Ocean“ with direct connection to the Meliata-Hallstatt Belt. In this case, the Kotel Zone was rooted south of the Rhodope Belt and was overthrust more than 500 km from the south. KOZUR & MOCK (1987 a, 1988) and KOZUR (1991 a, b) regarded the Kotel and Strandzha Zones as situated originally north or northeast of the Rhodope Belt with smaller amount of overthrust.

The correlation of the Meliaticum with oceans in the E and SE requires a comparison of the tectonic evolution of these oceans. Two methods are applied for these comparisons. KOVÁCS (1993) correlated selected tectonofacies without stratigraphic control, or he correlated selected identical lithofacies of otherwise different sequences. In both cases he did not discuss the different evolution of the oceans compared. MOCK (1987 a, 1988), TOLLMANN (1988), KOZUR (1991 a, b), MANDL & ONDREJIČKOVÁ (1991), KOZUR & MOSTLER (1992), MANDL (1992) correlated the Meliaticum and its marginal development by consideration of the entire geologic evolution of the areas compared. The results of the two methods are, of course, fundamentally different.

KOVÁCS (1993) recognized two oceans, the Sicilian-Aegean Ocean and the Meliata-Maliak-(Oman) Ocean. He constructed the first mentioned ocean on the base of "Late Paleozoic-Early Mesozoic olistostromal-flysch type sequences, extending from the Aegean domain to Sicily" (KOVÁCS, 1993, p. 340). He interpreted these sequences „as a trench complex connected to the subduction of a southerly-lying oceanic domain“ and assumed that these complexes indicate the final stages of a closing of this ocean. One of the present authors (H. KOZUR) has studied and dated the so-called "olistostromal-flysch type sequences" in all units, mentioned by KOVÁCS (1993), partly in cooperation with R. MOCK (Sicily, Greece). Therefore, both the age and the tectonic importance of the units mentioned by KOVÁCS (1993) as a selective literature compilation can be evaluated by our own data.

The mentioned formations of the "Late Paleozoic-Early Mesozoic olistostromal-flysch type sequences, extending from the Aegean domain to Sicily" sensu KOVÁCS (1993) have the following ages and characters:

The Lercara Formation of the Sicanian Paleogeographic Domain in western Sicily is a Late Hercynian Early Permian (Kungurian = Cathedralian) flyschoid turbidite complex with some olistoliths (CATALANO et al., 1991, 1992, KOZUR 1989 a, c, 1990 a, 1991 c, 1992 a, b, 1993 a, KRAINER et al., 1993). Subduction related volcanics (trench complex sensu KOVÁCS, 1993) are not present. Only basic volcanics can be found, but their relation to the Lercara Fm. (synsedimentary or younger) is not yet clear. The overlying Olistostrome Unit has a Roadian (basal Middle Permian Guadalupian Series) matrix (KOZUR, 1993 b). This is not related to a subduction trench system, but it is a base of slope deposit in a rapidly sinking basin (extensional regime).

The Mufara Formation of the same paleogeographic domain is a Middle Carnian distal Raible development with bedded radiolarian-bearing cherty limestones and marls. It is neither a trench deposit, nor related to subduction, indicating the final stages of closing as assumed by KOVÁCS (1993). The final closing of this basin was in post-Serravallian (Late Miocene) time.

The Monte Facito Formation s.str. is a predominantly siliciclastic, partly turbiditic sequence of Olenekian age (MARSELLA et al., 1993). The Early Olenekian is charaterized by Werfen facies shallow-water conodonts. The Late Olenekian contains mostly pelagic conodont faunas and in the uppermost part also radiolarians. This part of the sequence was deposited on a steep slope of a rapidly sinking basin. There is no connection to a subduction trench complex. The Middle Triassic to Middle Carnian part of the Monte Facito Fm. s.l. (MARSELLA et al., 1993) contain several olistostrome units and tuffitic layers. These olistostromes and the volcanics are mainly related to strong block-faulting at the margin of a radidly sinking basin. They do not indicate the final stage of closing, that was in the Tertiary.

Olistostrome units and intermediate volcanism occur in the Phyllite Unit of Crete (KRAHL et al., 1982, 1983, 1986, KOZUR & KRAHL, 1987). They are not related to the final closing of the ocean that was in the Tertiary.

The "olistostromal flyschoid complex" of the Karakaya Domain has Norian age (KAYA et al., 1986, WIEDMANN et al., 1992). It is related to the closing of an oceanic branch of the Cimmerian Ocean (Paleo-Tethys sensu ŠENGÖR, 1984) because of collision of a continental block within this ocean with the continental margin at the end of the Triassic.

The above discussion has demonstrated that the olistostromal-flyschoid sequences sensu KOVÁCS (1993) that indicate, according to his opinion, subduction-related trench deposits in the final stage of the closing of the Sicilian-Aegean Ocean, have totally different ages and are in most cases neither related to a subduction trench system, nor to the final stage of the closing of that hypothetical ocean. Sometimes these units are even not "olistostromal flysch type sequences" as assumed by KOVÁCS (e.g. Mufara Fm. of the Sicanian Paleogeographic Domain). Even, if all these units of different ages from the Early Permian to Late Triassic would be subduction-related deposits, this tectonofacies (without consideration of its different age) would not be an evidence for its position in the same ocean, because all subducted ancient oceans have a similar facies in their turbidite-olistostrome complexes (e.g. in Japan, Sichote Alin, in Chukotka, in the Franciscan Melange of California, or in the Bathonian to Early Oxfordian of the Meliaticum, to mention only a few areas studied by two of the authors, H. KOZUR and R. MOCK). The fact that in all these areas accretionary complexes (turbidites, olistostromes, melanges, the olistostromal-flysch type sequences sensu KOVÁCS, 1993) of Jurassic age are present, is no evidence that the Meliata Ocean was a part of the Circum-Pacific realm.

The Aegean-Sicilian Ocean (or branch of the Tethys) sensu KOVÁCS (1993) was never one single ocean with similar geologic history. The ocean that extented from the Sicanian Paleogeographic Domain through the eastern Mediterranian area toward the east to NE Iraq and Oman (KOZUR & KRAHL, 1987, KOZUR, 1989 c, 1990 a, 1992 a, b, 1993 a, CATALANO et al., 1991, 1992) is the southern branch of the Tethys well known since long time. In the meridian of western Turkey it was situated south of the Menderes Massif with few slope remnants in the Mamonia Complex of Cyprus. The Karakaya Complex is an oceanic branch north of the Ankara-Izmir Belt (and north of the Karaburun Unit and Menderes Massif). The Menderes Massif-Pelagonicum was not perpendicularly crossed by an ocean to join the northern Tethyan Karakaya oceanic branch with the southern branch of the Tethys as assumed by KOVÁCS (1993).

For the correlation of the Meliata Ocean with other oceans selected lithofacies have been used by KOVÁCS (1993); the geologic evolution of the Meliata Ocean and of the compared oceans have not been considered. For this reason, a short summary of the most important events in the development of the Meliata Ocean must be given (for comprehensive discussion see KOZUR, 1991 a, b).

The oceanic sea-floor spreading in the Meliaticum of the Western Carpathians and Eastern Alps began in the upper part of Early Anisian or in the Pelsonian. Dismembered ophiolites and pillow lavas have Middle Anisian to Cordevolian age (KOZUR, 1991 a, b, KOZUR & MOSTLER, 1992). Contemporaneous sediments are red pelagic Pelsonian-Illyrian limestones and red Ladinian to Cordevolian cherts. Both types of sediments may be free of volcanics (e.g. in the Meliata type locality) or small intercalations within pillow lavas (mainly inter-pillow fillings, but red shales dominate among the inter-pillow sediments).

The sea-floor spreading ended at the base of the Middle Carnian. Since this time, no volcanic activity can be observed in the entire Meliaticum. Middle Carnian and Norian sediments consists either of variegated, often dark radiolarites, or of cherty limestones. Shales, manganese-oxid shales, occasionally dark, bedded, pelagic limestones characterize the Rhaetian to Bajocian interval. The Bathonian and Callovian is characterized by greenish-grey and grey, subordinately black, shaly-silty distal turbidites. In the Early Oxfordian a coarsening-upwards sequence of proximal turbidites, sandstones, conglomerates is present. The final closing was at the end of the Early Oxfordian.

Crustal cooling after the end of the sea-floor spreading caused subsidence on the adjacent shelves. Therefore, shallow-water platform carbonates on the outer shelf are overlain by Late Carnian to Rhaetian pelagic limestones, often Hallstatt Limestones.

The southern and northern slopes have a similar development, but terrigenous input on the southern slope was always stronger (marly, cherty limestones instead of Hallstatt Limestones and Middle Carnian Raibl Beds are present on the southern slope). A passive margin sequence on the northern slope (e.g. pelagic limestones, marls, radiolarites, no turbidites, no olistostromes, no siliciclastic input, no volcanics), and turbidites, olistostrome units with sandstone olistoliths, and acidic volcanism during the Middle Jurassic on the southern slope favour a southward-directed subduction.

The correlation with the Vardar Ocean is according to KOVÁCS (1993) supported by the presence of a Triassic Diabase-Chert Formation in the Vardar Zone. However, the radiolarian dating in OBRADOVIĆ & GORIČAN (1988) has been misinterpreted by KOVÁCS (1993). Ladinian radiolarians have not been found in the Diabase-Chert Fm., but in olistoliths of the Porphyrite-Chert Formation of the innermost Vardar Zone. In the Vardar Zone and in marginal parts of other South Tethyan oceanic branches, the Ladinian is characterized by a strong acidic to intermediate, subordinately also basaltic volcanism. In most parts of the Vardar Zone, these volcanics are found in shallow-water carbonate platform deposits. Only in the innermost Vardar Zone some pelagic beds occur in this volcanic-bearing Ladinian, consisting of limestones, siliceous shales and chert intercalated with acidic to intermediate tuffs and tuffites. Ladinian radiolarians, published by OBRADOVIĆ & GORIČAN (1988), have been derived from such Buchenstein-type beds that are entirely unknown from the Meliaticum. Also in the other branches of the South Tethys, in this time pelagic or shallow-water sediments are mostly accompanied by acidic, intermediate, subordinately basic tuffs, tuffites or volcanics. For instance, in the Sicanian Paleogeographic Domain of western Sicily Early Ladinian gray cherts with thin tuffitic layers overlain by late Fassanian to Cordevolian reddish and greenish cherty limestones and marls are known from the lower nappe unit. Ladinian red, strongly siliceous limestones, cherts and volcanics are known from the upper nappe unit (Palazzo Adriano Nappe).

The Ladinian development of the Vardar Zone is entirely different from that of the Meliata Ocean, in which in this time oceanic sea-floor spreading took place (expressed by large bodies of dismembered ophiolites, pillow lavas and red chert). If in the Vardar Zone any Ladinian pelagic sediments are present (only in the innermost Vardar Zone), they are accompanied by acidic and intermediate volcanics and volcanoclastics.

Beginning with the Middle Carnian, widespread basinal development started in the Vardar Zone that differentiated in this time into basins and carbonate platforms. Basaltic volcanism started in that time in the basins. Mostly cherty limestones are known from the basinal facies, but in some places in the innermost Vardar Zone cherts are intercalated between the pillow lavas. From such chert intercalations radiolarians have been determined and figured by OBRADOVIĆ & GORIČAN (1988). One sample contains *Annulotriasocampe baldii* KOZUR (determined as *Triassocampe* sp.), *Spongostylus tortilis* KOZUR & MOSTLER, *Capnuchosphaera* sp. and *Vinassaspongus transitus* KOZUR & MOSTLER, a Late Carnian to Early Norian radiolarian fauna. The other sample contains *Capnodoce anapetes* DEWEVER, *Capnodoce* sp., *Capnuchosphaera triassca* DEWEVER, *Kahlerosphaera* sp., *Latium longulum* BLOME. This is an Early-Middle Norian fauna. What is shown in KOVÁCS (1993) as evidence for the same development in the Vardar Zone and in the Meliaticum proves in reality a totally different Triassic development. During the time of the maximum sea-floor spreading in the Meliaticum (with ophiolites, pillow lavas and cherts), in the Vardar Zone either shallow-water carbonate platforms or intraplatform basins occurred, both with strong acidic to intermediate volcanism. Since the Middle Carnian the Vardar Zone is divided into basinal development with cherty limestones, cherts and basaltic volcanism and carbonate platforms. Just at the time, where the basic volcanism ends in the Meliaticum, it starts in the Vardar Zone. However, the sea-floor spreading in the narrow oceanic embayment at the northwestern end of the Tethys (Meliaticum) did not begin earlier than in the broader oceanic domains further in the southeast.

The Jurassic developments of the Vardar Zone and of the Meliaticum are also totally different. Huge ophiolites are present in the Vardar Zone and in its continuation in the southern Apuseni Mts. that are mostly Middle Jurassic in age; overlying radiolarites are Late Jurassic in age. But also during the Liassic a strong basaltic volcanism was present continuing the Late Triassic basaltic volcanism. In the Meliaticum, a flysch development with Bathonian-Callovian turbidites and an Early Oxfordian coarsening-upwards sequence can be observed. Whereas in the Vardar Zone the maximum of the sea-floor spreading occurred, the closing of the Meliata Ocean was in its final stage.

KOVÁCS (1993) stated that KOZUR & MOCK (1977) recognized a strong similarity between the Meliata-Bükk development and the Vardar Zone, whereas KOZUR (1991) excluded the connection ot the Meliaticum with the Vardar Zone, without giving any explanation why he changed his opinion. Seemingly, KOVÁCS has not carefully read the papers of KOZUR (1991 a, b). KOZUR & MOCK (1977) united the Meliata and Bükk development, because at that time the Jurassic of the Meliaticum was unknown and therefore the character of the Meliaticum as Jurassic accretionary complex was unknown. Just 4 years before, KOZUR & MOCK (1973 a, b) had for the first time recognized pelagic Middle and Late Triassic in the Meliaticum, before regarded as Late Permian to earliest Scythian; Jurassic was first found by KOZUR & MOCK (1985). The age of the gabbros, pillow lavas etc. of the western Bükk Mts. was unknown in 1977 and the age of the Meliata ophiolites was unknown as well. At this preliminary state of knowledge, a separation of the ophiolitic complexes in the Bükk Mts. and in the Meliaticum was impossible and therefore also the separation from the development in the Vardar Zone was not possible. KOZUR (1991 a, b) had recognized these differences and separated the Bükk and Meliata development (as it is done now by all geologists, also by KOVÁCS). The Bükk development (marine Late Carboniferous, gap in the Early and Middle Permian, marine Late Permian, predominantly limey Lower Triassic, Middle Triassic shallow-water carbonate platform with strong intermediate volcanism, Late Triassic differentation in basinal facies with basic volcanism and shallow-water carbonate platform facies, huge amounts of Middle Jurassic ophiolites in the western and southern Bükk Mts., dated by KOZUR, 1984, Late Jurassic radiolarites, Early Cretaceous pre-flysch) is very similar to the developments in the Vardar Zone. Even the separation in oceanic throughs and carbonate platforms with the same development of both units is present both in the Bükk Mts. and in the Vardar Zone. KOZUR (1991 a, b) assumed that the Bükk Mts. are either a back-arc development of the Meliata subduction or the continuation of the Vardar Zone (or both) and he also stated, why the Meliaticum cannot be the continuation of the Vardar Zone.

The second continuation of the Meliata Ocean favoured by KOVÁCS (1993) is the Maliak Ocean in Greece (= Subpelagonicum, margin of the Pindos Ocean, ROBERTSON et al., 1991). According to his interpretation, all lithologic successions found in the Meliaticum and in its slope and outer shelf can be found in the Maliak Nappe. Also the classical Hallstatt Limestones of the Subpelagonicum (Maliak sequences according to KOVÁCS, 1993) "have their counter parts in the classical Hallstatt areas east of Sarajevo... containing equivalents of most of the North Alpine Hallstatt Triassic formations" (KOVÁCS, 1993). Unlike KOVÁCS, who made a selective compilation of literature data, we (KOZUR and MOCK) have studied in detail the key areas mentioned by KOVÁCS. The same lithofacies as in the Meliaticum and its margins are present in the Othris area as normal for oceanic sequences and their slopes and outer shelves. However, if these lithofacies are dated and their tectonic evolution is regarded, we cannot find "all lithiologic ***successions***" of the Meliaticum and its slope and outer shelf as assumed without own studies by KOVÁCS (1993).

Hallstatt Limestones with the same facies successions occur, for instance, also in Timor (Prof. L. KRYSTYN, Vienna, pers. comm.) that was surely not adjacent to the Meliaticum. They seemingly reflect climatic control and can be found in different areas of the Tethys. On the outer shelf of the Subpelagonicum, Hallstatt Limestones of Late Olenekian to Cordevolian age are overlain by shallow-water platform carbonates of Late Triassic age. On the outer shelf of the Meliaticum the opposite development can be observed. Middle Triassic (to Cordevolian or Julian) shallow-water carbonates are overlain by Hallstatt Limestones. The latter development is related to crustal cooling after the end of the sea-floor spreading at the base of the Middle Carnian. In the Southern Tethys strong sea-floor spreading began in the Middle Carnian and continued until the Middle Jurassic. The beginning of the sea-floor spreading is accompanied there by shoulder uplift on the continental margins. Therefore, the pelagic sedimentation (Hallstatt Limestones) on the outer shelf was replaced by shallow-water platform carbonates. This can be both observed in the outer shelf deposits of the Subpelagonicum and in the Sarajevo area, but nowhere on the outer shelf of the Meliaticum. The Hallstatt Limestone development of the Subpelagonicum continued only in deep-water sequences, as in Epidauros. But also this unit (Asklipion Unit) is basically different from the development in the Hallstatt Zone. The sequence begins with (Late Olenekian) Anisian andesitic lavas and tuffs that have no equivalents in the Meliaticum and its margin, but are characteristic for the southern Tethys. The following Anisian to Norian Hallstatt Limestones are overlain by the Adhami Limestone, which partly also replaces the Hallstatt Limestones. The Adhami Limestone consists of Middle or Late Triassic to Early Jurassic calciturbidites. It is overlain by ribbon radiolarites and by Kimmeridgian ophiolite-derived breccias, conglomerates and debris flows at the base of the overthrusted Migdhalitsa Ophiolite. The Hallstatt Limestones are sometimes blocks in the ribbon radiolarites of Oxfordian to Kimmeridgean age. Both the Jurassic development and the Triassic volcanism are different from the development in the Hallstatt Zone. Only the radiolarite in the Jurassic is comparable, but radiolarites of that age are widespread in the entire Tethys. Moreover, the radiolarites in the Hallstatt Zone end within the Oxfordian and are overlain by shallow-water Late Oxfordian and younger rocks. In Argolis, the radiolarite continues until the Kimmeridgean until the overthrust of the ophiolites. Independent from these differences in geologic evolution, CLIFT & ROBERTSON (1990) presented good evidences for the deposition of the Epidauros sequence in an intraplatform basin within a Mesozoic carbonate platform. This would exclude any continuation in the Hallstatt Zone that comprises the outer shelf and slope of the Meliata Ocean.

In the Othris Zone (Maliak Ocean sensu KOVÁCS, 1993), according to KOVÁCS desisive for the correlation with the Meliata Ocean, the geologic evolution published by ROBERTSON et al. (1991) could be confirmed by our investigations. This evolution is different from the evolution of the Meliata Ocean. According to these authors, Ladinian-Carnian shallow-water limestones are spatially associated with alkaline volcanics in the western Othris, unlike the ophiolite-ribbon radiolarite sequence of this age (up to Cordevolian) of the Meliaticum (KOZUR & RÉTI, 1986). In the eastern Othris, Late Permian to Anisian platform carbonates are overlain by Ladinian-Carnian quartzose siliciclastics, calciturbidites and carbonate breccias unlike any development of the Meliaticum. In other places of the Subpelagonicum, latest Scythian and Middle Triassic volcanism is also of andesitic composition, totally unknown in the Meliaticum, but typical for the South Tethyan oceanic branches from the Vardar Zone in the NE to Sicily in SW. As in the Pindos Ocean, also in the adjacent Subpelagonicum, widespreasd oceanic sea-floor spreading took place in the Middle Carnian-Norian time, whereas in the Meliaticum in that time and later no more volcanic activities can be observed. In the Othris area, basaltic lavas and pelagic sediments (red siliceous limestones, ribbon radiolarites with Middle Carnian to Norian radiolarians and conodonts) are overlain by thick calciturbidites of Early and Middle Jurassic age.

In structural higher position dismembered ophiolitic units which represent, according to ROBERTSON et al. (1991), Late Triassic-Early Jurassic (?) oceanic crust are present in the Othris area. According to ROBERTSON et al. (1991), oceanic crust was formed in the Othris area also in the Jurassic. Locally (Argolis), oceanic crust was formed until the time of their tectonic emplacement in the Kimmeridgean, well dated by radiolarians. Neither Late Triassic nor Jurassic ophiolites nor any basic volcanics are known from the Meliaticum. There, they are Middle Triassic in age. Also in other places of the Subpelagonicum dismembered ophiolitic sequences are present, in which the basalts have intercalations of Late Carnian to Norian pelagic sediments (*Halobia* limestones and radiolarites). The formation of oceanic crust began therefore in the Subpelagonicum in that moment, where it ended in the Meliata Ocean excluding the connection of the Meliata Ocean with that part of the South Tethys. All branches of the South Tethys, as the Vardar Ocean, Subpelagonicum (regarded by different authors as marginal part of the Pindos Ocean or as overthrusted parts of the Vardar Ocean) or the Pindos Ocean, have some similarities that exclude them as continuation of the Meliata Ocean. (1) Late Scythian to Middle Triassic andesitic volcanism is widely distributed, totally missing in the Meliaticum. (2) The oceanic rifting was very strong in the Late Triassic and Jurassic. The oceanic basins were partly formed in the Late Triassic, and partly they existed since the Paleozoic (Oman-Sicily Belt), but basic volcanism or oceanic sea-floor spreading also occurs in these areas during the Late Triassic (beginning with the Raibl event in the Middle Carnian), Jurassic or even in the Cretaceous. In the Meliaticum the oceanic sea-floor spreading and any basaltic volcanism ended at the base of the Middle Carnian. (3) Related to the Late Triassic break-up, shoulder uplift can be observed in many outer shelf areas of the South Tethys, where pelagic Late Olenekian to Cordevolian Hallstatt Limestones or other pelagic deposits are overlain by shallow-water carbonate platforms. In the Meliaticum, the opposite development can be observed. Crustal cooling related to the end of the sea-floor spreading at the base of the Middle Carnian caused subsidence on the outer shelves. Therefore, in many outer shelf sequences carbonate platform sediments are overlain by Hallstatt Limestones. (4) Final closing of the ocean cannot be observed near the Middle/Late Jurassic boundary, but it occurs by far later, mostly in the Tertiary. In the Meliaticum the final closing event was in the Early Oxfordian, like in the entire Cimmerian Ocean.

The development of the Meliaticum can be only found in the North Tethyan ocean (Paleo-Tethys sensu ŠENGÖR, 1984, Cimmerian Ocean sensu KOZUR, 1991 a, b). The final closing is near the Middle/Late Jurassic boundary during the Cimmerian orogeny. The Middle Jurassic (? and Early Oxfordian) is therefore, like in the Meliaticum, characterized by flysch development that ends in a coarsening-upwards sequence. In some areas earlier closing can be observed, if continental blocks within the ocean collided during the subduction with the continental margin of the ocean. Thus, the Karakaya branch closed already at the Triassic/Jurassic boundary. A continental block is known also within the Meliaticum (Gemericum s.str., KOZUR & MOCK, in press).

Oceanic crust in the Cimmerian Ocean of Turkey was formed, as in the Meliaticum, until the Cordevolian and no younger Late Triassic or Jurassic basaltic lavas or ophiolites are known (unfortunately, except the Karakaya Complex, the stratigraphic dating in the northern Tethys of Turkey is not yet well established). However, toward the east, the rifting began earlier. This could be expected, because the Cimmerian Ocean widened toward the east, whereas the Meliata Ocean is the northwestern embayment of the Cimmerian Ocean. In the Meliaticum of the Western Carpathians and Eastern Alps, the oceanic rifting began in the uppermost Early Anisian or in the Middle Anisian. Since this time basaltic lavas, ophiolites and pelagic rocks are known. In the Transylvanian nappes the first pelagic beds are known from the uppermost Scythian, pillow lavas are known since the basal Anisian. In the Kotel and Strandzha Zones most of the Early Triassic is pelagic and in the Karakaya Complex Late Dzhulfian and Early Changxingian pelagic limestones intercalated with pillow lavas are present (KOZUR & KAYA, 1994). The Late Permian oceanic spreading zone of the Cimmerian Ocean in NW Turkey continued as a continental rift until the Eastern Alps, indicated by thick Late Permian salinar rocks with few marine intercalation and partly with basaltic volcanism (KOZUR, 1991 a, b) after a long subaerial interval. In some areas of the Cimmerian Ocean (e.g. Kotel Zone in eastern Bulgaria), the pelagic Triassic is only known from blocks within Middle Jurassic flysch, like in the Meliaticum.

KOVÁCS (1993) recognized the above mentioned development of the Cimmerian Ocean. But because he ignored the fact that the Meliaticum is a Middle Jurassic accretionary complex and the oceanic Triassic is only present as blocks and olistoliths in Middle Jurassic flysch, he regarded the correlation of the Meliaticum and its slope with the Kotel and Strandzha Zones as an "absurdity". His arguments are the following: (1) The remnants of the Cimmerian Ocean in the east are separated by continental crust from the Transylvanian nappes, which he connected like KOZUR & MOCK (1987 a, 1988), KOZUR (1991 a, b) with the Meliaticum. (2) Sea-floor spreading continued in the Transylvanian nappes at least until the Kimmeridgian and this means "that when the Cimmerian Ocean was already in the stage of closure, spreading still continued in the Transylvanide domain" (KOVÁCS, 1993, p. 345). (3) The Middle Jurassic flysch of the Cimmerian Ocean is totally different from the Alpine Jurassic. On this topic he wrote: "Generally speaking, Alpine type Triassic occurs troughout the Tethyan system as far as China.... However, the Norian (-Dogger) flysch sedimentation [of the Strandzha and Kotel Zones] already totally deviates from the Alpine Triassic (and Jurassic)" (KOVÁCS, 1993, p. 345).

The remnants of the Meliata Ocean in the Western Carpathians and Eastern Alps are in their present position separated from all other oceanic belts of the Tethys by large areas of continental crust. These areas with continental crust came in their present position by nappe thrusting and horizontal block movements. Whereas KOVÁCS (1993) recognized this fact for the large continental block of Tisia between the Meliaticum and the Vardar Ocean (the "Maliak Ocean" of KOVÁCS is additionally separated by the continental Pelagonicum), he seemingly regarded the continental crust between the Cimmerian Ocean and the Transylvanides as an old feature. He indicated the presence of the Carpathian arc even in his Paleozoic paleogeographic reconstructions (KOVÁCS, in EBNER et al., 1991), despite the fact that the Carpathian arc is a young, largely Tertiary feature related to the subduction of the Outer Carpathians Ocean. Therefore it is easy to understand that he has difficulties to recognize that the continental crust between the Meliaticum and the Cimmerian Ocean is the result of basement nappes (well known from this area) and of lateral movement of the Moesia block. The present position of continental crust between the Meliaticum and all oceanic branches is no argument for exclusion of any of these connections. Therefore, we have never used the presence of a huge block of continental crust between the Meliaticum and the Vardar Zone as argument against that connection. Likewise, the presence of continental crust between the Cimmerian ocean and the Meliaticum cannot be used as an argument against the former connection of these ancient oceanic areas. Decisive is the comparison of the geologic evolution of the Meliaticum and of the compared oceans. This evolution is since the Middle Anisian identical in the Cimmerian Ocean and in the Meliaticum (with the same time of ending of the seafloor-spreading and the same time of the final closing), but basically different in the Vardar Zone and in the Pindos Ocean with its Subpelagonian margin (see above).

KOZUR & MOCK (1987 a, 1988), KOZUR (1991 a, b) regarded the Transylvanian domain as an oceanic triple point of the Cimmerian Ocean, one branch continued in the Pieniny Klippen Belt, the other branch in the Meliaticum. The Pieniny Klippen Belt was in Jurassic time involved in the rift system of the Penninicum that is connected with the opening of the Atlantic. For this reason, Jurassic rifting in parts of the Transylvanian nappes would be possible. That part of the Transylvanian domain that has Kimmeridgean pillow lavas (if really belonging to the Transylvanian domain !) surely was not connected with the Cimmerian Ocean; but likewise surely not connected with the Meliaticum that also closed in the Early Oxfordian. However, the Jurassic of the Transylvanian nappes is not well known and parts of the Transylvanian development are derived from Cretaceous Wildflysch of the Bucovinian Nappe. Dogger is only known from olistoliths. The view of KOVÁCS that "sedimentation continued throughout the Late Triassic and Early-Middle Jurassic, without siliciclastic input" (KOVÁCS, 1993, p. 345) is an attempt of KOVÁCS (1993) to find an argument against the connection with the Cimmerian Ocean, but not the reality. Bajocian sandy limestones and Bathonian calcareous sandstones are described from the Transylvanian nappes by SĂNDULESCU & BERCIA (1974). In any case, if no Middle Jurassic flysch would occur in all Transylvanian nappes and pillow lavas of Kimmeridgian age would be present in all Transylvanian nappes, then these nappes would neither be connected with the Cimmerian Ocean, nor with the Meliaticum. In this case, the Transylvanian nappes would be without meaning for the correlation of the Cimmerian Ocean with the Meliaticum.

KOVÁCS (1993) used the presence of Middle Jurassic flysch in the Kotel Zone as one of the three main arguments against the connection of the Meliaticum with the Cimmerian Ocean (and especially of the Kotel and Strandzha Zones, Strandzhidides sensu KOVÁCS, 1993). But in reality, it is the best evidence for this connection, because also the Meliaticum is characterized by Middle Jurassic flysch and final closing near the Dogger/Malm boundary. All the known Triassic is only present as blocks, olistoliths or in melanges of this Middle Jurassic flysch (like in the Kotel Zone), if it is not involved in salinar melanges at the base of higher nappe units.

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Explanation of plates

Plate 1

Early Callovian radiolarians from sample M 7 of locality E (Meliata type locality).

Fig. 1: *Archaeodictyomitra exigua* BLOME, x 500, rep.-no. 0546.
Fig. 2: *Archaeodictyomitra* sp., x 600, rep.-no. 0554.
Fig. 3: *Canoptum ? kamoensis* (MIZUTANI & KIDO), x 350, rep.-no. 0537.
Fig. 4: *"Stylocapsa oblongula"* KOCHER, x 500, rep.-no. 0535.
Fig. 5: *Eoxitus* sp. aff. *E. hungaricus* KOZUR, x 300, rep.-no. 0551.
Fig. 6: *Eucyrtidellum unumaense* (YAO), x 500, rep.-no. 0534.
Fig. 7: *Striatojaponocapsa conexa* (MATSUOKA), x 380, rep.-no. 0548.
Fig. 8: *"Stichocapsa" robusta* MATSUOKA, x 280, rep.-no. 0536.
Fig. 9: *Protunuma* cf. *turbo* MATSUOKA, x 400, rep.-no. 0557.
Fig. 10: *Semihsuum* cf. *brevicostatum* (OŽVOLDOVÁ), x 300, rep.-no. 0528.
Fig. 11: *Eucyrtidellum semifactum* NAGAI & MIZUTANI, x 550, rep.-no. 0526.
Fig. 12: *Williriedellum* sp. B, x 350, rep.-no. 0533.

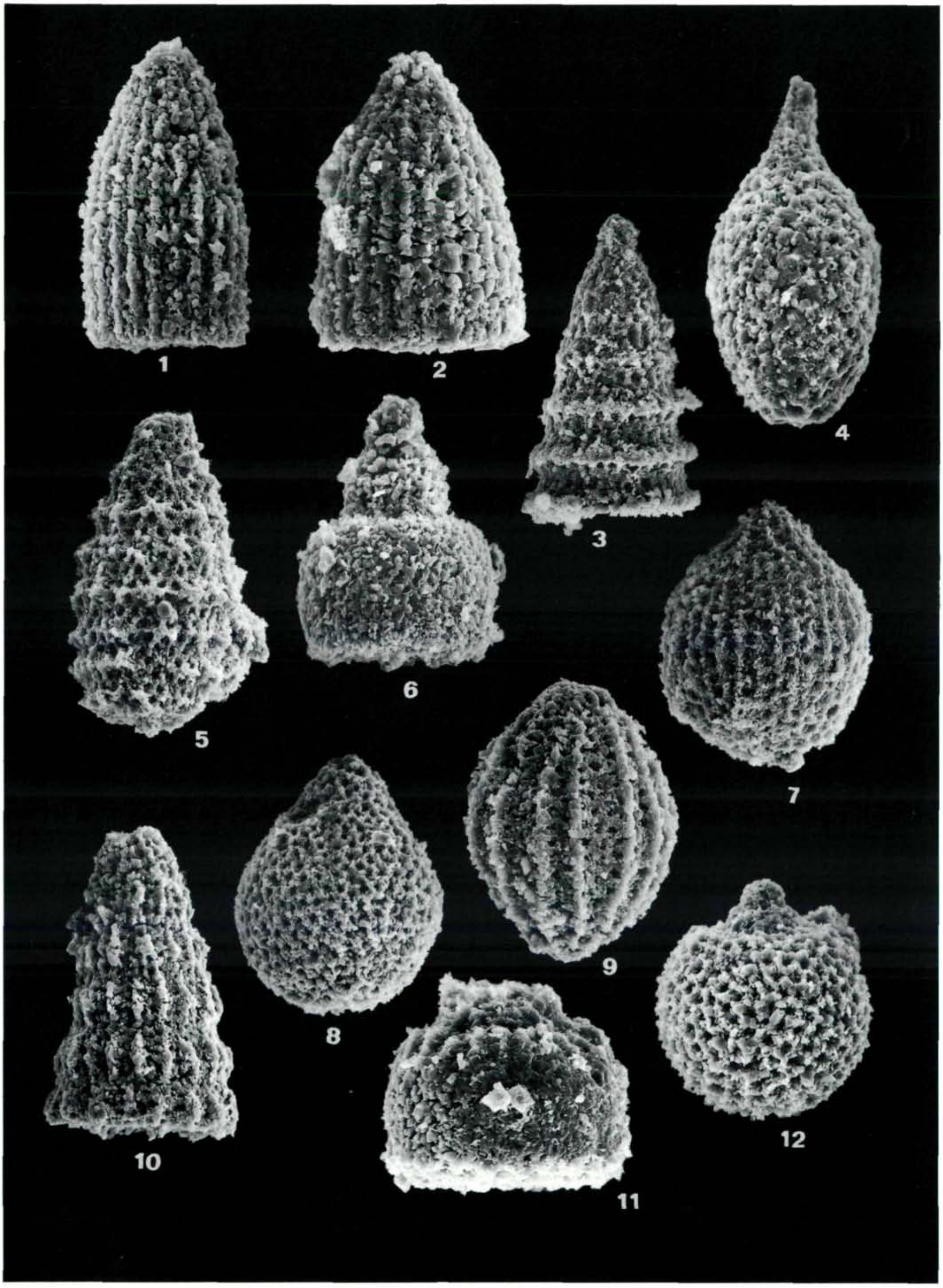
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Plate 2

Middle Jurassic radiolarians from distal turbidites of the Meliaticum in the type section (locality E, figs. 1–11, 14) and from locality B (figs. 12, 13).

Fig. 1: *Cinguloturris carpatica* DUMITRICĂ, x 280, rep.-no. 0183, sample M 103 B, Late Callovian.
Fig. 2: *Obesacapsula morroensis* PESSAGNO, x 175, rep.-no. 2805, sample M 3/3, Early Callovian.
Fig. 3: *Semihsuum brevicostatum* (OŽVOLDOVÁ), x 250, rep.-no. 2801, sample M 3/3, Early Callovian.
Fig. 4: *Semihsuum* sp., x 300, rep.-no. 2810, sample M 3/3, Early Callovian.
Fig. 5: Indeterminable proximal part of a multicyrtid Nassellaria, x 300, rep.-no. 2795, , sample M 3/3, Early Callovian.
Fig. 6: *Canoptum ? kamoensis* (MIZUTANI & KIDO), x 300, rep.-no. 2788, sample M 3/3, Early Callovian.
Fig. 7: *Striatojaponocapsa plicarum* (YAO), x 400, rep.-no. 3998, sample M 3, Early Callovian.
Fig. 8: *Pseudodictyomitrella hexagonata* (HEITZER), x 400, rep.-no. 4038, sample M 3, Early Callovian.
Fig. 9: *Praezhamoidellum* sp. aff. *yaoi* KOZUR, x 300, rep.-no. 4004, sample M 7 G, Early Callovian.
Fig. 10: *Williriedellum* sp. A MATSUOKA, 1983, x 400, rep.-no. 4006, sample M 7 G, Early Callovian.
Fig. 11: *Praezhamoidellum* sp., x 350, rep.-no. 1125, sample M 3, Early Callovian.
Fig. 12: *Striatojaponocapsa conexa* (MATSUOKA), x 300, rep.-no. 3671, sample M 13 N, Callovian.
Fig. 13: *Tetracapsa* sp., x 300, rep.-no. 3670, sample M 13 N, Callovian.
Fig. 14: *Williriedellum* sp. B, x 300, rep.-no. 4054, sample M 9 H2, Bathonian.

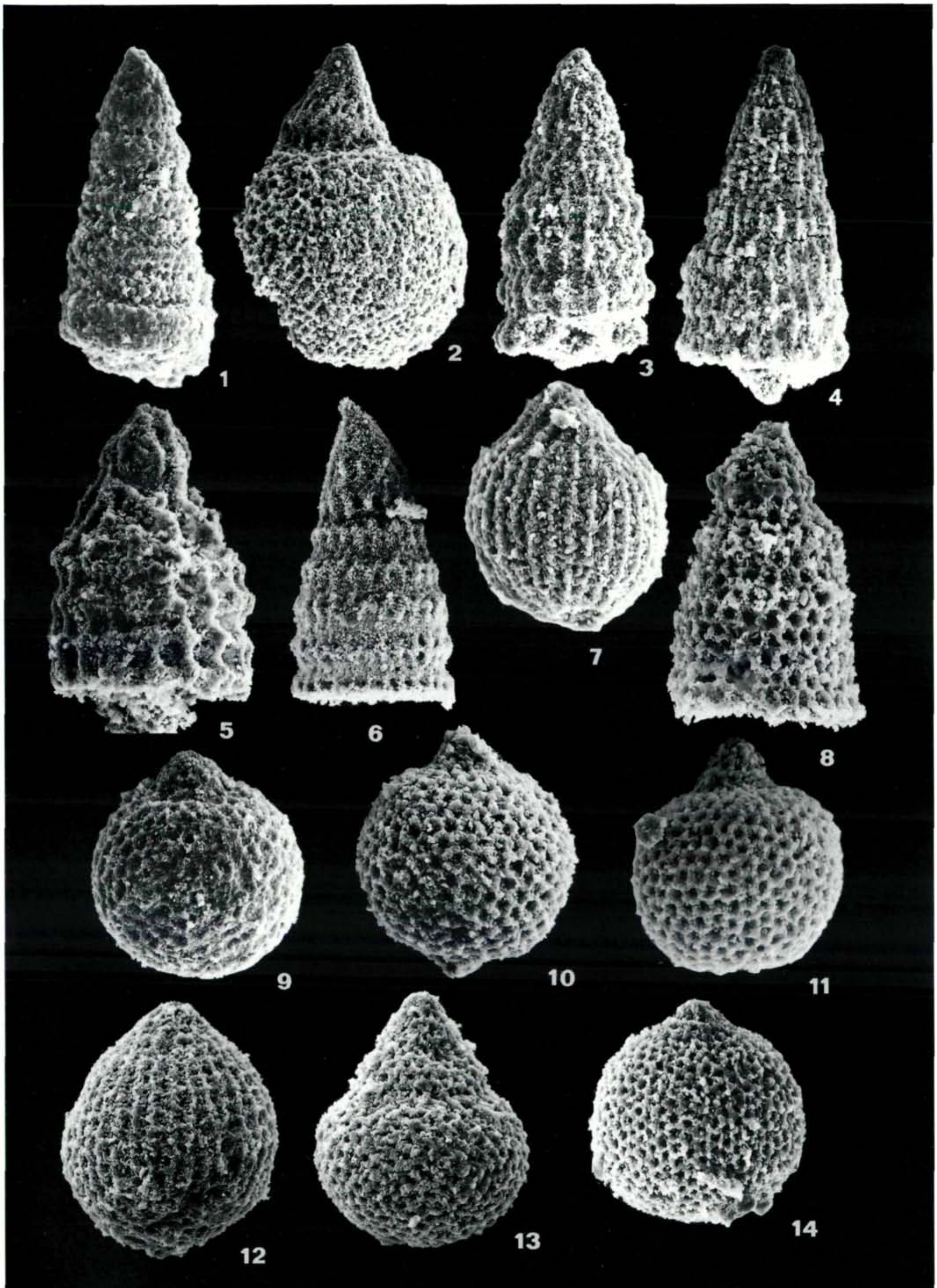
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Plate 3

Late Callovian radiolarians of sample M 103 B from the lower part of a 1.30 m thick radiolarite interalation at the top of the distal Callovian turbidites of the Meliata type locality (locality E).

Fig. 1: *"Stichocapsa" robusta* MATSUOKA, x 330, rep.-no. 0215.
Fig. 2: *Striatojaponocapsa conexa* (MATSUOKA), x 390, rep.-no. 0233.
Fig. 3. *Archaeospongoprunum imlayi* PESSAGNO, x 240, rep.-no. 0190.
Fig. 4: *Ristola altissima* (RÜST), x 175, rep.-no. 0186.
Fig. 5: *Diacanthocapsa cordis* (KOCHER), x 500, rep.-no. 0225.
Fig. 6: *Praewilliriedellum* cf. *cephalospinosum* KOZUR, x 300, rep.-no. 0215.
Fig. 7: *Archaeodictyomitra rigida* PESSAGNO, x 350, rep.-no. 0179.
Fig. 8: *Pseudodictyomitrella hexagonata* (HEITZER), x 400, rep.-no. 0180.
Fig. 9: *Semihsuum sourdoughense* PESSAGNO, BLOME & HULL, x 330, rep.-no. 0214.
Fig. 10: *Eucyrtidellum unumaense* (YAO), x 490, rep.-no. 0239.
Fig. 11: *"Stylocapsa oblongula"* KOCHER, x 500, rep.-no. 0240.
Fig. 12: *Praezhamoidellum* sp., x 330, rep.-no. 0215.
Fig. 13: *Eucyrtidellum* cf. *ptyctum* (RIEDEL & SANFILIPPO), x 420, rep.-no. 0185.
Fig. 14: *Quarticella* ? sp., x 410, rep.-no. 0185.

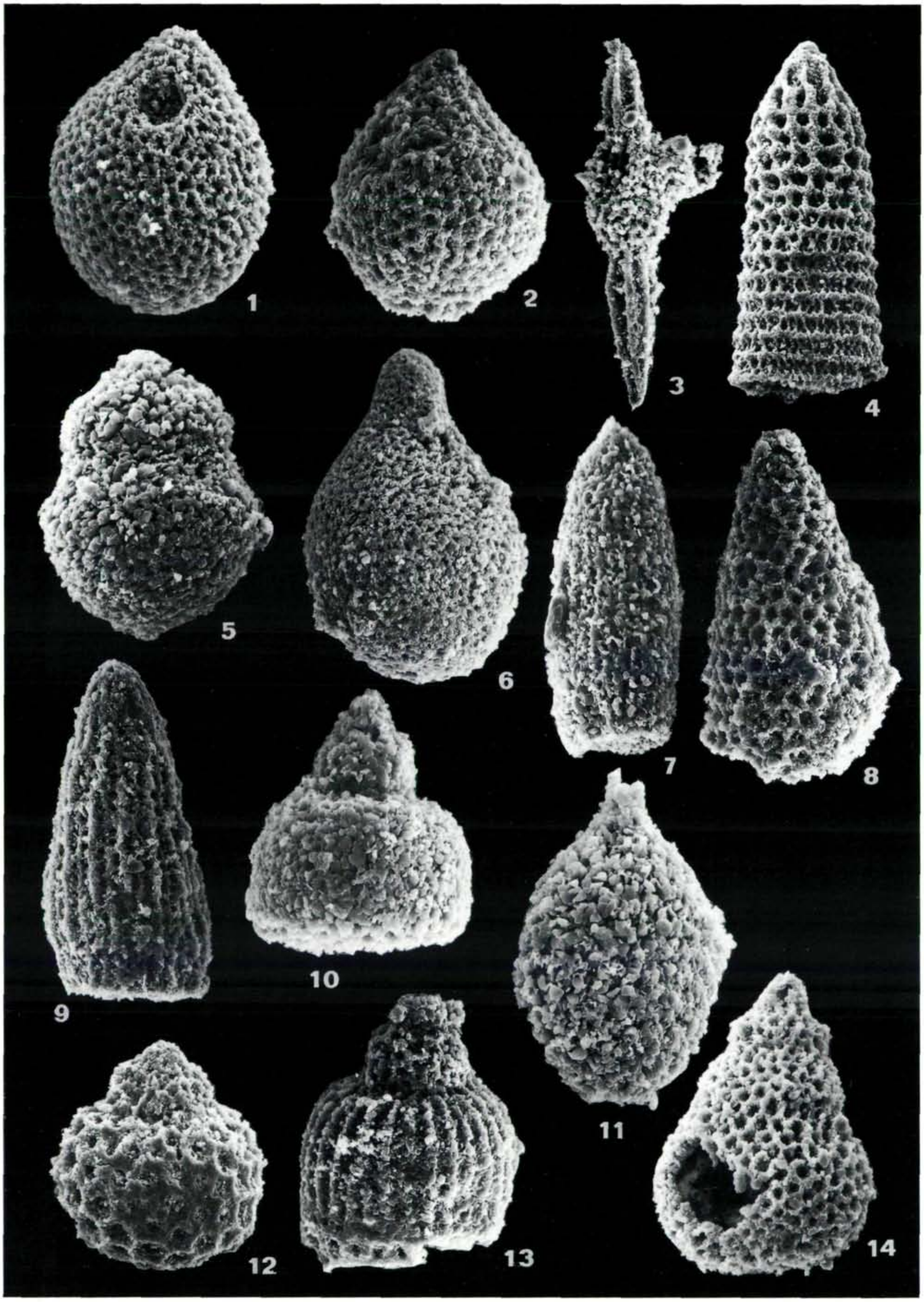
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Plate 4

Unless otherwise noted, Late Callovian radiolarians from thin, gray radiolarite in gray, partly graded, carbonate-free shaly-silty turbidites; sample G 6, locality Guba.

Fig. 1: *Acanthocircus variabilis* (SQUINABOL), x 300, rep-no. 2039.
Fig. 2: *Angulobracchia* sp., x 150, rep.-no. 2677.
Fig. 3: *Acanthocircus variabilis* (SQUINABOL), x 300, rep-no. 2684.
Figs. 4, 5: *Protunuma* ? sp. A, x 450, rep.-no. 2667; fig. 4: lateral view, fig. 5: oblique lateral-lower view.
Fig. 6: *Striatojaponocapsa plicarum* (YAO), x 400, x 400, rep.-no. 1972, sample H-22108, locality F (Hámor), Late Bajocian or Early Bathonian gray radiolarite (olistolith ?) in greenish-gray, carbonate-free, shaly-silty turbidites.
Fig. 7: *Eoxitus* ? *dhimenaensis* (BAUMGARTNER), x 390, rep.-no. 2661.
Fig. 8: *Archaeodictyomitra rigida* PESSAGNO, x 330, rep.-no. 2674.
Fig. 9: *Spongocapsula palmerae* PESSAGNO, x 290, rep.-no. 2688.
Fig. 10: *Semihsuum* ex gr. *maxwelli* (PESSAGNO), x 280, rep.-no. 2685.
Fig. 11: *Semihsuum maxwelli* (PESSAGNO), x 280, rep.-no. 2670.
Fig. 12: *Eoxitus* cf. *hungaricus* KOZUR, x 410, rep.-no. 2692.
Fig. 13: *Striatojaponocapsa conexa* (MATSUOKA), x 410, rep.-no. 2047.
Fig. 14: *Tetracapsa leiostraca* (FOREMAN), x 380, rep.-no. 2680.
Fig. 15: *Eucyrtidellum ptyctum* (RIEDEL & SANFILIPPO), x 400, rep.-no. 2041.

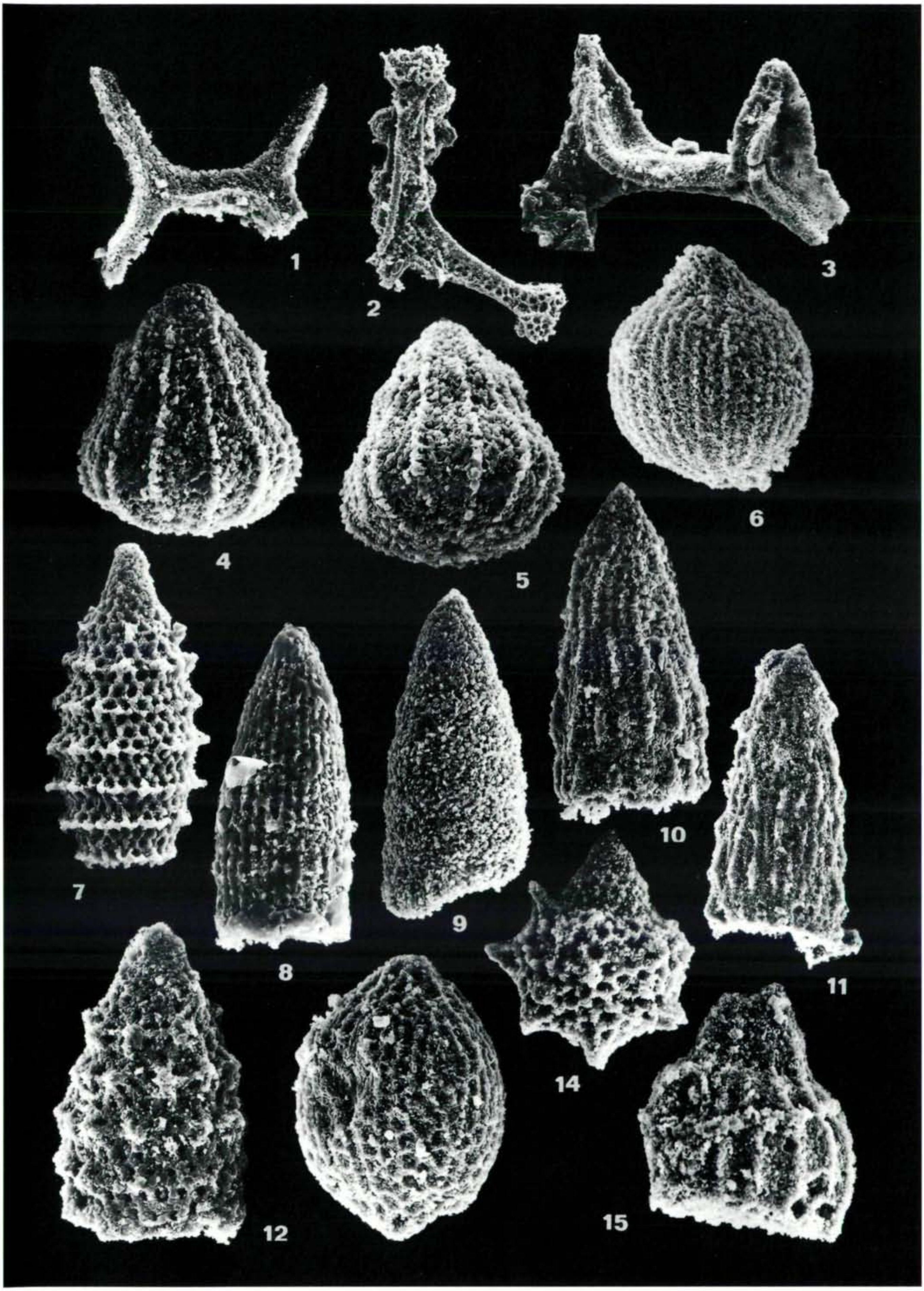
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Plate 5

Fig. 1: *Archicapsa* sp., x 320, rep.-no. 2699, sample G 6, locality A (Guba), Late Callovian thin, gray radiolarite in gray, partly graded, carbonate-free shaly-silty turbidites.

Fig. 2: *Protunuma* cf. *costata* (HEITZER), x 390, rep.-no. 2683, sample G 6 (see fig. 1).

Fig. 3: *Protunuma* ? sp. A, x 500, rep.-no. 2690, sample G 6 (see fig. 1).

Fig. 4: *Cinguloturris carpatica* DUMITRICĂ, x 410, rep.-no. 1954, sample H-22092, locality F (Hámor), Callovian variegated (greenish, gray and reddish) radiolarite within greenish-gray, carbonate-free, shaly-silty turbidites,

Fig. 5: *Unuma latusicostata* (AITA), x 400, rep.-no. 2691, sample G 6 (see fig. 1).

Fig. 6: *Protunuma ochiensis* MATSUOKA, x 400, rep.-no. 2659, sample G 6 (see fig. 1).

Fig. 7: *Praezhamoidellum convexus* (YAO), x 390, rep.-no. 2040, sample G 6 (see fig. 1).

Fig. 8: *Praezhamoidellum buekkense* KOZUR, x 520, rep.-no. 1971, sample H-22108, locality F (Hámor), Late Bajocian or Early Bathonian gray radiolarite (olistolith ?) in greenish-gray, carbonate-free, shaly-silty turbidites.

Fig. 9: *Praewilliriedellum* n. sp. (= *"Tricolocapsa"* sp. cf. *"T." parvipora* TAN sensu YAO, 1979), x 550, rep.-no. 1973, sample H-22108 (see fig. 8).

Fig. 10: *Praezhamoidellum* sp., x 460, rep.-no. 1965, sample H-22108 (see fig. 8).

Fig. 11: *Pseudodictyomitrella wallacheri* GRILL & KOZUR, x 580, rep.-no. 1963, sample H-22108 (see fig. 8).

Fig. 12: *"Stichocapsa"* sp. A, x 550, rep.-no. 1960, sample H-22108 (see fig. 8).

Fig. 13: „*Stichocapsa*“ sp. B, x 420, rep.-no. 1948, sample H-22109, locality F (Hámor), gray Middle Jurassic radiolarite in greenish-gray, carbonate-free, shaly-silty turbidites.

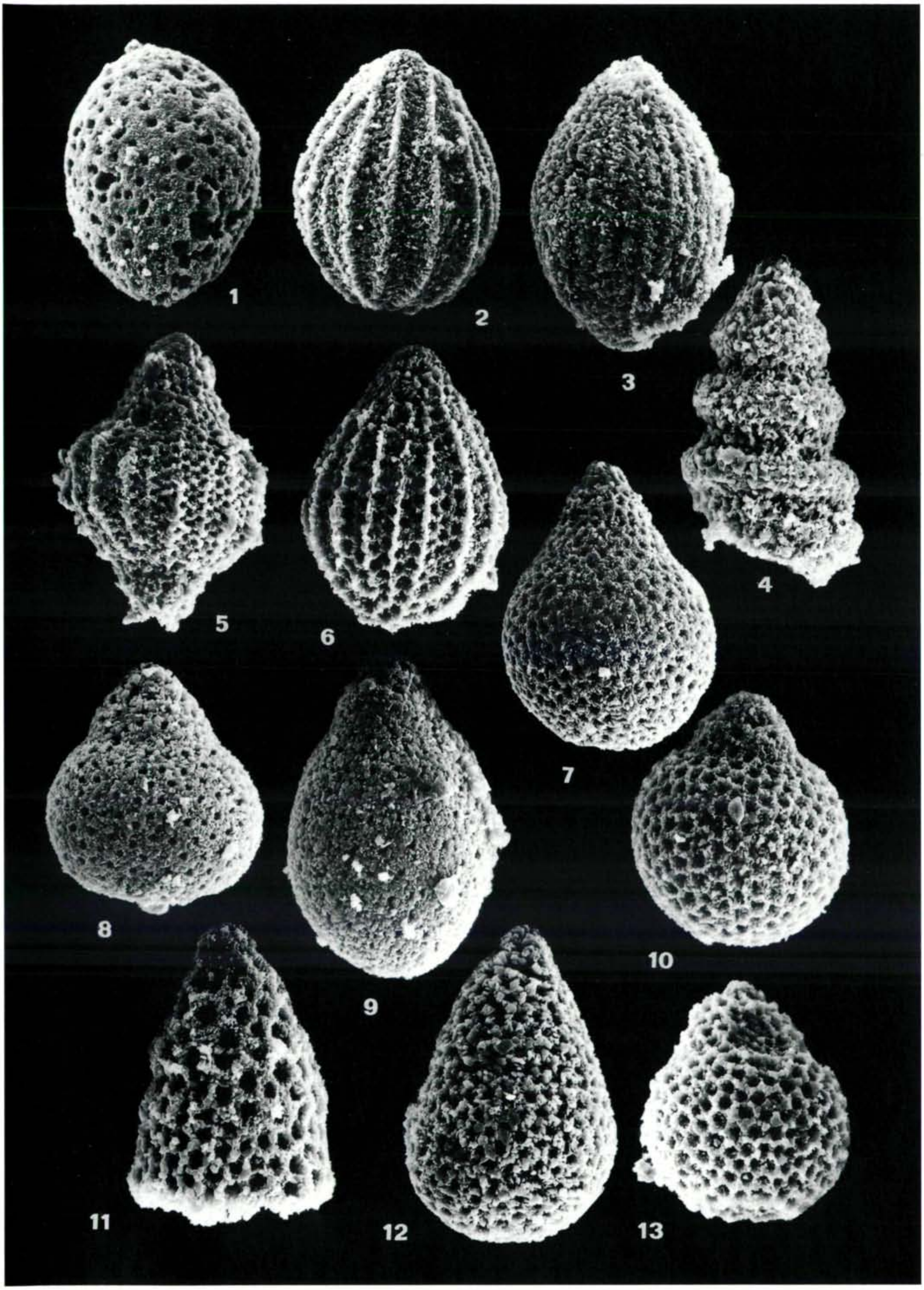
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Plate 6

Figs. 1, 2: *Lupherium* ? sp. (cf. Nassellaria in NAGAI & MIZUTANI, 1992, pl. 6, fig. 5), x 290, rep.-no. 0564; fig. 1: lateral view; fig. 2: oblique lower view. Sample M 13 N, Callovian gray thin-bedded radiolarite with reddish stripes within greenish-gray, carbonate-free shaly-silty turbidites, locality B.

Fig. 3: Very badly preserved *Striatojaponocapsa conexa* (MATSUOKA), x 423, rep.-no. 0565, sample M 13 N (see fig. 1).

Fig. 4: *Praezhamoidellum* cf. *yaoi* KOZUR, x 390, rep.-no. 0569, sample M 13 N (see fig. 1).

Fig. 5: *Eucyrtidellum unumaense* (YAO), x 488, rep.-no. 0570, sample M 13 N (see fig. 1).

Fig. 6: Very badly preserved *Tetracapsa* sp., probably *Tetracapsa tetragona* (MATSUOKA), x 325, rep.-no. 4705, sample M 2 D1, 2 cm thin gray radiolarites in greenish-gray, shaly-silty carbonate-free turbidites, locality C (Meliata village, behind house No. 72).

Fig. 7: *Podobursa* cf. *triacantha* (FISCHLI), x 125, sample Me 37, top of the uppermost radiolarite intercalation in the Jurassic turbidites at the boundary between the distal and proximal turbidites, Early Oxfordian, locality E (Meliata type locality); re-figured from KOZUR & MOCK (1985).

Fig. 8: *Urocyrtis* sp. (= "*Syringocapsa*" sp.), x 100, sample Me 37 (see fig. 7).

Fig. 9: *Pseudoeucyrtis* n. sp., x 170, sample Me 37 (see fig. 7).

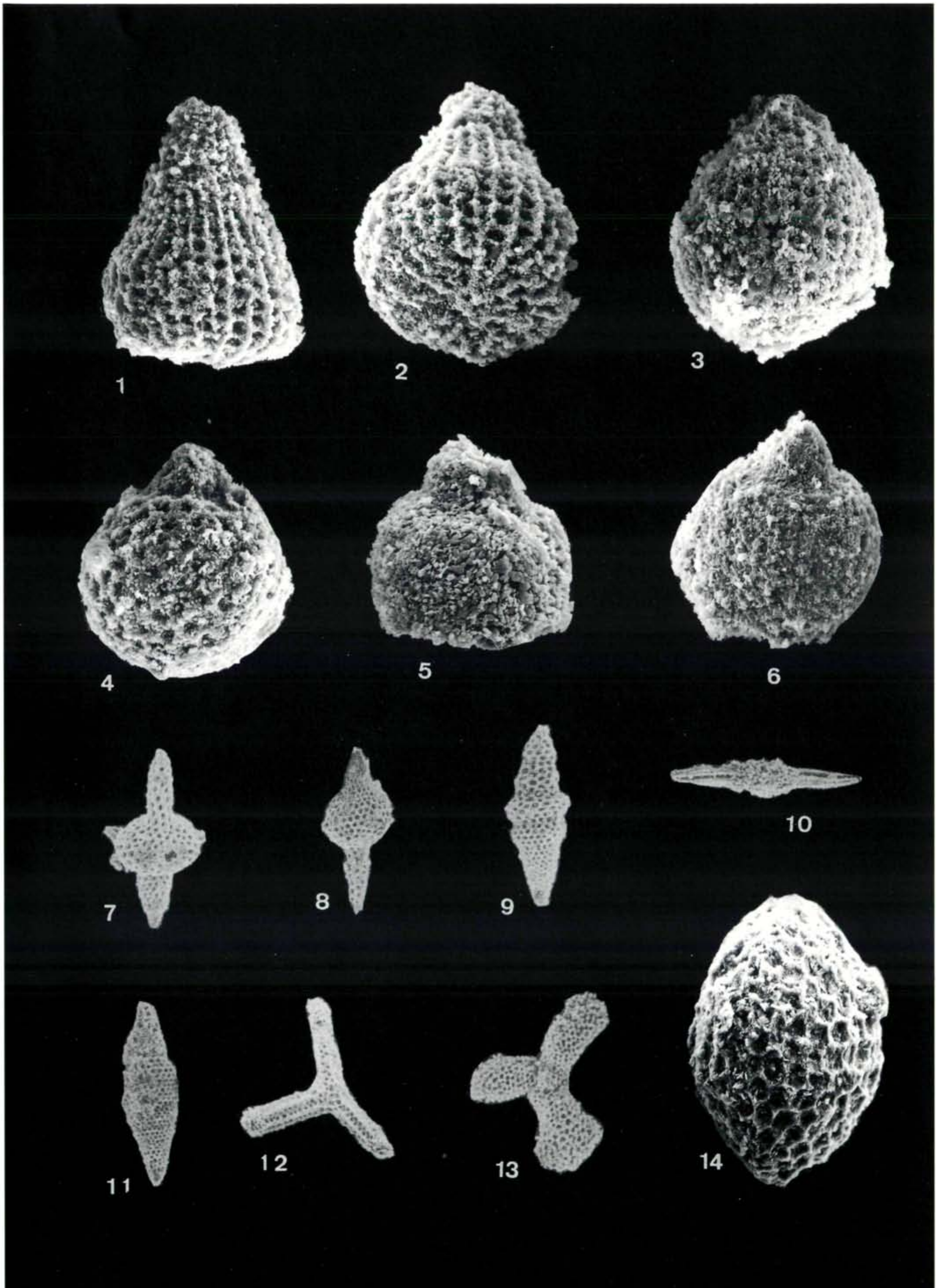
Fig. 10: *Archaeospongoprunum imlayi* PESSAGNO, x 130, sample Me 37 (see fig. 7).

Fig. 11: *Pseudoeucyrtis* sp. J CONTI & MARCUCCI, x 140, sample Me 37 (see fig. 7).

Fig. 12: *Tritrabs* sp. 1, x 140, sample Me 37 (see fig. 7).

Fig. 13: *Paronaella* sp. 1, x 150, sample Me 37 (see fig. 7).

Fig. 14: *Pentactinocarpus fusiformis* DUMITRICĂ, apical and antapical spine broken away, x 260, rep.-no. 2817, sample MTP-20/12, red Ladinian ribbon chert of locality E (Meliata type locality).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