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# Upper Jurassic Radiolaria from the Vocontian basin of SE France

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*Key words:* Radiolaria, Vocontian basin, France, Upper Jurassic

*Mots clés:* Radiolaires, Bassin Vocontien, France, Jurassique supérieur

## ABSTRACT

Two sections of the Vocontian basin (southeast France) were explored for their radiolarian content. Preservation in calcite impeded their extraction from the Châteauneuf d'Oze section, which is well dated by ammonites. Fortunately, oligospecific assemblages of pyritized radiolaria were yielded by twelve limestone beds of the Méouge section. In general, preservation worsens towards the top of the section. The extracted fauna is dominated by Nassellaria and more particularly by Archaeodictyomitridae, Pseudodictyomitridae and Williriedellidae. It is the first time that some species are reported outside their type area or from Western Tethys. Amongst the published zonations the scheme of Baumgartner et al. (1995a) is found to be the most useful and allows correlation of the studied part of the section with the mid-late Oxfordian to late Kimmeridgian-early Tithonian time interval.

## RESUME

Deux coupes du bassin Vocontien (Sud – Est de la France) ont été examinées pour leur contenu en radiolaires. Leur conservation en calcite dans la coupe de Châteauneuf d'Oze (bien datée par des Ammonites) n'a pas permis leur extraction. Par contre, des assemblages oligospécifiques de radiolaires pyritisés ont pu être extraits de douze niveaux calcaires de la coupe de Méouge. En général, la conservation des Radiolaires est moins bonne vers le haut de la coupe. La faune extraite est dominée par des Nassellaires et plus particulièrement des Archaeodictyomitridae, Pseudodictyomitridae et Williriedellidae. Quelques espèces sont signalées pour la première fois en dehors de leur région-type ou dans la Téthys occidentale. Parmi les biozonations publiées, celle de Baumgartner et al. (1995a) s'avère la plus utile et permet de dater la coupe étudiée avec la fourchette d'âge Oxfordien moyen-supérieur à Kimmeridgien supérieur-Tithonien inférieur.

## Introduction

In spite of the enormous progress made over the last thirty years on our knowledge of Mesozoic Radiolaria (see De Wever et al. 2001 and references therein) we are still far from unravelling the full biochronological potential of this plankton group. This is due to the large number of species that are still poorly known from a taxonomic and stratigraphic point of view and also to the small number of radiolarian-bearing samples, for which the age is calibrated independently of Radiolaria themselves. The latter point is also important when describing the dynamic of radiolarian macroevolutionary changes through time (Danelian & Johnson 2001).

The Vocontian Basin, situated in the south-eastern part of France (Fig. 1), represents a privileged area for multidisciplinary

stratigraphic studies because its pelagic sedimentary sequences are particularly thick and relatively complete (e.g. Jan du Chêne et al. 1993, 2000; Groupe Français d'étude du Jurassique 1997).

Radiolaria were known to be present in the Vocontian Basin (Beaudoin 1977), but observations were based on thin section. Recent reports by Lambert (1999) and Gardin et al. (2000) on Lower Cretaceous (Valanginian-Hauterivian) pyritized Radiolaria constitute the only modern study for the Vocontian basin. We present here radiolarian assemblages extracted from Upper Jurassic strata of the Vocontian Basin and discuss their biostratigraphic implications.

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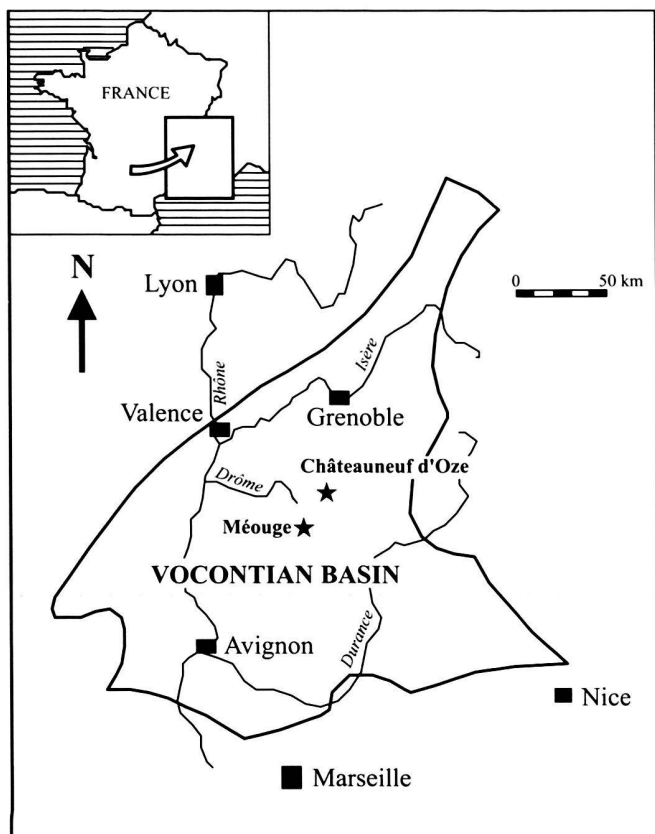


Fig. 1. Outcrops of the Vocontian basin in SE France and location of the two studied sections: Châteauneuf d'Oze and Méouge.

### Palaeogeographic and stratigraphic framework

The tectonic evolution of the Vocontian Basin is directly linked to the opening of the Ligurian branch of Tethys and the formation of its European margin (Dercourt et al. 1993). Sedimentary variations reflect the different stages of the opening of Tethys in this area. Break up of the Hercynian basement beginning in the Triassic led to the formation of a number of basins (Languedocian, Dauphinois, Provençal and Vocontian), well defined by the presence of submarine ridges (Dubois & Delfaud 1989). The basins were more clearly separated during the Early and Middle Jurassic tectonic subsidence, which was followed by a thermal subsidence during the Late Jurassic and Early Cretaceous. From the middle Oxfordian a generalized subsidence affected the Vocontian passive margin and allowed the development of highly homogeneous sedimentary facies both within the basin and on its edges (Dubois & Delfaud 1989). At this time, marine sedimentary environments reached their maximal extension.

The interest of the Upper Jurassic sequences of the Vocontian Basin lies with the high quality of its outcrops. Pederneiras

(1995) established a composite type mega-sequence for its Upper Jurassic sedimentary sequences and highlighted the presence of a number of different lithostratigraphic patterns. These are easily identifiable and correlatable throughout the basin with the bio-chronostratigraphic framework established by Atrops (1982) on the basis of ammonites found in various sections (Fig. 2A). Following an interval dominated by Oxfordian marls, Kimmeridgian sedimentary facies are essentially made of alternating limestones and marls, that become clearly calcareous in the Tithonian (Atrops 1982; Pederneiras 1995; De Rafélis 2000).

### Studied material

Two sections of the Vocontian basin are investigated for Radiolaria (Fig. 1). Châteauneuf d'Oze represents one of the reference sections for the Oxfordian – Kimmeridgian boundary interval of the subalpine regions because of its richness in ammonites and quality of outcrops (Atrops 1982; De Rafélis et al. 2001). It is situated a few kilometres to the South-East of Veynes on the left bank of Drouzet, along the Departmental road D20 between Veynes and Châteauneuf d'Oze (44°31'N-5°53'E). Situated on the northern side of the Serres Jurassic high, it represents an area of average sedimentation rates (Moussine-Pouchkine et al. 1998). The section is about 100 metres thick and consists of a regular alternation of marls and limestones interrupted by a 3 metre thick slump. Limestones are fairly homogeneous and consist of slightly bioturbated and organic matter-rich pelagic facies, often rich in ammonites.

The Méouge section is situated along the departmental road D 942 (44°12'N-5°33'E), about twenty kilometers to the south-southwest of Châteauneuf d'Oze. Situated at the southern flank of the Serres Jurassic high, it also represents a depositional environment of average sedimentation rates. The outcrop is about one hundred metres thick and starts close to the point where the road dips downhill beside the river Méouge. Although still poorly studied, the Méouge section has the advantage of being almost continuous and unaffected by the gravitational event present at Châteauneuf d'Oze (De Rafélis 2000). It is entirely composed of alternating marls and limestones organised in pluridecimeteric beds with an easily workable stratigraphy (Fig. 2B). As at Châteauneuf d'Oze, pelagic limestones at Méouge are very homogeneous (micritic). It is only towards the top of the sequence (bed 181 onwards, Fig. 2B) that they display some different facies (nodular limestones, calcarenites with bioclasts or finely laminated calcarenites). Macro- and microfossils are rare. The presence of *Globochaetes*, *Saccocoma*, *Tubiphytes* and a few foraminifera are reported (De Rafélis 2000; Langoisseux 2001). The few ammonites discovered do not provide any precise biostratigraphic information (Atrops, pers. comm.). However, the presence of lithostratigraphic units displaying distinct stratigraphic patterns, recognizable throughout the Vocontian basin, are present in the Méouge section and provide some clues as to the age of this section (Pederneiras 1995; Moussine-Pouchkine et

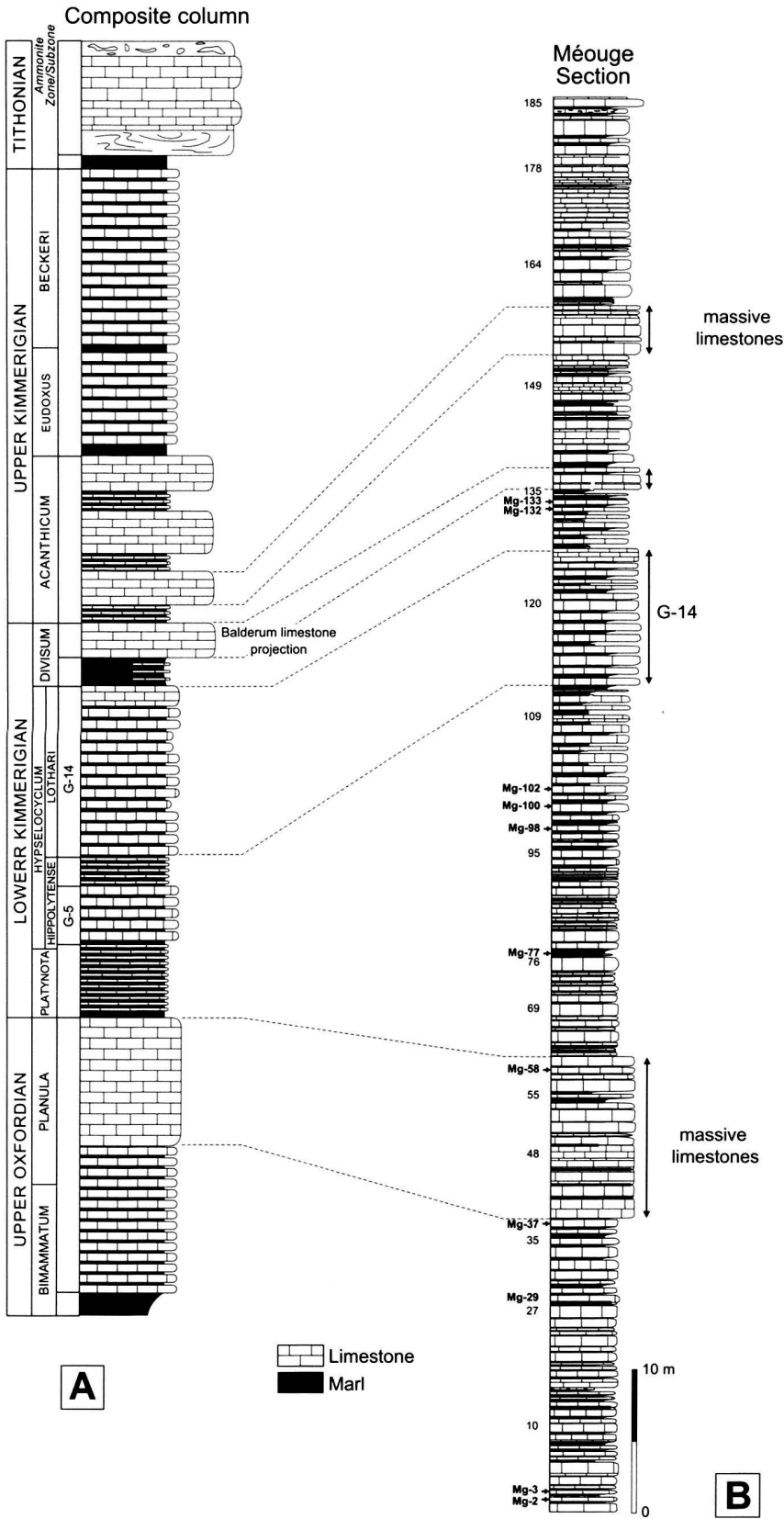


Fig. 2. A) Composite lithostratigraphic column of the Upper Jurassic megasequence of the Vocontian basin, between the "Terres noires" formation at the bottom and the massive Tithonian limestones at the top (modified after Pederneiras 1995). B) Detailed lithostratigraphic column of the Méouge section, including bed numbers and tentative lithostratigraphic correlations with the Upper Jurassic megasequence (after De Rafélis 2000). Arrows indicate limestone beds that yielded radiolaria.

Table 1. Occurrence of radiolarian taxa identified in samples of the Méouge section.

Species/Samples	Mg 2	Mg 3	Mg 21	Mg 29	Mg 37	Mg 58	Mg 77	Mg 98/99	Mg 100	Mg 102	Mg 132	Mg 133
<i>Acastea</i> sp.cf. <i>A. remusa</i> HULL									■			
<i>Archaeodictyomitra apiarium</i> (RÜST)	■											
<i>Archaeodictyomitra etrusca</i> CHIARI et al.				■								cf.
<i>Archaeodictyomitra patricki</i> KOCHER	■			■								
<i>Archaeodictyomitra</i> sp.aff. <i>A. patricki</i> KOCHER	■											
<i>Archaeodictyomitra shengi</i> YANG				■			■					
<i>Archaeodictyomitra spelae</i> CHIARI et al.							■					
<i>Archaeodictyomitra</i> sp.A	■											
<i>Cinguloturris fusiforma</i> HORI							cf.		■			
<i>Emiluvia pentaporata</i> STEIGER & STEIGER									■			
<i>Eucyrtidellum ptyctum</i> (RIEDEL & SANFILIPPO)	■						■					
<i>Gongylothorax favosus</i> DUMITRICA	■	■		■	■			■	■	■		
<i>Loopus doliolum</i> DUMITRICA				■	■							
<i>Loopus venustus</i> (CHIARI et al.)	■			■	■				cf.	■		■
<i>Pantanellium oligoporum</i> (VINASSA)									■			
<i>Praeconocaryomma scaterba</i> HULL			■									
<i>Protunuma japonicus</i> MATSUKA & YAO	■				■		■		■			
<i>Ristola altissima</i> ssp.cf. <i>R. a. altissima</i> (RÜST)					■							
<i>Saitoum pagei</i> PESSAGNO			■									
<i>Spongocapsula palmerae</i> (PESSAGNO)			■									
<i>Stichocapsa tuscanica</i> CHIARI et al.							■					
<i>Suna</i> sp.							■					
<i>Tethysetta</i> (?) sp.							■					
<i>Triactoma foremanae</i> MUZAVOR							■					
<i>Tripocyelia</i> sp.cf. <i>T. luciae</i> JUD									■			
<i>Tritrabs</i> sp.cf. <i>T. exotica</i> (PESSAGNO)					■							
<i>Williriedellum carpathicum</i> DUMITRICA			■				■					
<i>Williriedellum crystallinum</i> DUMITRICA		■	■		■							
<i>Zhamoidellum ovum</i> DUMITRICA	■	■	■	■	■	■	■	■	■	■	■	■

al. 1998; De Rafélis et al. 1997). Above the “Terres Noires” Formation one can thus recognize from bottom to top (1) an interval of massive limestones (beds 38 to 61) commonly present within the *Planula* Ammonite zone, (2) a bundle of limestone beds known as «the group of 14 (G-14)» (beds 113 to 128), commonly present within the *Lothari* Ammonite sub-zone, (3) a limestone projection (beds 136 to 140), which is tentatively correlated with the one occurring within the

*Balderum* horizon (*Divisum* Ammonite zone), and finally (4) a bundle of massive limestones (beds 153 to 162) which could possibly represent the ones occurring at the base of the Kimmeridgian (*Acanthicum* Ammonite zone). In summary, although no direct biostratigraphic age assignment existed for the Méouge section prior to our study, it could be tentatively considered as covering the upper Oxfordian to upper Kimmeridgian interval.

## Radiolarian fauna and age

Samples were first processed with hydrochloric acid, which was followed by a brief (30 min.) bath in diluted hydrofluoric acid (HF 5%). Sample size was in the order of several tens of cm<sup>3</sup>.

Although present in abundance in the limestones of Châteauneuf d'Oze section, Radiolaria are entirely calcified and no identifiable forms were extracted. However, twelve limestone and marly limestone samples from Méouge section yielded pyritized identifiable Radiolaria, which display different degrees of preservation and abundance. The occurrence of all radiolarian taxa identified in samples of Méouge section are given on Table 1. The identified fauna is oligospecific, with a dominance of Nassellaria over Spumellaria. Samples Mg-2, Mg-21, Mg-77 and Mg-102 yielded the best preserved assemblages, displaying a diversity of about a dozen species. Amongst Nassellaria, representatives of families Archaeodictyomitradae, Pseudodictyomitradae and Williriedellidae are the most abundant. In general, preservation worsens towards the top of the section, only four taxa being identified in samples Mg-132 and Mg-133.

Amongst the published radiolarian zonation schemes the scheme of Baumgartner et al. (1995a) was found to be the most useful. The co-occurrence of species *Zhamoidellum ovum* and *Gongylothorax favosus* in samples Mg-2 and Mg-100 (table 1) allows their assignment to Unitary Association Zones (UAZ) 9–10, which are correlated with the middle Oxfordian to early Kimmeridgian. This is inferred from the first occurrence (FO) of *Zhamoidellum ovum* and the last occurrence (LO) of *Gongylothorax favosus*. However, following the discovery of an exceptionally well-preserved radiolarian fauna in the Mariana trench (Matsuoka 1998), we now know that *G. favosus* existed until Berriasian time, at least in the Palaeopacific. Consequently, the age of the Méouge section can be only correlated with the mid-late Oxfordian to late Kimmeridgian-early Tithonian, based on the single occurrence of *Z. ovum* (UAZ 9–11) throughout the quasi-totality of the radiolarian-bearing samples. On the other hand, *Emiluvia pentaporata* (= *E. bisellea*) is considered in the biozonation of Baumgartner et al. (1995a) as constrained to UAZ 11. However, it is found to occur in middle Oxfordian to lower Kimmeridgian (UAZ 9–10) samples of the Ionian zone (Danelian 1995) and in Oxfordian strata of Roumania (Dumitrica, pers. commun.).

## Conclusion

Radiolaria occur abundantly in the ammonite-rich Châteauneuf d'Oze section, but their preservation in calcite did not allow extraction of any identifiable microfauna. On the contrary, an oligospecific and moderately diverse pyritized Radiolarian fauna was extracted from the Méouge section. Although the biochronologic resolution of Radiolaria does not allow a precise age assignment (mid-late Oxfordian to late Kimmeridgian-early Tithonian), it is currently the only biostratigraphic

evidence for the Méouge section. Some species are found for the first time outside their type area (i.e. *Loopus venustus*) or outside the Palaeopacific (*Cinguloturris fusiforma*). Much work is still left to be done in order to refine the biochronological potential of Upper Jurassic radiolaria.

## Systematic Palaeontology

Species and genera are discussed in alphabetical order. The suprageneric classification followed in this work is after De Wever et al. 2001 and is not repeated here. The synonymy lists contains, only a few representative studies.

### Genus *Acastea* YANG 1993

Type species: *Acaeniotyle diaphorogona* FOREMAN 1973

*Acastea* sp.cf. *A. remusa* HULL

(Pl. 1, Fig. 1)

cf. *Acastea remusa* n.sp. HULL 1997, p. 35, pl. 11, figs. 2, 6, 17.

*Remarks.* – The illustrated morphotype recalls *A. remusa* by its blunt spinal tips and presence of deep distally tapering longitudinal grooves running on the ridges of its massive spines.

### Genus *Archaeodictyomitra* PESSAGNO 1976

Type species: *Archaeodictyomitra squinaboli* PESSAGNO 1976

*Archaeodictyomitra etrusca* CHIARI, CORTESE & MARCUCCI

(Pl. 1, fig. 4)

*Archaeodictyomitra etrusca* n.sp. CHIARI, CORTESE & MARCUCCI in Chiari et al. 1997, p. 63, pl. 1, fig. 9–10.

*Remarks.* – This species can be distinguished from *A. suzuki* AITA by the presence of more numerous costae (13–14 costae visible per half perimeter).

*Archaeodictyomitra patricki* KOCHER

(Pl. 1, Fig. 5–7)

*Archaeodictyomitra patricki* n.sp. KOCHER 1981, p. 57, pl. 12, fig. 14–17.

*Archaeodictyomitra* sp.cf. *A. patricki* KOCHER; Chiari et al. 1997, pl. 1 fig. 16.

*Remarks.* – This small four-segment species is characterized by its conical proximal part becoming an inverted trapezoid distally. Faint traces of segmental divisions are often visible on the outline. 10–12 longitudinal costae visible per half perimeter run up to the chephalis.

*Archaeodictyomitra* sp.aff. *A. patricki* Kocher

(Pl. 1, Fig. 8)

aff. *Archaeodictyomitra patricki* KOCHER 1981, p. 57, pl. 12, fig. 14–17.

cf. *Archaeodictyomitra* sp.aff. *A. squinaboli* PESSAGNO, CHIARI et al. 1997, pl. 1, fig. 17.

*Remarks.* – This morphotype differs from *A. patricki* by its more elongated outline and lesser number of costae (about 10 visible per half perimeter).

*Archaeodictyomitra shengi* YANG

(Pl. 1, Fig. 9–10)

*Archaeodictyomitra shengi* n.sp. YANG 1993, p.64, pl. 1.

*Archaeodictyomitra labronica* n.sp. CHIARI, CORTESE & MARCUCCI in Chiari et al. 1997, p. 64, pl. 1, fig. 11–12.

Not *Archaeodictyomitra shengi* YANG, Hori 1999, fig. 7–13 (= *A. spelae* Chiari et al. 1997).

**Remarks.** – We do agree with Hori (1999) in considering *A. labronica* as a junior synonym of *A. shengi* YANG 1993 because it is practically impossible to differentiate these elongated, subconical to subcylindrical morphotypes with smooth outline. However, the specimen illustrated by Hori seems to us to be related to *A. spelae* because the last three segments are well individualised on the outline. The known age range of this species is Oxfordian to Tithonian.

*Archaeodictyomitra* sp. A

(Pl. 1, Fig. 12)

**Remarks.** – Small (total length : 110 µm) conical form bearing 11 costae visible per half perimeter. It differs from *A. patricki* by its smaller size and absence of an inverted trapezoidal distal part.

**Genus *Cinguloturris* DUMITRICA in Dumitrica & Mello 1982**

Type-species: *Cinguloturris carpatica* DUMITRICA in Dumitrica & Mello 1982

*Cinguloturris fusiforma* HORI

(Pl. 1, Fig. 13)

*Cinguloturris fusiforma* n.sp. HORI 1999, p. 93, fig. 9.3–9.6, 11.6.

**Remarks.** – Only two specimens of *Cinguloturris* were found in our material. One of them is incomplete and is questionably assigned to *C. fusiforma*. (pl. 1, fig. 14). This species was previously known only from the Palaeopacific (Japan and Far East Russia). *C. fusiforma* is likely to represent an offshoot lineage of *C. carpatica* from which it differs by its spindle-shaped contour.

**Genus *Emiluvia* FOREMAN 1973**

Type-species: *Emiluvia chica* FOREMAN 1973

*Emiluvia pentaporata* STEIGER & STEIGER

(Pl. 1, Fig. 15)

*Emiluvia pentaporata* n.sp. STEIGER & STEIGER 1994, p. 458, pl. 1, fig. 9–10

*Emiluvia bisellea* n.sp. DANELIAN in Baumgartner et al. 1995b, p. 196, pl. 4018, fig. 1–4.

**Genus *Eucyrtidiellum* BAUMGARTNER 1984**

Type-species: *Eucyrtidium* (?) *unumaensis* YAO 1979

*Eucyrtidiellum ptyctum* (RIEDEL et SANFILIPPO)

(Pl. 1, Fig. 16–17)

*Eucyrtidium ptyctum* n.sp.; Riedel & Sanfilippo 1974, p. 778, pl. 5, fig. 7, pl. 12, fig. 14; not fig. 15.

*Eucyrtidiellum ptyctum* (RIEDEL & SANFILIPPO); Baumgartner et al. 1995b, p. 214, pl. 3017, fig. 1–8; Hull 1997, p. 82, pl. 48, fig. 10.

**Remarks.** – Two distinct morphotypes were observed in our material. Morphotype A (fig. 16) displays a trapezoidal abdomen, bearing 7 prominent costae visible per half-circumference. Morphotype B (fig. 17) displays a much more rounded abdomen, bearing c. 12 faintly developed costae visible per half-circumference. In that respect it resembles *E. bortolotii* which nevertheless displays a more trapezoidal abdomen.

**Genus *Loopus* YANG 1993 sensu Hull (1997) and Dumitrica et al. (1997)**

Type-species: *Pseudodictyomitra primitiva* MATSUOKA & YAO 1985

*Loopus doliolum* DUMITRICA

(Pl. 1, Fig. 19–20)

*Dictyomitra* sp. C, YAO 1984, pl. 3, fig. 4.

*Pseudodictyomitra* sp. C sensu Yao, Gorican 1994, p. 84, pl. 22, fig. 15, ? fig. 14.

« *Dictyomitra* sp. C » in Yao, Danelian et al. 1996, fig. 4d–e.

*Loopus doliolum* n.sp.; DUMITRICA in Dumitrica et al. 1997, p. 30, pl. 5, fig. 3, 5, 14

**Remarks.** – Morphotypes that are not clearly constricted at their distal part are included under this species. They are all characterized by a single row of pores and faint costae interrupted by well-marked broad stictures. Its known age range is Oxfordian (Gorican 1994) to Berriasian (Dumitrica et al. 1997).

*Loopus venustus* (CHIARI, CORTESE & MARCUCCI)

(Pl. 1, Fig. 21–23)

*Cinguloturris* (?) *venusta* n.sp. CHIARI, CORTESE & MARCUCCI in Chiari et al. 1997, p. 66, pl. 2, fig. 4–5.

**Remarks.** – This species is characterized by segments displaying a single row of open pores situated in their middle part. Thin costae are placed above and below each pore in such a way that an upper and a lower row of depressions or relict pores are formed on each postabdominal segment. Costae do not loop around the pores. *L. venustus* is closely related to *L. primitivus* and might be its ancestor.

**Genus *Pantanellium* PESSAGNO 1977**

Type-species: *Pantanellium riedeli* PESSAGNO 1977

*Pantanellium oligoporum* (VINASSA)

(Pl. 2, Fig. 1)

*Ellipsoxiphus oligoporus* n.sp. VINASSA 1899, p. 228, pl. 17, fig. 44.

*Sphaerostylus oligoporus* (VINASSA); Sanfilippo & Riedel 1985, p. 590, fig. 4.5; Matsuoka 1992, pl. 3, fig. 4.

*Pantanellium oligoporum* (VINASSA); Chiari et al. 1997, pl. 3, fig. 8.

**Genus *Tethysetta* DUMITRICA in Dumitrica et al. 1997**

Type-species: *Tethysetta pygmaea* DUMITRICA et al. 1997

*Tethysetta* (?) sp.

(Pl. 2, Fig. 10)

**Remarks.** – A single specimen found in our material recalls

*T. dhimenaensis* with its fusiform outline and the presence of spinose ridges on intersegmental divisions. Uncertainties are due to the presence of 4 rows of pores per segment displayed clearly on the distal part of the shell.

### Genus *Tripocyelia* HAECKEL 1881

Type-species: *Tripocyelia trigonum* RÜST 1885

*Remarks.* – The amended definition of Pessagno et al. (1989, p. 205) is followed in the present study. *Tripocyelia* bears a cortical shell of subcircular to elliptical outline and possesses cortical buttresses. It thus differs from *Triactoma* which bears a nearly spherical cortical shell and lacks cortical buttresses. In agreement with Hull (1997) the three secondary spines of species assigned to *Tripocyelia* “may be symmetrically or asymmetrically arranged”. This leads us to consider *Neotripocyelia* Pessagno & Yang in Pessagno et al. (1989) as a junior synonym of *Tripocyelia*.

*Tripocyelia* sp.cf. *T.luciae* JUD

(Pl. 2, Fig. 12)

cf. *Triactoma luciae* n.sp. JUD 1994, p. 115, pl. 23, fig. 8–9.

*Triactoma* sp.cf. *T.luciae* JUD; Chiari et al. 1997, pl. 5, fig. 7.

*Triactoma jonesi* (PESSAGNO); Beccaro et al. 2002, pl. 4, fig. 6.

*Remarks.* – The single specimen found in our material resembles *T. luciae* based on the rounded triangular outline of its cortical shell and the crown-shaped spinal tips. However, it differs in the presence of deep longitudinal grooves running on the main ridges of its spines, which are thus six-fold in section, rather than tri-fold as in *T. luciae*.

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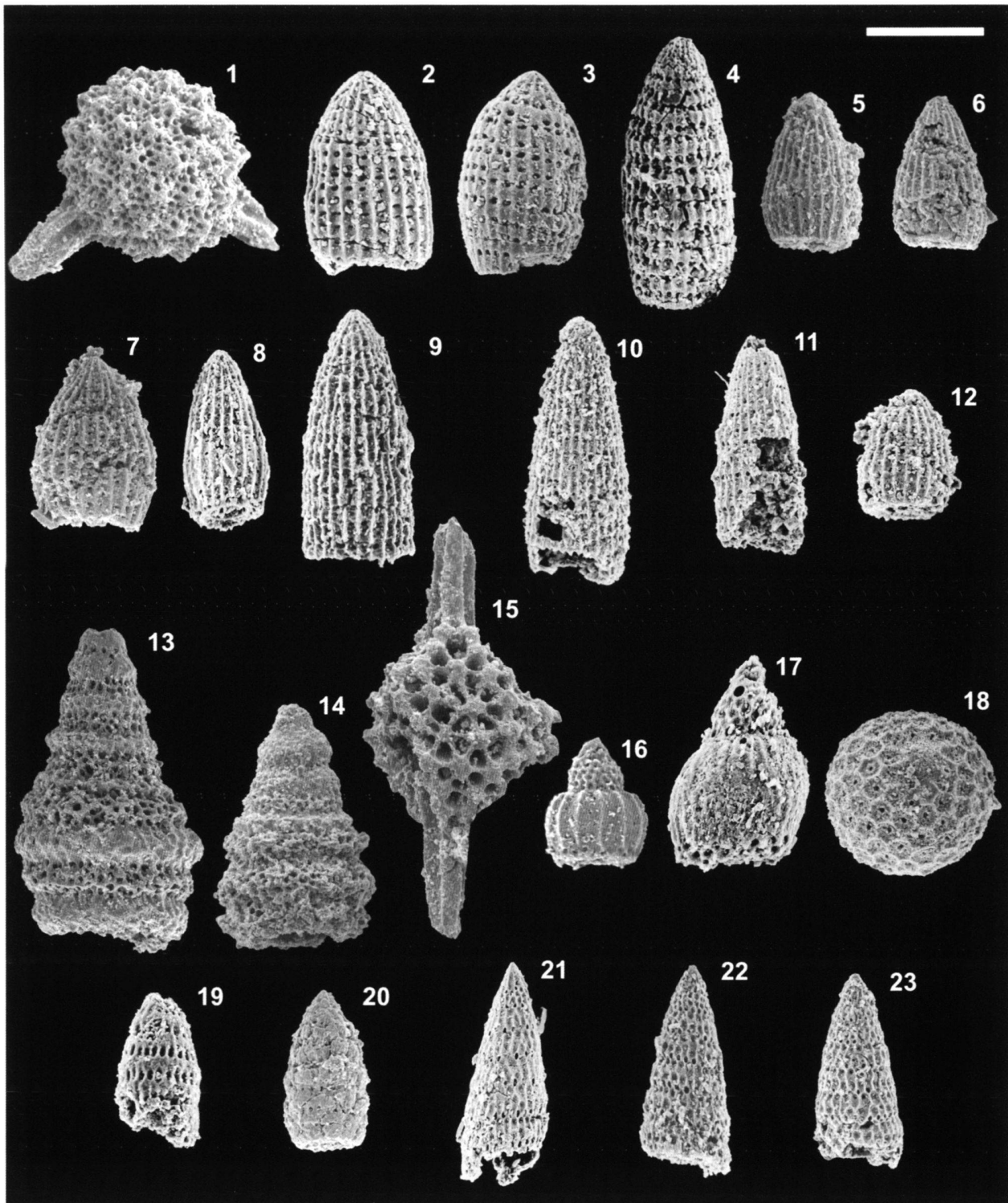
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**Plate 1**

Scanning Electron Micrographs of Radiolaria extracted from samples of the Méouge section. Bar scale (upper right) is equal to 100 µm for all figures.

1) *Acastea* sp.cf. *A. remusa* HULL, Mg-100; 2-3) *Archaeodictyomitra apiarium* (RÜST), Mg-2; 4) *Archaeodictyomitra etrusca* CHIARI et al. Mg-29; 5-6) *Archaeodictyomitra patricki* KOCHER, Mg-29; 7) *A. patricki*, Mg-2; 8) *Archaeodictyomitra* sp.aff. *A. patricki* KOCHER, Mg-2; 9) *Archaeodictyomitra shengi* YANG, Mg-29; 10) *A. shengi*, Mg-77; 11) *Archaeodictyomitra spelae* CHIARI et al., Mg-77; 12) *Archaeodictyomitra* sp. A, Mg-2; 13) *Cinguloturris fusiforma* HORI, Mg-100; 14) *Cinguloturris* sp.cf. *C. fusiforma* HORI, Mg-77; 15) *Emiluvia pentaporata* STEIGER & STEIGER, Mg-100; 16) *Eucyrtidiellum ptyctum* (SANFILIPPO & RIEDEL), Morphotype A, Mg-77; 17) *E. ptyctum*, Morphotype B, Mg-2; 18) *Gongylothorax favosus* DUMITRICA, Mg-37; 19) *Loopus doliolum* DUMITRICA, Mg-37; 20) *L. doliolum*, Mg-29; 21) *Loopus venustus* (CHIARI et al.), Mg-2; 22) *L. venustus*, Mg-2; 23) *L. venustus*, Mg-133.



## Plate 2

Scanning Electron Micrographs of Radiolaria extracted from samples of the Méouge section. Bar scale (upper right) is equal to 100  $\mu\text{m}$  for all figures except of fig. 7 (=200  $\mu\text{m}$ ).

1) *Pantanellium oligoporum* (VINASSA), Mg-2; 2) *Praeconocaryomma scatebra* HULL, Mg-21; 3) *Protunuma japonicus* MATSUOKA & YAO, Mg-37; 4) *P. japonicus*, Mg-37; 5) *Ristola altissima* cf. ssp. *R. a. altissima* (RÜST) *sensu* Baumgartner et al. 1995b, Mg-37; 6) *Saitoum pagei* PESSAGNO, Mg-21; 7) *Spongocapsula palmerae* (PESSAGNO), Mg-21; 8) *Stichocapsa tuscanica* CHIARI, CORTESE & MARCUCCI, Mg-77; 9) *Suna* sp., Mg-77; 10) *Tethysetta* (?) sp., Mg-77; 11) *Triactoma foremanae* MUZAVOR; Mg-77; 12) *Tripocyclia* sp. cf. *T. luciae* JUD, Mg-100; 13) *Tritrabs* sp. cf. *T. exotica* (PESSAGNO), Mg-37; 14) *Williriedellum carpathicum* DUMITRICA, Mg-77; 15) *W. carpathicum*, Mg-21; 16) *Williriedellum crystallinum* DUMITRICA, Mg-37; 17) *Zhamoidellum ovum* DUMITRICA, Mg-37; 18) *Z. ovum*, Mg-21; 19) *Z. ovum*, Mg-2.

