MAASTRICHTIAN-EARLY DANIAN RADIOLARIANS AND OSTRACODES FROM ODP SITE 1001B, CARIBBEAN SEA

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ABSTRACT – The ODP, Site 1001B (Leg 165), located in the Caribbean Sea, presents a well preserved sedimentary succession ranging from the Cretaceous to the Neogene that consists predominantly of pelagic limestone. The main objective of this article is to study taxonomically the Maastrichtian radiolarian and the Maastrichtian-early Danian ostracode faunas recovered in the studied site and to compare them to faunas previously described elsewhere. Despite the discontinuity of the occurrences and the scarcity of specimens, 45 radiolarian species and seven ostracode species assigned to six genera, were identified. The radiolarians were recovered only in the cores 21R and 20R and correspond to a typical Upper Cretaceous fauna, containing even species considered as index fossils such as *Orbiculiforma renillaeformis* (Campbell & Clark) Pessagno. The seven ostracode taxa occur in the Maastrichtian-early Danian interval. The single specimen of *Paleoabyssocythere* sp. here recorded could not be ascribed to none of the described species and possibly constitutes a new taxon. The presence of the ostracode association *Paleoabyssocythere-Krithe-Bairdoppilata-Cytherella* suggests deposition in a bathyal or outer shelf environment.

Key words: radiolarians, ostracodes, Cretaceous, Paleogene, ODP Site 1001B, Caribbean Sea.

RESUMO – O ODP Site 1001B (Leg 165), localizado no mar do Caribe, apresenta uma sucessão sedimentar bem preservada que abrange do Cretáceo ao Neógeno e é composta predominantemente por carbonatos pelágicos. O principal objetivo do presente artigo é descrever taxonomicamente a fauna de radiolários do Maastrichtiano e a fauna de ostracodes do intervalo Maastrichtiano-Eodaniano recuperadas no Site 1001B, comparando-as com faunas previamente descritas. Apesar da escassez de ocorrências e de espécimes, foram identificados seis gêneros de ostracodes, subdivididos em sete espécies, e 45 espécies de radiolários. Radiolários foram recuperados nos testemunhos 21R e 20R e correspondem a uma fauna típica do Cretáceo Superior, apresentando espécies consideradas fósseis guias, como *Orbiculiforma renillaeformis* (Campbell & Clark) Pessagno. Os sete táxons de ostracodes ocorrem no intervalo Maastrichtiano-Eodaniano. O único espécime de *Paleoabyssocythere* sp. registrado não pode ser atribuído a nenhuma das espécies já descritas, possivelmente constituindo um novo táxon. A presença da associação de ostracodes *Paleoabyssocythere-Krithe-Bairdoppilata-Cytherella* sugere deposição em um ambiente batial ou de plataforma externa.

Palavras-chave: radiolários, ostracodes, Cretáceo, Paleógeno, ODP Site 1001B, mar do Caribe.

INTRODUCTION

Stratigraphic successions containing the record of the Cretaceous/Paleogene (K/Pg) transition are rare and of great significance to the scientific community (MacLeod *et al.*, 1997). The Caribbean carbonated shelf contains one of the most important of these records, being closely related to the Yucatán Peninsula, where at 65 Myr ago a possible meteoric collision began one of the greatest mass extinctions in the history of the Earth (Ridley, 1996).

The main objective of the present work is to study the

radiolarian and ostracode faunas recovered in the Maastrichtian-early Danian interval of the ODP (Ocean Drilling Program) Site 1001B, contributing to the improvement of the knowledge about these groups in this time interval.

STUDY AREA

The samples analyzed in the present study comprise the Maastrichtian-early Danian interval of the ODP Leg 165, Site 1001B (15°45.418' N/74°54.626' W), cores 21R-16R (Figure 1). This interval possesses a precise biostratigraphic control

based on nannofossils and planktonic foraminifers (Sigurdsson *et al.*, 1997; Figure 2).

The tectonic reconstruction proposed to explain the origin of the Caribbean oceanic crust, encloses a crustal spreading zone localized at the Pacific Ocean (Burke, 1988; Donnelly *et al.*, 1990; Pindell & Barrett, 1990). These authors suggest that an intense volcanism associated to the Galápagos hot spot, had generated the Caribbean Oceanic Plateau, as well as, the Farallon Plate. Two stratigraphic sequences are recognized in the studied area (Sigurdsson *et al.*, 1997). The first sequence directly overlaid on the volcanic basement, which depositional period ranges from the Middle Campanian to the Middle Eocene, is predominantly composed by chalk and limestone interstratified with a minor amount of mudstone and siltstone. With the sea level fall, which occurred in the Eocene, an erosive boundary was generated, followed by the deposition of the second stratigraphic sequence, which is composed of pelagic ooze, and follows up from the middle Miocene to the Pleistocene.

MATERIAL AND METHODS

Lithologically the samples are composed dominantly by pelagic limestone interstratified with small proportion of mudstone and siltstone. Foraminifers are very abundant throughout the hole, whereas radiolarians and ostracodes only occur in some samples.

The samples were immersed in 40% hydrogen peroxide solution (H_2O_2) during 72 hours and later washed and fractionated in four meshes (45, 63, 180 and 250 μm), in order to recover both radiolarians and ostracodes. Finally, specimens were hand-picked under stereo-microscope. Representative radiolarians and ostracodes were photographed in Scanning Electron Microscope (SEM) at the CENPES/PETROBRAS and at the Centro de Microscopia e Microanálises (CEMM) of Pontifícia Universidade Católica do Rio Grande do

Sul (PUCRS). Radiolarians were also photographed under optical microscopy with the use of a Zeiss Axioscope 40.

In the two radiolarian-rich samples (1001B/21R/6W/71-75 cm and 1001B/20R/5W/69-73 cm) 300 specimens were picked. In the sample 21R/6W only specimens retained in the 63 μm mesh were recovered.

The specimens studied in the present work will be hold in the collections of Museu de Paleontologia, Universidade do Vale do Rio dos Sinos (UNISINOS), Brazil under the curatorial number ULVG-7011 to ULVG-7062. In the ostracode section of the systematic study the following **abbreviations** are used: **l**, length; **h**, height; **w**, width; **C**, carapace; **RV**, right valve; **LV**, left valve.

SYSTEMATIC PALEONTOLOGY

Radiolarians

Order NASSELLARIA Ehrenberg, 1875

Family ARCHAEODICTYOMITRIDAE Pessagno, 1976

Genus *Dictyomitra* Zittel, 1876 *emend.* Pessagno, 1976

Dictyomitra napaensis Pessagno, 1976

(Figure 3A)

Dictyomitra napaensis Pessagno, 1976, p. 53, pl. 4, fig. 16; pl. 5, fig. 1.

Dictyomitra napaensis Pessagno. Pessagno, 1977a, p. 942, pl. 3, fig. 1.

Dictyomitra napaensis Pessagno. Musavu-Moussavou & Danelian, 2006, p. 151, pl. 1, figs. 8-10.

Figured specimen. ULVG-7018.

Occurrence. Middle-upper Turonian to Upper Coniacian of Great Valley Sequence, California (Pessagno, 1976, 1977a); upper Cenomanian from ODP sites 1258 and 1261, Leg 207, Demerara Rise (Musavu-Moussavou & Danelian, 2006).

Material. 30 specimens; sample 1001B/21R/6W/71-75 cm.

Figure 1. Location of the ODP Site 1001B at the Caribbean Sea.

Dictyomitra rhadina Foreman, 1968
(Figure 3F)

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

Figured specimen. ULVG-7019.

Occurrence. Upper Maastrichtian of California (Foreman, 1968); Maastrichtian to lower Paleocene of New Zealand (Hollis, 1997); upper Cretaceous to lower Paleocene from DSDP site 208, New Zealand (Hollis, 2002).

Material. 15 specimens; samples 1001B/21R/6W/71-75 cm and 1001B/20R/5W/69-73 cm.

Dictyomitra andersoni (Campbell & Clark) Foreman, 1968
(Figure 3E)

Dictyomitra andersoni (Campbell & Clark) Foreman. Foreman, 1968, p. 68, pl. 7, figs. 6a,b.

Dictyomitra andersoni (Campbell & Clark) Foreman. Hollis, 1997, p. 69, pl. 16, figs. 11-16.

Figured specimen. ULVG-7020.

Occurrence. Upper Maastrichtian of California (Foreman, 1968); Campanian of Cyprus Island (Urquhart, 1994); Campanian-Maastrichtian to late Paleocene of New Zealand (Hollis, 1997; Hollis & Strong, 2003); middle Paleocene from ODP Site 1121 and Upper Cretaceous to Paleocene from DSDP Site 208, New Zealand (Hollis, 2002).

Material. 24 specimens; samples 1001B/21R/6W/71-75 cm and 1001B/20R/5W/69-73 cm.

Dictyomitra multicostata Zittel, 1876 emend. Pessagno, 1976
(Figure 3D)

Dictyomitra multicostata Zittel. Pessagno, 1963, p. 206, pl. 1, fig. 10; pl. 4, figs. 1,3; pl. 5, fig. 7.

Dictyomitra multicostata Zittel. Foreman, 1968, pl. 7, figs. 4a,b.

Dictyomitra multicostata Zittel. Pessagno, 1976, p. 52, pl. 14, figs. 4-9.

Dictyomitra multicostata Zittel. O'Dogherty, 1994, p. 82, pl. 4, figs. 17-18.

Dictyomitra multicostata Zittel. Hollis, 1997, p. 69, pl. 16, figs. 6-10.

Dictyomitra multicostata Zittel. Packer & Hart, 2005, p. 142, figs. 60,p.

Figured specimen. ULVG-7021.

Occurrence. Upper Maastrichtian of California (Foreman, 1968); lower Turonian of Italy and Spain (O'Dogherty, 1994); Campanian of Cyprus Island (Urquhart, 1994); Maastrichtian to lower Paleocene of New Zealand (Hollis, 1997); lower Campanian of Puerto Rico (Pessagno, 1963); middle Campanian to Maastrichtian of Great Valley Sequence, California (Pessagno, 1976); Upper Cretaceous to middle Paleocene from DSDP site 208, New Zealand (Hollis, 2002); Santonian-Campanian of Kara Crater, Russia (Vishnevskaya

& Alekseev, 2008); Coniacian-Santonian of Bornholm, Denmark (Packer & Hart, 2005); Coniacian-Turonian of Russia (Vishnevskaya *et al.*, 2006); Campanian of Russia (Olfer'ev *et al.*, 2007).

Material. 110 specimens; samples 1001B/21R/6W/71-75 cm and 1001B/20R/5W/69-73 cm.

Dictyomitra densicostata Pessagno, 1976
(Figure 4O)

Dictyomitra densicostata Pessagno, 1975, p. 1017, pl. 5, figs. 1-3.

Dictyomitra densicostata Pessagno. Pessagno, 1976, p. 51, pl. 14, figs. 10-14, 16.

Dictyomitra densicostata Pessagno. Pessagno, 1977a, p. 947, pl. 8, figs. 3, 4.

Dictyomitra densicostata Pessagno. Vishnevskaya & Alekseev, 2008, p. 1367, figs. 3j-l.

Dictyomitra densicostata Pessagno. Olfer'ev *et al.*, 2007, p. 646, pl. 19, fig. 10.

Figured specimen. ULVG-7022.

Occurrence. Upper Coniacian to uppermost Campanian of Great Valley Sequence, California (Pessagno, 1976); Campanian from the DSDP Site 275, New Zealand (Pessagno, 1975); upper Coniacian to Santonian of California (Pessagno, 1977a); Santonian of Russia (Olfer'ev *et al.*, 2007); Santonian-Campanian of Kara Crater, Russia (Vishnevskaya & Alekseev, 2008).

Material. 1 specimen; sample 1001B/21R/6W/71-75 cm.

Dictyomitra gracilis (Squinabol) O'Dogherty, 1994
(Figure 3C)

Dictyomitra gracilis (Squinabol, 1903b). O'Dogherty, 1994, p. 73, pl. 1, figs. 12-25.

Mita gracilis (Squinabol) Taketani. Urquhart, 1994, p. 1406, figs. 5(8, 14).

Figured specimen. ULVG-7023.

Occurrence. Campanian of Cyprus Island (Urquhart, 1994); upper Albian of Italy and Spain (O'Dogherty, 1994).

Material. 5 specimens; sample 1001B/21R/6W/71-75 cm.

Dictyomitra sp. 1
(Figure 3B)

Figured specimen. ULVG-7024

Description. Multi-segmented skeleton (10 to 13 segments) with elongated, conical to cylindrical-shaped test, and with well developed longitudinally aligned costae through all surface. Cephalis slightly acute apically with a small apical protrusion. Costae obscured at strictures. A single parallel row of aligned sub-circular pores lies between adjacent costae. Deep and well-developed constrictions occurring at joints between segments formed by two transverse rows of pores, which are followed by the costae outline. Lateral outlines of the test strongly lobate at segmental division levels. Chambers gradually increase in length and width,

becoming cylindrical distally, where one or two segments with pores bigger than the ones from the proximal segments occur, and costae became more irregular.

Remarks. This species differs from *Dictyomitra* cf. *crassispina* figured by Foreman (1968) by the two rows of pores at strictures. It can not be included in the genus *Pseudodictyomitra* due to the continuous costae obscured at strictures.

Material. 13 specimens; samples 1001B/21R/6W/71-75 cm and 1001B/20R/5W/69-73 cm.

Dictyomitra sp. 2
(Figure 3G)

Figured specimen. ULVG-7025.

Description. Multi-segmented form (six to eight segments) with test elongate and conical shape, with well developed vertically aligned costae obscured on cephalis and thorax. Cephalis slightly acute apically. Between adjacent costae, single parallel row of aligned sub-circular pores. Deep and well-developed constrictions occurring at joints of the segments, formed by one or two transverse rows of pores, which are followed by the costae outline. Costae are normally obscured at strictures. One transverse row of large circular depressions that may perforate the shell wall as pores is present on the central part of each abdominal segment between adjacent costae. Lateral outlines of the test strongly lobate at segmental division levels. Chambers gradually increase in length and width distally. Distal segment with distal margin ragged, may or may not possess small costal projections.

Remarks. Differs from all the other species of *Dictyomitra* recovered in the studied material by possessing deep constrictions at the joints of the segments, formed probably by two transverse rows of pores, and by its evident conical shape. Another significant difference is the presence of a transverse row of large circular depressions that may perforate the shell wall as pores at the central part of each abdominal segment between adjacent costae.

Material. 32 specimens; samples 1001B/21R/6W/71-75 cm and 1001B/20R/5W/69-73 cm.

Genus *Archaeodictyomitra* Pessagno, 1976
Archaeodictyomitra regina (Campbell & Clark)
Pessagno, 1976
(Figure 4P)

Dictyomitra regina (Campbell & Clark). Foreman, 1968, p. 68-79, pl. 8, figs. 5a-c.

Figured specimen. ULVG-7026.

Occurrence. Upper Campanian to Maastrichtian of Great Valley Sequence, California (Pessagno, 1976); upper Maastrichtian of California (Foreman, 1968).

Material. 6 specimens; samples 1001B/21R/6W/71-75 cm and 1001B/20R/5W/69-73 cm.

Family AMPHIPYNDACIDAE Riedel, 1967

Amphipyndax Foreman *emend.* Sanfilippo & Riedel, 1985

Amphipyndax pseudoconulus (Pessagno) Empson-Morin, 1982
(Figure 3N)

Lithostrobus (Lithostrobus) *pseudoconulus* Pessagno, 1963, p. 210, pl. 1, fig. 8; pl. 5, figs. 6, 8.

Amphipyndax pseudoconulus (Pessagno). Sanfilippo & Riedel, 1985, p. 596, fig. 7(1a-c).

Figured specimen. ULVG-7027.

Occurrence. Lower Campanian of Puerto Rico (Pessagno, 1963); Campanian of Cyprus Island (Urquhart, 1994).

Material. 28 specimens; sample 1001B/21R/6W/71-75 cm.

Family XITIDAE Pessagno, 1977b

Genus *Xitus* Pessagno, 1977b

Xitus sp.
(Figure 3H)

Figured specimen. ULVG-7028.

Description. Multi-segmented conical skeleton (six to eight segments) with imperforated cephalis and with or without apical spine. All segments present small subcircular pores, except by the cephalis. Circumferential ridges, composed by nodes and interconnected by bars, are present mainly at segmental divisions.

Remarks. Differs from *Stichomitra asymbatos* by the denser arrangement of the circumferential ridges, conspicuously developed at segmental divisions.

Material. 9 specimens; sample 1001B/21R/6W/71-75 cm.

Family EUCYRTIDIIDAE Ehremberg, 1847

Genus *Stichomitra* Cayeux 1897

Stichomitra stocki (Campbell & Clark) O'Dogherty, 1994
(Figure 3K)

Amphipyndax stocki (Campbell & Clark) Foreman, 1968, p. 78, pl. 8, figs. 12a-c.

Amphipyndax stocki (Campbell & Clark) Foreman. Pessagno, 1975, p. 1016, pl. 4, figs. 4-8.

Stichomitra stocki (Campbell & Clark) Foreman. O'Dogherty, 1994, p. 147, pl. 18, figs. 9-15.

Amphipyndax stocki (Campbell & Clark) gr., new group. Hollis, 1997, p. 66, pl. 15, figs. 5-11.

Stichomitra sp. cf. *Amphipyndax stocki* Packer & Hart, 2005, p. 142, fig. 6e.

Figured specimen. ULVG-7029.

Occurrence. Upper Maastrichtian of California (Foreman, 1968); lower Turonian and upper Cenomanian of Italy and Spain (O'Dogherty, 1994); Campanian of Cyprus Island (Urquhart, 1994); Campanian-Maastrichtian to lower Eocene of New Zealand (Hollis, 1997; Hollis & Strong, 2003); latest Campanian to Maastrichtian from DSDP Site 275, New Zealand coast (Pessagno, 1975); Upper Cretaceous to Paleocene from the ODP site 1121 and DSDP site 208, New Zealand (Hollis, 2002); Coniacian-Santonian of Bornholm,

Denmark (Packer & Hart, 2005); Campanian of Russia (Olfer'ev *et al.*, 2007); Coniacian-Turonian of Russia (Vishnevskaya *et al.*, 2006); Santonian-Campanian of the Russian Pacific Margin (Vishnevskaya & Basov, 2007).

Material. 5 specimens; samples 1001B/21R/6W/71-75 cm and 1001B/20R/5W/69-73 cm.

Stichomitra asymbatos Foreman, 1968
(Figures 3I, J)

Figured specimen. ULVG-7030.

Occurrence. Upper Maastrichtian of California (Foreman, 1968); Campanian of Russia (Olfer'ev *et al.*, 2007); Coniacian-Turonian of Russia (Vishnevskaya *et al.*, 2006).

Material. 21 specimens; samples 1001B/21R/6W/71-75 cm and 1001B/20R/5W/69-73 cm.

Stichomitra sp.1
(Figure 3L)

Figured specimen. ULVG-7031.

Description. Multi-segmented form. Cephalis is short, lacking apical horn, and poreless. Well developed strictures, generating a lobate outline; pores of the thorax and subsequent segments arranged in a square pattern or irregularly in only one shell layer.

Remarks. This species differs from all other species from the genus *Stichomitra* recovered in the studied material by its strong lobate outline.

Material. 19 specimens; samples 1001B/21R/6W/71-75 cm and 1001B/20R/5W/69-73 cm.

Stichomitra sp. 2
(Figure 3M)

Figured specimen. ULVG-7032.

Description. Test slender, conical to subcylindrical distally. Cephalis is small and imperforate. Polygonal pores of the thorax and subsequent segments quincuncially arranged.

Remarks. Differs from all other species of *Stichomitra* by the predominantly conical outline and large polygonal quincuncially arranged pore frames.

Material. 21 specimens; samples 1001B/21R/6W/71-75 cm and 1001B/20R/5W/69-73 cm.

Family CANNOBOTRYIDAE Haeckel, 1881
Genus *Rhopalosyringium* Campbell & Clark, 1944
Rhopalosyringium cf. *R. kleinum* Empson-Morin, 1981
(Figure 3O)

cf. *Rhopalosyringium kleinum* Empson-Morin, 1981, p. 265, pl. 8, figs. 2, 3.

Figured specimen. ULVG-7033.

Occurrence. Campanian from DSDP Site 313, Mid-Pacific Mountain (Empson-Morin, 1981).

Material. 7 specimens; sample 1001B/21R/6W/71-75 cm.

Rhopalosyringium cf. *R. magnificum* Campbell & Clark, 1944
(Figure 3Q)

cf. *Rhopalosyringium magnificum* Campbell & Clark, 1944, p. 30, pl. 7, figs. 16, 17.

cf. *Rhopalosyringium* cf. *magnificum* Empson-Morin, 1981, p. 265, pl. 8, figs. 1a-d.

Figured specimen. ULVG-7034.

Occurrence. Campanian from DSDP Site 313, Mid-Pacific Mountains (Empson-Morin, 1981); Upper Cretaceous of California (Campbell & Clark, 1944).

Material. 12 specimens; samples 1001B/21R/6W/71-75 cm and 1001B/20R/5W/69-73 cm.

Rhopalosyringium sp. 1
(Figure 3P)

Figured specimen. ULVG-7035.

Description. Test composed of three segments (including the tube). Cephalis small and hemispherical, with small pores that develop small nodes at the bars junctions of the pore frames. Thorax subspherical with large hexagonal to pentagonal pore frames. Test terminates in an open tube which has smaller pores than the thorax, and nodes irregularly distributed. The terminal tube may increase in width distally.

Remarks. This species possesses very poor-developed strictures and, differs from all other species of *Rhopalosyringium* recovered in this material by its terminal tube which may increase in width distally.

Material. 2 specimens; samples 1001B/21R/6W/71-75 cm and 1001B/20R/5W/69-73 cm.

Rhopalosyringium sp. 2
(Figure 3S)

Figured specimen. ULVG-7036.

Description. Test of three segments with strictures relatively diffuses in comparison to the other species of *Rhopalosyringium*. Cephalis small and hemispherical, bearing an apical horn, with small pores developing small nodes at the bars junctions of the pore frames. Thorax subspherical with large pentagonal and hexagonal pore frames arranged quincuncially. Test terminates in an open tube which presents pores and nodes slightly developed and irregularly distributed. Terminal tube decreases in width distally.

Remarks. This species presents the proximal part of test conical, and the distal portion (terminal tube) inversely conical in outline.

Material. 2 specimens; sample 1001B/21R/6W/71-75 cm.

Rhopalosyringium sp. 3
(Figure 3T)

Figured specimen. ULVG-7037.

Description. Test composed of cephalis, thorax and terminal tube. Cephalis is small, hemispherical, with small irregularly

distributed pores. Cephalis can develop an apical horn in well preserved specimens. Thorax subspherical with polygonal pore frames. Distal segment (portion of the test) inversely conical, open and bearing circular pores.

Remarks. Differs from *Rhopalosyringium* sp. 1 by having an inversely conical distal segment, and by the absence of well-developed strictures.

Material. 3 specimens; sample 1001B/21R/6W/71-75 cm.

Rhopalosyringium sp. 4
(Figure 3R)

Figured specimen. ULVG-7038.

Description. Skeleton composed by two segments. Cephalis hemispherical, bearing an acute small apical horn. Collar stricture diffuse. Thorax subspherical, with hexagonal pore-frames presenting small nodes at the bars junctions.

Remarks. In lateral view, under stereo-microscope, this species presents the distal margin ragged.

Material. 6 specimens; sample 1001B/21R/6W/71-75 cm.

Genus *Krempelinella* Empson-Morin, 1981
Krempelinella cf. *K. kronenartiga* Empson-Morin, 1981
(Figure 4Q)

cf. *Krempelinella kronenartiga* Empson-Morin, 1981, p. 265, pl. 8, figs. 4-7d; pl. 9, figs 1a-d.

Figured specimen. ULVG-7039

Occurrence. Campanian from DSDP Site 313, Mid-Pacific Mountains (Empson-Morin, 1981).

Material. 2 specimens; sample 1001B/21R/6W/71-75 cm.

Family WILLIRIEDELLIDAE Dumitrica, 1970
Genus *Cryptamphorella* Dumitrica, 1970
Cryptamphorella sp.
(Figure 3U)

Figured specimen. ULVG-7040.

Description. Cryptothoracic nassellarian, tri-chambered, with large spherical abdomen; small cephalo-thoracic portion, poreless or with small pores, and partially depressed in the abdominal cavity. Abdomen spherical with rough surface, and pentagonal and hexagonal pore frames, with bars developing nodes at junctions.

Material. 8 specimens; samples 1001B/21R/6W/71-75 cm and 1001B/20R/5W/69-73 cm.

NASSELLARIA INCERTAE SEDIS
Nassellaria gen. et sp. indet.
(Figure 4I)

Figured specimen. ULVG-7041.

Remarks. Possible cryptocephalic Nassellaria with pores quincuncially arranged.

Material. 4 specimens; sample 1001B/21R/6W/71-75 cm.

Order SPUMELLARIA Ehrenberg, 1875
Family ACTINOMMIDAE Haeckel 1862 *emend.* De Wever
et al., 2001
ACTINOMMIDAE gen. et sp. indet.
(Figure 4M)

Figured specimen. ULVG-7042.

Description. Test lenticular without spines. Cortical shell with small hexagonal pore frames.

Material. 19 specimens; samples 1001B/21R/6W/71-75 cm and 1001B/20R/5W/69-73 cm.

Family CONOCARYOMMIDAE Lipman, 1969 *emend.* De Wever *et al.*, 2001
Genus *Praeconocaryomma* Pessagno, 1976
Praeconocaryomma californiensis Pessagno, 1976
(Figure 3W)

Praeconocaryomma californiensis Pessagno, 1976, p. 41, pl. 7, figs. 1-8.

Praeconocaryomma californiensis Pessagno. Pessagno, 1977a, p. 942, pl. 3, figs. 3-6.

Praeconocaryomma californiensis Pessagno. Packer & Hart, 2005, p. 144, figs. 7j, k.

Praeconocaryomma californiensis Pessagno. Vishnevskaya & Alekseen, 2008, p. 1368, fig. 2f.

Figured specimen. ULVG-7043.

Occurrence. Coniacian of Great Valley Sequence, California (Pessagno, 1976, 1977a); Coniacian-Santonian of Bornholm, Denmark (Packer & Hart, 2005); Santonian of Russia (Olfer'ev *et al.*, 2007); Santonian-Campanian of Kara Crater, Russia (Vishnevskaya & Alekseev, 2008).

Material. 10 specimens; sample 1001B/21R/6W/71-75 cm.

Praeconocaryomma? sp.
(Figure 3X)

Figured specimen. ULVG-7044.

Description. Cortical shell presents six large elliptical pores surrounding each (?)mammary; area between (?)mammarye with circular to elliptical pores. Central area of (?)mammarye have triradiate spines in axial section. Mammary area weakly developed.

Remarks. This species is tentatively assigned to the genus *Praeconocaryomma*, based on the presence of weakly developed mammary areas.

Material. 10 specimens; sample 1001B/21R/6W/71-75 cm.

Family PSEUDOAULOPHACIDAE Riedel, 1967 *emend.* De Wever *et al.*, 2001
Genus *Alievium* Pessagno 1972b
Alievium sp.
(Figure 4G)

Figured specimen. ULVG-7045.

Description. Test sub-triangular in outline; with a meshwork comprised of triangular to subcircular pore frames arranged

Figure 3. A, *Dictyomitra napaensis* Pessagno, sample 1001B/21R/6W/71-75 cm. B, *Dictyomitra* sp. 1, sample 1001B/21R/6W/71-75 cm. C, *Dictyomitra gracilis* (Squinabol) O'Doguerty, sample 1001B/21R/6W/71-75 cm. D, *Dictyomitra multicostata* Zittel, sample 1001B/20R/5W/69-73 cm. E, *Dictyomitra andersoni* (Campbell & Clark) Foreman, sample 1001B/20R/5W/69-73 cm. F, *Dictyomitra rhadina* Foreman, sample 1001B/20R/5W/69-73 cm. G, *Dictyomitra* sp. 2, sample 1001B/20R/5W/69-73 cm. H, *Xitus* sp., sample 1001B/21R/6W/71-75 cm. I-J, *Stichomitra asymbatos* Foreman, sample 1001B/21R/6W/71-75 cm. K, *Stichomitra stocki* (Campbell & Clark) O'Doguerty, sample 1001B/21R/6W/71-75 cm. L, *Stichomitra* sp. 1, sample 1001B/20-5W. M, *Stichomitra* sp. 2, sample 1001B/20R/5W/69-73 cm. N, *Amphipyndax pseudoconulus* (Pessagno) Empson-Morin, sample 1001B/21R/6W/71-75 cm. O, *Rhopalosyringium* sp. cf. *R. kleinum* Empson-Morin, sample 1001B/21R/6W/71-75 cm. P, *Rhopalosyringium* sp. 1, sample 1001B/21R/6W/71-75 cm. Q, *Rhopalosyringium* sp. cf. *R. magnificum* Campbell & Clark, sample 1001B/21R/6W/71-75 cm. R, *Rhopalosyringium* sp. 4 (apical view), sample 1001B/21R/6W/71-75 cm. S, *Rhopalosyringium* sp. 2, sample 1001B/21R/6W/71-75 cm. T, *Rhopalosyringium* sp. 3, sample 1001B/21R/6W/71-75 cm. U, *Cryptamphorella* sp., sample 1001B/21R/6W/71-75 cm. V, *Spumellaria* gen. et sp. indet., sample 1001B/21R/6W/71-75 cm. W, *Praeconocaryomma californiensis* Pessagno, sample 1001B/21R/6W/71-75 cm. X, *Praeconocaryomma?* sp., sample 1001B/21R/6W/71-75 cm.

in all the surface, developing small nodes at pore-frame bars junctions. Three primary spines occur in the corners of the sub-triangular test, which are apparently tri-radiated in cross-section.

Remarks. No specific determination is possible (all specimens recovered are broken).

Material. 9 specimens; sample 1001B/21R/6W/71-75 cm.

Genus *Pseudoaulophacus* Pessagno, 1963 *emend.*

Pessagno 1972b

Pseudoaulophacus? sp.

(Figure 4F)

Figured specimen. ULVG-7046.

Description. Test circular in outline, with larger pores in the elevated central area than those of remainder test; central area poorly elevated. Large conical spines developed in the equatorial plane of the test.

Remarks: The knob-like area showed in the illustration is composed by sedimentary material, and was removed using ultrasound treatment.

Material. 1 specimen; sample 1001B/21R/6W/71-75 cm.

Family ANGULOBRACCHIIDAE Baumgartner, 1980 *emend.*

De Wever *et al.*, 2001

Genus *Paronaella* Pessagno, 1971

Paronaella sp. 1

(Figure 4A)

Figured specimen. ULVG-7047.

Description. Three-rayed test without brachchiopyle. Rays possess different lengths. Pores shape obscured by the poor preservation. Rays smooth without spines at extremities.

Remarks. Differs from *Paronaella?* sp. 3 by the presence of rays with practically the same width along their extension.

Material. 3 specimens; sample 1001B/21R/6W/71-75 cm.

Paronaella sp. 2

(Figure 4C)

Figured specimen. ULVG-7048.

Description. Three-rayed skeleton with rays at various angles. Two rays are positioned at about 180° to each other and are bigger, while the ray positioned at about 90° relative to others is smaller. Rays are probably elliptical in cross-section and have broken spines in extremities. Surface rough with nodes on the polygonal pore-frames junctions.

Remarks. This species differs from all other species of the genus recovered in the studied material by the presence of different inter-rays angles.

Material. 4 specimens; sample 1001B/21R/6W/71-75 cm.

Paronaella? sp. 3

(Figure 4B)

Figured specimen. ULVG-7049.

Description. Three-rayed test without brachchiopyle. Rays

equal in length, possibly elliptical in cross-section. Test rough without lateral or central spines, and with nodes on the surface. Rays smooth, tending to be slender distally and keep practically the same inter-rays angle.

Remarks. Differs from *Paronaella* sp. 1 by having rays which tend to be slender distally.

Material. 6 specimens; sample 1001B/21R/6W/71-75 cm.

Family HAGIASTRIDAE Riedel, 1971

Genus *Orbiculiforma* Pessagno, 1973 *emend.* Pessagno, 1976

Orbiculiforma persenex Pessagno, 1976

(Figure 4S)

Orbiculiforma persenex Pessagno, 1976, p. 35, pl. 6, figs. 12-13.

Orbiculiforma persenex Pessagno. Pessagno, 1977a, p. 944, pl. 5, fig. 6.

Orbiculiforma persenex Pessagno. Urquhart, 1994, p. 1406, fig. 5(8).

Orbiculiforma persenex Pessagno. Packer & Hart, p. 141, figs. 5g-i.

Figured specimen. ULVG-7050

Occurrence. Campanian of Cyprus Island (Urquhart, 1994); Coniacian of Great Valley Sequence, California (Pessagno, 1976, 1977a); Coniacian-Santonian of Bornholm, Denmark (Packer & Hart, 2005); Coniacian-Turonian of Russia (Vishnevskaya *et al.*, 2006); Santonian-Campanian of the Russian Pacific Margin (Vishnevskaya & Basov, 2007).

Material. 4 specimens, sample 1001B/21R/6W/71-75 cm.

Orbiculiforma renillaeformis (Campbell & Clark)

Pessagno, 1976

(Figure 4L)

Orbiculiforma renillaeformis (Campbell & Clark) Pessagno. Pessagno, 1976, p. 36, pl. 11, fig. 11.

Figured specimen. ULVG-7051.

Occurrence. Uppermost Campanian to Maastrichtian of Great Valley Sequence, California (Pessagno, 1976).

Material. 9 specimens; sample 1001B/21R/6W/71-75 cm.

Orbiculiforma sp. 1

(Figure 4T)

Figured specimen. ULVG-7052.

Description. Test is circular in outline, with or without peripheral spines. Center of test markedly depressed; central cavity flanked by a prominent rim.

Remarks. Differs from *Orbiculiforma* sp. 2 by possessing a depressed central cavity, and by the flat pattern of the test.

Material. 19 specimens; sample 1001B/21R/6W/71-75 cm.

Orbiculiforma sp. 2

(Figure 4R)

Figured specimen. ULVG-7053.

Description. Test is circular in outline without peripheral

spines. Center of test markedly depressed and narrow. Central cavity flanked by a rim.

Remarks. Differs from *Orbiculiforma* sp. 1 by possessing a narrow central cavity, and by the decrease in the height/width ratio.

Material. 20 specimens; sample 1001B/21R/6W/71-75 cm.

Orbiculiforma? sp. 3
(Figure 4K)

Figured specimen. ULVG-7054.

Description. Test circular to quadrangular in outline, without visible peripheral spines. Central area well marked.

Remarks. This species differs from all other species assigned to the genus *Orbiculiforma* in the present study by presenting a well marked central area. All specimens are incomplete.

Material. 5 specimens; sample 1001B/21R/6W/71-75 cm.

Genus *Crucella* Pessagno, 1971
Crucella aster (Lipman) Nakaseko & Nishimura, 1981
(Figure 4D)

Crucella aster (Lipman). Packer & Hart, 2005, p. 141, figs. 5c,d.

Crucella aster (Lipman). Vishnevskaya & Alekseev, 2008, p. 1368, fig. 2g.

Figured specimen. ULVG-7055.

Occurrence. Campanian of Chypre Island (Urquhart, 1994); Coniacian-Santonian of Bornholm, Denmark (Packer & Hart, 2005); Coniacian-Turonian of Russia (Vishnevskaya *et al.*, 2006); Santonian-Campanian of Kara Crater, Russia (Vishnevskaya & Alekseev, 2008).

Material. 4 specimens; sample 1001B/21R/6W/71-75 cm.

Crucella? sp.
(Figure 4E)

Figured specimen. ULVG-7056.

Description. Four-rayed hagiastrid, without brachiopyle. Rays are equal in length, sharply pointed distally and have three longitudinal costae in each face. Rays are sub-circular to elliptical in cross-section. Central area slightly elevated with pores composed of tetragonal pore-frames.

Remarks. *Crucella?* sp. differs from *Crucella aster* by the sharply pointed distally rays-shaped and tetragonal pore-frames.

Material. 3 specimens; sample 1001B/21R/6W/71-75 cm.

Family SPONGODISCIDAE Haeckel, 1862
Genus *Pentinastrum* Haeckel, 1882
Pentinastrum subbotinae Lipman, 1960
(Figure 4N)

Pentinastrum subbotinae Lipman. Bragina *et al.*, 1999, p. 496, pl. 2, fig. 5.

Figured specimen. ULVG-7057.

Occurrence. Upper Cretaceous of the Russian Plate (Bragina *et al.*, 1999).

Material. 8 specimens; sample 1001B/21R/6W/71-75 cm

Genus *Stylodictya* Ehrenberg, 1847
Stylodictya? sp.
(Figure 4H)

Figured specimen. ULVG-7058.

Description. Skeleton flat, slightly concave, and with rounded outline (central portion slightly depressed). In upper view presents polygonal pores distributed in concentric layers, with small nodes at pore-frames junctions. Test possesses a small rounded (in cross section) spine merging from the equatorial plane. Some spines are possible broken.

Remarks. Differs from the genus *Orbiculiforma* by having a conspicuous concentric arrangement of pores, and by having a more flattened pattern of the test without a central cavity very depressed. Although the genus was originally defined for the Eocene-Recent, Vishnevskaya & Alekseev (2008) recovered specimens from the Santonian-Campanian of Kara Crater-Russia.

Material. 8 specimens; sample 1001B/21R/6W/71-75 cm.

Family ARCHAEOSPONGOPRUNIDAE Pessagno, 1973
Genus *Archaeospongoprimum* Pessagno, 1973
Archaeospongoprimum sp.
(Figure 4J)

Figured specimen. ULVG-7059.

Description. Test ellipsoidal, spongy, with two polar spines; polar spines broken off, probably tetradial in axial section with an arrangement of ridges alternating with grooves.

Remarks. The broken spines make difficult a specific determination.

Material. 2 specimens; sample 1001B/21R/6W/71-75 cm.

SPUMELLARIA INCERTAE SEDIS
Spumellaria gen. *et* sp. indet.
(Figure 3V)

Figured specimen. ULVG-7060.

Remarks. Large spherical Spumellaria, with well-developed pores and smooth surface.

Material. 6 specimens; sample 1001B/21R/6W/71-75 cm.

Ostracodes

Classe OSTRACODA Latreille, 1802
Order PLATYCOPIIDA Sars, 1866
Superfamily CYTHERELLOIDEA Sars, 1866
Family CYTHERELLIDAE Sars, 1866
Genus *Cytherella* Jones, 1849
Cytherella sp.
(Figure 5A)

Figured specimen. ULVG-7011.

Figure 4. A, *Paronaella* sp. 1, sample 1001B/21R/6W/71-75 cm. B, *Paronaella*? sp. 3, sample 1001B/21R/6W/71-75 cm. C, *Paronaella* sp. 2, sample 1001B/21R/6W/71-75 cm. D, *Crucella aster* (Lipman) Nakaseko & Nishimura, sample 1001B/21R/6W/71-75 cm. E, *Crucella*? sp., sample 1001B/21R/6W/71-75 cm. F, *Pseudoaulophacus*? sp., sample 1001B/21R/6W/71-75 cm. G, *Alievium* sp., sample 1001B/21R/6W/71-75 cm. H, *Stylodictya*? sp., sample 1001B/21R/6W/71-75 cm. I, *Nassellaria* gen. et sp. indet., sample 1001B/21R/6W/71-75 cm. J, *Archaeospongoprunum* sp., sample 1001B/21R/6W/71-75 cm. K, *Orbiculiforma*? sp. 3, sample 1001B/21R/6W/71-75 cm. L, *Orbiculiforma renillaeformis* (Campbell & Clark) Pessagno, sample 1001B/21R/6W/71-75 cm. M, *Actinommidae* gen. et sp. indet., sample 1001B/21R/6W/71-75 cm. N, *Pentinastrum subbotinae* Lipman, sample 1001B/21R/6W/71-75 cm. O, *Dictyomitra densicostata* Pessagno, sample 1001B/21R/6W/71-75 cm. P, *Archaeodictyomitra regina* (Campbell & Clark) Pessagno, sample 1001B/21R/6W/71-75 cm. Q, *Krempelina* sp. cf. *K. kronenartiga* Empson-Morin, sample 1001B/21R/6W/71-75 cm. R, *Orbiculiforma* sp. 2, sample 1001B/21R/6W/71-75 cm. S, *Orbiculiforma persenex* Pessagno, sample 1001B/21R/6W/71-75 cm. T, *Orbiculiforma* sp. 1, sample 1001B/21R/6W/71-75 cm. Figures O-T are optic micrographs of Radiolaria from Site 1001B.

Dimensions. L=0.58 mm; h=0.40 mm; w=0.25 mm.

Locality. Sample 16R/5W/70-75cm.

Age. Danian.

Material. 2 C, 1 LV; samples 21R/6W/71-75cm, 18R/4W/70-75 cm and 16R/5W/70-75cm.

Range. Maastrichtian-early Danian.

Genus *Cytherelloidea* Alexander, 1929

Cytherelloidea sp.

(Figure 5B)

Figured specimen. ULVG-7012.

Dimensions. L=0.47 mm; h=0.33 mm.

Locality. Sample 20R/2W/77-82 cm.

Age. Maastrichtian.

Material. 1 LV; sample 20R/2W/77-82 cm.

Range. Maastrichtian.

Remarks. This species is identified as *Cytherelloidea* due to the reticulate ornamentation, not usual in *Cytherella*.

Order PODOCOPIDA Müller, 1894

Suborder BAIRDIOCOPINA Gründel, 1967

Family BAIRDIIDAE Sars, 1888

Genus *Bairdoppilata* Coryell, Sample & Jennings, 1935

Bairdoppilata aff. *B. southerhamensis* Weaver, 1982

(Figure 5C)

aff. *Bairdoppilata southerhamensis* Weaver, 1982, p. 25-26, pl. 4, figs. 4-6.

Figured specimen. ULVG-7013.

Dimensions. L=1.18 mm; h=0.79 mm; w=0.58 mm.

Locality. 18R/3W/72-77 cm.

Age. Danian.

Material. 2 C; samples 21R/4W/71-76 cm and 18R/3W/72-77 cm.

Range. Maastrichtian-early Danian.

Remarks. The precise taxonomic position of some bairdiids is under constant discussion. The main difference between *Bairdoppilata* and *Bairdia* McCoy, 1844 are the denticles present close to the terminal elements of the hinge of the first. According to the revision of the family Bairdiidae by Maddocks (1969), the genus *Bairdia* is restricted to the Paleozoic. For this reason, this species is here referred as *Bairdoppilata*.

Bairdoppilata sp.

(Figure 5D)

Figured specimen. ULVG-7014.

Dimensions. L=1.02 mm; h=0.69 mm.

Locality. 21R/4W/71-76 cm.

Age. Maastrichtian.

Material. 2 C, 3 LV, 4 RV; samples 21R/6W/71-75 cm, 21R/4W/71-76 cm, 21R/1W/70-75 cm, 20R/6W/73-78 cm, 17R/1W/68-73 cm and 16R/2W/71-76 cm.

Range: Maastrichtian-early Danian.

Family SIGILLIDAE Mandelstam, 1960

Genus *Cardobairdia* Bold, 1960

Cardobairdia sp.

(Figure 5E)

Figured specimen. ULVG-7015.

Dimensions. L=0.46 mm; h=0.22 mm.

Locality. 18R/4W/70-75 cm.

Age. Danian.

Material. 1 RV; sample 18R/4W/70-75 cm.

Range. Early Danian.

Remarks. The genus *Cardobairdia* is characterized by strong overlap, peculiar central muscle scars and, in most cases, a spine in the posterior margin. Bold (1974) comments that *Cardobairdia* might possibly be a junior synonym of *Sigillum* Kuznetsova, 1961. The suprageneric taxonomy of *Cardobairdia* is still a controverse subject, what explains its allocation in different families. We consider that the classification in the family Sigillidae, according to Dall'Antonia (2003) is more suitable than Saipanettidae as proposed by Bold (1974).

Family TRACHYLEBERIDIDAE Sylvester-Bradley, 1948

Genus *Paleoabyssocythere* Benson, 1977

Paleoabyssocythere sp.

(Figures 5F, G)

Figured specimen. ULVG-7016.

Dimensions. L=0.8 mm; h=0.51 mm.

Locality. 20R/1W/69-74 cm.

Age. Maastrichtian.

Material. 1 LV; sample 20R/1W/69-74 cm.

Range. Maastrichtian.

Remarks. The present specimen was identified as *Paleoabyssocythere* Benson, 1977 based on both internal and external morphological features. Despite its good preservation the material could not be ascribed to the species described by Benson (1977). It differs from *P. cretacea* by the absence of the reticulation and the ventrolateral nodosity poorly developed, and from *P. cenozoica* by the absence of reticulation and the anterodorsal ear less acuminate.

Family KRITHIDAE Mandelstam, 1958

Genus *Krithe* Brady, Crosskey & Robertson, 1874

Krithe sp.

(Figure 5H)

Figured specimen. ULVG-7017.

Dimensions. L=0.69 mm; h=0.36 mm; w=0.29 mm.

Locality. 16R/5W/70-75 cm.

Age. Danian.

Material. 1 LV, 1 C; samples 16R/5W/70-75 cm and 16R/2W/71-76 cm.

Range: Danian.

Remarks. The main morphological characteristic that allowed the identification of this specimen in *Krithe* is the presence of the posterior pit, present in all species of the genus.

Gen. *et sp.* indet.
(Figure 5I)

Figured specimen. ULVG-7061.

Dimensions. L= 0.51 mm; h= 0.25 mm.

Locality. Sample 18R/4W/70-75 cm.

Age. Danian.

Material. 1 RV; samples 18R/4W/70-75 cm.

Range. Danian.

RESULTS AND DISCUSSION

Radiolarians

Studies on Maastrichtian radiolarians are relatively rare. Foreman (1968) described Maastrichtian species, mainly nassellarians, emphasizing internal primary structures. Pessagno (1976) presented a taxonomic and biostratigraphic analysis of radiolarians from the Upper Cretaceous of the Great Valley Sequence, California. According to that author, however, the Maastrichtian interval was not extensively studied in that article. Ling & Lazarus (1990) and Ling (1991)

reported well-preserved Maastrichtian faunas from the Antarctic region of the ODP Leg 113 and Leg 114, respectively. Soloviev *et al.* (2000) reported the occurrence of Campanian-Maastrichtian Radiolaria from the Olyutor Zone (Southern Koryak upland). Dumitrica & Hollis (2004) studied Maastrichtian phaeodarian Radiolaria from the DSDP Site 275 near New Zealand. Studies about radiolarian faunas that registered the K/Pg transition are also not common, being restricted to the Pacific Ocean and more abundant in the New Zealand region (Keller *et al.*, 1997; Hollis, 1997, 2002; Hollis & Kimura, 2001; Hollis & Strong, 2003; Hollis *et al.*, 2003).

In the present study, radiolarians were found in two samples of the ODP Site 1001B (Figure 2), and their occurrences are restricted to Maastrichtian rocks (limestones), where 43 species were identified.

The radiolarian abundance, preservation index (PI), and nassellarians/spumellarians ratio (N/S) were estimated according to Kiessling (1996). In the sample 1001B/21R/6W/71-75 cm the estimated radiolarian abundance is of 1900 rads/g (radiolarians per gram), with PI= 3 and N/S= 1.28, while in the sample 1001B/20R/5W/69-73 cm the estimated abundance

Figure 5. All figures are SEM of ostracodes from Site 1001B. **A**, *Cytherella* sp., C right view, sample 16R/5W/70-75 cm. **B**, *Cytherelloidea* sp., LV lateral view, sample 20R/2W/77-82 cm. **C**, *Bairdoppilata* sp. aff. *B. southerhamensis* Weaver, 1982, C right view, sample 18R/3W/72-77 cm. **D**, *Bairdoppilata* sp., LV lateral view, sample 21R/4W/71-76 cm. **E**, *Cardobairdia* sp., RV lateral view, sample 18R/4W/70-75 cm. **F-G**, *Paleoabyssocythere* sp.: **F**, LV external view; **G**, LV internal view, sample 20R/1W/69-74 cm. **H**, *Krithe* sp., C right view, sample 16R/5W/70-75 cm. **I**, Gen. *et sp.* indet., RV lateral view, sample 18R/4W/70-75 cm.

is of 3000 rads/g, $PI=4$ and $N/S=4.88$. Increases in the relative abundance of nassellarians, as well as in the preservation index were observed in the last sample. The radiolarian fauna recovered from the ODP Site 1001B presents an elevated abundance of the genus *Dictyomitra* (corresponding approximately to 38% of the fauna). It contains also typical taxa for the Upper Cretaceous strata, and even species considered index fossils such as *Orbiculiforma renillaeformis* (Campbell & Clark) Pessagno.

Pessagno (1976) proposed a biostratigraphic zonation for the Great Valley Sequence, California, in which Maastrichtian strata are attributed to the *Orbiculiforma renillaeformis* Interval Zone (Pessagno, 1976). The lower limit of this zone is marked by the extinction of the family Phaseliformidae, while the upper limit is marked by the final occurrence of some taxa (see Pessagno, 1976). The absence of Phaseliformids, as well as the co-occurrence of *Orbiculiforma renillaeformis* (Campbell & Clark) Pessagno, *Archaeodictyomitra regina* (Campbell & Clark) and *Dictyomitra multicostata* Zittel in the material studied herein suggest a Maastrichtian age for the samples 1001B/21R/6W/71-75 cm and 1001B/20R/5W/69-73 cm, including them in the *Orbiculiforma renillaeformis* Interval Zone (Pessagno, 1976). A Maastrichtian age was previously reported by Sigurdsson *et al.* (1997), based on nannofossils and foraminifers, to the same interval of the section (Figure 2).

The sparse occurrences of radiolarians in the studied area could be related to occasional intensifications in the oceanic circulation pattern (Blueford, 1988). Those events could have generated increases in the planktonic productivity during the Late Cretaceous (De Wever & Baudin, 1996). This can be a relevant aspect in the determination of the similarity between radiolarian faunas in the Late Cretaceous, and could be corroborated with future studies.

More studies about Maastrichtian radiolarians in the near future could confirm the stratigraphic range of some Upper Cretaceous taxa, as presented in this study, and contribute to the improvement of the knowledge about the global oceanic circulation in the Upper Cretaceous.

Ostracodes

The ostracode fauna recorded in the present work shows an uneven distribution along the core. Seventeen out of the 29 samples studied were barren for ostracodes and the 19 specimens recovered were identified into seven taxa. They are left in open nomenclature following the scarcity of specimens and the poor preservation of most of them.

Bairdoppilata southerhamensis Weaver described in Cenomanian rocks of England has affinity with the species registered in the Maastrichtian-early Danian in the present study. The difference of age and the scarcity of specimens (two carapaces), however, make the identification of those taxa under the same species questionable.

The deep sea dweller genus *Paleoabyssocythere* has only two species described so far: *P. cretacea* and *P. cenozoica*, both proposed by Benson (1977) in the Cretaceous/Paleogene of São Paulo plateau and Rio Grande rise, South Atlantic.

The single specimen recorded in the present work is somewhat different of both and it is not clear if it is a new species. The only specimen of *Cardobairdia* sp. (RV) was filled with sediment, preventing a more detailed study and precise identification. *Cytherella* and *Krithe* are genera usually smooth and very diversified demanding the study of many specimens and the analysis of internal morphological features for the identification at specific level. The specimens of those two genera in the present study were exclusively carapaces and for that reason, left in open nomenclature.

Despite their scarcity, the ostracodes give some information for the paleoenvironmental characterization of the studied area. In the Cenozoic, the association *Paleoabyssocythere-Krithe-Bairdoppilata-Cytherella* would fit perfectly in a psychrospheric environment. Although some of those taxa present eurybathic distribution (e.g. *Krithe*, *Cytherella*, *Bairdoppilata*) and their ecologic preferences may have change since the Cretaceous (retrothermal tendencies), it is possible to assume that the depositional environment in the site 1001B was either a bathyal or outer shelf one.

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