

Original article

The Radiolarian biotic response to Oceanic Anoxic Event 2 in the southern part of the Northern proto-Atlantic (Demerara Rise, ODP Leg 207)

La réponse biotique des Radiolaires à l'événement anoxique OAE-2 dans la partie méridionale du proto-Atlantique septentrional (plateau de Demerara, Leg 207 de ODP)

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Abstract

Rare Radiolaria occur in the Upper Cenomanian–Lower Turonian part of finely laminated black shales recovered from Sites 1258 and 1261 of Demerara Rise (Ocean Drilling Program Leg 207, western tropical Atlantic, off Surinam). The observed fauna are of a low diversity, with up to 12 species co-occurring in a single sample and 49 species identified in total in both sites. Nassellarians and “Spumellarians” are equally represented in the assemblages. Diverse species of *Stichomitra* and *Theocampe* are particularly common, including the two new species described herein: *Theocampe costata* and *T. demeraraense*. Radiolarian preservation is on average moderate to poor, suggesting substantial influence of diagenetic alterations to species diversity. The few well-preserved assemblages can potentially provide better information about Cenomanian–Turonian Radiolarian biodiversity, but given their low abundance in the processed sediment samples, the diversity sampled during this study is considered to be an underestimate of the original Radiolarian diversity at Demerara. However, the abundance and diversity of *Theocampe* in Upper Cenomanian levels is noteworthy. Given the earliest known occurrence of the genus from Upper Albian sediments of the Deep Ivorian Basin it is likely that it originated and diversified in the opening Equatorial Atlantic Gateway. Based on the stable carbon isotope curve, the OAE-2 interval is clearly identified in the sedimentary sequence of both studied sites and helps to specify the known age range of three species (*Acanthocircus hueyi*, *Archaeospongoprimum bipartitum* and *Rhopalosyringium hispidum*). The most intriguing result of this study is the paucity of Radiolaria within the OAE-2 interval of the deeper site (1258) and the total absence of this micro-zooplankton group in the OAE-2 interval of the proximal site (1261). Radiolaria are the most abundant and diverse at the distal Site 1258, below OAE-2, while the proximal Site 1261 contains very few Radiolaria. The opposite pattern is observed above OAE-2 (few Radiolaria at site 1258, more abundant at site 1261). The paucity or absence of Radiolaria within the OAE-2 interval may be due to the upward excursion of the chemocline in the southern part of the Northern proto-Atlantic. Upwelling of deep warm waters may have fuelled primary productivity (sulfate-reducing bacteria) but prevented at the same time micro-zooplankton survival and proliferation after intensification of euxinic conditions in the surface waters.

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Résumé

De rares Radiolaires sont présents dans l'intervalle Cénomaniensupérieur – Turonien inférieur des argilites finement laminées des sites 1258 et 1261 du plateau de Demerara (Leg 207 de ODP, Atlantique tropical au large de Surinam). La faune observée est d'une très faible diversité, avec un maximum de 12 espèces par échantillon et 49 espèces déterminées en tout dans l'ensemble des deux sites. Les assemblages sont équitablement représentés par des Nassellaires et des « Spumellaires ». Diverses espèces de *Stichomitra* et de *Theocampe* sont fréquentes, y compris les deux espèces nouvellement décrites : *Theocampe costata* et *T. demeraraense*. La préservation des Radiolaires est en moyenne modestement

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bonne à pauvre, ce qui suggère une influence d'altérations diagénétiques au niveau de la diversité spécifique. De rares associations, bien préservées, ont le potentiel de fournir une meilleure idée de la biodiversité originale des Radiolaires, mais étant donné leur faible niveau d'abondance dans les échantillons traités, la diversité échantillonnée pendant cette étude est clairement une sous-estimation de la diversité originale des Radiolaires polycystines du Cénomanien-Turonien de Demerara. Néanmoins, il est intéressant de souligner l'abondance et la diversité du genre *Theocampe* dans les niveaux du Cénomanien supérieur. Selon la plus ancienne présence connue de ce genre dans des sédiments de l'Albien supérieur du bassin profond de Côte d'Ivoire, il est possible d'envisager que le genre est né et diversifié dans le corridor Atlantique équatorial. Sur la base de la courbe isotopique du Carbone, l'intervalle correspondant à l'événement anoxique OAE-2 est clairement déterminé dans la série sédimentaire des deux sites étudiés, ce qui nous a permis de préciser la répartition stratigraphique de trois espèces : *Acanthocircus hueyi*, *Archaeospongoprimum bipartitum* et *Rhopalosyringium hispidum*. Le résultat le plus intéressant de notre étude est la pauvreté des Radiolaires au sein de l'intervalle OAE-2 du site profond 1258 et leur absence totale dans le même intervalle du site 1261. Les Radiolaires sont plus abondants et plus diversifiés en-dessous de l'intervalle OAE-2 du site distal 1258, alors que le site proximal 1261 contient de très rares Radiolaires. Le contraire est observé au-dessus de l'intervalle OAE-2 (très rares Radiolaires au site 1258 et plus abondant au site 1261). La quasi-absence des Radiolaires au sein du niveau OAE-2 milite contre les modèles d'une fertilisation généralisée des océans (par le fer et des métaux). Une excursion de la chémocline vers le haut pourrait éventuellement être l'hypothèse qui explique le mieux l'enregistrement des Radiolaires dans la partie méridionale du proto-Atlantique septentrional : une productivité primaire élevée mais des conditions chimiques défavorables pour le pullulement du micro-zooplancton.

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1. Introduction

The Late Cenomanian–Early Turonian interval is of considerable interest to paleoceanography and paleobiology because of the presence of a globally recognized oceanic anoxic event (OAE-2), which had a profound impact on the evolution and productivity of the marine biosphere (Kuhnt et al., 1986; Hallam and Wignall, 1997; Harries and Little, 1999; Leckie et al., 2002). An improved understanding of the ecological disruption caused to pelagic ecosystems by OAE-2 may be obtained by studies of the biodiversity and abundance of planktonic organisms, especially those plankton groups capable of generating biogenic sediments. Among the fossilized plankton, Radiolaria appear to have responded to the environmental perturbation of OAE-2 by significantly changing their abundance and assemblage composition (Erbacher and Thurow, 1997; Premoli Silva et al., 1999; O'Dogherty and Guex, 2002). However, our current understanding of the Radiolarian response to OAE-2 is based essentially on data from Umbria-Marche of Italy (Marcucci et al., 1991; Erbacher and Thurow, 1997; Salvini and Marcucci Passerini, 1998; O'Dogherty and Guex, 2002).

Still little is known about the Radiolarian record from the Atlantic Ocean with respect to this critical interval in Earth and Life history. Early studies of DSDP material from the Atlantic (Fig. 1) reported Cenomanian Radiolaria from sites drilled west of Africa (i.e. Sites 136, 137 and 138; Petrushevskaya and Kozlova, 1972). Kuhnt et al. (1986) and Thurow (1988) are the first to have more specifically discussed the radiolarian record during OAE-2 in the central and northern parts (respectively) of the Northern proto-Atlantic. Finally, Erbacher and Thurow (1997, 1998) revised and synthesized existing data from DSDP/ODP sites from the Northern proto-Atlantic and tried to interpret the radiolarian faunal patterns in relation to paleoceanographic changes.

No data exist so far for the southern part of the Northern proto-Atlantic. The present study attempts to fill this gap, by

presenting the diversity and abundance of Radiolaria as preserved in pelagic sediments of the deep passive margin of Demerara Rise (Leg 207; Erbacher et al., 2003, 2004). The high-resolution C-isotope curve recently established by Erbacher et al. (2005) for the Cenomanian–Turonian boundary interval of Demerara provides a valuable stratigraphic/time framework to explore the Radiolarian response to OAE-2 in the tropical proto-Atlantic.

2. Geological and stratigraphic framework

Demerara Rise is a subsided part of the south American continental margin (Fig. 2). It was recently drilled during Leg 207 (Erbacher et al., 2003, 2004) along a bathymetric transect to recover expanded, but shallowly buried sediments of Cretaceous to Paleogene age. Albian sediments of essentially terrigenous nature (clay, siltstone, sandstone) are the oldest drilled stratigraphic levels and apparently come from the top of the synrift sequence. They are overlain by Cenomanian to Santonian finely laminated black shales, which accumulated on a thermally subsiding ramp. The overlying sediments are essentially made of Uppermost Cretaceous to Oligocene chalk (Erbacher et al., 2003; Danelian et al., 2005).

Our study focused on the Upper Cenomanian to Lower Turonian interval of black shales of two sites situated along a bathymetric transect: Site 1258 being located at the deepest end (3192 m of water depth), Site 1261 at the shallowest end (1899 m of water depth). Black shales are rich in organic matter of marine origin, with mean TOC values of ca. 5%, rising up to 29% within the OAE-2 interval (Erbacher et al., 2004). Black shales contain well-preserved fish debris and phosphatic nodules. Light colored, laminated foraminiferal packstones and wackestones may also occur. The OAE-2 interval is delimited by the C-isotope curve established by Erbacher et al. (2005), which allows detailed correlation amongst the investigated sites and with other OAE-2 intervals worldwide. Site 1261

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