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Maxime Renaud, Bertrand Lefebvre, Denis Bailliot, M-N Bailliot, Sophie Coat, et al.. First report of the mitrate *Mitrocystella* (Echinodermata, Stylophora) in the Middle Ordovician of the Crozon Peninsula, Brittany (France). *Estonian Journal of Earth Sciences*, 2023, 72 (1), pp.86. 10.3176/earth.2023.57 . hal-04271102

HAL Id: hal-04271102

<https://hal.science/hal-04271102v1>

Submitted on 5 Nov 2023

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SHORT COMMUNICATION

First report of the mitrate *Mitrocystella* (Echinodermata, Stylophora) in the Middle Ordovician of the Crozon Peninsula, Brittany (France)Maxime Renaud^a, Bertrand Lefebvre^{a*}, Denis Bailliot^b, Marie-Noëlle Bailliot^b, Sophie Coat^c, Christian Gaudu^{†d} and Muriel Vidal^e^a Univ Lyon, Univ Lyon 1, ENSL, CNRS, LGL-TPE, F-69622, Villeurbanne, France^b 84 Avenue du Maréchal Leclerc, F-29610 Plouigneau, France^c Réserve naturelle régionale des sites d'intérêt géologique de la presqu'île de Crozon – Communauté de communes presqu'île de Crozon - Aulne maritime, F-29160 Crozon, France^d 21, Poul Ranet, F-22970 Ploumagoar, France^e Laboratoire Géo-Océan, UMR 6538, UBO, Ifremer, CNRS, IUEM, F-29280 Plouzané, France* Corresponding author, bertrand.lefebvre@univ-lyon1.fr

Received 8 April 2023, accepted 28 April 2023, available online ...

Abstract. The mid-Ordovician mitrocystitid mitrate *Mitrocystella incipiens* was one of the most widespread stylophorans in the high latitude Mediterranean Province, with occurrences in the Armorican Massif (France), the Iberian Peninsula (Portugal and Spain) and the Prague Basin (Czech Republic), all restricted so far to the late Darriwilian (*Hustedograptus teretiusculus* Zone). The description of this taxon in the Corréjou Member (Postolonnec Formation) of the Crozon Peninsula (western Brittany, France) not only extends its spatial distribution within the Armorican Massif, but also its stratigraphic range into the mid-Darriwilian (*Didymograptus artus* Zone). The remarkable preservation of the new material and associated sedimentological evidence both suggest rapid burial by storm deposits.

Keywords: Armorican Massif, Echinodermata, Ordovician, Palaeobiogeography, Stylophora, Taphonomy.

INTRODUCTION

Stylophorans (cornutes, mitrates) are a clade of extinct, vagile echinoderms, which initially diversified on soft substrates during the Miaolingian (Zamora et al. 2013). In the Furongian–Floian interval, they were, along with eocrinoids and glyptocystitid rhombiferans, one of the dominant members of the low-diversity echinoderm faunas occurring worldwide before the major diversification of crinoids on hard substrates (Lefebvre & Fatka 2003). After this late Cambrian–Early Ordovician peak in both diversity and palaeobiogeographic distribution, stylophorans remained minor elements of benthic communities until their last appearance in the fossil record, in the Pennsylvanian of Oklahoma (Kolata et al. 1991). During the Darriwilian, the Armorican Massif (western France; Fig. 1) represents, along with the Prague Basin (Czech Republic), one of the two major diversity hotspots for stylophorans (Lefebvre & Fatka 2003; Lefebvre et al. 2022). This situation possibly results from the combination of originally favourable environmental conditions (widespread siliciclastic soft substrates) and over 150 years of regional sampling and scientific descriptions. Specimen labels in the collections of Rennes University indicate that, in April 1850, several individuals of the mitrate *Mitrocystella incipiens* were collected at Guichen (Ille-et-Vilaine; Fig. 1.1) by Marie Rouault in concretions of the Traveusot Formation (Darriwilian). Although possible occurrences of *Anatifopsis* sp. were mentioned by Tromelin & Lebesconte (1876) and Kerforne (1901) in regional faunal lists of Ordovician taxa, the first descriptions of Darriwilian stylophorans from the Armorican Massif were made by Chauvel (1937, 1941).

In the last decades, 10 stylophoran taxa were described in the Middle Ordovician of six distinct areas of the Armorican Massif (see Lefebvre 2000, Lefebvre et al. 2022 and references therein). In the Martigné-Ferchaud Syncline (Fig. 1.1), fine siltstones of the lower part of the Traveusot Formation (*Didymograptus artus* Zone) provided rare specimens of poorly preserved cornutes (*Domfrontia?* sp.) and mitrocystitid mitrates (*Aspidocarpus* sp.). In the same area, silico-aluminous concretions and shales of the upper part of the Traveusot Formation (*Hustedograptus teretiusculus* Zone) yielded the most diverse stylophoran assemblage of the Armorican Massif. This assemblage is dominated by extremely abundant remains of *Mitrocystella incipiens*, associated with relatively common kirkocystid mitrates (*Anatifopsis minuta* and *Balanocystites primus*), and rare representatives of anomalocystitids (*Diamphidiocystis regnaulti*), cornutes (*Domfrontia pissotensis*, *Milonicystis kerfornei* and *Thoralicarpus guilloui*), and lagynocystids (*Lagynocystis pyramidalis*). In the Ancenis Syncline (Fig. 1.2), the concretions of the Pierre Meslière Formation (*D. artus*–*Didymograptus murchisoni* zones) yielded rare individuals of the two mitrates *Lagynocystis pyramidalis* and *Mitrocystites mitra*. In the Menez-Belair Syncline (Fig. 1.3), several specimens of *Mitrocystella incipiens* were found at La Croixille, in upper Darriwilian shales (*H. teretiusculus* Zone) of the Andouillé Formation. In the Mortain-Domfront Syncline (Fig. 1.4), abundant remains of the cornute *Domfrontia pissotensis* were described in the fine siltstones of the Le Pissot Formation (*H. teretiusculus* Zone). In

the eastern part of the Châteaulin Syncline (Fig. 1.5), a single echinoderm-rich bed in shales of the upper part of the Postolon nec Formation (*H. teretiusculus* Zone) provided several flattened specimens of the mitrates *M. incipiens* and *D. regnaulti*. Finally, in the Crozon Peninsula (Fig. 1.6), the same levels yielded three specimens of *Aspidocarpus* sp.

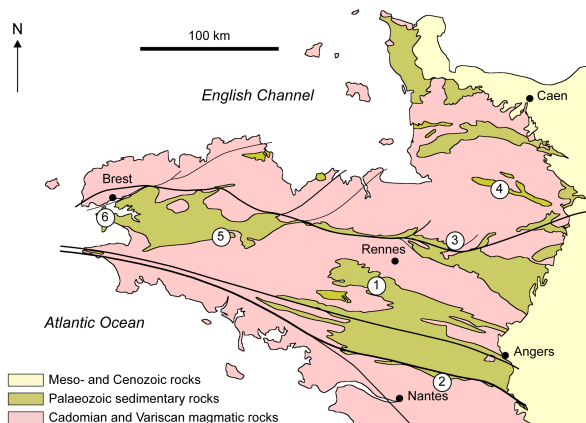


Fig. 1. Simplified geological map of the Armorican Massif (western France) showing the six main areas yielding Darrivilian stylophorans; 1, Martigné Ferchaud Syncline (Traveusot Formation); 2, Ancenis Syncline (Pierre Meslière Formation); 3, Menez-Belair Syncline (Andouillé Formation); 4, Mortain-Domfront Syncline (Le Pissot Formation); 5, eastern part of the Châteaulin Basin (Postolon nec Formation); 6, Crozon Peninsula (Postolon nec Formation).

The aims of this paper are to report the first occurrence of the mitrate *Mitrocystella* in the Crozon Peninsula and to discuss its preservation and palaeobiogeographic implications.

MATERIALS AND METHODS

In March 2021, several mitrate-like pyritized fossils were identified in the lowermost part of the Corréjou Member of the Postolon nec Formation (*D. artus* Zone, mid Darrivilian; Dabard et al. 2015) exposed on the Notinau beach, in Camaret (Crozon Peninsula, Finistère; Fig. 1.6), on the territory of the regional natural reserve of Crozon Peninsula (for a detailed description of local stratigraphy and palaeontology, please see e.g. Henry 1980; Guillocheau 1983; Loi & Dabard 2002; Dabard et al. 2007, 2015; Vidal et al. 2011). Once all official authorizations were obtained, a large rock sample containing the two, side-by-side, best-preserved specimens (Fig. 2A) was extracted from the cliff and registered in the palaeontological collections of the University of Western Brittany, in Brest. Two thin sections (also registered at the Brest University) were made perpendicularly to the bedding plane (Fig. 2B), so as to describe the associated lithology. As the two mitrates are preserved as 'negative' empty moulds in the rock, they were cast with latex, so as to better visualize their original 'positive' morphology. The two individuals were drawn with a camera-lucida apparatus mounted on a Zeiss SteREO Discovery.V8 stereomicroscope binocular. Photographs were made with a Canon 5DSR camera equipped with a MP-E 65 mm macro-lens.

RESULTS AND DISCUSSION

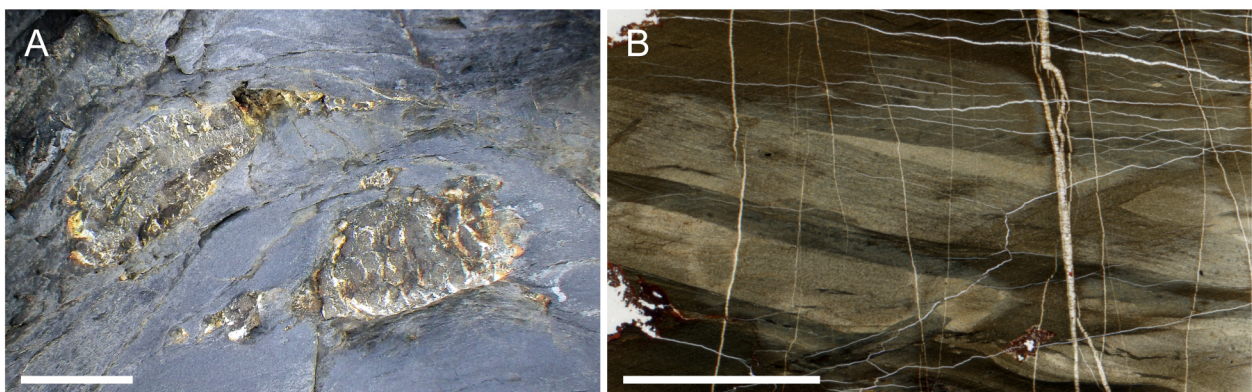


Fig. 2. **A**, two original individuals of *Mitrocystella incipiens* in lower (left specimen) and upper aspect (right individual), LPB 10711; Corréjou Member, Postolon nec Formation (*D. artus* Zone, middle Darrivilian), Notinau beach (Camaret, Finistère); **B**, thin section (BR3184/Notinau1) cut perpendicularly to the mitrate-bearing rock sample, with two distinct beds of very fine siltstones (distal tempestites) embedded within thinly laminated mudstones (background sedimentation). All scale bars: 10 mm.

Although they are strongly flattened, the two individuals can be unambiguously identified as stylophorans, based on the presence of two distinct parts: a relatively massive, polyplated theca and, articulated to it, a single feeding appendage (aulacophore) comprising a wide proximal region made of several telescopic rings, and a narrower distal part (Fig. 2A). Moreover, the preservation of their aulacophore in a recurved position indicates that these two stylophorans correspond to mitrates (cornutes were unable to flex their distal appendage; Lefebvre 2003). The absence of posterior spines (digital and/or glossal), along with the main features of their plate pattern on the two contrasted thecal sides make it possible to unambiguously assign these two mitrates to the mitrocytistid *Mitrocystella incipiens* (see e.g. Hunter et al. 2007 for similarly preserved specimens of *M. incipiens* in shales of the same formation, in the eastern part of Châteaulin Basin; Fig. 1.5).

The material collected in Camaret (Notinau beach; Fig. 1.6) at the base of the Corrèjou Member thus represents the stratigraphically earliest occurrence of *Mitrocystella incipiens* in the Armorican Massif (*D. artus* Zone, middle Darriwilian). In all other localities (Martigné-Ferchaud and Menez-Belair synclines, eastern part of the Chateaulin Basin; Fig. 1.1,3,5), it was always found within the same, younger stratigraphic interval (*H. teretiusculus* Zone, upper Darriwilian). However, the palaeobiogeographic distribution of *Mitrocystella incipiens* is not restricted to the Armorican Massif. During the Middle Ordovician, this mitrate was widely distributed in several other regions of the high-latitude Mediterranean Province. It was originally described in the Prague Basin, where it is relatively common in silico-aluminous concretions of the Dobrotivá Formation (*H. teretiusculus* Zone) (Barrande 1887, Chauvel 1941, Prokop & Petr 1999). Rare specimens of *Mitrocystella incipiens* were also reported in the lower Guindo Shales (*H. teretiusculus* Zone) in the Hesperian Massif, Spain (Chauvel & Meléndez 1978, Gutiérrez-Marco & Meléndez 1987), and in the Valongo Formation (*H. teretiusculus* Zone) in northern Portugal (Gutiérrez-Marco & Meléndez 1987, Couto & Gutiérrez-Marco 2000). Finally, a single specimen of mitrocytistid from the Pontyfenni Formation (Dapingien) of Wales was tentatively described as *Mitrocystella?* sp. by Jefferies (1987). However, its incomplete preservation (posterior half of the theca missing) precludes any firm taxonomic assignment. Consequently, this overview of all known occurrences of *Mitrocystella incipiens* indicates that the specimens from the lowermost levels of the Corrèjou Member in Camaret represent the earliest known record of this taxon. Everywhere else, its stratigraphic distribution is restricted to the late Darriwilian.

Thin sections (Fig. 2B) exhibit thinly laminated sediment, with mudstones interbedded with two distinct beds, each with a sharp base and consisting of siltstones to very fine sandstones with low-angle to planar, wavy laminations. These observations suggest the occurrence of two distinct 'event beds' (very fine sandstones), probably corresponding to relatively distal storm deposits, interbedded with thinly laminated mudstones suggesting relatively quiet environmental shelf conditions (background sedimentation). This interpretation is in good accordance with previous field observations and detailed sedimentological analyses of the lower part of the Postolonnec Formation (base of the Corrèjou Member) in Crozon peninsula, all indicating environmental conditions corresponding to a storm-influenced shelf (Guillocheau 1983; Loi & Dabard 2002; Dabard et al. 2007, 2015).

Similarly to the situation in extant echinoderms (Brett et al. 1997), it is very likely that the stylophoran multi-plated endoskeleton disarticulated rapidly (i.e. within a few weeks) after the death of the organism (Lefebvre 2007). Consequently, the preservation of intact, fully articulated mitrates in Camaret (Fig. 2A) implies that they were buried either alive or shortly after death. This interpretation is further supported by the preservation of their aulacophore in flexed position, which is generally interpreted either as a distressed posture and/or as resulting from the post-mortem, ligamentary-induced contraction of the appendage (Lefebvre 2003). When they are preserved in life position, mitrates have their feeding appendage held almost straight over the sea floor (Parsley & Gutiérrez-Marco 2005, Lefebvre & Ausich 2021). Moreover, the opposite, upside-down orientations of the two side-by-side individuals (one is in upper aspect and the other one in lower aspect) clearly demonstrate that they are not preserved in life position. These taphonomic observations are in good accordance with sedimentological data (see above) suggesting storm-influenced environmental conditions. Consequently, the remarkable preservation of the two specimens of *Mitrocystella incipiens* from Camaret probably results from their rapid burial, soon after death, by storm deposits.

CONCLUSIONS

The description of the mitrate *Mitrocystella incipiens* in the lower part of the Postolonnec Formation (Corrèjou Member) in the Crozon peninsula not only increases its distribution across the Armorican Massif, but it also represents the earliest known record of this taxon in the whole Mediterranean Province. Taphonomic characteristics of the specimens and associated sedimentological structures both suggest that the Notinau mitrates were very likely buried soon after death by storm deposits.

Acknowledgements. This study is a contribution to the IGCP Project 735 "Rocks and the Rise of Ordovician Life". The authors are particularly grateful to Martina Nohejlová and an anonymous reviewer for their helpful and constructive remarks, which helped improving the MS. Romain Vaucher greatly helped with the sedimentological interpretation of the thin sections, and Damien Gendry provided access to the Chauvel collections at Rennes University, and important information on Armorican localities.

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