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Original article

Noteworthy brachiopods of the Cenomanian stratotype: A synthesis of the biochronological, palaeoenvironmental and palaeoecological implications☆

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ABSTRACT

This study contributes to a general revision of the Cenomanian stratotype that is currently in progress. Many organisms, including brachiopods, have been used to characterise the Cenomanian stratotype. Brachiopod species in the stratotype area have been previously only evoked or partially described; they include rhynchonelliform brachiopods belonging to Rhynchonellida, Terebratulida (Terebratulidina and Terebratellidina), and craniiform taxa. Their morphological descriptions are re-examined using new techniques, including scanning electron microscope analysis (SEM) of the shell microstructure and 3D reconstruction of the brachidium using X-ray micro-tomography. These new methodologies allow a better definition of taxa and therefore improve their biostratigraphical usage. Some brachiopod species are significant as biochronostratigraphical markers, especially for the middle (Jalais Level) and the upper Cenomanian (''Sables du Perche'', ''Marnes à *Ostrea biauriculata*'', ''Sables à *Catopygus obtusus*'', and ''Craie à *Terebratella carantonensis*''). Some features, both on and in the brachiopod shell, indicate the mode of life of these brachiopods (e.g., ichnofacies, parental attachment), and some shell modifications (e.g., microboring activities) inform on the palaeoecological conditions in the contrasted environments of the Cenomanian stratotype.

1. Introduction

Although gradually decreasing during the Mesozoic, brachiopods are still well represented during the Cenomanian. Le Mans (in Latin, *Cenomanum*), on the Maine Platform (Fig. 1(A, B)), has been chosen as the type Cenomanian for the marine facies (stage 20) by d'Orbigny (1847, 1852). Since that time, this region has remained important for Cretaceous stratigraphy, being the location for continued research (e.g., Guéranger, 1850, 1853, 1861, 1867; Sæmann, 1858; Guillier, 1886; Juignet, 1974, 1980; Juignet and Louail, 1987; Robaszynski et al., 1998; Lasseur, 2007). The ammonite zones listed by Hancock (1959) have been subsequently confirmed by Juignet et al. (1978) and Kennedy and Juignet (1993, 1994a, 1994b). Brachiopods, although often collected, have not been the focus of subsequent publications. The present synthesis contributes to a forthcoming revision of the Cenomanian stratotype. The brachiopod fauna has been already listed (Guéranger, 1853, 1861) and/or morphologically illustrated *pro parte* by d'Orbigny (1847–1851) and Owen (1988); for some species, multivariate analyses and microstructural observations have been introduced (Gaspard, 1982a, 1982b, 1988). More recently, the RX micro-tomography has been used to construct 3D models of the different types of brachidium, some of them from representatives of the Cenomanian stratotype (Gaspard, 2013).

Diagnoses and descriptions of the principal Cenomanian taxa have been revised, including both external and internal morphology as well as microstructural characteristics that are described here for the first time. The species belong to two of the three brachiopod subphyla proposed by Williams et al. (1996): the Craniiformea (uncommon) and the Rhynchonelliformea. In the latter, the principal sampled genera are: *Orbirhynchia*, *Grasirhynchia*, *Cyclothyris* in the Rhynchonellida; *Backhausina* in the Thecideida; *Sellithyris*, *Phaseolina*, *Terebratulina* in the Terebratulida/Terebratulidina; and *Gemmarcula* and *Kingena* in the Terebratulida/Terebratellidina. The stratigraphical positions of the taxa are confirmed (Fig. 1(C)). Some of them have a biochronological value and have been essentially found in Western Europe, although in a few cases they are also known from outside that area. Finally, evidence of life activity both on, and within the shell, are analysed

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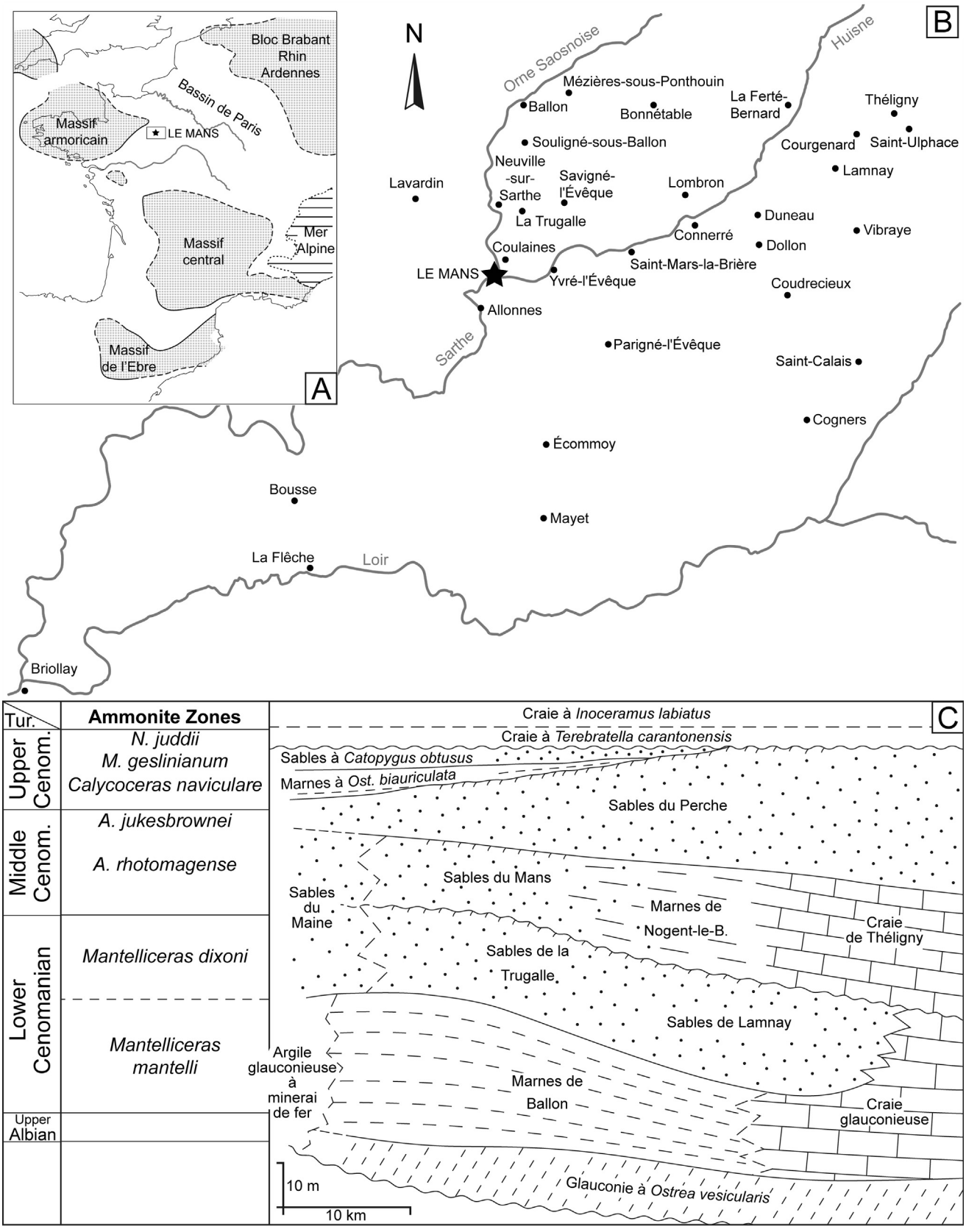

Fig. 1. A. Cenomanian stratotype: Le Mans, Maine Platform, France. **B**. Cenomanian localities with brachiopods. **C**. Cenomanian deposits in relation with the ammonite zonation (modified after Juignet et al., 1978).