Cretaceous Research 45 (2013) 76–90

Contents lists available at ScienceDirect

Cretaceous Research

journal homepage: www.elsevier.com/locate/CretRes

Broeckina gassoensis sp. nov., a larger foraminiferal index fossil for the middle Coniacian shallow-water deposits of the Pyrenean Basin (NE Spain)

Esmeralda Caus [a,*], Mariano Parente [b], Vicent Vicedo [c], Gianluca Frijia [d], Ricard Martínez [a]

[a] Departament de Geologia (Paleontologia), Universitat Autònoma de Barcelona, Spain
[b] DiSTAR, Università di Napoli "Federico II", Italy
[c] Museu de Ciències Naturals de Barcelona (Paleontologia), Barcelona
[d] Institut für Erd- und Umweltwissenschaften, Universität Potsdam, Germany

ARTICLE INFO

Article history:
Received 28 June 2013
Accepted in revised form 2 August 2013
Available online 13 September 2013

Keywords:
Larger Foraminifera
Biostratigraphy
Strontium isotope stratigraphy
Coniacian
Pyrenees
Spain

ABSTRACT

The Upper Cretaceous shallow-water carbonates of the Pyrenean Basin (NE Spain) host rich and diverse larger foraminiferal associations which witness the recovery of this group of protozoans after the dramatic extinction of the Cenomanian–Turonian boundary interval. In this paper a new, large discoidal porcelaneous foraminifer, *Broeckina gassoensis* sp. nov., is described from the middle Coniacian shallow-water deposits of the Collada Gassó Formation, in the Bóixols Thrust Sheet. This is the first complex porcelaneous larger foraminifer of the Late Cretaceous global community maturation cycle recorded in the Pyrenean bioprovince. It differs from the late Santonian–early Campanian *B. dufrenoyi* for its smaller size in A and B generations and the less developed endoskeleton, which shows short septula. *Broeckina gassoensis* sp. nov. has been widely employed as a stratigraphic marker in the regional geological literature, under the name of "*Broeckina*", but its age was so far controversial. Its middle Coniacian age (lowermost part of the *Peroniceras tridorsatum* ammonite zone), established in this paper by strontium isotope stratigraphy, indicates that it took about 5 My after the Cenomanian–Turonian boundary crisis to re-evolve the complex test architecture of larger foraminifera, which is functional to their relation with photosymbiotic algae and K-strategy.

1. Introduction

The evolution of foraminifera is punctuated by some episodes of drastic reduction of diversity (i.e. mass extinctions) coinciding with geologically short phases of global palaeoenvironmental perturbation (Brasier, 1988). During these crises, the rich inventory of functional morphological traits, accumulated during long phases of diversification and adaptive specialization, is suddenly lost. Each crisis affected most severely the larger foraminifera, i.e. the largest size and more specialized taxa, which represent symbiont-bearing K-strategists adapted to oligotrophic conditions (Hottinger, 1982, 2000; Hallock, 1985, 1987; Lee, 2006). After each crisis it took an extended time-period (some millions of years) to re-evolve the complex architecture supporting symbiont-hosting and K-strategy. This pattern of diversity evolution repeated several times during the long history of larger foraminifera, with some regularity that have been codified by Hottinger (1998, 2001) in the concept of Global Community Maturation cycle (GCM), which is defined as a period of continuous, gradual biotic change between two discontinuities represented by mass extinctions. After a first phase of slow recovery following the mass extinction, marked by the absence of larger foraminifera, there is a phase of diversification, marked by the appearance of a considerable number of new genera. In the next phase one or two representatives per basic body plan start to dominate by number of specimens and by size. Then, there is a sudden diversification of the species belonging to the dominant genera, marking the full recovery of K-strategy. This stage will last as long as environmental conditions remain undisturbed.

During the Cenomanian–Turonian boundary (CTB) interval the larger foraminifera of the middle Cretaceous GCM cycle suffered a dramatic mass-extinction (Calonge et al., 2002; Parente et al., 2008; Caus et al., 2009). Part of the "heritage" of larger foraminifera, like the different types of test texture and chamber arrangement or the life cycle with alternating sexual and asexual generations, survived in smaller foraminifera (r-strategists) (Hottinger, 2001). Other morphological traits, functional to hosting photosymbionts, like the

* Corresponding author.
E-mail address: esmeralda.caus@uab.es (E. Caus).

0195-6671/$ – see front matter © 2013 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.cretres.2013.08.002

endoskeletal and exoskeletal elements allowing subdivision of the chamber lumen, were completely lost in many lineages and had to be re-evolved anew during the next cycle. The recent studies of the Late Cretaceous GCM cycle suggest that the K-strategy was not recovered until the middle Coniacian–early Santonian, about 5–8 My after the CTB crisis (Boix et al., 2009; Hottinger and Caus, 2009; Boix et al., 2011).

At the southern margin of the Pyrenean Basin, the eutrophication of shallow marine environments near the CTB not only caused the extinction of the larger foraminifera but also severely reduced carbonate production (Caus et al., 1997). Platform drowning closely followed the larger foraminifera extinction (Drzewiecki and Simó, 1997). Cenomanian shallow-water carbonates are sharply overlain by the Turonian "*Pithonella* limestones" (Souquet, 1967). These sediments, which were deposited in a relatively deep open platform, contain abundant calcisphaerulids, planktonic foraminifera and small benthics. Larger foraminifera are totally absent.

After the deposition of the "*Pithonella* limestones", tectonics and a relative sea-level fall caused, in many areas of the south-central Pyrenees, a period of non-deposition, subaerial exposure and/or erosion, which comprises at least the late Turonian–early Coniacian (Boix et al., 2011). However, in the areas of the Sant Corneli-Bóixols Anticline and Santa Fe Syncline (NE Spain, Figs. 1 and 2) the sedimentation continued above the "*Pithonella* limestones" with a thick succession of marls, marly limestones and limestones. Open platform middle–upper Turonian marls and marly limestones with planktonic foraminifera and ammonoids pass upward into shallow-water carbonates. The latter are represented by two successive lithostratigraphic units, the Congost and Collada Gassó formations, which are widely exposed along both flanks of the Sant Corneli-Bóixols Anticline and Santa Fe Syncline. The Congost Formation is constituted mainly by massive limestones with corals and rudists. The Collada Gassó Formation is represented by sandy limestones and marls with fragmented oysters, small benthic foraminifera and a large, discoidal, very flat porcelaneous foraminifer, which marks the recovery of the K-strategy after the CTB crisis. This larger foraminifer has been widely employed, under the name of "*Broeckina*", as a regional stratigraphic marker for mapping and correlating discontinuous outcrops (Conesa, 1979; Caus et al., 1981; Gallemí et al., 1982, 1983). However, despite its common use, its morphology and systematic position have been never described in detail and its age has remained controversial.

The aims of this paper are: a) to formally describe this larger foraminifer as the new species *Broeckina gassoensis*; b) to discuss its systematic position and the differences and similarities with previously described taxa; c) to calibrate its chronostratigraphic age by means of strontium isotope stratigraphy, producing the first direct dating of the Collada Gassò Formation; d) to discuss the implications of this refined chronostratigraphic dating on the correlation of the Upper Cretaceous Units of the Bóixols Thrust Sheet with those outcropping in the Montsec Thrust Sheet; e) to briefly comment on the pattern of recovery of larger foraminifera after the CTB crisis.

2. Geological setting

The study area is located in the Bóixols Thrust Sheet that, together with the southern Montsec and Serres Marginals thrust sheets, forms the Upper Thrust Sheets of the south-central Pyrenees, a southern piggy back thrust sequence detached on the Late Triassic evaporites (Muñoz et al., 1986).

The Bóixols Thrust Sheet developed during the late Santonian to Maastrichtian. It consists mainly of Lower Cretaceous rocks, but Upper Cretaceous deposits are also represented. The Upper Cretaceous units correspond to two tectonostratigraphic phases: the "Transition phase", from the middle–late Cenomanian to the middle Santonian, and the "Convergence phase", from late Santonian to Maastrichtian (Berástegui et al., 2002). In this work only the units belonging to the "Transition phase" are briefly described.

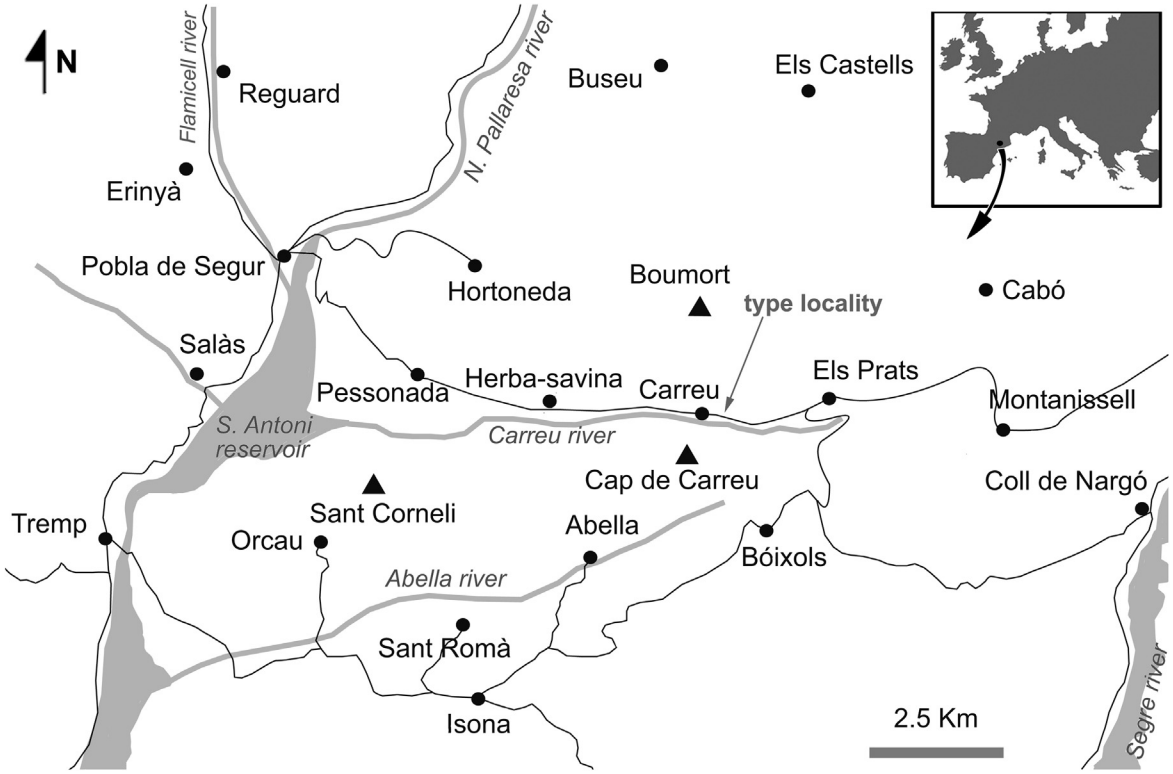

Fig. 1. Geographical sketch map of the study area, with the position of the type-locality of *Broeckina gassoensis* sp. nov.