XXIX Jornadas de Paleontología

Simposio del Proyecto PICG 596

LIBRO DE RESÚMENES

C. Álvarez-Vázquez e I. López Rodríguez (eds.)
Real Jardín Botánico de Córdoba
Córdoba, 2013

Unionoids (Bivalvia) and their associated microbialites from the Late Jurassic of Asturias (Spain)

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Introduction

Freshwater bivalves from the Jurassic of Spain are poorly known. However, recent studies on the Late Jurassic of Asturias have led to a review of their occurrence across the sequence. Examination of the Vega Formation at Abeu (Ribadesella) showed the presence of some bivalves, which we believe to be the oldest fossil record of Unionoida, currently known from Spain. The bivalves are preserved as elongate, bulb-shaped oncoids with different outlines developed around the bivalves. Most of the valves, both isolated and articulated, are covered with a compact calcite crust, which is thicker in isolated valves (up to 9.4 mm thick) than in articulated ones (up to 2 mm thick). The analysis of the crust in detail shows that it corresponds to calcified microbialitic coatings associated with the bivalves. From another section at Huerres (Colunga) similarly the specimens have little value for taxonomical purposes, but good development of crusts on their shells, has allowed the study of the nature and origin of the crusts.

Geological framework

The Vega Fm (Kimmeridgian) comprises alternating white, grey and reddish sandstones, with red mudstones and some conglomeratic beds, typically deposited as minor fining-upward cycles within a major cycle of the same character. Algal limestones from the Upper Jurassic series of Asturias were reported by Virgili *et al*. (1968). The Vega Fm represents fluvial deposits formed by ephemeral and highly sinuous streams separated by inter-channel areas with calcareous palaeosols (caliches) and sporadic ponds with high microbial activity where micritic grey limestones with oncoids were deposited. These ponds were partly fed by a number of freshwater carbonate-rich springs coming from synsedimentary faulted zones related to a rifting phase developed during Late Jurassic-Early Cretaceous times (García-Ramos *et al*., 2010). The climate was semi-arid with sporadic rainy episodes.

Materials and methods

This research is based on 20 samples for taxonomy and for analysis of crusts coming from the Abeu and Huerres sections. Those samples not useful for taxonomical descriptions were prepared as polished and/or thin sections, and observed by binocular, petrographic and Scanning Electronic microscopes. We examined the microbialites that partially cover the bivalve shells and oncoids whose nucleus is an isolated valve.

Results

The development of the microbialites, macro and microscopically, is very similar in the samples of the two sections; the microbialite coatings are 5.3 to 9.4 mm thick. They show a micropustular surface. The coatings are composed of an alternation of dark and light laminae, the dark one in contact with the shell. From base to top, the microstructure consists of 1) flat or slightly wavy, around 500 µm in thickness; and 2) an interval made of several domes with a thickness of approximately 1 mm. The upward growth of the domes results in the development of tiny cones, some incipiently branched. In samples of both sections, pyrite (10-50 μm) is dispersed in the micrite. The pyrite included in the matrix of the rock is much larger (maximum 500 μm). However, we can observe some differences between samples from Abeu and Huerres. In the former, the original aragonitic shell is neomorphized to calcite (mosaic of sparite). The primary porosity among well developed domes is occupied by mostly calcite spar, with scarce detritic elements (crystals of quartz) and occasionally gypsum. In the latter, the shell is totally dissolved and the space it occupied, totally collapsed. This process is described by Leinfelder & Hartkopf-Fröder (1990) and Astibia *et al.* (2012) in Tertiary and Cretaceous oncoids respectively. Within the microbialite, we observe sinsedimentary cracks, parallel to the lamination, which are filled with the matrix rock. The primary porosity is exclusively cemented by spar calcite and scarce detrital grains.

SEM observations show two types of calcite micrite (1 and 2). Type 1 is a compact mass of rounded crystals of 2 to 8 microns across. Its composition (EDX) shows traces of Fe. Type 2 is a porous mass of irregular crystals of 5 to 10 μm across, with no traces of Fe.

Discussion/conclusions

The development of domes and cones gave an increase of the surface used by the microorganisms responsible of the building. There is no polarity in the samples and some of them present the thicker microbialite on the concave part and other ones on the convex part. The initial growth of the microbialite (dark laminated lamina) could be related to the formation of biofilms on the periostracum of the shell. If film growth occurred during the life of the bivalve it could explain why the articulated specimens show a much thinner crust compared to isolated valves. Several cases of these biofilms on live marine recent bivalves (Gillan & Ridder, 1997) are known. The dark layers of the microbialite are composed of type 1 micrite, therefore, the dark colour could be attributed to the traces of Fe. The high porosity of type 2 micrite could be related to cyanobacterial filament ghosts as Leinfelder & Hartkopf-Fröder (1990) interpreted. Gypsum in specimens from Abeu section could be interpreted as indicative of saline conditions, perhaps linked higher evaporation.

Acknowledgements. Funds by project CGL2009-11838, and IGME. Thanks to Dr. Concha Arenas (Univ. Zaragoza) for comments on the manuscript.

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