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PALAEOECOLOGICAL SIGNIFICANCE OF RUDIST CONSTRUCTIONS: A CASE STUDY FROM LES COLLADES DE BASTURS (UPPER CRETACEOUS, SOUTH-CENTRAL PYRENEES)

Rudist thickets constitute a significant and important characteristic of the Upper Cretaceous carbonate platform of les Collades de Basturs, south-central Pyrenees. These rudist constructions are largely formed by long cylindrical hippocrinds growing upward, in close proximity, and constructing an organic framework. Rudists are to some extent mutually supporting, with no more than a few individuals attached together and the area of contact generally involves only a small part of the shell. Interstitial spaces are filled by matrix sediment which consists predominantly of lime mud and angular and unsorted rudist fragments. This is interpreted as a local accumulation of bioclasted skeletal sediment by intense in situ bioerosion. The growing rudist construction was in part supported by this infilling sediment. Characteristically, rudist thickets are of metric thickness and essentially lenticular or tabular in shape, not showing evidence of topographical relief. There is not much rudist species diversity and associated microfauna is very poor. In this area, rudist thickets are characteristic of shallow marine environments with restricted water circulation. Their high content in lime mud and the angular and unsorted rudist fragments indicate the lack of permanent water agitation and transportation. The monospecific to paucispecific condition of rudist constructions and the paucity of other fossils reflect stress conditions (e.g. turbidity, high nutrient levels) in their environment of deposition.

Introduction

There is a significant number of higher invertebrate taxa that contain species capable of constructing an organic framework by virtue of their skeletal strength, volume and packing density. Most Holocene low-diversity organic frameworks are formed by gregarious animals (e.g. oysters, vermetids, serpulids), densely packed concentrations of which are largely due to strong larval substrate selection and rapid post-larval growth rates. They occur most commonly in shallow, turbid coastal embayments of non-normal marine salinities (Fagerstrom, 1987).

Rudist constructions in the Collades de Basturs carbonate platform (Upper Cretaceous, south-central Pyrenees) (Fig. 1) are examples of fossil, paucispecific, organic frameworks which developed in unfavourable ecological conditions. They are largely formed by long cylindrical rudist elevators that grew upward in close proximity and constructed an organic framework. In these constructions rudists were in part mutually supported and in part mechanically supported by infilling sediment. Previous sedimentological and paleoecological studies in this area (Gili, 1984) indicate that rudist thickets prospered in the restricted marine environments where water could have been turbid and rich in nutrients, in a shallow carbonate platform.

The Collades de Basturs rudist constructions have similar characteristics to Upper Cretaceous paucispecific rudist constructions in France described by Philip (1970) and Freydet (1973); in Israel (Bein, 1976); in Spain (Floquet, 1982); and in Gosau (Höffing, 1985).

The objective of this paper is to describe the rudist thickets of les Collades de Basturs and to discuss the parameters that controlled their development.

The term “thicket” is used in this study to mean a skeletal supported rudist construction formed by closely-packed rudist elevators. Rudist construction communities are analyzed using the structural model for reef communities described by Fagerstrom (1988). The rudist paleoecological classification used is that of Skelton & Gili (1991).

Geological setting

The Collades de Basturs carbonate platform makes up the K2/4 depositional sequence defined by Puigdefabregas & Souquet (1986) on the southern flank of the Sant Corneli anticline in the south-central Pyrenees. It was deposited on a shallow carbonate platform, with the shelf edge oriented northeast-southwest, during a relative rise of sea-level in Santonian times. Stratigraphically, the sediments of les Collades de Basturs belong to the Collades Member of the Abella Formation (Gallelli et al., 1982). The Collades Member comprise three back-stepping rudist-coral platforms up to 50 m thick.
and up to 3 km long, separated by drowning surfaces. Rudist-coral platforms consist of bioelastic deposits, paucispecific rudist constructions (i.e. rudist thickets) and mixed rudist and coral constructions (Gili, 1984). Discussion in this paper is restricted to the paucispecific rudist constructions.

**Anatomy of the rudist constructions**

**Organisms**

The taxonomic composition of the building guild varies from thicket to thicket but the structural
characteristics of their communities are similar, and will be discussed below.

The species diversity of the constructor guild is remarkably low in all rudist constructions; the framework constructors consist of just 1-3 species of hippuritid elevators. The long cylindrical rudist (Hipppuritella toucasi (d’Orbigny) Hippurites matheroni Douvillé, Hippurites praeccessor Douvillé, Hippurites socialis Douvillé, Hippurites sublaevis Matheron, Vaccinutes galloprovincialis (Matheron) is the dominant morphotype of the building guild; rudists of large cylindrical form (Vaccinutes galloprovincialis (Matheron), Vaccinutes giganteus major Toucas) are common minor components. It should be noticed that V. galloprovincialis (Matheron), which has a large cylindrical form when solitary or minor component of an organic framework, assumes a more elongated shape when it is a dominant framebuilder.

One characteristic of rudist thickets is the virtual absence of baffler and binder guilds. The abundance of mud in the matrix sediment suggests low energy. Nevertheless, petrographic data indicate that biological in situ activity rather than baffling processes could account for the internal sediment.

In fact, borings are commonly very abundant in the rudist fragments of the infilling sediment. Boring micro-organisms of the destroyer guild were thus probably responsible for the biological destruction and weakening of the rudist framework, which resulted in the formation of the bulk of the lime mud and rudist debris of the internal sediment.

The dweller guild consists of scarce rudist clingers (Sauvagesia aliciae Pons, Plagiptychus paradoxxus Matheron) and a few small colonial corals of spheroidal form. Most of the smaller corals (3-7 cm in diameter) occur in small groups whereas the larger ones (15 cm in diameter) are scattered between rudist constructors.

Matrix sediment

Sediment trapped in the open space between rudist elevators consist predominantly of lime mud and angular and unsorted rudist fragments; other common constituents are peloids. Usually, it is wackestone in texture but locally it can be fine packstone (figs. 2, 3).

Rudist bioclasts probably originated from the breakage of heavily bioeroded shells. Bioerosion can also account for the greater part of the lime mud. Nevertheless, in situ precipitation of micrite related to organic and/or chemical processes should not be ruled out before further investigation of this sediment is done.

Biofabric

In the field, rudists are observed to form dense parallel to subparallel growth fabrics oblique to bedding.

In the outcrop (Fig. 4), rudist shells appear to be in physical contact with each other, but successive cross-sections of blocks of rudist thickets (impregnated with polyester resin, Resipol ND-0059, and 0.5% Mec peroxide), reveal that rudists are usually loosely supported by neighbours with no more than a few individuals attached together and the area of contact involving only a small part of the shell. Area counts in the cross-sections show that close-packing
in rudist constructions ranges from highly dispersed fabrics (60% matrix sediments by superficial area) to densely packed concentrations containing less than 10% matrix sediment of the cross-section area. In general, sediment forms 20-30% of the rock surface area (Fig. 5). The proportion of rudist shells and infilling sediment in 15 samples from a number of rudist thickets is shown in figure 6.

Typically, rudists lie at 50°-60° to the vertical of the bedding (Fig. 7-B). And, though rudist orientation varies from thicket to thicket, rudists are generally inclined towards the south-southeast (Fig. 7-A). The preferential growth of rudists in this particular direction has been interpreted as growth in response to the prevailing current direction. This is consistent with the paleogeographic reconstruction of the Collades de Basturs carbonate platform (Gili, 1984) that suggests decreasing water energies to the southeast.

**Geometry and size**

Rudist constructions have typically a lenticular or tabular shape. Lenticular constructions exhibit thicknesses ranging from 0.5-5 m and widths of 15-30 m, and tabular rudist constructions are approximately 3-11 m wide and 50-70 m thick. They occur in isolation or in contiguous lateral and/or vertical succession. Large rudist thickets are usually composed of several individual units that represent successive rudist colonizations.

The size and shape of rudist thickets depends mainly on their location in the rudist-coral platforms. Rudist thickets of lenticular morphology are usually in the inner zone of the platform interbedded in bioclastic deposits, whereas tabular rudist constructions occur predominantly in the upper zone of the platform. Sediment accumulation along with substrate morphology may have determined the eventual shape of these rudist constructions.
low and low energy environments, exposed to occasional or periodic disturbance. Moreover, the monospecific to paucispecific condition of rudist constructions, along with the absence of normal marine biota (i.e. echinoids, brioza, calcareous algae, etc.) and the abundance of bioeroded skeletal material, reflect unfavourable ecological conditions (e.g. turbidity, high nutrient levels) in their setting of deposition.

Most rudist constructions overlay bioclastic deposits that are mainly rudist and coral floatstone with a wackestone to grainstone matrix. Rudist debris comprises the bulk of microscopic bioclasts along with coral fragments; other skeletal components include fragments of echinoderms, brioza, calcareous algae and benthic foraminifera. The great diversity of fossils present suggests the sediments were driven from adjacent, more open, marine environments to lower energy areas where mud could not be completely winnowed away. Nevertheless, some rudist thickets overlay sandy marls, thereby indicating that rudist growth and subsequent thicket development also started on muddy substrates.

Development of most rudist constructions may have begun in periods of calm in which apparently opportunistic hippuritid species characterised by large population sizes colonised bioclastic or sandy marl deposits. Displaced individuals and large clasts of fragmented rudists are often observed at the base of a thicket. These pioneer rudist shells, probably disturbed by occasional high energy conditions, along with the bioclastic sands furnished the rudists with ideal settlement sites for a successful development. The rudist framework embedded in the substrate developed at the same rate as the sediment deposited in it and around it, and at no time exceeded it. The
RIASSUNTO

I «thickets» a rudiste rappresentano una caratteristica significativa ed importante della piattaforma carbonatica del Cretaceo superiore di les Collades de Basturs, Pirinei centro-meridionali.

Questa costruzione è costituita da rudiste formate da hipurritidi cilindrici allungati che crescono verso l'alto (l'indicazione può essere interpretata come direzione prevalente delle correnti) in strettà vicinanza e che costruiscono una struttura organica. Le rudiste in qualche grado si sostengono un l'altro, con non più di pochi individui attaccati insieme e con l'area di contatto che generalmente coinvolge solo una piccola parte del guscio. Gli spazi interstiziali sono riempiti da una matrice che consiste prevalentemente di fango limoso e di frammenti di rudiste angolosi e non classificati. Ciò viene interpretato come un accumulo locale di sedimento scheletrico oggetto di intensa bioerosione in situ. La costruzione a rudiste che cresceva era in parte sostenuta da questo sedimento di riempimento che comunque, in sezione trasversale, costituiva il 20-30% dell'area biocostruita. Di solito i «thickets» a rudiste hanno spessore dell'ordine del metro e forma essenzialmente lenticolare o tabulare, senza mostrare evidenza di rilievo topografico. Lateralmente i «thickets» lentiformi misurano circa 10 m, mentre quelli tabulari si possono estendere per decine di metri. Essi si trovano isolati o in successione verticale e laterale continua. Normalmente ampi «thickets» a rudiste sono formati da numerose unità che rappresentano colonizzazioni di rudiste successive. Non esiste molta diversità specifica tra le rudiste e la macrofauna associata è molto povera. In quest'area, i «thickets» a rudiste sono caratteristici di ambienti marini di acque basse e con circolazione ristretta. Il loro alto contenuto in fango limoso e i frammenti angolosi e non classificati di rudiste indicano la mancanza di continua agitazione delle acque e di trasporto. Le concentrazioni bioclastiche prodotte da eventi di tempesta producevano substrati adatti per l'attecchimento delle larve. Periodi di ridotta sedimentazione davano eccellenti opportunità alle rudiste per colonizzare questi sedimenti. La condizione da monospecifica a pausisspecifica delle costruzioni a rudiste e la scarsità di altri fossili riflettono condizioni di stress (ad esempio torbidità, alti livelli di nutrienti) nel loro ambiente di deposizione.
REFERENCES


