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ROVEACRINUS BERTHOUI NOV. SP., EARLY HAUTERIVIAN REPRESENTATIVE OF ROVEACRINIDAE (ROVEACRINIDA, CRINOIDEA) OF BUSOT (ALICANTE, SPAIN)

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Abstract: A new roveacrinid microcrinoid, *Roveacrinus berthoui* nov. sp., is described from the Lower Hauterivian marly limestones at Busot (Alicante, SE Spain). It represents the first record of this family from pre-Albian strata, and as such, constitutes a major stratigraphic and taxonomic advance in our knowledge of this unusual fossil crinoid group.

Key words: Cretaceous, Hauterivian, Spain, Alicante, Echinodermata, Roveacrinida, Roveacrinidae.

Introduction

In the province of Alicante (SE Spain), Mesozoic series crop out due to structural anomalies referred to "extrusions à noyau dur" (Polvêche 1963). In the Prebetic and Subbetic domains, the Hauterivian series are usually incomplete and condensed, in contrast to the relatively thick series developed at Busot (Fig. 1; Granier 1993). This is explained by the peculiar position of this locality at the edge of the Berriasian platform. During the Early Valanginian, an important transgressive wedge related to the platform flexure and subsequent drowning developed at the edge, on the slope basinwards and far beyond (Busot, Fig. 2). During the Late Valanginan–Hauterivian interval, the initiation of block-tilting induced condensation and/or erosion phenomena on the one hand, particularly on local highs, and sediment trapping in grabens and/or half-grabens on the other (Fig. 2). Such an environment favoured the preservation of Hauterivian deposits at Busot. Twenty kilometres NNE of Alicante, the village of Busot is located at the SW end of a Mesozoic belt called "bande à anomalies structurales de Busot-Altea" (Granier 1987). There, Lower Cretaceous (Valanginian to Aptian) deposits crop out within a hardcore extrusion complex. South of the village, two Cretaceous hills consist of Hauterivian marly limestones. These bioclastic carbonates with wackestone texture yield abundant small benthic foraminifers, echinoderm fragments, ammonites and calpionellids as autochthonous assemblage components. They also contain reworked, worn and micritized microfossils, mostly large benthic foraminifers and calcareous algae. However, reworking is limited and neither slumps nor conglomerates have yet been documented.

While the wackestone marly limestone displays a micritic matrix, the high-magnesium calcite (HMC) network of the echinoderm ossicles does not appear to have been affected by overgrowth or syntaxial cement. If micritization or corrosion of the echinoderm ossicles should occur, it is only moderate and does not alter noticeably the morphology of the HMC section considered below, nor its subsequent reconstruction.

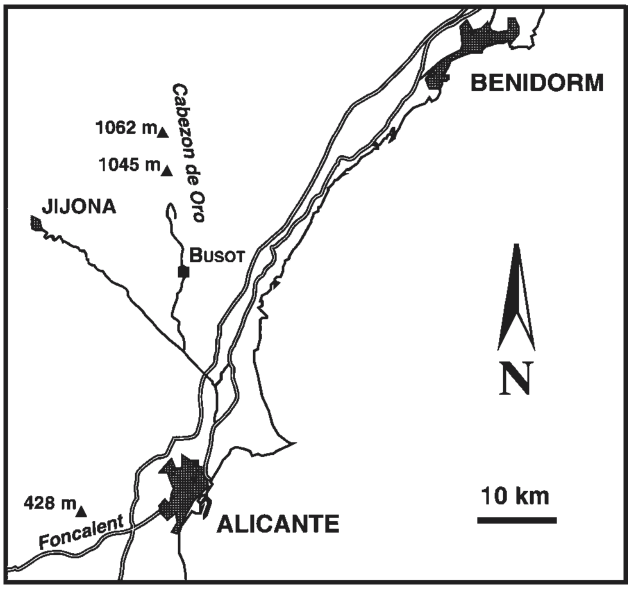

Fig. 1. Map showing the location of the study area (SE Spain).

No additional ossicles were found in the numerous thin sections processed to further document this new species. Destructive petrophysical measurements on the original subsample made any further research of conspecific plates by serial sections impossible. Our attempt to extract additional material from the original field sample was unsuccessful: the washing residues were devoid of any other thecal plate

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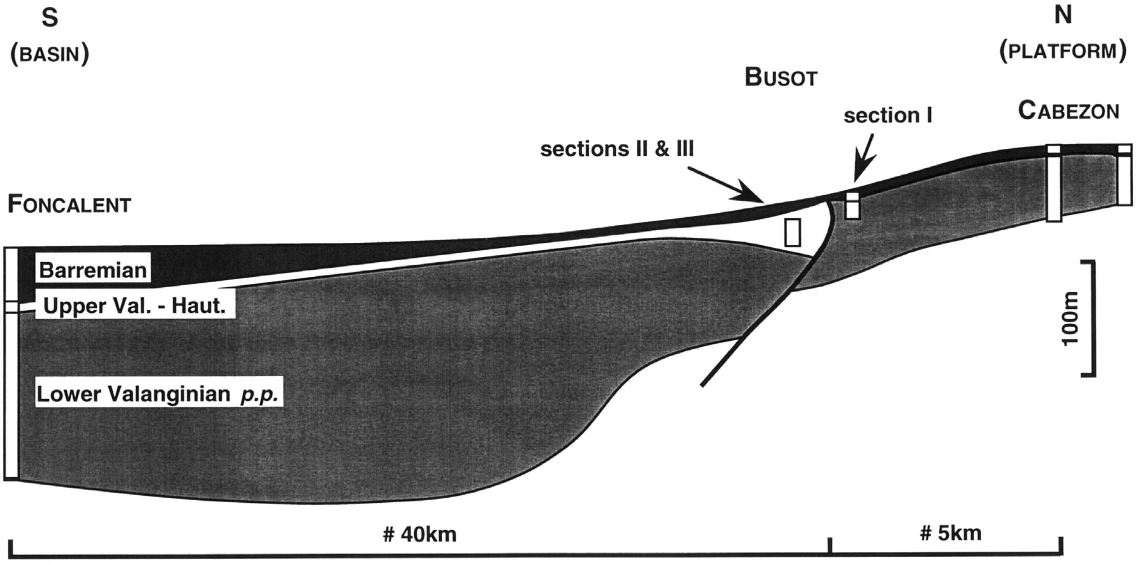


Fig. 2. Tectonic cross-section through the Busot-Altea hardcore extrusion complex reconstructed from field-section observations (from Granier et al. 1995).

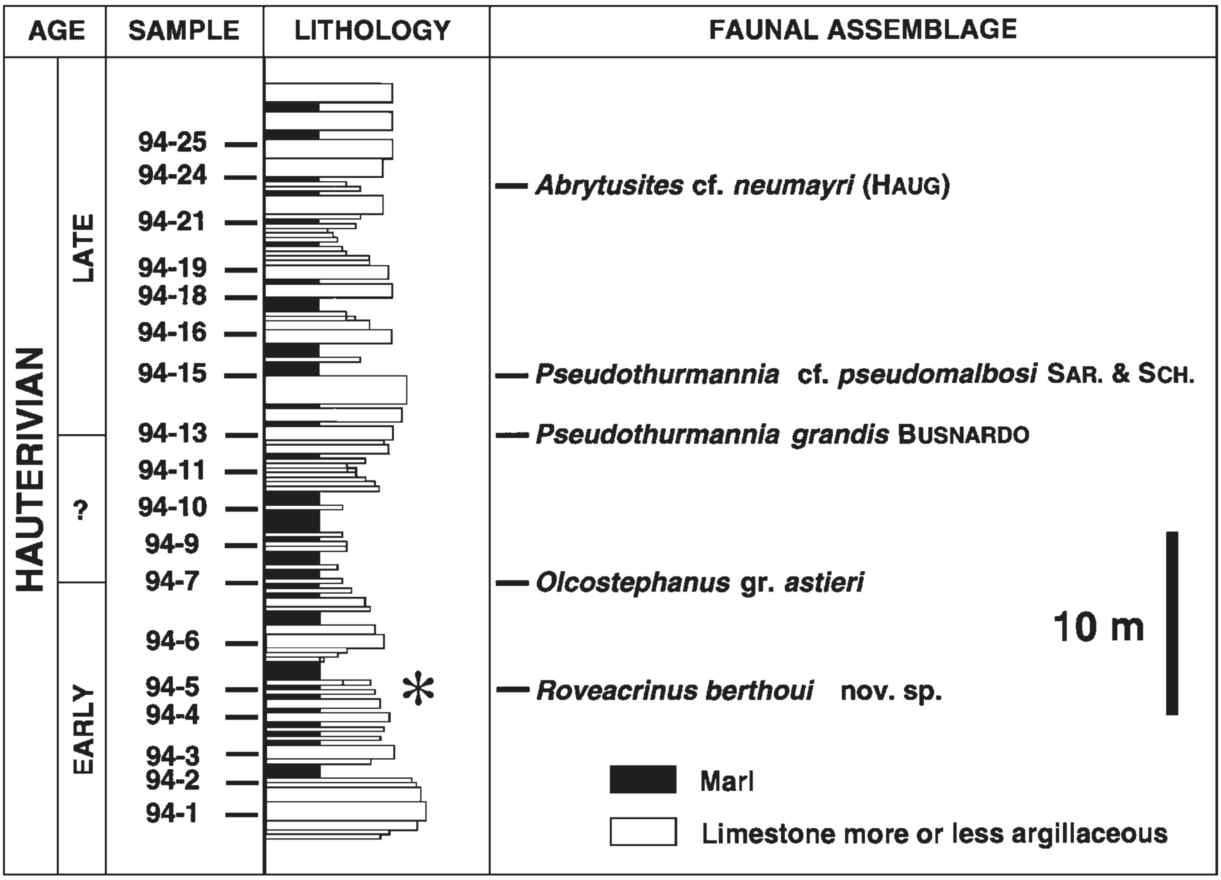


Fig. 3. Lithology, chronostratigraphy and ammonite occurrences in section Busot III, southeast of Busot, Alicante-Spain (adapted from Granier et al. 1995).

while, amongst the echinoderm ossicles, some rare roveacrinid plates could not be identified to species.

The present study describes one of these echinoderm components as the oldest stratigraphic record of the family Roveacrinidae to date, sections of which have commonly been referred erroneously to as the *Lombardia*-microfacies (Brönnimann 1955; Verniory 1956) or as Cretaceous saccocomids (for a review see Ferré 1997).

Systematic Paleontology

Morphological terminology follow Rasmussen (1961) and Scott et al. (1977). For the orientation of section planes and description of thin sections (Fig. 4), the microfaciological terminology of Ferré & Berthou (1994) has recently been refined and completed by Ferré & Granier (1997a, in press).

Order **Roveacrinida** Sieverts-Doreck, in Moore et al. 1952
Family **Roveacrinidae** Peck 1943 (emend. Rasmussen 1961)
?Subfamily **Roveacrininae** Peck 1943 (emend. Peck, in Ubaghs et al. 1978)

Genus *Roveacrinus* Douglas 1908
(=*Drepanocrinus* Jaekel 1918)
Type species *Roveacrinus communis* Douglas 1908
(=*Drepanocrinus sessilis* Jaekel 1918 =*Roveacrinus westphalicus* Sieverts 1933)

***Roveacrinus berthoui* nov. sp.**
Pl. I: Figs. 1–4

1995 Rovéacrinidé: Granier et al. Fig. 4.3.
1997b *Roveacrinus berthoui* nov. sp. Ferré & Granier: p. 338–339 (nomen nudum).

Holotype: By monotypy is Thin section No. AL 94–5, in the Office National de Gestion des Collections Paléontologiques (O.N.G.C.P., Villeurbanne, France) under registration number FSL 411 599, the original negative film being labelled nb 077–30A.

Material: Type specimen only (a unique oblique medial section).

Derivatio nominis: Dedicated to the late Dr. Pierre-Yves Berthou (Université Pierre and Marie Curie—Paris VI) for his outstanding contribution to our knowledge of the roveacrinid microfacies.

Type locality: Section Busot III (Granier et al. 1995), southeast hill of Busot (Alicante, Spain).

Type level: Bed 94–5, bioclastic wackestone carbonate bed, Los Villares Formation (Vera et al. 1982), Lower Hauterivian (Fig. 3).

Age: Early Hauterivian, Angulicostata Zone, Tintinnopsella Zone (sensu Pop 1980).

Dimension: Standard measurements cannot be taken. Approximate thecal width and height: ca. 550 μm and ca. 650 μm, respectively; H/W ratio: ca. 1.18–1.23.

Diagnosis: Theca medium to small, width equalling height, subconical to rounded, almost pentagonal to rounded from basal view. No subdivision between radials and basals, nor prominent constriction between dorsal and ventral cavities, nor interradial recess visible. Theca deeply indented between radial facets, which are large and slope outwards. Dorsal ligament pits thick and crescentic, nerve channels medium-sized to small. Interradial pegs without any relief. Radials strongly ornamented by a plume or acanthus-leaf pattern proceeding upwards from the polar edge and continuing to nearly up to the radial facets. Secondary plume flanges branching off along each side of the primary radial edge, and merging aborally to the polar edge. These secondary flanges grow laterally and slightly outwards, their bases maintaining distal connections with the main flange. Lateral flanges from adjoining rays never coalesce or efface. No interradial processes appear above the general edge of the calyx. Ventral cavity completely encased in the radial frame. Thecal microstructure of dense HMC. Arm structure, plating and ornament unknown, but most likely to be of the same type as thecal ornament.

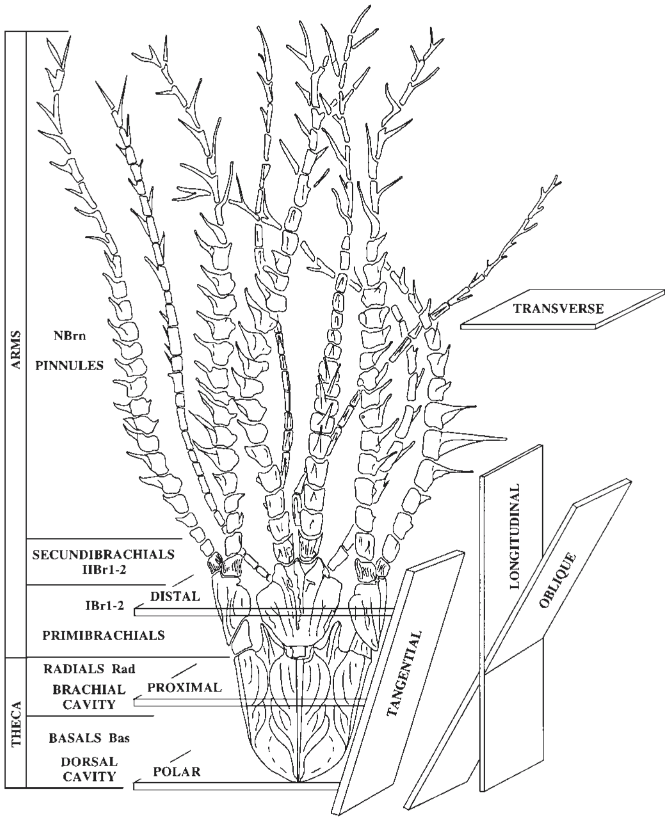


Fig. 4. Orientation of sections shown on a reconstructed roveacrinid (from Ferré & Berthou 1994; additional data from Ferré & Granier 1997 in press).

Description: This HMC section unquestionably represents a roveacrinid crinoid (Ferré 1997) since a ventro-dorsal stretching appears from the geometrical reconstruction. Indeed, this oblique section in part shows an elongated ventrodorsal theca which corroborates attribution to the family Roveacrinidae. For the time being, a possible assignment to the subfamily Roveacrininae is speculative, since there is no evidence of an additional inner set of plates (Schneider 1987, 1989). However, there is no evidence of their absolute absence either—they may have fallen victim to post-mortem decay or during transport as they are neither fused nor articulated to the basals.

Despite the section being oblique, we may estimate the cavity ratio: the dorsal cavity is slightly larger. Although two tiny indentations formed by the upper side of the basals (cavity wall) appear on the inner part of the section, indicating the presence of an inner partition, we cannot determine whether there is an additional set of plates defining cryptodicyclicity as defined by Schneider (1987). The dorsal cavity is rather large compared to the radial expansions preserved in this oblique plane, whilst the ventral cavity is rather depressed. The dorsal cup is rather smooth, if we consider it to be encased in the radials and the weak radial ornament effacing at the distal point of the basals.

The pentamerous symmetry induces irregular ridges and small flanges all around the theca to represent the respective set of five radials. Only two of them are available for full examination. Radial 2 (Pl. I: Fig. 4) is preserved articulated to and thus covered by the first primibrach: its articular facet is displayed in full in the oblique section at hand; thus the radial articular facet must have been oblique. Consequently, the preserved radial expansions and the associated first primibrach document the outward sloping of the articular facet, showing the specimen at hand to be a representative of the genus *Roveacrinus*.

The section area featuring Radial 1 (Pl. I: Fig. 4) shows a twisted ornament pattern. Due to the section obliquity and the radial position, this undulated frame must be interpreted as independent parallel flanges. These flanges, oblique to the radial vertical ridge, branch off along this very same vertical radial ridge. Geometrically, these oblique ridges occur just below the radial facet and continue down to the thecal base. They form a plume pattern which shows up as wavy ornament in oblique section; their proximal sides join weakly to the polar edge to result in a relatively smooth lower theca. There is no interradial ornament nor obvious secondary ornament on the radials, apart from the plume pattern appearing in between the radial ridges.

Unfortunately, our material does not contain any brachial ossicle section associated with the thecal remains, with the exception of the partial oblique section of the first primibrach connected to Radial 2. Based on that, as well as on a specimen from the Sergipe (Ferré & Bengtson 1997) and material from Texas (Scott et al. 1977), we may infer a similar, though less marked, ornament on brachial plates, i.e. either a coarse, rugose primibrach pattern and a smooth pinnule pattern, or a granulated brachial frame.

Discussion: The short twisted aboral knob, the plume radial ornament, as well as (to a lesser extent) the stratigraphical position, characterize this new find, and justify the erection of a new species of the genus *Roveacrinus* Douglas. With reference to the radial expansions preserved in this oblique section, we may infer a rather heavy ornamentation and strong arms consisting of large brachial plates. The ventral (or brachial or adoral) cavity is rather depressed compared to the dorsal cavity, explaining the relatively high dorsal/ventral cavity ratio.

The inferred marked ornament and the general low form of this theca rule out a benthic inhabitant of agitated shallow waters. This ecological assignment is based on observations of a complete *Roveacrinus* specimen (Ferré & Bengtson 1997) which is consistent with microfacies analyses. It has now become clear that the worldwide occurrence of roveacrinid microfacies and the light structure of their skeletons no longer support their previously widely accepted planktonic mode of life (Milsom 1989, 1999). These arguments were based exclusively on the early planktonic stages that characterize any echinoderm group. Therefore under favourable environmental conditions such as hypoxic high-productivity events, roveacrinids produced opportunistic broods which spread over the whole Tethys; then during a later stage, these broods sunk to the seafloor to become benthic suspension-feeding adult colonies. Thecal structure (mostly proportions and ornament), allows us to assume a rather shallow, open-marine environment since the accretion of the radials covering the dorsal cavity might have been related to the sinking of planktonic roveacrinid brood on the seafloor. This environment is consistent with the reconstruction elaborated by Granier (1987).

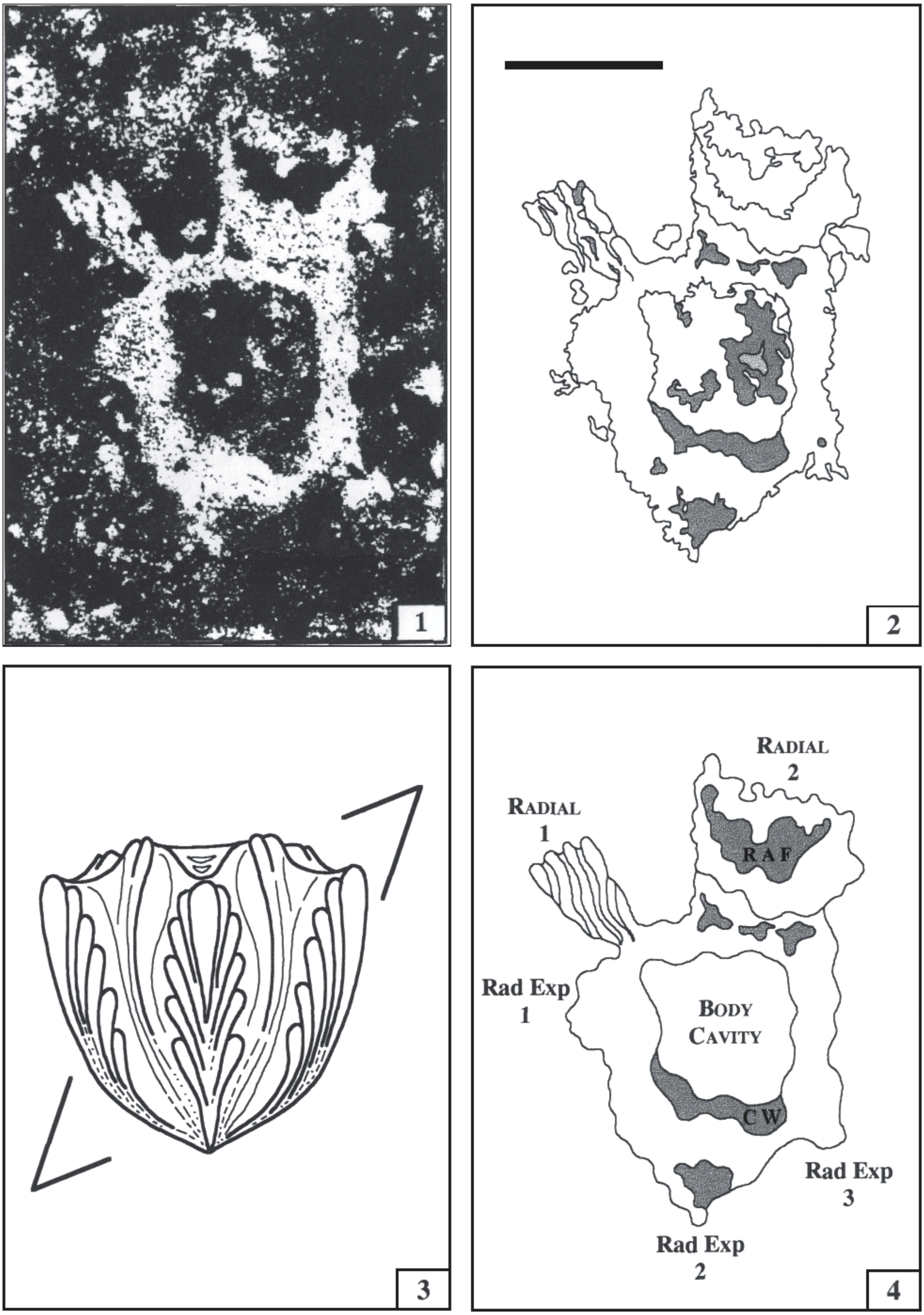
Although it displays the typical roveacrinid thecal stretching, its low profile recalls Tithonian Saccocomidae. However, in the present state of knowledge, much has to be still done to make *Roveacrinus berthoui*, nov. sp., the link from classic Jurassic Saccocomidae to Cretaceous Roveacrinidae. Finally, with regard to the geographical location, Busot lay at the crossroads of Tethyan seaways. Hence, by promoting the development of roveacrinid populations (comparable to Triassic *Osteocrinus*-facies; see Kristan-Tollmann 1970), the central Tethys might have actually been at the root of Cretaceous Saccocomidae (Peck 1973), as well as fostering a new strain towards Roveacrinidae (Ferré et al. 1997).

Age: The senior author has identified in thin sections *Tintinnopsella carpathica* Murgeanu & Filipescu and *T. longa* (Colom) indicative of the Tintinnopsella Zone (Pop 1980). The ammonite assemblage at the Busot locality comprises *Olcostephanus* sp., *Pseudothurmannia grandis* Busnardo, *Pseudothurmannia* cf. *pseudomalbosi* Sarasin & Schöndelmayer and *Pseudothurmannia* sp. (identifications by R. Busnardo & L.G. Bulot), dating this level as Early Hauterivian (Angulicostata Zone).

Assemblage: As stated above, this part of the section yielded an unusual faunal assemblage of both ammonites and calpionellids (Granier et al. 1995). The sedimentary texture of this marly carbonate is a bioclastic wackestone containing numerous benthic foraminifers (*Neotrocholina* sp., *Trocholina* gr. *alpina* (Leupold), *Montsalevia salevensis* (Charollais, Brönni-

▶

Plate I: *Roveacrinus berthoui* nov. sp., Early Hauterivian, Angulicostata Zone, Tintinnopsella Zone, Busot III, Alicante, Spain. **Fig. 1.** Holotype (ca. ×120). **Fig. 2.** Interpretative line drawing of the holotype section. Scale bar: ca. 250 μm. **Fig. 3.** Tentative reconstruction of the theca. The dihedrals indicate the plane section at hand. **Fig. 4.** Simplified version of 2. CW — cavity wall separating dorsal and ventral cavities; Rad Exp — radial expansion showing the radial edge cut slightly by the oblique plane section; RAF — radial articular facet of the first primibrach as preserved articulated to radial plate 2.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mann & Zaninetti, Lituolidae, and others), various echinoderm ossicles (starfish, ophiuroid and crinoid) and reworked calcareous algae (among others *Macroporella? praturloni* Dragastan and *Pseudocymopolia pluricellata* Bakalova), with additional silt-size detrital quartz grains.

Stratigraphical distribution: *Roveacrinus berthoui* nov. sp. represents the oldest member of the family Roveacrinidae known to date, previous records involving Early Albian forms (Dias-Brito & Ferré 1997, in press) and thus fills the gap between the Late Tithonian Saccocomidae and the latter Early-Middle Albian Roveacrinidae. As the stratigraphic gap is progressively being closed, the new species once again calls into question the previously assumed relationships between these two families (for a review see Ferré 1997).

Conclusion

To date, the specimen studied represents the oldest known representative of the family Roveacrinidae, previously recorded from the Early Albian (Dias-Brito & Ferré 1997, in press) and the Middle–Late Albian (Peck 1943, 1955; Rasmussen 1961; Schmid 1971; Jäger 1981; Destombes 1984; Griffiths 1989; Ferré & Granier 1997, in press) to the Late Maastrichtian (Jagt 1992, 1999). It fills the gap between the Late Tithonian Saccocomidae, the "dubious" *Microcalamoides diversus* Bonet 1956 (see Ferré 1997) and the later Early–Middle Albian Roveacrinidae. However, additional material (particularly isolated calyces, or at least orthogonal/axial thecal sections) will be needed to refine our present diagnosis and a more definitive phyletic statement.

As the stratigraphical gap between these sister groups is closing, the new material again casts doubts on the phyletic relationships between Saccocomidae and Roveacrinidae, and puts a much earlier date on the branching if these families are really related. Furthermore, from a paleogeographic point of view, as Kristan-Tollmann (1970) promoted the *Osteocrinus*-facies in the Late Triassic "Tethys Ocean", this new material stresses the role played by the Tethyan seaway in the appraisal of Cretaceous roveacrinid microfacies (Dias-Brito & Ferré 1997, in press; Ferré et al. 1997).

The presence of identifiable diagnostic roveacrinid remains in thin sections greatly enhances the chronostratigraphical value of roveacrinid microfacies.

The previously established framework of roveacrinid microfacies, still being refined, offers a means of rapid and reliable identification of local stages in the Tethyan Realm and beyond (Gulf of Mexico, Brazilian and West African marginal basins). The relative proportions and the occurrence of roveacrinid taxa appear to be of supraregional chronostratigraphic significance.

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