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New European localities for coral-associated Cretaceous decapod crustaceans

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Abstract

The number of localities globally yielding coral-associated decapod crustaceans from the Cretaceous is limited. Decapods from three new localities from the Cretaceous of Europe are described, all of which are associated with corals. One new locality is the Olazagutía quarry in northern Spain in which coral reef limestones from the Albian/Cenomanian Eguino Formation are exposed. Callianassid claws and the galatheoids *Paragalathea ruizi* and *P. straeleni* were found here. Decapod remains are also reported from three Central European localities exposing coral reef limestones from the upper Barremian to lower Aptian Schrattenkalk Formation in Switzerland (Säntis mountain), Austria (Brandalpe/Kühberg), and at the Austrian/German border (Göttesacker Plateau). The first and the third localities are new. These latter three localities yield callianassid and ?upogebiid claws. The potential of finding a decapod-rich fauna at the localities in the Schrattenkalk Formation is low in comparison to the Spanish Olazagutía quarry.

Key words: Cretaceous, Decapoda, Callianassidae, Upogebiidae, Europe, Spain, Switzerland, Austria, Germany

Introduction

The number of decapods species known from the fossil record is approximately 3,300 species (see Schweitzer *et al*., 2010), whereas approximately 15,000 species are known from the recent (De Grave *et al*., 2009). Over the last two centuries, a number of European localities yielding Cretaceous decapods have been discovered, some of them yielding a rich decapod fauna, especially those associated with reefal deposits. Good examples include the Albian/Cenomanian decapod fauna from the Monte Orobe quarry in northern Spain (Van Straelen, 1940, 1944; Ruiz de Gaona, 1943; Via Boada, 1981, 1982; Gómez-Alba, 1989; López-Horgue *et al*., 1996; Fraaije *et al*., 2008, Artal *et al*., in press), the Koskobilo fauna from the same deposits and in the same geographic area (Fraaije *et al*., 2009, in press; Klompmaker *et al*., 2011a–d), and the Maastrichtian fauna from the ENCI quarry in the Netherlands (Fraaye and Collins, 1987; Jagt *et al*., 1991, 2010; Collins *et al*., 1995; Fraaye, 1996a–c, 2002; Fraaye and Van Bakel, 1998; Swen *et al*., 2001). These cases suggest that a relatively high diversity of decapods lived within reefal facies. This is further corroborated by the presence of numerous decapods in recent coral reefs in comparison to other habitats (e.g. Abele, 1974, 1976). The purpose of this paper is to report on decapod crustaceans in association with coral reef deposits in the Cretaceous of Europe from four localities, three of which are new; to describe the decapod remains; and to discuss the potential for finding more species at those localities.

Localities and stratigraphy

The specimens described herein originate from four localities, three of which are within the Schrattenkalk Formation as exposed in central Europe, and one is from the Eguino Formation in northern Spain.

The new Spanish locality is the Olazagutía quarry (42°53′03″N / 2°12′17″W) in the Albian/Cenomanian Aldoirar patch reef within the Albeniz Unit of the Eguino Formation (see López-Horgue *et al*., 1996). The active quarry is located just west of the abandoned decapod-rich Koskobilo quarry, situated 2 km south-west of the city of Alsasua. The active quarry contains the reef core consisting mainly of massive colonial corals, orbitolinid foraminifera, and echinoid fragments, but also contains bryozoans, bivalves, brachiopods, algae, and serpulids. Reefal debris, found adjacent to the reef core, consists of orbitolinids, corals, bryozoans, echinoid spines, bivalves, decapods, and brachiopods.

The Schrattenkalk Formation is exposed in Germany, Austria, and Switzerland and is late Barremian to early Aptian in age (Bolliger, 1988; Császár *et al*., 1994; Bodin *et al*., 2006). All localities reported

on here are situated within the Schrattenkalk Member of this formation, which is a limestone unit consisting mainly of corals, sponges, rudists, stromatoporoids, and foraminifera (Bolliger, 1988; Császár *et al*., 1994). The first locality is a new locality for decapods at the German/Austrian border on the Göttesacker Plateau (47°22′N / 10°06′E), 6–7 km west of Riezlern, Austria. The lower Albian limestones (Bolliger, 1988; Császár *et al*., 1994) at this locality are intensely karstified and exhibit deep grooves. Colonial and solitary corals can be observed once rock surfaces have been exposed to extensive weathering. Fragmented decapod appendages were found in association with the corals.

The second locality, from which the first decapod was reported by Klompmaker *et al*. (2011), is the Brandalpe/Kühberg on the Austrian side of the German/Austrian border (47°22′25″N / 10°10′42″E), which is 2 km north-west of Reizlern, Austria. The reefal limestones contain patches of colonial and solitary corals, but also yield bivalves, brachiopods, algae, bryozoans, rare gastropods, spines of echinoids, and rare fish teeth. The decapod specimens are found close to the patches containing corals. The limestones are interpreted to be early Aptian in age using to Bolliger (1988) and Császár *et al*. (1994).

The third new decapod locality is halfway up the Säntis mountain near the first stop of the lift toward the top (47°15′06″N / 9°19′56″E), 20 km south of Sankt Gallen in Switzerland. The layered limestones contain corals and echinoid spines and are part of the upper Barremian Lower Schrattenkalk Member of the Schrattenkalk Formation (see Bodin *et al*., 2006). Fragmented appendages of decapods appeared concentrated in a thick debris layer.

Systematics

Institutional abbreviation: MAB k-numbers refer to specimens deposited in Oertijdmuseum De Groene Poort, Boxtel, The Netherlands.

Order Decapoda Latreille, 1802
Infraorder Thalassinidea Latreille, 1831
Superfamily Thalassinoidea Latreille, 1831
Family Upogebiidae Borradaile, 1903

?Upogebiidae indet.

(Fig. 1A–D)

Description: Appendages with tubercular ornamentation perpendicular to axis of appendage; often accompanied by grooves.

Material examined: Four appendage fragments (MAB k3012a–d).

Occurrence: The specimens were collected from the lower Aptian Schrattenkalk Member as exposed on the Brandalpe/Kühberg on the Austrian side of the German/Austrian border. The specimens were found *in situ*.

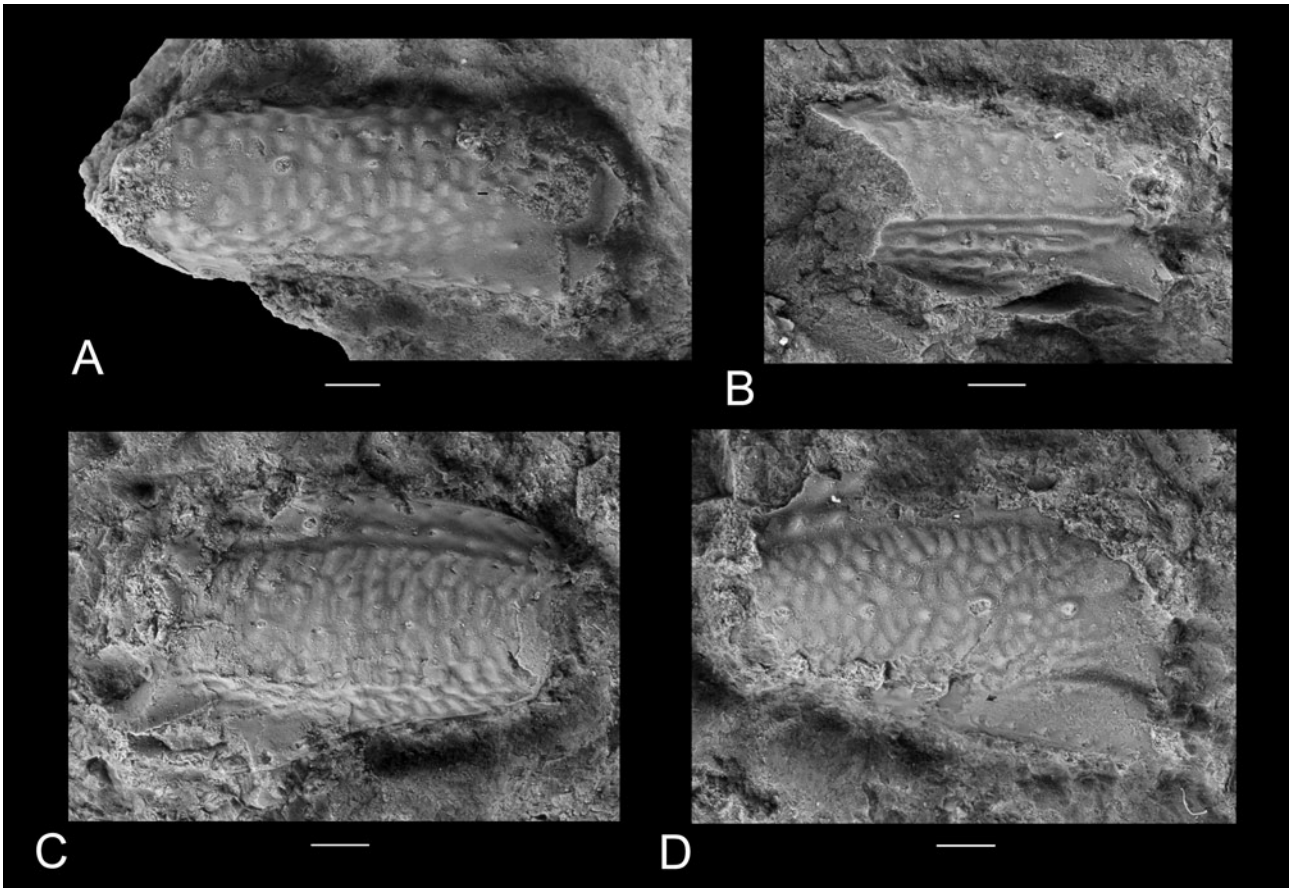

Fig. 1. ?Upogebiidae indet. Early Aptian decapod appendage fragments (MAB k3012a–d) from the Brandalpe/Kühberg on the Austrian side of the German/Austrian border. Scale bars are 1.0 mm.

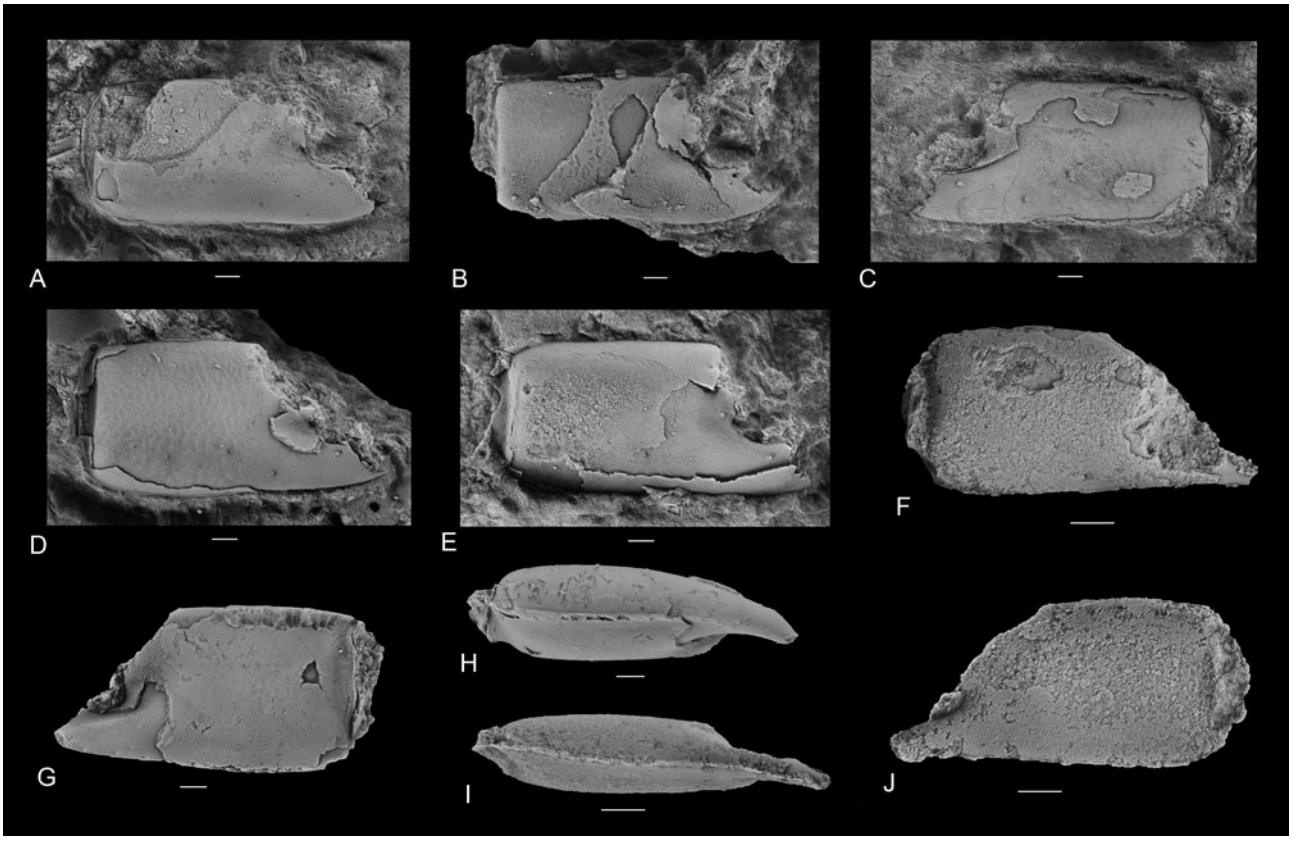

Fig. 2. Callianassidae indet 1. Albian/Cenomanian callianassid propodi (MAB k2792a–f) from the Olazagutía quarry in northern Spain. A, B, D, E, F, outer surface right propodus; C, outer surface left propodus; G, J, inner surface right propodus; H, I, lower rim. Scale bars are 1.0 mm.

Discussion: The grooves on the propodi are also seen on other upogebiids, which is why we tentatively place it within this family until more complete specimens are available.

Superfamily Callianassoidea Dana, 1852

Family Callianassidae Dana, 1852

Callianassidae indet. 1

(Fig. 2A–J)

Description: Palm of propodus rectangular in shape. Maximum propodus length approximately 12 mm, maximum height nearly 6 mm; maximum length of fixed finger approximately 3.5 mm. Carpus/propodus articulation at 90°. Left and right propodus appear to be similar in shape and size (Fig. 2D and 2E). Inner and outer surfaces convex. Pronounced fixed finger with tip curved slightly upward and inward, accompanied by another, distally directed tooth near distal end. Small tubercle present at origination of inner curvature of fixed finger. Upper and lower surfaces rimmed, rim decreases in strength on fixed finger. Inner surface does not exhibit ornamentation. Outer surface ornamented, consisting of a weak reticulate pattern across the proximal part of the propodus forming a wavy pattern. Internal mold of outer surface exhibiting some tubercles on distal part. Other parts of pereiopods, abdomen, and carapace not preserved.

Material examined: Six propodi (MAB k2792a–f).

Occurrence: The Olazagutía quarry in the Albian/Cenomanian Aldoirar patch reef. The specimens were found in *ex-situ* rocks in the southern part of the quarry.

Discussion: The smaller specimen (Fig. 2F, I, J) appears to be less convex on both surfaces and the upper keel appears to be less straight.

The propodi are similar to those of other Callianassidae based upon comparison to propodi of other callianassid taxa such as *Cheramus marginatus* (Rathbun, 1901), *Neocallichirus maryae* Karasawa, 2004 (= *Callianassa rathbunae* Schmitt, 1935, see Karasawa, 2004), and *Notiax brachyophthalma* A. Milne-Edwards, 1870 (Biffar, 1971; Manning and Felder, 1991). Even though the preservation of the propodi is relatively good, they cannot be used for classification beyond the family level. Schweitzer and Feldmann (2002: p. 940) mentioned that, "the morphology of the propodus and dactylus are not as useful in making generic distinctions; therefore, many callianassids known only from these distal elements remain enigmatic." They also noted that generic level identification could only be performed when the merus and carpus are preserved. The sole use of propodi is even more discouraged when reading over diagnoses of several genera within the Callianassidae because it appears that the propodus is either not mentioned or is mentioned briefly (e.g. Manning and Felder, 1991; Schweitzer and Feldmann, 2002; Schweitzer *et al*., 2006). The carpus/propodus articulation angle, however, appears to be important for distinguishing genera. Thus, genus and species identification is not performed here until more complete material is discovered.

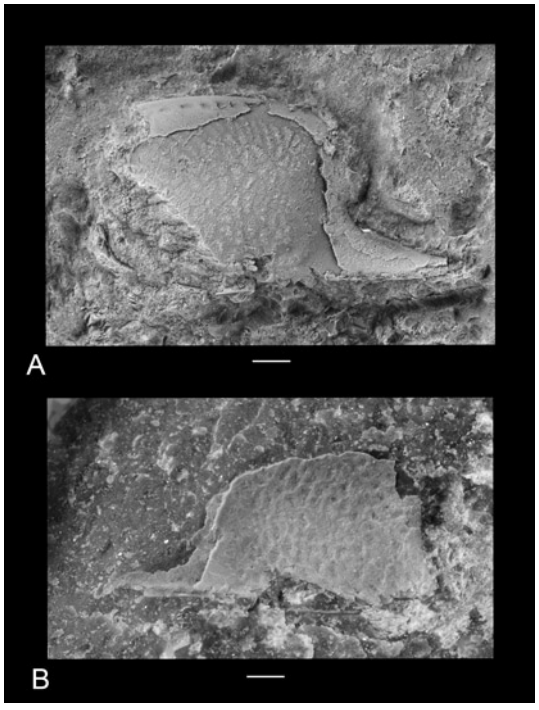

Fig. 3. Callianassidae indet 2. An early Aptian callianassid propodus (MAB k3010a, b) from the Göttesacker Plateau at the Austrian/German border. A, inner surface; B, cuticle of outer surface. Scale bars are 1.0 mm.

Callianassidae indet. 2

(Fig. 3A, B)

Description: Palm of propodus rectangular in shape. Maximum propodus length approximately 10 mm, maximum width 5.3 mm; fixed finger 3 mm long. Carpus/propodus articulation not visible, external mold suggests that it is close to 90°. Inner surface convex. Short, sharp, small fixed finger with tip curving inward; no teeth visible. Lower surface rimmed; upper surface not visible. Inner surface exhibits weak, reticulate ornamentation across proximal part of propodus producing wavy pattern on internal mold and internal part of cuticle. Row of six pits, paralleling lower rim at inner surface. Other parts of pereiopods, abdomen, and carapace not preserved.

Material examined: One propodus (MAB k3010a, b).

Occurrence: The lower Aptian Schrattenkalk Member of the Göttesacker Plateau at the German/Austrian border. The specimen was found *in situ*.

Discussion: The single propodus appears to be very similar in shape and ornamentation to propodi of callianassids such as *Callianassa* spp. (e.g. Rathbun, 1935; Biffar, 1971; Manning and Felder, 1991; Karasawa, 1993; Hyžný, 2011). In overall shape, the propodus also resembles *Neocallichirus fortisi* Beschin *et al*., 2002 and *Eucalliax vicetina* Beschin *et al*., 2002, as shown in Beschin *et al*. (2005). Therefore, we place it within the Callianassidae. As described above, genus and species identification is not possible without more complete material.

?Callianassidae indet. 3

(Fig. 4A, B)

Description: Maximum propodus length without fixed finger approximately 10 mm. Carpus/propodus articulation not visible. Inner and outer surfaces slightly convex. Short, small fixed finger curving inward; no teeth visible; notched at base; lower part near rim very sharp; concave profile toward top part. Lower surfaces exhibits strong rim; upper rim not visible. Inner and outer surfaces exhibit weak, reticulate ornamentation across proximal part of propodus forming wavy pattern on internal mold and internal part of cuticle. Other parts of pereiopods, abdomen, and carapace not preserved.

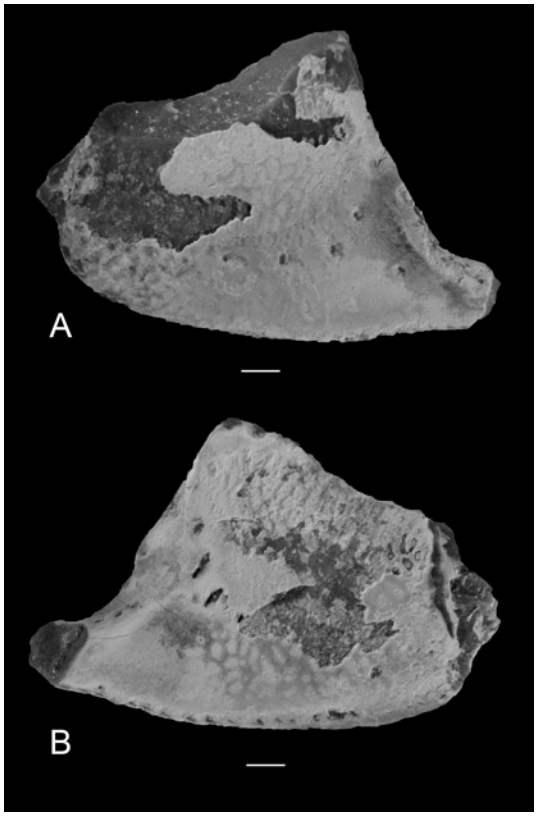

Fig. 4. ?Callianassidae indet 3. A late Barremian ?callianassid propodus (MAB k3011) collected at the Säntis mountain in Switzerland. A, outer surface; B, inner surface. Scale bars are 1.0 mm.

Material examined: One propodus (MAB k3011).

Occurrence: The upper Barremian Schrattenkalk Member on the Säntis mountain in Switzerland. The specimen was found *in situ*.

Discussion: The single propodus appears to be similar in shape and ornamentation to callianassid propodi as mentioned above. This suggests that the species could be placed within this family. However, because of the incomplete preservation, placement must be considered tentative until new material is discovered.

Discussion

The Olazagutía quarry in Spain is located in the same Aldoirar patch reef as the Koskobilo quarry; thus, a similar, decapod-rich fauna might be anticipated after intensive collecting. Only one day of exploring and collecting has occurred thus far in the Olazagutía quarry, yielding six propodi of the mud shrimp herein and two species of galatheids, four carapaces of *Paragalathea ruizi* Van Straelen, 1925 and one carapace

of *P. straeleni* (Ruiz de Gaona, 1943). No callianassids have thus far been collected from Koskobilo. Investigation of the paleoecology of decapods found within the Aldoirar patch reef is ongoing (AAK).

The decapods from the Schrattenkalk Member within the Schrattenkalk Formation were also associated with corals. In 2009, after only one hour of collecting, a new species based on a carapace, *Rathbunopon schrattenkalkensis*, was found at the Austrian side of the Brandalpe/Kühberg (Klompmaker *et al*., 2011b), suggesting a potential for finding a decapod-rich fauna. However, a week of field work in the summer of 2011 proved the opposite as only fragments of appendages were found, all in the vicinity of corals. Approximately 5 km southwest on the Göttesacker Plateau, claw fragments with a similar preservation style were noted. After half a day of collecting in 2009, only some claw remains were discovered. Decapods in the Schrattenkalk as exposed on the Swiss Säntis mountain also exhibited a similar preservation style with fragments of appendages only after two days of collecting. Thus, the potential to find carapaces appears to be limited within the Schrattenkalk Member based on the overall paucity of the material. The style of preservation suggests that the environment of the Schrattenkalk during its formation may have been characterized by moderate to high levels of bioturbation, microbiological decomposition, and/or a high hydrodynamic energy regime (*sensu* Müller *et al*., 2000). High bioturbation may be one of the reasons for the presence of only appendage fragments as several internal molds of bivalves and brachiopods had fecal pellets preserved (pers. observation). Additionally, degradation due to hydrodynamics may also be a factor, especially for the Säntis mountain and the Brandalpe/Kühberg localities. Many biogenic fragments were encountered in the close vicinity of the decapod remains. What is probably important as well is the nature of the rock, as the rocks show most fossils best after a period of weathering at all three localities within the Schrattenkalk Member. Splitting such a rock results usually in a dark gray exposure along the split surface showing little of the fossil exposed on the weathered surface.

Given the preservational style and the number of decapod remains found so far taking into account the collecting time, the potential of finding a diverse decapod fauna at localities exposing the Schrattenkalk Member is considered to be low in comparison to the Spanish Olazagutía quarry.

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