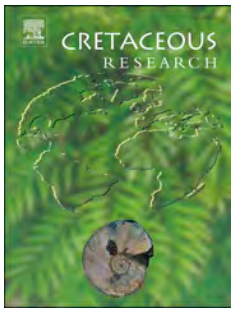
Accepted Manuscript



A new decapod crustacean assemblage from the lower Aptian of La Cova del Vidre (Baix Ebre, province of Tarragona, Catalonia)

Àlex Ossó, Barry van Bakel, Fernando Ari Ferratges-Kwekel, Josep Anton Moreno-Bedmar

PII: S0195-6671(17)30554-2

DOI: 10.1016/j.cretres.2018.07.011

Reference: YCRES 3924

To appear in: *Cretaceous Research*

Received Date: 27 December 2017

Revised Date: 11 June 2018

Accepted Date: 19 July 2018

Please cite this article as: Ossó, À., van Bakel, B., Ferratges-Kwekel, F.A., Moreno-Bedmar, J.A., A new decapod crustacean assemblage from the lower Aptian of La Cova del Vidre (Baix Ebre, province of Tarragona, Catalonia), *Cretaceous Research* (2018), doi: 10.1016/j.cretres.2018.07.011.

A new decapod crustacean assemblage from the lower Aptian of La Cova del Vidre (Baix Ebre, province of Tarragona, Catalonia)

Àlex Ossó [a], Barry van Bakel [b], Fernando Ari Ferratges-Kwekel [c], Josep Anton Moreno-Bedmar [d,*]

[a] *Llorenç de Vilallonga, 17B, 1er-1ª. 43007 Tarragona, Catalonia*

[b] *Oertijdmuseum, Bosscheweg 80, 5283 WB Boxtel, the Netherlands*

[c] *Área de Paleontología, Departamento de Ciencias de la Tierra, Universidad de Zaragoza, Zaragoza, Spain*

[d] *Instituto de Geología, Universidad Nacional Autónoma de México, Ciudad Universitaria, Coyoacán, Ciudad de México, 04510 Mexico*

* Corresponding author.

E-mail address: josepamb@geologia.unam.mx (J.A. Moreno-Bedmar).

A B S T R A C T

During fieldwork in a small outcrop of the lower Aptian Margas de Forcall Formation at La Cova del Vidre, hitherto known as the type locality of the anomuran *Pagurus avellanedai*, new decapod crustacean material has been recovered. In this newly recovered lot, two undescribed species of brachyuran have been recognised; there are here described as *Rathbunopon tarraconensis* and *Pithonoton lluismariaorum*. In addition, numerous remains of the anomuran *P. avellanedai*, enable an improvement of the original description of this taxon, and an analysis of associated ammonites from La Cova del Vidre has resulted in precise age calibration for the first time.

Keywords:

Cretaceous

Paguridae

Brachyura

Prosopidae

Dromiidae

New species

1. Introduction

A new decapod crustacean assemblage has been recovered from strata exposed at La Cova del Vidre, in the municipality of Roquetes (Els Ports Massif, Baix Ebre, Catalonia, NE Iberian Peninsula). The recovery of associated fauna such as ammonites has now permitted to confirm that the level with decapod crustaceans is assignable to the *Deshayesites deshayesi* Zone (lower Aptian) within the Margas de Forcall Formation (Canérot et al., 1982).

The decapod crustacean assemblage is dominated by pagurids, but prosopids and dromiids are also present, comprising two new species that are described herein. The small outcrop at La Cova del Vidre was already known as the type locality of *Pagurus avellanedai* Vía, 1951 (Bataller, 1943; Vía, 1951). The recovery of new material of *P. avellanedai* allows us to complement Vía's (1951) original description, by describing the right cheliped and completing the description of the left cheliped. The new prosopid *Rathbunopon tarraconensis* **n. sp**. from La Cova del Vidre constitutes the third species of the genus *Rathbunopon* on record from the Iberian Peninsula (Klompmaker et al., 2011; González-León et al., 2016), while the new dromiid (goniodromitine), *Pithonoton lluismariaorum* **n. sp.**, is only the second member of this genus to be described from Cretaceous strata.

The new assemblage from La Cova del Vidre can be compared to other Aptian decapod crustacean faunas at localities in northeast Iberian basins, such as Cal Cassanyes (Barcelona) in the Salou-Garraf Basin (see Vía, 1951; Moreno-Bedmar et al., 2008; Artal et al., 2010) and Forcall (Castelló) and neighbouring outcrops in the Maestrat Basin, which are currently under study. However, those faunas differ from that from La Cova del Vidre in that they are linked to bioherms (sponges) and a reefal (coralgal) environment, respectively, indicating sheltered settings. In contrast, lithology and fauna at La Cova del Vidre suggest an open-marine, muddy environment.

The present lot also allows to improve the knowledge of the Iberian Aptian paguroids and brachyurans. In general, data on about the Aptian decapod crustaceans across the globe are scanty (e.g., Wright and Collins, 1972; Martins-Neto, 1987; Schweitzer et al., 2012).

2. Geological setting and stratigraphy

La Cova del Vidre (abbreviated CV) is situated in the linking zone placed between the Maestrat and Salou-Garraf basins (Fig. 1A). The linking zone was part of a large intracratonic Mesozoic rift along the eastern margin of the Iberian plate, which developed on account of tectonic extension related to the opening and spreading of the Neotethys towards the west, and the opening of the central Atlantic Ocean and the Bay of Biscay (Salas and Casas, 1993; Salas et al., 2001). During the Paleogene–Early Miocene, as a result of collision between the Iberian and European plates during Alpine orogeny, the Maestrat Basin, the linking zone and the Salou-Garraf Basin were inverted, thus giving rise to the eastern part of the Iberian Chain and Catalan coastal chain (Salas et al., 2001). The present note focuses the Margas de Forcall Formation that is exposed in the isolated CV outcrop, which is surrounded by Jurassic strata (Fig. 1B). In this

78 section, the Margas de Forcall Formation, which overlies the uppermost portion of the
79 Xert Formation (Fig. 2), is covered, in particular its upper part. In a cliff, limestones of
80 the Villarroya Formation (Fig. 2; Appendix 1) can be seen to overlie the Margas de
81 Forcall Formation. The stratigraphy of the linking zone is the same as that in the
82 Maestrat Basin, but in the study area the classic division of the Margas de Forcall into
83 three members is not developed.

84 In contrast, in the Salou-Garraf Basin possesses other equivalent units are
85 developed, such as the Vallcarca marls Unit, which corresponds to the Margas de
86 Forcall Formation, the Villarroya Formation and the lower and middle part of the
87 Benassal Formation (Moreno-Bedmar et al., 2009, 2016, 2017). The Salou-Garraf Basin
88 is situated in a more basinal context than both the Maestrat Basin and the linking zone,
89 and in consequence, its stratigraphic record is characterised by a more open-marine
90 sedimentation.

91 The decapod crustacean material recorded herein originates from a small outcrop
92 of less than 5 metres in thickness, situated within the middle part of the Margas de
93 Forcall Formation (Fig. 2; Appendix 1). This level has also yielded quite rich ammonite
94 assemblages that allow precise age calibration for the associated decapod crustaceans.
95 Also present are echinoids (quite common), bivalves (e.g., *Plicatula placunea* Lamarck,
96 1819; *Neithea* sp.) and rare gastropods. This invertebrate assemblage reflects an open-
97 marine environment, the presence of ammonites and the plicatulid bivalve being
98 particularly characteristic of such a setting. Bed CV3 in particular yields a quite
99 abundant record of this invertebrate assemblage.

100

101 **3. Ammonite biostratigraphy and systematic notes**

During a collecting trip in October 2016, 23 ammonites were recovered from the Margas del from the Margas de Forcall Formation at La Cova del Vidre (Appendix 2). These specimens are housed at PUAB (Colecciones de Paleontología de la Universitat Autònoma de Barcelona, Barcelona, Catalonia). In addition to the worn phragmocone of a large-sized, indeterminate species of *Pseudosaynella* from the overgrown base of the formation, three intervals (CV-1, CV-3 and CV-4) have yielded ammonites, being associated with decapod crustacean remains in CV-1 and CV-3 (Fig. 2). Some of the ammonites are *ex situ*, but these were collected from very close to the top of CV-3, here labelled as CV-3E (Appendix 2). The three intervals, together with CV-3E, have yielded fragments and/or juveniles of *Deshayesites deshayesi* (d'Orbigny, 1841) (Fig. 3A–I, K–L) and *Cheloniceras* cf. *cornuelianum* (d'Orbigny, 1841) (Fig. 3J), an association that marks the mid lower Aptian *Deshayesites deshayesi* Zone of the standard Mediterranean ammonite zonation (Reboulet et al., 2014).

It should be noted that our understanding of the index species *D. deshayesi* has recently been discussed in two taxonomic papers (Moreno-Bedmar et al., 2014 and Bersac and Bert, 2015). According to the latter authors, the type material of *D. deshayesi* from the Plicatulas Marls Formation of the Paris Basin (France) is older than our current understanding of the species in the literature, and the base of the zone should be lowered. In their opinion, features of *D. deshayesi* as retained by Moreno-Bedmar et al. (2014) match its direct descendant, i.e., *D. multicostatus* Swinnerton, 1935. The latter forms are assumed to mark the interval between levels with true *D. deshayesi* (i.e., *D. deshayesi* Subzone *sensu* Bersac and Bert, 2015) and the *D. grandis* Subzone, which typifies the upper part of the standard *D. deshayesi* Zone. In view of the problems surrounding the origin of the type material of *D. multicostatus* (see discussion in Bersac and Bert, 2015) and the polyzonal character of the Plicatulas Marls Formation (Bulot et

al., in press) that questions the statistical analysis of *D. deshayesi* proposed by Bersac and Bert (2015), we here follow the concept of the species that was proposed by Moreno-Bedmar et al. (2014). Deshayesitids from La Cova del Vidre closely resemble specimens illustrated by Moreno-Bedmar et al. (2014) from the Morella sub-basin (eastern Spain), having a flat smooth ventral band and subtabulate venter. The stratigraphic interval with decapod crustacean remains probably belongs to the lower part of the standard *D. deshayesi* Zone. This dating corresponds to that previously reported for the middle part of the Margas de Forcall Formation at other localities in the Maestrat Basin (Moreno-Bedmar et al., 2010; Garcia et al., 2014).

4. Systematic palaeontology

Order Decapoda Latreille, 1802

Infraorder Anomura MacLeay, 1838

Superfamily Paguroidea Latreille, 1802

Family Paguridae Latreille, 1802

Genus *Pagurus* Fabricius, 1775

Type species. *Pagurus bernhardus* Linnaeus, 1758, by original designation.

*Fossil species included***.** *Pagurus alabamensis* Rathbun, 1935; *Pagurus alatoides* Philippe and Secrétan, 1971; *Pagurus albus* Müller, 1979 (= *P. tuberculosus* Harvey, 1998); *Pagurus avellanedai* Vía, 1951; *Pagurus banderensis* Rathbun, 1935; *Pagurus*

aff. *bernhardus* (Linnaeus, 1758); *Pagurus concavus* Müller, 1979; *Pagurus convexus* Whetstone and Collins, 1982; *Pagurus granosimanus* (Stimpson, 1859); *Pagurus langei* Collins and Jakobsen, 2004; *Pagurus latidactylus* Müller and Collins, 1991; *Pagurus malloryi* Schweitzer and Feldmann, 2001; *Pagurus manzonii* (Ristori, 1888); *Pagurus marceti* Vía, 1959; *Pagurus marini* Vía, 1959; *Pagurus mezi* Lőrenthey, 1909; *Pagurus rakosensis* Müller, 1979; *Pagurus squamosus* Ristori, 1886; *Pagurus texensis* Franţescu, 2014; *Pagurus travisensis* Stenzel, 1945; *Pagurus turcus* Müller, 1984 and *Pagurus valdagnensis* Beschin, De Angeli, Checchi and Zarantonello, 2012.

Pagurus avellanedai Vía, 1951

Figs. 4–6.

1943 fragmento de pata; Bataller, p. 547.

*1951 *Pagurus Avellanedae* Vía, p. 171, text-fig. 11; pl. 1, fig. 11–11a.

1982 *Pagurus avellanedae* Via, 1951; Whetstone and Collins, p. 1219.

1988 *Pagurus avellanedai* Via, 1951; Via, pp. 344, 350, fig. 344.

1988 *Pagurus avellanedai* Via, 1951; Solé and Via, p. 26.

2010 *Pagurus avellanedae* Vía, 1951; Schweitzer et al., p. 56

2015 *Pagurus avellanedae* Via, 1951; Fraaije et al., p. 356.

Material. Four specimens with cuticle preserved, as follows: two propodi of the right, and two propodi of the left cheliped, and another propodus and fragment of carpus of a left cheliped, in the collections of the Museu de Geologia del Seminari de Barcelona (MGSB). Measurements (L, length; W, width; T, thickness) are as follows: MGSB 82920 (palm), L 32 mm, W 34,5 mm, T 17,5 mm; MGSB 82921, L 16 mm, W 19 mm, T 10,5 mm; MGSB 82922 (palm), L 20,5 mm, W 22 mm, T 14 mm; MGSB 82923

(palm), L 19 mm, W 22 mm, T 10,3 mm. For comparison, the holotype of the present species, MGSB 1732, measures L 22 mm and W 26 mm.

*Type locality***.** La Cova del Vidre, in the municipality of Roquetes (Baix Ebre County, province of Tarragona, Catalonia) in the Els Ports Massif.

Stratigraphic horizon. Margas de Forcall Formation; lower Aptian, *Deshayesites deshayesi* Zone.

Etymology: This species is named after Dr Domingo Avellaneda; the name was spelled incorrectly in the original description. It is herein emended, as per the rules in the International Code of Zoological Nomenclature pertaining to incorrect original spellings (article 32.3).

*Emended description***.** Chelipeds heterochelous**.** Palm of right propodus subquadrate, slightly wider than high; maximum length at distal part; gently curved inwards; transverse section ovoid; outer and inner sides convex, strongly convex in first upper third of inner side; outer and inner surface closely set with conical tubercles of different sizes, forming rows in the lower part, coarser distally. Upper margin convex, acute, armed with two irregular rows of spiny tubercles directed upwards and forwards. Lower margin gently convex, slightly edged. Pollex inverted triangular in section, very strong, equaling about half of palm width; occlusal margin longitudinally sunken, with acute outer margin raised medially, forming a lateral cutting edge. Dactylus subtriangular in section, very strong, curved downwards, laterally depressed forming a ridge in upper margin; outer side of cutting edge with proximal tooth. Both dactyli closely set with coarse rounded tubercles. Setal pits not observed.

Palm of left propodus subquadrate, slightly wider than high; maximum length in proximal end; transverse section ovoid; gently curved inwards but less so than in right

propodus; outer and inner sides convex, strongly convex at the mid of inner side; outer and inner surface densely covered by acute tubercles of different sizes, coarser and spiny distally; articulating rims smooth. Upper margin convex, with two irregular rows of spiny tubercles, the inner directed upwards, and the outer directed forwards. Lower margin straight, with row of fordwardly directed spiny tubercles. Dactylus incomplete, subtriangular in section; upper margin of dactylus spiny. Setal pits not observed.

Carpus of left cheliped, taller distally, ovoid in distal transverse section, subtriangular in proximal transverse section, ornamented with tubercles in the upper and lower outer side, articulating rim smooth. Upper margin with tubercles directed upwards.

Remarks. The find of more complete new material at the type locality of this taxon allows to complete the original description that was based on fragmentary material (Fig. 5J–K; see Vía, 1951) to be complemented. The general morphology of the chelae of the present species matches characters of *Pagurus* (*sensu lato*) well, in that the right propodus is much larger than the left, with a convex lower margin and a short, strong fixed finger with hollow occlusal margin.

Isolated remains of *P. avellanedai* are also found in correlative strata at several other localities in the Maestrat Basin (Solé and Via, 1988, p. 26; pers. obs.), being striking the abundance of this species in the relatively small outcrop of La Cova del Vidre.

.

Infraorder Brachyura Latreille, 1802

Section Podotremata Guinot, 1977

Subsection Dynomeniformia Guinot, Tavares and Castro, 2013

Superfamily Homolodromioidea Alcock, 1900

Family Prosopidae von Meyer, 1860

Genus *Rathbunopon* Stenzel, 1945

Type species. *Rathbunopon polyakron* Stenzel, 1945, by original designation.

Species included. *Rathbunopon obesum* (Van Straelen, 1944); *R. oblitum* (Carter, 1898); *R. polyakron* Stenzel, 1945; *R. schrattenkalkensis* Klompmaker, Artal and Gulisano, 2011; *R. tarraconensis* **n. sp**.; *R. tuberculatum* (Van Straelen, 1936); *R. viai* González-León, Ossó, Moreno-Bedmar and Vega, 2016 and *R. woodsi* Withers, 1951.

***Rathbunopon tarraconensis* n. sp**.

Figs. 7–8

*Derivation of name***.** From (the province of) Tarraco, the Roman name of Tarragona.

*Type locality***.** La Cova del Vidre (municipality of Roquetes), Baix Ebre County, province of Tarragona (Catalonia), Els Ports Massif.

Stratigraphic horizon. Margas de Forcall Formation, lower Aptian (*Deshayesites deshayesi* Zone).

Material. Two specimens with near-complete dorsal carapaces, preserving details of the dorsal ornament, as well defined as regions; cuticle partially preserved. Housed in the collections of the Museu de Geologia de Barcelona (MGB). The holotype is MGB 84275; measurements are as follows: L 18 mm, W 15 mm, fronto-orbital width 11,2 mm; MGB 84276 is paratype; measurements: L 16,8 mm, W 14,9 mm, fronto-orbital width 9,8 mm.

Diagnosis. Carapace of small size, subovoid, nearly pyriform, sculptured; longer than wide; strongly convex transversely, moderately convex longitudinally**.** Regions well defined by strong tubercles or inflations, separated by deep grooves. Surface coarsely granulated posteriorly. Fronto-orbital width/maximum carapace width ratio about 0,72 of maximum width. Maximum width at posterior third of carapace. Rostrum subtriangular. Orbits large and deep, complete; supraorbital margin with two strong projections; infraorbital tooth strong, dorsally visible. Anterolateral margin short. Posterolateral margin strongly convex. Posterior margin rimmed. Epigastric region with two tubercles. Protogastric region with two tubercles adjacent to anterior part of mesogastric region. Mesogastric region subtriangular elongate, with three inflations. Metagastric region with a large transverse lobe. Urogastric region with transverse lobe. Cardiac region inverted triangular, swollen. Branchial regions separated by well-marked grooves. Epibranchial region transverse, with two tubercles. Mesobranchial region defined by a transverse lobe. Metabranchial region large, strongly inflated, coarsely granulated. Hepatic region small, defined by a transverse inflation. Intestinal region transversely narrow, medially slightly inflated, smooth. Well-marked cervical, branchial and branchiocardiac grooves.

Description. Small-sized, near-complete carapace, with cuticle partially present, longer than wide, subovoid almost pyriform in outline; maximum width in posterior third of carapace at level of metabranchial region. Dorsal surface strongly sculptured, regions well defined by strong tubercles or inflations and delimited by deep grooves; surface apparently smooth except for posterior third where it is coarsely granulated. Anterolateral margins short, convergent, medially divided by cervical groove; marked by strong and salient epibranchial tooth directed laterally, and outer orbital tooth directed forwards. Posterolateral margins strongly convex, over twice that of

anterolateral margins; anterior notch formed by the branchiocardiac groove. Posterior margin convex, defined by a smooth ribbon between metabranchial and intestinal regions and the posterior rim. Front with lateral folds that form the inner orbital teeth. Rostrum triangular, strongly downturned, axially depressed, narrowing sharply towards front. Orbits large and deep, complete; supraorbital margin with two strong rounded and upwardly directed projections; outer orbital tooth strong, directed forwards, closing laterally the orbit; infraorbital margin with a strong subtriangular tooth, dorsally visible. Epigastric region with two strong tubercles at both sides of the axial depression. Mesogastric region subtriangular elongate anteriorly, longer than wide, with three inflations, two transversely contiguous at base and one in the anterior part of the region. Protogastric lobes, with a strong posterior tubercle near the median mesogastric tubercle, and a less marked anterior tubercle near the end of mesogastric region. Metagastric region defined by a narrow transverse lobe, laterally separated from epibranchial lobe by a faint depression, and from the meso- and urogastric lobes by grooves anteriorly and posteriorly. Urogastric region defined by a faint narrow transverse lobe, bounded by grooves. Cardiac region inverted triangular elongate, inflated and well bounded laterally by deep branchiocardiac groove. Epibranchial region defined by a transverse lobe with two tubercles, separated from the epibranchial tooth by a depression and separated from the mesobranchial lobe by the post-cervical groove. Mesobranchial region, formed by a well-defined, swollen and transverse lobe faintly depressed distally, obliquely directed towards the epibranchial tooth, separated from that by a notch, and separated from the metabranchial region by deep and well-marked branchial groove. Metabranchial region subtrapezoidal, large, strongly inflated, laterally prominent, with scattered coarse granules. Hepatic region small, defined by a transverse inflation, contiguous to the rearmost protogastric tubercle and ending below the outer

orbital tooth. Intestinal region transversely narrow, defined by a smooth area between the cardiac lobe and the rim of posterior margin, slightly inflated medially. Cervical, post cervical, branchial and branchiocardiac grooves well marked, deep, smooth. Ventral carapace and appendages not preserved.

Remarks. These two specimens, clearly referable to *Rathbunopon*, bring the number of species of this genus in the Iberian basins Peninsula during the Early Cretaceous to three. They match the generic diagnosis precisely, possessing a characteristic pyriform outline and a marked dorsal sculpture, formed of strong tubercles and bars and of deep grooves separating them. As such, they are closely resemble congeners. Wright and Collins (1972, pp. 14, 23) noted the close similarity between the type species *R. polyakron* and *R. woodsi*, stating that, "In addition *Rathbunopon polyakron* Stenzel from Texas is very close to, if not identical with, *R. woodsi* Withers from England.", and suggested that, with more material available, both taxa should be treated as members of a single, variable species (Wright and Collins 1972, pp. 14, 23). However, there are in fact subtle differences between these two species (see González-León et al., 2016, pp. 119–120). In addition, new species or others that had previously been assigned to other genera, have lately also be placed in *Rathbunopon* (see Wright and Collins, 1972; Klompmaker et al., 2011; González-León et al., 2016). The new species is compared with congeners below.

Although they have the inflated metabranchial lobes with maximum width at the level of the mid-metabranchial lobe and a closely similar, strong dorsal sculpture in common, *Rathbunopon tarraconensis* **n. sp.** differs from *R. polyakron*, the type species of the genus, from the Cenomanian of Texas, in having coarsely granulated metabranchial region (*vs* only a few scattered granules on inner part of metabranchial

lobes in *R. polyakron*), more produced and less individualized proto-, meso-, and epibranchial tubercles; a longer cardiac, more laterally produced epibranchial teeth and a sharply narrowing front. In addition, the supraorbital margin in the new species has two rounded projections, rather than a single one in *R. polyakron* (see Stenzel, 1945, pp. 450–452, text-fig. 16; pl. 41, figs. 18–21; Klompmaker et al., 2011, fig. 5A).

In many respects *Rathbunopon tarraconensis* **n. sp.** is morphologically close to *R. obesum* from the upper Albian of Spain and the Cenomanian of the United Kingdom, but differs in having its maximum width in the posterior third (*vs* at mid-length of carapace in *R. obesum*) and in lacking the faint axial concavity in the posterior margin seen in *R. obesum.* In the new species, the metagastric lobe is separated by a groove from adjacent epibranchial lobes (*vs* continuous in *R. obesum*), the rostrum narrows sharply and the supraorbital margin possesses two rounded projections (*vs* one in *R. obesum*; see Van Straelen, 1940, pp. 6–10, pl. 1, fig. 3–3a; Wright and Collins, 1972, pp. 23–24, pl.1, fig. 8; and Klompmaker et al., 2011, figs. 3A–J, 4, 5C).

Apparently, *Rathbunopon tarraconensis* **n. sp**. has metabranchial lobes with scattered granules in common with *R. oblitum* from the upper Albian of Cambridge (United Kingdom), as based on Carter's (1898) illustration, while in the description it is said that the whole dorsal surface has traces of tubercles, thus differentiating it from the new species. Based on the original illustration, *R. oblitum* seems to have two supraorbital projections (as in *R. tarraconensis* **n. sp.),** but it does reveal lesser produced epibranchial teeth a lack of tubercles on the epibranchial lobes. It is impossible to compare these taxa in more detail, because the single specimen of *R. oblitum* was lost (see Wright and Collins, 1972, p. 22).

Rathbunopon tarraconensis **n. sp.** differs from *R. schrattenkalkensis* from the lower Aptian of the German-Austrian border, in having: two protogastric tubercles (*vs*

one in *R. schrattenkalkensis*), epi- and mesobranchial lobes separated from the metagastric lobes (*vs* interconnected), and two supraorbital projections (vs one in *R. schrattenkalkensis*; see Klompmaker et al., 2011, pp. 199–200, fig. 6A–C).

Comparison of *Rathbunopon tarraconensis* **n. sp**. with *R. tuberculatum* from the Hauterivian of Auxerre (France), is difficult in view of the fragmentary nature of the latter, but the new species differs from it in having a more sculptured dorsal carapace, more prominent outer-orbital and epibranchial teeth, a lack of tubercles in the hepatic region; two supraorbital projections and a smooth anterior part of the carapace (*vs* apparently granulated in *R. tuberculatum*; see Van Straelen, 1936, pp. 31–33, pl. 4, fig. 4).

Rathbunopon tarraconensis **n. sp.** differs from *R. viai* from the lower Aptian of Cantabria (Spain) in having a less marked pyriform shape than the latter, a granulated surface only on metabranchial lobes (*vs* entire dorsal carapace granulated in *R. viai*), a greater fronto-orbital/carapace width ratio, a wider rostrum; two supraorbital projections (*vs* slightly sinuous supraorbital margin in *R. viai*) and a better-marked urogastric region (see González-León et al., 2016).

Rathbunopon tarraconensis **n. sp.** has the same inflated metagastric regions in common with *R. woodsi* from the Cenomanian of Devon (United Kingdom) and the lower Cenomanian of Orne (France), but differs from the latter in having granulated metabranchial lobes (*vs* completely smooth cuticle in *R. woodsi*), two supraorbital projections (vs one in *R. woodsi*) a greater fronto-orbital/carapace width ratio, a narrower intestinal region and shorter posterior margin (see Withers, 1951, p. 179, pl. 16, figs. 5–6; Wright and Collins, 1972, pp. 22–23, pl. 1, fig. 7a–e; Klompmaker et al., 2011, fig. 5b; and González-León et al., 2016).

375 All these differences, justify the erection of a new species for the La Cova del
376 Vidre specimens, despite the evident similarities amongst all species of *Rathbunopon*.
377 In addition, the temporal and palaeobiogeographical distribution of these taxa, ranging
378 from the Hauterivian to the Cenomanian of North America and Europe, reinforces this
379 view (see also González-León et al., 2016).

380

381 Superfamily Dromioidea De Haan, 1833
382 Family Dromiidae De Haan, 1833
383 Subfamily Goniodromitinae Beurlen, 1932
384 Genus *Pithonoton* von Meyer, 1842
385
386 *Type species*. *Pithonoton marginatum* von Meyer, 1842, by original designation.
387
388 *Species included*. *Pithonoton cardwelli* Armstrong, Nyborg, Bishop, Ossó-Morales and
389 Vega, 2009; *P. campichei* (de Tribolet, 1874); *P. elongatum* von Meyer, 1860; *P.*
390 *laevimarginatum* Lőrenthey and Beurlen, 1929; *P. lluismariaorum* **n. sp**.; *P.*
391 *marginatum* von Meyer, 1842; *P. obtusum* (von Meyer, 1857); *P. rusticum* Patrulius,
392 1966 and *P. simplex* (von Meyer, 1837).
393
394 *Remarks. Pithonoton* was used as 'litter bin' genus, and many species have been
395 assigned to it over time. Most have subsequently been reassigned to other genera such
396 as *Goniodromites*, *Eodromites* and *Tanidromites* (Schweitzer and Feldmann, 2007).
397 Here we include only those species that have not been assigned to these other genera
398 with confidence, and only species with subvertical, subparallel lateral margins, wide
399 branchial regions, longitudinally and transversely strongly vaulted dorsal carapaces,

with widely U-shaped cervical grooves, in which both the cervical and the branchial grooves notch the carapace margin.

Pithonoton lluismariaorum n. sp.

Figs. 9–10

Derivation of name. From María Sánchez and Lluís Prieto, who found and donated the holotype.

Type locality. La Cova del Vidre (municipality of Roquetes), Baix Ebre County, province of Tarragona (Catalonia) in the Els Ports Massif.

Stratigraphic horizon. Margas de Forcall Formation, lower Aptian (*Deshayesites deshayesi* Zone).

Material. Two specimens with complete dorsal carapace preserving cuticle, and a third incomplete specimen in the collections of the Museu de Geologia de Barcelona (MGB). The holotype is MGB 84277, measuring L 14,2 mm, W 11 mm, fronto-orbital width 8,8 mm. Paratype MGB 84278 measures L 11 mm, W 10 mm, fronto-orbital width 8,5 mm, and paratype MGB 84279 measures L 11,4 mm, W 8 mm.

*Diagnosis***.** Carapace subovate; wide fronto-orbital margin occupying entire anterior carapace width; length slightly exceeding width, markedly convex in longitudinal and transverse cross sections; front conspicuously wide, produced, triangular with bilobed tip; anterolateral carapace margins anteriorly with strong teeth, posteriorly with equal-sized, blunt spines; carapace surface smooth, areolation weak; cardiac region rather

425 broad, cervical and branchial grooves parallel, both notching the lateral carapace
426 margins; orbits large, deep, ovate, suborbital margin produced in pointed tooth.
427
428 *Description*. Carapace subovate, length exceeding width, greatest carapace width
429 approximately 40 per cent total carapace length from front; markedly convex in
430 longitudinal and transverse cross sections; orbitofrontal margin slightly narrower than
431 maximum carapace width, lateral spines included. Front prominent, produced, broadly
432 triangular, tip bilobed; orbital margins long, entire, slightly raised; orbits conspicuously
433 large, deep, broadly ovate, with blunt outer orbital corner. Suborbital margin sinuous,
434 indented just below outer orbital corner, and produced in pointed tooth dorsally visible.
435 Anterolateral margins sharp in cross section, subdivided by cervical groove notching the
436 margin anteriorly, making short anterior partition with strong spine directed outwards
437 and forwards, and longer, convex posterior portion, bearing three small, equally divided
438 spines. Posterolateral margin long, strongly curved towards posterior margin. Posterior
439 margin concave in dorsal view, strongly concave in posterior view, relatively narrow,
440 lined by a subtle rim and a shallow groove.
441 Epigastric regions small, weakly vaulted, closely interspaced, bounding the
442 weakly defined, broadly triangular mesogastric region. Posterior mesogastric process
443 broadly based. Protogastric regions large, barely separated from narrow hepatic region.
444 Urogastric lobe low, wide, anterior margin concave, posterior margin straight, ornated
445 with small granules transversely aligned. Cardiac region shield shaped, swollen,
446 laterally well delimited by short branchiocardiac grooves, ornate with a transverse row
447 of small granules. Meso- and metabranchial regions weakly differentiated, oblique,
448 paired by cervical and branchial grooves. Cervical groove shallow, entire, as a wide V,
449 notching carapace margin; axially interrupted between closely interspaced gastric pits.

Branchial groove sinuous, subparallel to cervical groove, more clearly defined, strongly notching lateral carapace margin. Grooves continued converging on ventral carapace, which is conspiuously large, with prominent subhepatic region.

Remarks. Von Meyer (1837, 1842, 1857, 1860) described four species of *Pithonoton* from the Upper Jurassic of Germany, namely *P. elongatum*, *P. marginatum*, *P. obtusum* and *P. simplex*. Comparison with *P. lluismariaorum* **n. sp.** is difficult since all of von Meyer's originals were lost during the Second World War, and only of the type species *P. marginatum* has a neotype been designated. Based on the original figures and descriptions, all Late Jurassic species from Germany differ from *P. lluismariaorum* **n. sp**. at least by the sinuous shape of the cervical groove, which marks a lowered portion at the base of the mesogastric region. Also, the posterior portion of the mesogastric region is defined in the Late Jurassic species from Germany, but not in *P. lluismariaorum* **n. sp**. The cuticle of *P. marginatum* is entirely granular while only some scattered granules are seen in the new species.

Prosopon laevimarginatum from the Upper Jurassic of Hungary, is more elongate, with more diverging lateral margins. The gastric region is well defined, in contrast to that in *P. lluismariaorum* **n. sp.** in which only the anterior mesogastric process, and the posterior base of the gastric regions are noticeable. The outer orbital corners of *P. laevimarginatum* are simple and prominent, while they are double, blunt and more subtle in *P. lluismariaorum* **n. sp.** (see Lőrenthey and Beurlen, 1929, pp. 85–87, pl. 3, fig. 8).

Pithonoton rusticum from the Upper Jurassic of Romania is closely comparable to the type species, *P. marginatum*. Wehner (1988) synonymised the two species but

Schweitzer and Feldmann (2007) considered them distinct, following re-examination of a paratype of Patrulius's species. Both forms have fairly straight, continuous lateral margins, which are diverging towards anterior; they have sinuous cervical grooves with the median third distinctly lowered, and the mesogastric region completely defined. On the basis of these characteristics they are readily distinguished from *P. lluismariaorum* **n. sp.** (see Patrulius, 1960, pp. 511–512, pl. 31, figs. 17–18).

Pithonoton cardwelli, from the Paleocene of Texas, represents the youngest member of the genus, being known from the holotype only, a carapace with some parts of the lateral margins crumbled, and the anterior portion of the thoracic sternum preserved. Lateral margins in *P. cardwelli* are smooth, not granular as in *P. lluismariaorum* **n. sp**., and the cervical and branchial grooves are more V-shaped in the fomer. On the lateral carapace flanks, the cervical and branchial grooves rapidly converge in *P. lluismariaorum* **n. sp**. while they remain distant in *P. cardwelli*. Also, the posterior carapace in *P. cardwelli* is relatively wider, and the cardiac region is lower. Nevertheless, these species are morphologically similar in having an overall rather smooth carapace with weakly inflated regions, subparallel lateral margins, and carapaces that are convex in both cross sections (see Armstrong et al., 2009, pp. 748–750, figs. 3, 9–12).

Pithonoton campichei, from the Hauterivian (Lower Cretaceous) of Switzerland, is the only other Cretaceous member of the genus. The taxon is represented by two partial carapaces, currently housed in the colletions of the Musée cantonal de Géologie (Lausanne). Of all *Pithonoton* spp. it is morphologically most closely similar to *P. lluismariaorum* **n. sp**. in having an overall smooth carapace, subparallel lateral margins, lateral margins that are convex between the cervical and branchial grooves, and overall rather horizontal cervical and branchial grooves. The new species differs in having more

inflated dorsal regions, in particular the branchial and cardiac regions; in having a continuously U-shaped cervical groove (sinuous, median third distinctly lowered, in *P. campichei*), and a more domed carapace in lateral view (see de Tribolet, 1874, pp. 360–361, pl. 12, fig. 9).

Thus, *P. lluismariaorum* **n. sp**. is most closely similar to the other Cretaceous and Paleocene species of *Pithonoton* in having a continuous cervical groove, rather smooth carapace, and a weakly defined mesogastric region. The genus flourished in the Late Jurassic but was only a minor component of Cretaceous decapod crustacean faunules. It appears to have became extinct after the Paleocene.

5. Conclusions

For the first time the stratigraphic section at the La Cova del Vidre outcrop is described and illustrated, and ammonites are used for a biozone interpretation of the sequence exposed. Newly collected specimens of *Pagurus avellanedai* from the type locality have enabled an improvement and emendation of the original description. The marked abundance of *P. avellanedai* at La Cova del Vidre, contrasts with the paucity of this species in other relatively close localities in the Maestrat Basin.

In addition, two new brachyuran species are erected herein, *Rathbunopon tarraconensis* **n. sp.** (Prosopidae) and *Pithonoton lluismariaorum* **n. sp.** (Dromiidae). It is of note that three (out of six) species of *Rathbunopon*, inclusive of the new one, have been recorded and described from the Lower Cretaceous of the Iberian Peninsula.

Acknowledgements

We are indebted to María Sánchez and Lluís Prieto (Barcelona, Catalonia) and Manuel Cervantes (Rubí, Catalonia), who found and kindly donated the type material of the new decapod crustacean species described herein. Scott Morrison (University of Oregon, Corvallis, Oregon) provided important items of literature; Enric Forner (Ateneu de Natura, Castelló de la Plana, Spain) assisted during field work and identified the associated fauna. We are grateful to René H.B. Fraaije (Oertijdmuseum, Boxtel, The Netherlands) and Matúš Hyžný (Natural History Museum, Vienna, Austria and Comenius University, Bratislava, Slovakia) and Associate Editor John W.M. Jagt (Natuurhistorisch Museum Maastricht) for its constructive reviews. The present study was partially supported by the projects CGL2015-69805-P (MINECO, FEDER, EU) and PAPIIT IN107617 (DGAPA, Universidad Nacional Autónoma de México).

References

Alcock, A., 1900. Materials for a carcinological fauna of India, No. 5. The Brachyura Primigenia or Dromiacea. Journal of the Asiatic Society of Bengal 68 (2) 3, 123–169.

Armstrong, A., Nyborg, T., Bishop, G.A., Ossó-Morales, À., Vega, F.J., 2009. Decapod crustaceans from the Paleocene of Central Texas, USA. Revista Mexicana de Ciencias Geológicas 26, 745–763.

Artal, P., Ossó, À., van Bakel, B., Fraaije, R., Jagt, J., 2010. A new crab assemblage from the middle Aptian of Barcelona Province (Catalonia, northeast Spain), p. 7. *In*: Schweigert, G. (Ed.), 4th Symposium on Mesozoic and Cenozoic Decapod Crustaceans, Eichstätt, Germany, Abstracts, 7. Jura-Museum Eichstätt, Eichstätt.

546 Bataller, J.R., 1943. Los estudios paleontológicos sobre el Cretácico español. Memorias
547 de la Real Academia de Ciencias y Artes 26 (560), 519–561.

548 Bersac, S., Bert, D., 2015. Two ammonite species under the same name: Revision of
549 *Deshayesites deshayesi* (d'Orbigny, 1841) based on topotype material (Lower
550 Aptian, Lower Cretaceous, Northeast of France). Annales de Paléontologie 101,
551 265–294.

552 Beschin, C., De Angeli, A., Checchi, A., Zarantonello, G., 2012. Crostacei del
553 giacimento eocenico di Grola presso Spagnago di Cornedo Vicentino (Vicenza,
554 Italia settentrionale) (Decapoda, Stomatopoda, Isopoda). Museo di Archeologia
555 e Scienze naturali "G. Zannato", 100 pp.

556 Beurlen, K., 1932. Brachyurenreste aus dem Lias von Bornholm mit Beiträgen zur
557 Phylogenie und Systematik der brachyuren Dekapoden. Paläontologische
558 Zeitschrift 14, 52–66.

559 Bulot, L.G., Frau, C., Pictet, A., in press. Revision of *Toxoceratoides royeri* (d'Orbigny,
560 1842) and its bearing on the systematics of the Aptian Acrioceratidae
561 Vermeulen, 2004 (Ammonoidea, Ancyloceratina, Ancyloceratoidea). Cretaceous
562 Research.

563 Canérot, J., Cuny, P., Pardo, G., Salas, R., Villena., J., 1982. Ibérica Central-
564 Maestrazgo, pp. 273–344. *In*: Universidad Complutense de Madrid (Ed.). El
565 Cretácico de España. Universidad Complutense de Madrid, Madrid.

566 Carter, J., 1898. A contribution to the palaeontology of the decapod Crustacea of
567 England. The Quarterly Journal of the Geological Society of London 54, 15–44.

568 Collins, J.S.H., Jakobsen, S.L., 2004. New crabs (Crustacea, Decapoda) from the
569 Eocene (Ypresian/Lutetian) Lillebælt Clay Formation of Jutland, Denmark.
570 Bulletin of the Mizunami Fossil Museum 30 (for 2003), 63–96.

571 De Haan, W., 1833-1850. Crustacea. *In*: von Siebold, P. F. (Ed.), Fauna Japonica sive
572 Descriptio Animalium, quae in Itinere per Japoniam, Jussu et Auspiciis
573 Superiorum, qui summum in India Batava Imperium Tenent, Suscepto, Annis
574 1823-1830 Collegit, Notis, Observationibus et Adumbrationibus Illustravit. J.
575 Müller et Co., Lugduni Batavorum (Leiden), i–xvii, i–xxxi, ix–xvi + 243 pp.

576 Fabricius, J.C., 1775. Systema Entomologiae, sistens Insectorum Classes, Ordines,
577 genera, Species, adjectis synonymis, Locis, Descriptionibus, Observationibus.
578 Flensburgi et Lipsiae: Officina Libraria Kortii, 832 pp.

579 Fraaije, R.H.B, van Bakel, B.W.M., Jagt, J.W.M., 2015. A new Albian hermit crab
580 (Anomura, Paguroidea) from France – another example of capsulated setae in an
581 extinct form. Neues Jahrbuch für Geologie und Paläontologie Abhandlungen
582 277(3), 353–359.

583 Franţescu, O., 2014. Fossil decapods from the Cretaceous (late Albian) of Tarrant
584 County, Texas. Neues Jahrbuch für Geologie und Paläontologie Abhandlungen
585 273(3), 221–239.

586 Garcia, R., Moreno-Bedmar, J.A., Bover-Arnal, T., Company, M., Salas, R., Latil, J.-L.,
587 Martín-Martín, J.D., Gomez-Rivas, E., Bulot, L.G., Delanoy, G., Martínez, R.,
588 Grauges, A., 2014. Lower Cretaceous (Hauterivian-Albian) ammonite
589 biostratigraphy in the Maestrat Basin (E Spain). Journal of Iberian Geology 40,
590 99–112.

González-León, O., Ossó, À., Moreno-Bedmar, J.A., Vega, F.J., 2016. A new Prosopidae (Brachyura, Homolodromioidea) and the second record of *Mithracites vectensis* (Homoloidea) from the Aptian of Spain. Neues Jahrbuch für Geologie und Paläontologie Abhandlungen 282(2), 115–124.

Guinot, D., 1977. Proposition pour une nouvelle classification des Crustacés Décapodes Brachyoures. Comptes Rendus hebdomadaires des Séances de l'Académie des Sciences (Paris) D 285, 1049–1052.

Guinot, D., Tavares, M., Castro, P., 2013. Significance of the sexual openings and supplementary structures on the phylogeny of brachyuran crabs (Crustacea, Decapoda, Brachyura), with new nomina for higher-ranked podotreme taxa. Zootaxa 3665(1), 1–414.

Harvey, A.W., 1998. New names for Miocene hermit crabs (Decapoda, Anomura, Paguridae). Crustaceana 71(1), 119–121.

Institut Cartogràfic de Catalunya, 2006. 22 Montsià. Mapa geològic comarcal de Catalunya 1:50 000. Barcelona.

Klompmaker, A.A., Artal, P., Gulisano, G., 2011. The Cretaceous crab *Rathbunopon*: revision, a new species and new localities. Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen 260(2), 191–202.

Lamarck, J.B.P.A., 1819. Histoire naturelle des animaux sans vertèbres 6, 232 pp. Paris, A. Belin.

Latreille, P.A., 1802–1803. Histoire naturelle, géneral et particulière des crustáces et des insects 3, 468 pp. Paris, F. Dufart.

Linnaeus, C., 1758. Systema Naturae per Regna Tria Naturae, Secundum Classes, Ordines, Genera, Species, cum Characteribus, Differentiis, Synonymis, Locis. (Editio decimo) 1, iii + 824 pp. Holmiae, Laurentii Salvii.

Lőrenthey, E., 1909. Beiträge zur Kenntnis der Eozänen Dekapodenfauna Ägyptens. Mathematische und Naturwissenschaftlichen Berichte aus Ungarn 24, 106–152 [Hungarian version published in 1907].

Lőrenthey, E., Beurlen, K., 1929. Die fossilen Decapoden der Länder der Ungarischen Krone. Geologica Hungarica, Series Palaeontologica 3, 1–420.

MacLeay, W.S., 1838. On the brachyurous decapod Crustacea brought from the Cape by Dr. Smith, pp. 53–71. *In*: Smith, A., Illustrations of the Annulosa of South Africa; consisting chiefly of figures and descriptions of the objects of natural history collected during an expedition into the interior of South Africa, in the years 1834, 1835, and 1836; fitted out by "The Cape of Good Hope Association for Exploring Central Africa." Smith, Elder and Company, London.

Martins-Neto, R.G., 1987. Primeiro registro de decápode na Formação Santana, Bacia do Araripe (Cretáceo Inferior), Brasil. Ciência e Cultura 39, 406–410.

Meyer, H. von, 1837. Briefliche Mitteilungen. Neues Jahrbuch für Mineralogie, Geologie und Paläontologie 1837, 1–314.

Meyer, H. von, 1842. Über die in dem dichten Jurakalk von Aalen in Würtemburg vorkommenden Spezies des Crustaceengenus *Prosopon*. Beiträge zur Petrefaktenkunde 5, 70–75.

Meyer, H. von, 1857. Briefliche Mitteilungen. Neus Jahrbuch für Mineralogie, Geologie und Paläontologie 1857, 1–556.

Meyer, H. von, 1860. Die Prosoponiden oder die Familie der Maskenkrebse. Palaeontographica 7, 183–222.

Moreno-Bedmar, J.A., Ferrer, O., Artal, P., Bover-Arnal, T., Company, M., Gallemí, J., Martín-Closas, C., Martínez, R., Ossó, A., Salas, R., Villalba-Breva, S., 2008. Bioestratigrafía integrada del Aptiense del Macizo del Garraf (Cadenas Costero-Catalanas, NE de España). Datos preliminaries, pp. 158–159. Ruiz-Omeñaca, J.I., Piñuela, L., García-Ramos, J.C. (Eds), Libro de Resúmenes. XXIV Jornadas de la Sociedad Española de Paleontología. Museo del Jurásico de Asturias (MUJA), Colunga, 15-18 de octubre de 2008.

Moreno-Bedmar, J.A., Ramírez, L., Company, M., Delanoy, G., Bover-Arnal, T., Bulot, L.-G., Latil, J.-L., Salas, R., 2009. Biostratigrafía de los amonites de Can Casanyes, Macizo del Garraf (Barcelona, España). Batalleria 14, 91–98.

Moreno-Bedmar, J.A., Company, M., Bover-Arnal, T., Salas, R., Delanoy, G., Maurrasse, F.J.-M.R., Grauges, A., Martínez, R., 2010. Lower Aptian ammonite biostratigraphy in the Maestrat Basin (Eastern Iberian Chain, Eastern Spain). A Tethyan transgressive record enhanced by synrift subsidence. Geologica Acta 8(3), 281–299.

Moreno-Bedmar, J.A., Barragán, R., Delanoy, G., Company, M., Salas, R., 2014. Review of the early Aptian (Early Cretaceous) ammonoid species *Deshayesites deshayesi* (d'Orbigny, 1841). Cretaceous Research 51, 341–360.

Moreno-Bedmar, J.A., Albalat, D., Mallofré, A., Ossó, A., Vilà, M., 2016. Estratigrafia mesozoica i nous cefalòpodes de l'Aptià del Vendrell, sud-oest del massís del Garraf (Catalunya). Nemus 6, 61–72.

Moreno-Bedmar, J.A., Robert, E., Matamales-Andreu, R., Bover-Arnal, T., 2017. Review of the early Albian ammonites of the Montmell Formation near

661 Marmellar (Salou-Garraf Basin, Tarragona, Catalonia, Spain). Carnets de
662 Géologie/Notebooks on Geology, Brest, Article 17(1), 1–10.

663 Müller, P., 1979. Decapoda (Crustacea) fauna a budapesti miocénbol (5). Földtani
664 Közlöny 108(3), 272–312.

665 Müller, P., 1984. Decapod Crustacea from the Badenian. Geologica Hungarica 42, 1–
666 317.

667 Müller, P., Collins, J. S. H., 1991. Late Eocene coral-associated decapods (Crustacea)
668 from Hungary. Mededelingen van de Werkgroep voor Tertiaire en Kwartaire
669 Geologie 28(2–3), 47–92.

670 Orbigny, A. d', 1841. Paléontologie Française. Description zoologique et géologique de
671 tous les animaux mollusques et rayonnés fossiles de France. Terrains Crétacés.
672 1, Céphalopodes. Part II (1841), 121–430. Masson, Paris.

673 Patrulius, D., 1960. Les Décapodes du Tithonique Inférieur deWoïniki (Carpates
674 Polonaises Occidentales). Annales de la Société géologique de Pologne 36 (4),
675 495–517.

676 Patrulius, D., 1966. Les Décapodes du Tithonique inférieur de Woźniki (Carpates
677 Polonaises Occidentales). Annales de la Société Géologique du Pologne 34,
678 495–517.

679 Philippe, M., Secrétan, S.,1971. Crustacés Décapodes du Burdigalien des Courennes
680 (Vaucluse). Annales de Paléontologie (Invertébrés) 57, 117–134.

681 Rathbun, M.J., 1935. Fossil Crustacea of the Atlantic and Gulf Coastal Plain.
682 Geological Society of America, Special Paper 2, i-viii + 160 pp.

683 Reboulet, S., Szives, O., Aguirre-Urreta, B., Barragán, R., Company, M., Idakieva, V.,
684 Ivanov, M., Kakabadze, M.V., Moreno-Bedmar, J.A., Sandoval, J., Baraboshkin,
685 E.J., Çaglar, M.K., Főzy, I., González-Arreola, C., Kenjo, S., Lukeneder, A.,
686 Raisossadat, S.N., Rawson, P.F., Tavera, J.M., 2014. Report on the 5th
687 International Meeting of the IUGS Lower Cretaceous Ammonite Working
688 Group, the Kilian Group (Ankara, Turkey, 31st August 2013). Cretaceous
689 Research 50, 126–137.

690 Ristori, G., 1886. I crostacei brachiuri e anomuri del pliocene italiano. Bollettino della
691 Società Geologica Italiana 5, 93–128.

692 Ristori, G., 1888. Alcuni crostacei del miocene medio italiano. Atti della Società
693 Toscana di Scienze Naturali (Pisa) 9, 212–219.

694 Salas, R., Casas, A., 1993. Mesozoic extensional tectonics, stratigraphy, and crustal
695 evolution during the Alpine cycle of the eastern Iberian basin. Tectonophysics
696 228, 33–55.

697 Salas, R., Guimerà, J., Mas, R., Martín-Closas, C., Meléndez, A., Alonso, A., 2001.
698 Evolution of the Mesozoic central Iberian Rift System and its Cainozoic
699 inversion (Iberian chain). In: Ziegler, P.A., Cavazza, W., Robertson, A.H.F.,
700 Crasquin-Soleau, S. (Eds.), Peri-Tethys Memoir 6: Peri-Tethyan Rift/Wrench
701 Basins and Passive Margins. Mémoires du Muséum national d'Historie naturelle
702 Paris 186, 145–186.

703 Schweitzer, C.E., Feldmann, R.M., 2001. New Cretaceous and Tertiary decapod
704 crustaceans from western North America. Bulletin of the Mizunami Fossil
705 Museum 28, 173–210.

706 Schweitzer, C.E., Feldmann, R.M., 2007. A new classification for some Jurassic
707 Brachyura (Crustacea: Decapoda: Brachyura: Homolodromioidea): families
708 Goniodromitidae Beurlen, 1932 and Tanidromitidae new family.
709 Senckenbergiana Lethaea 87, 119–156.

710 Schweitzer, C.E., Feldmann, R.M., Garassino, A., Karasawa, H., Schweigert, G., 2010.
711 Systematic list of fossil decapod crustacean species. Crustaceana Monograph 10,
712 1–222.

713 Schweitzer, C.E., Feldmann, R. M., Karasawa, H., 2012. Part R, Revised, Volume 1,
714 Chapter 8M: Systematic descriptions: Infraorder Brachyura, Section Dromiacea.
715 Treatise Online 51, 1–43.

716 Solé, J., Via, L., 1988. Crustacis Decàpodes fossils dels Països Catalans (Recopilació i
717 actualització des de 1855 a 1988). Batalleria 2, 23–42.

718 Stenzel, H.B., 1945. Decapod crustaceans from the Cretaceous of Texas. The University
719 of Texas Publication 4401, 401–477.

720 Stimpson, W. 1859. Notes on North American Crustacea. [Preprint from] Annals of the
721 Lyceum of Natural History in New York 7: 49–93.

722 Swinnerton, H.H., 1935. The rocks below the Red Chalk of Lincolnshire and their
723 cephalopod faunas. The Quarterly Journal of the Geological Society of London
724 91, 1–46.

725 Tribolet, M. de, 1874. Description des Crustacés du terrain néocomien du Jura
726 neuchâtelois et vaudois. Bulletin de la Société géologique de France (3) 2, 350-
727 365.

728 Van Straelen, V., 1936. Crustaces Décapodes nouveaux ou peu connus de l'époque
729 Crétacique. Bulletin du Musée royal d'Histoire naturelle de Belgique 12, 1–49.

730 Van Straelen, V., 1944. Anomure et Brachyures du Cénomanien de la Navarre. Bulletin
731 du Musée royal d'Histoire naturelle de Belgique 20, 1–12.

732 Vía, L., 1951. Contribución al estudio de los decápodos del secundario en España.
733 Anales de la Escuela de Peritos Agrícolas y Superior de Agricultura y de los
734 Servicios Técnicos de Agricultura 10, 151–180.

735 Vía, L., 1959. Decápodos fósiles del Eoceno español.: Boletín del Instituto Geológico y
736 Minero de España 70, 331–402.

737 Via, L., 1988. Els decàpodes, pp. 343–352. *In*: Enciclopèdia Catalana (Ed.), Història
738 Natural dels Països Catalans, 15 (Registre fòssil). Barcelona, Fundació
739 Enciclopèdia Catalana.

740 Wehner, G., 1988. Über die Prosoponiden (Crustacea, Decapoda) des Jura. Dissertation
741 zur Erlangung des Doktorgrades der Fakultät für Geowissenschaften der
742 Ludwig-Maximilians-Universität zu München, 154 pp.

743 Whetstone, K.N., Collins, J.S.H., 1982. Fossil crabs (Crustacea: Decapoda) from the
744 Upper Cretaceous Eutaw Formation of Alabama. Journal of Paleontology 56(5),
745 1218–1222.

746 Withers, T.H., 1951. Some Jurassic and Cretaceous crabs (Prosoponidae). Bulletin of
747 the British Museum (Natural History) Geology Series 1(6), 171–186.

748 Wright, C.W., Collins, J.S.H., 1972. British Cretaceous crabs. Monographs of the
749 Palaeontographical Society London 126(533), 1–113.

Figure captions

Fig. 1. A, Map of the Iberian Peninsula showing the location of the study area within the linking zone, Catalonia (northeast Iberian Peninsula). The area is situated between the Maestrat and Salou-Garraf basins in the Iberian Chain and Catalan Coastal Ranges, respectively. **B**, Geological map (modified from Institut Cartogràfic de Catalunya, 2006) of the Mas Barberans area, that showing the sampling site (red star) at La Cova del Vidre locality. Geographical co-ordinates in UTM.

Fig. 2. Stratigraphic log of La Cova del Vidre section with details of the interval sampled and the beds (CV1-CV4) that yielded decapod crustaceans and ammonites within the Margas de Forcall Formation.

Fig. 3. *Deshayesites deshayesi* (A–I, K–L) and *Cheloniceras* cf. *cornuelianum* (J). **A1–2**, lateral and ventral views of specimen 89914, bed CV1. **B**, lateral view of specimen 89918, bed CV3. **C1–2**, lateral and ventral views of specimen 89930, bed CV3E. **D**, lateral view of specimen 89921, bed CV3E. **E1–2**, lateral and ventral views of specimen 89925, bed CV3E. **F1–2**, lateral and ventral views of specimen 89926, bed CV3E. **G1–2**, lateral and ventral views of specimen 89928, bed CV3E. **H**, lateral view of specimen 89929, bed CV3E. **I**, lateral view of specimen 89934, bed CV3E. **J**, *Cheloniceras* cf. *cornuelianum*, ventral view of specimen 89915, bed CV3. **K**, lateral view of specimen 89933, bed CV3E. **L1–2**, lateral and ventral views of specimen 89932, bed CV3E. Scale bars equal 10 mm.

Fig. 4. *Pagurus avellanedai* Vía, 1951, right chelae. **A–E**, MGSB 82920, in outer lateral, inner lateral, frontal, lower margin and upper margin views, respectively. **F–J**,

MGSB 82921, in outer lateral, inner lateral, frontal, upper margin and lower margin views, respectively. Scale bars equal 10 mm.

Fig. 5. *Pagurus avellanedai* Vía, 1951, left chelae. **A–E**, MGSB 82922, in outer lateral, inner lateral, upper margin and lower margin views, respectively. **F–I**, MGSB 82923, in outer lateral, inner lateral, frontal and upper margin views, respectively. **J–K**, holotype MGSB 1732a, in outer lateral view and inner lateral views, respectively. Scale bars equal 10 mm.

Fig. 6. *Pagurus avellanedai* Vía, 1951, reconstructions of right (A) and left (B) chelae (illustrations by F.A. Ferratges-Kwekel). Scale bar equals 10 mm.

Fig. 7. *Rathbunopon tarraconensis* **n. sp. A–C**, Holotype MGB 84275, in dorsal (A), frontal (B) and right lateral views (C) and a closeup of left orbit (B'). **D–F**, Paratype MGB 84276, in dorsal, frontal and right lateral views, respectively. Abbreviations: r, rostrum; in, infraorbital tooth; sup, supraorbital tooth; ou, outer orbital tooth; epb, epibranchial tooth. Scale bars equal 10 mm (5 mm for B').

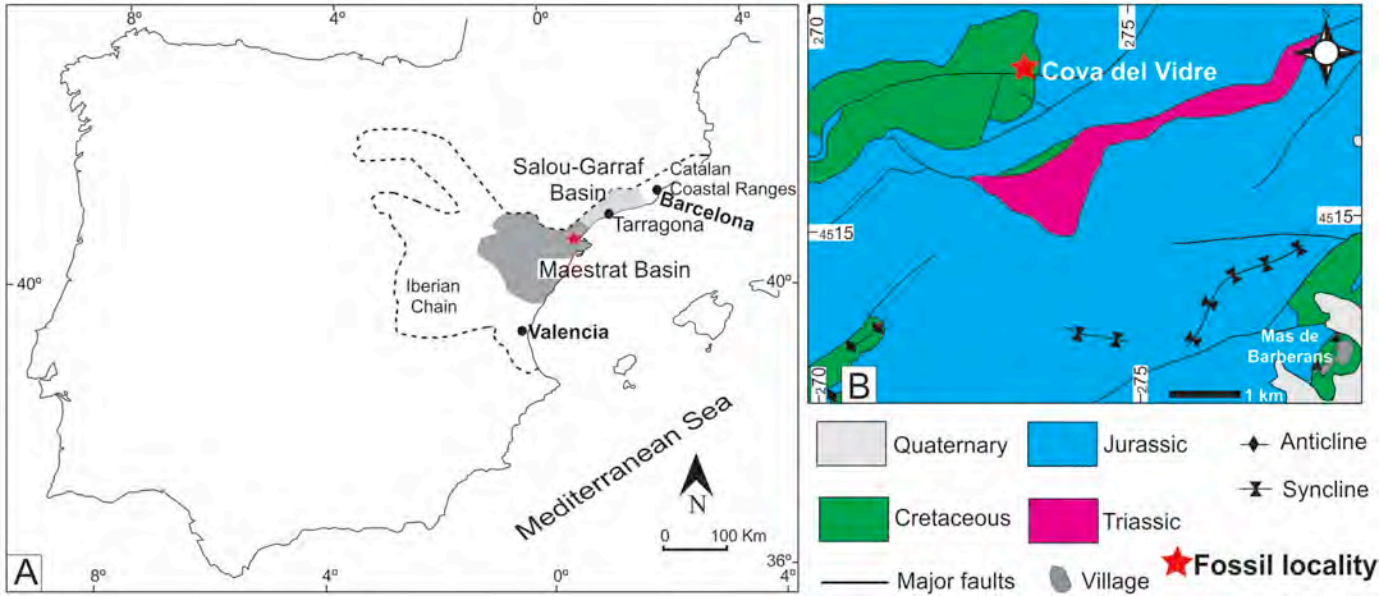
Fig. 8. *Rathbunopon tarraconensis* **n. sp.**, reconstruction of dorsal carapace (illustration by F.A. Ferratges-Kwekel). Scale bar equals 10 mm.

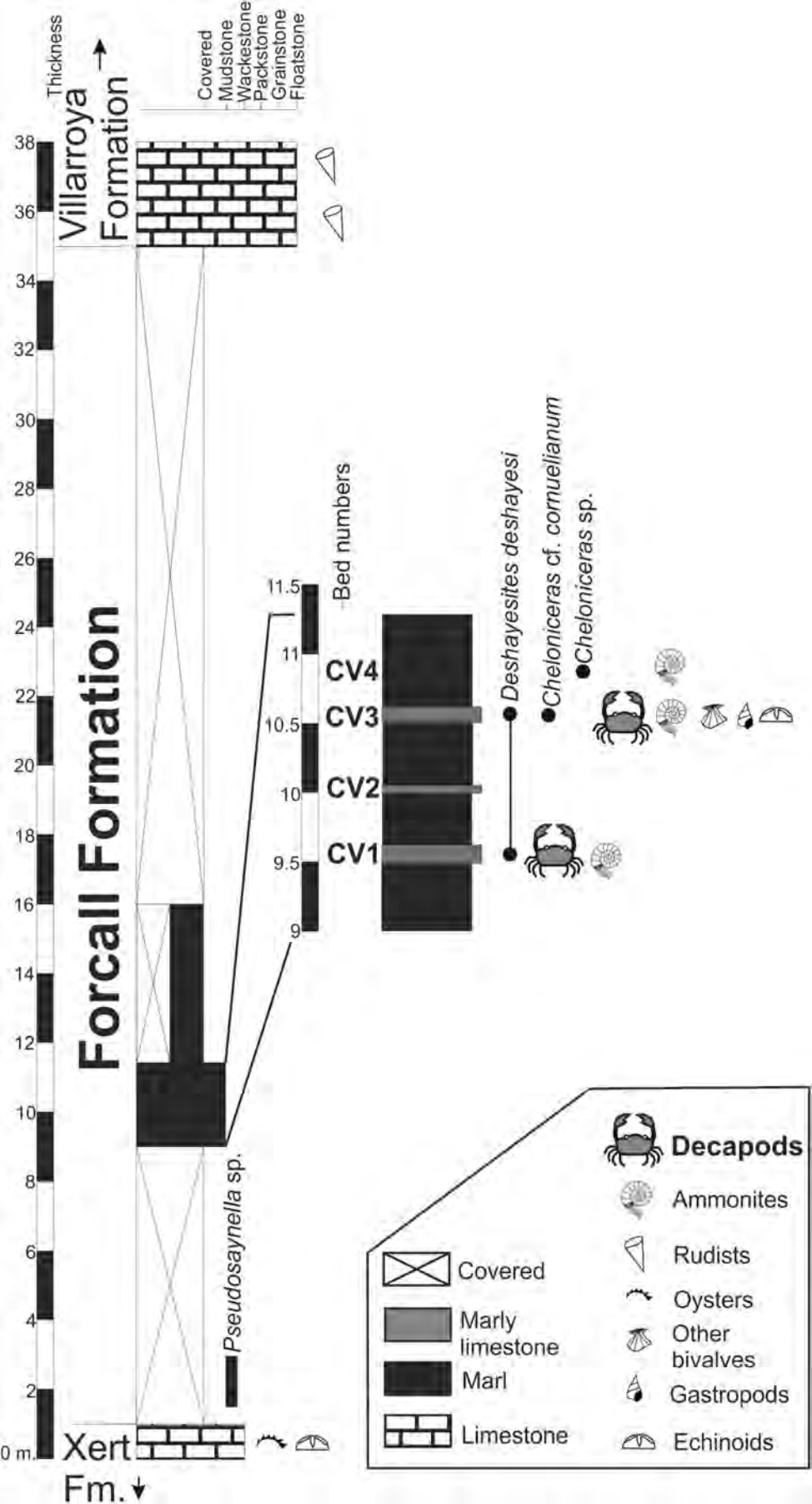
Fig. 9. *Pithonoton lluismariaorum* **n. sp. A–C, I**, holotype MGB 84277, in dorsal, frontal, left lateral and right lateral views, respectively. **D–E**, paratype MGB 84278, in right lateral and dorsal views, respectively. **F–H**, paratype MGB 84279, in dorsal, frontal and left lateral views, respectively. Scale bar equals 10 mm.

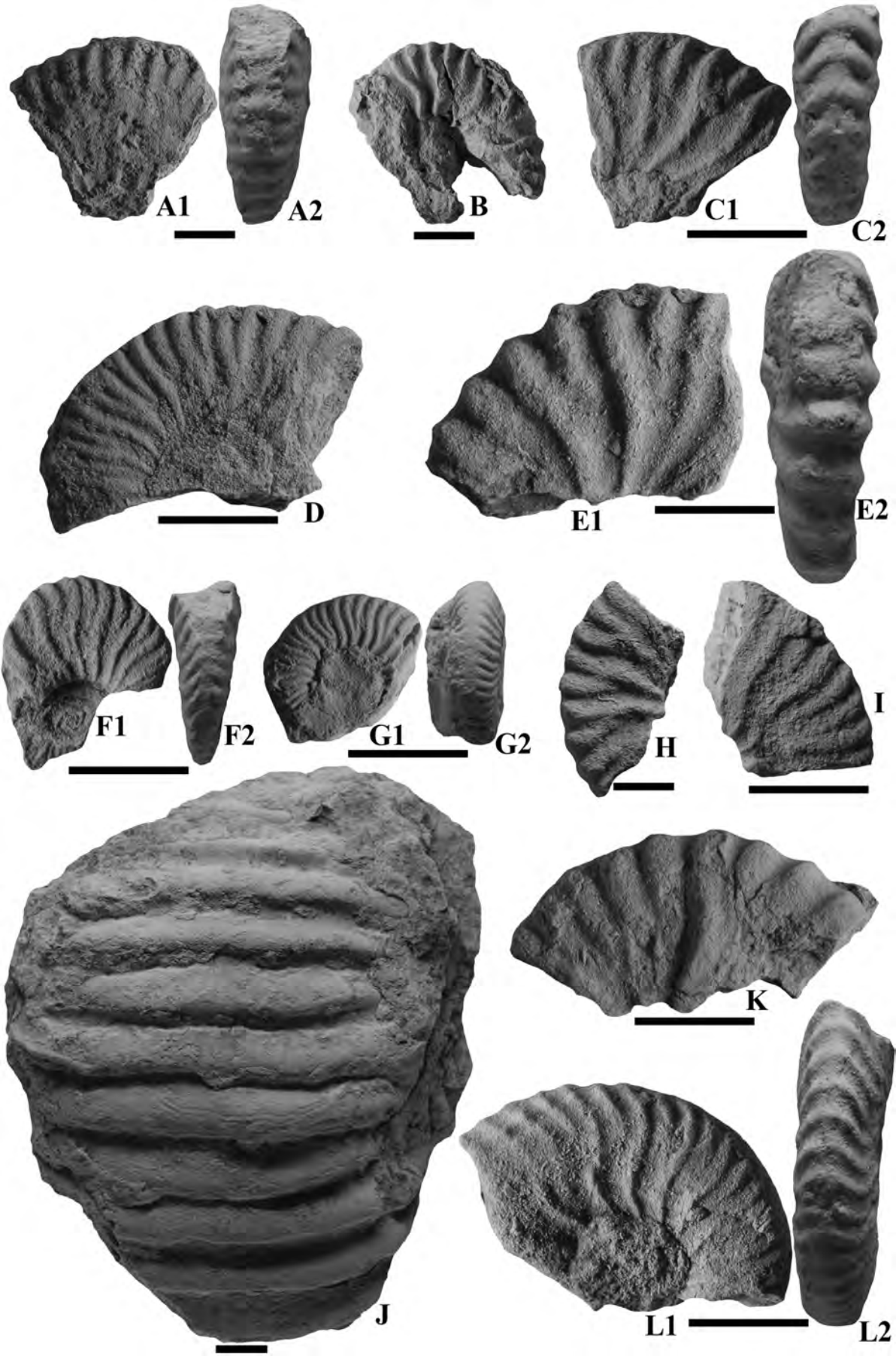
796 **Fig. 10.** *Pithonoton lluismariaorum* **n. sp.**, reconstruction of dorsal carapace

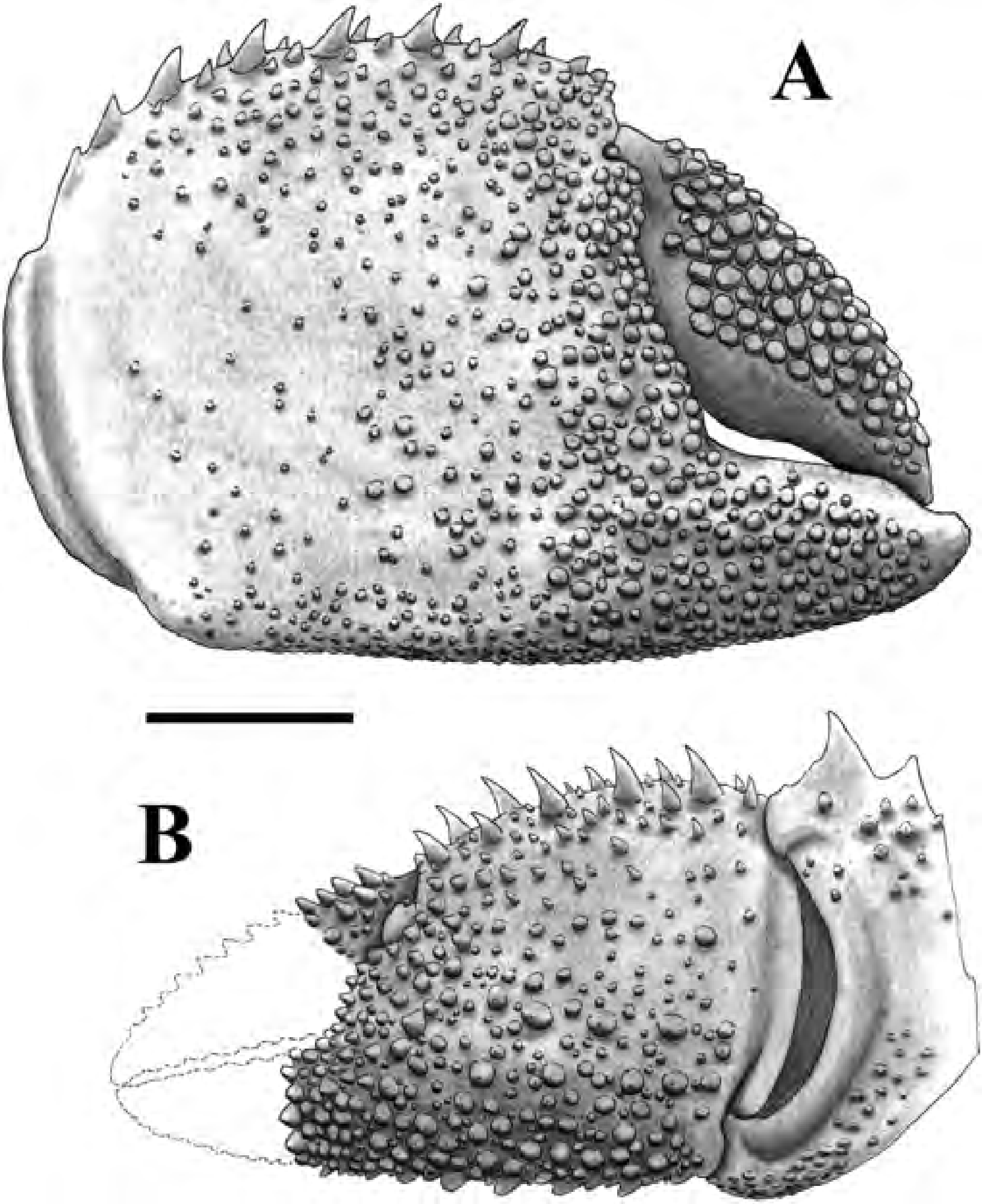
797 (illustration by F.A. Ferratges-Kwekel). Scale bar equals 10 mm.

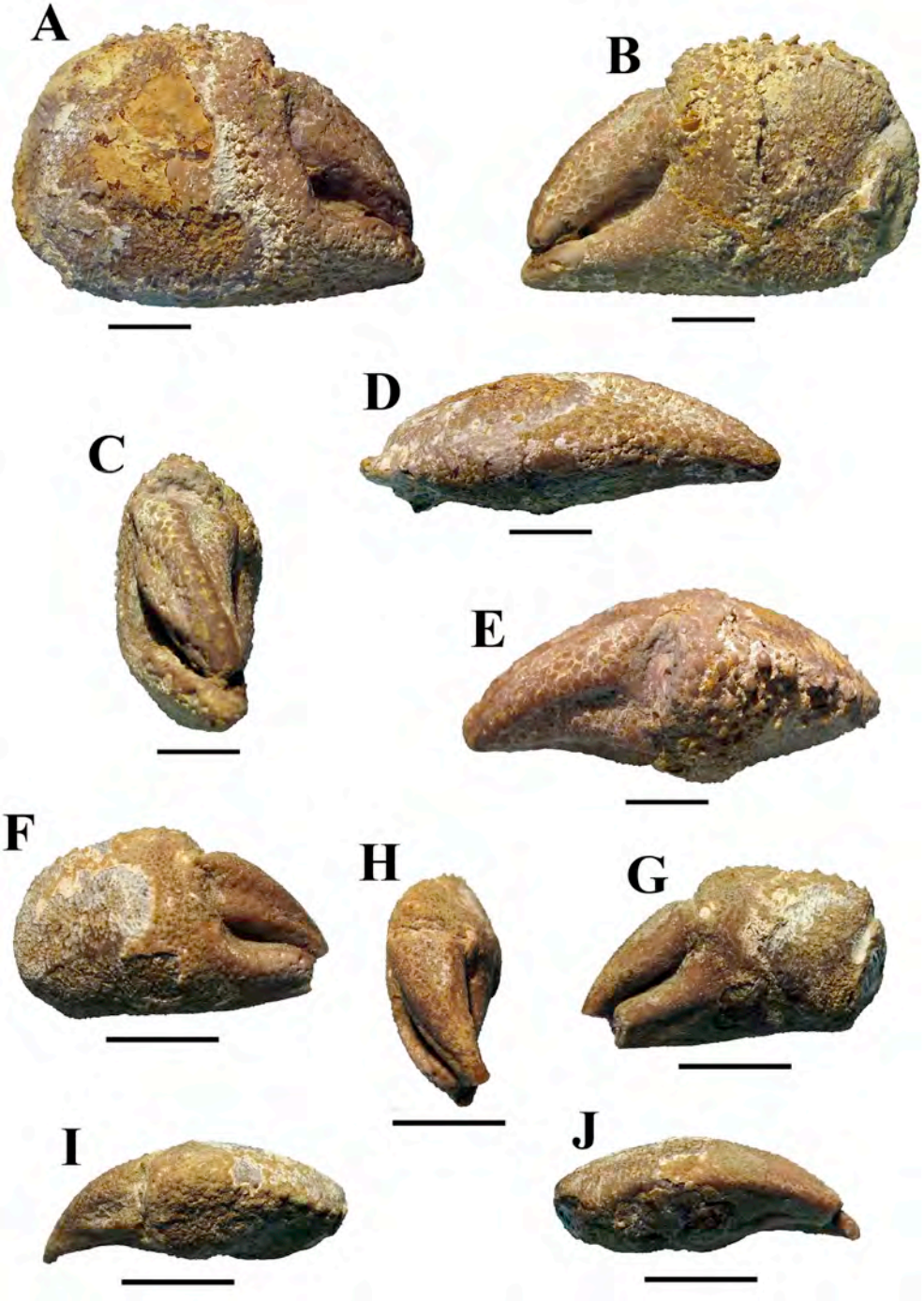
798

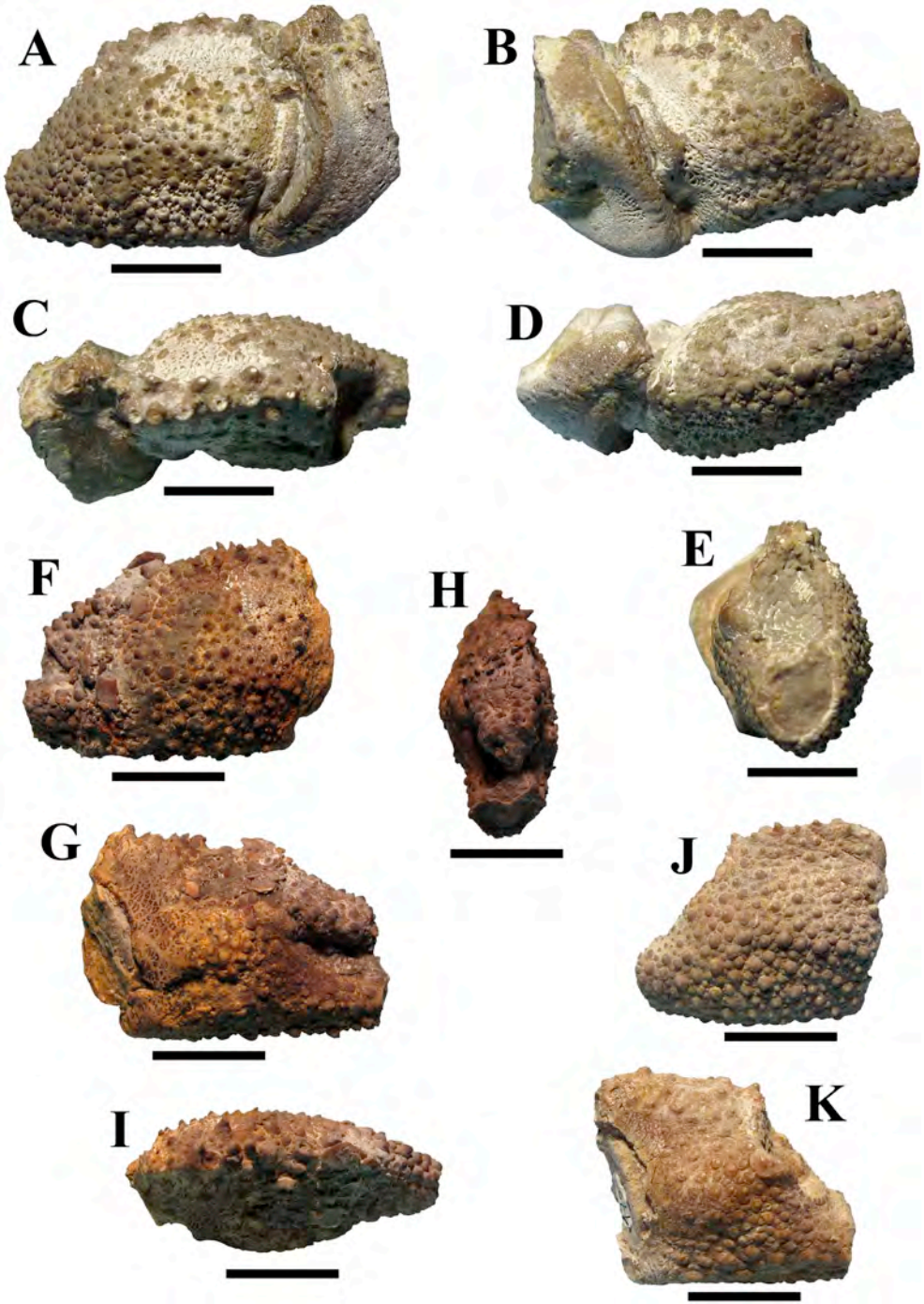

8°
4°
0°
4°
Salou-Garraf
Basin
Catalan
Coastal Ranges
Barcelona
Tarragona
Maestrat Basin
Iberian
Chain
40°
Valencia
Mediterranean Sea
N
0 100 Km
36°
A
Cova del Vidre
270
275
4515
Mas de
Barberans
1 km
B
Quaternary
Jurassic
Anticline
Syncline
Cretaceous
Triassic
Major faults
Village
Fossil locality

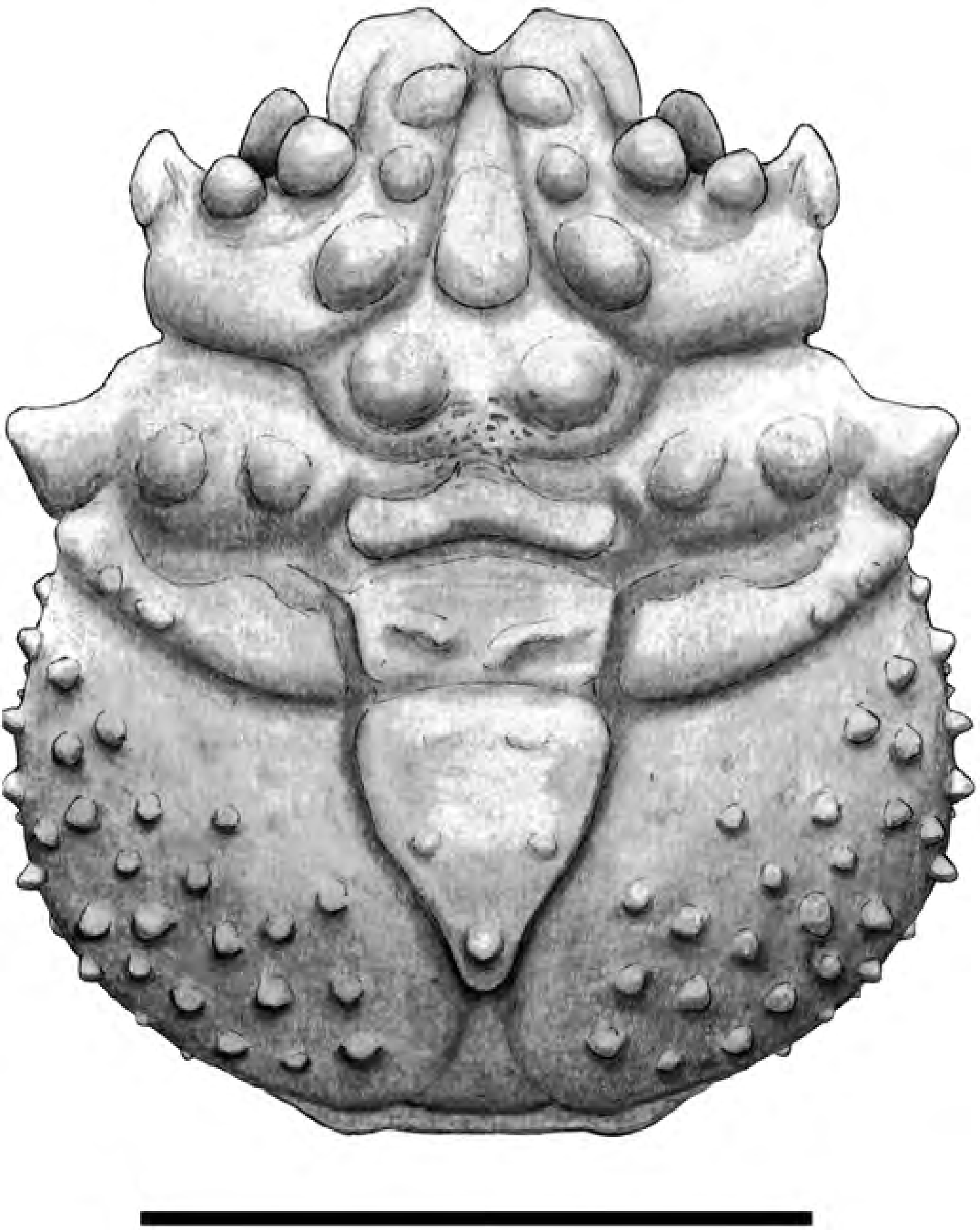

Thickness
Covered
Mudstone
Wackestone
Packstone
Grainstone
Floatstone
Villarroya Formation
Forcall Formation
Xert Fm.
Bed numbers
11.5
11
10.5
10
9.5
9
CV4
CV3
CV2
CV1
Deshayesites deshayesi
Cheloniceras cf. cornuelianum
Cheloniceras sp.
Pseudosaynella sp.
38
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0 m.
Decapods
Ammonites
Rudists
Oysters
Other bivalves
Gastropods
Echinoids
Covered
Marly limestone
Marl
Limestone

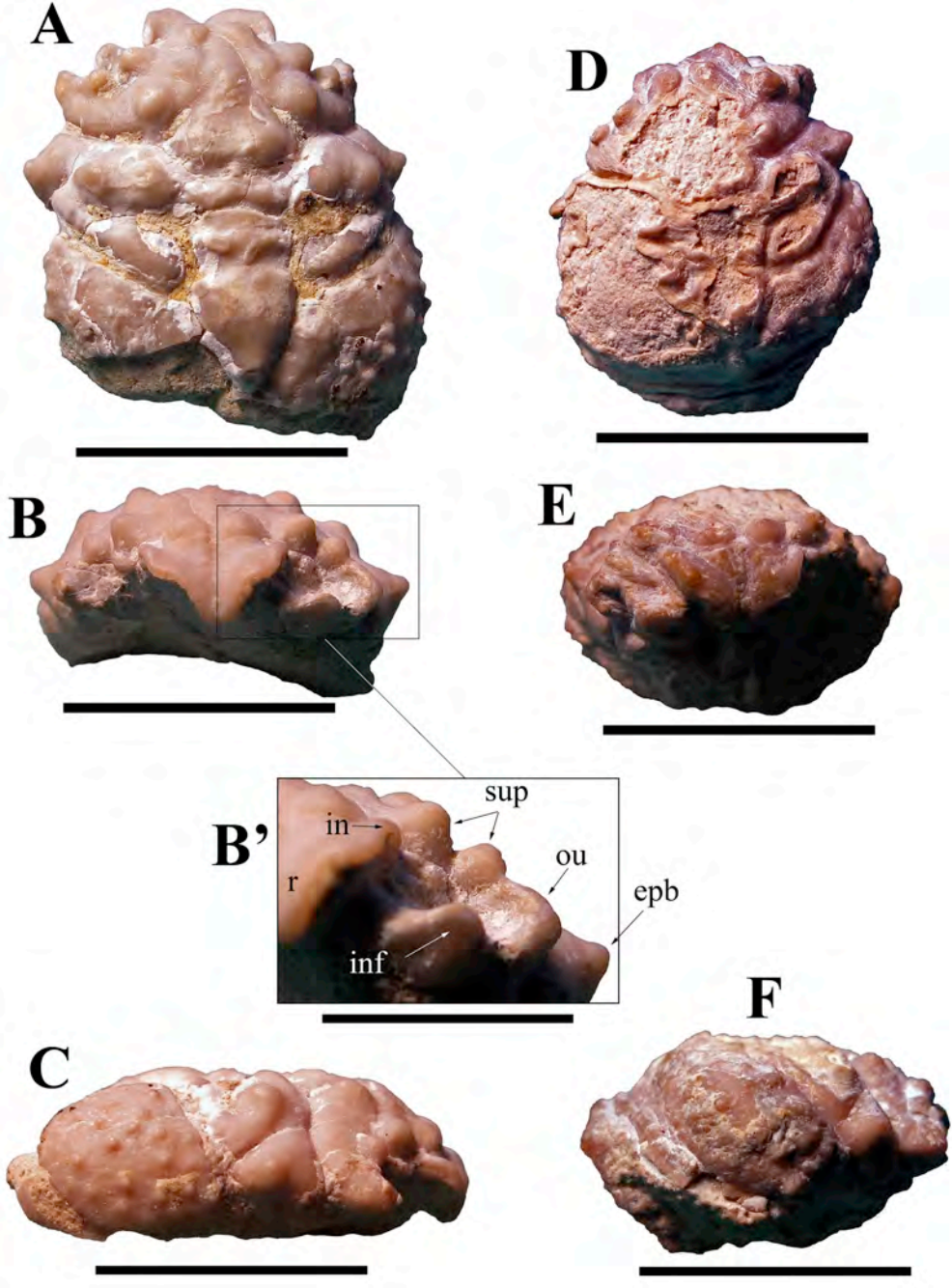

A1
A2
B
C1
C2
D
E1
E2
F1
F2
G1
G2
H
I
J
K
L1
L2

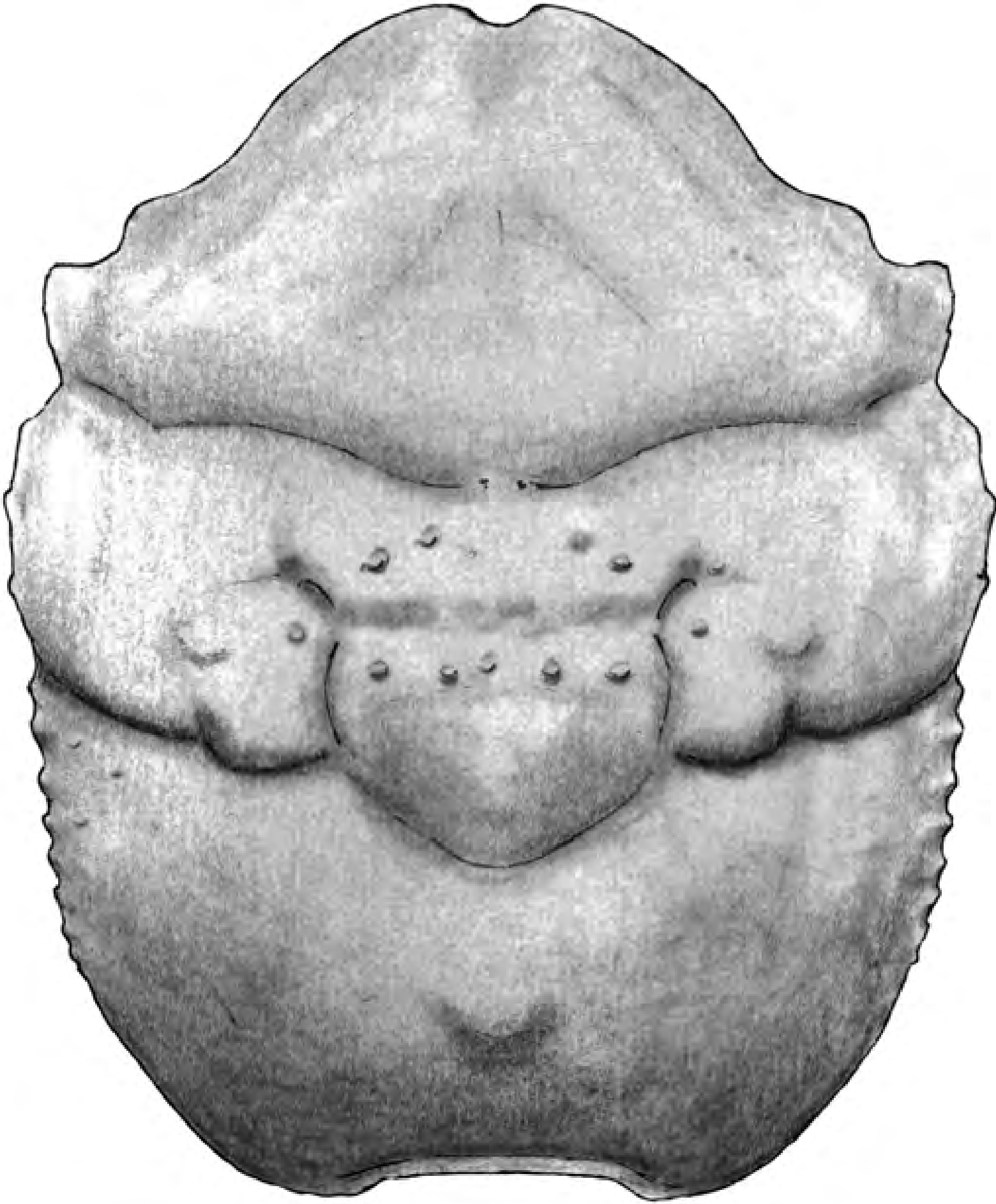

A
B

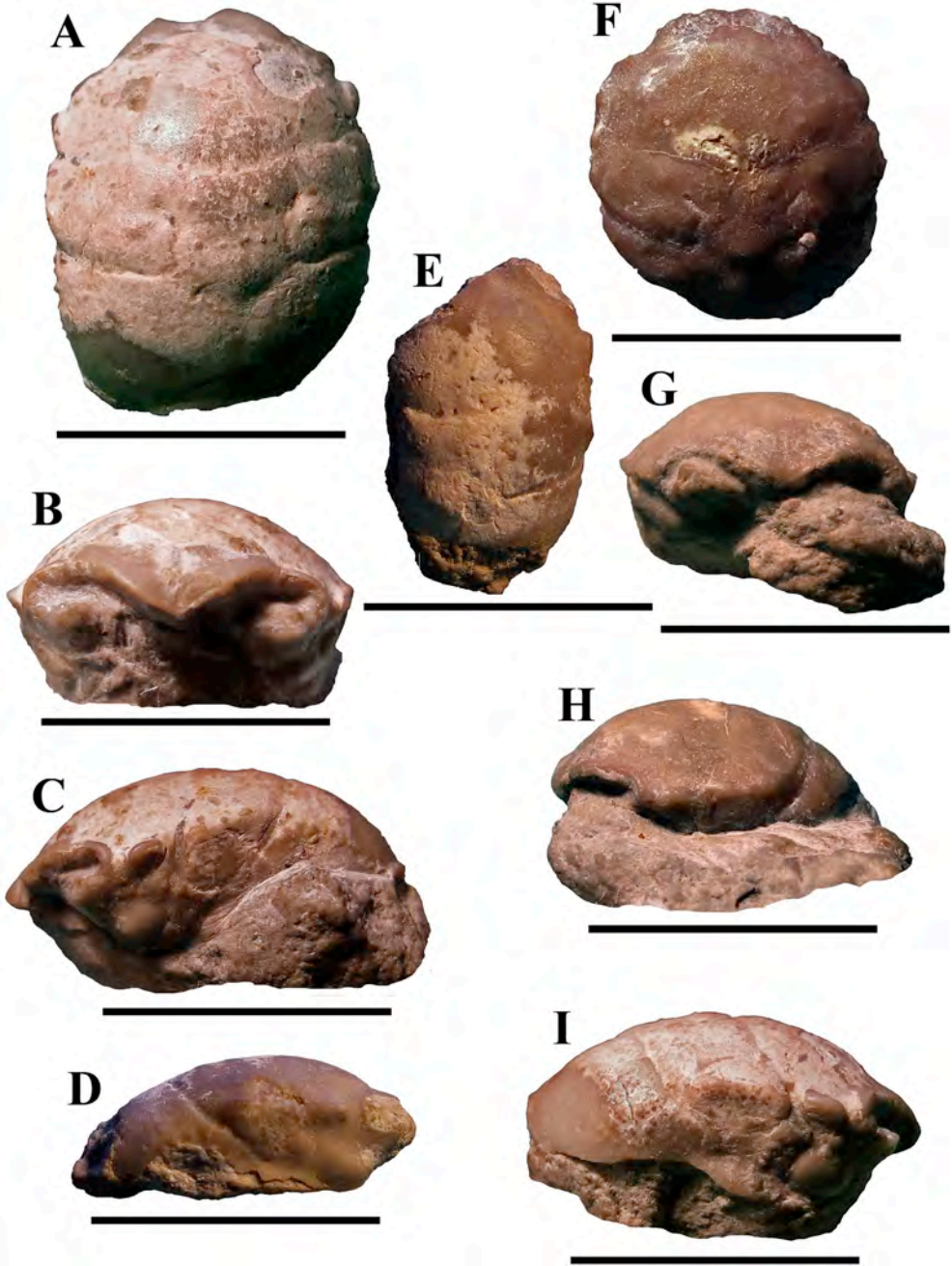

A
B
C
D
E
F
H
G
I
J


A
B
C
D
F
H
E
G
J
I
K




A
D
B
E
B'
sup
in
ou
r
epb
inf
C
F




A
F
E
G
B
H
C
I
D