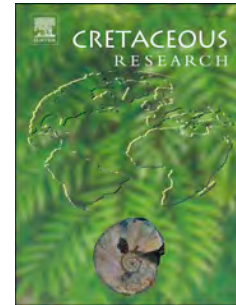


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A new decapod crustacean assemblage from the lower Aptian of La Cova del Vidre (Baix Ebre, province of Tarragona, Catalonia)

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

3

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16

17 **A B S T R A C T**

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

26

27 *Keywords:*

28 Cretaceous

29 Paguridae

30 Brachyura

31 Prosopidae

32 Dromiidae

33 New species

34

35 **1. Introduction**

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

42 The decapod crustacean assemblage is dominated by pagurids, but prosopids and
43 dromiids are also present, comprising two new species that are described herein. The
44 small outcrop at La Cova del Vidre was already known as the type locality of *Pagurus*
45 *avellanedai* Vía, 1951 (Bataller, 1943; Vía, 1951). The recovery of new material of *P.*
46 *avellanedai* allows us to complement Vía's (1951) original description, by describing
47 the right cheliped and completing the description of the left cheliped. The new prosopid
48 *Rathbunopon tarraconensis* **n. sp.** from La Cova del Vidre constitutes the third species
49 of the genus *Rathbunopon* on record from the Iberian Peninsula (Klompaker et al.,
50 2011; González-León et al., 2016), while the new dromiid (goniodromitine), *Pithonoton*
51 *lluismariaorum* **n. sp.**, is only the second member of this genus to be described from
52 Cretaceous strata.

53 The new assemblage from La Cova del Vidre can be compared to other Aptian
54 decapod crustacean faunas at localities in northeast Iberian basins, such as Cal
55 Cassanyes (Barcelona) in the Salou-Garraff Basin (see Vía, 1951; Moreno-Bedmar et al.,
56 2008; Artal et al., 2010) and Forcall (Castelló) and neighbouring outcrops in the
57 Maestrat Basin, which are currently under study. However, those faunas differ from that
58 from La Cova del Vidre in that they are linked to bioherms (sponges) and a reefal
59 (coralgal) environment, respectively, indicating sheltered settings. In contrast, lithology
60 and fauna at La Cova del Vidre suggest an open-marine, muddy environment.

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

66 **2. Geological setting and stratigraphy**

67 La Cova del Vidre (abbreviated CV) is situated in the linking zone placed
68 between the Maestrat and Salou-Garraff basins (Fig. 1A). The linking zone was part of a
69 large intracratonic Mesozoic rift along the eastern margin of the Iberian plate, which
70 developed on account of tectonic extension related to the opening and spreading of the
71 Neotethys towards the west, and the opening of the central Atlantic Ocean and the Bay
72 of Biscay (Salas and Casas, 1993; Salas et al., 2001). During the Paleogene–Early
73 Miocene, as a result of collision between the Iberian and European plates during Alpine
74 orogeny, the Maestrat Basin, the linking zone and the Salou-Garraff Basin were inverted,
75 thus giving rise to the eastern part of the Iberian Chain and Catalan coastal chain (Salas
76 et al., 2001). The present note focuses the Margas de Forcall Formation that is exposed
77 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 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**

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

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

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

136

137

138

139 **4. Systematic palaeontology**

140

141 Order Decapoda Latreille, 1802

142 Infraorder Anomura MacLeay, 1838

143 Superfamily Paguroidea Latreille, 1802

144 Family Paguridae Latreille, 1802

145 Genus *Pagurus* Fabricius, 1775

146

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

148

149 *Fossil species included.* *Pagurus alabamensis* Rathbun, 1935; *Pagurus alatoides*

150 Philippe and Secrétan, 1971; *Pagurus albus* Müller, 1979 (= *P. tuberculosus* Harvey,

151 1998); *Pagurus avellanedai* Vía, 1951; *Pagurus banderensis* Rathbun, 1935; *Pagurus*

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

160

161 *Pagurus avellanedai* Vía, 1951

162 Figs. 4–6.

163 1943 fragmento de pata; Bataller, p. 547.

164 *1951 *Pagurus Avellanedae* Vía, p. 171, text-fig. 11; pl. 1, fig. 11–11a.

165 1982 *Pagurus avellanedae* Via, 1951; Whetstone and Collins, p. 1219.

166 1988 *Pagurus avellanedai* Via, 1951; Via, pp. 344, 350, fig. 344.

167 1988 *Pagurus avellanedai* Via, 1951; Solé and Via, p. 26.

168 2010 *Pagurus avellanedae* Vía, 1951; Schweitzer et al., p. 56

169 2015 *Pagurus avellanedae* Via, 1951; Fraaije et al., p. 356.

170

171 *Material.* Four specimens with cuticle preserved, as follows: two propodi of the right,
172 and two propodi of the left cheliped, and another propodus and fragment of carpus of a
173 left cheliped, in the collections of the Museu de Geologia del Seminari de Barcelona
174 (MGSB). Measurements (L, length; W, width; T, thickness) are as follows: MGSB
175 82920 (palm), L 32 mm, W 34,5 mm, T 17,5 mm; MGSB 82921, L 16 mm, W 19 mm,
176 T 10,5 mm; MGSB 82922 (palm), L 20,5 mm, W 22 mm, T 14 mm; MGSB 82923

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

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

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

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

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

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

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

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

211 *Remarks.* The find of more complete new material at the type locality of this taxon
212 allows to complete the original description that was based on fragmentary material (Fig.
213 5J–K; see Vía, 1951) to be complemented. The general morphology of the chelae of the
214 present species matches characters of *Pagurus (sensu lato)* well, in that the right
215 propodus is much larger than the left, with a convex lower margin and a short, strong
216 fixed finger with hollow occlusal margin.

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

221

222 Infraorder Brachyura Latreille, 1802

223 Section Podotremata Guinot, 1977

224 Subsection Dynomeniformia Guinot, Tavares and Castro, 2013

225 Superfamily Homolodromioidea Alcock, 1900

226 Family Prosopidae von Meyer, 1860

227 Genus *Rathbunopon* Stenzel, 1945

228

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

230

231 *Species included.* *Rathbunopon obesum* (Van Straelen, 1944); *R. oblitum* (Carter, 1898);

232 *R. polyakron* Stenzel, 1945; *R. schrattenkalkensis* Klompmaker, Artal and Gulisano,

233 2011; *R. tarraconensis* **n. sp.**; *R. tuberculatum* (Van Straelen, 1936); *R. viai* González-

234 León, Ossó, Moreno-Bedmar and Vega, 2016 and *R. woodsi* Withers, 1951.

235

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

237 Figs. 7–8

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

239 *Type locality.* La Cova del Vidre (municipality of Roquetes), Baix Ebre County,

240 province of Tarragona (Catalonia), Els Ports Massif.

241 *Stratigraphic horizon.* Margas de Forcall Formation, lower Aptian (*Deshayesites*

242 *deshayesi* Zone).

243

244 *Material.* Two specimens with near-complete dorsal carapaces, preserving details of the

245 dorsal ornament, as well defined as regions; cuticle partially preserved. Housed in the

246 collections of the Museu de Geologia de Barcelona (MGB). The holotype is MGB

247 84275; measurements are as follows: L 18 mm, W 15 mm, fronto-orbital width 11,2

248 mm; MGB 84276 is paratype; measurements: L 16,8 mm, W 14,9 mm, fronto-orbital

249 width 9,8 mm.

250

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

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

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

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

305

306 *Remarks.* These two specimens, clearly referable to *Rathbunopon*, bring the number of
307 species of this genus in the Iberian basins Peninsula during the Early Cretaceous to
308 three. They match the generic diagnosis precisely, possessing a characteristic pyriform
309 outline and a marked dorsal sculpture, formed of strong tubercles and bars and of deep
310 grooves separating them. As such, they are closely resemble congeners. Wright and
311 Collins (1972, pp. 14, 23) noted the close similarity between the type species *R.*
312 *polyakron* and *R. woodsi*, stating that, “In addition *Rathbunopon polyakron* Stenzel
313 from Texas is very close to, if not identical with, *R. woodsi* Withers from England.”,
314 and suggested that, with more material available, both taxa should be treated as
315 members of a single, variable species (Wright and Collins 1972, pp. 14, 23). However,
316 there are in fact subtle differences between these two species (see González-León et al.,
317 2016, pp. 119–120). In addition, new species or others that had previously been
318 assigned to other genera, have lately also be placed in *Rathbunopon* (see Wright and
319 Collins, 1972; Klompmaker et al., 2011; González-León et al., 2016). The new species
320 is compared with congeners below.

321 Although they have the inflated metabranchial lobes with maximum width at the
322 level of the mid-metabranchial lobe and a closely similar, strong dorsal sculpture in
323 common, *Rathbunopon tarraconensis* **n. sp.** differs from *R. polyakron*, the type species
324 of the genus, from the Cenomanian of Texas, in having coarsely granulated
325 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*

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

354 Comparison of *Rathbunopon tarraconensis* **n. sp.** with *R. tuberculatum* from the
355 Hauterivian of Auxerre (France), is difficult in view of the fragmentary nature of the
356 latter, but the new species differs from it in having a more sculptured dorsal carapace,
357 more prominent outer-orbital and epibranchial teeth, a lack of tubercles in the hepatic
358 region; two supraorbital projections and a smooth anterior part of the carapace (*vs*
359 apparently granulated in *R. tuberculatum*; see Van Straelen, 1936, pp. 31–33, pl. 4, fig.
360 4).

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

367 *Rathbunopon tarraconensis* **n. sp.** has the same inflated metagastric regions in
368 common with *R. woodsi* from the Cenomanian of Devon (United Kingdom) and the
369 lower Cenomanian of Orne (France), but differs from the latter in having granulated
370 metabranchial lobes (*vs* completely smooth cuticle in *R. woodsi*), two supraorbital
371 projections (*vs* one in *R. woodsi*) a greater fronto-orbital/carapace width ratio, a
372 narrower intestinal region and shorter posterior margin (see Withers, 1951, p. 179, pl.
373 16, figs. 5–6; Wright and Collins, 1972, pp. 22–23, pl. 1, fig. 7a–e; Klompmaker et al.,
374 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 Goniidromitinae 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* Lörenthey and Beurlen, 1929; *P. lluismariaorum* **n. sp.**; *P.*

391 *marginatum* von Meyer, 1842; *P. obtusum* (von Meyer, 1857); *P. rusticum* Patručius,

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 *Goniidromites*, *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,

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

402

403 *Pithonoton lluismariaorum* n. sp.

404 Figs. 9–10

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

407

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

410

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

413

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

419

420 *Diagnosis.* Carapace subovate; wide fronto-orbital margin occupying entire anterior
421 carapace width; length slightly exceeding width, markedly convex in longitudinal and
422 transverse cross sections; front conspicuously wide, produced, triangular with bilobed
423 tip; anterolateral carapace margins anteriorly with strong teeth, posteriorly with equal-
424 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.

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

453

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

465 *Prosonon laevimarginatum* from the Upper Jurassic of Hungary, is more
466 elongate, with more diverging lateral margins. The gastric region is well defined, in
467 contrast to that in *P. lluismariaorum* **n. sp.** in which only the anterior mesogastric
468 process, and the posterior base of the gastric regions are noticeable. The outer orbital
469 corners of *P. laevimarginatum* are simple and prominent, while they are double, blunt
470 and more subtle in *P. lluismariaorum* **n. sp.** (see Lörenthey and Beurlen, 1929, pp. 85–
471 87, pl. 3, fig. 8).

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

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

480 *Pithonoton cardwelli*, from the Paleocene of Texas, represents the youngest
481 member of the genus, being known from the holotype only, a carapace with some parts
482 of the lateral margins crumbled, and the anterior portion of the thoracic sternum
483 preserved. Lateral margins in *P. cardwelli* are smooth, not granular as in *P.*
484 *lluismariaorum* **n. sp.**, and the cervical and branchial grooves are more V-shaped in the
485 fomer. On the lateral carapace flanks, the cervical and branchial grooves rapidly
486 converge in *P. lluismariaorum* **n. sp.** while they remain distant in *P. cardwelli*. Also,
487 the posterior carapace in *P. cardwelli* is relatively wider, and the cardiac region is
488 lower. Nevertheless, these species are morphologically similar in having an overall
489 rather smooth carapace with weakly inflated regions, subparallel lateral margins, and
490 carapaces that are convex in both cross sections (see Armstrong et al., 2009, pp. 748–
491 750, figs. 3, 9–12).

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

499 inflated dorsal regions, in particular the branchial and cardiac regions; in having a
500 continuously U-shaped cervical groove (sinuous, median third distinctly lowered, in *P.*
501 *campichei*), and a more domed carapace in lateral view (see de Tribolet, 1874, pp. 360–
502 361, pl. 12, fig. 9).

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

508

509 **5. Conclusions**

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

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

520

521

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534

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750

751 **Figure captions**

752 **Fig. 1.** A, Map of the Iberian Peninsula showing the location of the study area within
753 the linking zone, Catalonia (northeast Iberian Peninsula). The area is situated between
754 the Maestrat and Salou-Garraf basins in the Iberian Chain and Catalan Coastal Ranges,
755 respectively. **B**, Geological map (modified from Institut Cartogràfic de Catalunya,
756 2006) of the Mas Barberans area, that showing the sampling site (red star) at La Cova
757 del Vidre locality. Geographical co-ordinates in UTM.

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

761 **Fig. 3.** *Deshayesites deshayesi* (A–I, K–L) and *Cheloniceras* cf. *cornuelianum* (J). **A1–**
762 **2**, lateral and ventral views of specimen 89914, bed CV1. **B**, lateral view of specimen
763 89918, bed CV3. **C1–2**, lateral and ventral views of specimen 89930, bed CV3E. **D**,
764 lateral view of specimen 89921, bed CV3E. **E1–2**, lateral and ventral views of specimen
765 89925, bed CV3E. **F1–2**, lateral and ventral views of specimen 89926, bed CV3E. **G1–**
766 **2**, lateral and ventral views of specimen 89928, bed CV3E. **H**, lateral view of specimen
767 89929, bed CV3E. **I**, lateral view of specimen 89934, bed CV3E. **J**, *Cheloniceras* cf.
768 *cornuelianum*, ventral view of specimen 89915, bed CV3. **K**, lateral view of specimen
769 89933, bed CV3E. **L1–2**, lateral and ventral views of specimen 89932, bed CV3E. Scale
770 bars equal 10 mm.

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

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

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

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

782

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

788

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

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

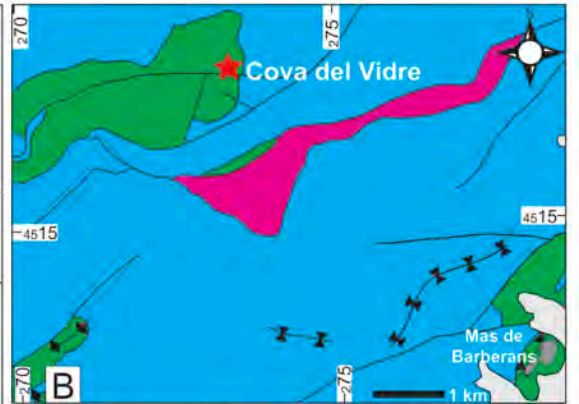
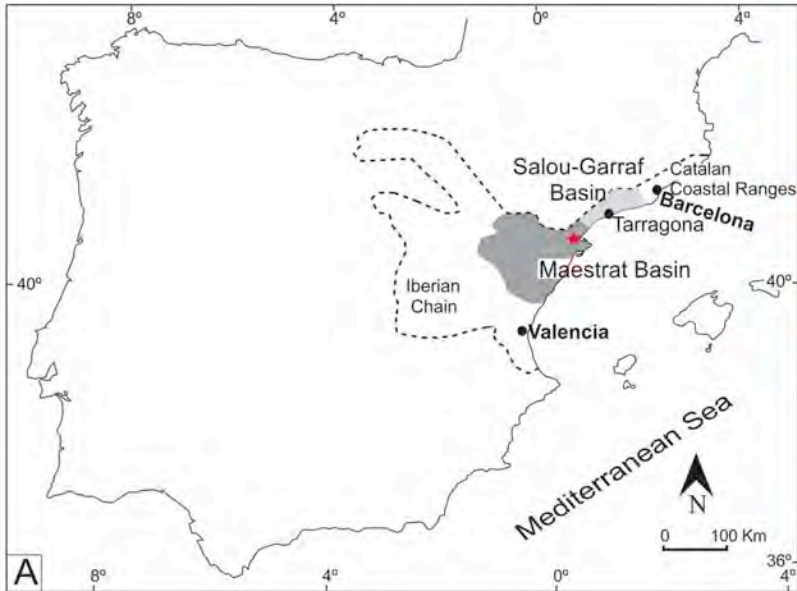
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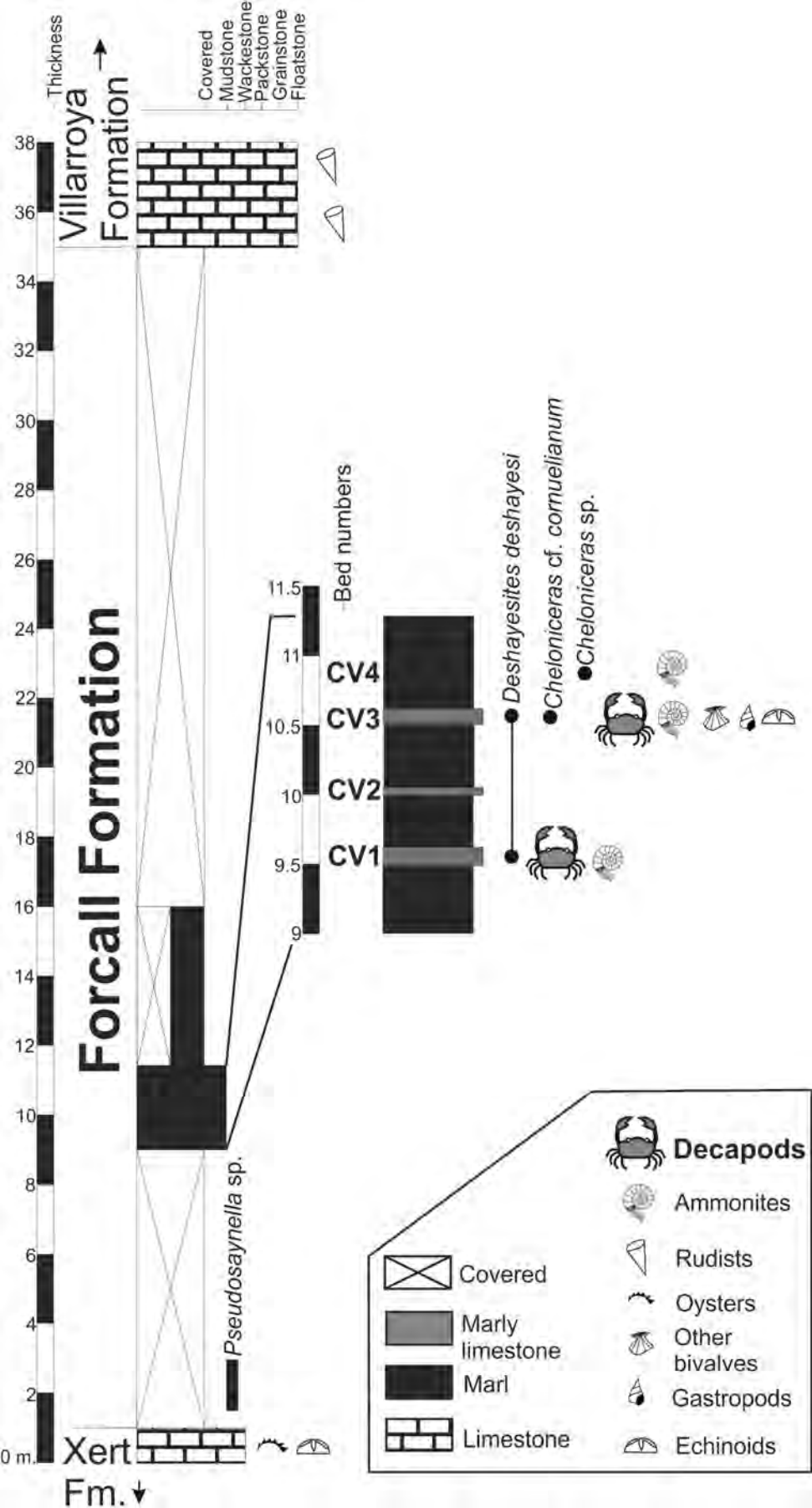
796 **Fig. 10.** *Pithonoton lluismariaorum* n. sp., reconstruction of dorsal carapace

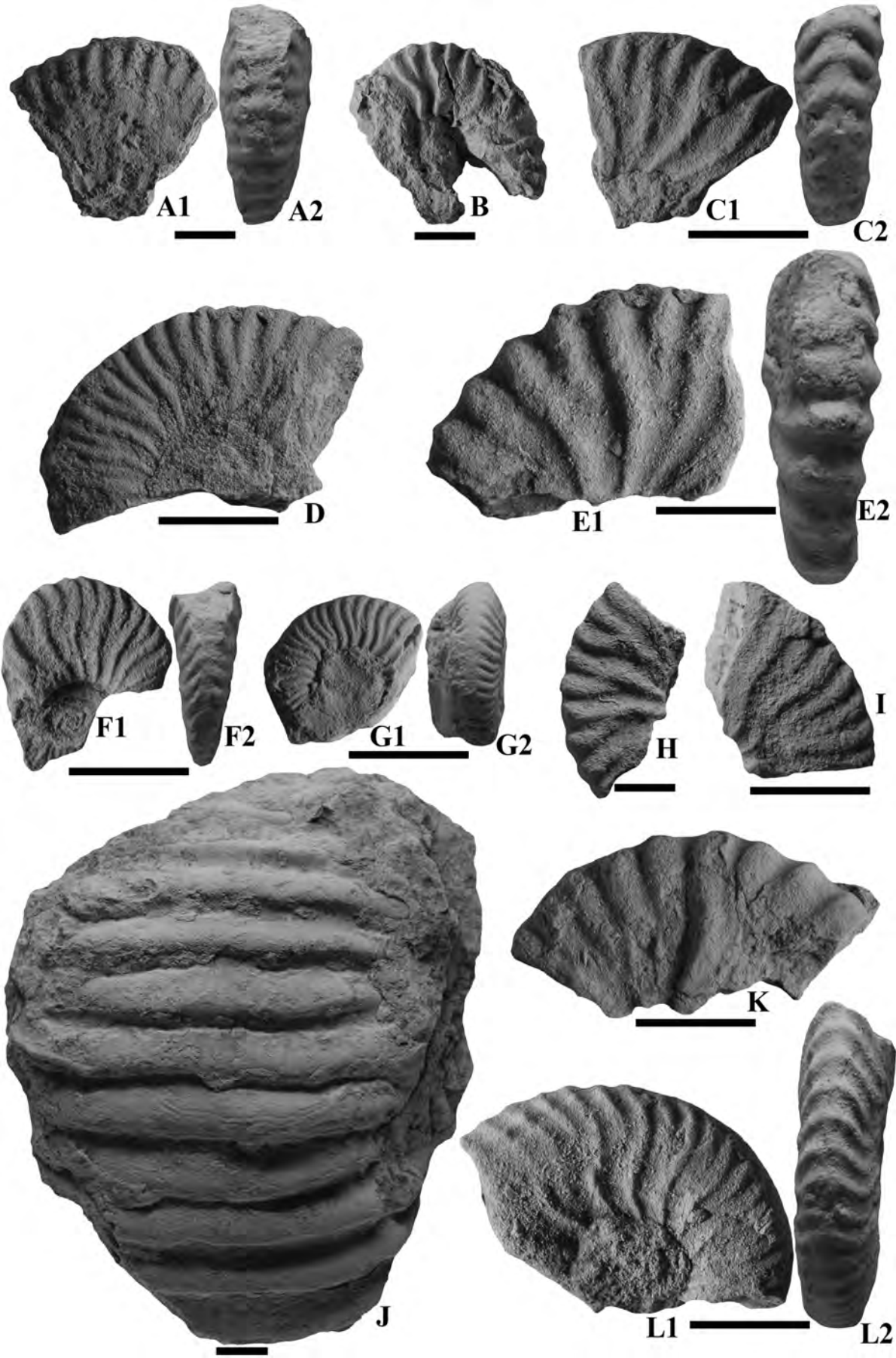
797 (illustration by F.A. Ferratges-Kwekel). Scale bar equals 10 mm.

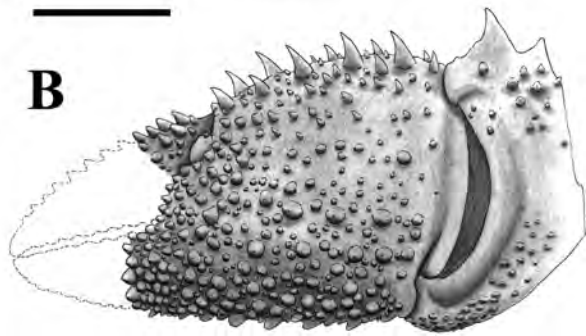
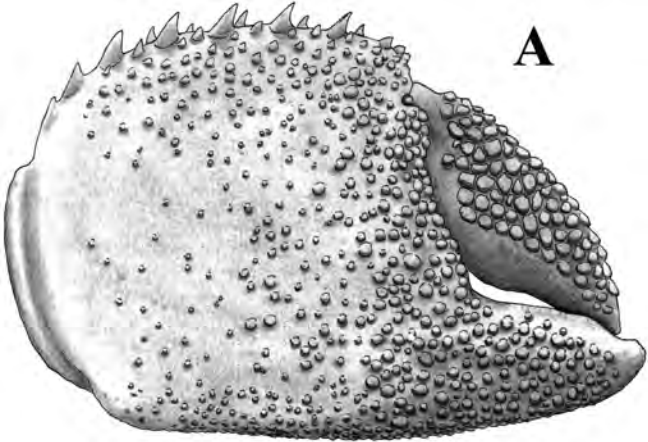
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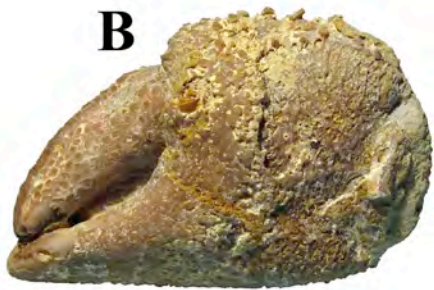
ACCEPTED MANUSCRIPT









A**B****C****D****E****F****H****G****I****J**

