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A new pseudoziid crab (Crustacea: Decapoda: Brachyura) from the Lutetian outcrops of Girona and Barcelona (Catalonia, NE Iberian Peninsula)

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Abstract

A new fossil taxon assigned to the family Pseudoziidae, *Osonacarcinus* n. gen. is recorded from outcrops of Lutetian age of regions of the Barcelona and Girona provinces (Catalonia). The new taxon is compared with distinct present and fossil genera assigned to the family, mainly with all the species of the genus *Euryozius*. The current pseudoziid fossil genera are known from United States, Hungary, Italy and New Zealand. This is the first record of a pseudoziid crab in the Iberian Peninsula.

Key words: Decapoda, Brachyura, Pseudoziidae, Eocene, Tethys

1. Introduction

Lutetian decapod faunas are especially diverse and abundant in amount of specimens in the outcrops of central and north–eastern Catalonia, which corresponds to the north–eastern part of the Foreland Ebro Basin (Fig.1). Since the works of Via (1932, 1941, 1969), Via Boada (1959), and the summary of Solé and Via (1989), several new papers have resulted in numerous new records and appraisals in the last decades (Artal et al., 2006, 2014; Artal and Hyžný, 2016; Artal and Onetti, 2017; Ossó, 2020). All the known studies to date, together with the present paper, and others in press, confirm the extraordinary fauna of crustacean decapods, both in number of specimens and diversity in the study area. The numerous outcrops, with similar lithology,

indicative of similar habitats from regions of Barcelona (Osona and Berguedà) and Girona (Gironès and Baix Ampurdà) provinces, have been revealed as one of the larger crustacean assemblages in Eocene deposits.

The status of the family Pseudoziidae Alcock, 1898, has always been historically controversial, being recovered recently and included in a distinct superfamily, the Pseudozioidea Alcock, 1898 (Ng et al., 2008; Davie et al., 2015). Ng and Liao (2002) established the main characters for the family Pseudoziidae, including in it four genera, and finally Števcíć (2005) recognized the superfamily Pseudozioidea (Ng et al., 2008).

Concerning to the fossil record, only three genera were first assigned to the family Pseudoziidae (Schweitzer, 2003, p. 1112). At that time, they were

included within the Xanthoidea (Schweitzer, 2003, p. 1110) or in Eriphioidea (Karasawa and Schweitzer, 2006, p. 23). Finally, all these fossil genera were also included in the Pseudozioidea (Davie et al., 2015; Schweitzer et al., 2022).

The purpose of this study is the confirmation of the first record of a pseudoziid fossil genus in the Iberian Peninsula, the third fossil genus recorded in Europe (see Müller and Collins, 1991; Beschin et al., 2016a) and the sixth fossil genus of Pseudoziidae known to date.

Repository: Museu Geològic del Seminari de

Barcelona (Catalonia), under acronym MGSB.

2. Geological setting

The early and middle–late Eocene marine sediments of the north–eastern part of the Ebro Foreland Basin, deposited during the two relative sea level rises (see Sanjuan et al., 2012), have yielded abundant faunas of decapod crustaceans. From the Lutetian (middle Eocene), decapod crustacean faunas have been recovered from central and north–eastern Catalonia, in two close areas of Barcelona and Girona Provinces (Fig. 1).

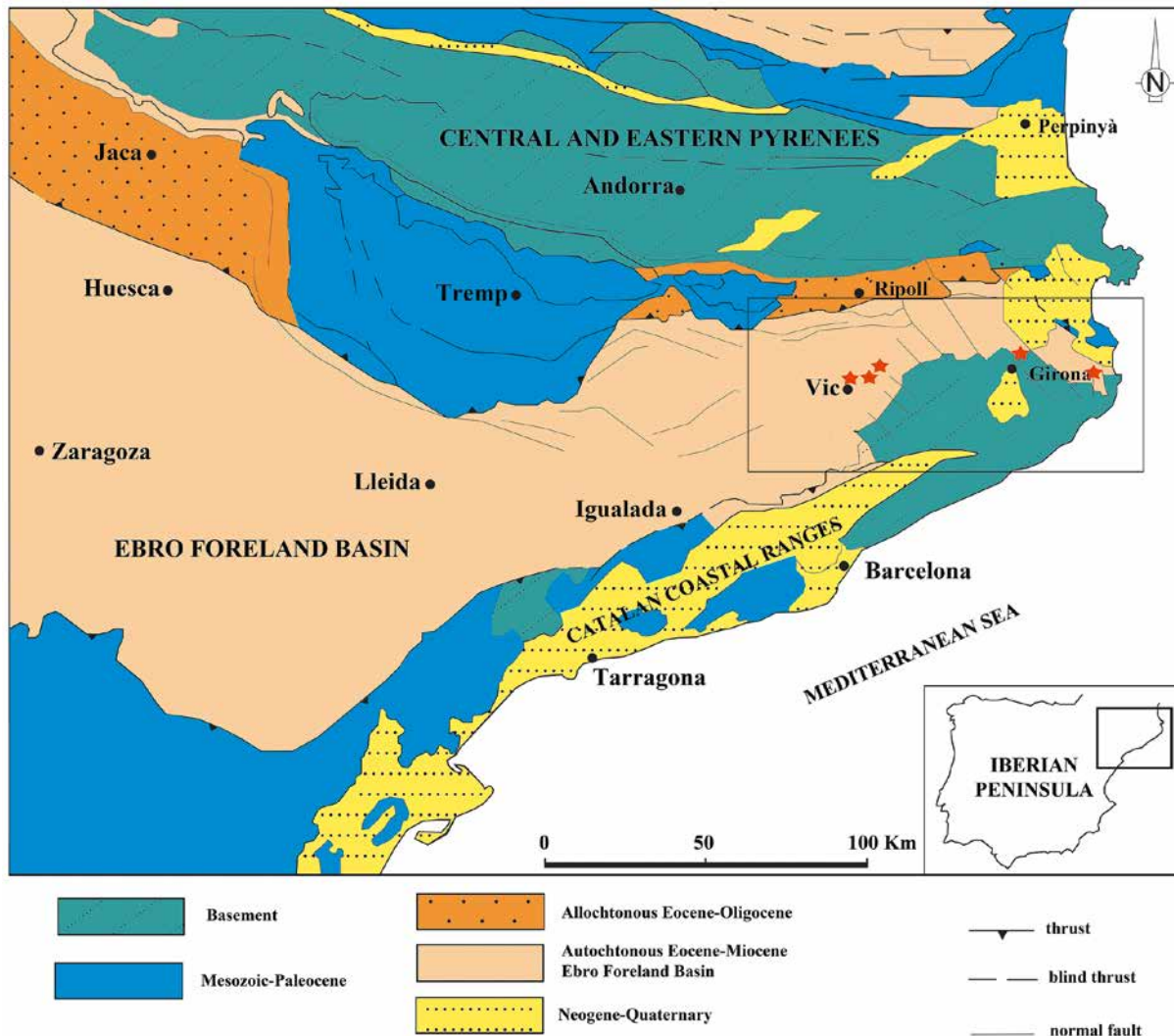


Fig. 1. Location map and geological sketch of the eastern part of the Ebro foreland basin showing the location of the studied area. Red stars indicate the fossiliferous localities (modified from Sanjuan et al., 2012 and Vergés et al., 1998, Ossó and Domínguez, 2016, and reproduced with permission of Geologica Acta).

Three localities close to Vic (Osona, Barcelona), the surroundings of the villages of Tavèrnoles, Folgueroles, and Tavertet, present numerous outcrops around with layers of Lutetian age, all of them with a very similar lithology. The layers correspond to the Coll de Malla Marl Formation (Clavell et al., 1970) and consist of 50 meters of grey marly strata with at least three condensation levels. According to Serra-Kiel et al. (2003a); this lithostratigraphic unit corresponds to the so called third Lutetian cycle, which is considered middle Lutetian in age and records a transgressive system (Serra-Kiel et al., 2003a, p. 210, 211). This system is interpreted as siliciclastic shelf deposits (Serra-Kiel et al., 2003a). The new taxon was recovered from two condensation levels in the higher portion of the unit. The marls that outcrops in the three mentioned localities, show the same fossil faunas, with horizons containing numerous foraminifera, molluscs, oysters, sponges, bryozoans, echinoids, and crustacean decapods (Reguant, 1967; Via, 1969; Via Boada, 1959; Serra-Kiel et al., 2003a; Artal et al., 2014; Artal and Hyžný, 2016; Artal and Onetti, 2017). Common invertebrates accompanying the crustaceans are *Cipraevovula*, *Cardita*, *Chlamys*, *Natica*, *Coelopleurus*, and *Eupatagus*.

Concerning the localities of the area of Girona, the new genus has been recovered from outcrops around the localities of Santa Susanna de Peralta (Baix Empordà) and Sant Julià de Ramis (Gironès). The sediments containing similar fossiliferous levels correspond in this area to the Margas de Banyoles Formation (Almela and Rios, 1943) and was also interpreted as a transgressive cycle. The unit is interpreted as a protected shelf facies with siliciclastic deposits. The lithostratigraphic unit presents similarities with the Coll de Malla Marl Formation, and also confirmed as middle Lutetian in age (Serra-Kiel et al., 2003a, b). The crustacean faunas in the numerous outcrops in Girona Province, yielded exactly same decapod assemblages, with *Ctenocheles*, *Colneptunus*, *Dromilites*, *Folguerolesia*, *Tavernolesia*, as the commonest genera.

3. Systematics

Order Decapoda Latreille, 1802

Infraorder Brachyura Latreille, 1802
Superfamily Pseudozioidea Alcock, 1898

Family Pseudoziidae Alcock, 1898

Remarks: The main characters of the studied specimens matches well with the general diagnosis of the different genera within the family Pseudoziidae, such as transversely ovate outline of the carapace, being much wider than long, L/W ratio about 0.6; the maximum width usually at the level of the first anterolateral node; a downturned front; convex anterolateral margins bearing nodes, and a posterior thin ridge; posterior margins straight, convergent at angle about 40–45 degrees to posterior margin and dorsal regions scarcely defined. This set of characters, together with others, are common diagnostic features for the family (Davie et al., 2015; Ng and Liao, 2002). Nevertheless, the well-defined array of characters preserved in the new taxon, exhibits numerous detailed differences that allow the proposal of a new genus. Concerning the possible similarities with members of Carpiliidae Ortmann, 1893, the specimens studied herein present enough differences to separate them from Carpiliidae, in agreement with the differences highlighted by Schweitzer (2003, pp. 1113, 1115), as explained below.

Genus *Osonacarcinus* n. gen.

urn:lsid:zoobank.org:act:0309BE63-78E8-462F-9D58-69A17DC5AC11

Type species: *Osonacarcinus lenis* by present designation.

Diagnosis: Small sized crab transversely ovate in outline, wider than long, L/W ratio about 0.6 Dorsal regions not defined. Front nearly straight from dorsal view; downturned, only slightly arched from frontal view. Orbits small, almost subcircular, entire, Anterolateral margins bearing two notable subtriangular teeth, the last one extending over the carapace as an extremely thin ridge. Dorsal surface smooth. Chelipeds large, stout, smooth, outer side of the hand strongly convex; dactyli with strong molariform tooth.

Etymology: From Osona (Catalonia), the region where the new taxon was recovered first.

Discussion: Major differences in *Osonacarcinus* n. gen., compared with all the pseudoziid genera, are the L/W ratio, about 0.6; the maximum width of the carapace in the anterior portion, about 62 percent from the posterior margin; the frontal margin entire, slightly arched, not bilobed, weakly protruding; the orbits scarcely visible from dorsal view, the outer orbital corner without notable nodes; the gently convex first portion of the anterolateral margins, obliquely directed; the stout subtriangular tooth, the last one extending as a very thin ridge over the dorsal region, which is about the half of the carapace.

The six different extant species of the genus *Euryozius* Miers, 1886, type species *Euryozius bouvieri* (A. Milne-Edwards, 1869), appear to be the closest taxa to *Osonacarcinus* n. gen. (see Ng and Liao, 2002, p. 585). However, the major differences are the maximum width about half the carapace length; frontal margin protruding, convex, bilobed, with clear axial notch, whereas in *Osonacarcinus* n. gen. it is not so protruded and not clearly bilobed; orbits slightly rimmed, visible from dorsal view, outer orbital tooth acutely triangular, which is not marked in the new genus; anterolateral margins strongly convex, abruptly directed backwards; dorsal surface with slight depressions or inflations around the suborbital or the hepatic area, which is smooth in *Osonacarcinus* n. gen. (e.g., Ng and Liao, 2002, p. 587, figs. 1, 2; see <https://science.mnhn.fr/institution/mnhn/collection/iu/item/2014-10425> accessed 7th August, 2023). The two fossil species of *Euryozius*, *E. bidentatus* Karasawa, 1993 and *E. angustus* Karasawa, 1993, from the Miocene of Shizuoka (Japan), appear to have less prominent anterolateral teeth than *Osonacarcinus* n. gen., and the former, a more convex anterolateral margin. In any case, the temporal difference between both taxa, justifies the separation among them (see Karasawa, 1993, pp. 67, 68, pl. 17, figs. 1–6).

Species of the extant genus *Pseudozius* Dana, 1851, type species *Pseudozius caystrus* (Adams and White, 1849), presents notable differences with *Osonacarcinus* n. gen., such a very different outline of the carapace, with very rounded lateral margins; bilobed frontal margin, somewhat protruding, visible

from dorsal view and orbits visible from dorsal view, while in *Osonacarcinus* n. gen. the front is not protruded and the orbits are barely visible from dorsal view; and the anterolateral margins bear three subtriangular teeth anteriorly directed, and a sinuous posterior margin, instead of two lateral teeth and straight posterior margin in the new proposed genus (see Mendoza and Ng, 2014, p. 303, figs. 1, 2).

Flindersoplax Davie, 1989, type and sole species *F. vincentiana* (Rathbun, 1929), clearly differs of *Osonacarcinus* n. gen. in having anterolateral margins with four blunt teeth, maximum width at the anterior third of carapace, and strongly granulate surface of carapace in its anterior half (cf. Davie, 1989, pp. 150–154, figs. 11, 12).

Concerning all the fossil genera assigned to the Family Pseudoziidae (Schweitzer, 2003; Karasawa and Schweitzer, 2006; Beschin et al., 2016a, b; Schweitzer et al., 2022) present many major differences. *Archaeozius* Schweitzer, 2003, type species *A. occidentalis* (Schweitzer, Feldmann, Tucker and Berglund, 2000) from the Eocene of Washington (USA), is diagnosed as being widest at about 60 percent the distance posteriorly, but in some illustrations the maximum width appears to be in the second blunt anterolateral node, at about half the carapace length; the L/W ratio is about 70 percent; the frontal margin is quadrilobed, protruding, clearly visible from dorsal view; the orbits are subcircular, rimmed, visible from dorsal view; the anterolateral margins are strongly convex, abruptly directed backwards, bearing two blunt nodes; dorsal carapace with well-marked branchiocardiac grooves, all of them are distinct characters, which separates it from *Osonacarcinus* n. gen. (Schweitzer, 2000; Schweitzer et al., 2000; Schweitzer, 2003, p. 1115, fig. 3). *Priabonocarcinus* Müller and Collins, 1991, type species *P. gallicus* Müller and Collins, 1991, from the late Eocene of Hungary and Italy, is diagnosed as having a L/W ratio about 0.7; widest about half the distance posteriorly on carapace; front axially notched; orbits rimmed, visible from dorsal view; anterolateral margin nearly entire, weakly rimmed, with two small projections, the last one extending onto the carapace as a weak ridge, more pronounced in *Osonacarcinus* n. gen., which also has less longitudinally vaulted

dorsal carapace (see Müller and Collins, 1991, p. 78, fig. 4e, pl. 5, figs. 12, 15, 16; Beschin et al., 2018, p. 198, fig. 134; Ceccon and De Angeli, 2019, p. 65, fig. 27, t. 16, figs. 1–4; <http://www.mbfossilcrabs.com/Carpilioidea.html> accessed 7th August, 2023). *Santeexanthus* Blow and Manning, 1996, type species *S. wardi* Blow and Manning, 1996, from the Eocene of North Carolina (USA) and northern Italy, differs from *Osonacarcinus* n. gen. in having a length about 2/3 carapace width; dorsal surface densely punctuated anteriorly; and the anterolateral margin divided by two marked notches, in the case of the type species (see Blow and Manning, 1996, pp. 23, 24, pl. 5, fig. 4; <http://www.mbfossilcrabs.com/Carpilioidea.html> accessed 7th August, 2023). Personal examination by one of us (À.O. September, 2019) of the holotype of *S. caporiondoi* Beschin, De Angeli, Checchi, and Zarantonello, 2016 from Italy, confirms that it also differs from *Osonacarcinus* n. gen. in having a more projected front, slightly four-lobed and rimmed frontal margin; orbits rimmed; first anterolateral tooth less prominent; and branchiocardiac grooves weakly marked which are obsolete in the new genus, and a punctate surface instead of smooth in *Osonacarcinus* n. gen. (Beschin et al., 2016a, pp. 63, 64, fig. 56, pl. 11, figs. 2, 3). *Ramozius* Beschin, Busulini, Tessier, and Zorzin, 2016 can be easily distinguished from the new taxon in having a bilobed, protruding frontal margin, and anterolateral margin with four lobes, the two posterior ones spinous (Beschin et al., 2016b, p. 141, pl. 18). *Tongapapaka* Feldmann, Schweitzer and McLauchlan, 2006, type and sole species *T. motunauensis* Feldmann, Schweitzer and McLauchlan, 2006, from the Miocene of New Zealand, does not show, neither by morphology nor by degree of conservation of the holotype, the slightest similarity with *Osonacarcinus* n. gen. (see Feldmann et al., 2006, pp. 420–423, fig. 2.1–3).

Several genera, mainly placed within Carpiliidae Ortmann, 1893 (see Schweitzer et al., 2018), also exhibit similar carapace outline with two anterolateral nodes and sometimes a conspicuous short ridge that extend from the last anterolateral tooth to the dorsal carapace, thus superficially resembling *Osonacarcinus* n. gen. In this regard, it is worth noting that based on the data provided by recent molecular analyses

(Wolfe et al., 2022) Pseudoziidae appears to be a polyphyletic family since *Pseudozius caystrus* and *Euryzius camachoi* Ng and Liao, 2002, used for these analysis, are not closely related. Indeed, the former, *Pseudozius caystrus*, appears as sister taxon to the clade formed by [(Platyxanthidae + Tetriliidae) + (Tanaochelidae + Pilumnidae *s.l.*)], while the latter, *Euryzius camachoi*, one of the morphologically closest to *Osonacarcinus* n. gen., appears as sister taxon of Carpiliidae (J. Luque, pers. comm. August, 2023). Therefore, even though these aforementioned fossil carpiliid genera can be differentiated from the new genus, we also compare them with *Osonacarcinus* n. gen. with them as follow.

Proxicarpilius Collins and Morris, 1978 (type species *P. planifrons* Collins and Morris, 1978), from the Paleocene–Eocene of Pakistan, also presents an anterolateral margin with two acute teeth and similar outline of carapace, but it clearly differs from *Osonacarpilius* n. gen. by the lack of the characteristic ridge extending over the branchial region from the last anterolateral tooth and the dorsal surface with inflations and ridges (cf. Collins and Morris, 1978, pp. 972–976, pl. 117, figs. 5, 7, pl. 118, figs. 1–4, 7; Charbonnier et al., 2013, pp. 107–111, figs. 3–5, 6A–I).

Lovaracarpilius Beschin, De Angeli, Checchi, and Zarantonello, 2016a (type species *L. incisus* Beschin, De Angeli, Checchi, and Zarantonello, 2016) from the Eocene of northern Italy, clearly differs from *Osonacarcinus* n. gen. by its strongly vaulted and nearly subcircular carapace, protruded subtriangular front, punctuated dorsal surface and with marked grooves, whereas the new genus has a transversely ovate carapace with smooth surface (Beschin et al., 2016a, p. 55, 56, fig. 47, pl. 9, figs. 4A, B).

The genus *Holcocarcinus* Withers, 1924 (type species *H. sulcatus* Withers, 1924) from the Eocene of Nigeria, also presents two anterolateral nodes, but it is a clearly distinct taxon. The frontal margin is fairly protruding, bilobed, and the dorsal surface exhibits two notable transverse ridges along the carapace that distinguishes it from *Osonacarcinus* n. gen. (Withers, 1924, p. 94, pl. 5, figs. 1, 2; Schweitzer et al., 2018, p. 5, fig. 4-1).

Other genus that superficially resembles *Osonacarpilius*, as *Corallicarcinus* Müller and Collins, 1991 (Euryplacidae Stimpson, 1871), also present a similar carapace outline and a couple of anterolateral teeth, but relationship can be clearly discarded because it exhibits distinct characters, as the anterolateral depressions, terraces, and arched dorsal ridges which are absent in *Osonacarcinus* n. gen. (cf. Beschin et al., 2018, pp. 200–201, figs. 135–138).

Thus, based solely on the outline of the carapace, dorsal and fronto-orbital features, and despite the lack of important diagnostic features, not preserved in the studied specimens, such as the sterno-pleonal elements, we consider appropriate the erection of a new genus to accommodate our specimens, *Osonacarcinus*, within Pseudoziidae.

***Osonacarcinus lenis* n. sp.**

(Figs. 2, 3)

urn:lsid:zoobank.org:act:D60010CE-2B5D-454A-87DE-D6FB06A50A96

Etymology: From the Latin word *lenis* with means smooth.

Diagnosis: As for the genus.

Material and measurements: Three rather complete carapaces, one of them with right cheliped and remains of ventral portions. Holotype MGSB88660: length 14 mm, width 23 mm. Paratype MGSB88664: length 20 mm, width 12 mm. Additional material, five not totally complete carapaces, MGSB88661, MGSB88662, MGSB88663a–b and MGSB88671, with attached right cheliped, length 17 mm, height 9 mm.

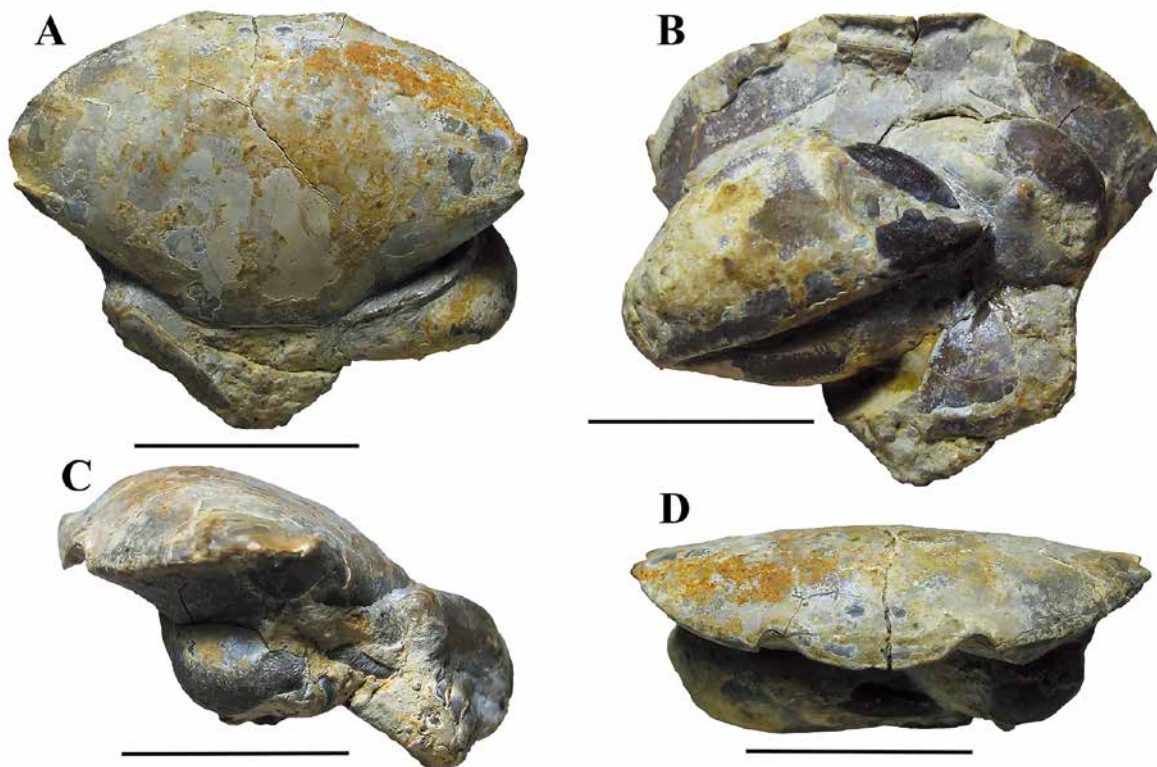


Fig. 2. *Osonacarcinus lenis* n. gen., n. sp. A–D, Holotype MGSB88660, from the Lutetian of Tavèrnoles (Osona, Catalonia). A, Dorsal view; B, Ventral view; C, Left lateral view; D, Frontal view. Scale bar equal to 10 mm.

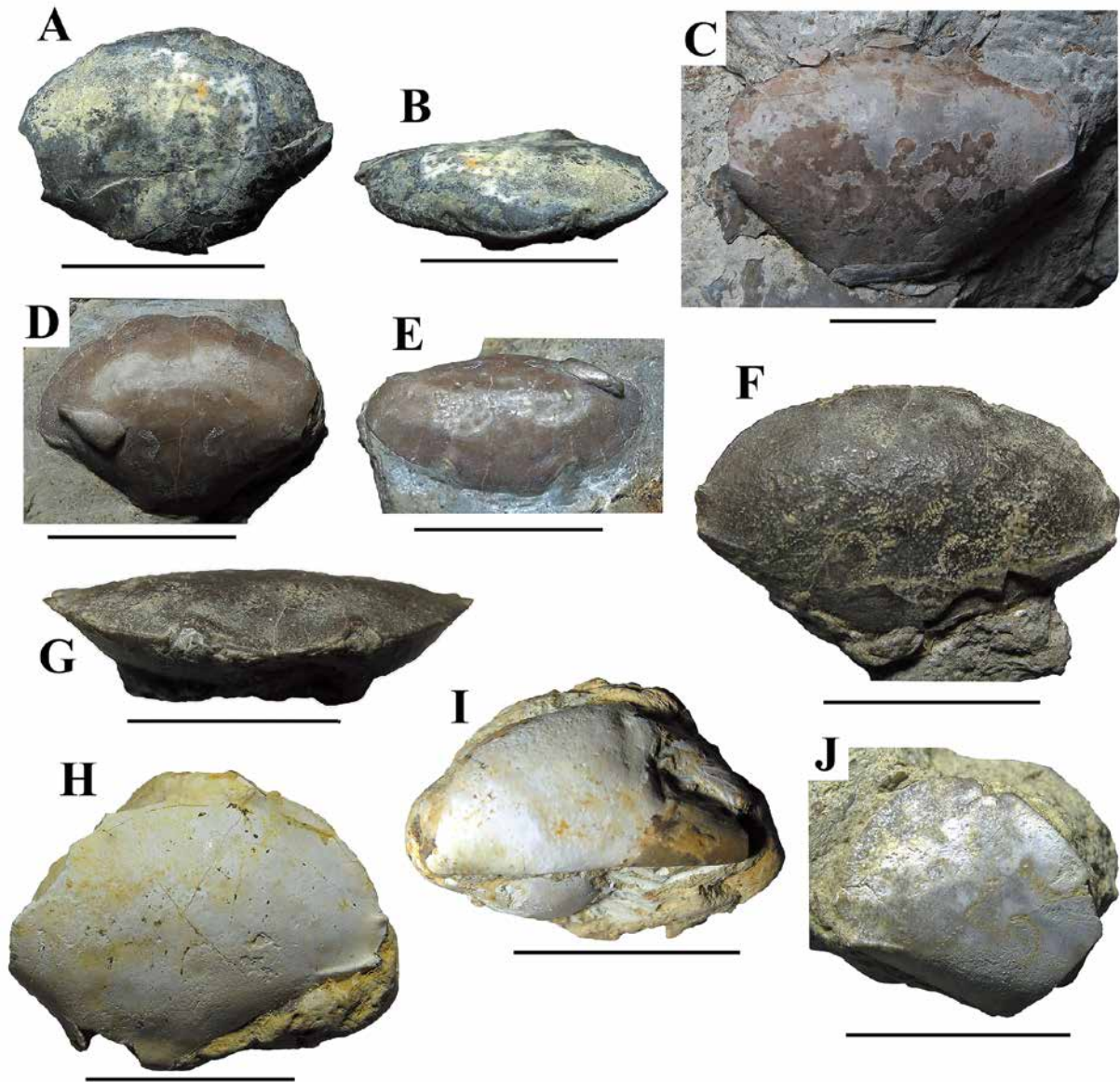


Fig. 3. *Osonacarcinus lenis* n. gen., n. sp. **A, B**, MGSB88661 from the Lutetian of Tavèrnoles (Osona, Catalonia), **A**, dorsal view; **B**, ventral view. **C**, MGSB88662 from the Lutetian of Tavertet (Osona, Catalonia), dorsal view. **D, E**, MGSB88663a from the Lutetian of Sant Julià de Ramis (Gironès Catalonia), **D**, dorsal view; **E**, oblique frontal view. **F, G**, Paratype MGSB88664 from the Lutetian of Folgueroles (Osona, Catalonia), **F**, dorsal view; **G**, frontal view. **H, I**, MGSB88671 from the Lutetian of Santa Susanna de Peralta-Forallac (Baix Empordà, Catalonia), **H**, dorsal view; **I**, ventral view. **J**, MGSB88663b from the Lutetian of Sant Julià de Ramis (Gironès, Catalonia), dorsal view. Scale bar equal to 10 mm.

Description: Small sized crab, carapace subelliptical in outline, fairly wider than long, L/W about 0.6; weakly vaulted in both directions, nearly flat in transverse section. Maximum width of carapace in the first subtriangular tooth, at the level of the epibranchial

region, in the anterior portion, about 62 percent of the posterior margin. Frontal margin nearly straight, to somewhat concave when seen from dorsal view, slightly downturned, slightly arched from frontal view, suggesting the presence of four subtle small lobes.

Orbits small, almost subcircular, slightly raised, few visible from dorsal view. Anterolateral margin gently arched, first portion nearly obliquely directed, with two stout, projecting, subtriangular teeth, the last one extending over the carapace, as a thin ridge, straight, just like a line. Posterolateral margins converging backwards, from straight to slightly concave. Posterior margin straight, with a thin rim, bounded by two concavities for the coxa. Dorsal regions of carapace not differentiated, dorsal surface smooth. Branchio-cardiac grooves weak, defined as opposed half-moon muscles scars. Female pleon with telson subtriangular, with the lateral margins fairly convex and the lower margin broadly arched; pleonal somites 5 and 6 sub-rectangular with curved upper and lower margins, somite 6 twice as high as somite 5. Chelipeds stout, smooth, palm with the outer surface strongly convex, upper and lower margins rounded; height of propodus about the half of the length. Pollex bearing three molariform teeth.

Remarks: As for the genus.

4. Discussion

Decapod crustaceans are relatively abundant in the extensive Eocene outcrops of the Iberian Peninsula, in particular in the different South-Pyrenean basins and the Basque-Cantabrian Basin, as well as in the south-eastern margin of the peninsula (e.g., Vía, 1969, 1991; Vía Boada, 1959; López-Horgue and Bodego, 2017). While the early Eocene Iberian decapod fauna shows strong affinities with those of the north Pyrenean and Atlantic basins (e.g., A. Milne-Edwards, 1863a, 1863b; Vía, 1988; Artal and Van Bakel, 2018a; Ferratges et al., 2021) but to a lesser extent with the western Tethys fauna (e.g., Vía, 1988; Artal and Castillo, 2005; Artal and Van Bakel, 2018b; Ossó et al., 2020). In the middle-late Eocene the Iberian decapod faunas appear to have clear affinities with the western Tethys fauna, sharing a large number of genera, for instance, *Dromilites*, *Eocalcinus*, *Harpactocarcinus*, *Harpactoxanthopsis*, *Micromaia*, *Montezumella*, *Hepaticus*, *Liopsalis*, *Periacanthus*, *Phrynotambus*, *Retropluma*, *Retrocypoda*, *Spinirostrimaia*, among others, and even the same species (e.g., Vía, 1932; Vía, 1941; Vía Boada, 1959; Vía, 1969;

Solé and Vía, 1989; De Angeli and Garassino, 2006; Artal and Hyžný, 2016; Artal and Onetti, 2017; De Angeli et al., 2019; Ferratges et al., 2023a, b). As suggested by Vía (1969, 1991), the south Pyrenean basins played an important role as a path to connect the western Tethys waters with the north Atlantic waters of south British Islands and North of France, where faunas with clear Tethys affinities have been reported (see Quayle and Collins, 1981, 2012; Domínguez and Ossó, 2016; Ferratges et al., 2023b). Although this marine connection is still controversial, the presence of the aforementioned decapod fauna during the Eocene shows that some type of connection, perhaps intermittent, existed between the western Tethys and the Bay of Biscay, through southern Pyrenees, until its definitive closure at the end of the Eocene (Puigdefàbregas et al., 1992; Sanjuan et al., 2012; Domínguez and Ossó, 2016; Ossó et al., 2020; and references therein).

The Eocene is particularly rich in decapod crustacean assemblages in the Iberian Peninsula, during the Lutetian the greatest diversity is found in the north-eastern part of the Ebro Foreland Basin, as indicated by the current fossil record. The presence of the pseudoziid *Osonacarcinus lenis* n. gen., n. sp. reinforces the Lutetian Catalan outcrops as the richest of the Iberian Peninsula from that time, as well as its strong affinity with the western Tethys fauna.

As aforementioned, in addition to this new report in Catalonia, fossil pseudoziids have been recorded in Italy and Hungary, but also in the Pacific coast of North America and questionably in New Zealand. This is not surprising given the relative faunal homogeneity at familial and generic level, in low latitudes of the entire Tethys Realm, Atlantic Ocean, Caribbean and even Pacific Ocean (e.g., Feldmann and Schweitzer, 2006; Bahrami et al., 2023; Ossó et al., 2023).

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