

# A new genus and species: *Pilummede penderensis* (Decapoda: Brachyura) from the Castle Hayne Limestone Formation (Eocene) of Pender County, North Carolina (USA)

Àlex Ossó<sup>a,\*</sup>, Don Clements<sup>b</sup>

<sup>a</sup>J.V. Foix, 12H, 1er-1<sup>a</sup>, 43007 Tarragona, Catalonia.

<sup>b</sup>Field Associate in Paleontology with the North Carolina Museum of Natural Sciences in Raleigh NC; 67 South Hummingbird Lane, Rocky Point, NC 28457, USA.

\* aosso@comt.cat

## Abstract

Discovery of new material from two previously known outcrops in the Bartonian and Priabonian levels of the Castle Hayne Limestone Formation (Eocene) of Pender County (North Carolina, USA), permits the description of a new decapod genus and species, *Pilummede penderensis*, and the assignation to it of specimens from the same outcrops, hitherto described as *Lessinarcinus euglyphos*. Even though some of the studied specimens exhibit dorsal carapaces exquisitely well-preserved, only little of ventral structures have been preserved, precluding a proper familial placement. Nevertheless, based on overall similarities, the new taxon is placed within Pilumnoidea with reservations. Comparisons with related forms show that the dorsal pattern of *Pilummede penderensis* is widely shared by a variety of fossil and extant decapod taxa.

Keywords: Eubrachyura, Pilumnoidea, Paleogene, Castle Hayne Limestone Formation, North Carolina, U.S.A.

## Resumen

El hallazgo de nuevo material de estudio en dos conocidos afloramientos de los niveles Bartoniano y Priaboniano, de la Formación Castle Hayne Limestone (Eoceno) en el Condado de Pender (Carolina del Norte, EUA), nos permite describir un nuevo género y una nueva especie, *Pilummede penderensis*, y al mismo tiempo asignarle especímenes previamente descritos como *Lessinarcinus euglyphos*. Aunque los caparazones dorsales presentan una exquisita conservación, únicamente algunos restos de sus partes ventrales se han conservado, lo que impide su exacta asignación familiar. Sin embargo, en base a algunas similitudes, ubicamos el nuevo taxón en Pilumnoidea, con reservas. Las comparaciones con otras formas relacionadas, muestran que el patrón dorsal de *Pilummede penderensis* es ampliamente compartido por diversas formas de decápodos, tanto fósiles como actuales.

Palabras clave: Eubrachyura, Pilumnoidea, Paleógeno, Formación Caliza de Castle Hayne, North Carolina, E.U.A.

## 1. Introduction

Nicely preserved decapod carapaces of *Pilummede penderensis* n. gen., n. sp., were recovered in two well-known fossiliferous outcrops of Pender County (North Carolina, USA), the former Martin Marietta Rocky Point quarry, and the Lanier Pit at Maple Hill (Fig. 1). The strata bearing decapod corresponds to the middle to late Eocene Comfort Member of the Castle Hayne Limestone Formation (Fig. 2). Diverse decapod fauna have been reported and/or described from the same or nearby Castle Hayne exposures, for instance Bishop and Withmore (1986), Blow and Manning (1996) and Feldmann *et al.* (1998). Franțescu (2013) summarized the list of species currently known from the Eocene of North Carolina and compared them with coeval Tethyan faunas.

Specimens of *Pilummede penderensis* n. gen., n. sp. recovered in the Rocky Point quarry (locality A, Fig. 1 and Fig. 3) preserve an exquisite granular ornamentation covering all the dorsal swellings, whereas in the Maple Hill specimens (locality B), the dorsal surface is partially eroded and most of the granular ornamentation is lost. Indeed, locality A specimens preserve the complete dorsal cuticle, ornate with mushroom shaped granules in all swelling regions (Fig. 4A-D). Locality B specimens have lost part of the external cuticle and all dorsal surface ornamentation (see Fig. 4E-F; Feldmann *et al.*, 1998, f. 15; Schweitzer *et al.*, 2007, f. 1A-B). However, examination of a specimen from locality B illustrated in Schweitzer *et al.* (2007, f. 1B) shows how part of the cuticle and ornamentation on the left side, even if not well preserved, is present like in the specimens from locality A. In the specimen from locality B (Fig. 4E-F), some remains of granules can be observed,

as well as pustules scattered along the swelling regions, which are scars of broken granules, thereby showing that specimens of both localities are conspecific. Thorough examination of those specimens permits us, as is explained below, to ascertain that they do not belong to *Lessinacarcinus euglyphos* (Bittner, 1875) (see Feldmann *et al.*, 1998; De Angeli and Garassino, 2006; Schweitzer *et al.*, 2007; Franțescu, 2013), and place them in the new genus and species herein described.

The systematic placement in the family of *Pilummede penderensis* n. gen., n. sp. is not clear. The fact that all the material available consists of isolated carapaces, from which only one preserved little remains of thoracic sternum, does not help us find a proper placement for the new taxon. In addition, as it was pointed out by Ossó *et al.* (2014, p. 41–42), the dorsal pattern of *Pilummede penderensis* n. gen., n. sp. is widely shared by different taxa belonging to distinct families, for instance Vultocinidae Ng and Manuel-Santos, 2007, Martinocarcinidae Schweitzer, Feldmann and Bonadio, 2009, Tumidocarcinidae Schweitzer, 2005, Xanthidae Macleay, 1838, Pilumnoididae Guinot and Macpherson, 1987, Pilumnidae Samouelle, 1819, or Galenidae Alcock, 1898.

The absence of well-preserved thoracic or pleonal elements in the studied specimens prevent us from conclusively assigning *Pilummede penderensis* n. gen., n. sp. to any of the aforementioned families. Nevertheless, based on the apparent similarities with some pilumnoids like *Halimede* De Haan, 1833 (see for instance Galil, 2000), *Pilummede penderensis* n. gen., n. sp. is placed within the Pilumnoidea with reservations, family *incertae sedis*.

*Pilummede penderensis* n. gen., n. sp. is compared with a group of coeval species from North America, most of

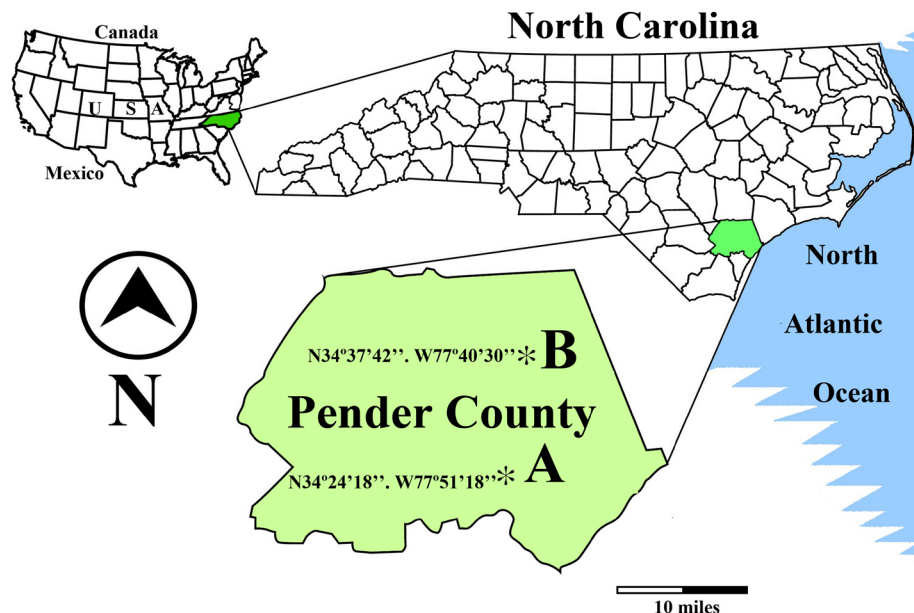


Figure 1. Location map.

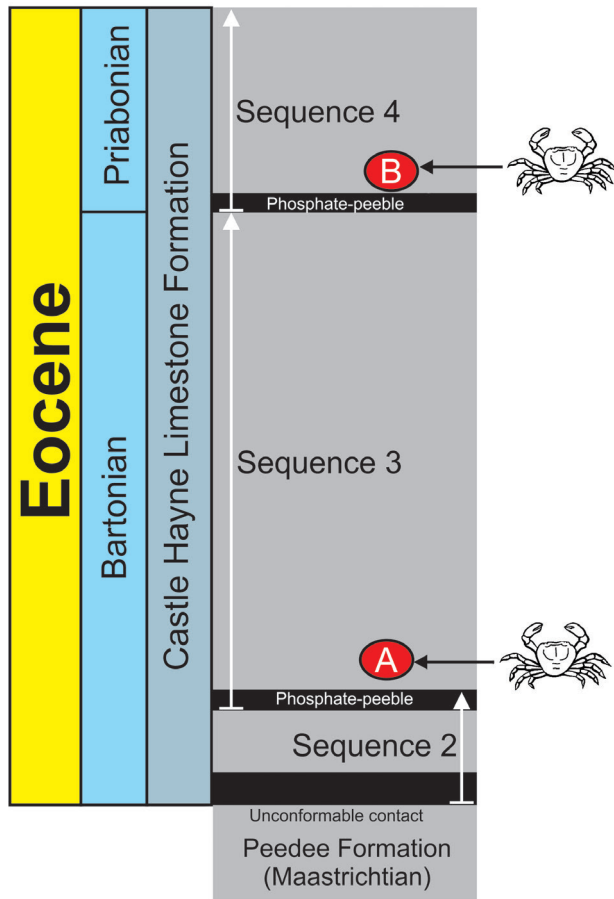


Figure 2. Approximate stratigraphic column of the two bearing crabs localities of Pender Co. (North Carolina, USA). A: Martin Marietta Rocky Point quarry. B: Lanier Pit at Maple Hill. Modified from Harris and Zullo (1991) and Frantescu (2013).

them from the Atlantic and Gulf Coast, and related with the Western Tethyan Province fauna (see Frantescu, 2013; Ossó *et al.*, 2014; Ossó, 2014). Several of these species, formerly attributed to genera such as *Titanocarcinus* A. Milne-Edwards, 1864 and *Lobonotus* A. Milne-Edwards, 1863 (see for instance Schweitzer *et al.*, 2007; Ossó *et al.*, 2014), exhibit similar dorsal features but also differences with *Pilummede penderensis* n. gen., n. sp. However, one of them, "*Lobonotus*" *bakeri* (Rathbun, 1935 as *Plagiolophus*), presents enough dorsal coincidences to say that it is congeneric with the new species. Therefore, it is transferred to the new genus as *Pilummede bakeri* (Rathbun, 1935) new combination.

## 2. Geological setting

Specimens from both localities were recovered from loose bryozoan biomicrudite of the Comfort Member (Ward *et al.*, 1978) in the Castle Hayne Limestone. The Castle Hayne Limestone ranges from middle to late Eocene



Figure 3. Typical landscape of the upper portion of Castle Hayne Limestone Formation at Martin Marietta Rocky Point quarry (picture courtesy of Linda McCall).

(Harris and Zullo, 1991). Specimens from Martin Marietta Rocky Point quarry (locality A) were recovered from loose bryozoan hash at the base of Sequence 3 (Bartonian) of Harris and Zullo (1991), about one meter or so above the basal phosphate pebble biomicrudite, which represents an initial transgressive lag of the sequence. The biomicrudite facies (Baum, 1980) represent the lower energy and deeper waters of the Castle Hayne embayment during the Eocene transgression (see Feldmann *et al.*, 1998). In this locality, specimens were found closely associated to echinoids of the Kier's Middle Biozone (Kier, 1980). The specimen from the Lanier Pit at Maple Hill (locality B) is from Sequence 4 (Priabonian) of Harris and Zullo (1991), which is characterized by the presence of the echinoid *Periarchus lyelli*; the pectinids *Chlamys deshayesii dennisoni*, *C. cookei* and *C. membranosa*; the barnacle *Arcoscalpellum jacksonense*; and the oyster *Pycnodonte trigonalis* (see Harris and Zullo, 1991). The Castle Hayne Limestone Formation is a highly fossiliferous carbonate unit. Bryozoans are the most common faunal element, and echinoderms and bivalves are relatively abundant. Decapods are relatively uncommon compared to other faunal groups but are occasionally locally abundant (see Feldmann *et al.*, 1998). They are usually molts, with different degrees of preservation in their carapace surface ornamentation. Poor preservation may be attributable to the proximity of the soil surface, rather than high energy conditions of the environment where the bryozoan biomicrudite was deposited, because it occurred in quiet conditions in the deepest waters (50 – 100 m) attained by the Eocene transgression in this area (see Feldmann *et al.*, 1998). An exhaustive study of the paleoenvironment of the Castle Hayne Formation regarding factors such as water temperature, clarity, salinity, wave and currents activity was conducted by Feldmann *et al.* (1998).

### 3. Material

Three carapaces, dorsally well preserved, one of them partially preserving the thoracic sternum, are designated as holotype and paratypes, and housed in the NC Museum of Natural Sciences (NCSM), Raleigh, North Carolina, USA.

### 4. Systematic Palaeontology

Order Decapoda Latreille, 1802  
 Infraorder Brachyura Latreille, 1802  
 Section Eubrachyura de Saint Laurent, 1980  
 Subsection Heterotremata Guinot, 1977  
 Superfamily Pilumnoidea Samouelle, 1819  
 Family *Incertae sedis*  
 Genus: *Pilummede* n. gen.

**Type species.** *Pilummede penderensis* n. sp.

**Species included.** *Pilummede penderensis* n. gen., n. sp., and *P. bakeri* (Rathbun, 1935) new combination.

**Etimology.** The generic name refers to the existing genera *Pilumnus* and *Halimede*, from Roman and Greek mythology and used in carcinology. Gender feminine.

**Diagnosis.** Carapace relatively small sized, suboctagonal, wider than long, sculpted. Maximum width at level of fourth anterolateral tooth, about 0.75 L/W ratio. Fronto orbital ratio about 0.60. Slightly vaulted longitudinally at anterior third. Regions well marked, inflated, except urogastric region; all inflated regions densely covered by clusters of mushroom shaped granules. Grooves separating regions smooth. Front bilobed densely granulated, with medial notch. Orbits forward directed; supraorbital margin with two fissures separated by a medial tooth; inner orbital tooth separated from the front by a notch; infraorbital margin visible dorsally. Anterolateral margin convex with four granulated teeth or nodes (excluding exorbital tooth). Posterolateral margin markedly convex. Posterior margin straight, rimmed, medially concave, ornate with a row of granules. Cervical and gastrohepatic grooves well-marked. Gastric process well-marked; epigastric lobes swollen; protogastric lobes swollen, anterior portion medially depressed, J shaped; mesogastric lobe broad posteriorly, anterior portion slender, reaching half of the protogastric lobes; metagastric lobe indistinct; urogastric region depressed, smooth, separated of meso-metagastric lobe by two gastric pits. Cardiac region swollen, broadly T-shaped. Intestinal region transversely elongate, inflated, medially divided by small smooth depression. Thoracic sternum flattened, finely granulated; sternite 3 inverted subtriangular; sternite 4 medially divided in two subtrapezoidal halves by sterno-abdominal cavity, lateral edges with parallel grooves; episternite well-developed, downward directed; sternite 5 subtrapezoidal laterally elongate, ending in a well-developed, downward directed episternite. Suture 2/3 complete; suture 3/4 laterally

visible, medially marked by a transverse groove; suture 4/5 complete, possibly interrupted medially.

**Discussion.** Familial placement of *Pilummede* n. gen. is not evident since we have isolated carapaces, and only one sample remains of a small fragment of thoracic sternum. Absence of a completely preserved thoracic sternum and/or pleon seriously hampers a proper familial accommodation for the new genus. Indeed, the dorsal morphology of *Pilummede* n. gen., while very informative, is in fact, beyond its particular granular ornamentation, very common and largely exhibited by large number of fossil and extant taxa belonging to different genera, families or even superfamilies. This fact was already pointed out by Ossó *et al.* (2014, p. 41) and suggests either an evolutionary success or an example of convergence (see Ng *et al.*, 2008, p. 9; Lai *et al.*, 2011).

Several similar genera such as *Lobonotus sensu stricto* (Pilumnidae) and *Pyreneplax* Ossó, Domínguez and Artal, 2014 (Vultocinidae), or the species retained in *Titanocarcinus* (?Tumidocarcinidae) and in “*Lobonotus*” *sensu lato* (Tumidocarcinidae) (see Ossó *et al.*, 2014, p. 40–41; Ossó, 2014), differ from *Pilummede* n. gen. as is explained below in the species discussion. Two genera of Goneplacoidea families, Vultocinidae and Martinocarcinidae, exhibit a similar dorsal morphology of carapace and an axial groove in the sternites 3 and 4, but they cannot accommodate *Pilummede* n. gen. because this axial groove reaches only the end of sternite 4 in the new genus, and its dorsal morphology presents clear differences, as explained below.

An array of xanthoid genera included in Xanthidae exhibit a similar dorsal morphology as in *Pilummede* n. gen., mainly regarding the anterior gastric process, and even some of them have an axial groove in sternite 4. For instance *Paraxanthias taylori* (Stimpson, 1861), which also presents a depressed urogastric region as in *Pilummede* n. gen. (see Rathbun, 1930a, t. 188, f. 1–3). Some species of *Cymo* De Haan, 1833, and *Pseudoliomera* Odhner, 1925, exhibit a granulated dorsal surface as well. However, generally Xanthidae are defined by a more transversely ovate carapace with large anterolateral margins, and usually concave posterolateral margins, which is not the case in *Pilummede* n. gen. (Lai *et al.*, 2011).

Also, species of *Pilumnoides* Lucas in H. Milne-Edwards, 1844 (Pilumnoididae) exhibit a sculpted and granulated dorsal surface of carapace, similar to *Pilummede* n. gen., but their usually present oblique branchial ridge and their extremely narrow sternum discard a familial relationship between both genera (see Guinot and Macpherson, 1987).

Some taxa of Pilumnoidea Samouelle, 1819, such as *Lobopilumnus* A. Milne-Edwards, 1880 (Pilumnidae), exhibit a similar dorsal morphology to that of *Pilummede*, or as it is seen in some species of *Halimede* (Galenidae), exhibit a similar outline of the carapace, anteriorly vaulted, and similar dorsal regions with urogastric region usually not well defined, the sternite 4 is crossed sometimes with

by an axial groove, as in *Pilummede* n. gen. (see Rathbun, 1930a; Galil, 2000).

Discussing the synapomorphies that define the aforementioned families and superfamilies in placing the new genus is beyond of the scope of this work. Although we concur that there is, "...inherent danger of relying on proxy characters, with convergence rampant in many taxa..." (see Ng *et al.*, p. 9), in absence of more complete samples preserving thoracic or pleonal parts, and in view of the apparent similarity of *Pilummede* n. gen. with the aforementioned pilumnoids, we place with reservations the new genus within Pilumnoidea, family *incertae sedis*.

*Pilummede penderensis* new species

Figure 4A–F

- 1986 *Lobonotus* n. sp., Bishop and Withmore; f. 3K  
 1998 *Titanocarcinus euglyphos* Bittner, 1875; Feldmann *et al.*, p. 12–13, f. 15–16.  
 2006 *Titanocarcinus euglyphos* Bittner, 1875; De Angeli and Garassino, 2006, p. 73.  
 2007 "*Titanocarcinus*" *euglyphos* Bittner, 1875; Schweitzer *et al.*, p. 283, f. 1A-B.  
 2010 "*Titanocarcinus*" *euglyphos* Bittner, 1875; Schweitzer *et al.*, p. 130.  
 2013 *Lessinarcinus euglyphos* (Bittner, 1875); Franțescu, t. 88.

**Etymology.** From Pender County in North Carolina (USA).

**Holotype.** NCSM 12217.

**Type locality.** Rocky Point, Pender County, North Carolina USA.

**Geological Age.** Middle and late Eocene (Bartonian and Priabonian).

**Material and measurements (in mm).** Holotype NCSM 12217: length = 17; width = 21; fronto-orbital width = 12. Paratype NCSM 11753: length = 14.20; width = 17.06; fronto-orbital width = 10. Paratype NCSM 12225: length = 11; width = 15; fronto-orbital width = 9.4.

**Diagnosis.** As for the genus.

**Description.** Carapace relatively small sized, suboctagonal, wider than long, sculpted, ornate. Maximum width at anterior third of carapace, at level of third anterolateral tooth, about 0.75 L/W. Fronto orbital ratio about 0.60. Slightly vaulted longitudinally at anterior third; almost flattened transversally. Regions well-marked, inflated, except for urogastric region; all inflated regions densely covered by clusters of mushroom shaped granules. Smooth grooves separate the granular and swollen regions. Front straight, bilobed, densely granulated, with medial V-shaped notch. Orbits forward directed, entire; supraorbital margin with two fissures, one medial and the other at outer margin, separated by a medial granulated tooth; inner orbital tooth separated from the front by a notch; infraorbital margin ornate with granules, visible dorsally. Anterolateral

margin convex with four granulated teeth or nodes (excluding exorbital tooth); additional small granulated tooth in subhepatic region. Posterolateral margin markedly convex. Posterior margin straight, rimmed, medially slightly concave, ornate with a row of fine granules. Cervical and gastrohepatic grooves well-marked, smooth. Gastric process well-marked; epigastric lobes swollen; protogastric lobes swollen, anterior portion medially depressed and smooth, with granulated inflations that draw two opposing Js, separated by the mesogastric region; mesogastric lobe broad posteriorly, anterior portion slender, granulations reaching the mid-length of protogastric lobes; metagastric lobe indistinct; urogastric region depressed, smooth, separated of meso- metagastric lobe by two gastric pits. Cardiac region swollen, broadly T-shaped. Intestinal region transversely elongate, inflated, medially divided by small smooth depression. Thoracic sternum flattened, finely granulated; sternite 3 inverted subtriangular; sternite 4 medially divided in two subtrapezoidal halves by sterno-abdominal cavity, which is large and triangular until the mid-length of the sternite to receive the telson, becoming a narrow groove anteriorly, lateral edges of sternite with parallel grooves; episternite 4 well-developed, downward directed; sternite 5 subtrapezoidal, laterally elongate, ending in a well-developed, downward directed episternite. Suture 2/3 complete; suture 3/4 laterally visible, medially marked by a groove; suture 4/5 complete, possibly interrupted medially.

**Discussion.** The Castle Hayne Formation specimens of *Pilummede penderensis* n. gen., n. sp., have been previously reported by Bishop and Withmore (1986, f. 3K), Feldmann *et al.* (1998), Schweitzer *et al.* (2007, p. 283, f. 1A-B), and Franțescu (2013, t. 88). Feldmann *et al.* (1998 p. 12–13, f. 15–16) described and assigned the specimens from the Maple Hill outcrops (locality B) to *Titanocarcinus euglyphos*, based on the similarities with the illustrations in Beschin *et al.* (1994) of the Eocene Italian specimens, while highlighting the fact that the metagastric-urogastric area (urogastric region herein) is not developed as an elevated area in the Castle Hayne Formation specimens like in the Italian ones. Posteriorly, Schweitzer *et al.* (2007, p. 283, f. 1A-B, D, t. 1) discussed the front morphology of the specimens and referred to them as "*Titanocarcinus*" *euglyphos*. De Angeli (2012), based on the original description by Bittner (1875) and on new findings, re-described this taxon and erected a new genus *Lessinarcinus* to accommodate "*Titanocarcinus*" *euglyphos*. The examination of the Castle Hayne Formation specimens shows significant differences between these specimens and *Lessinarcinus euglyphos*, and indicates that they are neither congeners nor conspecifics. In fact, De Angeli and Garassino (2006, p. 73) pointed out: "The American specimen show the following differences respect the Italian ones: wider carapace, more converging posterolateral margins and wider cardiac region. Therefore, the American species could be ascribed to a different species". Indeed, samples of *Pilummede penderensis* n.



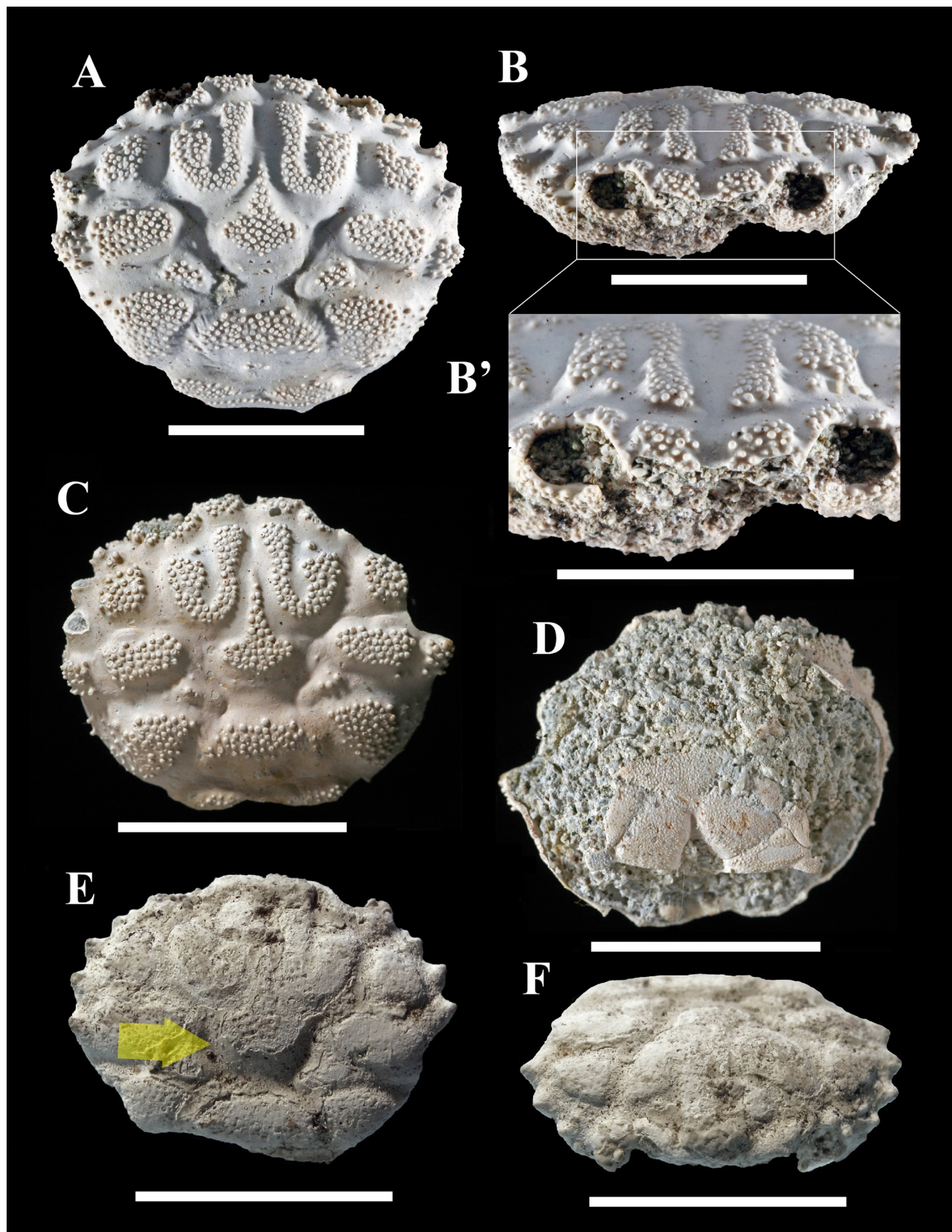


Figure 4. *Pilummede penderensis* n. gen., n. sp. A–D from Martin Martin Marietta Rocky Point quarry. A: holotype NCSM 12217, dorsal view; B: frontal view; B': close-up of fronto-orbital area. C: paratype NCSM 11753, dorsal view; D: ventral view. *Pilummede penderensis* n. gen., n. sp. from Lanier Pit at Maple Hill. E: paratype NCSM 12225, dorsal view; F: frontal view. Yellow arrow showing granules. Scale bar equal to 10 mm (pictures of specimens A–D from Richard Chandler).

gen., n., sp., differ from *L. euglyphos* in having a wider carapace, about 0.75 instead of 0.84; a lower fronto-orbital ratio, about 0.60 while in *L. euglyphos* it is 0.75; a posterior margin that is shorter, and posterolateral margins that are more convergent in the new species than in *L. euglyphos*. Also, the regions are more strongly ornate with clusters of granules in *P. penderensis* n. gen., n. sp. than in *L. euglyphos*; in the metabranchial region of *P. penderensis*, two swellings that *L. euglyphos* possess are not present; the urogastric region is smooth and completely depressed in *P. penderensis* n. gen., n., sp., whereas it is well defined, slightly swollen and ornate with some small granules in *L. euglyphos* (this region is treated as metagastric region in the De Angeli description). The differences between both species are clear. (see Feldmann *et al.*, 1998, p. 12–13, f. 15–16; De Angeli and Garassino, 2006, p. 73; Schweitzer *et al.*, 2007, p. 283, f. 1A-B).

*Eohalimede walleri* Blow and Manning, 1996 (Pilumnidae), from the equivalent Santee Limestone Formation (South Carolina), appears to be related to *Pilummede penderensis* n. gen., n. sp. given its dorsal appearance. As it is readily noticeable, the website of the Smithsonian collections shows that the holotype of *E. walleri* USNM-PAL 484580 (record ID: nmnhpaleobiology\_3590033) is a fragmentary internal negative mold of a carapace embedded in matrix. In addition, the presumed paratype USNM-PAL 484581 of *E. walleri* is in fact a silicone cast of that holotype, as seen in the picture and also as indicated in a personal communication by Thomas Jorstad (Smithsonian Institution-NMNH). It is clear that the relief of the internal side of a carapace does not correspond exactly with the relief of the external side, and even less regarding the ornamentation (see Guinot, 1979, p. 48–56, f.14A, t. 3, f. 3a–b; Ossó and Stalennuy, 2011, f.3, 13–14). But at least in terms of depression/elevation, it can provide some information of its external relief. In this way, we can observe the marked urogastric region either in the holotype, as a range of small holes, or in the presumed paratype (cast), as a transverse granulated inflation, whereas this region is completely depressed in *Pilummede penderensis* n. gen., n. sp. This important difference discards a close relationship of *E. walleri* with *P. penderensis* n. gen., n. sp. In our opinion, it does not rule out the possibility of *Eohalimede walleri* being an incomplete sample of *Pyreneplax sandersi* (Blow and Manning, 1997), which occurs in the same formation, and might be preferable to consider *E. walleri* as a *nomen dubium* (see Blow and Manning, 1996, 1997, 1998; Beschin *et al.*, 2009; Franțescu, 2013, f. 49–4; Ossó *et al.*, 2014).

The dorsal appearance of *Pilummede penderensis* n. gen., n., sp. is similar to several species formerly assigned to the genus *Titanocarcinus* A. Milne-Edwards, 1864 and to the genus *Lobonotus* A. Milne Edwards, 1863 (see Ossó *et al.*, 2014). Indeed, Feldmann *et al.* (1998, p. 13) pointed out already the largely shared morphology of the protogastric lobes of these fossil species, defined herein as: “inflations

that draw two opposing Js, separated by the mesogastric region”. Ossó *et al.* (2014, p. 41) pointed out the same idea and expanded it not only to the morphology of the protogastric lobes, but also to the whole morphology of the anterior two-thirds of carapace, a pattern that is shared by a diverse array of fossils and extant forms, and even belonging to different superfamilies as may be seen below.

In order to establish the relationship of *Pilummede penderensis* n. gen., n. sp. with other genera or species, we compared it with taxa that share similar dorsal morphology, as follow.

*Pilummede penderensis* n. gen., n. sp. differs from the species of *Pyreneplax* Ossó, Domínguez and Artal, 2014 (Vultocinidae) (ex *Eohalimede*; ex *Lobonotus*) from the Eocene of South Carolina (USA), northern Iberian Peninsula and northern Italy, in having a not so squarish carapace outline, denser clusters of granules in the inflated regions, and the absence of a marked urogastric region, which is well-marked in *Pyreneplax*, even though this area is treated as depressed in the description of Franțescu (2013, p. 356) for *P. sandersi* (see Blow and Manning, 1997, p. 177–179, f. 2, 1998; Beschin *et al.*, 2002, p. 19–20, t. 4, f. 1; Beschin *et al.*, 2009, p. 12–15, t. 3, f. 1–2; Franțescu, 2013, p. 354–358, f. 49.4; Ossó *et al.*, 2014; De Angeli, 2014; Ossó, 2014).

“*Lobonotus*” *natchitochensis* Stenzel, 1935, from the equivalent Eocene Claiborne Group of Louisiana (USA), appears to be very close to *Pilummede penderensis* n. gen., n. sp. based on its similar dorsal morphology with inflated regions densely covered by granules. However, it differs from *Pilummede penderensis* n. gen., n. sp. in having a squarish carapace, broader posterior margin, anterolateral margins without prominent teeth as in *P. penderensis* n. gen., n. sp., coarser granules covering the swollen regions, and the urogastric region, even described as “much lower than the surrounding areolations” as in the new species. It is granulated instead of smooth, like in *P. penderensis* n. gen., n. sp. Examination of further material would be needed in order to establish the relationship among both species (see Stenzel, 1935, p. 382–384, f.1, t. 14, 1–2).

*Pilummede penderensis* n. gen., n. sp. differs from “*Lobonotus*” *sturgeoni* (Feldmann, Bice, Schweitzer-Hopkins, Salva and Pickford, 1998) from the Eocene Castle Hayne Formation of North Carolina (USA), even though its urogastric region is not well defined as in *P. penderensis* n. gen., n. sp., in having: a wider, more sculpted and ornate carapace; straight bilobed front instead of six pointed in “*L.*” *sturgeoni*; flattened carapace rather than strongly vaulted anteriorly in “*L.*” *sturgeoni*; and the cardiac region is strongly inflated and ornate in *P. penderensis* n. gen., n. sp., instead of weakly defined in “*L.*” *sturgeoni*. Thus, no close relationship can be established (see Feldmann *et al.*, 1998, p. 13–14, f. 17–1, 18; Karasawa and Schweitzer, 2004, p. 150, f. 1–1; Távora *et al.*, 2005, p. 396, f. 5a-b; Franțescu, 2013).

As seen, one of the most significant differences between *Pilummede penderensis* n. gen., n. sp., and the numerous

groups that share similar dorsal morphology is the absence of a well-marked urogastric region in *P. penderensis* n. gen., n. sp., which is depressed and smooth. In this entire group, the urogastric region is defined as a well-marked inflation, usually transverse, behind the gastric pits. Namely: “*Lobonotus*” *australis* Fritsch, 1878, from the Eocene of Kalimantan (Indonesia) (see Fritsch, 1878, p.137–138, t.18, f. 7a); “*Lobonotus*” *beschini* De Angeli and Checchi, 2012, from the Eocene of northern Italy (see De Angeli and Checchi, 2012); “*Lobonotus*” *purdyi* (Blow and Manning, 1996) from the Eocene of South Carolina (USA) (see Blow and Manning, 1996, p. 24–25, t.5, f. 5; Franțescu, 2013, p. 351–354, f. 49–1,2,3), all of them are placed within Tumidocarcinidae; *Lobonotus sculptus* A. Milne-Edwards, 1863 (?Pilumnidae) from the Miocene of the Caribbean; *Martinocarcinus ickeae* Böhm, 1922 (Martinocarcinidae) from the Eocene of Indonesia (see Schweitzer *et al.*, 2009); *Glyphithyreus wetherelli* (Bell, 1858) (Panopeidae) from the lower Eocene of UK (see Karasawa and Schweitzer, 2004). In the above mentioned species, the urogastric region is well-defined by a marked inflation, or at least it is not depressed as in *Pilummede penderensis* n. gen., n. sp., thus ruling out any close relationship among these taxa and the new species.

For the same reason, among other significant differences, *Pilummede penderensis* n. gen., n. sp., cannot be placed within the group of species described and illustrated in Schweitzer *et al.*, (2007, f. 1-2), earlier referred to as *Titanocarcinus* (different families) or currently referred to as *Titanocarcinus sensu stricto* (Tumidocarcinidae). In the case of *Titanocarcinus decor* (Schweitzer *et al.*, 2007), which is the only species of this genus with preserved ventral structures, beyond the aforementioned dorsal differences, it differs from *Pilummede penderensis* n. gen., n. sp., in having strongly vaulted thoracic sternites 3 and 4, which are flattened in the new species, and in having a large longitudinal groove crossing the sternite 4, which is narrow in *P. penderensis* n. gen., n. sp. Also, *Titanocarcinus kambuehelensis* Verhoff, Feldmann, Müller and Schweitzer, 2009, and *T. schweitzeriae* Robin, van Bakel, Pacaud and Charbonnier, 2016 differ from *Pilummede penderensis* n. gen., n. sp., like the aforementioned species, in having a well-marked urogastric region, and their cardiac region is not T-shaped as in *Pilummede penderensis* n. gen., n. sp. (see Schweitzer *et al.*, 2007, f. 3B-C; Verhoff *et al.*, 2009; Robin *et al.*, 2016; Fig. 4A-F).

“*Lobonotus*” *mexicanus* Rathbun, 1930b from the Eocene of Baja California (Mexico) differs clearly from *Pilummede penderensis* n. gen., n. sp. in its unique dorsal morphology, not so sculpted and ornate as in the new species, and in the vaulted sternite 4 and large axial groove crossing the sternite 4, reaching the end of sternite 3, whereas in *P. penderensis* n. gen., n. sp., the sternites 4 and 3 are flattened and the axial sterno-abdominal groove reaches only the end of sternite 4 (see Rathbun, 1930b, p. 2–3, t.1, f. 1-3; Fig. 4D).

“*Lobonotus*” *bakeri* from the Eocene Clairbone Group of Texas (USA) presents a clear similarity in appearance with *Pilummede penderensis* n. gen., n. sp., having the same pattern of swollen regions ornate with clusters of granules; four anterolateral granulated teeth, straight bilobed front; bifissured supraorbital margin; metagastric region indistinct; urogastric region depressed and smooth, and inflated T-shaped cardiac region. However, “*Lobonotus*” *bakeri* presents slight differences from *Pilummede penderensis* n. gen., n. sp. as: a squarish carapace, about 0,87; blunt anterolateral teeth instead of prominent ones in *P. penderensis* n. gen., n. sp.; the long end of the J shaped protogastric lobe clearly interrupted instead of usually continuous in the new species; the mesobranchial lobe is rounded whereas in *P. penderensis* n. gen., n. sp. it is transversely elongate, and the cardiac lobe is transversely shorter than in the new species. The aforementioned similarities, despite the minor differences, suggest that both species can be congeneric; thus “*Lobonotus*” *bakeri* is transferred herein to the new genus as *Pilummede bakeri* (Rathbun, 1935) new combination (see Rathbun, 1935, p. 94–95, t. 21, f. 23).

According with the extensive study of Feldmann *et al.* (1998), *Pilummede penderensis* n. gen., n. sp. inhabited an open marine environment of clear and warm, temperate to subtropical waters, with normal salinity. Probably the water depths in which this decapod dwelt were below wave base and the environment was low energy. *Pilummede penderensis* n. gen., n. sp. increases the number of decapod species yielded by the Castle Hayne Formation, which shows strong affinities with the Mediterranean Tethys fauna as demonstrated by diverse previous works (see for instance Feldmann *et al.*, 1998; Beschin *et al.*, 2009; Franțescu, 2013; Ossó *et al.*, 2014; Ossó, 2014).

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