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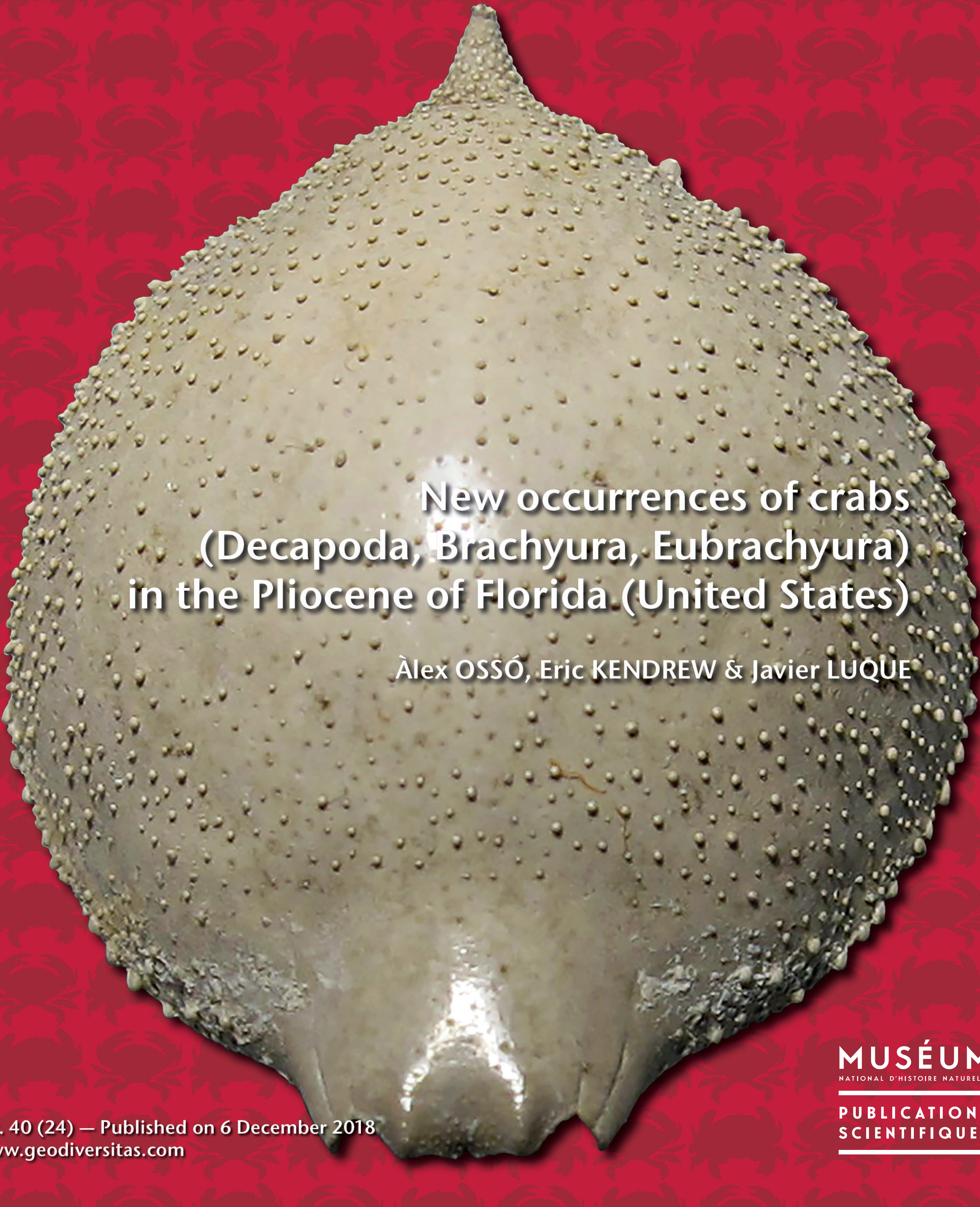

New occurrences of crabs (Decapoda, Brachyura, Eubrachyura) in the Pliocene of Florida (United States)

Àlex OSSÓ, Eric KENDREW & Javier LUQUE

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Persephona cf. *P. subovata* (Rathbun, 1893), USNM PAL 720104 from the Pinecrest Member of Tamiami Formation (middle Piacenzian, Pliocene), Florida (United States).

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New occurrences of crabs (Decapoda, Brachyura, Eubrachyura) in the Pliocene of Florida (United States)

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ABSTRACT

Despite the rich fossil record of decapod crustaceans in Florida, there are still several stratigraphic intervals for which almost no fossil decapods have been reported. Here we document the occurrence of two species of eubrachyuran crabs from the Pliocene Pinecrest Member of the Tamiami Formation, Sarasota County, based on complete and well preserved dorsal carapaces: the leucosiid *Persephona* cf. *P. subovata* (Rathbun, 1893), and the xanthid *Paractaea* cf. *P. nodosa* (Stimpson, 1860). The specimen of *Paractaea* cf. *P. nodosa* represents the second fossil record of the genus and the oldest occurrence known to date. The specimen of *Persephona* cf. *P. subovata,* despite its geographic occurrence, it is more similar anatomically to some extant tropical Eastern Pacific species than to any of the species occurring in Florida today. It is possible that ancestral populations of *P. subovata* were present in the tropical Eastern Pacific and western Atlantic before the water masses were isolated after the final closure of the currents connecting both water masses, and that the fossil *Persephona* here studied is part of a relict population of *P. subovata* that disappeared in the Atlantic after the late Pliocene.

KEY WORDS
Heterotremata,
Leucosiidae,
Paractaea,
Persephona,
Xanthidae,
Tamiami Formation.

RÉSUMÉ

Nouvelles occurrences de crabes (Decapoda, Brachyura, Eubrachyura) dans le Pliocène de Floride (États-Unis).
Malgré le riche registre fossilifère des crustacés décapodes de Floride, il y a des niveaux stratigraphiques où ils n'ont pas été encore trouvés. La présence de deux espèces de crabes eubrachyures provenant du Membre Pinecrest de la Formation Tamiami (Pliocène) à Sarasota County, est ici documentée sur la base de carapaces dorsales complètes et bien conservées : le Leucosiidae *Persephona* cf. *P. subovata* (Rathbun, 1893), et le Xanthidae *Paractaea* cf. *P. nodosa* (Stimpson, 1860). Le spécimen de *Paractaea* cf. *P. nodosa* est la seconde occurrence de ce genre dans le registre fossilifère et la plus ancienne connue à ce jour. Le spécimen de *Persephona* cf. *P. subovata*, même s'il a été récolté en Floride, est anatomiquement plus proche des espèces qui vivent dans le Pacifique Est tropical que des espèces qui habitent en Floride actuellement. Il est possible que des populations ancestrales de *P. subovata* aient été présentes dans le Pacifique Est tropical et l'Atlantique Ouest avant l'isolement des masses d'eau après la fermeture finale des courants reliant les deux masses d'eau. Ainsi, le fossile *Persephona* étudié ici, aurait pu faire partie d'une population relique de *P. subovata* qui a disparu de l'Atlantique après la fin du Pliocène.

MOTS CLÉS
Heterotremata,
Leucosiidae,
Paractaea,
Persephona,
Xanthidae,
Formation Tamiami.

INTRODUCTION

The fossil record of decapod crustaceans in southern Florida (United States) is well known and broadly studied (see Luque *et al.* 2017 and references therein), yet several stratigraphic intervals remain undersampled or with fossil findings unreported. This is the case of the Pliocene Tamiami Formation, a fossiliferous unit from where only a handful of fossil decapods been properly described including the porcellanid crab *Petrolisthes myakkensis* Bishop & Portell, 1989, associated to the sun star *Heliaster microbrachius* Xantus, 1860 (Portell & Agnew 2004; Luque *et al.* 2017: fig. 14A). Most other fossil decapod records known from the Tamiami Formation seem to be fragmentary and largely represented by carapace fragments or cheliped remains (FLMNH Invertebrate Paleontology catalogue online https://www.floridamuseum.ufl.edu/invertpaleo/). Here we describe two eubrachyuran crab occurrences from the Pinecrest Member of Tamiami Formation, Sarasota County: the leucosiid crab *Persephona* cf. *P. subovata* (Rathbun, 1893), and the xanthid crab *Paractaea* cf. *P. nodosa* (Stimpson, 1860). Based on complete dorsal carapaces, we compare them with related crab taxa and discuss their paleobiogeographic affinities.

LOCATION AND STRATIGRAPHY

The specimens studied herein were collected by the second author (Eric Kendrew) in the Sarasota County, Florida (United States), from two different localities separated from each other by no more than 15 km (Fig. 1). Locality A corresponds to the SMR Aggregates quarry (27°20’05”N, 82°19’58”W), and locality B to the old APAC Shell quarry, West of I-75 (Interstate) (27°14’18”N, 82°27’11”W). The section outcropping in the APAC quarry from Sarasota, showing the superjacent and subjacent beds, is used as standard reference section for the Pinecrest Member (Olsson & Petit 1964) of Tamiami Formation, equivalent to mid-Piacenzian (Pliocene) in age (Petuch & Roberts 2007: fig. 4.3).

According to Hunter (1968), the lithology of the Pinecrest Member of the Tamiami Formation (Okeechobee Group) is composed of clean quartz sandstones, locally with shell beds and calcareous muds. Some of these shell beds are composed almost exclusively of either oysters, scallops, strombids, or the large worm gastropod *Vermicularia recta* Olsson & Harbison, 1953 (see Petuch & Roberts 2007). This member yields one of the richest molluscan fauna known in the Pliocene of Florida that lived during the warmest and most tropical time of the entire Pliocene (Petuch & Roberts 2007). The extension of the Pinecrest Member is approximately to that of the Tamiami Formation, and in Sarasota County it reaches 10 m of thickness (Petuch & Roberts 2007: 85, fig. 4.8).

The specimen of *Persephona* cf. *P. subovata* (Rathbun, 1893) (Fig. 2) was found in sediment inside of a large gastropod *Hexaplex hertweckorum* (Petuch, 1988), recovered from *ex situ* spoil piles coming from the SMR quarry (locality A). This endemic gastropod species is considered as an index fossil for the Pinecrest Member (see Petuch & Roberts 2007: 85; fig. 4.10K), suggesting that the spoil materials belong to the Unit 7 of the Pinecrest Member of Tamiami Formation (Petuch & Roberts 2007). The specimen of *Paractaea* cf. *P. nodosa* (Fig. 3) was found *in situ* in the APAC quarry (locality B), together with bioherms of *Vermicularia recta* from the Unit 5 of the Pinecrest Member, which is index fossil of this member as well (see Petuch & Roberts 2007: 85, figs 4.11G, 4.13). Thus, the age of the studied specimens can be considered as middle Piacenzian (Late Pliocene). Specimens are housed in the Natural Museum of Natural History (USNM), Washington, DC (United States).

SYSTEMATIC PALAEONTOLOGY (FOLLOWING NG *ET AL.* 2008)

Order DECAPODA Latreille, 1802
Infraorder BRACHYURA Latreille, 1802
Section EUBRACHYURA Saint Laurent, 1980
Subsection HETEROTREMATA Guinot, 1977
Superfamily LEUCOSIOIDEA Samouelle, 1819
Family LEUCOSIIDAE Samouelle, 1819
Subfamily EBALIINAE Stimpson, 1871

Genus *Persephona* Leach, 1817

TYPE SPECIES. — *Persephona latreillei* Leach, 1817, by subsequent designation of Rathbun (1922).

Persephona* cf. *P. subovata (Rathbun, 1893)
Fig. 2A-D

MATERIAL. — One dorsal carapace, USNM PAL 720104, found inside the shell of a specimen of the gastropod *Hexaplex hertweckorum* (Petuch, 1988).

MEASUREMENTS (in mm). — Length = 17; width = 14; fronto-orbital width = 5.4; posterior margin = 6.9.

DESCRIPTION

Carapace roundish, sub-ovate to sub-pyriform, slightly longer than wide, strongly vaulted, with coarse granulation dorsally, particularly towards the carapace margins. Fronto-orbital margin prominent, about two times as wide as it is long, somewhat upturned, extending forward well beyond the anterolateral margin (Fig. 2A); front narrow, wider than the orbits; orbits bearing two closed orbital fissures, the innermost orbit almost half as long as the outermost orbit (Fig. 2B). Sub-hepatic region not inflated and lacking a sub-hepatic spine or tubercle. Lateral margins ornamented with aligned coarse granules (Fig. 2C). Posterior margin bearing three well-developed marginal conical spines nearly as long as they are wide at their bases (Fig. 2D); mesial spine slightly longer than lateral spines; posterior margin between the lateral spines with large conspicuous granules. Sternal, pleonal, and appendicular elements not preserved.

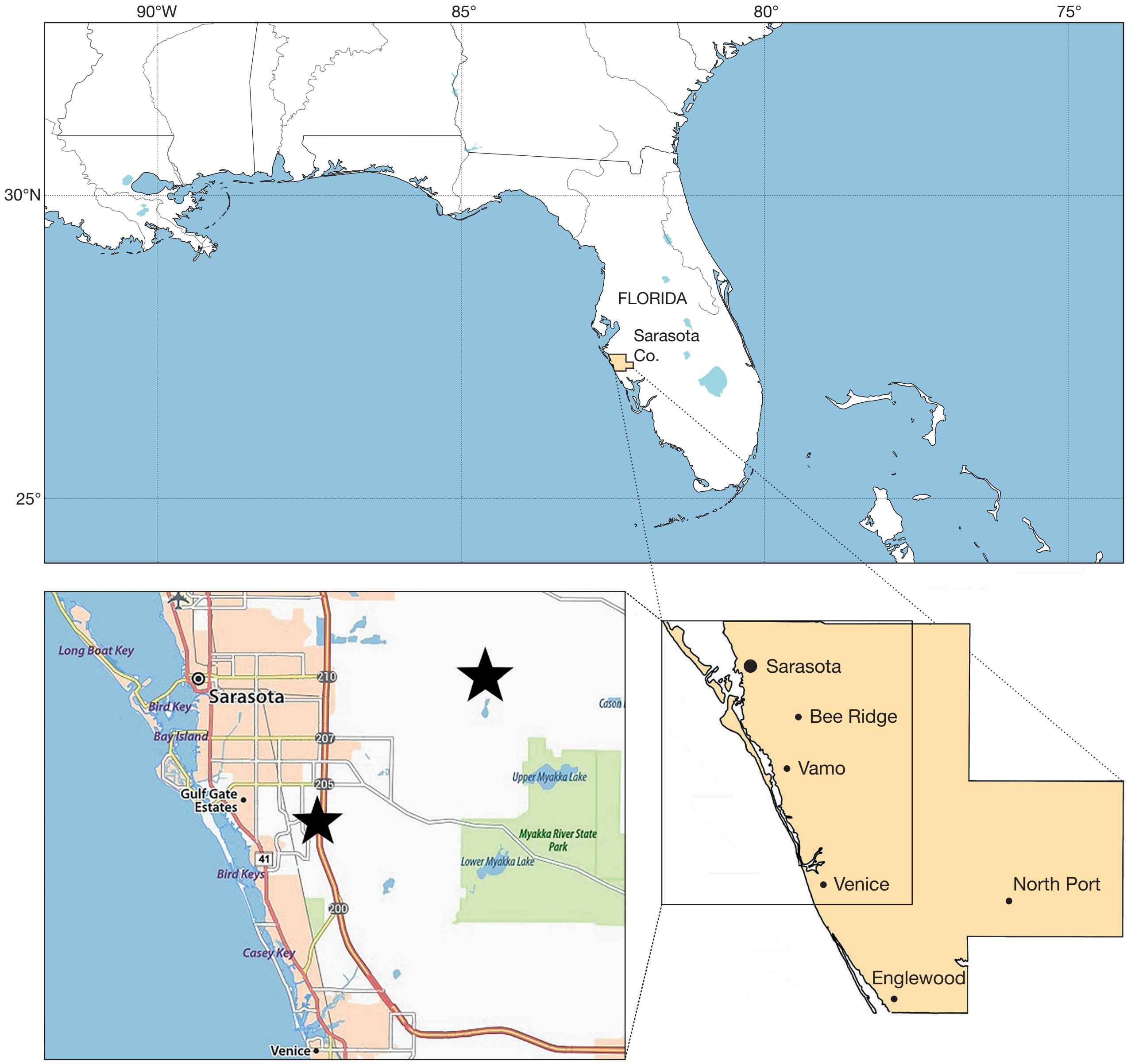

Fig. 1. — Location map of the two fossiliferous localities of the Pliocene Tamiami Formation in Sarasota County, Florida (United States). Locality A: SMR Aggregates quarry (27°20’05”N, 82°19’58”W). Locality B: Old APAC Shell quarry (27°14’18”N, 82°27’11”W). Maps modified after different sources and ViaMichelin.

REMARKS

Based on the overall carapace form, the dorsal granulation, and the presence of three posterior spines, the specimen studied could be assigned to either *Persephona* or *Iliacantha* Stimpson, 1871, both closely related leucosiid genera within the Ebaliinae, and co-occurring in the western Pacific and eastern Atlantic coasts of the Americas. However, species within these genera are sometimes difficult to differentiate (Hendrickx 1997), and most of their diagnostic characters are found on their chelipeds, ambulatory legs, mouthparts, pleon, gonopods, sternum, and carapace color patterns, which are not preserved in the fossilized studied material. Furthermore, juvenile specimens of *Iliacantha* spp. and *Persephona* spp. may lack some conspicuous traits seen in adults of their species such as the sub-hepatic swelling and the development of a sub-hepatic spine, obscuring the placement of incomplete fossil taxa.

Today, several species of *Persephona* occur in the coasts of Florida, such as *P. aquilonaris* Rathbun, 1933, and *P. mediterranea* (Herbst, 1794). Nevertheless, and despite the incompleteness of the material available for study, the fossil specimen does not seem to match any of the extant species currently known from the eastern Atlantic and the Gulf of Mexico (D. Felder and B. Galil, pers. comms. June 2018). In fact, the fossil from the Tamiami Formation seems to be more similar to either *P. edwardsii* Bell, 1855, or *P. subovata* (Rathbun, 1893) (Fig. 4A, B); both species from the eastern Pacific of the Americas. These species share with the fossil from the Tamiami Formation here reported the subovate carapace outline and the lack of a strong sub-hepatic

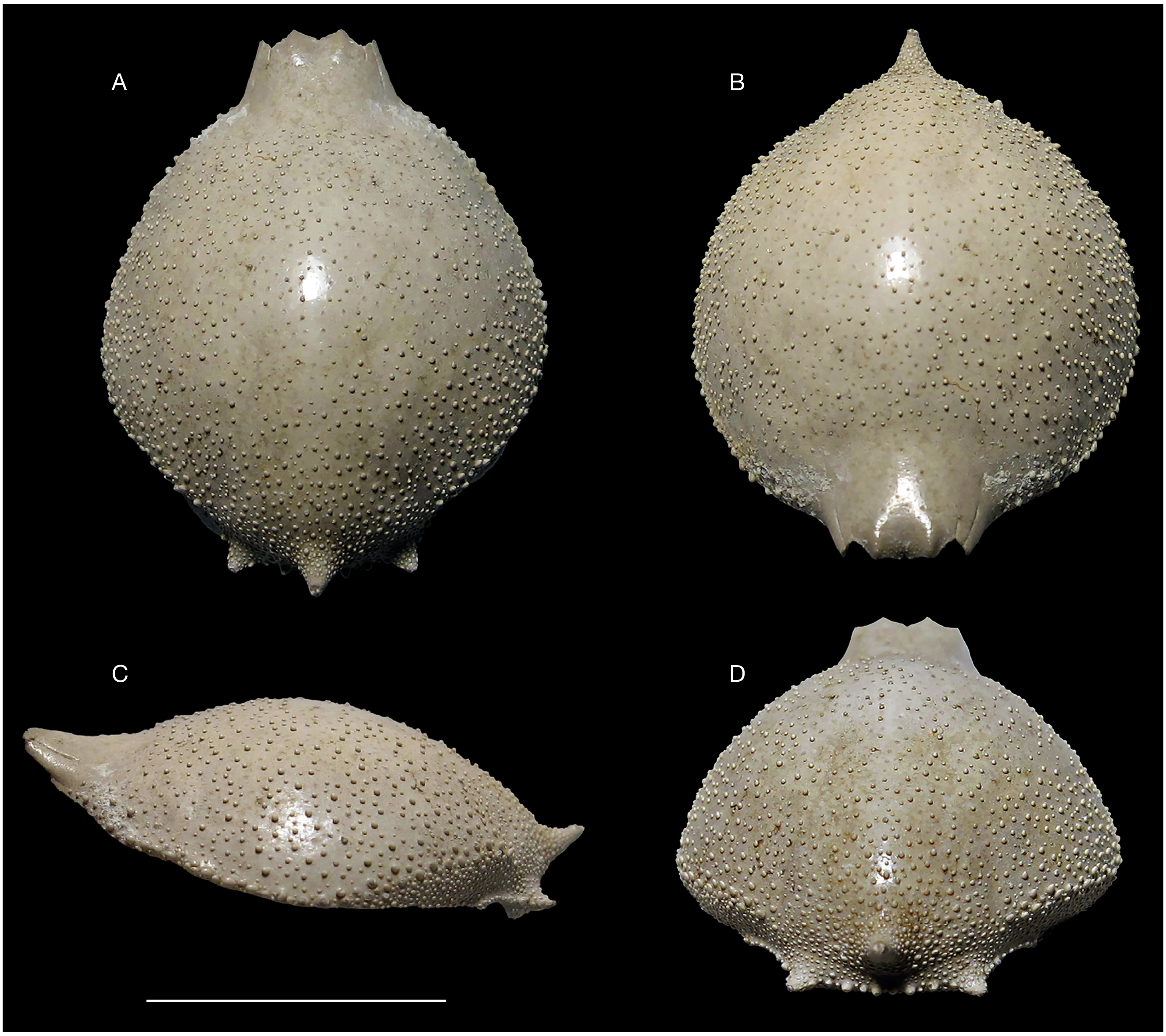

Fig. 2. — *Persephona* cf. *P. subovata* (Rathbun, 1893), USNM PAL 720104 from the Pinecrest Member of Tamiami Formation (middle Piacenzian, Pliocene) of locality A in Sarasota County, Florida (United States): **A**, dorsal view; **B**, frontal view; **C**, left lateral view; **D**, posterior view. Scale bar: 10 mm. Photographs by À. Ossó.

tubercle (compare to Boone 1930: pl. 10; Hendrickx 1997: fig. 104; Magalhães 2012: fig. 16). Although *P. edwardsii* and *P. subovata* are restricted to the western Pacific and the fossil here studied comes from the Atlantic Gulf, it is possible that ancestral populations of *P. edwardsii* or *P. subovata* were present at both sides prior to the closure of the connectivity of water masses between the tropical Eastern Pacific and the Atlantic, and that the fossil from Florida is part of a relict population of *P. edwardsii* or *P. subovata* that disappeared in the Atlantic.

Several fossil records of *Persephona* are known from the Neogene and Quaternary of the tropical and subtropical Americas (see summary in Luque *et al.* 2017), including a similar specimen from the early-middle Pleistocene of Fort Drum, Okeechobee County, Florida, assigned to *P. mediterranea* by Portell & Agnew (2004) (Luque *et al.* 2017: 49, 50, fig. 14F). Both specimens from Florida share the presence of some small granulations on the posterior margin between the main lateral spines, a carapace longer than wide, a similar dorsal granulation pattern, and a fronto-orbital margin extending well beyond the anterolateral margin, although the Pleistocene specimen from Okeechobee County is almost three times larger than the Sarasota specimen herein illustrated. In the Florida Museum of Natural History (FLMNH) Invertebrate Paleontology webpage, there are several records of *Persephona* sp. from the Tamiami Formation, most being cheliped articles (meri). Several other *Persephona* sp. remains from the Plio-Pleistocene Nashua and Caloosahatchee formations, and the Bermont and Fort Thompson formations are also included in the Invertebrate Paleontology collections at the FLMNH (see also Portell & Agnew 2004, and references therein). The new carapace confirms the presence of the genus

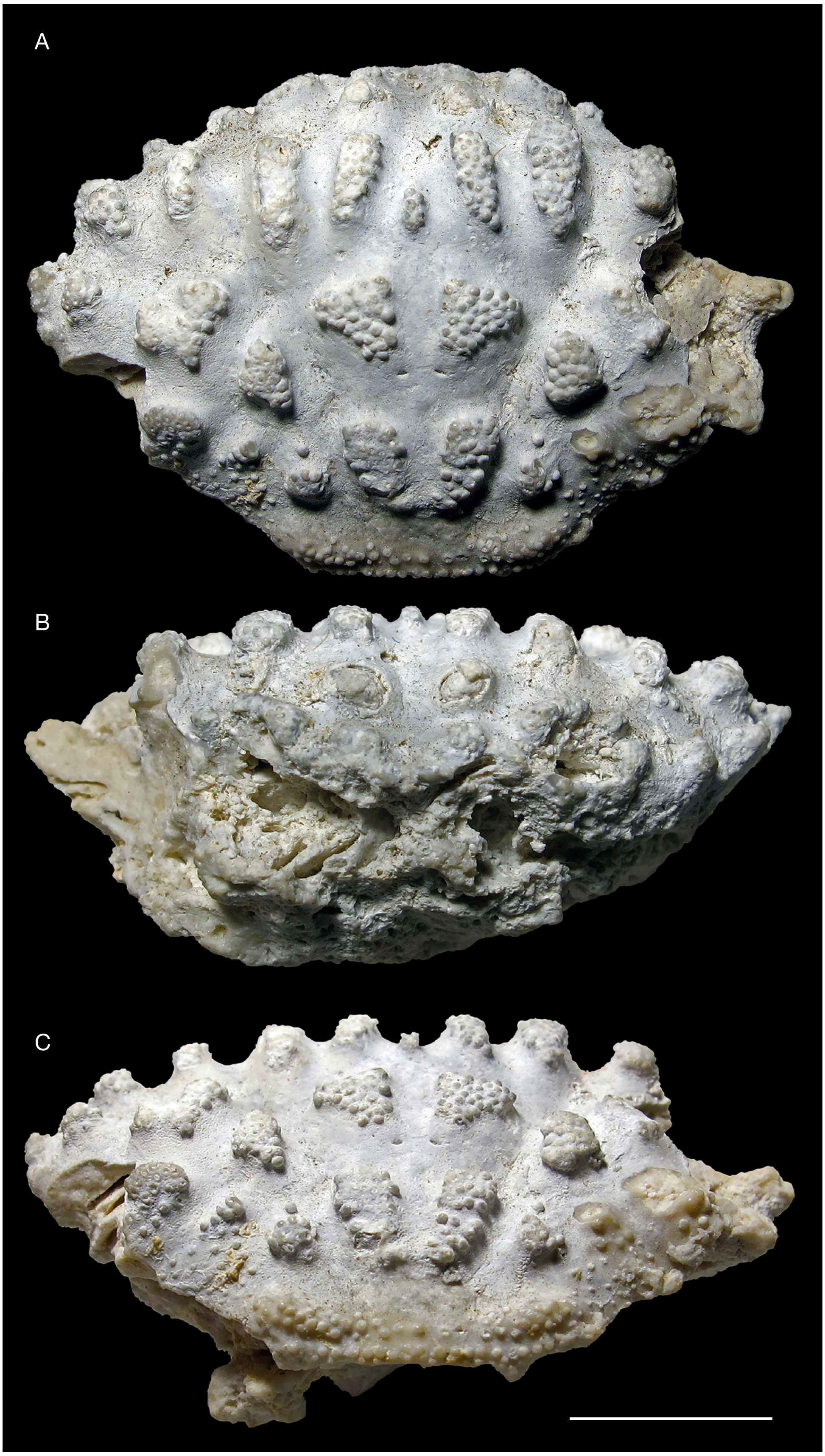

FIG. 3. — *Paractaea* cf. *P. nodosa* (Stimpson, 1860), USNM PAL 720105 from the Pinecrest Member of Tamiami Formation (middle Piacenzian, Pliocene) of locality B in Sarasota County, Florida (United States): **A**, dorsal view; **B**, frontal view; **C**, posterior view. Scale bar: 10 mm. Photographs by À. Ossó.

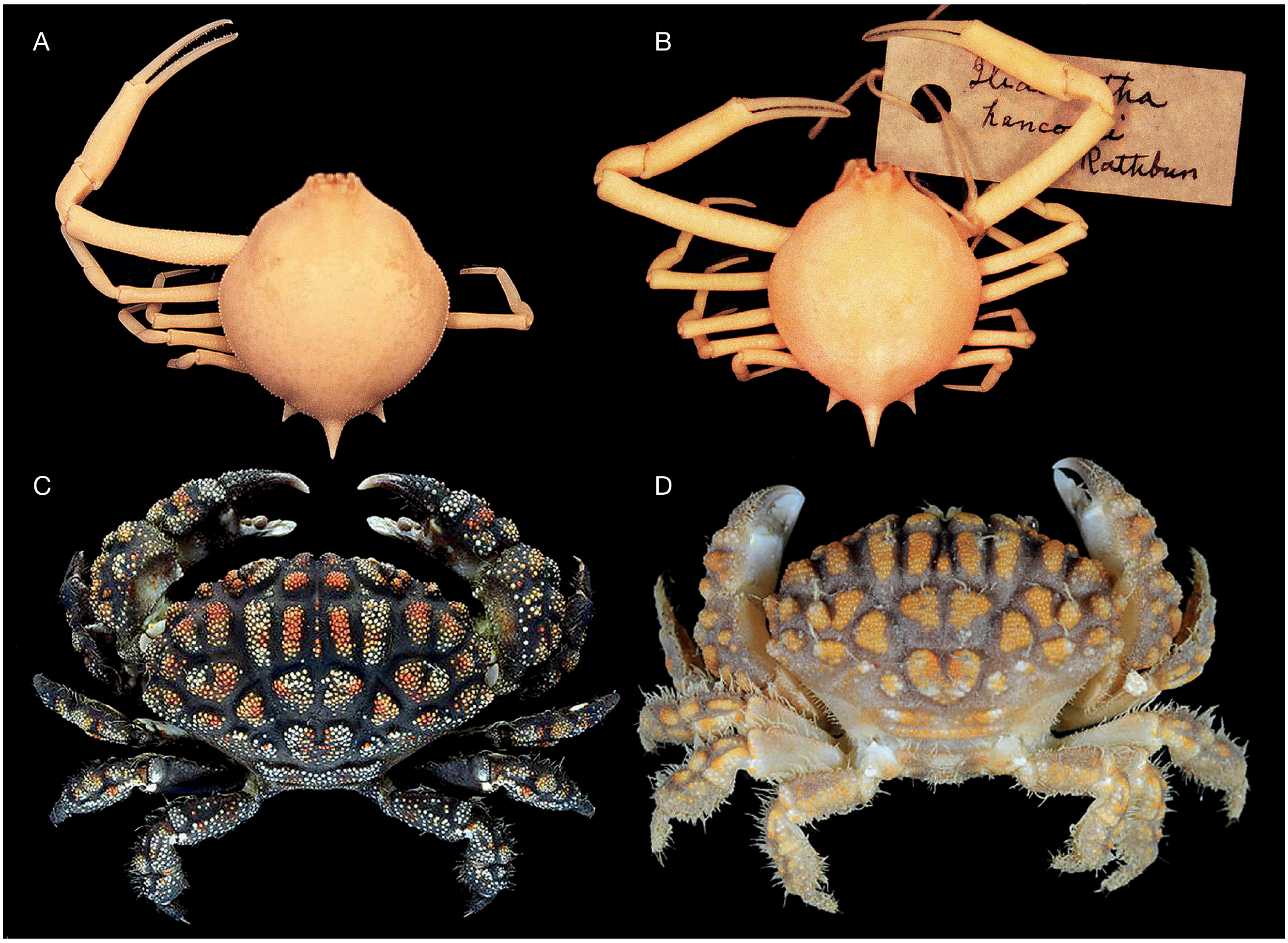

Fig. 4. — **A**, **B**, *Persephona subovata* (Rathbun, 1893) type material: **A**, USNM 17385 (as *Myra subovata* Rathun, 1893); **B**, USNM 69260 (as *Iliacantha hancocki* Rathbun, 1935), (photographs by Karen Reed); **C**, *Paractaea rufopunctata* (H. Milne Edwards, 1834) from Surigao Island, Philippines (Crab Database) (photograps by Ondřej Radosta); **D**, *Paractaea nodosa* (Stimpson, 1860) from Guadeloupe (from Legall & Poupin [2018]) (photographs by Joseph Poupin).

in the Pliocene of Florida. *Persephona aquilonaris* has been reported for the Pleistocene Beaumont Formation of Texas (Collins *et al.* 2014). Although it is tempting to include the Pliocene fossil here studied within *P. aquilonaris* due to the overlapping geographic ranges that include eastern United States and Mexico (Magalhães *et al.* 2016), based on the evidence available it is not possible for us to include the new fossil among other Atlantic taxa with certainty, and rather seems to be more similar to *P. subovata*. For the time being, we assign this fossil to the latter species until more complete specimens become available for a more thorough comparison.

Superfamily XANTHOIDEA MacLeay, 1838
Family XANTHIDAE MacLeay, 1838
Subfamily ACTAEINAE Alcock, 1898

Genus *Paractaea* Guinot, 1969

TYPE SPECIES. — *Xantho rufopunctatus* H. Milne Edwards, 1834, by original designation.

***Paractaea* cf. *P. nodosa* (Stimpson, 1860)**
Fig. 3A-C

MATERIAL. — One carapace, USNM PAL 720105, with cuticle preserved, partially embedded on limestone matrix, and with broken posterolateral margins.

MEASUREMENTS (in mm). — Length = 27; width = 38; fronto-orbital width = 20; posterior margin = 12.

DESCRIPTION

Carapace transversely hexagonal, strongly sculpted, much wider than long, approximately 70% as long as the carapace maximum width. Fronto orbital approximately 50% the carapace maximum width. Carapace vaulted longitudinally at anterior third, weakly convex transversely. Regions well marked and defined by strong sub-regional lobules, except urogastric region; all sub-regional lobules covered by clusters of rounded granules. Grooves separating regions and sub-regions, broad, smooth. Front bilobed, slightly advanced, medially notched, sinuous with granulated edges; separated from the inner orbital angle by notches. Orbits directed forwardly; supraorbital margin raised, edges granulated, with two distal fissures separated by a medial tooth; infraorbital margin visible dorsally. Anterolateral margins convex with five granulated teeth or nodes (extraorbital tooth included; epibranchial tooth not preserved). Posterolateral margins straight. Posterior margin straight, rimmed, ornate with a row of granules, about 30% of total width. Frontal region smooth; post-frontal lobule distinct. Gastric process well defined by lobules; Protogastric region distinct of divided and parallel protogastric lobes. Mesogastric region three lobed, anterior small, reaching half of protogastric lobes, and the two-posterior subtriangular; metagastric region indistinct from posterior part of mesogastric region; urogastric region flattened, smooth, separated of meso- metagastric region by two gastric pits. Cardiac region V-shaped, divided posteriorly; intestinal region narrow, inflated laterally. Hepatic region smooth. Outer epibranchial lobe do not reaches anterolateral margin; inner epibranchial lobe V-shaped. Meso and metabranchial lobules distinct. Sternal, pleonal, and appendicular elements not preserved.

REMARKS

The general outline of the Florida's specimen and its sculptured dorsal carapace indicates it belongs to *Paractaea* (see Guinot 1969). Nevertheless, its specific affinities are less clear given the great similarity among the different species and subspecies of *Paractaea*, all of them extant. Indeed, besides the number of existing species and subspecies of this genus, a number of forms of the type species *P. rufopunctata* (H. Milne Edwards, 1834) (Fig. 4C) have been erected through time, mostly based on differences in the dorsal sculpture, setations, appendages, and even geographic distribution (e.g. Guinot 1969; Mendoza *et al.* 2014: 275). In this respect, herein we follow the list of species and subspecies available of *Paractaea*, validated by Ng *et al.* (2008: 195, 196, 207). The anterolateral margin with five nodose teeth, and the pattern of the dorsal sculpture of the Florida's specimen, fit perfectly within the anatomical range seen in *P. rufopunctata*. However, the fossil specimen has broader grooves separating the lobes and lobules than modern *P. rufopunctata*, in particular the urogastric region, which is large and smooth, and the two posterior lobules of metagastric region, which are subtriangular. Those characters match the diagnosis of Guinot (1969: 252, 253) for the American Atlantic species *P. nodosa* (as *P. rufopunctata* forme *nodosa*): "un très large sillon entre l'aréole mésogastrique et la région cardiaque […] notons chez les *nodosa* des sillons dorsaux plus larges et, en conséquence, des lobules plus espacés." (see also Rathbun 1930: 251, 257, 258). Therefore, in absence of other diagnostic features as chelae, ambulatory legs or ventral parts, missing in the specimen here studied, we consider it tentatively as *P. nodosa* (Fig. 4D).

Previously, Collins & Morris (1976: 125, 126, pl. 19, fig. 7) reported a specimen from the Pleistocene Coral Rock Series of Barbados as *Actaea rufopunctata nodosa* (Luque *et al.* 2017: 55). That specimen matches well the general diagnoses of either *P. rufopunctata* or *P. nodosa*. However, its lobules appear larger and tighter than in the specimen from Florida, and consequently the grooves separating them appear very narrow instead of broad as in the latter, which would separate it from the diagnosis of *P. nodosa* (*sensu* Guinot 1969). To our knowledge, the specimen from the Pliocene of Florida represents the second record of *Paractaea* in the fossil record and the oldest for the genus known to date.

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