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Taxonomy of Ostracods from the Pirabas Formation (Upper Oligocene to Lower Miocene), Eastern Amazonia (Pará State, Brazil)

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Abstract

Ostracods from the Upper Oligocene to Lower Miocene Pirabas Formation, Northeastern Amazonia, Pará State, Brazil were examined from one subsurface and four outcrop sections. A total of 119 species were recognized and are illustrated; another 53 species were left in open nomenclature. Twenty-seven of the species are common to the Neogene of Caribbean, another two species are known from areas other than the Caribbean, and one species was already described from the studied unit. This study provides a robust taxonomic database for paleoenvironmental, biostratigraphic and paleogeographic studies and contributes to the knowledge of the paleodiversity of Neogene Ostracods from the Southwestern Atlantic.

Key words: taxonomy, Ostracoda, Miocene, Pirabas Formation, Northeastern Amazonia, Brazil

Introduction

The Upper Oligocene to Lower Miocene Pirabas Formation is one of the most important fossiliferous units of the Cenozoic of Northeastern Amazonia. The geology and paleontology of the Neogene of this region, including the Pirabas Formation, were summarized by Rossetti & Góes (2004). Paleontological studies reported a diverse invertebrate fauna, as well as abundant microfossils (Maury 1925; Petri 1952; 1954; 1957; Macedo 1971; Fernandes 1984; Ferreira 1966; Ferreira *et al.* 1981, 1984; Távora 1994a, 1994b, 1994c; Ramos *et al.* 2004; Távora *et al.* 2007).

Previous taxonomic and biostratigraphic studies of ostracods from the Pirabas Formation revealed an ostracod fauna similar to the Caribbean region (Macedo 1970; 1971; Távora 1994a; 1994b; 1994c; Távora *et al.* 2001). Fernandes (1988) and Fernandes & Távora (1990) studied the biostratigraphy and paleoenvironment of the Pirabas Formation based on ostracods and foraminifers.

More recent studies revealed that the high diversity of ostracods from the Pirabas Formation is in need of more detailed taxonomic study in order to better understand the paleoenvironment, biostratigraphy and paleobiogeography of this fauna. Nogueira *et al.* (2011) revised the taxonomy of the genera *Haplocytheridea* and *Cytheridea* from the Capanema region, Pará State, northern Brazil. These genera occur consistently and abundantly in that studied locality, which represents shorelines and cycles of progradation during the deposition of the Pirabas succession. These genera were diverse in these deposits, and they share species with similar-aged units in North America and the Caribbean. Also, recently the genus *Perissocytheridea* from different sections of the Pirabas Formation was studied in detail, with emphasis on paleoenvironmental interpretation (Nogueira & Ramos 2016). This work showed the intercalation of brackish and marine facies during the deposition of the Pirabas sequence.

The ostracod fauna studied herein provides an extensive database, documenting the occurrence of 119 species from the Neogene of northeastern Amazonia, Brazil; such information is very important for studies of the origin and dispersal of regional faunas. Based on a preliminary generic-level database, Wood *et al.* (1999) suggested that the Caribbean region was an important center of Neogene ostracod origins and that the Miocene was the peak of diversification and dispersal throughout South America. The present study fills an important gap in the ostracod record of the Neogene of northeastern Amazonia necessary for evaluating these and other evolutionary hypotheses.

Geological Setting and Age

The Pirabas Formation consists of a geographically extensive and highly fossiliferous unit of the Upper Oligocene and Lower Miocene that is part of a larger transgressive-regressive cycle covered by siliciclastic deposits of the Barreiras Formation (Ferreira *et al.* 1978; Fernandes 1984). It is well exposed in the northeastern Amazonia of Pará State and along the shoreline of Maranhão and Piauí states in Brazil.

The Late Oligocene—Early Miocene age of the Pirabas formation was firstly supported by records of the gastropod *Orthaulax pugnax* (Heilprin, 1887) (Maury 1925). Later studies based on planktonic foraminifera and nannofossils from boreholes (Petri 1957; Ferreira *et al.* 1981, 1984; Fernandes 1984; Fernandes & Távora 1990; Concheyro & Távora 1992; and Távora & Fernandes 1999) indicate a range in age from Chattian to Burdigalian (correlated to biozones N2 to N4/N5 of Blow 1969) to the Pirabas Formation. More recently, studies with Sr

isotopic analysis in pectinids from outcrops of Pirabas Formation attest an age range of 16.0 to 17.3 Ma, correlating the younger part of the Burdigalian, to the thick, exposed portion of the Pirabas depositional sequence (Martinez et al. 2017).

These deposits are internally organized into three stratigraphic successions delimited by regional discontinuity surfaces indicative of an incised estuarine valley system. These sedimentary successions had accumulated during numerous episodes of high-frequency fluctuations of relative sea level, superimposed upon an overall transgressive phase (Góes *et al.* 1990; Rossetti & Góes 2004; Rossetti 2006). The paleoenvironments have been interpreted as a complex of transitional (lagoon and mangrove swamps) to marine (outer to inner shelf and bays) deposits, with sporadic coral reefs in the Pirabas Formation (Ferreira 1977; Ferreira & Fernandes 1987; Rossetti & Góes 2004; Rossetti *et al.* 2013). The ostracods also reaffirm the paleoenvironmental complexity that is part of a cyclical deposition of coastal deposits influenced by continental influx (this study; Ramos *et al.* 2004; Nogueira *et al.* 2011; Nogueira & Ramos 2016; Nogueira & Nogueira 2017).

The study area is located in the northeastern Amazonia, Pará State, north Brazil from where five localities were sampled, including four outcrops and one core drilled near Primavera village (Fig. 1). A brief summary of the localities is presented in Tables 1 and 2.

TABLE 1. Total number of ostracod species from B-17 Quarry, Primavera core, Aricuru, Fortaleza Island and Atalaia beach sites recovered from the Pirabas Formation in the present study.

Species	B-17 quarry	Primavera core	Aricuru site	Fortaleza Island site	Atalaia beach site
New species	33	27	27	6	4
Species left in open nomenclature (aff. or cf.)	12	11	11	1	2
Species previously known from the Caribbean	19	19	18	3	4
Species previously known from areas outside the Caribbean	2	3	2	1	-
Species previously described from the present study area	1	7	2	-	-
Total	67	67	60	11	10

TABLE 2. Geological descriptions and coordinates for the localities studied in the present work.

Localities	Geological Information	Coordinates
Capanema, B-17 quarry	12m-thick carbonate succession exposed in open pit, overlaid by siliciclastic deposits of the Barreiras Formation. Marls and secondarily biocalcirudite.	1°2' 53.77" S/ 47°9' 9.21" W
São João de Pirabas/Ponta do Castelo and Fortaleza Island	4m-thick carbonate succession exposed in cliffs mainly during low tide. Predominately biocalcirudites and biocalcarenites.	0°40'59.19"S/ 47°10'14.47"W
Maracanã District, Aricuru	4m-thick carbonate succession exposed in isolated cliff. Marls interbedded with hardgrounds/boundstone beds. Pirabas carbonate in tectonic contact (normal fault with metric off set) with the Barreiras Formation.	0°42'46.08"S/ 47°30'7.2"W
Salinópolis and Atalaia Beach	4m-thick carbonate succession exposed in outcrops. Biocalcirudites, marls and black mudstones. Gradational contact with the Barreiras Formation.	0°35'37.01"S/ 47°18'57.44"W
Primavera, core FPR-160	45m-thick carbonate succession, overlaid by siliciclastic deposits of the Post-Barreiras Unit. Marls and secondarily biocalcirudite. Core samples are stored in the repository of the Laboratory of Sedimentology in the Universidade Federal do Para, Belém, Northern Brazil.	0°56'52.76"S/ 47°5'48.58" W

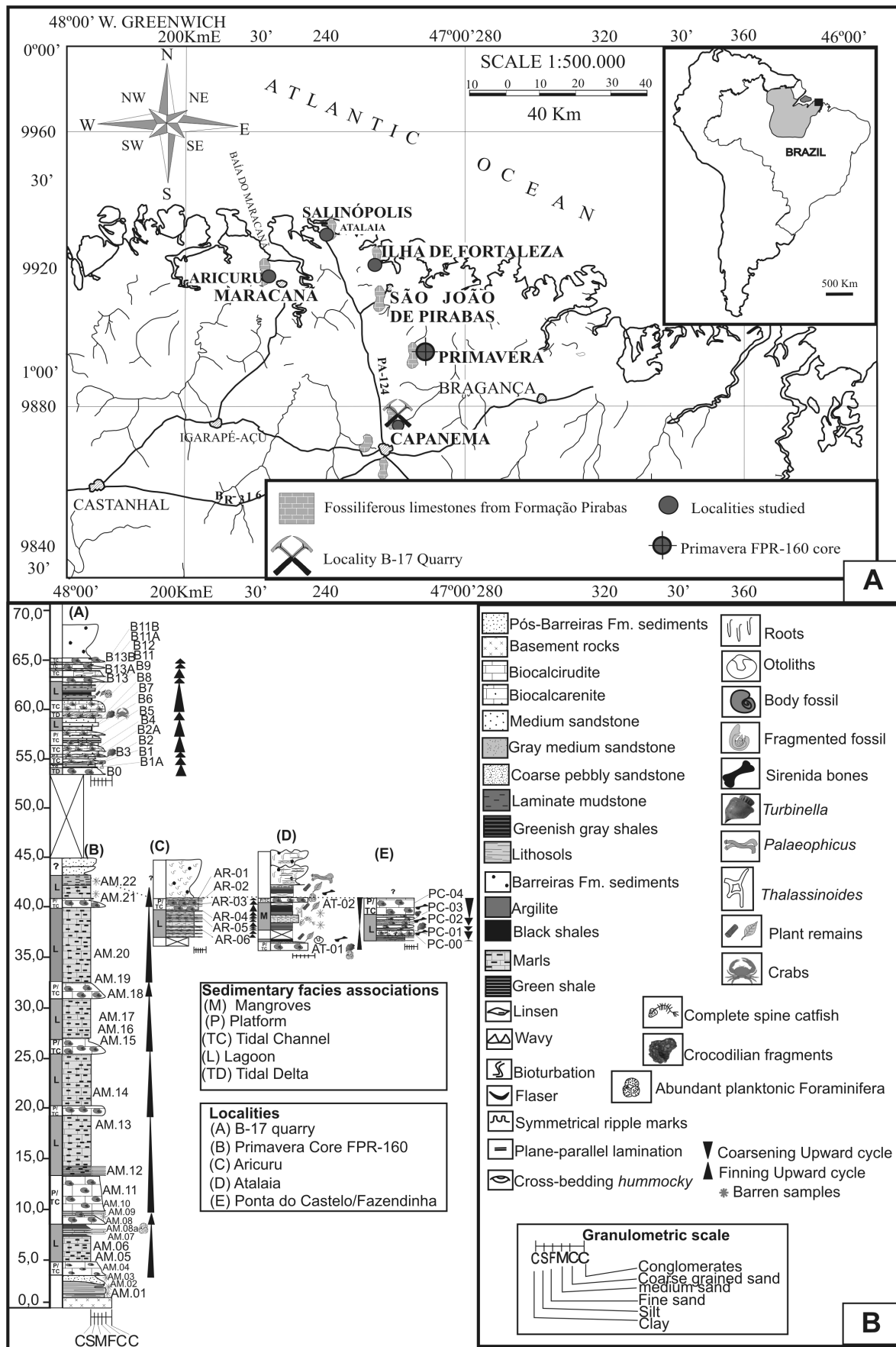


FIGURE 1. General information about the area of study: A) Location map and the respective localities (Modified from CPRM, 2000—Geological Chart) and B) Stratigraphic sections and its sampling.

Material and methods

The studied material comprises 57 samples (7 of them barren) collected from 4 surface sections: B-17 quarry (19 samples), Ponta do Castelo (Fortaleza Island; 5 samples), Aricuru (Maracan bay; 6 samples) and Atalaia (Salinpolis; 4 samples); 23 additional samples were recovered from the Primavera FPR-160 Core.

Samples were processed according to standard methods for calcareous microfossils in the sedimentology laboratories of the Museu Paraense Emlio Goeldi (MPEG) and Universidade Federal do Par (UFPA): 1 kg of sediment from each sample was washed through the standard sieves (63, 125, 250 and 500 m); a water bath was used to facilitate the disintegration of samples. Indurated samples from the Fortaleza Island and Atalaia sites were disaggregated using the acetolysis method, which involves soaking 30 g of sediment in 100 ml (10%) of acetic acid for 12 hours. The samples were washed subsequently with deionized water and sieved using 63, 125 and 250 m fractions (Rodrigues *et al.* 2011). For quantitative analysis, the samples were standardized to 6 g of sediment after washing; all ostracods were picked from ≥ 0.250 mm fraction using a Zeiss Stereo Microscope. Micrographic images were taken using one of the following scanning electron microscopes: LEO 1450VP (Museu Paraense Emlio Goeldi (MPEG), State of Par, Brazil), HITACHI TM3000 (Universidade Federal do Par (UFPA), PHILIPS FEI (XL30) SEM and ESEM (Smithsonian Institution National Museum of Natural History (NMNH), Washington DC, USA).

Type material and illustrated specimens were deposited in the paleontological collection (micropaleontological section) of MPEG under the numbers (MPEG-549-M to MPEG-845-M). The Indexes of Non-Marine and Marine Ostracoda (Kempf 1986 a and b) and the Ellis and Messina catalogue (1965) were used to aid in the species identification, as well as additional publications dealing with Neogene ostracods from North and Central America. Type material from the collections of van den Bold and H. V. Howe (HVH) deposited in the Louisiana State University Museum and in the Smithsonian Institution (National Museum of Natural History, NMNH) were extensively consulted for comparative purposes. Suprageneric and superfamily classifications follows respectively the ostracod volume of the Treatise on Invertebrate Paleontology (Moore 1961) and Liebau (2005). Synonymy lists format follows Mathews (1973).

The following abbreviations are used in the species description: C = carapace; RV = right valve; LV = left valve; H: height, L: length and W: width. The sizes of carapaces are defined as follows: Small (<0.5 mm), Medium (0.5–1.0 mm), and Large (>1.0 mm).

Systematic Paleontology

Twenty-three families, sixty genera and one hundred and nineteen ostracod species were identified and are illustrated herein. Counting results for all species and samples are summarized in Table 1.

The species common to all localities are *Cytherella stainforthi* van den Bold, 1960, *Bairdoppilata pinto* **sp. nov.**, *Pontocypris aguilerai* **sp. nov.**, *Cushmanidea? bragantinaensis* **sp. nov.**, *Jugosocythereis pannosa* (Brady, 1869) and *Coquimba congestocostata* (van den Bold, 1963). In general, the most abundant species are *C. stainforthi* van den Bold, 1960, *B. pinto* **sp. nov.**, *Cytheridea petrii* Nogueira *et al.*, 2011, *Quadracythere? sp.2*, *Pellucistoma magniventra* Edwards, 1944, *J. pannosa*, *Quadracythere adornata* **sp. nov.**, *Pontocypris aguilerai* **sp. nov.** and *Xestoleberis? dactylo* *typa* van den Bold, 1965.

Class OSTRACODA Latreille, 1802

Subclass MYODOCOPA Sars, 1866

Superorder MYODOCOPOMORPHA Kozur, 1972

Order HALOCYPRIDA Dana, 1853

Suborder CLADOCOPINA Sars, 1866

Family POLYCOPIDAE Sars, 1866

Subfamily POLYCOPINAE Sars, 1866

Genus *Polycope* Sars, 1866

***Polycope* sp.**

Fig. 2: 1–2

Material: 1 carapace.

Dimensions: MPEG-549-M, C; LV: L: 0.38; H: 0.33 mm; W: 0.18 mm.

Description: Small sized, rounded in lateral view and lacking the rostrum seen in many species of the genus. Surface smooth; pore channels not observed.

Remarks: Only one specimen of this genus was found in the studied material, precluding a detailed study. This species resembles *Polycope orbicularis* Sars, 1866 in carapace shape; however, it differs in size and in lacking the reticulate ornament of that species. In addition, it also resembles *Polycope punctata* Sars, 1869 in carapace shape, but it lacks that species' punctate ornamentation.

Occurrence: B-17 quarry in B11A sample.

Distribution: Lower Miocene (N5/N6 zones, Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Subclass PODOCOPA Müller, 1894

Order PLATYCOPIDA Sars, 1866

Suborder PLATYCOPINA Sars, 1866

Superfamily CYTHERELLOIDEA Liebau, 2005

Family CYTHERELLIDAE Sars, 1866

Genus *Cytherella* Jones, 1849

***Cytherella stainforthi* van den Bold, 1960**

Fig. 2: 3–8

v* 1960 *Cytherella stainforthi* van den Bold, **new species**.—Van den Bold: p. 150, pl. 1, fig. 3a–c.

Material: 16 Carapaces and 18 valves.

Dimensions: MPEG-550-M, Female, C; LV: L: 0.57 mm and H: 0.35 mm; RV: L: 0.60 mm and H: 0.40 mm; W: 0.31 mm. MPEG-551-M, Male, C; LV: L: 0.56 mm and H: 0.34 mm; RV: L: 0.59 mm and H: 0.37 mm; W: 0.26 mm.

Diagnosis: Female carapace is ovate, highest in the middle, with both ends broadly rounded. Dorsal margin with slightly concave anterior slope in the left valve and broadly convex in the right; ventral margin strongly convex. Right valve overlapping the left along the entire periphery with strongest overlap along the ventral margin and anterodorsally. The left valve has about the same shape as the right, but its greatest height lies slightly more posteriorly. Dorsal view elongate and pear-shaped, posterior end wide, broadly rounded, clearly showing the overlap of the right valve; anterior end relatively wide and blunt, narrowly rounded. Greatest height at about one third from posterior; sides slightly concave in front of the middle. Male carapace ovate, higher in front than behind, with greatest height just in front of the middle. Anterior end broadly rounded; dorsal margin in both valves almost straight in front of the greatest height, convex and sloping down behind; posterior end narrowly rounded below the middle; ventral margin almost straight in both valves, with a slight concavity just behind the middle in the right valve. In dorsal view narrower than the female, especially the posterior end (van den Bold 1960).

Remarks: The type material of *C. stainforthi* van den Bold, 1960 (USNM MO 563474 and USNM MO 563475) recorded in Oligocene of Trinidad is very similar to the species recorded here, especially in shape and overlap of the valves. The only differences observed are the straighter ventral margin in the present material of this study, especially in LV and in the presence of a depressed area on the anterodorsal region.

Occurrence: Aricuru Location (Maracanã bay); Samples AR-01 to AR-03; B-17 quarry (Samples B0-B2, and B13B); FPR-160 core (Samples AM4 to AM20).

Distribution: This species occurs throughout Trinidad in the Oligocene San Fernando Formation and in the Lower Cipero Formation (van den Bold 1960), with the highest occurrence observed in the *Globigerina ciperoensis ciperoensis* zone (Late Oligocene). In the *Catapsydrax dissimilis* zone it is replaced by *Cytherella* sp. van den Bold, 1960. In the Pirabas Formation, *C. stainforthi* spans the entire sequence, from Upper Oligocene to Lower Miocene (N3 to N7 zones; Blow 1969) (Nogueira & Nogueira 2017).

Cytherella kempfi sp. nov.

Fig. 2: 9–14

Material: 94 carapaces and 287 valves.

Etymology: In honor and memory of the micropaleontologist Prof. Dr. Eugen Kempf (1932–2017), for his great contributions to ostracod studies, which helped to verify the names of the new species appearing in this work.

Holotype: MPEG-552-M, Female, C; LV: L: 0.52 mm and H: 0.30 mm; RV: L: 0.53 mm and H: 0.33 mm; W: 0.26 mm.

Paratypes: MPEG-553-M, Male, C; LV: L: 0.54 mm and H: 0.31 mm; RV: L: 0.55 mm and H: 0.32 mm; W: 0.20 mm. MPEG-554-M, C; LV: L: 0.50 mm and H: 0.27 mm; RV: L: 0.52 mm and H: 0.30 mm.

Type locality: FPR 160 Core, depth 40–45m, AM3 and AM5, Primavera town.

Diagnosis: This species presents a slender shape; highest on the anterior region to the mid-length of the valve with a slight inclination to the posterior region; sparsely and weakly pitted in the lateral surface; pronounced sexual dimorphism.

Description: Subelongate and subovate carapace, highest on the anterior to the mid-length. Dorsal margin almost straight, highest in the anterior region to the mid-length in the LV; convex in the RV. Mid-dorsal region slightly concave, mainly in males. Ventral margin nearly straight, but sometimes concave in the middle in males. Anterior margin rounded. Posterior margin rounded and lower than anterior margin. RV overlapping the LV along the entire margin, strongest in the anterior part of the ventral margin. RV is slightly depressed in the central dorsal region, more so in the middle portion and in the posterior part of the ventral margin. Widest posterior of mid-length. Surface smooth, sparsely and weakly pitted. Sexually dimorphic: females wider and more robust than males.

Remarks: This species resembles to the *Cytherella altacaelateralis* sp. nov. recorded here mainly in the shape and size of the males, but that species differs in ornamentation pattern, in the carapace shape of females, in having a more pronounced valve overlap, and in its straighter dorsal margin of the RV in males.

Occurrence: All samples from Aricuru Location (Maracanã bay); Atalaia (AT-1 sample); Ponta do Castelo Location (PC-01, PC-03 and PC-04); B-17 quarry (B13B; B13A; B13; B11A; B7A; B7; B5; B2; B1A; B1; B0 samples) and FPR-160 core (AM4, AM6, AM8, AM10, AM11, AM12, AM15, AM17 and AM20).

Distribution: In the Pirabas Formation, this species occurs through the entire section from the Upper Oligocene to Lower Miocene (N3 to N7 zones, Blow 1969), Pará, Brazil (Nogueira & Nogueira 2017).

Cytherella altacaelateralis sp. nov.

Fig. 2: 15–20

Material: 101 carapaces and 386 valves.

Etymology: Alta from Latin *altum* or *altus* = height, referring to the elevated posterodorsal portion; caelata from Latin *caelatum* = carved, referring to species already described which is very similar in lateral view; from Latin *lateralis* = lateral; referring to lateral view very similar to the species *C. caelata*.

Holotype: MPEG-555-M, Female, C; LV: L: 0.55 mm and H: 0.30 mm; RV: L: 0.57 mm and H: 0.33 mm; W: 0.24 mm.

Allotype: MPEG-556-M, Male, C; LV: L: 0.54 mm and H: 0.29 mm; RV: L: 0.56 mm and H: 0.31 mm; W: 0.20 mm.

Paratype: MPEG-557-M, C; C; LV: L: 0.54 mm and H: 0.30 mm; RV: L: 0.55 mm and H: 0.30 mm.

Type locality: FPR 160 Core, depth 35m, AM8 Primavera town.

Diagnosis: Subovate to subrounded carapace, higher in the posterodorsal region in side view. Dorsal and ventral margins almost straight. Mid-dorsal region with a slightly flattened area. Conspicuous pits in the posterior and anterior region. Wider at the posterior end in dorsal view. Surface finely pitted at the margins, more sparsely in the middle of carapace.

Description: Medium-sized carapace, with a subovate to subrounded shape in lateral view. Dorsal and ventral margin almost straight, especially in the RV. The anterior margin is more regularly rounded than the posterior margin. LV overlaps RV strongly on the posterior, dorsal and ventral margins, but less so on the anterior margin. The maximum height occurs in the posterior region. In the mid-dorsal region, the carapace has an area that is flattened into a shallow sulcus. Suboval in dorsal view, wider at the posterior end. Surface finely pitted at the margins, more sparsely in the middle of carapace. Sexually dimorphic: females are higher than males in lateral view and wider at the posterior end in dorsal view. Internal features were not observed.

Remarks: *Cytherella caelata* van den Bold, 1963 (van den Bold 1963a: pl.1, figs. 1a–1d) is similar to the species described herein mainly in the lateral view of the males. However, *C. caelata* differs from *C. altacaelateralis* in being more subrectangular lateral view. The females differ mainly in the prominent ridge in the anterior region and the more truncate posterior region, better seen in dorsal view, than the species described herein. *Cytherella* sp. aff. *C. pulchra* van den Bold, 1957, recorded from Trinidad (Upper Eocene to Recent), differs a little from the species described herein in shape and size (length 0.77 mm; height 0.49 mm).

Occurrence: All the samples from Aricuru (Maracanã bay); B-17 Quarry, Capanema, Pará (samples: B0-B2A, B4, and B6-B13B); Ponta do Castelo Location (PC-02-PC-03); FPR-160 core (samples AM4-AM10, AM12-AM15 and AM17-AM20).

Distribution: Upper Oligocene to Lower Miocene (N3 to N7 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Cytherella notossinuosa sp. nov.

Fig. 2: 21–23

Material: 13 carapaces and 23 valves.

Etymology: Notos from Greek *nôton* = dorsal, back; referring to dorsal region; sinuosa from Latin *sinuous* = curved, not straight; referring to dorsal margin with a strong concavity at the mid-length.

Holotype: MPEG-558-M, C; LV: L: 0.63 mm and H: 0.32 mm; RV: L: 0.65 mm and H: 0.33 mm; W: 0.28 mm.

Paratype: MPEG-559-M, C, LV: L: 0.63 mm and H: 0.33 mm; RV: L: 0.65 mm and H: 0.35 mm.

Type locality: FPR 160 Core, depth 40–45 m, AM3 and AM5, Primavera town.

Diagnosis: This species presents a dorsal margin strongly concave at the mid-length and surface strongly ornamented in the anterior, posterior and ventral regions with a set of peripheral, concentric, and delicate ridges.

Description: Carapace medium to large and elongate in lateral view. Dorsal margin with a sinuous concavity in the anterior region, somewhat pronounced cardinal angles with a posterodorsal region that is relatively oblique. Ventral margin straight. Anterior region broadly rounded. Posterior subrounded or truncate. Surface with a set of peripheral, concentric, and delicate ridges that weaken progressively toward the central portion of the valves, more evident on the lateral margins of the anterior, posterior, and ventral regions. In dorsal view, broader in the posterior tapering to the anterior portion; being wider than other species of the same genus.

Remarks: This species is similar to *Cytherella circumrugosa* Babinot, Moullade & Tronchetti, 2007 described from the Lower Cretaceous of the vicinity of Saint-Saturnin-lès-Apt, Vaucluse, SE France. Both have dorsal and ventral margins that are sinuous and surface with the same set of concentric ridges that weaken progressively toward the inner portion of the surface of the valves; they differ in that the present species has a small arched area in the dorso-posterior margin in both valves. The present species is similar in shape to *Cytherella* aff. *contracta*

contracta Veen, 1932 (Weaver 1982) of the Cenomanian of England, but in the latter species the front part of the carapace is more flattened and apparently smooth whereas that region is pitted in the species herein described.

Occurrence: Aricuru Loc. (Maracanã bay, samples: AR-01 to AR-05); Atalaia Loc. (sample AT-1); B-17 quarry, Capanema (samples: B0 and B11B); Primavera FPR-160 core (samples: AM4, AM15 and AM20).

Distribution: Upper Oligocene to Lower Miocene (N3 to N6 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Genus *Cytherelloidea* Alexander, 1931

Cytherelloidea colini sp. nov.

Fig. 3: 1–3

Material: 7 carapaces and 30 valves.

Etymology: In honor of Prof. Dr. Jean-Paul Colin (1948–2013) for his contributions to the study of the fresh- and brackish water ostracods.

Holotype: MPEG-560-M, C; LV: L: 0.45 mm and H: 0.25 mm; RV: L: 0.46 mm and H: 0.26 mm; W: 0.17 mm.

Paratypes: MPEG-561-M, C; LV: L: 0.50 mm and H: 0.29 mm. MPEG-562-M, RV: L: 0.48 mm and H: 0.27 mm. MPEG-563-M, C; LV: L: 0.58 mm and H: 0.31 mm.

Type locality: B17 Quarry, sample B1A, Capanema town.

Diagnosis: Presence of punctate ornamentation across the entire lateral surface with the exception of the sulcus; a sinuous and delicate vertical ridge in the posterior region and high posterior tubercles that can be seen in dorsal view.

Description: Medium-sized carapace, subrectangular in lateral view. Dorsal margin sinuous with a concavity in the middle almost forming a shallow and large sulcus. Ventral margin almost straight. Anterior margin rounded and posterior margin oblique in lateral view. The posterior region is truncated and the anterior region is broad. Surface is strongly punctate across the entire lateral surface with the exception of the sulcus, near the ridges. A weak dorsal, longitudinal ridge extends in front of the posterodorsal tubercle, although it is not connected to it. The posteroventral ridge spans approximately half of the carapace. An anterior ridge follows to the ventral region, weakly disappearing in the middle portion. Dorsal view thin in the middle with ridges prominent in the extremities.

Remarks: Compared to other Miocene species of this genus, this species differs in the presence of a curved, vertical ridge in the posterior region that extends irregularly to the dorsal margin and another ridge along the ventral margin that is pronounced but narrow.

Occurrence: Aricuru Loc. (samples: AR-03, AR-04 and AR-06); B-17 quarry, Capanema, Pará, samples: B0, B1; B12; B9-B11A; B13-B13B; FPR-160 core, Primavera (samples: AM8, AM 17 and AM20).

Distribution: Lower Miocene (N4 to N7 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Cytherelloidea cumpassorobusta sp. nov.

Fig. 3: 4–6

Material: 5 carapaces and 27 valves.

Etymology: *cumpasso* from Latin *cumpassare* = compass; referring to the strong ridges that look like a compass drawing tool; *robusta* from Latin *robustum* = robust or strong.

Holotype: MPEG-564-M, C; LV, L: 0.46 mm and H: 0.24 mm; RV, L: 0.47 mm and H: 0.27 mm; W: 0.21 mm.

Paratypes: MPEG-565-M, RV: L: 0.43 mm and H: 0.23 mm. MPEG-566-M, RV: L: 0.39 mm and H: 0.21 mm. MPEG-567-M, C, LV: L: 0.44 mm and H: 0.25 mm; RV: L: 0.46 mm and H: 0.27 mm; W: 0.18 mm.

Type locality: FPR-160, depth 35 m, AM8 sample, Primavera city.

Diagnosis: Ridges on lateral surface arranged as a half loop, with a smooth area between these ridges.

Description: Small and ovate carapace. Dorsal and ventral margins subparallel. Ventral margin with a slight concavity in the middle portion. Anterior margin rounded and posterior margin subangular, obliquely rounded to

the posteroventral margin. RV overlapping the LV over the entire margin, except anteriorly. Subrectangular in dorsal view with longitudinal ridges and a posterodorsal tubercle. Surface smooth with a pronounced vertical ridge in the posterior region, which is in connection with two tumid horizontal ridges running towards the anterior region: one shorter, dorsally curved to the anteromedian region, the other parallel and above the ventral margin, extending to the anteromedian region. This arrangement of the ridges resembles a semi-loop.

Remarks: *C. cumpassorobusta* **sp. nov.** differs from the others species of this genus mainly in the distinguishing arrangement of the ridges as described above.

Occurrence: Aricuru Loc. (Maracanã bay, sample: AR-03); B-17 quarry, Capanema (samples: B1A, B7 and B9-B11A); Primavera FPR-160 core (samples: AM8 and AM12-AM14).

Distribution: Lower Miocene (N4 to N6 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Cytherelloidea mediocythara **sp. nov.**

Fig. 3: 7–9

Material: 5 carapaces and 24 valves.

Etymology: media from Latin *medium* = middle, referring to the sinuous middle part of the ventral and dorsal margin; *cythara* from Latin *cithara* = guitar, referring to the guitar-shape of the carapace, mainly in the LV.

Holotype: MPEG-568-M, C; LV: L: 0.52 mm and H: 0.26 mm; RV: L: 0.54 mm and H: 0.29 mm; W: 0.15 mm.

Paratypes: MPEG-569-M, LV: length 0.51 mm and height 0.26 mm. MPEG-570-M, LV: length 0.50 mm and height 0.27 mm. MPEG-571-M, LV: length 0.48 mm and height 0.25 mm. MPEG-572-M, juvenile, LV: length 0.44 mm and height 0.23 mm.

Type locality: B17 Quarry, sample B11B, Capanema town.

Diagnosis: Dorsal and ventral margins almost parallel, strongly biconcave in the middle of the carapace. Bears a continuous marginal rib and a pair of subparallel longitudinal ridges. Dorsal view more elongated and straight than in others species.

Description: Subrectangular carapace in lateral view. Dorsal and ventral margins almost parallel, strongly biconcave in the middle of the carapace. Anterior margin rounded and posterior margin more truncated. The dorsal and ventral margins of the left valve are strongly sinuous. Posterodorsal margin strongly sloped downward. Both valves narrow towards the posterior; this region is less rounded and more oblique than the anterior margin. Dorsal view elongate and straight, with almost parallel sides. Surface smooth, with marginal ridges that extend uninterrupted around the entire valve and two longitudinal ridges on the median part of the carapace. RV overlaps the LV in all margins except in the posteroventral area.

Remarks: This species was not recorded in previous studies of the Pirabas Formation or others units. This species is similar to *Cytherelloidea anderseni* Sexton, 1951, in presenting a weak overlap the valves, but the ridges are more evident in the RV, and it differs in the shape of the vertical ridge.

Occurrence: Aricuru Loc. (Maracanã bay, sample: AR-01, AR-03 to AR-05); B-17 quarry, Capanema (samples B1A, B1, B8, B11-B13B); Primavera FPR-160 core (sample: AM13).

Distribution: Lower Miocene (N4 to N7 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Cytherelloidea quasilenisa **sp. nov.**

Fig. 3: 10–12

Material: 3 carapaces and 10 valves.

Etymology: from Latin *quasi* = nearly or almost, and *lenis* = smooth, referring to the smooth lateral surface and costae.

Holotype: MPEG-573-M, C; LV: L: 0.53 mm and H: 0.27 mm; RV: L: 0.54 mm and H: 0.28 mm; W: 0.22 mm.

Paratype: MPEG-574-M, C; LV: L: 0.54 mm and H: 0.28 mm; RV: L: 0.52 mm and H: 0.29 mm; W: 0.23 mm.

Type locality: FPR 160 Core, depth 40 m, sample AM5, Primavera town.

Diagnosis: Weak ridge running from the median region of the carapace, extending parallel to the posterior and ventral margin. In the median region of the carapace, the more median ridge is weaker than that in the ventral region; these ridges are more discrete on the anteromedian region of the LV; a strong ridge extends from the posterodorsal to the posteroventral region. Surface smooth between the costae.

Description: Subrectangular carapace in lateral view. Dorsal and ventral margins almost parallel, biconcave in the middle portion. Anterior margin subrounded and posterior margin straight. Postero-dorsal region higher than anterior region. Weak ridge running from the median region of the carapace, extending parallel to the posterior and ventral margin. The posterior ridge is high and straight, running parallel to the posterior margin and becoming swollen at the posterior end. In the median region, the median ridge is weaker than the ventral ridge; these ridges are discrete in the anteromedian region of the LV. RV overlaps the LV at all margins, except in the posterior. Surface smooth between the ridges.

Remarks: This species is most similar to *Cytherelloidea anderseni* Sexton, 1951 found in the Chipola Formation (Miocene), Florida (USA). Both species are subrectangular in shape with a posterior ridge that is high and swollen at the extremities. Also, they exhibit two horizontal ridges in the posterior region: one shorter and sinuous in the central carapace region and the other parallel to the ventral region extending over nearly 3/4 of the carapace. However, these differ in the marginal ridge, which is more pronounced in the *C. anderseni* Sexton, 1951. The species *C. obliquecostata* van den Bold, 1963 differs from the present species in the presence of three median ridges and lacking the ridges on the ventral and posterior margin as in the species here described. *Cytherelloidea quasilenisa* sp. nov. is also similar to *C. mediocythara* sp. nov., mainly in the disposition of the ridges, but differs in dorsal view with more pronounced ridges, in the almost straight ventral margin, and in its dorsal margin that is more curved in the middle part in both valves. *Cytherelloidea anderseni* Sexton, 1951 is more similar to *C. quasilenisa* than to *C. mediocythara* in general shape and in ornamentation pattern.

Occurrence: Aricuru Loc. (sample AR-06); B-17 quarry, Capanema, Pará. samples: B13B; B13; B12; B11A; B11; B4; B2A; B1.

Distribution: Lower Miocene (N5 to N7 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

***Cytherelloidea* cf. *C. vanveeni* van den Bold, 1946**

Fig. 3: 13

.cf. 1946 *Cytherelloidea vanveeni* n. sp.—Van den Bold: p. 61, pl. 5, fig. 1a–d.

.cf. 1963a *Cytherella vanveenae* (van den Bold).—van den Bold: p. 385, 401, pl. 1, fig. 1a–b.

Material: 3 valves.

Dimensions: MPEG-575-M, LV: L: 0.59 mm and H: 0.29 mm; MPEG-576-M, LV: L: 0.55 mm and H: 0.29 mm.

Description: Oblong, subquadrangular, highest at the anterior margin, slightly sloped in the posterior margin, and narrow in the middle. Anterior margin broadly rounded. Posterior margin almost truncate. Dorsal margin slightly concave in the middle. Greatest width is at the posterior margin, where a distinct vertical ridge occurs. Lateral surface of valves covered with large, rough punctae, which disappear toward the center.

Remarks: *Cytherelloidea vanveeni* van den Bold, 1946 is probably the same species recorded herein, and differs only in the anterior and posterior margins, and in the smoother marginal part of the lateral surface. The present species does not present the typical *Cytherelloidea* ridge pattern, with only a discrete vertical posterior ridge, and thus looks more like *Cytherella*. *Cytherelloidea vanveeni* (Bold 1946) was re-assigned to *Cytherella* by van den Bold (1963a; 1965) who considered that the species belonged to a group intermediate between *Cytherella* and *Cytherelloidea*. Here, we follow the generic position of this species as in the original description of van den Bold (1946) as we have little material and could not observe the internal features.

Occurrence: Aricuru (Maracanã bay); samples: AR-03 and AR-04.

Distribution: Aricuru Locality, Pirabas Formation (Lower Miocene—N5/N6 zones; Blow 1969), Pará, Brazil (Nogueira & Nogueira 2017).

Genus *Keijcyoidea* Malz, 1981

Keijcyoidea sp.

Fig. 3: 14

Material: 4 valves.

Dimensions: MPEG-577-M, RV: L: 0.62 mm and H: 0.36 mm.

Description: Medium-sized carapace, subrectangular in side view, highest in front of the middle region. Dorsal margin sinuous. Ventral margin strongly concave in the middle. Anterior margin broadly rounded; posterior margin almost truncate, angular in the dorsal margin, nearly forming a right angle. Lateral surface of the RV reticulate forming a mesh with concentric and parallel rows to the anterior region; the mesh becomes more punctate and larger towards the posterior region. Posterior vertical ridge-like swelling near the posterior end, from which two sinuous longitudinal ridges extend forward. The dorsal ridge is strongly sinuous and curves around the ventral side of a shallow subcentral and subdorsal pit, which is somewhat triangular with the apex pointing upward. The ventral ridge is almost straight. The anterior end bears a prominent ridge, which runs towards the ventral and posterior margins. In the RV the posterior ridge seems to be more evident than the anterior ridge. Reticulate in the anterior and posterior marginal areas.

Remarks: This species is similar to *Keijcyoidea praecipua* (van den Bold, 1963b) Malz, 1981 originally recorded in Recent coral sand from a beach at Pidgeon Point, southwestern Tobago. That species is similar mainly in shape, ornamentation and pattern of ridges; however, it is smaller. More material is necessary to confirm the identity of this species or to describe it as new. *Cytherelloidea flosculus* Bonaduce, Ruggieri, Russo and Bismuth, 1992 from Upper Miocene, Melqart Formation, Gulf of Gabès, (Tunisia) also resembles to the present species in shape and size, but differs in its straighter dorsal margin, prominent posterodorsal ridge and in the absence of punctae in the anterior region.

Occurrence: Aricuru (Maracanã bay); samples: AR-01; Primavera FPR-160 core (sample: AM17).

Distribution: Lower Miocene (N5/N6 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Order PODOCOPIDA Sars, 1866

Suborder BAIRDIOCOPINA Gründel, 1967

Superfamily BAIRDIOIDEA Liebau, 2005

Family BAIRDIIDAE Sars, 1888

Genus *Bairdoppilata* Coryell, Sample & Jennings, 1935

Bairdoppilata antillea (van den Bold, 1946) comb. nov.

Fig. 3: 15–19

v 1946 *Bairdia antillea* n. sp.—Van den Bold: n. sp., p. 69, pl. 1, figs. 2A–c.

1961 *Bairdia gigacantha* Kornicker, **new species**.—Kornicker: p. 62, pl. 1, figs. 2a–c; text-figs. 6A–H, 10A, D.

v 1965 *Bairdia antillea* van den Bold.—van den Bold, p. 387, pl. 1, fig. 13.

nov. comb. 1988 *Paranesidea antillea* (Bold).—van den Bold, p. 23–24, pl. 1, fig. 15.

Material: 50 carapaces and 163 valves.

Dimensions: MPEG-578-M, C; LV: L: 0.81 mm and H: 0.54 mm; RV: L: 0.80 mm and height 0.47 mm. MPEG-579-M, LV: L: 0.77 mm and H: 0.48 mm. MPEG-580-M, internal view, LV: L: 0.89 mm and H: 0.58 mm.

Diagnosis: Carapace elongate and subovate, highest very slightly behind the middle. Anterior end angled above the middle, dorsal margin arched. Anterior slope long and rather straight, posterior slope concave at the end. Ventral margin convex. Anterior margin rounded and often denticulate, posterior end extends into a slight caudal

process, concave above, and rounded below. Left valve regularly overlapping the right. Dorsal view elliptical, greatest width near the middle (van den Bold 1946).

Remarks: The present species was originally described as *Bairdia antillea* van den Bold, 1946 from the Dominican Republic (Neogene, Yague Group). It was later assigned to *Paranesidea* (van den Bold 1988) without explanation. The specimens studied herein have generic characteristics more similar to *Bairdoppilata* than *Paranesidea*, including shorter and rounded extremities, overall carapace shape, and internal features such as the pattern of muscle scars (Fig. 3: 19). The specimen figured (HVH No. 8294) in van den Bold (1965) as *Bairdia antillea* is very similar to the species studied herein, but is slightly larger (HVH No. 8294, Howe Collection; L 0.94 mm; H 0.68 mm). The species *Bairdia gigacantha* Kornicker, 1961 is also similar; however, it is larger and does not have a frill with a series of denticles in the posterior end of the LV as seen in the species herein recorded.

Occurrence: Aricuru (Maracanã Bay): samples 01–05; B-17 quarry, Capanema, samples: B1A, B11A, B13–B13B; Ponta do Castelo (Fortaleza Island), sample PC-00; FPR-160 Core (Primavera), sample AM17.

Distribution: Neogene of the Dominican Republic (Mao, Gurabo and Cercado Formation; van den Bold 1988); Lower Miocene of Cuba (Paso Real Formation; van den Bold 1946); Miocene of Puerto Rico (Lares, Cibao and Aguada Formations; van den Bold 1965). Lower Miocene to Recent of northern and western Caribbean (van den Bold 1988). Lower Miocene (N5/N7 zones, Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

***Bairdoppilata oblongata* (van den Bold, 1946)**

Fig. 3: 20–22

- | | |
|---------------|--|
| 1946 | <i>Bairdia amygdaloides</i> var. <i>oblongata</i> n. var.—Van den Bold: p. 70, pl. 1, figs. 5a,b. |
| 1974 | <i>Bairdia</i> aff. <i>amygdaloides</i> (Brady, 1880).—van den Bold, pl. 3, figs. 1, 1a. |
| 1975 | <i>Bairdia oblongata</i> van den Bold.—van den Bold, p. 131, 139; pl. 14, fig. 10, pl. 15, figs. 11, 12. |
| nov. comb. v* | 1988 <i>Bairdoppilata oblongata</i> (Bold).—van den Bold, p. 23, pl. 1, figs. 16–17. |

Material: 31 carapaces and 86 valves.

Dimensions: MPEG-581-M, C; LV: L: 0.71 mm and H: 0.42 mm; RV: L: 0.70 mm and H: 0.38 mm. MPEG-582-M, C; LV: L: 0.91 mm and H: 0.56 mm; RV: L: 0.89 mm and H: 0.48 mm. MPEG-583-M, C; LV: L: 0.56 mm and H: 0.91 mm.

Diagnosis: An elongate to ovate species of *Bairdoppilata* with strongly convex dorsal and ventral margins; dorsal margin angled at greatest height and halfway up the posterior slope; anterior end very obliquely rounded, posterior end somewhat knoblike (van den Bold 1988).

Remarks: *Bairdoppilata oblongata* (van den Bold, 1946) as shown in van den Bold (1988) from the Dominican Republic is the closest species to the specimens described herein, differing only in its larger size (L 1.05 mm; H 0.63 mm) and by its more convex ventral margin of the LV when compared to the figured specimen (HVH No. 10497). The plesiotype of *Bairdoppilata triangulata* Edwards, 1944 (HVH No. 2490) from North Carolina and the Miocene of Florida (*Ecophora* facies, Jackson Bluff) is a little bit larger than the species recorded herein and has a very similar carapace shape, but its dorsal margin in the LV is more arched. The present species is also similar to *B. pinto* sp. nov. described herein but it is more elongate and lower in lateral view.

Occurrence: Aricuru (Maracanã bay): samples 01–04; in all samples from Atalaia (Salinópolis); B-17 quarry, Capanema, samples: B2, B5–B8, B11, B12, B11A, B13–B13B; Ponta do Castelo (Fortaleza Island), sample PC-00; FPR-160 Core (Primavera), samples AM8, AM12, AM13, AM19 and AM20.

Distribution: Upper Miocene and Pliocene from Cuba and Dominican Republic (Gurabo, Cercado and Mao Formations; van den Bold 1988). Lower Miocene (N4/N7 zones, Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

***Bairdoppilata pinto* sp. nov.**

Fig. 4: 1–7

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| v* | 1950 | <i>Bairdia</i> sp.—van den Bold, pl. 19, fig. 3. |
|----|------|--|

Material: 1188 carapaces and 2008 valves.

Etymology: In honor of the Brazilian ostracodologist Prof. Irajá Damiani Pinto (1919–2014) for his significant contributions to the studies of ostracods in Brazil.

Holotype: MPEG-584-M, adult, C; LV: L: 0.86 mm and H: 0.55 mm; RV: L: 0.84 mm and H: 0.53 mm; W: 0.49 mm.

Paratypes: MPEG-585-M, internal view, LV: L: 0.88 mm and H: 0.58 mm. MPEG-586-M, J, C; LV: L: 0.56 mm and H: 0.37 mm; RV: L: 0.53 mm; H: 0.35 mm; W: 0.28 mm. MPEG-587-M, internal view, LV: L: 0.61 mm and H: 0.39 mm.

Type locality: FPR 160 Core, depth 40–45 m, sample AM3, Primavera town.

Diagnosis: Dorsal margin slightly concave to almost straight in the LV. Ventral margin nearly rounded and strongly convex in the LV. Dorsal view with slight acuminate cardinal angles, a curved and short hinge line. Surface smooth with rounded normal pores scattered across the lateral surface, mainly distributed at mid-length in the posterior region.

Description: Carapace medium to large-sized and subtriangular in lateral view. Dorsal margin sinuous and highest at the cardinal angles. Ventral margin nearly rounded and strongly convex in both valves with a small concavity in the median portion. Anterior margin broadly rounded. Posterior margin subacute. Dorsal view with sinuous outline and hinge line almost straight; widest in the middle of the carapace tapering to the ends. Surface smooth with rounded normal pores scattered across the lateral surface, mainly distributed at mid-length in the posterior region. Internal view: hinge line is apparently thicker and simpler in the adults than in the juveniles (Fig. 4: 6). Selvage strongly developed in adult specimens. Muscle scars form a cluster of 9–10 ovoid scars concentrated almost in the center of the carapace with two rounded mandibular scars. Other internal features were not observed.

Remarks: This species was assigned to the genus *Bairdoppilatta* due to similarity with the diagnostic characteristics of the genus, such as the auxiliary dentition of the hinge at anterior and posterior ends observed in apparent juvenile specimens, muscle scar pattern, and overall shape. The specimens illustrated by van den Bold (1950) were originally assigned to *Bairdia* sp. (*sensu* van den Bold 1950; HVH No. 4022) from the Miocene La Rosa Formation of Zulía, Venezuela that are similar to *B. pinto* (Fig. 4: 1–2) in terms of carapace shape and size. *Bairdoppilata pinto* also resembles the plesiotype of *Bairdoppilata* sp. Howe & Chambers, 1935 (HVH No. 5757) and the figured specimen of *Bairdoppilata* sp. Blake, 1950 (HVH No. 4052), but differs from both in its more truncate anteroventral margin. The hypotype of *Bairdoppilata martyni* Coryell, Sample & Jennings, 1935 (HVH No. 6468) and the plesiotype of *Bairdoppilata triangulata* Edwards, 1944 (HVH No. 2490) are similar in carapace shape although they are larger and more rounded in the dorsal margin.

Occurrence: Quarry B-17, town of Capanema, PA, all samples except for the B9 and all samples from FPR-160 Core (Primavera), except AM 5 and AM 7.

Distribution: La Rosa Formation, Miocene of Quiroz region, Venezuela (van den Bold 1950). Upper Oligocene to Lower Miocene (N3/N7 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

***Bairdoppilata vandenboldi* sp. nov.**

Fig. 4: 8–10

Material: 6 carapaces and 4 valves.

Etymology: In honor of the ostracodologist Prof. Dr. Willem van den Bold (1921–2000) for his significant contributions to the study of ostracods in Caribbean region.

Holotype: MPEG-588-M, C; LV: L: 0.82 mm and H: 0.51 mm; RV: L: 0.79 mm and H: 0.45 mm; W: 0.45 mm.

Paratype: MPEG-589-M, LV: L: 0.85 mm and H: 0.56 mm.

Type locality: FPR 160 Core, depth 40–45 m, sample AM3, Primavera town.

Diagnosis: Dorsal margin strongly convex and slightly pointed in middle of the LV, coincident with the greatest height of the carapace; anterior cardinal angle turned downward with a depressed area in the posterodorsal region in side view. Surface apparently smooth except for the presence of normal pore canals distributed irregularly in the margins.

Description: Carapace medium to large-sized, thick-shelled, subtriangular to subovate in lateral view; greatest

height at about the middle point of the dorsal margin in the LV; in the RV, it is coincident with the anterior cardinal angle. Dorsal margin broadly arched in the LV and longer and straight in the RV; antero and posterodorsal slope slightly concave at the ends in the RV. Ventral margin slightly convex in the LV and almost straight in the RV. Anterior margin asymmetrically rounded. In the RV, posterior bluntly caudate. In dorsal view, valves gape slightly at the anterior and posterior ends, and very inflated in the middle portion. Surface apparently smooth, except near the borders, which are slightly ornamented by rounded normal pore canals distributed irregularly on the lateral surface. Flattened in the anterodorsal region; abruptly and strongly compressed in the posteroventral region. Weak denticles in the posteroventral margin. Internal features were not observed.

Remarks: The species resembles the figured specimen (topotype?) of *B. rotunda* (Alexander, 1927) Howe & Laurencich, 1958 (HVH No. 5339) from the Cretaceous; however that species bears a more arched dorsal margin, a more robust carapace and a shorter posterior end than the species described herein. *Bairdoppilata vandenboldi* **sp. nov.** is similar to *B. antillea* (Bold, 1946) in general shape, but presents a lower dorsal margin, anterior and posterior extremities that are less concave, and lacks the flattened area in the anterodorsal region of *B. antillea*.

Occurrence: Aricuru (Maracanã bay): samples AR-01, AR-03 and AR-05.

Distribution: Lower Miocene (N5/N6 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

***Bairdoppilata dorsoarcuata* sp. nov.**

Fig. 4: 11–14

Material: 18 carapaces and 26 valves.

Etymology: dorso from Latin *dorsum* = back, referring to the dorsal margin, upper portion; arcuata from Latin *arcuatus* = arched, curved as an arc.

Holotype: MPEG-590-M, C; LV: L: 0.80 mm and H: 0.55 mm; RV: L: 0.79 mm and H: 0.48 mm; W: 0.41 mm.

Paratype: MPEG-591-M, internal view, LV: L: 0.87 mm and H: 0.56 mm.

Type locality: B17 Quarry, sample B2, Capanema town.

Diagnosis: Medium to large-sized, thick-shelled carapace, lateral view subtriangular in the LV and subquadrate in the RV. Dorsal margin angularly convex and strongly pointed in the middle of the LV; shorter and straighter in the RV. Surface smooth with normal pore canals distributed irregularly over the margins.

Description: Medium to large-sized, thick-shelled carapace, LV subtriangular in lateral view; RV subquadrate. Dorsal margin angularly convex and strongly pointed in the middle of LV; straight, obliquely sloping to posterior and concave in the ends in RV; cardinal angles rounded. Antero- and posterodorsal margin strongly inclined and straight in the LV, slightly concave in the extremity of the RV. Ventral margin straight in the LV and concave in the RV; antero- and posteroventral margins convex towards the extremities. Anterior asymmetrically rounded, more angular in the RV than in the LV. Posterior bluntly caudate; acutely rounded in the LV. Surface smooth with normal pore canals distributed irregularly over the margins in lateral view. Internal view: hinge with socket at anterior and posterior ends as described for the genus. Other internal features were not observed.

Remarks: This species is very similar to *Paranesidea? confusa* Titterton & Whatley, 1988 but differs in its smaller size, moderately thicker carapace, and more triangular shape.

Occurrence: Aricuru (Maracanã bay): samples AR-01 and AR-03; B-17 quarry, Capanema, samples: B0, B1, B2, B3, B4, B5, B7, B13A and B13B; FPR-160 Core, samples AM8, AM13, AM18 and AM20.

Distribution: Upper Oligocene to Lower Miocene (N3/N7 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

***Bairdoppilata* sp.**

Fig. 4: 15

Material: 1 carapace and 24 valves.

Dimensions: MPEG-592-M, LV: L: 0.84 mm and H: 0.60 mm.

Description: Medium to large valve, subovate in lateral view; greatest height at about the middle. Thick-

shelled, LV overlaps the RV. Posterior bluntly angular; extremity acutely rounded in LV. Dorsal margin angularly convex in the middle portion; cardinal angles rounded; anterodorsal region slightly concave in the LV and convex in the posterodorsal region. Ventral margin slightly convex in the LV. Anterior margin asymmetrically rounded. Anteroventral margin broadly rounded. Posteroventral slope convex towards the extremity. Surface apparently smooth except for normal pore canals, irregularly distributed. Internal features were not observed.

Remarks: This species is similar to *Bairdoppilata pintoii* **sp. nov.** described herein in carapace shape and size, but the present species has a dorsal margin that is more arched and robust than that species.

Occurrence: All the samples from Aricuru (Maracanã bay), samples AR-1 to AR-5; all the samples from Atalaia (Salinópolis); B-17 quarry, Capanema, samples: B11, B11A, B11B and B13B; FPR-160 Core (Primavera), sample AM15.

Distribution: Lower Miocene (N4/N7 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Genus *Mydionobairdia* Titterton & Whatley, 1988

Type-species *Triebelina schyroconcha* Maddocks, 1969

Emended Diagnosis: A small robust genus of the Bairdiinae, subrhomboidal in lateral view, subcylindrical to subelliptical in dorsal view. Anterior margin with long, convex anteroventral slope and apex above mid-height; posterior margin with subventral apex and long straight or slightly concave posterodorsal slope. In dorsal region, the surface is papillate, punctate, or covered with small spines. Two short marginal spines posteroventrally. Hinge adont, narrow. Auxiliary dentition absent. Adductor muscles scars usually 8 in two obliquely curved rows.

Remarks: Titterton & Whatley (1988) commented that other punctate species with similar shape to *Mydionobairdia* were identified from Indonesia, as well as *Bairdia tuberculata* (Brady, 1880) and *B. sp. aff. tuberculata* from Recent of Panamá, that may be included in this genus and suggested that its diagnosis needed to be emended. The emended diagnosis above accounts for these taxa and for *Mydionobairdia cauladelicata* **sp. nov.** from the Pirabas Formation.

Mydionobairdia cauladelicata **sp. nov.**

Fig. 4: 18–20

Material: 2 carapaces and 1 valve.

Etymology: caula from Latin *caula* = pore, hole, aperture; referring to the deep punctation; delicata from Latin *delicata* = delicate; referring to the delicate nature of the punctations.

Holotype: MPEG-593-M, C; LV: L: 0.60 mm and H: 0.31 mm; RV: L: 0.56 mm and H: 0.30 mm; W: 0.30 mm.

Paratype: MPEG-594-M, C; LV: L: 0.68 mm and H: 0.37 mm; RV: L: 0.66 mm and H: 0.36 mm.

Type locality: FPR 160 Core, depth 40 m, sample AM8, Primavera town.

Diagnosis: Subrhomboidal carapace in lateral view and surface evenly punctate.

Description: Subrhomboidal carapace in lateral view; subcylindrical in dorsal view. LV overlaps the RV more strongly in the dorsal margin. Dorsal margin angular with cardinal angles less developed in the LV; long, straight or slightly concave posterodorsal slope. Ventral margin straight. Anterior margins of both valves possess a long, convex anteroventral slope and apex above mid-height. Posterior margin with a subventral apex. LV with short and flattened spines anteriorly and two short and flattened spines posteriorly. Surface evenly punctate.

Remarks: This species is similar to *Mydionobairdia schyroconcha* (Maddocks, 1969) Titterton & Whatley, 1988 mainly in shape, but it differs in the densely punctate ornamentation. *Bairdia* cf. *B. tuberculata* (Brady, 1880) Swain, 1968 from the Recent of Panama is similar in its densely punctate ornamentation, however, it differs in carapace shape and size.

Occurrence: B17 quarry, Capanema, samples B7 and B13; FPR-160 core (Primavera) in the samples AM 8 and Aricuru Location (Maracanã bay), samples AR-1 to AR-3.

Distribution: Lower Miocene (N4 zone; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Genus *Neonesidea* Maddocks, 1969

Neonesidea sp. 1

Fig. 4: 16–17

Material: 9 valves.

Dimensions: MPEG-595-M, RV: L: 0.83 mm and H: 0.46 mm. MPEG-596-M, RV: L: 0.92 mm and H: 0.48 mm. MPEG-597-M, RV: L: 0.91 mm and H: 0.45 mm.

Description: Typical *Neonesidea* in shape. Large RV. Moderately thick-shelled. Shape subtrapezoidal in lateral view. Dorsal margin slightly straight at mid-length; slightly concave anterodorsally and strongly concave posterodorsally. Ventral margin slightly concave. Caudal process strongly acuminate. Cardinal angles pronounced. Valve surface almost smooth, covered irregularly with normal pore channels. Internal features typical of genus.

Remarks: *Neonesidea* sp. 1 is similar in shape to *Neonesidea? crepidula* Titterton & Whatley, 1988 but that species has a surface with dense and minute punctae.

Occurrence: Aricuru Location (Maracanã bay), samples AR-03 and AR-05; B17 quarry, Capanema, sample B13; FPR-160 core (Primavera) in sample AM14.

Distribution: Lower Miocene (N4/N6 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Neonesidea sp.2

Fig. 4: 21

Material: 3 valves.

Dimensions: MPEG-598-M, RV: L: 0.56 mm and H: 0.28 mm.

Description: Medium-sized and broadly truncated in the posterior end. Moderately thin-shelled. Trapezoidal in shape. Dorsal margin strongly inclined to the posterior region becoming concave near the extremity. Ventral margin sinuous, concave in the middle; anteroventral region convex and nearly straight ventrally; posteroventral region slightly turned upwards and extended to a posterior end that is very sharp. Anterior margin sinuous. Posterior margin acute. Cardinal angles pronounced. Valve surface smooth.

Remarks: This species is similar to *Neonesidea* sp. aff. *Neonesidea woodwardiana* (Brady, 1880) from the Quaternary of the Solomon Islands (Titterton & Whatley 1988), which is more trapezoidal, less elongated in shape, and larger. In addition, the present species is lower and longer posteriorly than *Neonesidea woodwardiana* (Brady, 1880). *Neonesidea* sp. 2 is very similar to *Neonesidea* sp. 1 but differs in the carapace shape and in being smaller than *N. sp.1*.

Occurrence: FPR-160 core (Primavera); samples AM4 and AM8.

Distribution: Upper Oligocene to Lower Miocene (N3/N4 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Neonesidea sp. 3

Fig. 4: 22–24

Material: 3 valves.

Dimensions: MPEG-599-M, Adult, RV: L: 0.75 mm and H: 0.38 mm. MPEG-600-M, Juvenile, RV: L: 0.59 mm and H: 0.30 mm. MPEG-601-M, Juvenile, RV: L: 0.47 mm and H: 0.23 mm.

Description: Medium-sized carapace, subrhomboidal in lateral view. Dorsal margin subtriangular in the adult, convex in the middle; antero- and posterodorsal portion slope slightly downward; slightly concave in the ends. Dorsal margin straight in the juveniles, with cardinal angles well marked. Ventral margin sinuous with a concavity in the middle; anteroventrally straight and convex posteroventrally. Anterior margin strongly angular with apex above mid-height. Posterior margin strongly acute, with apex below mid-height. Surface slightly punctate, with punctae distributed irregularly.

Remarks: In general, this species resembles *Neonesidea* sp. 2 in lateral view, in the pronounced cardinal angles, and the ornamentation pattern; however, it differs in being more subrhomboidal than trapezoidal.

Occurrence: B17 quarry, Capanema, sample B5; FPR-160 core (Primavera) in the sample AM8.

Distribution: Lower Miocene (N4 to N6 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Genus *Paranesidea* Maddocks, 1969

Paranesidea elegantissima (van den Bold, 1946)

Fig. 5: 1–3

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| | 1946 | <i>Bairdia elegantissima</i> n. sp.—Van den Bold: p. 69, pl.1, figs. 9A–b. |
| v* | 1965 | <i>Bairdia elegantissima</i> van den Bold.—van den Bold, p. 387, pl.1, fig. 15a–b. |

Material: 2 carapaces and 5 valves.

Dimensions: MPEG-602-M, C; LV: L: 0.56 mm and H: 0.30 mm; RV: L: 0.55 mm and H: 0.27 mm; W: 0.24 mm. MPEG-603-M, C, RV: L: 0.55 mm and H: 0.27 mm. MPEG-604-M, RV: L: 0.52 mm and H: 0.27 mm. MPEG-605-M, RV: L: 0.48 mm and H: 0.25 mm.

Diagnosis: Carapace elongate, highest slightly anterior to the middle. Dorsal margin arched, with a nearly straight and horizontal middle part and two concave and downsloping parts. Anterior cardinal angle somewhat higher than the posterior end. Anterior and posterior margin rounded and denticulate, subequal. The denticulate lips in each end diverge slightly in dorsal view. Carapace widest just posterior to the middle; middle part of lateral outline almost parallel in the two valves in dorsal view. LV overlaps RV at dorsal margin and in the middle of the ventral margin (van den Bold 1946).

Remarks: This species corresponds very well to *Bairdia elegantissima* van den Bold, 1946 in all features except that it is much smaller compared to the figured specimen of van den Bold (1965), (HVVH No. 7760; L: 0.81 mm, H: 0.43 mm). Specimens recorded here are probably juveniles (A-1 or A-2 stages). In addition to their smaller size, they also differ from van den Bold's (1965) material in having a dorsal margin that is more arched with less overlap of the LV over the RV and a more truncated posterior end, resulting in a subrectangular carapace.

Occurrence: B-17 quarry; samples: B1, B5, B12, B11A and B13; FPR-160 core (Primavera); sample AM 8.

Distribution: Lower Miocene from Cuba (Guines and Cojimar Formations; van den Bold 1946), Puerto Rico (Lares Formation; van den Bold 1965), Panama (Panama Formation; van den Bold 1972a), early to Middle Miocene from Central of Haiti ("Arc" Formation, van den Bold 1981) and Brazil (Pirabas Formation; N4 to N7 zones; Blow 1969; Nogueira & Nogueira 2017).

Genus *Triebelina* Stephenson, 1946

Triebelina crumena (Stephenson, 1944)

Fig. 5: 4–7

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| . | 1944 | <i>Bairdia? crumena</i> Stephenson, n. sp.—Stephenson: p. 156, pl. 28, fig.5. |
| | 1946 | <i>Glyptobairdia crumena</i> (Stephenson).—Stephenson, pp. 346–347. |
| | 1946 | <i>Triebelina cubensis</i> n. sp.—Van den Bold: p. 74, pl. 5, fig. 4A–d. |
| v* | 1965 | <i>Triebelina crumena</i> (Stephenson).—van den Bold, p. 389, pl. 2, fig. 9A–c. |

Material: 1 carapace and 6 valves.

Dimensions: MPEG-606-M, C; LV: L: 0.58 mm and H: 0.32 mm; RV: L: 0.55 mm and H: 0.28 mm. MPEG-607-M, C; LV: L: 0.58 mm and H: 0.33 mm.

Diagnosis: Carapace subrhomboidal in lateral view, somewhat elongate. Left valve slightly longer than right, strongly overlapping on the dorsal side, to a lesser extent on the ventral side. Dorsal and ventral margins subparallel, nearly straight. Anterior end bluntly rounded; posterior end narrower, somewhat extended into a

roundly pointed beak. Surface rather strongly sculptured, pits elongate, closely spaced, of moderate size and depth, covering entire exterior. Well defined angular ridge, near and subparallel to the dorsal margin, extends almost along entire length of carapace. Broader horizontal ridge, thickened at center, extends from anterior to posterior ends, somewhat below center of shell, interrupted at about anterior one-fourth by broad notch (Stephenson 1944).

Remarks: This species was first classified as *Bairdia? crumena* by Stephenson (1944), but later Stephenson (1946) proposed a new genus considering this species as *Glyptobairdia crumena*. In the same year, van den Bold (1946) recorded the same species as *Triebelina cubensis*. However, *Glyptobairdia crumena* prevailed and van den Bold's species was later (van den Bold 1965) changed to *Triebelina crumena* (checked the figured specimen: HVH No. 9059; sample C3038 from Cuba), but this author does not explain why he transferred it to the new genus. The present specimens resemble other species of *Triebelina* recorded by van den Bold (1946), and their assignment to this genus is in agreement with the classification of van den Bold (1965). Features supporting this assignment include the presence of strong ridges with the arrangement observed in the studied species described herein; the hinge, although poorly preserved, has dentitions in the anterior and posterior ends as presented by Stephenson (1946). *Glyptobairdia* does not have these dentitions and it also has weaker ornamentation and a different arrangement of ridges. The species recorded herein differs from the figured specimen of *T. howei* Stephenson, 1946 (HVH No. 9083) from Puerto Rico and the figured specimen and plesiotype of *T. sertata* Triebel, 1948 (HVH No. 4769; HVH No. 5095) from recent deposits of the Caribbean Sea by having a less evenly curved dorsal ridge in the LV (rather than a more quadrate shape), by the presence of a well-defined median ridge in the LV, and by its less elongate RV with a less rounded dorsal ridge.

Occurrence: Aricuru Location (Maracanã bay), sample AR-03; B11 and B11B (B-17 quarry); AM 17 (Primavera core).

Distribution: Caribbean (late-early Miocene) and Gulf Coast (Anahuac Formation); Miocene units: Cuba (Maguey, Paso Real and Guines Formations; van den Bold 1946 and 1972a), Puerto Rico (Upper Lares Formation; van den Bold 1965), Haiti (Madame Joie Formation; van den Bold 1972a), Trinidad (Kapur and Mejias Formation; van den Bold 1972a), Panama (La Boca Formation; van den Bold 1972a), Guatemala (Rio Dulce Formation; van den Bold 1972a), sample C3038 from Bermúdez, Cuba (van den Bold 1972a), early to Middle Miocene from Central of Haiti ("Arc" Formation; van den Bold 1981) and Lower Miocene (N5/N6 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Suborder CYPRIDOCOPINA Jones, 1901

Superfamily MACROCYPRIDOIDEA Liebau, 2005

Family MACROCYPRIDIDAE Müller, 1912

Genus *Macrocypris* Brady, 1867

Macrocypris gracilis (Brady, 1890)

Fig. 5: 8–11

(?)	1890	<i>Pontocypris gracilis</i> Brady, n. sp.—Brady: p. 491, pl. 1, figs. 5, 6.
nov. comb. v*	1967	<i>Macrocypris gracilis</i> (Brady), 1890.—Holden, p. 16, 17, text-figs. 9a, b.

Material: 5 carapaces and 8 valves.

Dimensions: MPEG-608-M, C; LV: L: 1.03 mm and H: 0.48 mm; RV: L: 1.25 mm and H: 0.49 mm; W: 0.34 mm. MPEG-609-M, C; RV: L: 0.86 mm and H: 0.38 mm.

Diagnosis: Low, elongate, inflated carapace; slightly to moderately concave venter; broadly, evenly arched dorsum (Holden 1967).

Remarks: The hypotype of *Macrocypris gracilis* (Brady, 1890) Holden, 1967 (USNM MO 648715) recorded in recent sediments from the Hawaiian Islands is very similar to the species studied herein, differing only in its posterior end that tapers to a blunt point and reversed overlap, in which the RV slightly overlaps the LV. The present species described here is also similar to the figured specimen of *Macrocypris* sp. van den Bold, 1965 (HVH N° 7758), but that species differs by its more concave ventral margin and its more convex posterodorsal region.

Occurrence: Aricuru (Maracanã bay); samples AR-01 to AR-04.

Distribution: This species is widespread in the central Pacific, occurring in the Cenozoic (Neogene) to recent sediments in the Hawaiian Islands and Easter Island and living in Fiji (Holden 1967; 1976). Aricuru Locality, Pirabas Formation (Lower Miocene—N5/N6 zones; Blow 1969), Pará, Brazil (Nogueira & Nogueira 2017).

Superfamily PONTOCYPRIDOIDEA Liebau, 2005

Family PONTOCYPRIDIDAE Müller, 1894

Genus *Argilloecia* Sars, 1865

Argilloecia? sp.1

Fig. 5: 12–14

Material: 2 carapaces and 10 valves.

Dimensions: MPEG-610-M, C; LV: L: 0.33 mm and H: 0.14 mm; RV: L: 0.33 mm and H: 0.15 mm; W: 0.14 mm.

Description: Small and subelliptical carapace in lateral view. Highest behind the middle of the valve. Reverse overlap except at the dorsal margin. Ventral margin nearly straight. Dorsal margin slightly convex. Posterior margin truncated. Posteroventral end with one spine.

Remarks: This species is similar to the figured specimen of *Argilloecia* sp. 1 van den Bold, 1968 (HVH No. 8291) from Miocene (Middle) of the Dominican Republic (Gurabo Formation) mainly in general carapace shape; however, externally, *Argilloecia* sp. 1 has a distinctly arched dorsal margin, it is smaller than other species of the genus *Argilloecia*, and it has a posterior spine.

Occurrence: Aricuru Location (Maracanã bay), sample AR-04; B13A and B13B (B-17 quarry); Ponta do Castelo, Fortaleza Island, sample PC-03.

Distribution: Lower Miocene (N5 to N7 zones; Blow 1969), Pirabas Formation, Brazil (Nogueira & Nogueira 2017).

Argilloecia sp. 2

Fig. 5: 15–16

Material: 1 carapace.

Dimensions: MPEG-611-M, C; LV: L: 0.48 mm and H: 0.18 mm; RV: L: 0.49 mm and H: 0.20 mm.

Description: Small and subelliptical carapace in lateral view. Highest in the middle of the valve. RV larger and overlapping LV on all margins. Dorsal margin slightly convex. Ventral margin of LV more concave than in the RV, which is almost straight. Posterior margin subrounded.

Remarks: This species is similar to *Argilloecia?* sp. 1 but it differs in being smaller, more elongated and having overlap typical of the genus.

Occurrence: Capanema, B-17 quarry (sample B11A).

Distribution: Lower Miocene (N5/N6 zones; Blow 1969), Pirabas Formation, Brazil (Nogueira & Nogueira 2017).

Genus *Pontocypris* Sars, 1866

Pontocypris aguilerai sp. nov.

Fig. 5: 17–19

Etymology: In honor to the paleontologist Prof. Dr. Orangel Antonio Aguilera Socorro, who contributed in the field work by helping with the collection of samples and in the discussions of how to develop this work.

Material: 175 carapaces and 225 valves.

Holotype: MPEG-612-M, C; LV: L: 0.73 mm and H 0.36 mm; RV: L: 0.72 mm and H: 0.33 mm; W: 0.29 mm.

Paratype: MPEG-613-M, C; LV: L: 0.74 mm and H 0.37 mm; RV: L: 0.73 mm and H: 0.33 mm.

Type locality: B17 Quarry, sample B11A, Capanema town.

Diagnosis: Externally, this species has a distinctly arched dorsal margin, ventral margin almost straight or slightly sinuous, and posterior end acuminate.

Description: Medium to large-sized, subtriangular carapace in lateral view. Maximum height in front of the middle region of the LV. Reverse overlap present around all margins except in the anterior. Ventral margin almost straight. The dorsal margin is highly arched. The anterior cardinal angle is well formed with a slightly concave anterodorsal margin. Anterior margin subrounded and posterior margin short and acute.

Remarks: This species is similar in size and lateral view to the figured specimens *Pontocypris dreikanter* (Coryell & Fields, 1937) (HVH No. 5100; HVH No. 10150) from Caribbean Sea of Nicaragua (Holocene), which differs by its more arched dorsal margin. The species *P. dreikanter* (Coryell & Fields, 1937) recorded by van den Bold (1958) also has a more strongly arched dorsal margin, a ventral margin that is straighter, a posterior end that is less acute, and is sinuous in dorsal view. This species is also similar to the holotype and hypotype of *Macrocypris menardensis* (Harlton, 1929) Kellett, 1935 (USNM PAL 80594 and USNM PAL 90102, respectively) from the Stanton Formation (Pennsylvanian), Kansas, in general carapace shape, but differs in size and in that the dorsal margin is more arched at the anterior cardinal angle. This species has several features suggesting an assignment to *Pontocypris* rather than to *Macrocypris* or *Paracypris*, including an inner lamella that is broad in the anterior region but narrow in the ventral and posterior regions. This species also is unlike *Paracypris* as that genus presents a strong difference in the concavity of the anterodorsal cardinal angle, mainly in the RV. *Propontocypris* differs from those genera in the inner lamella, which is wider in the anterior and posterior region and in bearing a dorsal margin that is strongly arched in the middle portion.

Occurrence: Aricuru (Maracanã bay); Atalaia (Salinópolis) and some samples from B17 Quarry, samples: B0-B2A, B4-B9, B12-B11B, B13A and B13B; Ponta do Castelo (Fortaleza Island), samples: PC-02 and PC-03; FPR-160 core (Primavera), samples: AM4, AM6, AM8, AM10, AM12, AM13, AM16, AM17, AM19 and AM20.

Distribution: Upper Oligocene to Lower Miocene (N3 to N7 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Pontocypris sp. 1

Fig. 5: 20, 22–23

Material: 1 Carapace and 2 valves.

Dimensions: MPEG-614-M, C; LV: L: 0.82 mm and H: 0.40 mm; RV: L: 0.81mm and H: 0.37 mm; W: 0.33 mm.

Description: Medium-sized carapace, subtriangular in lateral view. Maximum height in front of the middle of the LV. Reverse overlap, overlapping all margins except in the antero- and posteroventral areas. Dorsal margin acute in the median region. Ventral margin nearly straight. Anterior margin subrounded to slightly truncate in LV; RV with concavity in the anterodorsal and subrounded in the anteroventral region. Posterior margin narrow and acute. Wide inner lamella; hinge adont with a short groove.

Remarks: This species is similar to *Pontocypris aguilerai* **sp. nov.** described here, which differs by its more acute posterior end, its thinner valves and its more rounded dorsal margin. *Paracypris posteriusacuminatus* Andreu, 1996 from Boulmane, Marroco, Tighboul Formation (Cretaceous) presents similarities in size, and general lateral view; however, the dorsal margin in that species is more convex.

Occurrence: Aricuru (Maracanã bay); Atalaia (Salinópolis) and some samples from B17 Quarry, samples: B9 and B11B; FPR-160 core (Primavera), sample AM20.

Distribution: Lower Miocene (N5/N6 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Pontocypris sp. 2

Material: 2 carapaces and 6 valves.

Dimensions: MPEG-615-M, C; LV: L: 0.78 mm and H: 0.46 mm; RV: L: 0.76 mm and H: 0.43 mm; W: 0.47 mm.

Description: Medium-sized carapace, subtriangular in lateral view. Maximum height in front of the middle of the LV, which is slightly larger than RV, overlapping at all margins except for the anterior. Dorsal margin truncate, curved to the posterior. Ventral margin slightly concave in the LV, strongly concave in the RV. Anterior margin subrounded. Internal features not observed. Slender in dorsal view with valves opened at the posterior end.

Remarks: This species is similar to species of the genus *Paracypris* mainly due to the elongated shape and strongly acute posterior end. However, it differs from many other species of this genus in its more curved and arched dorsal margin. Furthermore, *Pontocypris acuminata* (Müller, 1894) recorded by Sciuto *et al.* (2015) from the recent sediments of the Ciclopi Islands Marine Protected Area (Ionian Sea, Eastern Sicily) presents similarities in carapace morphology, such as a posterior margin that is acutely tapered and a ventral margin that is almost straight, mainly in the LV.

Occurrence: B-17 quarry (Capanema) in B1A, B11A, B13 and B13A; and FPR-160 core (Primavera) in the samples AM12 and AM17.

Distribution: Lower Miocene (N4 to N7 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Genus *Propontocypris* Sylvester-Bradley, 1947

Propontocypris? cf. *M.?* *dimorpha* (Hazel & Holden, 1971)

Fig. 6: 1–4

v* cf. 1971 *Macrocypris*? *dimorpha*, n. sp.—Hazel and Holden: p. D6, pl. 5, figs. 8, 11, 13, 17, 19.

v* cf. 1976 *Macrocypris*? sp. aff. *M.?* *dimorpha* Hazel and Holden.—Holden: pp. F18–F19, pl. 10, figs. 12–14, 19, 20.

Material: 9 carapaces and 16 valves.

Dimensions: MPEG-616-M, C; LV: L: 0.56 mm and H: 0.30 mm; RV: L: 0.57 mm and H: 0.29 mm; W: 0.25 mm. MPEG-617-M, C; LV: L: 0.56 mm and H: 0.30 mm.

Diagnose Carapace robust, length about 600–680 µm; strong sexual dimorphism, supposed males being posteriorly sharply pointed; shell thick; valve overlap prominent (Hazel & Holden 1971).

Remarks: The species recorded herein is very similar to the holotype of *Macrocypris*? *dimorpha* Hazel & Holden, 1971 (USNM MO 651442) in size and in lateral view of females, differing only in the line of hinge in dorsal view and in the more pointed extremities in males. The late Eocene hypotype of *Macrocypris*? sp. aff. *M. dimorpha* Hazel and Holden recorded by Holden (1976) (USNM PAL 184363) is close to the species described here in the carapace shape of adult males (Fig. 20; Pl. 10, pp. 69–70), but *M.?* cf. *M.?* *dimorpha* Hazel & Holden, 1971 is a bit smaller and its ventral margin is more curved in the mid-anterior region. There are some morphological differences between *Macrocypris*? sp. aff. *M.?* *dimorpha* of Holden (1976) and *Macrocypris*? *dimorpha* Hazel & Holden, 1971. In the first material, specimens have a median dorsal area that is more pointed and a more concave ventral margin. However, the morphology of *Macrocypris*? sp. aff. *M.?* *dimorpha* males—more so than females—is closest to the species described herein. The generic assigned of this species is not confirmed, as the internal features could not be observed. Although the outline of this species is shorter than that of *Macrocypris* and it is more similar to *Propontocypris* because of the strongly arched dorsal margin.

Occurrence: Aricuru (Maracanã bay): samples AR-01 to AR-04; B-17 quarry, Capanema, samples: B0, B5 and B13A; FPR-160 Core, samples AM17.

Distribution: Lower Miocene (N5 to N7 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Suborder CYTHEROCOPINA Gründel, 1967

Infraorder ARCHAEOCYTHERININA Liebau, 1991

Superfamily BYTHOCYTHEROIDEA Liebau, 2005

Family BYTHOCYTHERIDAE Sars, 1866

Genus *Bythoceratina* Hornibrook, 1952

***Bythoceratina binodosa* van den Bold, 1966**

Fig. 6: 5–8

- | | | |
|-----|---------|---|
| | 1954 | <i>Bythoceratina</i> aff. <i>utilazea</i> Hornibrook.—Keij, p. 227, pl. 5, fig. 10. |
| non | 1965 | <i>Pseudoceratina droogeri</i> n. sp.—Van den Bold: p.161, pl. 1, figs. 1–4. |
| v* | 1966a | <i>Bythoceratina binodosa</i> n. sp.—Van den Bold: p. 14, pl. 2, fig.7a–c, pl. 5, fig. 3. |
| . | 1994a ? | <i>Pseudoceratina droogeri</i> Bold.—Távora: p. 95, fig. 3. |
| non | 2010 | <i>Vandenboldina droogeri</i> (van den Bold, 1965).—Brent: p. 187, figs. 1a–c. |

Material: 2 carapaces and 34 valves.

Dimensions: MPEG-618-M, C; LV: L: 0.48 mm and H: 0.25 mm; RV: L: 0.50 mm and H: 0.23 mm.

Diagnosis: Carapace subretangular to trapezoidal, alate. Anterior margin obliquely rounded and denticulate; posterior margin also denticulate. Dorsal margin straight, obscured over its entire length by a parallel ridge in each valve. Ventral margin slightly sinuate with an elongate and acute alar process. Posterior margin almost straight over its greater part and meeting the dorsal margin at the posterior extremity at an angle of 60°. Hinge of RV with a small, short, finely crenulate tooth at the anterior cardinal angle followed by a long, narrow, crenulate groove, which terminates close to the posterior extremity in front of a small, crenulate posterior tooth. LV hinge is complementary to that in the RV (van den Bold 1966a).

Remarks: The present species is identical with *Bythoceratina binodosa* (paratype HVH No. 7925 and the figured specimens HVH No.10243 and HVH No.8203) originally recorded by van den Bold (1966a) from the Recent off Trinidad, SE Caribbean Sea. The species record here is identical to the species recorded by Távora (1994a) also from the Pirabas Formation; however it is not *P. droogeri* = *Vandenboldina droogeri* (van den Bold, 1965) Brent, 2010 as they differ significantly. *B. binodosa* is more subrectangular with a dorsal margin that is more straight, and its hinge presents crenulate teeth, which are absent in *V. droogeri*.

Occurrence: Aricuru (Maracanã bay), samples AR-03 to AR-06; B-17 quarry, Capanema, Pará (sample: B13); Primavera FPR-160 core (samples: AM08, AM13-AM17 and AM19).

Distribution: Upper Miocene, in the Upper Cubagua Formation of Venezuela (van den Bold 1966a); Tubará Formation of Colombia and the Savaneta glauconitic sand member of the Springvale Formation of Trinidad (van den Bold 1966c). Lower Miocene (N4 to N7 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Távora 1994a; Nogueira & Nogueira 2017).

***Bythoceratina? asulcata* sp. nov.**

Fig. 6: 9–10

Material: 17 valves.

Etymology: *a* = without; *sulcata* = sulcus due to the absence of the dorsomedian sulcus characteristic of the genus *Bythoceratina*.

Holotype: MPEG-619-M, C; LV: L: 0.56 mm and H: 0.30 mm; RV: L: 0.58 mm and H: 0.30 mm.

Paratypes: MPEG-620-M, RV: L: 0.48 mm and H: 0.27 mm. MPEG-621-M, RV: L: 0.51 mm and H: 0.27 mm. MPEG-622-M, RV: L: 0.43 mm and H: 0.23 mm. MPEG-623-M, LV: L: 0.40 mm and H: 0.23 mm. MPEG-624-M, RV: L: 0.43 mm and H: 0.21 mm. MPEG-625-M, LV: L: 0.42 mm and H: 0.25 mm.

Type locality: B17 Quarry, sample B11, Capanema town.

Diagnosis: A species with low relief, reticulate ornamentation and lacking a dorsomedian sulcus.

Description: Medium-sized carapace, subrectangular in lateral view. Dorsal margin straight. Ventral margin almost straight, masked by the alar process. Anterior margin subrounded. Posterior margin nearly truncated and subacute. Unequal valves only in the anterior and posterior margins: RV longer than LV. Surface reticulation regular and of low relief; in the mid-anterior to mid-ventral region, there are 3–4 weak ridges parallel to the margin followed by rounded fossae toward the alaform process; dorsomedian sulcus absent. Alaform process weakly developed and directed ventrally to the posteroventral region; short, upturned caudal process. Eyespot absent. Internal features poorly preserved.

Remarks: This species is similar *Bythoceratina? sinuocostata* **sp. nov.**, in size as well as lateral shape, but differs from other *Bythoceratina* species in the absence of a prominent median sulcus extending from dorsal margin to near the median region of the valve. Most species of *Bythoceratina* recorded in the present study do not have the prominent median sulcus typical of this genus, instead bearing only a slightly depressed area in the middle of the carapace. For this reason, they also may belong to the genus *Bythocythere* because it does not have this median sulcus, but possesses a short and upturned caudal process; however this last one is not observed in *Bythoceratina* (Moore 1961).

Occurrence: B-17 quarry, Capanema, Pará (samples B1A, B11-B11A); Ponta do Castelo outcrop (Fortaleza Island), sample PC-03; Primavera FPR-160 core (samples: AM08 and AM10).

Distribution: Lower Miocene (N4 to N6 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Bythoceratina? sinuocostata **sp. nov.**

Fig. 6: 11–13

Material: 1 carapace and 164 valves.

Etymology: *sinuo* from Latin *sinuatum* = curved; referring to the curved shape of the ridges; *costata* from Latin *costata* = ribbed; referring to the horizontal ridges.

Holotype: MPEG-626-M, C; LV: L: 0.53 mm and H: 0.28 mm; RV: L: 0.54 mm and H: 0.28 mm; Dorsal: H: 0.56 mm and W: 0.32 mm.

Paratypes: MPEG-627-M, C; LV: L: 0.52 mm and H: 0.29 mm; RV: L: 0.51 mm and H: 0.26 mm. MPEG-628-M; RV: L: 0.51 mm and H: 0.25. MPEG-629-M; RV: L: 0.57 mm and H: 0.29.

Type locality: FPR 160 Core, depth 20 m, sample AM15, Primavera town.

Diagnosis: Transverse sulcus in the middle of the carapace; surface strongly reticulate with pronounced dorsal ridge, rounded fossae and an alaform process.

Description: Medium-sized carapace, subrectangular in lateral view. Dorsal margin straight with a pronounced ridge parallel to the dorsal margin. Ventral margin slightly concave in the RV with a weakly developed alaform process directed ventrally in the mid-posterior portion. Anterior margin obliquely rounded. Posterior margin subacuminate to the dorsal margin, forming a short caudal process; transverse sulcus evident. Ventral margin inflated or alate. Surface strongly and regularly reticulate; in the ventral region, there are 3–4 ridges bearing rounded fossae toward the alaform process. Dorsal ridges pronounced and parallel to the dorsal margin. Internal features were not observed.

Remarks: The species is similar to *Bythoceratina? asulcata* **sp. nov.** in lateral view and size, but it differs in its strong reticulation, more pronounced caudal process, in its strong, horizontal ridge parallel to the dorsal margin, depressed area separated by diagonal ridges in the anterodorsal region, and also in its stronger horizontal posteroventral ridges.

Occurrence: Aricuru (Maracanã bay), sample AR-01; B-17 quarry, Capanema, Pará (samples: B1A, B1, B6, B7, B11-B13, and B13B); Ponta do Castelo outcrop (Fortaleza Island), sample PC-03; Primavera FPR-160 core (samples: AM4, AM8, AM10, AM13-AM15, AM17 and AM19).

Distribution: Upper Oligocene to Lower Miocene (N3 to N7 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

***Bythoceratina?* sp. 1**

Fig. 6: 14–15

Material: 2 valves.

Dimensions: MPEG-630-M, LV: L: 0.50 mm and H: 0.29 mm.

Description: Carapace medium-sized and subovate in lateral view. Dorsal margin slightly convex or almost straight, terminating in a short caudal process. Ventral margin slightly convex with a pointed alaform process. Anterior margin obliquely rounded. Posterior margin nearly subacuminate. Surface strongly and regularly reticulate; median sulcus present. Internal features were not observed due to the poorly preserved and scarce material.

Remarks: This species is similar to *Bythoceratina?* sp. 2 in the presence of a pointed alaform process but differs in the ornamentation pattern that is more delicate and in its more rounded shape in lateral view.

Occurrence: B-17 quarry, Capanema, Pará (sample B9).

Distribution: Lower Miocene (N5/N6 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

***Bythoceratina?* sp. 2**

Fig. 6: 16

Material: 3 valves.

Dimensions: MPEG-631-M, RV: L: 0.43 mm and H: 0.23 mm.

Description: Medium-sized carapace, subrectangular to subelongate in lateral view. Dorsal margin long and straight ending in a caudal process. Ventral margin slightly convex with a pointed alaform process. Anterior margin obliquely rounded. Posterior margin subrounded and subacuminate. Surface strongly and regularly reticulate with a deep and large vertical median depression like a median sulcus. Internal features were not observed due to scarce and poorly preserved material.

Remarks: See remarks of the *Bythoceratina* sp. 1.

Occurrence: Aricuru (Maracanã bay), sample AR-01; B-17 quarry, Capanema, Pará (sample: B12); Primavera FPR-160 core (sample: AM8).

Distribution: Lower Miocene (N4 to N6 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Superfamily PARADOXOSTOMATOIDEA Liebau, 2005

Family PARADOXOSTOMATIDAE Brady & Norman, 1889

Subfamily PARADOXOSTOMATINAE Brady & Norman, 1889

Genus *Paradoxostoma* Fischer, 1855

***Paradoxostoma artum* van den Bold, 1966a**

Fig. 6: 17–19

v 1963a *Paradoxostoma* sp.—van den Bold: p. 404, pl. 10, fig. 8.

v* 1966a *Paradoxostoma artum*, n. sp.—Van den Bold: p. 37, pl. 3, fig. 4A–b.

non 1994b *Paradoxostoma* cf. *P. artum* Bold, 1966a.—Távora: p. 122–123, fig. 5.

Material: 2 carapaces.

Dimensions: MPEG-632-M, C; LV: L: 0.56 mm and H: 0.23 mm; RV: L: 0.50 mm and H: 0.20 mm; W: 0.19 mm.

Diagnosis: Carapace strongly elongate, ovate, highest at 3/5 of the length from the anterior extremity. Anterior

end very low, obliquely and narrowly rounded; dorsal margin broadly arched; ventral margin sinuate, curved upward into the posterior end, which is narrowly rounded above the middle, slightly convex above and below. Dorsal view lanceolate, widest in the middle. Valves subequal. Posterior part of ventral margin strongly compressed laterally, sharp (van den Bold 1966a).

Remarks: The present material was compared respectively with the holotype, paratype and figured specimen (USMN MO 649193; HVH No. 7926; HVH No. 10250) of *Paradoxostoma artum* van den Bold, 1966a and figured specimen (HVH No. 6885) of *Paradoxostoma* sp. in van den Bold (1963a) and was found to be quite similar, differing only in its smaller size. Based on the outline of carapace, *Paradoxostoma* cf. *P. artum* (van den Bold, 1963a) *sensu* Távora (1994b) differs from the species described herein by having a more ovate carapace and rounded ends. The present species is also similar in shape to *Paradoxostoma robustum* Puri, 1953b (nom. corr. for *P. robusta* Puri, 1953b, p. 289, pl. 15, fig. 1, pl. 14, figs. 7–9), which is less elongate posteriorly.

Occurrence: B-17 quarry, Capanema, Pará (sample: B13B).

Distribution: This species also was recorded in the Melajo Clay member of the Springvale Formation (Upper Miocene) from Trinidad (van den Bold 1963a), Upper Miocene, Cubagua Formation, Cubagua Island, Venezuela (van den Bold 1966a) and Aricuru Locality, Pirabas Formation (Lower Miocene, N7 zone; Blow 1969), Pará, Brazil (Nogueira & Nogueira 2017).

Paradoxostoma? sp.

Fig. 6: 20–22

Material: 2 carapaces and 15 valves.

Dimensions: MPEG-633-M, C; LV: L: 0.78 mm and H: 0.37 mm; RV: L: 0.77 mm and H: 0.36 mm; W: 0.34 mm. MPEG-634-M, C; LV: L: 0.78 mm and H: 0.37 mm. MPEG-635-M, C; LV: L: 0.78 mm and H: 0.37 mm.

Description: Subelongate carapace in lateral view, highest in the middle. Dorsal margin sinuous, slightly convex at the mid-length. Ventral margin concave-convex, strongly convex in the posteromedian region, curved upward into the posterior end forming a dorsal caudal process. Anterior margin obliquely and narrowly rounded; surface smooth. Dorsal view biconvex, widest at the mid-length; posterior end narrow and mitten-shaped. Valves subequal: LV overlapping RV in the ventral and anterior margins. Inner lamella well developed. Other internal features were not observed.

Remarks: This species differs from other *Paradoxostoma* species in outline; in the presence of a dorsal margin that is almost straight or slightly sinuous in the posterodorsal region and a caudal process-like posterodorsal extension. Thus, this species is dubiously assigned to *Paradoxostoma*.

Occurrence: Aricuru (Maracanã bay), sample AR-01; B-17 quarry, Capanema, Pará (samples: B1A, B5, B11, B12 and B13); Primavera FPR-160 core (samples: AM10, AM12, AM15, AM17 and AM18).

Distribution: Lower Miocene (N4 to N7 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Genus *Cytherois* Müller, 1884

Cytherois? sp.

Fig. 6: 23–25

Material: 2 carapaces and 1 valve.

Dimensions: MPEG-636-M, C; LV: L: 0.50 mm and H: 0.20 mm; RV: L: 0.46 mm and H: 0.19 mm; W: 0.13 mm.

Description: Carapace strongly elongate; highest at 3/5 of the length from the anterior extremity. Dorsal and ventral margins parallel and slightly convex, converging to the posterior end, which is narrowly rounded above the middle. Anterior end obliquely and narrowly rounded; dorsal view lanceolate, widest in the middle. Valves subequal: LV overlapping RV. Posterior part of ventral margin strongly compressed laterally, sharp posteriorly. Internal features were not observed.

Remarks: This is considered here a species of *Cytherois* Müller, 1884 mainly on the basis of its down-turned postero- and anterodorsal margins, straighter, less sinuous, ventral margin, and the absence of a caudal process.

Occurrence: Aricuru (Maracanã bay), sample AR-04.

Distribution: Aricuru Locality, Pirabas Formation, Lower Miocene (N5/N6 zones; Blow 1969), Pará, Brazil (Nogueira & Nogueira 2017).

Family CYTHEROMATIDAE Elofson, 1939

Genus *Pellucistoma* Coryell & Fields, 1937

Pellucistoma magniventra Edwards, 1944

Fig. 7: 1–3

- | | | |
|-----|-------|---|
| v* | 1944 | <i>Pellucistoma magniventra</i> Edwards, n. sp.—Edwards: p. 528, pl. 88, figs. 33–35. |
| | 1951 | <i>Pellucistoma</i> cf. <i>P. magniventra</i> Edwards.—Swain: 234-A, p. 52. |
| | 1953b | <i>Pellucistoma magniventra</i> (Edwards).—Puri: pp. 289–290, pl.15, fig. 4, text fig. 12a. |
| (?) | 1957 | <i>Pellucistoma magniventra</i> .—Puri & Hulings: p. 187, fig. 11. |
| | 1960 | <i>Pellucistoma magniventra</i> Edwards.—Puri: p.119, pl.2, figs.10–11, text-figs.8–9. |
| v* | 1994b | <i>Pellucistoma magniventra</i> Edwards, 1944.—Távora: pp. 123–124, fig. 6. |

Material: 340 carapaces and 364 valves.

Dimensions: MPEG-637-M, C; LV: L: 0.50 mm and H: 0.26 mm; RV: L: 0.52 mm and H: 0.28 mm; W: 0.21 mm.

Diagnosis: A species of *Pellucistoma* with a very constricted anterior vestibule, posterior vestibule absent or extremely narrow, ventral vestibule elongate and narrow, and a characteristic pattern of radial and false radial pore canals (Edwards 1944).

Remarks: Edwards (1944) originally recorded this species from the Duplin Marl (Pliocene) of North Carolina. According to Puri (1960), this species occurs in Recent deposits along the coast of Florida. In Trinidad, it occurs from the Upper Brasso to the Upper Morne l'Enfer sands (Upper Miocene), and it is replaced in Recent deposits by a slightly more elongate species. Specimens recovered from the Pirabas Formation by Távora (1994c) and during the present study differ only in size, with those from the present study smaller when compared to those found by Távora (1994b), as well as those described as '*Pellucistoma* species aff. *P. magniventra* Edwards, 1944' by van den Bold (1988) from the Neogene of Dominican Republic (Río Cana: Gurabo Formation).

Occurrence: Aricuru (Maracanã bay), samples AR-02- AR-4 and AR-06; B-17 quarry, Capanema, Pará (samples B0-B1, B2A, and B5-B13B); Primavera FPR-160 core (samples: AM04, AM06, AM08, AM10, AM12, AM13 and AM15-AM20).

Distribution: Miocene to Recent. Upper Brasso, Upper Morne l'Enfer Formations, Quinam Quarry from Trinidad (Middle Miocene-Pliocene; van den Bold 1957; van den Bold 1963a), Cuba (middle Miocene-Pliocene), Puerto Rico, Costa Rica (late Miocene), Hispaniola (middle Miocene-early Pliocene), Central Haiti (Mio-Pliocene of the upper Thomonde and the Las Cahobas Formations; van den Bold 1981), Venezuela (Miocene, La Rosa Formation; van den Bold 1950); Upper Miocene from Gurabo Formation (Republic Dominican; van den Bold 1988), Duplin Marl, North Carolina (Pliocene; Edwards 1944; Swain 1951; Puri 1953b) and Recent deposits off Florida coast, Mississippi (Pleistocene; Puri 1960), the east coast of the USA (Maryland) to southern Florida, the northern and southern Gulf of Mexico (Late Miocene, Pliocene and Holocene; Maddocks *et al.* 2009), Recent deposits from Panama City to Florida Bay area (Puri & Hulings 1957), Texas and South Carolina (Cenozoic to Recent). Further scattered indications come from the Pacific coast of Mexico (Sinaloa, Nayarit, Gulf of Tehuantepec), Colombia (Bahia de Tumaco) and Upper Oligocene to Lower Miocene (N3 to N7 zones; Blow 1969), Pirabas Formation, Pará, (Nogueira & Nogueira 2017). For a more records of this species, see Gross *et al.* (2015).

***Pellucistoma* sp. aff. *P. kingmai* van den Bold, 1972**

Fig. 7: 4–6

(?) 1972b *Pellucistoma? kingmai* n. sp.—Van den Bold: pp. 1044–1045, pl. 2, figs. 6a–c; pl. 3, figs. 1a–c, pl. 4, fig. 6.

Material: 4 carapaces and 3 valves.

Dimensions: MPEG-638-M, C; LV: L: 0.51 mm and H: 0.26 mm; RV: H: 0.52 mm and H: 0.28 mm; W: 0.17 mm.

Description: Medium-sized and elongate carapace. Dorsal margin gently convex in the LV, strongly concave in the RV. Ventral margin strongly sinuous. Anterior margin obliquely rounded, more narrowly rounded anteroventrally. Posterior margin with a short, subventral caudal process; the posterodorsal margin is long and concave. RV overlapping the LV mainly along the dorsal margin, with slight overlap around the anterior, posterior and ventral margins. Surface finely punctate. Dorsal view lanceolate, widest in the middle, with compressed ends.

Remarks: This species is very close to *P. kingmai* van den Bold (1972b) in size and in some aspects of the carapace shape. This species is quite different from *P. magniventra* Edwards, 1944 mainly in the posterior and anterior ends being more obliquely rounded and more narrowly rounded in the ventral margin, although its size and smooth surface are similar.

Occurrence: B-17 quarry, Capanema, Pará (sample B11A).

Distribution: Lower Miocene (N5/N6 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Superfamily XESTOLEBERIDOIDEA Liebau, 2005

Family XESTOLEBERIDIDAE Sars, 1928

Genus *Xestoleberis* Sars, 1866

***Xestoleberis? dactylotypa* van den Bold, 1946**

Fig. 7: 7–10

- . 1946 *Xestoleberis dactylotypa*, n. sp.—Van den Bold: p. 119, pl. 16, fig. 16a–d.
- . 1965 *Xestoleberis dactylotypa* van den Bold.—van den Bold: p. 404, pl. 2, fig. 5a–5b.
- . 1973 *Pontoleberis dactylotypa* (van den Bold).—van den Bold: p. 157–158.

Material: 218 carapaces and 564 valves.

Dimensions: MPEG-639-M, C; LV: L: 0.43 mm and H: 0.27 mm; RV: L: 0.41 mm and H: 0.25 mm; W: 0.28 mm. MPEG-640-M, RV: L: 0.46 mm and H: 0.26 mm. MPEG-641-M, LV: L: 0.48 mm and H: 0.30 mm.

Diagnosis: Carapace egg-shaped, highest and widest behind the middle. Sexual dimorphism strong.—Female: Anterior end obliquely rounded, dorsal margin arched, ventral margin almost straight, posterior end obliquely and more broadly rounded than the anterior end. Greatest width behind the middle in the same region as the greatest height. Dorsal view egg-shaped. Male: More triangular in side view than the female, highest behind the middle, dorsal margin gibbous at the greatest height. Anterior end narrowly rounded, posterior end obliquely rounded. Dorsal view more angular than the female, rather narrowly rounded behind. Middle part of the lateral outline almost straight, slightly converging anteriorly. A remarkable phenomenon in this species is the ornamentation. The surface is punctate and the punctations form curved rows on the surface, the pattern of which is indicated in the figures. In side view, it makes the impression of a fingerprint. Left valve overlapping in the posterior part of the dorsal margin; in dorsal view the suture shows a curve to the right (van den Bold 1946).

Remarks: The present material is morphologically identical to *Xestoleberis dactylotypa* of van den Bold (1946; 1965). This species has sometimes been assigned to the genus *Pontoleberis*, erected by Krstić and Stancheva (1967), which has been considered by some a subgenus of *Xestoleberis*. In addition, van den Bold (1970b) noted the similarity of *Uroleberis* sp. (Pl. 2, fig. 16 a–b) to what he called *Pontoleberis dactylotypa* (van den Bold, 1946); the genus *Uroleberis* presents features of both *Pontoleberis* and *Xestoleberis*. In the case of the

present species, it has a semicircular carapace with an arched dorsal margin and a swollen ventral margin as in *Uroleberis*, but it differs in lacking a caudal process and ridges. Also, the specimens from the present study do not present the antero-dorsal spot; the hinge also differs in the median bar and in the posterior tooth arrangement. Typical features of *Xestoleberis* can be seen in the species *Xestoleberis* sp. recorded in this study (plate 7:11). For this reason, the present species is generically dubious. The relationship between these forms is not known, and we provisionally assign the present species to the genus *Xestoleberis*. *Pontoleberis dactylotypa* was recorded from the Paso Real Formation of Cuba (van den Bold 1973), but this material was not illustrated.

Occurrence: Aricuru (Maracanã bay), samples AR-01-AR-06; B-17 quarry, Capanema (samples: B0, B1A, B1, B2, B7, B11, B12, B11A, B11B and B13); Ponta do Castelo, Fortaleza Island (samples: PC-00, PC-02 and PC-03); Primavera FPR-160 core (samples: AM8a, AM08, AM10, AM12, AM15 and AM17).

Distribution: Found at many other localities in Cuba and at one locality in Guatemala from Lower Miocene. Upper Cibao Formation. In Cuba, it occurs in the Guines Formation, while in Trinidad it has been found only in the Morne Diablo Quarry (van den Bold 1965). Upper Oligocene to Lower Miocene (N3 to N7 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Xestoleberis sp.

Fig. 7: 11–14

Material: 12 carapaces and 11 valves.

Dimensions: MPEG-642-M, C; LV: L: 0.45 mm and H: 0.30 mm; RV: L: 0.44 mm and H: 0.29 mm; W: 0.28 mm. MPEG-643-M, C; LV: L: 0.43 mm and H: 0.21 mm; RV: L: 0.41 mm and H: 0.25 mm. MPEG-644-M, LV: L: 0.46 mm and H: 0.26 mm. MPEG-645-M, RV: L: 0.43 mm and H: 0.28 mm.

Description: Carapace medium-sized and ovate, highest just behind mid-length. Dorsal margin gently arched. Ventral margin only slightly sinuous in front of mid-length. Anterior margin obliquely rounded, continuing to the arched dorsal margin. Posterior margin broadly rounded. In dorsal view, carapace is ovate, widest at 3/5 of the length from the anterior margin. Surface smooth and lightly pitted. Normal pore canals moderately abundant and open, distributed regularly. Dorsal view drop- or egg-shaped, however, narrower in the anterior end and oval in the posterior end. Internal view: Hinge merodont, with elongate crenulate terminal cusps in RV, separated by a straight, weakly crenulate furrow, a few crenulations on each end, engaging with crenulated anterior and posterior sockets in the LV. Marginal areas of moderate width anteriorly. Vestibule moderately narrow and nearly equal in width all around the posterior end. Adductor scars in vertical row of four, with an arrowhead-shaped frontal scar in front and two mandibular scars below and in front, with a crescent-shaped scar above this group in the eye region.

Remarks: This species is similar to *Xestoleberis* sp. van den Bold, 1965 and *Xestoleberis tunisiensis* Esker, 1968 in shape, in its smooth surface, shape in dorsal view and internal features, but it is smaller than *Xestoleberis* sp. van den Bold, 1965. *Xestoleberis* cf. *X. sagamiensis* Kajiyama, 1913 (p. 436, pl. 2, figs. 6, 7) has the same outline, but that species has a small, sub-acute portion in the mid-anterior margin.

Occurrence: Aricuru (Maracanã bay), samples AR-02 to AR-05; Ponta do Castelo, Fortaleza Island (sample PC-00).

Distribution: Lower Miocene (N5/N6 zones; Blow, 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Suborder CYTHEROCOPINA Gründel, 1967

Infraorder NOMOCYTHERININA Liebau, 1991

Superfamily CYTHEROIDEA Liebau, 2005

Family CUSHMANIDEIDAE Puri, 1974 in Hartmann & Puri, 1974

Genus *Cushmanidea* Blake, 1933

***Cushmanidea? bragantinaensis* sp. nov.**

Fig. 7: 15–18

non	1946	<i>Cytherideis howei</i> n. sp.—Van den Bold: p. 88, pl. 7, fig. 9.
v*	1966	<i>Cushmanidea</i> n. sp. 1. Salahi: p. 14, pl. 1, figs. 28, 32, 33.
.	1994b	<i>Cushmanidea howei</i> (Bold, 1946).—Távora: p. 98–99, fig. 5.

Material: 121 carapaces and 355 valves.

Etymology: Alluding to the northeastern region of the Pará State (Bragantina region), where the five localities of this study and where this species was recorded.

Holotype: MPEG-646-M, C; LV: L: 0.87 mm and H: 0.44 mm; RV: length 0.85 mm and H: 0.42 mm; W: 0.37 mm.

Paratype: MPEG-647-M, C; LV: L: 0.85 mm and H: 0.42 mm; RV: L: 0.76 mm and H: 0.36 mm; MPEG-648-M, LV: internal view, L: 0.87 mm and H: 0.40 mm.

Type locality: FPR 160 Core, depth 40 m, sample AM10, Primavera town.

Diagnosis: Anterior margin sloped. Valves unequal: LV overlaps the RV on all margins. Surface smooth without punctae.

Description: Large carapace, subelongate in lateral view; valves subequal, LV slightly larger than RV, overlapping on all margins. Dorsal margin moderately convex posteriorly and inclined anteriorly in the LV; slightly concave anteriorly and more sinuous in the RV. Ventral margin almost straight; slightly convex in the posterior of the LV. Anterior margin subrounded. Posterior margin narrowly curved, extended below, truncate above. Surface smooth, except for scattered pits that represent the opening of normal pore canals. Hinge: RV consists of terminal elongate flanges and an intervening furrow, which correspond to terminal grooves and a median bar in LV. Inner lamella broad anteriorly, narrower posteriorly and ventrally. Line of concrescence and inner lamella widely separated at the anterior and posterior ends. Other internal features not observed due to poor preservation.

Remarks: Specimens from this species from the Pirabas Formation were identified as *Cushmanidea howei* van den Bold, 1946 by Távora (1994b). However, the present species differs from the type of *C. howei* in size and shape in lateral view, and in its smoother ornamentation. The general outline of this species has similarities to the paratype of *Argilloecia barrigonensis* van den Bold, 1966a (HVH No. 7904) from the Upper Miocene of the Cubagua Formation (Venezuela), but that species differs in the valve overlap (RV larger than LV), in its prominent sexual dimorphism, and in carapace size. The figured specimen of *Cushmanidea* n. sp. 1 Salahi, 1966 (USNM MO 648666) is the most similar species in lateral view and in the smooth surface, but it differs in presenting a larger carapace and a slightly punctate surface.

Occurrence: Aricuru (Maracanã bay), all the samples; outcrops Atalaia, sample AT-01; B-17 quarry, Capanema, Pará (samples B0-B2; B5-B8; B11; B11A-B13B); outcrops Ponta do Castelo (sample PC-03); Primavera FPR-160 core (samples: AM04, AM 06, AM08a, AM10-AM13, AM16, AM17, AM 19, AM20).

Distribution: Upper Oligocene to Lower Miocene (N3 to N7 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Genus *Hulingsina* Puri, 1958

***Hulingsina reticulorugosa* sp. nov.**

Fig. 7: 19–22

Material: 13 carapaces and 20 valves.

Etymology: reticulo from Latin *reticulum* = network or mesh; rugosa from Latin *rugosum* = rugose.

Holotype: MPEG-649-M, C; LV: L: 0.55 mm and H: 0.21 mm; RV: L: 0.47 mm and H: 0.17 mm; W: 0.20 mm.

Paratypes: MPEG-650-M, C; RV: L: 0.47 mm and H: 0.17 mm. MPEG-651-M, C; LV: L: 0.47 mm and H: 0.17 mm; RV: L: 0.46 mm and H: 0.16 mm. MPEG-652-M, RV: internal view, L: 0.48 mm and H: 0.17 mm.

Type locality: FPR 160 Core, depth 20 m, sample AM15, Primavera town.

Diagnosis: Species of *Hulingsina* with an elongate carapace that is strongly ornamented with coarse reticulations distributed irregularly, being more pronounced in the anterior region.

Description: Small carapace, elongate in lateral view. Dorsal margin gently arched. Ventral margin slightly concave in the middle. Anterior margin broadly rounded. Posterior margin almost round below, oblique above. RV subacute in the posterior end. LV overlaps RV especially in the anterior and posterodorsal margins. Surface reticulate with fossae distributed irregularly, more defined in the anterior region; posterior region with a depressed area and a vertical chevron-like arrangement of ridges and reticulate ornament in the anterolateral area; median region with pronounced vertical sulcus. Internal view presents a wide inner lamella mainly in the posterior and anterior regions; it also has a strong selva with hinge of RV characterized by a socket along the anterior and middle region, and teeth in the posterior end.

Remarks: Some characters are shared between this species and *H. tuberculata* Puri, 1958 from Recent sediments of the Gulf of Mexico, Texas (USA), such as carapace shape in lateral view, but this species differs in valve overlap and in ornamentation.

Occurrence: Aricuru (Maracanã bay), sample AR-04; B-17 quarry, Capanema, Pará (B11 and B12); Primavera FPR-160 core (samples: AM4, AM8 and AM14).

Distribution: Upper Oligocene to Lower Miocene (N3 to N6 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Hulingsina? lorenesmithae sp. nov.

Fig. 7: 23–27

Material: 7 carapaces and 4 valves.

Etymology: In honor to Ms. Lorene E. Smith from Louisiana State University, Baton Rouge, a North American micropaleontologist and manager of the micropaleontological collection.

Holotype: MPEG-653-M, Female, C; LV: L: 0.63 mm and H: 0.32 mm; RV: L: 0.62 mm and H: 0.29 mm; W: 0.30 mm.

Paratypes: MPEG-654-M, Male, LV, L: 0.66 mm and H: 0.27 mm. MPEG-655-M, RV, L: 0.56 mm and H: 0.25 mm.

Type locality: FPR 160 Core, depth 30 m, sample AM12, Primavera town.

Diagnosis: Robust carapace, subrectangular in lateral view. Surface reticulate with fossae following ridges; median region with a sulcus extending from the dorsal margin at approximately mid-length of the carapace; ornamented with small and medium fossae distributed regularly and arranged transversely.

Description: Medium-sized and robust carapace, subrectangular in lateral view. LV overlaps the RV mainly along the dorsal margin. Dorsal margin and ventral margin subparallel: dorsal margin almost straight with cardinal angles less pronounced in males; ventral margin slightly concave. Anterior margin subrounded, sloping downward in the anterodorsal area. Posterior margin truncated; ventral margin slightly concave in the median region. Surface reticulate with fossae following ridges; median region with a marked vertical sulcus extending from the dorsal margin, at approximately mid length of the carapace. Ornamented with small and medium fossae distributed regularly and arranged transversely. Dorsal view subovate and slightly compressed in the middle at the sulci. Hinge antimerodont: LV with terminal crenulate sockets separated somewhat by a raised crenulate bar; inner margin narrow with calcified inner lamella and thick outer margin; other internal features were not observed.

Remarks: The present species is only questionably assigned to *Hulingsina* because its lophodont hinge, similar to species of *Cushmanidea*, differs from the antimerodont condition typical of the genus *Hulingsina*. The present species is quite different from others in this genus in shape in both lateral and dorsal views of the LV; however, it presents some similarities, particularly in the lateral view of the RV to *Hulingsina reticulorugosa* sp. nov. recorded herein. This species is similar in lateral view and in ornament to some ornate species of *Cyprideis*, but differs in hinge type from that genus.

Occurrence: Aricuru (Maracanã bay), samples AR-03 to AR-05; B-17 quarry, Capanema, Pará (samples: B1A, B1, B4-B6, B12–B11B); Primavera FPR-160 core (samples: AM07, AM12, AM14).

Distribution: Lower Miocene (N3 to N6 zones; Blow, 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Family CYTHERIDAE Baird, 1850

Subfamily PERISSOCYTHERIDEINAE van den Bold, 1963

Genus *Gangamocytheridea* van den Bold, 1963

***Gangamocytheridea macedoi* (Távora, 1998)**

Fig. 8: 1–7

1998 *Hemicytherura macedoi* n. sp.—Távora: pp. 3–15, figs. 4–8.

Material: 134 carapaces and 229 valves.

Dimensions: MPEG-656-M, C, Female; LV: L: 0.34 mm and H: 0.21 mm; RV: L: 0.33 mm and H: 0.20 mm; W: 0.20 mm. MPEG-657-M, C, Male; LV: L: 0.35 mm and H: 0.20 mm; RV: L: 0.35 mm and H: 0.19 mm; W: 0.19 mm. MPEG-658-M, Female, Internal View, RV: L: 0.35 mm and H: 0.18 mm.

Diagnosis: small and suboval carapace with prominent elevation in the dorsal region. External surface strongly reticulate with a longitudinal row of fossae in the ventral region, diagonal lines on the anterior region and subvertical lines posteriorly. Subventral compressed and finely reticulated caudal process (Távora 1998).

Remarks: Távora (1998) assigned this species to the genus *Hemicytherura* previously. However, this species presents more affinities with the genus *Gangamocytheridea* of van den Bold (1963a), including the presence of a compressed caudal process, strong ornamentation pattern and the internal features as described below. The species found herein is sexually dimorphic and differs from *Gangamocytheridea dictyon* van den Bold, 1963a in the arrangement of the sieve pore canals, in the overlap of the valves and in the shape of the anteroventral region; however, they are very similar in general shape, ornamentation and in having 3–4 furrows in the mid-dorsal region in lateral view. Internal view: hinge typical of the genus; inner margin and line of concrescence coincident. Muscle scars with 4 rows of adductors, 1 or 2 frontal scars, 2 mandibular muscle scars and 2 dorsal muscle scars.

Occurrence: Aricuru (Maracanã bay), samples AR-01-04 and AR-06; B-17 quarry, Capanema, Pará (samples: B0-B1, B7, B11-B13B); Primavera FPR-160 core (samples: AM06 and AM07 AM08, AM13, AM 15, AM17, AM20).

Distribution: This species was originally recorded from the Aricuru locality by Távora (1998) and was recorded from all other localities in the present work, Upper Oligocene to Lower Miocene (N3 to N7 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

***Gangamocytheridea* sp.**

Fig. 8: 8, 11–12

Material: 3 carapaces.

Dimensions: MPEG-659-M, C; LV: L: 0.31 mm and H: 0.20 mm; RV: L: 0.31 mm and H: 0.19 mm; W: 0.19 mm.

Description: Carapace small, subrectangular in lateral view and subrhomboidal to subovate in dorsal view. Thick-shelled. Dorsal margin slightly arched mainly at the anterior cardinal angle and inclined to the posterior region. Ventral margin overhung by a ridge. Anterior margin rounded. Posterior margin truncated at postero-dorsal region and with a short caudal process postero-ventrally. Small eye tubercle crossed by a transverse ridge. The central area of the lateral surface is coarsely and irregularly reticulate. Three strong subalar ridges: the ventral one spans the whole margin, two shorter ridges are above.

Remarks: This species is different from others species of the same genus recorded in the present study mainly in the ornamentation pattern that is more reticulate with strong ridges and larger fossae that are more subrectangular in shape.

Occurrence: Aricuru (Maracanã bay), samples AR-03 and AR-04; B-17 quarry, Capanema, Pará (sample B1 and B7, B11-B13); Primavera FPR-160 core (sample AM08, AM10, AM 17 and AM 20).

Distribution: Lower Miocene (N4 to N7 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Genus *Pumilocytheridea* van den Bold, 1963

Pumilocytheridea sp.

Fig. 8: 9, 13–14

v* 1994b *Pumilocytheridea* aff. *P. realejoensis* Swain & Gilby, 1967.—Távora, pp. 127–128, figs. 4–8.

Material: 2 carapaces and 1 valve.

Dimensions: MPEG-660-M, C; LV: L: 0.31 mm and H: 0.13 mm; RV: L: 0.31 mm and H: 0.11 mm; W: 0.11 mm.

Description: A species of *Pumilocytheridea* characterized by a small and elongate carapace, slightly concave in the medial ventral margin, ornamented by longitudinal ridges and punctae in the middle of lateral surface; flat rims on both ends. Highest in the anterior half, more inflated posteriorly. Dorsal margin slightly convex, slightly inclined to the posterior region. Anterior margin obliquely rounded. Posterior margin truncated to slightly tapered ventrally. Lanceolate in dorsal view; wider in the postero-median region and strongly compressed at the posterior end. Ornamentation consisting of flat marginal ridges mainly in the posterior region and of longitudinal rows of pits separated mostly by irregular longitudinal ridges. Normal pore canals sieve type. Internal features not observed due to scarcity and fragility of the material.

Remarks: Based on shape and ornamentation pattern, the species apparently is very similar to *Pumilocytheridea* aff. *P. realejoensis* (Swain & Gilby, 1967) already recorded in this unit by Távora (1994b). However, the species described herein differs from *P. realejoensis* Swain & Gilby, 1967 previously recorded from Recent sediments from Corinto Bay, western Nicaragua, which is longer, has a more evident anterior cardinal angle, and differs in anterior ornamentation pattern. It also resembles the figured specimen (HVV No. 7911) of *Pumilocytheridea sandbergi* van den Bold, 1963a from the Malajo Clay Member of the Springvale Formation (Upper Miocene), Louisiana (USA) and Cumaná Formation, Venezuela (Pliocene), mainly in lateral view shape and dimensions of the carapace, but differs in ornamentation and it has a less robust carapace. Moreover, the North American and Venezuelan species is a little higher and has a dorsal view with more sinuous and subparallel margins.

Occurrence: Aricuru (Maracanã bay), sample AR-04; B-17 quarry; Primavera FPR-160 core (sample: AM08).

Distribution: Pirabas Formation (Lower Miocene—N4 to N6 zones; Blow 1969), Pará, Brazil (Távora 1994b; Nogueira & Nogueira 2017).

Family CYTHERURIDAE Müller, 1894

Subfamily CYTHERURINAE Müller, 1894

Genus *Cytheropteron* Sars, 1866

Cytheropteron? *yorktownensis* (Malkin, 1953)

Fig. 8: 10, 15–16

- (?) 1951 *Eocytheropteron?* sp.—Swain: p. 47, pl. 7, fig. 16.
v 1953 *Eocytheropteron yorktownensis* Malkin, **n. sp.**—Malkin: p. 780, pl. 79 figs. 1–4.
(?) 1953b *Cytheropteron leonensis* Puri, **n. sp.**—Puri: p. 242, pl. 4, figs. 11–12, figs. 6C–d.
v. 1968 *Cytheropteron?* *yorktownensis* (Malkin).—Swain: p. 13, pl. 4, figs. 7A–c, 11.
nov. comb. p. 1974 *Shattuckocythere yorktownensis* (Malkin).—Swain: p. 22, pl. 3, figs. 9, 12, 14, 15.
. 1994a *Cytheropteron* cf. *C. yorktownensis* (Malkin, 1953).—Távora: pp. 104–105, fig. 10.

Material: 25 carapaces and 38 valves.

Dimensions: MPEG-661-M, C; LV: L: 0.30 mm and H: 0.18 mm; RV: L: 0.30 mm and H: 0.19 mm; W: 0.22 mm. MPEG-662-M, RV: L: 0.41 mm and H: 0.23 mm.

Diagnosis: Shell subquadrate in lateral view; highest about one-fourth from anterior end; dorsal margin nearly straight, about two-thirds of shell length; ventral margin sinuate and converging posteriorly toward dorsum; anterior margin broadly rounded, extended below; posterior margin narrowly rounded. Ventral portion of shell swollen, especially the posterior third where enlargement overhangs ventral margin as weakly developed alae. Posterior end somewhat compressed. Surface has a faint reticulate pattern of narrow ridges and broad minutely punctate interspaces. Hinge of left valve consists of terminal, elongate, weakly crenulate sockets, an interterminal crenulate ridge, dorsal of which is a narrow groove. Muscle scar of single specimen found consists of a subvertical row of three elongate spots. Inner lamellae fairly broad anteriorly, narrower elsewhere; antero-ventrally, inner margin and line of concrescence widely separated. Radial canals few, flaring where they open along line of concrescence, giving it a scalloped outline. Length of figured specimen, a left valve, 0.44 mm height 0.25 mm (Swain 1951).

Remarks: Specimens recovered during the present study are identical to the holotype of Malkin (1953) and are the same as recorded by Távora (1994a) in the Pirabas Formation. *Cytheropteron? yorktownensis* (Malkin) of Swain (1968) has a ventral alar process that is less elongate than the species found herein. It is a very common species in the Pliocene sediments along the North Atlantic Coastal Plain. This species may be distinctive enough to be placed in a new genus and its generic assignment is uncertain at present. Swain (1974) assigned *C. yorktownensis* to a new genus *Shattuckocythere*. However, *Shattuckocythere* is not a useful taxon because the type species selected by Swain, *Cythere? shattucki* (Ulrich & Bassler, 1904), is a typical member of the genus *Microcytherura* Müller, 1894. Our species is related to *Cytheropteron (Cytheropteron) dominicanum* van den Bold, 1988 from the Upper Miocene to Recent of the Dominican Republic, but it is a bit smaller and has a stronger ventral ridge.

Occurrence: Aricuru (Maracanã bay), samples AR-03- AR-04; B-17 quarry, Capanema, Pará (samples: B0, B1A, B1, B4, B7, B11-B13, and B13B); Ponta do Castelo, Fortaleza Island, sample PC-00; Primavera FPR-160 core (samples: AM08, AM12, AM15, AM17 and AM20).

Distribution: In the Chesapeake Group, USA, the species has been found only in the Yorktown Formation (Late Miocene to Middle Pliocene; Malkin 1953; Forester 1980). It also occurs from Lower Pliocene to Lower Pleistocene in the North Atlantic Coastal Plain (Swain 1968; 1974; Maddocks *et al.* 2009). Lower Miocene (N4 to N7 zones; Blow 1969), Pirabas Formation (Távora 1994a), Pará, Brazil (Nogueira & Nogueira 2017).

***Cytheropteron bichense* van den Bold, 1963a**

Fig. 8: 17–20

v* 1963a *Cytheropteron bichense* van den Bold, **new species**.—Van den Bold: p. 400, pl. 9, fig. 9a–9b.

Material: 3 carapaces and 5 valves.

Dimensions: MPEG-663-M, C; LV: L: 0.30 mm and H: 0.21 mm; RV: L: 0.30 mm and H: 0.17 mm.

Diagnosis: Carapace small, ovate, alate, posterior portion much higher than the anterior, greatest height slightly behind the middle. Anterior end low, almost evenly rounded, but with a long dorsal slope; dorsal margin straight in the right valve, broadly arched in the left; ventral margin generally broadly convex, slightly sinuate in front of the middle, sweeping upward into the posterior end, which is produced into a sub-median caudal process, slightly concave above and below. Left valve overlapping the right strongly along the dorsal margin. The ala runs from just below the middle of the anterior ventral rounding to about one quarter of the length from the hind end, obscuring the middle third of the ventral margin. It possesses thickenings in the posterior and anterior parts, which extend in the direction of a dorsal ridge that lies parallel to the dorsal margin of the right valve. The area between the thickened ridges of the ala is depressed, forming an oblique elongate sulcus. In dorsal view, carapace shaped like a spear point, widest at about one third of the length from the posterior extremity, just in front of the posterior ends of the alae. The posterior side of the ala is rounded backwards. Anterior end of the carapace somewhat compressed with the lateral outline of the valves slightly concave in this region; posterior end strongly compressed (van den Bold 1963a).

Remarks: Specimens recovered from the Pirabas Formation are morphologically identical to the type specimens of *Cytheropteron bichense* van den Bold, 1963a (USNM MO 684087; HVH No. 6883). Not mentioned

in the original description of that species is the presence of large pits in the dorsomedian region in lateral view. The species resembles *Cytheropteron latum* Müller, 1894 (p. 300, pl. 20, figs. 3, 9; pl. 21, figs. 10–14), but differs by the presence of a median sulcus in the dorsal ridge.

Occurrence: Aricuru (Maracanã bay), sample AR-04; B-17 quarry, Capanema, Pará (samples: B1A, B11 and B12); Primavera FPR-160 core (samples: AM08 and AM17).

Distribution: Biche Craelius Borehole: beds at 30–32 feet, Upper Miocene, Trinidad (van den Bold 1963a). Lower Miocene (N4 to N6 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Genus *Oculocytheropteron* Bate, 1972

Oculocytheropteron cf. *Oculocytheropteron reticulopunctatum* Whatley, Chadwick, Coxill & Toy, 1988

Fig. 8: 21–24

cf. 1988 *Oculocytheropteron reticulopunctatum* sp. nov.—Whatley *et al.*: p. 186–187, pl. 5, figs. 3–7.

Material: 3 carapaces and 35 valves.

Dimensions: MPEG-664-M, C; LV: L: 0.33 mm and H: 0.21 mm; RV: L: 0.30 mm and H: 0.21 mm; W: 0.23 mm. MPEG-665-M, C; LV: L: 0.34 mm and H: 0.22 mm.

Description: Ventral margin overhung by subalar ridge; well-developed oval concavity. The central area of the lateral surface is coarsely and irregularly reticulate, secondary ornamentation finely punctate for all surfaces; pore canals that are straight, simple, and widely spaced.

Remarks: *Oculocytheropteron* cf. *O. reticulopunctatum* Whatley *et al.*, 1988 is very similar externally to *Oculocytheropteron reticulopunctatum* Whatley *et al.*, 1988 recorded from the Recent of the southwestern Atlantic Ocean, mainly in carapace shape and ornamentation pattern, but it differs in its more rounded posterior end and in bearing secondary ornamentation that is more delicate; internally its ventral ridges are more evident and its anterior cardinal angle is more arched than seen in *O. reticulopunctatum* Whatley *et al.*, 1988. *Oculocytheropteron macropunctatum* Whatley, Chadwick, Coxill & Toy, 1988 also is similar to species described herein mainly in carapace shape, but compared to that species, the present one is more inflated and less punctate, it lacks an eye tubercle, its subalar ridge is less defined and it lacks a posterodorsal loop. Although *O. cf. O. reticulopunctatum* presents a carapace shape and an ornamentation pattern similar to *Gangamocytheridea*, it is more reticulate and presents a more acuminate posterior end. Compared to that genus, species of *Oculocytheropteron* present a combination of reticulation and punctuation with secondary punctations on the surface and are less acute in the posterior end as seen in *O. cf. O. reticulopunctatum*.

Occurrence: Aricuru (Maracanã bay), samples AR-03 to AR-04.

Distribution: Aricuru Locality, Pirabas Formation (Lower Miocene—N5/N6 zones; Blow 1969), Pará, Brazil (Nogueira & Nogueira 2017).

Genus *Cytherura* Sars, 1866

Cytherura? sp. 1

Fig. 8: 25

Material: 1 valve.

Dimensions: MPEG-666-M, LV: L: 0.38 mm and H: 0.20 mm.

Description: Small and sub-elongate in lateral view. Dorsal and ventral margins are subparallel: dorsal margin almost straight and ventral margin slightly convex, with a slight oral concavity. Anterior margin subrounded and posterior margin with a caudal process at the mid-posterior point; maximum height at posteromedian region. Surface reticulate with numerous anastomosing and slightly thick ridges; some dense minute punctae distributed and arranged regularly. Hinge features as for genus. Eye tubercle not prominent.

Remarks: Based on general external morphology and ornamentation, this species is similar to *Semicytherura* sp. aff. *S. clavata* (Brady, 1880) Whatley, Chadwick, Coxill & Toy, 1988 recorded in the present study (see Fig. 9:

19–21), but it differs in its more prominent ornamentation, and in having a posteroventral depression and a less elongated shape.

Occurrence: Primavera FPR-160 core (sample AM08).

Distribution: Lower Miocene (N4 zone; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Cytherura? sp. 2

Fig. 8: 26

1944 *Cytherura elongata* Edwards, n. sp.—Edwards: p. 526, pl. 88, figs. 21–25.

1994a *Cytherura elongata* Edwards, 1944.—Távora: p. 99–100, fig. 6.

Material: 5 valves.

Dimensions: MPEG-667-M, C; LV: L: 0.37 mm and H: 0.24 mm.

Description: Small and elongate to subrectangular carapace in lateral view. Dorsal margin slightly convex, almost straight. Ventral margin slightly sinuous with a pronounced ventrolateral alar process overlapping the ventral margin. Anterior margin obliquely rounded. Posterior margin with a posterodorsal caudal process that slopes obliquely to the posteroventral margin. Eye tubercle is not prominent. Surface with a weak reticulate ornament; delicate and sinuous longitudinal ridges, intermittent in the median portion; delicate transverse ridges defining a rectangular and irregular pattern.

Remarks: Távora (1994a) recorded this species in the Pirabas Formation as *Cytherura elongata* (Edwards, 1944); however, the present specimen differs slightly from the species described by Távora in its smaller size and in the lack of a prominent ventrolateral alar process overlapping the ventral margin. The species *Cytherura elongata* Edwards, 1944 from the Duplin Marl (Upper Miocene) of North Carolina resembles the specimen described here in ornamentation and somewhat in shape, but it differs in its more rectangular lateral view. The material found in the present study is too sparse to confirm this identification. The identified specimen of *Cytherura elongata* (Edwards, 1944) recorded from Recent deposits from Mexico (HVH No. 8389) by Morales (1966) is more elongate and has a rather different shape in lateral view from the species described herein.

Occurrence: Aricuru (Maracanã bay), samples AR-04; B-17 quarry, Capanema, Pará (samples B11 and B12); Primavera FPR-160 core (sample AM08).

Distribution: Lower Miocene (N4 to N6 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Cytherura? *punctocentrata* sp. nov.

Fig. 8: 27–31

1994a *Cytherura* sp. 1.—Távora: pp. 102–103, fig. 8.

Material: 6 carapaces and 2 valves.

Etymology: puncto from Latin *punctatum* = punctations or punctae, referring to the ornamentation; centrata from Latin *centratum* or *centratus* = centered, referring to the position of the punctations around the central portion of the lateral surface of the carapace.

Holotype: MPEG-668-M, C; Female, LV: L: 0.33 mm and H: 0.18 mm; RV: L: 0.33 mm and H: 0.19 mm; W: 0.20 mm.

Paratype: MPEG-669-M, C; Male, LV: L: 0.34 mm and H: 0.15 mm; RV: L: 0.34 mm and H: 0.16 mm; W: 0.17 mm. MPEG-670-M, Male, internal view, RV: L: 0.36 mm and H: 0.20 mm.

Type locality: B17 Quarry, sample B7, Capanema town.

Diagnosis: Surface ornamented with large and deep punctae concentrated in the median portion of the carapace, transversely aligned. The mid-ventral alar process is acute, low, thick and swollen. Two vertical sulci in the dorsomedian region.

Description: Small carapace, oval to elongate in lateral view. Dorsal margin arched. Ventral margin nearly

straight, concave in the middle portion. Anterior margin rounded. Posterior margin with a pointed caudal process and short. Surface ornamented with large and deep punctae concentrated in the median portion of the carapace, transversely aligned. Ventral ridge irregularly swollen, mainly in the mid-ventral portion, forming a low, acute and thick alar process. Two vertical sulci in the dorsomedian region. Smoother in the anteromedian and posteromedian regions. Dorsal view with anterior end subrounded and posterior end acute. Sexually dimorphic: females wider and higher than males. Internal features not preserved.

Remarks: This species is morphologically identical to *Cytherura* sp. 1 recorded from the Pirabas Formation by Távora (1994a), although the specimen illustrated by Távora is a male. In addition, *Cytherura?* sp. aff. *C. cybaea* Garbett & Maddocks, 1979 also is very similar in carapace shape to the present species, but it differs in ornamentation pattern and in the presence of a prominent alar process on the posterior end.

Occurrence: Aricuru (Maracanã bay), sample AR-04; Primavera FPR-160 core (samples: AM08 and AM 20).

Distribution: Lower Miocene (N4 to N6 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Cytherura? ornatareticulum sp. nov.

Fig. 9: 1–3

Material: 1 carapace and 13 valves.

Etymology: ornate from Latin *ornata*, *ornatum* = ornamentation, and from Latin *reticulum* = network, referring to the richly reticulate ornamentation.

Holotype: MPEG-671-M, LV, L: 0.35 mm and H: 0.17 mm, RV, L: 0.35 mm and H: 0.17 mm.

Paratypes: MPEG-672-M, LV: L: 0.36 mm and H: 0.17 mm. MPEG-673-M, internal view, RV: L: 0.36 mm and H: 0.17 mm. MPEG-674-M, internal view, RV: L: 0.35 mm and H: 0.17 mm.

Type locality: FPR 160 Core, depth 35–40 m, sample AM8, Primavera town.

Diagnosis: Reticulate; small carapace; posterior margin truncate; valves subequal: RV more subrectangular than the LV.

Description: Small carapace, subrectangular in lateral view; maximal height at the anterior cardinal angle and maximal length below the mid-height. Dorsal margin almost straight and slightly converging to the posterior end. Ventral margin almost straight, sinuous in the RV. Anterior margin subrounded and slightly truncated, mainly in the RV; posterior margin acute and short; valves subequal: RV more subrectangular than the LV; valve surface with numerous rounded reticulations distributed regularly. Hinge in RV with a bifid anterior tooth, a crenulate median groove and an elongate posterior tooth. Inner lamella broad anteriorly and narrow on the posterior and ventral margins.

Remarks: This species is similar to *Cytherura? quasilenisa* sp. nov. described in the present study (see below), which differs in ornamentation pattern and in its more elongated shape in lateral view. *Procytherura? elongatissima* Andreu *et al.*, 2013 is also similar, mainly in lateral view of the carapace; however, it differs in ornamentation pattern and size.

Occurrence: Aricuru (Maracanã bay), samples AR-03 to AR-04; B-17 quarry, Capanema, Pará (samples B1A, B1, B11, B12 and B13B); Primavera FPR-160 core (samples: AM08, AM13, AM14 and AM17).

Distribution: Lower Miocene (N4 to N6 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Cytherura? quasilenisa sp. nov.

Fig. 9: 4–6

Material: 2 carapaces and 5 valves.

Etymology: quasi from Latin = nearly or almost; and lenisa from Latin *lenis* = smooth, referring to the extremely weak ornamentation.

Holotype: MPEG-675-M, C; LV: L: 0.41 mm and H: 0.17 mm; RV: L: 0.36 mm and H: 0.15 mm; W: 0.13 mm.

Paratype: MPEG-676-M, C; LV: L: 0.37 mm and H: 0.15 mm; RV: L: 0.36 mm and H: 0.14 mm.

Type locality: FPR 160 Core, depth 35–40 m, sample AM8, Primavera town.

Diagnosis: Ornamentation almost smooth with very numerous, weak punctae distributed regularly across the lateral surface.

Description: Carapace small, subrectangular in lateral view; maximum height at 1/3 the distance from the anterior and maximum length below the mid-height. Dorsal margin almost straight. Ventral margin sinuous to slightly concave. Dorsal and ventral margins slightly converging to the posterior end. Anterior margin subrounded. Posterior margin with a short caudal process. Valves subequal in side view: RV overlaps the LV in the mid-anteroventral region; LV overlaps the RV in the posterior margin and slightly so in the mid-anteroventral region. Valve surface almost smooth with numerous, weak punctae distributed regularly; dorsal view sub-ellipsoidal. Inner lamella broad anteriorly running along the anteroventral margin.

Remarks: The present species differs from the others assigned to this genus from the Neogene and Recent of the Americas. It resembles *Procytherura? elongatissima* Andreu *et al.*, 2013 from late Cenomanian of the Preafrican Trough, Morocco, mainly in its shape in lateral view. However, that species has a more prominent caudal process, it is markedly bigger (length 0.62 mm, height 0.26 mm), and it has flat anterior and posterior portions of the carapace. Dorsally, *P.? elongatissima* also has a very slight central and vertical sulcus and in dorsal view it is biconcave, very elongate and ellipsoidal. *Cytherura? ornatareticulum* sp. nov. is also similar to *C.? quasilenisa* in shape and size, but it differs in ornamentation pattern.

Occurrence: Aricuru (Maracanã bay), samples AR-03 to AR-04; B-17 quarry, Capanema, Pará (samples B1A, B1 and B11); Primavera FPR-160 core (samples: AM04 and AM08).

Distribution: Upper Oligocene to Lower Miocene (N3 to N6 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

***Cytherura? sp. aff. C. cybaea* Garbett & Maddocks, 1979**

Fig. 9: 7–11

. aff. 1979 *Cytherura cybaea* n. sp.—Garbett & Maddocks: p. 879–880, pl. 5, figs. 3–6.

Material: 2 carapaces and 1 valve.

Dimensions: MPEG-677-M, Female, C; LV, L: 0.44 mm and H: 0.23 mm; RV, L: 0.44 mm and H: 0.22 mm; W: 0.22 mm. MPEG-678-M, Male, C; RV, L: 0.46 mm and H: 0.23 mm.

Description: Carapace small and subtriangular in lateral view. Dorsal margin almost straight with a concavity in the anterodorsal region. Ventral margin almost straight, hidden in the middle by the ventral alae in lateral view. Anterior margin subrounded. Posterior margin with a tapered caudal process just below the mid-posterior region coincident with maximum length; posteroventrally, slightly concave in the RV continuing to a flattened area in the posterior region of the caudal process. Discrete alar process slightly extended and ornamented with small to medium punctae distributed regularly and arranged transversely on the surface. Eye tubercle absent. Dorsal view ovoid and slightly swollen, slightly compressed in the posterior end with a discrete but subdued alar process. Sexual dimorphism evident: males more subrectangular in lateral view, with almost the same height as females but with straighter margins and with a ventrolateral alar process that is less pronounced than in females.

Remarks: With respect to carapace shape, this species is very similar to *Cytherura? punctocentrata* sp. nov., but it differs in the ornamentation pattern which has finer and more widespread punctation and in the appearance of the alar process in the posteroventral region. *C.? sp. aff. cybaea* has a very similar carapace shape to the identified specimen (HVH No. 10089) of *Cytherura cybaea* Garbett & Maddocks, 1979 from Matagorda Bay, Texas (UH 2554), with which it also shares a posterior alar process that is slightly extended in the ventrolateral region; however, that species differs in its stronger ornamentation pattern and in the presence of an eye tubercle. This species is provisionally assigned to *Cytherura* on the basis of its lateral view. Unfortunately, features of the hingement and the calcified inner lamella that could definitively distinguish it from *Semicytherura* (Wagner 1957; Yamada *et al.* 2005) are not clearly observable in this material.

Occurrence: B-17 quarry, Capanema, Pará (samples: B1A, B7, B11–B11B); Primavera FPR-160 core (samples: AM08 and AM20).

Distribution: Lower Miocene (N4 to N6 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Genus *Hemicytherura* Elofson, 1941

Hemicytherura bradyisimilis sp. nov.

Fig. 9: 12–13

Material: 11 valves.

Etymology: similis from Latin *similis* = similar or resemblance, referring to the close similarities to *H. bradyi* Puri, 1960.

Holotype: MPEG-679-M, Female carapace, LV: L: 0.30 mm and H: 0.17 mm; RV: L: 0.29 mm and H: 0.17 mm.

Paratype: MPEG-680-M, Male, LV: L: 0.28 mm and H: 0.15 mm.

Type locality: B17 Quarry, sample B11, Capanema town.

Diagnosis: Valves unequal and very small: discrete overlap of the LV over RV. Surface with irregular and large ridges covering the lateral surface in concentric way like a heavy “cobweb” in the middle part; secondary punctuation.

Description: Very small and nearly semicircular in lateral view. Valves unequal: RV smaller than LV. Dorsal margin in the RV broadly subrounded and maximum height at 1/3 from the anterior end. Ventral margin almost straight with a slight oral concavity. Anterior margin obliquely rounded. Posterior margin pointed: subrounded in the posterodorsal region and more angular in the posteroventral region, terminating in a medial and pronounced caudal process. In LV, the dorsal margin is almost straight with somewhat prominent cardinal angles. Surface with irregular and large ridges covering the surface in concentrically like a heavy “cobweb” in the middle part; secondary punctuation.

Remarks: *Hemicytherura bradyi* (Puri, 1960) *sensu* van den Bold, 1988 is similar to the species here described in shape and size, but it differs in the pattern of ornamentation. The species *H. cranekeyensis* Puri, 1960 in van den Bold (1988) is very similar in size and ornamentation, but it differs in shape in lateral view. *Hemicytherura bradyi* (Puri, 1960) *sensu* Coimbra *et al.*, 1999 also is similar to *H. bradyisimilis* sp. nov. in shape and size, but it differs in the pattern of ornamentation.

Occurrence: B-17 quarry, Capanema, Pará; B11 and B12 samples.

Distribution: Lower Miocene (N5/N6 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Hemicytherura sp.

Fig. 9: 14–15

Material: 1 valve.

Dimensions: MPEG-681-M, RV: L: 0.29 mm and H: 0.19 mm.

Description: Small and subovate in lateral view. Valve obliquely subrounded in the anterior margin and truncate in the posterior margin. Dorsal margin high and strongly convex. Ventral margin almost straight with a convex portion in the posteroventral region. Surface strongly reticulate with coarse ridges arranged regularly. Of these, two median ridges are especially prominent, converging from the mid-posterior region to the anterior end; the superior ridge is shorter than the median ridge. Muri and fossae large. Some ridges are intercalated by well-marked secondary punctae, mainly in the dorsal area. Hinge pattern typical of the genus.

Remarks: The present species is similar to *Hemicytherura auriculata* Ramos *et al.*, 1999 from Recent sediments from the northern Rio de Janeiro coast, mainly in the presence of the convex dorsal margin, subovate shape in lateral view, and strong ornamentation; however, it is smaller in size.

Occurrence: FPR-160 core (Primavera), sample AM8.

Distribution: Lower Miocene (N4 zone; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Genus *Hemingwayella* Neale, 1975

Hemingwayella sp.

Fig. 9: 16–18

Material: 11 valves.

Dimensions: MPEG-682-M, RV: L: 0.39 mm and H: 0.17 mm. MPEG-683-M, LV: L: 0.34 mm and H: 0.16 mm.

Description: Very thick-shelled and robust carapace. Dorsal margin straight to slightly sinuous. Ventral margin with a swollen and straight alaform ridge. Anterior margin nearly rounded. Posterior margin almost rounded to truncate, with a short caudal process dorsally positioned. Surface coarsely punctate and ridges irregularly distributed with strong pits below the ridges. Pronounced ridges in the median and anteromedian region; strong pits between and above the ridges. Hinge seems weak or worn, with faint indications of sockets in RV and a hinge margin or crenulate groove between them. Other diagnostic internal features were not observed due to the poor quality of preservation.

Remarks: *Hemingwayella pumilio* (Brady, 1880) Whatley & Maybury, 1991 is similar in carapace shape and also has a strong, straight ventral ridge like an alar process, but it differs in ornamentation and in its shape in lateral view, which is more subrectangular than the species in this study.

Occurrence: Aricuru (Maracanã bay), samples AR-03, AR-04 and AR-06; B-17 quarry, Capanema, Pará (sample B1, B11A and B11B); Primavera FPR-160 core (sample: AM08).

Distribution: Lower Miocene (N4 to N6 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Genus *Semicytherura* Wagner, 1957

Semicytherura sp. aff. *S. clavata* (Brady, 1880) Whatley, Chadwick, Coxill & Toy, 1988

Fig. 9: 19–21

aff. 1880 *Cytherura clavata* n. sp.—Brady: p. 133, pl. 29, figs. 7A–d.

aff. 1976 *Cytherura clavata* Brady.—Puri & Hulings: p. 303, pl. 19, figs. 7–10.

. aff. 1988 *Semicytherura clavata* (Brady), 1880.—Whatley, Chadwick, Coxill & Toy: p. 178, pl. 2, figs. 6–8.

Material: 5 valves.

Dimensions: MPEG-684-M, LV: L: 0.43 mm and H: 0.20 mm. MPEG-685-M, RV: L: 0.43 mm and H: 0.19 mm.

Description: Small, subrectangular to elongate in lateral view. Dorsal and ventral margins are subparallel in both valves; dorsal margin straight with a flatted area in the mid-dorsal region. Ventral margin slightly sinuous. Anterior margin subrounded. Posterior margin with a caudal process situated at mid-height, coincident with the maximum length; posteroventrally straight and converging upward until the end of the caudal process. Surface presents ornamentation of numerous delicate anastomosing ridges and some minute punctae, distributed and arranged regularly, smoother in the posterior region. Eye tubercle not evident. Hinge features as for genus.

Remarks: This species resembles to *Cytherura clavata* Brady, 1880 in general shape and ornamentation, but it has a sinuous posterodorsal margin and a deeper median sulcus differing of the species described here. Based on lateral view of the carapace and in ornament of numerous delicate horizontal anastomosing ridges, *Semicytherura clavata* (Brady, 1880) Whatley, Chadwick, Coxill & Toy, 1988 is close to the present species, but differs in the presence of a surface completely covered with dense minute punctae and a weak median sulcus. *Cytherura elongata* Morales, 1966 (identified specimen: HVH No. 8389) is similarly elongate in shape, but its ornamentation is stronger and it has a more prominent eye tubercle than the species described herein.

Occurrence: Aricuru (Maracanã bay), sample AR-04; Primavera FPR-160 core (sample: AM08).

Distribution: Lower Miocene (N4 zone; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

***Semicytherura* sp.**

Fig. 9: 22–24

Material: 1 carapace and 2 valves.

Dimensions: MPEG-686-M, C; LV: L: 0.37 mm and H: 0.19 mm; RV: L: 0.37 mm and H: 0.20 mm; W: 0.19 mm.

Description: Carapace small and subelongate in lateral view. LV larger in the anterior region and narrower in the posterior region. Dorsal and ventral margins subparallel: dorsal margin straight and ventral margin almost straight, slightly biconvex. Anterior margin subrounded. Posterior margin with a caudal process situated at mid-height, coincident with maximum length; ventrolateral region presents delicate longitudinal ridges and medium punctae, concentrated in the median region of the carapace. Eye tubercle absent. Dorsal view ovoid, slightly compressed in the posterior end and broad in the anterior end. Hinge features as for genus.

Remarks: This species resembles *Semicytherura* aff. *S. clavata* (Brady, 1880) Whatley, Chadwick, Coxill & Toy, 1988 described in the present study, however, the present species differs in being slightly smaller, less elongate and more suboval in outline, in its ornamentation pattern.

Occurrence: Aricuru (Maracanã bay), samples AR-03 to AR-04; B-17 quarry, Capanema, Pará (samples: B11 and B12); Primavera FPR-160 core (samples: AM20 and AM08).

Distribution: Lower Miocene (N4 to N6 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

***Semicytherura? fortisreticulata* sp. nov.**

Fig. 9: 25–27

Material: 3 carapaces and 11 valves.

Etymology: fortis from Latin *fortis* = strong; reticulata from Latin *reticulatum* = network, mesh, referring to the strong and well-organized reticulation pattern.

Holotype: MPEG-687-M, C, Female; LV: L: 0.33 mm and H: 0.20 mm; RV: L: 0.33 mm and H: 0.18 mm; W: 0.23 mm.

Paratypes: MPEG-688-M, C, Male; LV: L: 0.37 mm and H: 0.18 mm; RV: L: 0.37 mm and H: 0.17 mm; W: 0.21 mm. MPEG-689-M, C, female; LV: L: 0.35 mm and H: 0.19 mm; RV: L: 0.35 mm and H: 0.17 mm.

Type locality: Aricuru outcrop (Maracanã bay), sample AR-04, Aricuru town.

Diagnosis: Ornamentation highly reticulate to coarsely punctate, with deep punctae and ridges distributed longitudinally, mainly parallel to the ventral and dorsal region.

Description: Carapace small, subelongate in lateral view. Valves with almost equal heights, with a small overlap of the RV on the dorsal margin. Dorsal margin and ventral margin almost straight; in lateral view, the posteroventral margin is hidden by the ventral alae in the LV. Anterior margin rounded. Posterior margin with a caudal process situated at mid-height coincident with maximum length; posteroventrally, a wing-like alar process. Ornamentation highly reticulate to coarsely punctate, with deep punctae and ridges distributed longitudinally, mainly parallel to the ventral and dorsal margins. Ventrolateral region with discrete alar process ornamented by large reticulations. Eye tubercle prominent. Dorsal view sub-ovate, strongly angular in the posteromedian region and compressed in the posterior end extending to a large and swollen alar process. Sexual dimorphism evident: males more subrectangular in lateral view, but smaller with lower height and a less pronounced alar process. Internal features were not observed.

Remarks: This species is similar to *Cytherura reticulata* (Edwards, 1944) from the Pliocene of North Carolina, USA, which differs in having a straight dorsal margin and in lacking a prominent alar process. *Cytherura* sp. G figured in van den Bold 1988 (pl. 8, fig. 7–8) from the Neogene of the Dominican Republic is also similar to *Semicytherura? fortisreticulata* sp. nov.; however, it differs in its larger size (L 0.41 mm, H 0.20 mm), weaker ornamentation and its less pronounced alar process. In addition, *Semicytherura bertelsae* Coimbra, Carreño & Michelli, 1999, an abundant species recorded in Recent sediments from the Brazilian equatorial continental shelf, has a similar ornament arrangement but with less pronounced dorsal ridges with a more punctate appearance; *S.? fortisreticulata* sp. nov. exhibits more open reticulations, a ventral ridge that is more accentuated and sinuous from the wing-like alar process to the anterior end, and a more concave posterodorsal margin.

Occurrence: Aricuru (Maracanã bay), samples AR-03 to AR-04; B-17 quarry, Capanema, Pará (samples: B11A and B12); Primavera FPR-160 core (sample: AM08).

Distribution: Lower Miocene (N4 to N6 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Genus *Kangarina* Coryell & Fields, 1937

Kangarina quellita Coryell & Fields, 1937

Fig. 10: 1–5

- | | | |
|-----|-------|---|
| . | 1937 | <i>Kangarina quellita</i> , new species .—Coryell & Fields: p. 13, fig. 15a, b, c. |
| (?) | 1953b | <i>Kangarina quellita</i> Coryell & Fields.—Puri: p. 248. pl. 4, fig. 9. |
| non | 1953b | <i>Kangarina chipolensis</i> Puri, n. sp. —Puri: p. 246. pl. 4, fig. 10, text |
| (?) | 1958 | <i>Kangarina quellita</i> Coryell & Fields.—van den Bold: p. 416, pl. 4, fig. 8. fig. 6g. |
| non | 1954 | <i>Cytheropteron</i> (<i>Kangarina</i>) <i>quellita</i> Coryell & Fields.—Keij: p. 226: pl. 5, fig. 8 (= <i>Kangarina ancyla</i> van den Bold, 1963). |
| non | 1960 | <i>Kangarina</i> cf. <i>K. quellita</i> Coryell & Fields.—Curtis: pl. 1, fig. 24. |
| v* | 1963a | <i>Kangarina quellita</i> Coryell & Fields.—van den Bold: p. 396, pl. 10, fig. 2. |

Material: 3 carapaces and 3 valves.

Dimensions: MPEG-690-M, Female, C, LV: L: 0.34 mm and H: 0.18 mm. MPEG-691-M, C; Female, C, RV: L: 0.36 mm and H: 0.19 mm; W: 0.17 mm. MPEG-692-M, Male, LV: L: 0.38 mm and H: 0.18 mm. MPEG-693-M, Male, C; RV: L: 0.39 mm and H: 0.19 mm.

Diagnosis: Carapace small, translucent, thick-shelled, with a blunt, subdorsal caudal projection; anterior margin truncated dorsally and narrowly rounded ventrally; dorsal margin straight and much shorter than the ventral margin; ventral margin almost straight with the ventral surface of the valve flattened; posterior margin is truncated ventrally and dorsally, both borders curving posteriorly to form the caudal projection in the dorsal half. A marginal rim borders the valve, less prominent on the posterior margin than elsewhere. A loop-shaped ridge, that opens forward into an extended channel occurs in the posterior ventral one-fourth; posterior to the middle a transverse ridge extends from the dorsal margin to the upper edge of the loop; the surface of the valve is marked by irregular reticulations except within the loop where it is relatively smooth. The inner marginal area is broadly developed as an inner lamella, leaving only an oval area in the posterior part of the anterior half uncovered; in the anterior, the line of concrescence parallels the border with several radial pore canals present; the inner extension of the lamellar platform rises sufficiently above the surface of the valve in the posterior ventral area to form a tunnel-like structure that opens anteriorly into the lower portion of the uncovered oval area. The hingement of the left valve consists of a short, thin, crenulated bar with single, long, narrow, obliquely arranged, crenulated tooth at each end; a narrow abutment lies above the bar and parallel to the dorsal margin; the right valve hinge structure consists of terminal pitted sockets and a connecting groove with a lower wall that is very narrow and that bears coarse terminal crenulations, and a dorsal wall that is much heavier and formed to meet the abutment in the left valve (Coryell & Fields 1937).

Remarks: This species is characterized by the anterior prolongation of the posteroventral depressed oval area and by a rather long connected ridge between the posterior loop and dorsal ridge. The figured specimen recorded by van den Bold (1963a) from the Brasso Formation (Trinidad), deposited under the number HVH No. 6880, is similar to the species recorded here mainly in size and shape in lateral view, but differs somewhat in dorsal view (it is widest from the middle to the posterior region) and it has thicker ridges.

Occurrence: B-17 quarry, Capanema, Pará; samples B1, B7 and B13; FPR-160 core, Primavera, samples AM17 and AM14.

Distribution: Miocene to Recent. The species has been found in the upper part of the Brasso Formation (Miocene), in the Tamana Formation and Manzanilla Formation from Trinidad (Mio-Pliocene; van den Bold 1958; van den Bold 1963a); Gatun Formation from the Miocene of Panama (Coryell & Fields 1937; van den Bold 1967b). In the Springvale Formation (Neogene), this species is replaced by a related form, *Kangarina ancyla* van

den Bold, 1963a. Upper Miocene from Shoctawhatchee stage (Puri 1953b) and Lower Miocene (N4 to N7 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Family CYTHERIDAE Baird, 1850

Subfamily PARACYTHERIDEINAE Puri, 1957

Genus *Paracytheridea* Müller, 1894

Paracytheridea tschoppi van den Bold, 1946

Fig. 10: 6–7

- | | | |
|-----|-------|---|
| . | 1946 | <i>Paracytheridea tschoppi</i> n. sp.—Van den Bold: p. 220, pl. 4, fig. 4. |
| . | 1954 | <i>Paracytheridea tschoppi</i> van den Bold, 1946.—Keij: p. 85, pl. 16, figs. 6–7. |
| . | 1957 | <i>Paracytheridea tschoppi</i> van den Bold.—van den Bold: p. 245, pl. 4, fig. 7. |
| . | 1963 | <i>Paracytheridea tschoppi</i> van den Bold, 1946.—Benson & Coleman: p. 33–34, pl. 6, figs. 7, 9–10; text-fig. 20a–b. |
| . | 1988 | <i>Paracytheridea tschoppi</i> Bold.—van den Bold: p. 62, 63, pl. 11, fig. 2. |
| non | 1948 | <i>Paracytheridea tschoppi</i> Van den Bold.—Kingma: p. 74, pl. 7, fig. 12a–b. |
| non | 1994a | <i>Paracytheridea tschoppi</i> Bold, 1946.—Távora: p. 108–109, fig. 13. |
| v | 1994a | <i>Paracytheridea</i> sp. 1.—Távora: pp. 109–110, fig. 14. |

Material: 2 carapaces and 304 valves.

Dimensions: MPEG-694-M, C; LV: L: 0.50 mm and H: 0.23 mm; RV: L: 0.47 mm and H: 0.23 mm; W: 0.40 mm. MPEG-695-M, C; LV: L: 0.51 mm and H: 0.26 mm. MPEG-696-M, C; LV: L: 0.45 mm and H: 0.21 mm.

Diagnosis: Carapace small, elongate, ornate, alate. Anterior end broadly and obliquely rounded. Anterior cardinal angle projecting strongly over the dorsal margin in the LV, only slightly projecting in the right. Dorsal and ventral margin nearly straight, converging towards the posterior. Posterior end tapering to a long and pointed subdorsal caudal process. Carapace ornamented with several swellings: one in the muscle-scar-area and one just in front of the posterior cardinal angle, rising into several peaks. The ventral margin is largely obscured by a strong ala. The ala, subcentral- and dorsal swellings are separated by a deep and broad depression. Halfway between the ala and the posterior end with downwardly projecting spine. The anterior end is ornamented with several ridges, which apparently tend to radiate from the subcentral swelling. One, running almost horizontal, is more prominent. Dorsal view more or less triangular, widest at the end of the alae, slightly narrower in the region of the central swelling. In the RV the dorsal boss rises into 3, in the LV into 4 peaks; in both cases the second one is the most conspicuous. The hinge in the LV consists of a long crenulate part of the dorsal margin, which curves over terminal sockets at the cardinal angles. In the RV there is a long crenulate tooth at the anterior—and a large pointed tooth at the posterior cardinal angle. They are connected by a shallow groove in the dorsal margin, which is deepest anteriorly. Calcified portion of the inner lamella rather narrow. No pore canals were seen (van den Bold 1946).

Remarks: The present material is identical to the type specimen of van den Bold (1946). Benson & Coleman (1963) illustrated specimens that closely resemble the species described herein and seem to be the same species. The specimen illustrated in the present study is also very similar to the species of van den Bold (1988), but is distinct, especially with respect to the alaform ridge that is more pointed. This species is quite different from *Paracytheridea tschoppi* (van den Bold, 1946) *sensu* Távora (1994a; fig. 13) recorded from the Pirabas Formation, mainly in the presence of a prominent swollen area in the middle to mid-posterior region.

Occurrence: Aricuru, Maracanã bay (samples AR-01, AR-03 to AR-06); B-17 quarry, Capanema, Pará (samples B1, B2, B8, B12–B13B); Ponta do Castelo outcrop, Fortaleza Island (sample: PC-00); Primavera FPR-160 core (samples: AM08a, AM10, AM15, AM17–AM20).

Distribution: Miocene from Trinidad (*Globorotalia fohsi* zone and *Globogerinatella insueta*); Los Atajos (Forest Formation); Ste. Croix Quarry, in the upper part of the Brasso formation, and the Forest Formation (van den Bold 1957). This species was recorded from modern and Quaternary sediments near Trinidad. Miocene from Cuba, Guatemala and Panamá. Palm Beach County, Florida, United States, Bermont formation (Pleistocene). Atlantic Ocean, Gulf of Mexico (Cenozoic—Recent; Maddocks *et al.* 2009). Recent sediments from Continental Shelf

Coast, Brazil (Purper & Ornellas 1987a and b). Platform carbonate, Belize (Teeter 1975). Ilha de Trinidad, Júcaro Formation (Middle Miocene). Upper Oligocene to Lower Miocene (N3 to N7 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Távora 1994a; Nogueira & Nogueira 2017).

***Paracytheridea* sp. aff. *P. altila* Edwards, 1944**

Fig. 10: 8–12

- aff. 1944 *Paracytheridea altila* Edwards, n. sp.—Edwards: p. 512, pl. 85, figs. 20–21.
aff. 1968 *Paracytheridea altila* Edwards.—van den Bold: p. 76, pl. 7, figs. 1a–1d.
aff. 1974 *Paracytheridea altila* Edwards.—Swain: p. 20–21, pl. 1, fig. 17.
aff. 1979 *Paracytheridea altila* Edwards, 1944.—Cronin: p. 146, pl. 4, figs. 1–4.
aff. 1988 *Paracytheridea altila* Edwards.—van den Bold: p. 62, pl. 11, fig. 1.
1994a *Paracytheridea* sp. 2.—Távora: p. 110–111, fig. 15.

Material: 1 carapace and 41 valves.

Dimensions: MPEG-697-M, C; LV: L: 0.55 mm and H: 0.28 mm; RV: L: 0.54 mm and H: 0.25 mm; W: 0.40 mm.

Description: Stout and robust carapace. Dorsal margin irregular and sinuous with prominent ridges in the posterodorsal region. Ventral margin with a rearward-pointing alaform ridge with several swellings on either side. Anterior margin nearly truncated. Posterior margin with pointed extremity. Surface reticulate with a swollen tubercle on the median to posterodorsal portion; ridges are more delicate and less evident in the anteromedian region. Alar process well developed. Hinge with faint indications of sockets in anterior region and pronounced, elongated, and globose teeth in the posterior region of the RV, and a crenulate groove between them. Narrow inner lamella. Others internal features were not observed due to poor preservation.

Remarks: This species is similar to *P. altila* (Edwards, 1944) recorded from the Neogene of the Dominican Republic by van den Bold (1988, pl. 11, fig. 1), which differs in that its posteromedian ornamentation is less smooth and its ventral alar process is more strongly developed. The species also resembles *Paracytheridea tschoppi* van den Bold, 1946 mainly in carapace shape in lateral view, but that species differs in the details of its more delicate ornamentation, its prominent swelling in the posterodorsal region, and in its surface that is more clearly reticulate. *Paracytheridea* sp. 2 recorded by Távora (1994a) from the Pirabas Formation is the same species described herein.

Occurrence: Aricuru, Maracanã bay (sample AR-05).

Distribution: Aricuru locality in the Pirabas Formation (Lower Miocene—N5/N6 zones; Blow 1969) Pará, Brazil (Távora 1994a; Nogueira & Nogueira 2017).

***Paracytheridea* sp. 1**

Fig. 10: 13

Material: 2 valves.

Dimensions: MPEG-698-M, RV: L: 0.53 mm and H: 0.29 mm.

Description: Robust carapace, rather high in lateral view. Dorsal margin almost straight with a strong ridge or dorso-alar processes hiding the posterodorsal margin. Ventral margin straight, parallel to the dorsal one. Anterior margin rounded. Posterior margin pointed in the extremity with its caudal process turned up abruptly. Surface strongly reticulate with a short posteroventral ridge extending to the central portion of the carapace. Internal features were not observed.

Remarks: This species differs from other *Paracytheridea* species mainly in its strongly reticulate ornament.

Occurrence: B-17 quarry, Capanema, Pará (sample: B11); Primavera FPR-160 core (sample: AM08).

Distribution: Lower Miocene (N4 to N6 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

***Paracytheridea* sp. 2**

Fig. 10: 14–15

Material: 1 valve.

Dimensions: MPEG-699-M, LV: L: 0.52 mm and H: 0.27 mm.

Description: Robust carapace, very high. Dorsal margin almost straight, merging to the posterior region. Anterior margin rounded. Posterior margin pointed. Surface with delicate ridges mainly in the anteroventral region and in the middle portion. Three swollen processes in the central, posterodorsal and posteroventral areas, typical of *Paracytheridea*. The ventral alar process is only moderately developed.

Remarks: This species differs from others in the genus in its less swollen and less pronounced alar process.

Occurrence: Aricuru (Maracanã Bay), sample AR-03.

Distribution: Lower Miocene (N5/N6 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

***Paracytheridea* sp. 3**

Fig. 10: 16

Material: 1 valve.

Dimensions: MPEG-700-M, LV: L: 0.52 mm and H: 0.27 mm.

Description: Subrectangular species of *Paracytheridea* with smooth and subtrapezoidal carapace and a posterodorsal process that is less pointed than is typical of the genus. Dorsal and ventral margins almost straight and parallel. Anterior margin straight. Posterior margin truncate. Hinge with indications of crenulate sockets in the extremities of the LV, hinge margin with teeth or a crenulate bar between them. Other diagnostic internal features were not observed due to poor preservation.

Remarks: This species is similar to *Paracytheridea altita* Edwards, 1944 but differs in its shorter and higher valves.

Occurrence: Aricuru (Maracanã bay), sample AR-03.

Distribution: Lower Miocene (N5/N6 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

***Paracytheridea?* sp. 4**

Fig. 10: 17

Material: 3 valves.

Dimensions: MPEG-701-M, RV: L: 0.48 mm and H: 0.21 mm.

Description: Medium-sized carapace, subrectangular to subelongate in lateral view. Dorsal margin long and straight, ending in caudal process. Ventral margin slightly convex with a weakly developed alarform process. Anterior margin obliquely rounded. Posterior margin subrounded and subacuminate. Surface strongly and regularly reticulate with one marked and irregular ridge along the dorsal margin and another V-shaped one in the posteroventral region; no median sulcus. Internal features were not observed due to poor preservation.

Remarks: The classification of this species *Paracytheridea* is arguable because it does not present the swollen alar dorsal and ventral posterior projections typical of that genus; the internal characteristics were not observed due to the bad preservation of the valves and to the rare material available to study, which does not allow a more precise classification. The present species differs externally to *Bythoceratina* in the outline and ornamentation pattern, but we could not evaluate this affinity because of the absence of the internal features.

Occurrence: B-17 quarry, Capanema, Pará (samples: B1 and B11A); Primavera FPR-160 core (sample: AM4).

Distribution: Upper Oligocene to Lower Miocene (N3 to N6 zones; Blow, 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Family LOXOCONCHIDAE Sars, 1925

Genus *Loxoconcha* Sars, 1966

Loxoconcha sp. aff. *Loxoconcha cyrton* van den Bold, 1963

Fig. 10: 18–23

aff. 1963a *Loxoconcha cyrton* van den Bold, **new species**.— Van den Bold: pp. 394, 395, pl. 8, fig. 11A–b.

Material: 67 carapaces and 479 valves.

Dimensions: MPEG-702-M, Female, C; LV: L: 0.47 mm and H: 0.27 mm; RV: L: 0.44 mm and H: 0.26 mm; W: 0.23 mm. MPEG-703-M, Male, C; LV: L: 0.51 mm and H: 0.26 mm; RV: L: 0.49 mm and H: 0.27 mm; W: 0.25 mm.

Description: Carapace subovate to subrhomboidal in lateral view. Greatest height just behind the middle, height more than half the length. Dorsal margin slightly irregular and slightly plump in the anterior region; LV overlapping RV. Ventral margin straight, turned upwards posteriorly. Anterior margin obliquely rounded. Posterior margin short and obliquely rounded. Surface deeply and roughly pitted, ventral margin with three to four ridges parallel to the margin extending to the postero- and anteroventral regions. Pronounced posterodorsal ridge runs parallel to the margin and terminates posteriorly at mid-height. Behind this ridge, the carapace is strongly compressed. Eye tubercle pronounced. In dorsal view, lenticular carapace, posterior end compressed and sides gently convex. Sexually dimorphic: carapace of the male is more elongate than that of female; females have the greatest height in front of the middle; posteriorly flattened and slightly concave posterodorsally towards the posterior cardinal angle. Internal features typical of the genus.

Remarks: The species *L. cyrton* van den Bold, 1963a presents many characteristics similar to species identified herein, however, it differs in some aspects of shape, ornamentation and valve overlap. The present species has also some superficial similarities to *L. savanetensis* van den Bold, 1963a, but that species differs by its gibbous dorsal margin of the left valve and by its absence of the ventral ridges.

Occurrence: Aricuru (Maracanã bay), samples AR-01, AR-04 and AR-06; B-17 quarry, Capanema, Pará (samples: B0 to B2A; B5 to B7; B9 to B11 and B11A to B13); Primavera FPR-160 core (samples: AM 4, AM6, AM 8, AM13 to AM15, AM 17, AM19 and AM20).

Distribution: Upper Oligocene to Lower Miocene (N3 to N7 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Loxoconcha sp.

Fig. 10: 24–25

Material: 5 valves.

Dimensions: MPEG-704-M, LV: L: 0.36 mm and H: 0.19 mm. MPEG-705-M, RV: L: 0.39 mm and H: 0.22 mm.

Description: Carapace medium-sized and subrectangular in lateral view. Dorsal margin straight with cardinal angles slightly pronounced. Ventral margin slightly convex in the LV, almost straight in the RV, gently turned up posteriorly. Anterior and posterior margins obliquely rounded in both valves. Surface deeply reticulate with circular to polygonal fossae distributed regularly. Along the entire edge of the anterior margin, a row of fossae and short ridges extends towards the middle of the carapace. In RV, a ventral ridge is more evident than in LV; this ridge follows from the anteroventral region towards the posteroventral region, forming a very short alar process. Eye tubercle pronounced. Internal features not preserved.

Remarks: This species differs from the other members of the genus *Loxoconcha* described herein in that the carapace shape is more rectangular than subovate or subrhomboidal. *Loxoconcha santosi* Dung & Tsukagoshi, 2014 is similar to the species described herein mainly in the outline of the LV, in the pronounced eye tubercle and in the reticulation pattern, but it differs in its smaller size (L 0.44 mm; H 0.28 mm) and in the presence of three short and weak ridges in the anterior region.

Occurrence: Primavera FPR-160 core (samples: AM08).

Distribution: Lower Miocene (N4 zone; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

***Loxoconcha corpulenta* sp. nov.**

Fig. 11: 1–9

Material: 10 carapaces and 6 valves.

Etymology: corpulenta from Latin *corpulentus* = fat, referring to the robust and globose aspect of the carapace shape.

Holotype: MPEG-706-M, Female, C; LV: L: 0.46 mm and H: 0.30 mm; RV: L: 0.45 mm and H: 0.28 mm.

Allotype: MPEG-707-M, Male, C; LV: L: 0.54 mm and H: 0.31 mm; RV: L: 0.52 mm and H: 0.30 mm.

Paratypes: MPEG-708-M, Female, RV: L: 0.52 mm and H: 0.30 mm. MPEG-709-M, Female, W: 0.30 mm. MPEG-710-M, Female, C; LV: L: 0.52 mm and H: 0.30 mm. MPEG-711-M, Female, LV: L: 0.51 mm and H: 0.30 mm. MPEG-712-M, juvenile, RV: L: 0.42 mm and H: 0.25 mm. MPEG-713-M, juvenile, LV: L: 0.34 mm and H: 0.19 mm. MPEG-714-M, juvenile, LV: L: 0.33 mm and H: 0.21 mm.

Type locality: Aricuru outcrop (Maracanã bay), sample AR-04, Aricuru town.

Diagnosis: This species has a globose outline in dorsal view; the surface is deeply reticulate, circular to elliptical fossae, distributed regularly; in the posterodorsal region, a thickened muri is situated between the punctae.

Description: Carapace medium-sized and rhomboidal to subovate, almost almond-shaped, in lateral view. Dorsal margin straight. Ventral margin convex, upturned gently posteriorly. Anterior margin rounded. Posterior margin subrounded. LV overlapping RV in the dorsal margin and RV overlaps LV in the free margins. Surface deeply reticulate, fossae circular to elliptical, distributed regularly; in the posterodorsal region, there is a thickened muri between the punctae. Two or three ventral ridges, parallel to the ventral margin, extended from the anteroventral region in the RV, and converging towards the posterior region in both valves; posterior ridge extends further, parallel to the posterodorsal region, mainly in the RV. Area behind this ridge is strongly compressed. The anterior margin comprises a narrow and compressed flange with a row of fossae. Eye tubercle pronounced. Sexually dimorphic: males more elongate than females. Greatest height in front of the middle; posteriorly flattened and slightly concave in the posterodorsal area towards the posterior cardinal angle. Some juvenile instars were observed, showing the same characters as adults, although less developed. Internal features typical of the genus.

Remarks: This species is very similar to *Loxoconcha avellana* (Brady, 1866) recorded by Palacios-Fest *et al.* (1983) in recent sediments from Mexico, differing only in ornamentation. Differs from the figured specimen of *L. avellana* (Brady, 1866) in van den Bold (1966a) (HVH No. 7916) from Cubagua Formation, Venezuela (Upper Miocene) in the presence of the ventral ridges parallel to the margin.

Occurrence: Aricuru (Maracanã bay), samples AR-01 to AR-04; B-17 quarry, Capanema, Pará (samples: B11A to B13).

Distribution: Lower Miocene (N5 to N7 zones; Blow, 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Subfamily LOXOCONCHINAE Sars, 1926

Genus *Loxocorniculum* Benson & Coleman, 1963

***Loxocorniculum* sp. aff. *Loxoconcha rugosa* (van den Bold, 1946)**

Fig. 11: 10–12

aff. 1946 *Loxoconcha antillea* var. *rugosa*, n. var.—Van den Bold: p. 110, pl. 15, fig. 6A–b.

aff. 1963a *Loxoconcha rugosa* van den Bold.—van den Bold: p. 394, pl. 8, fig. 7.

aff. 1981 *Loxoconcha rugosa* Bold, 1946.—van den Bold: p. 81, pl. 5, fig. 8, table 15.

Material: 4 carapaces and 43 valves.

Dimensions: MPEG-715-M, C; LV: L: 0.45 mm and H: 0.25 mm; RV: L: 0.40 mm and H: 0.23 mm. MPEG-716-M, Juvenile, LV: L: 0.43 mm and H: 0.25 mm.

Description: Carapace medium-sized and subrectangular in lateral view. Dorsal margin irregular, almost straight with a posterodorsal projection. Ventral margin almost straight, gently concave in the middle. Anterior margin obliquely rounded and compressed. Posterior margin obliquely subrounded and pointed in the mid-posterior region. Behind this margin and in the posteroventral region the valve is strongly compressed. Surface weakly reticulate with three short and weak longitudinal anteromedian ridges. Eye tubercle evident. Three or four weak ventral ridges parallel to the margin converging towards the posteroventral region. Posterodorsal tubercle evident. Internal features were not observed.

Remarks: This species is very similar to *Loxoconcha rugosa* originally described by van den Bold (1946; 1963a); the figured specimen of *Loxoconcha antillea* van den Bold, 1965 (HVH No. 7780) and also *Loxoconcha antillea* var. *rugosa* (van den Bold 1946; 1981) are also very similar, mainly in the carapace shape and in the ornamentation pattern, as well as in the presence of a conspicuous eye tubercle, ventral ridges that are weakly alate and prominent, horn-like posterodorsal tubercle, all of which are more prominent in *L. rugosa*. The presence of a strong and well-preserved reticulate surface and a horn-like posterodorsal protuberance are typical of the genus *Loxocorniculum*. The only characteristic not observed here and typical of this genus is the presence of a gongylodont hinge which comprises a crenulate hinge with a systematic increase in size of teeth and socket from anterior to posterior in RV, but the teeth in the species found here appear to be of the same size along the entire median bar. Benson and Coleman (1963) included the species *Loxoconcha rugosa*, *L. antillea* and *L. fischeri* in their new genus *Loxocorniculum*, and we follow this assignment here.

Occurrence: Aricuru (Maracanã bay), samples AR-01, AR-03 and AR-04; Primavera FPR-160 core (samples: AM4, AM6 and AM8).

Distribution: Upper Oligocene to Lower Miocene (N3 to N6 zone; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Loxocorniculum fischeri (Brady, 1869)

Fig. 11: 13–16

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| | 1869 | <i>Cythere? Fischeri</i> (G.S. Brady)—Brady: p. 154, pl. 18, figs. 15–16. |
| partim . | 1957 | <i>Loxoconcha fischeri</i> (Brady).—van den Bold: p. 244, pl. 2, fig. 7; pl. 7, figs. 9, 10. |
| . | 1963a | <i>Loxoconcha fischeri</i> (Brady).—van den Bold: p. 393, pl. 8, figs. 8–9. |
| nov. comb. | 1963 | <i>Loxocorniculum fischeri</i> (Brady, 1869) Benson & Coleman n. comb.—Benson & Coleman: p. 39, pl. 7, Figs. 3–4, 24. |
| . | 1988 | <i>Loxoconcha (Loxocorniculum) fischeri</i> (Brady).—van den Bold: p. 49, pl. 7, Figs. 9, 10 |

Material: 17 valves.

Dimensions: MPEG-717-M, Female, RV: L: 0.50 mm and H: 0.31 mm. MPEG-718-M, Male, RV: L: 0.54 mm and H: 0.30 mm. MPEG-719-M, Male, RV: L: 0.54 mm and H: 0.30 mm. MPEG-720-M, Male, RV: L: 0.54 mm and H: 0.30 mm.

Diagnosis: A species of *Loxocorniculum* with two posteroventral tubercles (van den Bold 1988).

Remarks: The present species is similar to the material figured by van den Bold (1963a) mainly in the shape, size, and presence of a horn-like posterodorsal tubercle, ventral ridges and pronounced eye tubercle. This species also resembles the holotype figured in van den Bold (1963a) of *Cythere fischeri* Brady, 1869 in its ventral ridge and in the posterodorsal tubercle; however, the holotype has a smaller eye node. *Loxoconcha (Loxocorniculum) fischeri* (Brady, 1869) *sensu* van den Bold (1988) differs in its posterodorsal and ventral nodes that are more developed, in its greater length and in its middle anterior ridges that are not parallel as they are in the species described herein. The species is assigned here to *Loxocorniculum* following Benson & Coleman (1963) mainly due to the presence of prominent hornlike protuberances typical to this genus on the posterodorsal region as in *Loxocorniculum* sp. aff. *L. rugosa* (van den Bold, 1946) described herein.

Occurrence: Primavera FPR-160 core (samples: AM08 and AM17).

Distribution: Upper Miocene to Recent: Trinidad (Upper Miocene and Recent; van den Bold 1963a), Greater Antilles, Miocene of Venezuela (van den Bold 1957), Cuba, Guatemala, Colombia and Panama (Colón Harbor—

Recent; van den Bold 1966d; 1957), Costa Rica, Mexico (Maddocks *et al.* 2009). Ste. Croix Quarry (Recent; van den Bold 1957). Manzanilla Formation upward, Upper Miocene (van den Bold 1963a). Lower Miocene (N4 to N6 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

***Loxocorniculum antillum* (van den Bold, 1946) comb. nov.**

Fig. 11: 17

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|------------|------|--|
| . | 1946 | <i>Loxoconcha antillea</i> , n. sp.—Van den Bold: p. 110, pl. 15, figs. 3a–c; p. 86. |
| p. | 1957 | <i>Loxoconcha fischeri</i> (Brady).—van den Bold: p. 244, pl. 2, fig. 7. |
| v | 1965 | <i>Loxoconcha antillea</i> van den Bold.—van den Bold: pl. 4, fig. 3A–b. |
| nov. comb. | 1988 | <i>Loxoconcha</i> (<i>Loxocorniculum</i>) <i>antillea</i> (Bold).—van den Bold: p. 50. |

Material: 8 carapaces and 32 valves.

Dimensions: MPEG-721-M, LV: L: 0.52 mm and H: 0.29 mm. RV: L: 0.42 mm and H: 0.25 mm.

Diagnosis: Carapace in lateral view almost the same shape as *L. cubensis*, but differing in possessing an ornamentation of tubercles. Posterior end somewhat more produced. At both cardinal angles a tubercle occurs, while the ventral portion of the carapace bears two raised ridges. Valves reticulate, varying from nearly smooth to rather strongly reticulate. In the anterior end two faint transverse ridges may be seen, rising at the ends of the vertically truncate extremity and converging posteriorly. Dorsal view similar to the preceding species, but irregular owing to the projecting tubercles. Greatest width at the anterior one of two ventral tubercles or ridges, slightly behind the middle. Hinge-structure and marginal area typical, the bar in the left valve is finely crenulate (van den Bold 1946).

Remarks: As for the others species recorded above, this species is here considered as *Loxocorniculum* because the presence of the evident dorsal and ventral posterior horns typical to this genus. The studied material has apparently the same features as the figured specimen of *Loxoconcha antillea* van den Bold, 1965 (HVVH No. 7780), particularly in the presence of a tubercle or hornlike protuberance posterodorsally. However, the posteroventral area differs by having a large depressed area, a reduced tubercle or horn-like protuberance and a strongly reticulate lateral surface. *Loxocorniculum fischeri* (Brady, 1869) recorded here is similar to the present species but differs in the absence of evident secondary punctuation present in the specimens of this paper. In addition, *Loxoconcha fischeri* (Brady, 1869) of van den Bold (1957) and *Loxocorniculum* sp. aff. *Loxoconcha rugosa* described herein also show similarities in ornamentation pattern and in an evident tubercle on the posterodorsal region; however, they differ in the absence of a tubercle in the posteroventral region.

Occurrence: B-17 quarry, Capanema, Pará (samples: B1A, B7 and B12); Primavera FPR-160 core (samples: AM4, AM6, AM8 and AM19).

Distribution: This species is widespread in the Caribbean region from the *Catapsydrax stainforthi* Zone (N6) upward to the Upper Miocene. In Panamá (Cibao and La Boca Formations; van den Bold 1965; 1972a), also recorded in Cuba, Paso Real Formation (Lower Miocene; van den Bold 1946; 1972a; 1965), Río Yaque del Norte (López), however, its general range occurs in Lower to Upper Miocene in the Dominican Republic, Caribbean region (van den Bold 1988). La Rosa Formation, Venezuela (van den Bold 1950). This species also was recorded in Ste. Croix, Morne Diablo, Brasso and Tamana Formations (Upper Miocene) from Trinidad, Porto Rico (Cibao and Lares Formation; van den Bold 1972a), Guatemala (Rio Dulce; van den Bold 1972a) and Haiti (Madame Joice; van den Bold 1972a). Upper Oligocene to Lower Miocene (N3 to N6 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

***Loxocorniculum* sp. aff. *Loxoconcha longispina* (Key, 1953)**

Fig. 11: 18–20

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| aff. | 1953 | <i>Loxoconcha alata</i> Brady var. <i>longispina</i> nov. var.—Key: p. 160, pl. 1, figs. 10a, b. |
| aff. | 1967 | <i>Loxoconcha longispina</i> Keij, 1953.—Holden: p. 32–34, figs. 23A–d. |
| aff. | 1976 | <i>Loxoconcha longispina</i> (Key).—Holden: pl. 4, fig. 14; pl. 5, figs. 3–6; pl. 14, figs. 12–15. |

Material: 12 carapaces and 13 valves.

Dimensions: MPEG-722-M, Female, LV: L: 0.43 mm and H: 0.27 mm. MPEG-723-M, Female, LV: L: 0.42 mm and H: 0.24 mm. MPEG-724-M, Male, LV: L: 0.44 mm and H: 0.25 mm.

Description: Carapace medium-sized and subovate in lateral view. Dorsal margin straight to slightly concave with a weak posterodorsal protuberance. Pronounced eye tubercle in the anterodorsal region. Ventral margin convex, gently upturned posteriorly. Anterior margin narrowly rounded. Posterior margin obliquely subrounded. Behind this margin and in the posteroventral region the valve is strongly compressed. Surface coarsely reticulate, with circular fossae. Sexually dimorphic: males more elongate than females. Muscle scars with a row of four inflated adductor scars. Others internal features were not observed.

Remarks: This species is similar in shape and ornamentation to *Loxoconcha longispina* Key, 1953 of Holden (1976); however, the current material differs in the absence of two weak, parallel and short longitudinal ridges extending from subcentral region to the anteromedian region. This species is considered here as *Loxocorniculum* because it bears posterodorsal and posteroventral tubercles typical to this genus, although they are weakly developed (see fig. 11: 20). Internal features are poorly preserved.

Occurrence: Aricuru (Maracanã bay), samples AR-03 to AR-05; B-17 quarry, Capanema, Pará (samples: B11 and B12); Primavera FPR-160 core (samples: AM08).

Distribution: Lower Miocene (N4 to N6 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Loxocorniculum sp.

Fig. 11: 21–27

Material: 2 carapaces and 8 valves.

Dimensions: MPEG-725-M, Female, LV: L: 0.50 mm and H: 0.29 mm. MPEG-726-M, Female, RV: L: 0.47 mm and H: 0.26 mm. MPEG-727-M, Male, LV: L: 0.50 mm and H: 0.26 mm. MPEG-728-M, Male, RV: L: 0.47 mm and H: 0.25 mm. MPEG-729-M, Male, LV: L: 0.44 mm and H: 0.22 mm.

Description: Carapace medium-sized and subrectangular in lateral view. Dorsal margin straight. Ventral margin convex posteriorly; anterior margin obliquely rounded and compressed. Posterior margin strongly oblique with a pointed portion in the mid-posterior region forming a short caudal process. Surface coarsely reticulate. Two pronounced tubercles with a conical shape; one in the posterodorsal and the other in the posteroventral region. Three ventral ridges follow the ornamentation pattern. Posteroventral region flat and broadly reticulate behind the alar tubercle. Anterior and posterior margin flat and smooth. Two mid-anterior ridges converging to the anteromedian region. Eye tubercle prominent. Hinge of LV with a groove in the anterior region following a crenulate median groove, with a posterior tooth surrounded by a socket; RV complementary. Hinge crenulate, with a systematic increase in the size of teeth and in the size of sockets from anterior to posterior; different from that of *Loxoconcha*. Muscle scars with a row of 4 adductor scars, one crescent-shaped frontal scar, two oval mandibular scars. Other internal features were not observed.

Remarks: This species resembles *Loxoconcha* aff. *L. (Loxocorniculum) fischeri* (Brady, 1869) of van den Bold (1988) in shape and hingement, but differs in many aspects of the ornamentation, mainly in the strong mid-anterior “v”-shaped ridges; and in the posteroventral and posterodorsal tubercles that are more prominent than the species studied here. In addition, *Loxocorniculum antillum* (van den Bold, 1946) comb. nov. resembles this species mainly in the carapace shape; however, it differs from *L. sp.* in the straighter posteroventral outline, presence of two short and parallel ridges more prominent in the anteromedian region, a depressed posteroventral region that lacks a horn-like protuberance, and weaker reticulation with secondary reticulations. This is probably a new species, but due to the paucity of material, it is left in open nomenclature.

Occurrence: Primavera FPR-160 core (samples: AM4, AM6, AM8 and AM17).

Distribution: Upper Oligocene to Lower Miocene (N3 to N6 zones; Blow, 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Subfamily LOXOCAUDINAE Schornikov, 2011

Genus *Phlyctocythere* Keij, 1958

Phlyctocythere sp.

Fig. 11: 28–29

Material: 6 carapaces and 13 valves.

Dimensions: MPEG-730-M, C; LV: L: 0.38 mm and H: 0.23 mm; RV: L: 0.37 mm and H: 0.24 mm.

Description: Small-sized carapace, short and irregularly ovate in lateral view and highest at mid-length. Dorsal margin gently convex and irregular with a slight concavity posterodorsally. Ventral margin slightly sinuous, concave in the anteromedian region and slightly convex in the posteroventral region, gently turned up posteriorly. Anterior margin evenly rounded in both valves. Posterior margin obliquely rounded with a subdorsal caudal process. Surface smooth and strongly compressed above and below the caudal process. RV overlaps the LV in the dorsal and anterior margins. Internal features not observed.

Remarks: This species is similar to *Phlyctocythere curva* van den Bold, 1988 in general shape, but that species differs in its dorsal margin being strongly sinuous, in its prominent and subdorsal caudal process, and in its faint reticulate pattern in the anterior region. This species also resembles *Phlyctocythere stricta* van den Bold, 1988 in its carapace shape and smooth surface, but *P. stricta* has a straighter dorsal margin than the specimens studied here.

Occurrence: Aricuru (Maracanã bay), samples AR-02 to AR-04; and AR-06; B-17 quarry, Capanema, Pará (sample: B11B); Primavera FPR-160 core (samples: AM17).

Distribution: Lower Miocene (N5/N6 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Genus *Touroconcha* Ishizaki & Gunther, 1976

Touroconcha ishizakii sp. nov.

Fig. 12: 1–8

Material: 8 carapaces and 22 valves.

Etymology: in honor of the retired ostracodologist Dr. Kunihiro Ishizaki (born in 1934), one of the authors of this genus. He worked almost his entire life at Tohoku University (1962–1997) in Japan.

Holotype: MPEG-731-M, Female, C; LV: L: 0.41 mm and H: 0.25 mm; RV: L: 0.40 mm and H: 0.22 mm; W: 0.25 mm.

Allotype: MPEG-732-M, Male, C, LV: L: 0.44 mm and H: 0.24 mm; W: 0.24 mm.

Paratypes: MPEG-733-M, Female, LV: L: 0.37 mm and H: 0.22 mm; RV: L: 0.37 mm and H: 0.22 mm. MPEG-734-M, Male, RV: L: 0.42 mm and H: 0.23 mm.

Type locality: FPR 160 Core, depth 10–15 m, sample AM19, Primavera town.

Diagnosis: Surface coarsely reticulate with a secondary ornament comprising fossae; two posterodorsal ridges converging posterodorsally.

Description: Carapace small and subrectangular to subrhomboidal in lateral view. Dorsal margin straight with two posterodorsal ridges converging posterodorsally; there is a pronounced eye tubercle in the anterodorsal region. Ventral margin moderately convex, gently upturned posteriorly; ventral ridge slightly irregular. Anterior margin obliquely rounded and compressed. Posterior margin obliquely rounded. Compressed area around the anterior margin and, particularly around the posterior margin, forming a flange. Surface coarsely reticulate. Along the ventral margin, especially in the posterior half, there are two ventral ridges filled with a secondary ornament comprising fossae, which follow those ridges. The sinuous, median longitudinal rib deviates and bifurcates around the area of the adductor muscles. Hinge: anterior end of LV with an elongate tooth followed by a rounded and small socket; a median crenulate bar and a tooth surrounded by an elongate socket at the posterior end. Muscle scars poorly preserved but four oval adductor scars with one or two oval (?) frontal scars situated slightly above an antero-central position have been observed; two additional flattened and suboval mandibular scars. Other internal features were not observed.

Remarks: The species is similar to species of the genus *Loxonconcha* in general shape, but the posterior is more rounded and the hinge consists of a socket-tooth-socket arrangement. However, *T. ishizakii* **sp. nov.** differs from members of that genus in its strongly reticulate ornamentation with fossae framed by pronounced ridges distributed irregularly. There are turreted sieve-plate pore canals between the prominent ridges and the straight dorsal outline or hinge line are typical of *Touroconcha*. In contrast, *Loxoconcha* has more organized reticulations with less prominent ridges and a more arched dorsal outline or hinge line. The type specimens of *Touroconcha lapidiscola* (Hartmann, 1959) Ishizaki & Gunther, 1976 (HVV 11, 061) accepted as *Loxoconcha (Touroconcha) lapidiscola* (Hartmann, 1959) by Brandão *et al.* (2014) have prominent ridges irregularly distributed, a posterior margin more acutely pointed in the median region and a more sinuous ventral margin.

Occurrence: B-17 quarry, Capanema, Pará (samples: B7, B9 and B13); Primavera FPR-160 core (samples: AM08, AM12, AM13 and AM19).

Distribution: Lower Miocene (N4 to N7 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Family NEOCYTHERIDEIDAE Puri, 1957

Genus *Copytus* Skogsberg, 1939

Copytus sp.

Fig. 12: 9

Material: 2 valves.

Dimensions: MPEG-735-M, LV: L: 0.55 mm and H: 0.18 mm. MPEG-736-M, RV: L: 0.68 mm and H: 0.20 mm.

Description: Carapace medium-sized and elongate in lateral view. Dorsal margin low and slightly concave, with dorsal edge straighter than in *Cushmanidea*. Ventral margin slightly convex to almost straight. Anterior margin obliquely subrounded. Posterior margin narrow. Surface smooth. Internal features not observed.

Remarks: This species has the strongly elongate carapace and straight dorsal margin typical of the genus *Copytus*. Two specimens of this species have been found, insufficient for the establishment of a new species.

Occurrence: B-17 quarry, Capanema, Pará (sample B11 and B12).

Distribution: Lower Miocene (N5/N6 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Family PECTOCYTHERIDAE Hanai, 1957

Genus *Munseyella* van den Bold, 1957

Munseyella minuta (van den Bold, 1946)

Fig. 12: 10–12

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|-------------------|-------|---|
| | 1946 | <i>Cytheromorpha minuta</i> n. sp. —Van den Bold: p. 105, pl. 14, fig. 12. |
| | 1953b | <i>Cytheromorpha subminuta</i> Puri, n. sp. —Puri: p. 276, pl. 6, figs. 9–10; text-fig. 111–j. |
| <i>nov. comb.</i> | 1957 | <i>Munseyella minuta</i> (van den Bold).—van den Bold: p. 238. |
| . | 1958 | <i>Munseyella minuta</i> (van den Bold).—van den Bold: p. 402, pl. 4, figs. 1a–1e, pl. 5, figs. 2a–c. |
| v | 1968 | <i>Munseyella subminuta</i> (Puri)—Swain: p. D30, pl. 5, figs. 3a–d. |
| . | 1994b | <i>Munseyella minuta</i> (van den Bold, 1946).—Távora: p.124–125, fig. 7. |

Material: 2 carapaces and 2 valves.

Dimensions: MPEG-737-M, C; LV: L: 0.30 mm and H: 0.17 mm; RV: L: 0.30 mm and H: 0.16 mm; W: 0.12 mm. MPEG-738-M, C; LV: L: 0.30 mm and H: 0.17 mm; RV: L: 0.30 mm and H: 0.16 mm.

Diagnosis: Carapace small, pellucid, highest at the anterior cardinal angle. Anterior end obliquely rounded,

dorsal and ventral margins almost straight, converging posteriorly, posterior end rounded or truncate, bearing two stout spines. From the eye tubercle at the anterior end a thickened ridge parallels the anterior margin. Surface ornamented with several irregular low plications. Carapace widest about the middle, nearly as wide at a thickened ridge at the posterior cardinal angle. Hinge-structure and marginal area almost the same as in *Cytheromorpha fuscata* (Brady, 1869) (van den Bold 1946).

Remarks: The present species is identical with *Munseyella minuta* (van den Bold, 1946) van den Bold, 1957 that was also previously recorded by Távora (1994b) from the Pirabas Formation. It is very similar to the figured specimen (HVH No. 6891) of *Munseyella subminuta* (Puri, 1953b) in shape and size; however, that species bears a dorsal ridge that is more pronounced and overlaps the dorsal edge making it more convex in lateral view. This species is also rather similar to *Munseyella bolli* van den Bold, 1966a; but differs in its weaker dorsal ridge and stronger ventral ridge.

Occurrence: Aricuru (Maracanã bay), samples AR-03 and AR-04.

Distribution: Miocene of Florida; Springvale Formation (Upper Miocene), Cipero, Brasso, Lengua and Cruse formations from Trinidad (van den Bold 1957). Lower Miocene (N5/N6 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Superfamily TRACHYLEBERIDOIDEA Liebau, 2005

Family CYTHERETTIDAE Triebel, 1952

Subfamily CYTHERETTINAE Triebel, 1952

Genus *Cytheretta* Müller, 1894

Cytheretta cf. *C. punctata* Sanguinetti, 1979

Fig. 12: 13–18

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|---------|------|---|
| cf. (?) | 1979 | <i>Cytheretta punctata</i> Sanguinetti, sp. nov. —Sanguinetti: p.126–127, pl. 2, figs. 2a–e, pl. 9, figs. 5a–b. |
| cf. (?) | 1982 | <i>Cytheretta punctata</i> (Sanguinetti, 1979).—Bertels, Kotzian & Madeira-Falcetta: p. 138, pl. 4, figs 1a–1c. |
| non | 1991 | <i>Cytheretta punctata</i> Sanguinetti, 1979.—Sanguinetti, Ornellas & Coimbra: p.140, pl. 2, figs. 1–4. |
| non | 1997 | <i>Cytheretta punctata</i> Sanguinetti, 1979.—Whatley, Moguilevsky, Toy, Chadwick & Ramos: p. 67, pl.2, figs. 4–6. |
| non | 2005 | <i>Cytheretta punctata</i> Sanguinetti, 1979.—Machado, Coimbra & Carreño: p. 244, pl. 4, fig. 9. |
| non | 2012 | <i>Cytheretta</i> sp. aff. <i>C. punctata</i> Sanguinetti, 1979.—Ramos, Coimbra, Bergue & Whatley: p.12, fig. 4, numbers 19–20. |

Material: 39 carapaces and 177 valves.

Dimensions: MPEG-739-M, C, Female, RV, L: 0.75 mm, H: 0.42 mm, LV, L: 0.77 mm, H: 0.45 mm. MPEG-740-M, C, Male, RV, L: 0.77 mm, H: 0.42 mm; LV, L: 0.79 mm, H: 0.43 mm. MPEG-741-M, C, Male, RV, L: 0.81 mm, H: 0.42 mm; LV, L: 0.84 mm, H: 0.47mm. MPEG-742-M, C, Female, W: 0.32 mm. MPEG-743-M, C, Male, W: 0.30 mm.

Description: Elongate and ovate carapace. Unequal valves: LV larger and more oval than RV. Lateral surface ornamented with moderately weak longitudinal ridges, extending from anterior region to posterior region, interrupted by a weak median sulcus. Dorsal region with ridges strongly concave extending from median anterior region to the posterior cardinal angle, running along two small and parallel ridges. Region between ridges are lightly reticulate to punctate.

Remarks: This species resembles *Cytheretta punctata* Sanguinetti, 1979 from the Miocene of the Pelotas Basin and also recorded to the Quaternary of the Chui Formation (Bertels *et al.* 1982), southern Brazil, mainly in general shape. However, the present material differs in its ornamentation that is somewhat obscured due to recalcification during the fossilization process. The present species also differs in size and outline: the posterior cardinal angle is more accentuated in the RV and the anterior cardinal angle is weaker; males and females have arched dorsal margins, but the males are more elongate. Further, the ridges on the lateral surface are weaker and appear to have gone through a celation process. The present species is not the same *Cytheretta punctata*

Sanguinetti, 1979 recorded by Sanguinetti *et al.* (1991) in the post-Miocene of the Pelotas Basin and also differs from the Recent *Cytheretta* sp. aff. *C. punctata* (Sanguinetti, 1979) recorded from South Brazil (Ramos *et al.* 2012) in size, in ornamentation pattern, and in the outline near the cardinal angles. Specimens of the same species recorded from Recent sediments off Argentina (Whatley *et al.* 1997) also differ in the ornamentation pattern and prominent cardinal angles. In both records, the specimens are smaller than the present species. Finally, the species studied here is probably a new species, but comparison with additional material of *C. punctata* Sanguinetti, 1979 is necessary to confirm its status.

Occurrence: Aricuru (Maracanã bay), samples AR-01 and AR-03; B-17 quarry, Capanema, Pará (samples: B0-B2A; B4 and B5; B7-B11; B11A-B13); Primavera FPR-160 core (samples: AM08 and AM12).

Distribution: Lower Miocene (N4 to N7 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Cytheretta fortiscostata sp. nov.

Fig. 12: 19–24

Material: 97 carapaces and 113 valves.

Etymology: forte from Latin *fortis*= strong; costata from Latin *costa*=ridges; referring to the prominent longitudinal ridges of this species.

Holotype: MPEG-744-M, C, Female, LV: L: 0.54 mm; H: 0.31 mm, RV: L: 0.52 mm; H: 0.29 mm.

Allotype: MPEG-745-M, C, Male, RV, L: 0.51 mm, H: 0.28 mm; LV, L: 0.57 mm, H: 0.30 mm.

Paratypes: MPEG-746-M, C, Female, RV, L: 0.53 mm, H: 0.27 mm; LV, L: 0.54 mm, H: 0.31 mm. MPEG-747-M, C, Female, W: 0.21 mm. MPEG-748-M, C, Male, W: 0.30 mm.

Type locality: B17 Quarry, sample B1A, Capanema town.

Diagnosis: Small and elongate-ovate carapace, sinuous and slightly convex dorsal margin, with a thick and rounded anterior margin and prominent longitudinal ridges with slight irregular pits between these; unequal valves: LV oval (female); RV elongate-oval.

Description: Small, thick-shelled, and elongate-ovate in lateral view. Anterior margin broadly rounded. Posterior margin rounded below and subtruncate above. Unequal valves: LV larger than RV and overlapping it strongly along the ventral margin. Dorsal margin in the LV sinuous and slightly convex in the middle region followed by pronounced cardinal angles. Ventral margin slightly convex, upturned in the posterior region. Anterior margin rounded to slightly oblique and thick. Posterior margin slightly angular. Surface with 6–8 longitudinal ridges, which tend to radiate from the posterior end, and a flat area behind the marginal ridge in the anterodorsal region. Dorsomedian region with three small ridges, convex and parallel. Between the ridges slight punctae occur, unevenly distributed, primarily in the anterior region. Distinct sexual dimorphism: female valves more inflated and less elongate than the male valves. Hinge holamphidont: RV consists of a massive, blunt tooth on the anterior end, behind which is an elongate socket tapering to a shallow groove just below and parallel to the dorsal margin. A high and elongate tooth in the posterior end. The hinge of the LV is complementary to the RV. Inner lamella irregular, typical of the genus. Muscle scars typical of the genus.

Remarks: The species *Cytheretta alexanderi* Howe & Chambers, 1935 from Louisiana (Eocene) shares many characters with the present species, but differs mainly in carapace size and by the presence of weak denticles in the postero-ventral region. *C. punctata* Sanguinetti, 1979 is similar in ornamentation pattern mainly with respect to the outline of the carapace and the dominant horizontal ridges along the surface; however, it is larger, more punctate between the ridges, it bears an anterior margin that is slightly downturned, and it is more rounded in the posterior region. In addition, *C. cf. C. punctata* Sanguinetti, 1979 described herein also presents some similarities to *C. fortiscostata* sp. nov. such as the presence of longitudinal ridges and carapace shape in dorsal and lateral views, but *C. fortiscostata* sp. nov. differs in its smaller size, thicker surface ridges, weaker punctae between the ridges, more prominent anterior cardinal angle and in the absence of delicate ornament on the posterior region.

Occurrence: Atalaia Beach outcrop (Salinópolis county), samples AT-01 and AT-02; B-17 quarry, Capanema, Pará (samples: B0-B8; B11-B13); Ponta do Castelo outcrop (Fortaleza Island), sample PC-00; Primavera FPR-160 core (samples: AM08, AM12, AM15 and AM17).

Distribution: Lower Miocene (N4 to N7 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

***Cytheretta petrii* sp. nov.**

Fig. 12: 25–29

Material: 9 carapaces and 53 valves.

Etymology: In honor of Dr. Setembrino Petri, Brazilian micropaleontologist and pioneer in the study of the Pirabas Formation, born in 1922 and working at university of São Paulo, Brazil.

Holotype: MPEG-749-M, C, LV: L: 0.84 mm, H: 0.36 mm; RV: L: 0.81 mm, H: 0.32 mm.

Paratypes: MPEG-750-M, LV, L: 0.74 mm, H: 0.36 mm. MPEG-751-M, LV, L: 0.74 mm, H: 0.35 mm. MPEG-752-M, RV, L: 0.70 mm, H: 0.33 mm.

Type locality: B17 Quarry, sample B1A, Capanema town.

Diagnosis: A species of *Cytheretta* with pronounced longitudinal ridges and intercostal reticulation.

Description: Large carapace, elongate and sub-rectangular in lateral view. LV larger than the RV, overlapping in the anterior portion. Dorsal margin nearly straight, parallel to ventral margin. Ventral margin slightly sinuous with a median concavity, mainly in the LV. Anterior margin obliquely rounded. Posterior margin acuminate. Surface strongly reticulate in the posterior and ventral regions, with strong ornamentation and 8–9 strong longitudinal ridges; two median longitudinal ridges extend from the subcentral tubercle to the posteroventral region. Muscle scars consist of a V-shaped frontal scar followed by a vertical row of four small ovate scars. The axis of the four adductor muscles is usually inclined anteroventrally. Some additional scars were observed anteriorly with one or more frontal or mandibular scars. Hinge typically of the genus. Inner lamella irregular, typical of the genus, and wider in the anterior region.

Remarks: In lateral view, this species is similar to *Cytheretta bambruggensis* Keij, 1957 from Belgium (Eocene-Oligocene), which differs in the presence of short marginal spines in the anterior and posterior regions, small transverse ridges with rounded depressions in between, and valves with highest inflation posteroventrally. *C. anderseni* Butler, 1963 from Louisiana to Florida (Miocene-Oligocene boundary) has similarities mainly in lateral view of the LV and in the general arrangement of the ornament; however, it differs in size and in that some longitudinal ridges are crossed by transverse ridges in the median region. The Oligocene species *C. sagri* Deltel, 1964 and *C. samothracia* Deltel, 1964 resemble the present species somewhat in shape and ornamentation pattern, but *C. petrii* sp. nov. differs in its more elongate carapace, lack of posterior spines, reticulate pattern between the ridges, presence of 8–10 marked longitudinal ridges and intercostal ornamentation on the whole surface.

Occurrence: Aricuru (Maracanã bay), samples AR-01, AR-02 and AR-05; Atalaia Beach outcrop (Salinópolis County), sample AT-01; B-17 quarry, Capanema, Pará (samples: B2A-B5, B7-B11A); Primavera FPR-160 core (samples: AM12 and AM17).

Distribution: Lower Miocene (N4 to N6 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Family CYTHERETTIDAE Hazel, 1967

Subfamily BUNTONIINAE Apostolescu, 1961

Genus *Quasibuntonia* Ruggieri, 1958

***Quasibuntonia*? sp.**

Fig. 13: 1–3

Material: 4 carapaces.

Dimensions: MPEG-753-M, C; LV: L: 0.50 mm and H: 0.29 mm; RV: L: 0.48 mm and H: 0.27 mm; W: 0.24 mm.

Description: Carapace small, subtriangular, highest at anterior cardinal angle, nearly 1/3 of the length from the anterior extremity. Dorsal margin straight and arched at the anterior cardinal angle. Ventral margin slightly convex. Anterior margin rounded with a flat border. Posterior margin narrow, obliquely truncate, curved ventrally. Prominent and coarse anterior rim continues ventrally and branches into long ventral ridges to the posteroventral region. Two horizontal ridges along the middle to the posteromedian regions, each ending in tubercles. Just in front of the posterior cardinal angle, the dorsal ridge bends downward and diverges into four short transverse ridges; in the mid-dorsal region, two short vertical sulci extend to the dorsomedian region. Greatest width at about 1/3 of the length from the posterior end; dorsal view biconvex, pear-shaped.

Remarks: The present species is very similar to *Quasibuntonia radiatopora sculpta* (Seguenza, 1880) of Sciuto (2014; Pl. 1, figs. 3–4) mainly in carapace shape, but that subspecies differs in ornamentation pattern with a strongly reticulate surface, prominent and parallel ridges, LV overlap of RV only at the anterior cardinal angle, and short and small spines in the posterior region. Although it resembles *Munseyella bermudezi* (van den Bold, 1966a) in general outline shape and size, it differs in ornamentation pattern, arrangement of the ridges, and in some aspects of the carapace shape such as the straighter dorsal margin, arched anterior cardinal angle and its slightly convex ventral margin. Thus, the genus *Munseyella* does not correspond to the described species herein in many relevant aspects.

Occurrence: B-17 quarry, Capanema, Pará (samples: B11A and B11B); Primavera FPR-160 core (sample: AM20).

Distribution: Lower Miocene (N5/ N6 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Family HEMICYTHERIDAE Puri, 1953a

Subfamily HEMICYTHERINAE Puri, 1953a

Genus *Aurila* Pokorný, 1955

Aurila laevicula (Edwards) Swain, 1968

Fig. 13: 4–8

	1944	<i>Hemicythere laevicula</i> Edwards, n. sp. —Edwards: p. 518–519, pl. 86, figs. 27–30.
	1953a	<i>Hemicythere laevicula</i> Edwards.—Puri: p. 174, pl. 1, figs. 1–2.
	1953b	<i>Hemicythere laevicula</i> Edwards.—Puri: p. 267, pl. 11, fig. 13.
	1958	<i>Hemicythere laevicula</i> (Edwards, 1944).—Brown: p. 66, pl. 7, fig. 2.
v*	1963a	<i>Hemicythere laevicula</i> Edwards.—van den Bold: p. 384–385, pl. 7, fig. 1.
v* nov. comb.	1968	<i>Aurila laevicula</i> (Edwards).—Swain: p. D24, pl. 5, fig. 12.
<i>lapsus calami</i>	1974	<i>Aurila laeviculoidea</i> Swain & Gilby, n. sp. —Swain & Gilby: Plate 7, figure 10; text-figure 27a–f.

Material: 7 carapaces and 5 valves.

Dimensions: MPEG-754-M, Female, C; LV: L: 0.52 mm and H: 0.35 mm; RV, L: 0.52 mm and H: 0.31 mm; W: 0.25 mm. MPEG-755-M, Male, C; LV, L: 0.52 mm and H: 0.32 mm; RV, L: 0.52 mm and H: 0.31 mm. MPEG-756-M, Female, LV: L: 0.52 mm and H: 0.35 mm. MPEG-757-M, Male, LV: L: 0.54 mm and H: 0.32 mm.

Diagnosis: Carapace small, somewhat elongate; dorsal outline of right valve straight, of left valve rather strongly convex; anterior obliquely rounded with marked antero-cardinal angle on right valve, but more gradual merge on left valve; ventral outlines convex except for sharp concavity about one-third distance from anterior; posterior of RV concave above, rounded below middle, of LV truncated above, rounded below. Surface with narrow, flat rim except along dorsal edge, covered with faint pits, which become larger near margins, nearly forming a reticulated surface. A few faint ridges present parallel to ventral border on ventral surface. Hinge, marginal area and radial pore-canals characteristic of genus (Edwards 1944).

Remarks: The species identified in this study is identical to the identified specimen (HVH No. 8831) of *Aurila laevicula* (Edwards) confirmed by the comparative study with that type material, recorded by van den Bold (1963a) (as *Hemicythere laevicula* Edwards), from the Miocene of the United States and with material under the number

USNM 649980 recorded by Swain (1968) from the Neogene of South Carolina, United States (Maccamaw Formation).

Occurrence: B-17 quarry, Capanema, Pará (samples: B1, B11, B11A and B11B).

Distribution: This species occurs in the Melajo Clay Member of the Springvale Formation (Late Miocene), Trinidad and in Calyx n° 44, Biche (van den Bold 1963a); Duplin Marl (Upper Miocene) of North Carolina and the Upper Tertiary Waccamaw Formation of North Carolina and South Carolina, United States (Edwards 1944), and in USGS-Belle Fontaine No. 1 Core, Southern Jackson County, Mississippi (Pleistocene). Lower Miocene (N5/N6 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Aurila cf. *A. cicatricosa* (Reuss, 1850)

Fig. 13: 9–11

cf. 1850 *Cypridina cicatricosa* **m.**—Reuss: p. 67–68, Taf. 9, Fig. 21.

cf. 2006 *Aurila (Aurila) cicatricosa* (Reuss 1850).—Gross: Abb. 6, Taf. 21, Fig. 1–12, Taf. 22, Fig. 8–10.

Material: 16 carapaces and 15 valves.

Dimensions: MPEG-758-M, C; LV: L: 0.68 mm and H: 0.49 mm; RV: L: 0.64 mm and H: 0.42 mm. MPEG-759-M, C; LV: L: 0.68 mm and H: 0.49 mm; RV: L: 0.66 mm and H: 0.44 mm. MPEG-760-M, C; internal view, LV: L: 0.74 mm and H: 0.48 mm.

Description: Medium sized and robust carapace, ear-shaped in lateral view, heavily calcified. Dorsal margin broadly convex in the LV and almost straight in the mid-dorsal portion with blunt cardinal angles in the RV. Ventral margin convex in the LV and slightly concave in the mid-central to anterior region of the RV. Anterior margin broadly rounded in the RV; subrounded and sloped downward in the LV. Small caudal process in the posteroventral region, particularly upturned in the RV. Maximum height about the midpoint in LV, and at about one third from the front in RV; maximum width at the mid-length. Surface pitted with a swelling in the mid-ventral region; weak eye tubercles present. Muscle scar pattern typical of the genus, with four adductor muscle scars, an oblique row of 3 frontal scars in front and 1 mandibular scar below. Hinge holamphidont with the frontal element strongly developed.

Remarks: The identified specimen (HVH No. 10026) and the figured specimen (HVH No. 10027) of *Aurila* sp. aff. *A. ? cicatricosa* (Reuss, 1850) from Haiti (Miocene) are similar to the present material, mainly in lateral view of RV, but they differ in the ornamentation pattern that is stronger and more regularly pitted. In addition, *Aurila (Aurila) cicatricosa* (Reuss, 1850) in Gross (2006) from the Vienna basin (Middle Miocene) seems to be larger, the ornamentation is more delicate and weak, and although similar in carapace shape, the posterior margin is more elongate and acute. Moreover, the species recorded here is also similar to *A. laevicula* (Edwards, 1944), but differs in the ventral margin, which is more convex.

Occurrence: B-17 quarry, Capanema, Pará (samples: B11A and B11B).

Distribution: Lower Miocene (N5/N6 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Genus *Caudites* Coryell & Fields, 1937

Caudites medialis Coryell & Fields, 1937

Fig. 13: 12–13

. 1937 *Caudites medialis* **new species.**—Coryell & Fields: p. 11, pl. 2, figs. 12a, b, c, d.

p. 1957 *Caudites sellardsi* (Howe and Neill).—van den Bold: p. 239, pl. 3, fig. 8.

v* 1966c *Caudites medialis* Coryell and Fields.—van den Bold: p. 360, pl. 1, fig. 7, table 1.

. 1967b *Caudites medialis* Coryell and Fields.—van den Bold: p. 311, pl. 1, fig. 4, table 1.

. 1968 *Caudites medialis* Coryell and Fields.—van den Bold: p. 19, pl. 4, figs. 1a, b, tables 6, 8, 10.

. 1988 *Caudites medialis* Coryell and Fields.—van den Bold: p. 34, pl. 3, fig. 7.

Material: 2 carapaces and 2 valves.

Dimensions: MPEG-761-M, C; LV: L: 0.58 mm and H: 0.30 mm; RV: L: 0.61 mm and H: 0.26 mm.

Diagnosis: Carapace small, thick-shelled, elongate, subtriangular in side view; dorsal margin convexly sinuous; ventral margin concave anterior to the middle, otherwise straight; anterior end broadly rounded; posterior end obliquely truncated above and produced to a blunt caudal projection below; greatest height at the anterior cardinal angle; LV overlaps RV on the ventral margin in the concave portion. The ornamentation consists of two ridges paralleling the ventral margin; the inner one continues forward and becomes the marginal anterior ridge; it ends in the posterior quarter of the valve; the marginal one of the two rises in the ventral anterior, extends around the caudal projection, and ends in a blunt spine near the dorsal cardinal angle; an anteriorly curved transverse ridge crosses the valve below the posterior cardinal angle; a median longitudinal ridge rises from the posterior transverse one just above the middle and extends toward the anterior marginal ridge, bifurcating near the middle of the anterior half, one limb extending slightly upward to the anterior margin and the other, which is larger, extending to the anterior ventral curvature of the submarginal ridge. Internally, the valves are shallow and smooth, with a moderately broad marginal area, a narrow platform, and many short straight radial pore canals. The free contact of the valves is rabbeted; the RV bears a sharp ridge near the center of the marginal area, which is developed into a prominent flange that curves inward just anterior to the middle of the ventral margin with a sharply defined narrow groove below it. The hinge structure in the RV consists of a high, knob-like anterior tooth, behind which a deep, oblique socket extends almost to the middle of the valve where it gradually narrows to an incised groove that extends to the posterior cardinal tooth. The socket and groove are finely pitted. The dorsal margin of the valve is flanged above the groove. The posterior cardinal tooth is a large, flattened, triangular one that extends some distance down the posterior slope. The hingement of the LV is a complement of the right. An eyespot occurs below the anterior dentition (Coryell & Fields 1937).

Remarks: This species is identical to the species originally recorded by Coryell & Fields (1937). The figured specimen (HVH No.8199) from Tubará Formation (Upper Miocene) recorded by van den Bold (1966c) is identical to the specimens studied herein. The present specimens are also similar to *Caudites sellardsi* (Howe & Neill, 1935) recorded in van den Bold (1957) mainly in the arrangement of the ridges and in lateral view, but that species is smaller (L 0.47 mm; H 0.22 mm) and has a longer caudal process.

Occurrence: B-17 quarry, Capanema, Pará (sample B1).

Distribution: Middle Miocene to Lower Pliocene; Colombia, Costa Rica, Panama (Gatun Formation), Jamaica, Dominican Republic, Trinidad (Coryell & Fields 1937; van den Bold, 1957; 1966c; 1967a e b; 1968; 1988); and Lowest portion of B-17 quarry, Capanema, Lower Miocene (N5/N6 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Genus *Cornucoquimba* Ohmert, 1968

Cornucoquimba hornibrooki (Puri, 1960) comb. nov.

Fig. 13: 14–17

	1954	<i>Trachyleberis</i> cf. <i>thoracophora</i> (van den Bold.).—Keij: p. 223, pl. 4, figs. 12a,b..
nov. comb. v*	1960	<i>Bradleya hornibrooki</i> Puri, n. sp.—Puri: p. 123, pl.1, figs. 9, 10 (not text-figs. 27, 28).
v*	1966d	<i>Hermanites hornibrooki</i> (Puri).—van den Bold: pl.1, fig. 14.
.	1968	<i>Hermanites hornibrooki</i> (Puri).—van den Bold: p. 66, pl. 4, fig. 3.
.	1975	<i>Hermanites hornibrooki</i> (Puri).—Teeter: p. 419, figs. 11n, 12e.
.	1988	<i>Hermanites hornibrooki</i> (Puri).—van den Bold: p. 37, pl.3, fig. 18.
.	1994b	<i>Hermanites</i> sp.—Távora: p. 133–134, fig. 14.
non	1994b	<i>Hermanites hornibrooki</i> (van den Bold, 1946).—Távora: p. 132–133, fig. 13.

Material: 19 carapaces and 29 valves.

Dimensions MPEG-762-M, C; LV: L: 0.50 mm and H: 0.27 mm; RV: L: 0.51 mm and H: 0.26 mm; W: 0.26 mm.

Diagnosis: A small species of *Hermanites* with well developed subcentral tubercle and dorsal and ventral ridges. Greatest width at subcentral tubercle (van den Bold 1988).

Remarks: The present species is identical to the identified specimen (HVH No. 5135) and the figured

specimen (HVH No. 8260) of *Hermanites hornibrooki* (Puri, 1960) differing subtly only in the size of the carapace. This species is better assigned to *Cornucoquimba* Ohmert (1968) than to *Hermanites*. A detailed study of the internal features of both genera (see Ramos 1996 and Tsukagoshi & Kamiya 1996 for more details) show that they are very similar in the type of hinge and in the muscle scars. Externally, they also have similar ornamentation, comprising a subcentral tubercle and horn-like projections in the posterodorsal and ventral region. Species of *Hermanites* are generally bigger than those in *Cornucoquimba* and the latter has a heavier ornamentation pattern: the subcentral tubercle is more prominent and its internal depression is deeper, making it difficult to see the central muscle scars. The present species has these features of *Cornucoquimba*, and thus we assign it to this genus. Other figured specimens (HVH No. 10032; HVH No. 7774) that resemble the species of this study are of *Hermanites hutchinsoni* van den Bold, 1965 from Haiti (Miocene) and Puerto Rico (Oligocene); however, that species differs in size, in the position of greatest width, in its shorter and higher appearance in lateral view, in its weaker subcentral tubercles and ventral and dorsal ridges compared to *C. hornibrooki* comb. nov.

Occurrence: Aricuru (Maracanã bay), samples AR-01 to AR-05; B-17 quarry, Capanema, Pará (samples: B13).

Distribution: Upper Miocene to Recent: Caribbean, Gulf of Mexico. Neogene and Recent deposits from Dominican Republic (van den Bold 1968; 1988). Távora (1994b) recorded this species in the Pirabas Formation (Lower Miocene—N5 to N7 zone; Blow 1969), Pará, Brazil (Nogueira & Nogueira 2017).

Genus *Hermanites* Puri, 1955

Hermanites sp.

Fig. 13: 18

Material: 3 valves.

Dimensions: MPEG-763-M, C; RV: L: 0.49 mm and H: 0.26 mm.

Description: Subquadrate and medium to small-sized carapace. Both dorsal and ventral margins almost straight. Anterior margin broadly rounded; posterior margin subacute, and truncated, tufted with six to seven spines distributed sparsely in the ventral half of the posterior end. Surface reticulate, with two longitudinal and parallel ridges to the ventral and dorsal margins; ventral ridge more prominent and both ridges alate posteriorly, sloping gradually towards the anterior and merging near the rim of the anterior end. The subcentral tubercle is very prominent. Internal features not observed.

Remarks: The specimen illustrated herein has well developed but irregular ornamentation as in the figured specimen (HVH No. 7773) of *Hermanites tschoppi* (van den Bold, 1946) from the Lares Formation, Puerto Rico (Late Miocene) of van den Bold (1965), but that species differs in bearing a posterior end that is more elongate and in the presence of a prominent dorsal ridge.

Occurrence: B-17 quarry, Capanema, Pará (samples: B1 and B11).

Distribution: Lower Miocene (N5/N6 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Genus *Tenedocythere* Sissingh, 1972

Tenedocythere? rugosocostata sp. nov.

Fig. 13: 19–21

Material: 1 carapace and 10 valves.

Etymology: rugosa from Latin *rugosum* = rugose; referring to the wrinkled shape of the ridges; costata from Latin *costata* = ribbed; referring to the ridges.

Holotype: MPEG-764-M, C; LV: L: 0.50 mm and H: 0.29 mm; RV: L: 0.49 mm and H: 0.26 mm; W: 0.27 mm.

Paratype: MPEG-765-M, C; LV: L: 0.54 mm and H: 0.33 mm; RV: L: 0.48 mm and H: 0.28 mm.

Type locality: FPR 160 Core, depth 15–20 m, sample AM17, Primavera town.

Diagnosis: A hemicytherine species with a strongly ornamented surface with wrinkled reticulations and an alaform ridge in the ventral region.

Description: Medium sized carapace, subrectangular in lateral view. Dorsal margin almost straight; highest at the extreme anterodorsal region, coincident with the well-developed anterior cardinal angle. Ventral margin almost straight. Anterior margin broadly rounded and finely denticulate, with a well-developed marginal ridge. Posterior margin compressed and subtriangular, with a short tuft of six to seven spines. Subcentral tubercle present. Dorsal view with pronounced ridges along the borders and a sulcus parallel to the anterodorsal margin. Surface strongly ornamented with wrinkled reticulations and an alaform ridge in the ventral region. Small eye tubercle. Internal features not observed.

Remarks: This species presents some features typical of the genus *Hermanites* Puri, 1955; however, it is strongly and irregularly ornamented with pronounced ridges similar to *Tenedocythere* and thus it requires more detailed study to confirm its generic position.

Occurrence: Aricuru (Maracanã bay), samples AR-03 to AR-05; B-17 quarry, Capanema, Pará (samples: B11 and B12); Primavera FPR-160 core (samples: AM08).

Distribution: Lower Miocene (N4 to N6 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Genus *Jugosocythereis* Puri, 1957

Jugosocythereis pannosa (Brady, 1869)

Fig. 13: 22–28

.	1869	<i>Cythere pannosa</i> (G. S. Brady)—Brady: p. 154, pl. 19, fig. 1, 2.
non nov. comb.	1946	<i>Cythereis vicksburgensis</i> Howe & Law.—van den Bold: p. 89, pl. 10, fig. 5.
.	1952	<i>Quadracythere mediaplana</i> Hornibrook, n. sp.—Hornibrook: p. 45–46, pl. 9, figs. 121–123.
.	1957	<i>Hermanites? pannosa</i> (Brady).—van den Bold: p. 240, pl. 2, fig. 2.
(?)	1963a	<i>Jugosocythereis</i> sp. aff. <i>J. vicksburgensis</i> (Howe)?—van den Bold: p. 388, pl. 7, fig. 6.
.	1966d	<i>Jugosocythereis pannosa</i> (Brady).—van den Bold: p. 47–48, pl. 1, fig. 11.
.	1972a	<i>Jugosocythereis pannosa</i> (Brady, 1869).—Benson: pl. 2, fig. 1.
.	1974	<i>Jugosocythereis pannosa</i> Brady.—Maddocks: p. 210, pl. 5, figs. 1, 5–6, 8–9.
.	1975	<i>Jugosocythereis pannosa</i> (Brady).—Teeter: p. 449, figs. 11 m, 12d.
.	1976	<i>Jugosocythereis pannosa</i> (Brady).—Holden: p. F25, pl. 3, figs. 17–21, pl. 12, fig. 14.
v*	1988	<i>Jugosocythereis pannosa</i> (Brady).—van den Bold: p. 36, pl. 3, fig. 3.
.	1994b	<i>Tenedocythere</i> cf. <i>T. turda</i> (Holden, 1976).—Távora: p. 136–137, fig. 17.

Material: 176 carapaces and 1252 valves.

Dimensions: MPEG-766-M, C; LV: L: 0.64 mm and H: 0.40 mm; RV: L: 0.64 mm and H: 0.39 mm; W: 0.37 mm. MPEG-767-M, C; LV: L: 0.50 mm and H: 0.29 mm; RV: L: 0.49 mm and H: 0.26 mm; W: 0.27 mm. MPEG-768-M, C; LV: L: 0.49 mm and H: 0.30 mm. MPEG-769-M, RV: L: 0.48 mm and H: 0.28 mm. MPEG-770-M, LV: L: 0.53 mm and H: 0.30 mm. MPEG-771-M, LV: L: 0.50 mm and H: 0.29 mm. MPEG-772-M, C, LV: L: 0.49 mm and H: 0.28 mm.

Diagnosis: A species of *Jugosocythereis* with high-crested system of median ridges, pronounced dorsal and ventral ridge (van den Bold 1988).

Remarks: The present species is identical to the type species originally recorded by Brady (1869). Comparative studies verify that the present species is identical to the figured specimen (HVH No.10546) recorded from the Dominican Republic and to the figured specimen (HVH No.10179) recorded from Trinidad both by van den Bold (1988). However, it is smaller than the specimens from Recent deposits of Panama (van den Bold 1988). This species is the same as *Tenedocythere* cf. *T. turda* (Holden 1976) recorded from the Pirabas Formation by Távora (1994b).

Occurrence: Aricuru (Maracanã bay), samples AR-03 to AR-06; Atalaia Beach outcrop (Salinópolis), sample AT-01; Ponta do Castelo outcrop (Fortaleza Island), samples PC-02 and PC-03; B-17 quarry, Capanema, Pará (samples B1A, B11, B12, B11A, and B13); Primavera FPR-160 core (samples: AM7, AM08, AM12–AM14, AM19 and AM20).

Distribution: This species has a long stratigraphic range and wide geographic distribution in tropical America. It is known from the late Eocene to Holocene in the Gulf coast-Caribbean region, North Cercado, Gurabo and Mao formations; and Río Cana (Gurabo formation; van den Bold 1988). Dominican Republic—Río Gurabo: Panamá, Gulf of Mexico (Maddocks *et al.* 2009) and Trinidad (van den Bold 1963a). Upper Oligocene to Lower Miocene (N3 to N7 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Genus *Neocaudites* Puri, 1960

Neocaudites macertus (Stephenson, 1944)

Fig. 14: 1–5

- | | | |
|----|------|--|
| . | 1944 | <i>Cythereis macerta</i> Stephenson, n. sp. —Stephenson: p. 157, pl. 28, figs. 6–7. |
| p. | 1946 | <i>Cythereis guinesensis</i> n. sp. —van den Bold: p. 89, pl. 5, figs. 10a–b. |
| . | 1957 | <i>Costa macerta</i> (Stephenson).—van den Bold: p. 242. |
| v* | 1965 | <i>Neocaudites macertus</i> (Stephenson).—van den Bold: p. 399, pl. 4, fig. 2. |

Material: 5 carapaces and 1 valve.

Dimensions: MPEG-773-M, Female, C; LV: L: 0.50 mm and H: 0.27 mm; RV: L: 0.48 mm and H: 0.25 mm; W: 0.17 mm. MPEG-774-M, Male, C; LV: L: 0.54 mm and H: 0.25 mm; RV: L: 0.56 mm and H: 0.26 mm; W: 0.17 mm.

Diagnosis: Carapace small, in lateral view subrhomboidal, elongate, compressed. Dorsal margin low, straight, sloping gently to posterior; ventral margin straight or slightly sinuated. Anterior end rounded, bearing numerous very short, knoblike spines; posterior end steeply sloping to blunt posteroventral angle, denticulate like anterior. Surface bears rather irregularly disposed pits of moderate size. Peripheral rim extends from eyespot around anterior, ventral and posterior margins. Narrow dorsal ridge forms arc beginning below and behind eye-spot, extending back to point inside postero-cardinal angle, where it coalesces with elevated, irregular knob of clear shell material. Slight inflation or ridge often extends from this knob laterally toward anterior, shell wall excavated dorsally and ventrally (Stephenson 1944).

Remarks: The species identified in the present study is very similar to a figured specimen recorded by van den Bold (1965) from the Lower Miocene of Puerto Rico (HVH No. 7776), mainly in ornamentation, shape and size of carapace. This species was recorded by van den Bold (1957) from the Miocene of Trinidad as *Costa macerta* (Stephenson, 1944), but later this author (van den Bold 1965) changed the genus to *Neocaudites* without discussion. Here this species is kept in *Neocaudites* because of the thick marginal ridge that extends along the whole free margin and an oblique ridge in the middle of the carapace with adjacent punctations typical of the genus. *Neocaudites* differs from *Costa* in its rectangular shape and in lacking the three ridges in the mid-lateral area.

Occurrence: Aricuru (Maracanã bay), samples AR-04 and AR-05; B-17 quarry, Capanema, Pará (samples: B1A and B1, B11A, B13 and B13B).

Distribution: This species occurs in deposits from the Oligocene to Quaternary—the Anahuac Formation Gulf Coast (Lower Miocene); the Guines Formation and sample C3038 of Cuba (Lower to Middle Miocene; van den Bold 1965); Miocene from Colombia; Ste. Croix Quarry of Trinidad in *G. insueta* Zone and the upper part of the Lares Formation also from Lower Miocene and Oligocene, Puerto Rico (van den Bold 1965). Pliocene of United States, North Carolina and Quaternary of Panama. Lower Miocene (N5 to N7 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Neocaudites triplistriatus (Edwards, 1944)

Fig. 14: 6–9

- | | | |
|------------|-------|---|
| | 1944 | <i>Cythereis triplistriata</i> Edwards, n. sp. —Edwards: p. 522, pl. 87, figs. 24–26. |
| (?) | 1953b | <i>Rectotrachyleberis</i> cf. <i>R. triplistriata</i> (Edwards).—Puri: p. 264, pl. 11, figs. 1–2. |
| nov. comb. | 1963a | <i>Neocaudites triplistriatus</i> (Edwards).—van den Bold: p. 389, pl. 8, fig. 4.b. |

non	1951	<i>Trachyleberis?</i> of <i>T. triplistriata</i> (Edwards).—Swain: p. 37, pl. 6, figs. 2–3.
non	1994b	<i>Neocaudites</i> cf. <i>N. triplistriatus</i> (Edwards, 1944).—Távora: p. 130–131, fig. 12.
non	2004	<i>Neocaudites triplistriatus</i> (Edwards, 1944).—Coimbra, Ramos, Whatley & Bergue: p. 115, pl. 2, figs 7–8.

Material: 2 carapaces and 1 valve.

Dimensions: MPEG-775-M, Female, C; LV: L: 0.52 mm and H: 0.28 mm; RV: L: 0.45 mm and H: 0.23 mm; W: 0.21 mm. MPEG-776-M, Male, C; LV: L: 0.57 mm and H: 0.27 mm; RV: L: 0.55 mm and H: 0.26 mm.

Diagnosis: Carapace elongate, compressed; anterior rounded; posterior rounded ventrally, very slightly concave dorsally; dorsal outline nearly straight; ventral outline slightly sinuate, concave in middle. Anterior marginal rim well defined, complete, posterior rim less pronounced, merging ventrally with border, with double row of short denticles on lower side and on margin. Surface ornamented by three distinct ridges. Dorsal ridge scalloped on inner margin, makes right angle bend just anterior to posterocardinal area, continues diagonally toward anteroventral region to anterior node where it bifurcates; one faint ridge continues nearly to antero dorsal angle the other much stronger, scalloped, continues to anteroventral region. Third ridge extends from ventral margin in front of posteroventral angle, to ventral area, turns abruptly, joins marginal rim at posteroventral angle. Surface otherwise generally smooth or slightly granular. Hinge structure characteristic of genus. Marginal area widest anteriorly with line of concrescence just inside inner margin. Radial pore-canals not well preserved, give appearance of being paired anteriorly at denticles (Edwards 1944).

Remarks: The species identified in the present study has most of the features of *Neocaudites triplistriatus* (Edwards, 1944); the only difference is that the carapace is smaller in our material. *Neocaudites* cf. *N. triplistriatus* (Edwards, 1944) recorded by Távora (1994b) from the Pirabas Formation is the same as *Costa petrii* **sp. nov.** recorded in this study (see the discussion of that species), which is quite different from the species herein described. In addition, *Neocaudites triplistriatus* (Edwards, 1944) of Coimbra *et al.* (2004) is different in the posterior margin, which is more rectangular, and also has reticulate ornament between the main ridges.

Occurrence: B-17 quarry, Capanema, Pará (sample: B7). Primavera FPR-160 core (samples: AM08, AM15 and AM20).

Distribution: Duplin Marl, North Carolina (Upper Miocene; Edwards 1944); Springvale Formation, Trinidad (Upper Miocene; van den Bold 1963a). Recent, Equatorial continental Brazilian margin (Coimbra *et al.* 2004); in Pleistocene and Recent deposits it is apparently replaced by a species described by Keij (1954). Lower Miocene (N4 to N6 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Genus *Orionina* Puri 1953b

Orionina sp. aff. *Orionina similis* van den Bold, 1963

Fig. 14: 13–14

aff. 1963c *Orionina similis* **n. sp.**—Van den Bold: p. 47, pl. 4, figs. 7–8; text-fig. 6, figs. 8–9.

Material: 2 carapaces.

Dimensions: MPEG-778-M, carapace; LV: L: 0.56 mm and H: 0.30 mm; RV: L: 0.54 mm and H: 0.30 mm.

Description: Medium-sized carapace, subrectangular and highest in the anteromedian region. Dorsal margin sinuous and obscured by the posterodorsal ridge. Ventral margin almost straight to slightly concave in the median ventral margin. Anterior margin nearly rounded. Posterior margin concave in the posterodorsal region and with a pronounced posteroventral extension like a truncated caudal process. Surface strongly reticulate between the three main longitudinal ridges as for the genus, with the posterior vertical ridge weaker. Subcentral tubercle discrete.

Remarks: The species in this study has similarities to the holotype (HVH No. 6651) of *O. similis* van den Bold, 1963c from Trinidad (Upper Miocene) mainly with respect to carapace shape and ornamentation pattern of the ridges; it differs in being larger, more elongate in shape in lateral view, and in the presence of a prominent subcentral tubercle. The ornamentation of this species, which comprises three longitudinal ridges, is very similar to the plesiotype specimen (HVH No. 2793) of *Orionina vaughani* (Ulrich & Bassler, 1904) Puri, 1953b but differs in that the median ridge is less oblique because of the lower position of the posterior cardinal angle. The anterior part

of the dorsal ridge is parallel to the median ridge as in *O. vaughani*. In the present material, the subcentral tubercle is very weakly developed and the posterior ridge is often not well developed; if present, it joins the ventral ridge with a curved ridge, concave to the posterior margin, whereas in *O. vaughani* (Ulrich & Bassler, 1904) it meets the ventral ridge at right angles. Posterior portion of the ventral ridge more nodular than in *Orionina vaughani* (Ulrich & Bassler, 1904) or *Orionina serrulata* (Brady, 1869). The identified specimen (HVH No. 5122) of *Orionina bradyi* van den Bold, 1963c from Recent sediments from Bahamas and Bermuda, and from Cayos Miskitos Location in offshore of Nicaragua (Holocene) differs from the present species in size, thickness, the absence of a subcentral tubercle, and in ornamentation pattern. *Orionina* sp. aff. *O. similis* van den Bold, 1963c apparently has a large subcentral tubercle, which connects to both longitudinal ridges near the anterior region. In *O. bradyi* van den Bold, 1963c, the longitudinal ridges are connected by small transverse ridges, and its carapace is more rectangular, its posterior margin is less elongate and its dorsal margin straighter than in the species described herein.

Occurrence: B-17 quarry, Capanema, Pará (samples: B1 and B11).

Distribution: Lower Miocene (N5/N6 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Orionina sp.

Fig. 14: 10–11

Material: 2 carapaces and 3 valves.

Dimensions: MPEG-777-M, C; LV: L: 0.60 mm and H: 0.30 mm; RV: L: 0.57 mm and H: 0.26 mm.

Description: Carapace medium-sized, subrectangular, and highest in the anterior region. Dorsal margin almost straight. LV overlaps the RV in the anterodorsal region. Ventral margin sinuous, with a concave portion in the median ventral margin. Anterior margin rather wide and subrounded. Posterior margin angular and truncate. Surface ornamented by three main longitudinal ridges: the dorsomedian ridge extends from the anteromedian area, turning upward to the posterodorsal region where it connects to a shorter vertical posterior ridge. The ventromedian ridge is shorter and curved, extending from the anteroventral region to the mid-ventral area and connecting to the ventral ridge; the ventral ridge is parallel to the ventral margin and linked to the short vertical ridge in the posterior region. Posterior ridge well developed. Secondary fine ridges distributed irregularly between the main ridges. Discrete eye tubercle present.

Remarks: This species is similar to *Orionina vaughani* (Ulrich & Bassler, 1904) *sensu* van den Bold (1963a) from Trinidad, mainly in the arrangement of the ridges, but the species described herein is smaller, less elongate and its reticulations between the ridges are very worn. In addition, it is very similar to the plesiotype of *O. vaughani* (HVH No. 2793) of Puri (1953b) from Chipola facies in Florida (Miocene) but it differs in its larger size, strong reticulation between the ridges, and carapace shape, with the anterior margin less rounded, and turned down.

Occurrence: B-17 quarry, Capanema, Pará (samples B1, B11 and B12).

Distribution: Lower Miocene (N5/N6 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Genus *Coquimba* Ohmert, 1968

Coquimba congestocostata (van den Bold, 1963)

Fig. 14: 12, 15–22

v*	1963a	<i>Puriana? congestocostata</i> van den Bold, new species .—Van den Bold: p. 390–391, pl. 7, fig. 5a–b; pl. 12, fig. 9.
nov. comb.	1971	<i>Coquimba congestocostata</i> (van den Bold), 1963.—van den Bold, p. 337, tables 2, 3–6.
	1981	<i>Coquimba congestocostata</i> (Bold).—van den Bold, p. 81, pl. 4, fig. 6, table 13.
	1988	<i>Coquimba congestocostata</i> (Bold).—van den Bold, p. 38, pl. 3, fig. 17.

Material: 19 carapaces and 56 valves.

Dimensions: MPEG-779-M, Female, C; LV: L: 0.60 mm and H: 0.29 mm; RV: L: 0.53 mm and H: 0.27 mm.

MPEG-780-M, Female, RV: L: 0.55 mm and H: 0.27 mm. MPEG-781-M, Female, LV: L: 0.70 mm and H: 0.36 mm. MPEG-782-M, Male, C; W: 0.21 mm. MPEG-783-M, Male, C; LV: L: 0.81 mm and H: 0.37 mm; RV: L: 0.79 mm and H: 0.35 mm. MPEG-784-M, Male, C; LV: L: 0.52 mm and H: 0.24 mm; RV: L: 0.52 mm and H: 0.26 mm.

Diagnosis: An elongate species of *Coquimba* with narrow, irregular fossae and broad ridges separating them (van den Bold 1988).

Remarks: This species was originally assigned to the genus *Puriana* (Coryell & Fields, in Puri 1953b), but later it was considered a member of *Coquimba* Ohmert, 1968 (van den Bold 1971), mainly because of its hinge and marginal area, although the posterior tooth is distinctly shorter in the species from Trinidad (van den Bold 1963a). According to van den Bold (1963a), the dorsal view is very similar to *Puriana* and the three broad, posteroventral teeth are reminiscent of that genus. The paratype of *Puriana? congestocostata* van den Bold, 1963a (HVH No. 6862) from the Upper Miocene of Trinidad is comparable with the current species in terms of its similar size, carapace shape and ornamentation. Moreover, the figured specimen of *Coquimba congestocostata* (van den Bold, 1963a) in van den Bold, 1971 (HVH No. 9135) from Cuba is closest to the species presented here. The posterior margin is more rectangular than subacuminate and also the arrangement of the ridges obscures the subcentral tubercle.

Occurrence: Aricuru (Maracanã bay), samples AR-01 to AR-05; Atalaia Beach outcrop (Salinópolis), sample AT-01; B-17 quarry, Capanema, Pará (samples: B0, B1A and B12); Ponta do Castelo outcrop (Fortaleza Island), samples PC-00, PC-02 and PC-03; Primavera FPR-160 core (samples: AM08, AM11, AM13, AM15, AM17 and AM19).

Distribution: San José Calcareous Silt Member of Manzanilla Formation, Upper Miocene, Trinidad (van den Bold 1963a). Lower Miocene (N4 to N6 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Genus *Puriana* Coryell & Fields in Puri, 1953b

Puriana rugipunctata (Ulrich & Bassler, 1904)

Fig. 14: 23–25

	1904	<i>Cythere rugipunctata</i> n. sp. —Ulrich & Bassler: p. 118, pl. 38, figs. 16–17.
.	1937	<i>Favella puella</i> new species. —Coryell & Fields: p. 8, fig. 8A–c.
	1937	<i>Cythereis rugipunctata</i> var. <i>gatumensis</i> new variety. —Coryell & Fields: p. 10, fig. 11.
nov. comb.	1944	<i>Favella rugipunctata</i> (Ulrich and Bassler).—Edwards: p. 524, pl. 88, figs. 5–6.
.	1953b	<i>Puriana rugipunctata</i> (Ulrich and Bassler).—Puri: p. 257, pl. 12, figs. 18–19, text-fig. 8k.
.	1953b	<i>Puriana puella</i> (Coryell and Fields).—Puri: p. 257, pl. 12, fig. 17.
v*	1967b	<i>Puriana rugipunctata</i> (Ulrich and Bassler).—van den Bold: p. 311, pl. 1, fig. 7.

Material: 7 carapaces.

Dimensions: MPEG-785-M, C; LV: L: 0.57 mm and H: 0.28 mm; RV: L: 0.56 mm and H: 0.27 mm; W: 0.27 mm.

Diagnosis: Carapace small, subquadrate, thin, translucent, moderately ornamented; greatest height at the anterior cardinal angle, greatest thickness through the subcentral node. Dorsal margin almost straight; anterior margin broadly rounded, slightly flattened in the upper half; ventral margin concave anterior to the middle, otherwise nearly straight; posterior margin is broadly rounded and is marked by four or five short, blunt spines. The free margin is bordered by a narrow rim, parallel to which is a narrow sharp flange anteriorly. Parallel to the ventral margin on the lower half of the shell is a ridge, above which are three short ridges in the anterior part of the valve that converge on the subcentral node, while a single ridge continues backward from the node along the mid-line. The anterior half of the surface of the valve is additionally ornamented by a fine, line-like reticulation; the posterior is ornamented by irregularly placed small knobs and spines. Many minute pores puncture the surface. An interior marginal area occurs within the anterior end with a few short radial pore canals. The free margin of the left valve bears a groove, deepest at the midventral area; the right valve possesses a flanged panel, which fits into the groove. The hingement of the RV consists of a long, blade-like anterior cardinal tooth that is raised above the dorsal margin, and a posterior cardinal, flattened, angled tooth that extends a short distance down the posterior slope.

Between the teeth is a narrow pitted groove. The LV has a complementary hinge structure, with cardinal sockets formed by the outward curving of the dorsal margin, and, between the sockets, the finely crenulated dorsal margin arranged to fit into the groove of the RV (Coryell & Fields 1937).

Remarks: The species recorded here is very similar to the figured specimen of *Puriana rugipunctata* (Ulrich & Bassler, 1904) in van den Bold 1967b (HVH No. 8227) from the Upper Miocene of Gatun Formation (Panama Canal Zone) in ornamentation, shape and size. However, the present species has three additional denticles in the posterior region, which are absent to weakly developed in the compared type material. In outline, this species is also very similar to *Puriana minuta* van den Bold, 1963a, but that species differs by lacking evident denticles on posterior end, and in the less pronounced ornamentation and eye tubercles.

Occurrence: B-17 quarry, Capanema, Pará (samples B1A, B4, B11A and B11B).

Distribution: Lower Miocene (*Globorotalia fohsi barisanensis* Zone) to Recent: Upper Miocene of Gatun Formation in Panama Canal Zone (van den Bold 1967b). Mio-Pliocene of Northeastern Venezuela. Neogene from northern Dominican Republic (van den Bold 1968). Miocene of Florida Panhandle, USA. In Puerto Rico, it occurs in the Cibao and Aguada Formations; Guines Formation, Cuba (van den Bold 1965). Lower Miocene (N5/N6 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Genus *Pokornyella* Oertli, 1956

Pokornyella deformis? (Reuss, 1850)

Fig. 15: 1–6

- p. nov. comb.* 1957 *Aurila deformis* (Reuss).—van den Bold: p. 239 (part, not pl. 1, fig. 8).
p. 1963a *Aurila deformis* (Reuss).—van den Bold: p. 386, pl. 7, fig. 4.
1965 *Procythereis*? *deformis* (Reuss)?.—van den Bold: p. 396, pl. 5, figs. 4a, b.
1973 *Procythereis*? *deformis* (Reuss).—van den Bold: p. 153, pl. 1, figs. 4a–c.
. 1976 *Pokornyella deformis* (Reuss)?.—Holden: p. F21, pl. 1, fig. 4; pl. 11, figs. 7–9.
. 1994b *Aurila amygdala* (Stephenson, 1944).—Távora: p. 119–121, fig. 3.

Material: 127 carapaces and 399 valves.

Dimensions: MPEG-786-M, C; LV: L: 0.78 mm and H: 0.48 mm; RV: L: 0.76 mm and H: 0.43 mm; W: 0.43 mm. MPEG-787-M, LV: L: 0.69 mm and H: 0.43 mm. MPEG-788-M, RV: L: 0.68 mm and H: 0.39 mm.

Diagnosis: Egg-shaped, posterior end tapered, compressed and denticulated, anterior end rounded. The ventral margin is almost straight, the dorsal margin arched. The back [posterior margin] ascend strongly from the posterior, compressed end and descends gradually towards anterior margin. Ventral ridge suddenly ends in a pointed protuberance/node posteriorly. A second, smaller protuberance is located above the former one, close to the dorsal margin in the area of the posterior hinge tooth and is especially prominent at older, more arched individuals. The mentioned ridge separates the ventral side from the back, which [the pectoral side] forms a heart-shaped, at both sides of the ventral commissure shallow holed surface [?]. The surface is coarsely punctuated. On the ventral surface the punctae are arranged in longitudinal rows (Reuss 1850).

Remarks: The species recorded here is identical to “*Pokornyella deformis* (Reuss, 1850)?” recorded by Holden (1976) from the Miocene of Midway Island (Hawaii) in ornamentation, shape and size. This species appears to be confined to lower to middle Miocene rocks in the Caribbean (Bold 1966b). *Aurila deformis* (Reuss, 1850) recorded by van den Bold (1963a), is considered here as synonymous with this species. *A. deformis sensu* van den Bold (1963a) was recorded in Miocene formations from Cuba, Guatemala, Panamá, Dominican Republic, Tampa/Catahoula/Alum Bluff (Florida) and in Ste. Croix and Morne Diablo Quarries, Trinidad (van den Bold 1957; 1963a; 1966b; 1988). The specimen identified by van den Bold (1957) differs from that published in 1963a in carapace shape and ornamentation. These features closely resemble both the species described here and *Procythereis deformis* (Reuss, 1850)? (*sensu* van den Bold 1965; 1972a), recorded from Antilles and Central America (Lower to Upper Miocene), and that material also falls within the same size range (L 0.74 mm; H 0.46 mm; W 0.45 mm). However, to which the species in the present study resembles more is *Pokornyella deformis* (Reuss)? of Holden (1976), which was classified as *Pokornyella* rather than *Aurila* because it had muscle scars typical of that genus. Our species is also the same as *Aurila amygdala sensu* Távora (1994b) recorded to the

Pirabas Formation, but it seems to be quite different from the species *Aurila amygdala* (Stephenson, 1944) in van den Bold 1965 in ornamentation as well as in carapace outline.

Occurrence: Aricuru (Maracanã bay), samples AR-03 to AR-06; Ponta do Castelo outcrop (Fortaleza Island), samples PC-02 and PC-03.

Distribution: Antilles, Central America (Lower to Upper Miocene; van den Bold 1965; 1972a). Miocene of Midway Island (Hawaii; Holden 1976). Occurs in Miocene from Trinidad from the *Globigerinatella insueta* zone to above the *Globorotalia menardii* Zone (Manzanilla Formation; van den Bold 1957; 1965). It is common in the Cojímar and Guines Formations of Cuba, the Cercado Formation of the Dominican Republic, the Caribe and Rio Dulce Formations of Guatemala and the Chipola Formation of Florida (van den Bold 1957; 1973; 1988). In Puerto Rico, it occurs in the Cibao and Aguada Formations (van den Bold 1965). Lower Miocene (N5/N6 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

HEMICYTHERIDAE

Family HEMICYTHERIDAE Puri, 1953a

Subfamily THAEROCYTHERINAE Hazel, 1967

Genus *Bradleya* Hornibrook, 1952

Bradleya? sp. 1

Fig. 15: 7–8

Material: 3 valves.

Dimensions: MPEG-789-M, LV: L: 0.43 mm and H: 0.28 mm. MPEG-790-M, RV: L: 0.58 mm and H: 0.28 mm.

Description: Carapace subquadrate, thick-shelled; slightly higher near the anterior end. Ventral margin nearly straight, as is the dorsal margin except for a concavity in the posteroventral area. Small denticles situated around the anterior and posterior margins. Anterior margin obliquely rounded. Posterior margin angular in the middle, sinuous above, convex. Ornamentation strongly reticulate with smaller fossae forming delicate secondary ornamentation; subcentral and eye tubercles discrete. Ridges arranged in parallel lines; two short dorsomedian ridges in the mid-posterior region; two anterior ridges diverging toward the middle part and a prominent and ornamented ventral ridge. The more dorsal one of these ridges converges toward the dorsal margin at its posterior end; both dorsomedian ridges converge anteriorly and become one ridge that follows sinuously close to the anterior cardinal angle. Hinge seems to be amphidont; large, slightly reniform posterior tooth of right valve connected by deep, slightly crenulate furrow to a deep socket behind a large complex anterior element which consists of a high rounded tooth with a raised, elongate, and rounded platform anterior to the tooth. Muscle scars observed externally with near-vertical row of four elongate adductors and two rounded frontal scars in an oblique row.

Remarks: This species resembles *Bradleya* sp. van den Bold (1957) in ornamentation and outline, but it differs in the arrangement of the dorsal ridges and in the concavity of the posteroventral margin. *Bradleya?* sp.1 is very similar to *B.* sp. in outline shape and in the subcentral tubercle, but differs in having a sharp ventral ridge, strong development of primary and secondary reticulation, in lacking a pronounced cardinal angle, and in its more prominent eye tubercle and elongate carapace. It is similar to the genus *Thaerocythere* Hazel, 1967 mainly in general shape, ornamentation, hinge and muscle scars, but differs in the ventral ridge, which is sharper in the extremities of the posterior portion whereas in *Thaerocythere* it is more rounded. Moreover, eye and subcentral tubercles are more discrete in *Bradleya* compared to *Thaerocythere*. However, because of the paucity of material, the generic assignment is uncertain.

Occurrence: Primavera FPR-160 core (sample: AM 8).

Distribution: Lower Miocene (N4 zone; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

***Bradleya* sp.**

Fig. 15: 9

Material: 1 valve.

Dimensions: MPEG-791-M, RV: L: 0.46 mm and H: 0.26 mm.

Description: Carapace subrectangular, highest near the anterior end. Dorsal and ventral margins nearly straight and converging slightly posteriorly. Anterior margin obliquely rounded and denticulate. Anterior cardinal angle arched. Posterior margin angular in the middle, straight above, convex and denticulate below. Ornamentation consists of a coarse reticulate pattern with secondary reticulation and a subcentral tubercle. Median ridge extends from the middle portion to the posterior end and a strong ventral ridge converges toward the mid-posterior, ending in an acute tubercle. The dorsal ridge converges toward the mid-anterior portion, ending in a small and compressed area near the arched anterior cardinal angle. In both valves, there are two parallel and short dorsomedian ridges in the mid-posterior region. Four flatted adductor muscle scars arranged in a vertical row and two rounded frontal scars. Other internal features were not observed.

Remarks: *B. dictyon* (Brady, 1880) of van den Bold (1963a) has some similarities to this species in ornamentation pattern and in the arrangement of ridges, but differs in size, and outline (dorsal margin is more concave and posterior margin converges abruptly upward). This species also resembles *Bradleya?* sp. 1 described herein in shape and in its discrete subcentral tubercle, as described in the remarks above.

Occurrence: Primavera FPR-160 core (sample: AM08 and AM20).

Distribution: Lower Miocene (N4 to N6 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Genus *Quadracythere* Hornibrook, 1952

***Quadracythere brachypygaia* van den Bold, 1965**

Fig. 15: 10–13

- v 1965 *Quadracythere brachypygaia* van den Bold, **new species**.—Van den Bold: p. 396, pl. 6, fig. 6a–b.
. 1994b *Quadracythere* sp. 1.—Távora: p. 134–135, fig. 15.

Material: 408 carapaces and 932 valves.

Dimensions: MPEG-792-M, C; LV: L: 0.56 mm and H: 0.37 mm; RV: L: 0.60 mm and H: 0.39 mm. MPEG-793-M, C, W: 0.36 mm. MPEG-794-M, LV: L: 0.62 mm and H: 0.37 mm.

Diagnosis: Carapace subquadrate, highest at anterior cardinal angle, about 1/3 of the length from the anterior end. Anterior end obliquely rounded; dorsal margin depressed behind the anterior cardinal angle, especially in the LV, otherwise almost straight; ventral margin slightly sinuate, roughly parallel to the dorsal margin; posterior end very short, angled below the middle, strongly concave above, forming an angle of ca 90 degrees with the dorsal margin, subtruncate below and bearing 2 or 3 large spines. Posterior end of dorsal margin obscured by a short ridge, which ends at about 1/10 of the length from the posterior end in a strong node, just in front of the posterior cardinal angle. Ventral ridge long, obscuring most of the ventral margin and ending at about 1/6 of the length from the posterior end. Surface reticulate, the rows of meshes generally parallel to the dorsal and ventral margins in the posterior 2/3 of the carapace, but rather obscure just in front of the middle. Here, the meshes become smaller, while in the anterior end they are larger again, and 2 or 3 ridges occur parallel to the anterior margin. Between the first ridge and the margin itself, the reticulations are still larger. In dorsal view, carapace in general lens-shaped, but irregular in the anterior end because of the raised ridges and in the posterior end because of the projecting dorsal node. The ventral ridge projects only slightly. Greatest width in or slightly behind the middle (van den Bold 1965).

Remarks: The morphology of the present species corresponds well with the paratype of *Q. brachypygaia* van den Bold, 1965 (HVH No. 7752) from the San Sebastián Formation (Puerto Rico). It exhibits similarities in the presence of sinuous transverse ridges in the anterior region and in the general outline of the carapace. This species is the same as *Quadracythere* sp. 1 recorded by Távora (1994b) from the Pirabas Formation. *Quadracythere antillea* (van den Bold, 1965) is smaller, with a dorsal margin that is more steeply sloping and a posterior end that is more truncate.

Occurrence: Aricuru (Maracanã bay), samples AR-01 to AR-06; B-17 quarry, Capanema, Pará (samples: B0-B2, B4-B7, B11-B13 and B13B); Ponta do Castelo, Fortaleza Island (samples: PC-00, PC-02-PC-04); Primavera FPR-160 core (samples: AM08, AM10, AM12 and AM19).

Distribution: Upper San Sebastián Formation and Lares Formation in Puerto Rico (Upper Oligocene-Lower Miocene: van den Bold 1965). Lower Miocene (N4 to N7 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

***Quadracythere adornata* sp. nov.**

Fig. 15: 14–17

Material: 110 carapaces and 436 valves.

Etymology: *adorno* from Latin *adornatum*, *adornare* = ornament; referring to ornamentation like a fishing net or sewing crochet.

Holotype: MPEG-795-M, C; LV: L: 0.61 mm and H: 0.38 mm; RV: L: 0.61 mm and H: 0.35 mm; W: 0.37 mm.

Paratypes: MPEG-796-M, LV: L: 0.56 mm and H: 0.35 mm. MPEG-797-M, RV: L: 0.60 mm and H: 0.34 mm. MPEG-798-M, C; LV: L: 0.56 mm and H: 0.35 mm.

Type locality: Aricuru outcrop (Maracanã bay), sample AR-05, Aricuru town.

Diagnosis: Surface reticulate, with coarse, longitudinal ridges extending across the posterior part of the valve and converging to the mid-anterior region, forming a mesh. Strong, arcuate posterodorsal ridge extends from the anteromedian to the posterodorsal region, obscuring the dorsal margin.

Description: Subquadrate carapace, highest at about 1/3 from the anterior. Dorsal margin slightly concave, obscured by the dorsal ridge. Ventral margin slightly concave and obscured by the ventral ridge. Anterior margin obliquely rounded. Posterior margin very short, angular below mid-height, strongly concave posterodorsally, forming an angle of approximately 90° with the dorsal margin, subtruncate below and bearing two or three large spines. Posterior end of dorsal margin obscured by a short ridge, which ends in a strong node just in front of the posterior cardinal angle. Ventral ridge long, obscuring most of the ventral margin and ending at about 2/3 from the anterior of the carapace. Surface reticulate, with coarse posterior ridges converging to the mid-anterior region forming a mesh. Strong, arcuate posterodorsal ridge extends from the anteromedian to the posterodorsal region, obscuring the dorsal margin. Anterodorsal region with a depressed area below the eye tubercle, especially in the LV, which extends parallel to the anterior margin. In dorsal view, carapace is lens-shaped in general, but irregular in the anterior end because of the raised ridges and in the posterior end because of the strong ridge that projects to a dorsal node at the extremity. The ventral ridge is weak. Greatest width is at mid-length. Internal features typical of the genus.

Remarks: The species *Quadracythere mediaruga* Hornibrook, 1952 resembles the present species in outline, ornamentation pattern and in its prominent eye tubercle, but it differs in lacking short and pronounced longitudinal ridges in the middle portion, in the presence of a smaller ridge along the mid-dorsal margin, in its larger size and straight ventral ridge. *Quadracythere adornata* sp. nov. also resembles *Quadracythere brachypygaia* van den Bold, 1965 in shape and size; however, that species differs in that it is more elongate in dorsal view and in its more prominent and sinuous ridges. The present species also lacks the larger, vertical and irregular ridges at the anterior end what are characteristics of *Quadracythere brachypygaia* van den Bold, 1965.

Occurrence: Aricuru (Maracanã bay), samples AR-01 to AR-06; B-17 quarry, Capanema, Pará (samples: B1A, B8, B9, B12, B11A, B11B and B13B); Ponta do Castelo, Fortaleza Island (sample: PC-03); Primavera FPR-160 core (samples: AM08, AM10, AM12, AM19 and AM20).

Distribution: Lower Miocene (N4 to N7 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

***Quadracythere limbimodesta* sp. nov.**

Fig. 15: 18–20

Material: 3 carapaces and 11 valves.

Etymology: limbi plural from Latin *limbus* = edge, border; referring to the outline of the carapace; modesta from Latin *modestus*, *modestum*, *modesta* = discrete, moderate, gentle; referring to the weakly developed cardinal angles, which render this species more subrectangular than other species of the genus.

Holotype: MPEG-799-M, LV: L: 0.57 mm and H: 0.32 mm; RV: L: 0.55 mm and H: 0.31 mm; W: 0.32 mm.

Paratypes: MPEG-800-M, C; RV: L: 0.55 mm and H: 0.31 mm; W: 0.33 mm. MPEG-801-M, RV: L: 0.52 mm and H: 0.30 mm. MPEG-802-M, RV: L: 0.57 mm and H: 0.33 mm. MPEG-803-M, C; RV: L: 0.62 mm and H: 0.33 mm. MPEG-804-M, C; LV: L: 0.50 mm and H: 0.28 mm. MPEG-805-M, C; RV: L: 0.54 mm and H: 0.30 mm. MPEG-806-M, Female, RV: L: 0.55 mm and H: 0.32 mm. MPEG-807-M, LV: L: 0.57 mm and H: 0.32 mm.

Type locality: B17 Quarry, sample B11, Capanema town.

Diagnosis: This species is characterized by a dorsal ridge, which obscures the dorsal margin, and the weakly developed cardinal angles mainly in the LV; three pronounced ridges run parallel to the anterior margin.

Description: Carapace subrectangular, thick-shelled, highest about 1/3 from the anterior of the carapace. Dorsal margin straight with subdued cardinal angles, especially in the LV. Ventral margin almost straight, slightly concave in the anteromedian portion. Dorsal margin straight and almost parallel to the ventral margin. Cardinal angles weak. Anterior margin narrow, truncated and subrounded. Posterior margin very short, very straight above, subtruncate below, and bearing four or five flat, wide and short spines. Surface strongly reticulate, the rows of ridges generally in parallel to each other in the median region, and in the dorsal and ventral margins at the posterior 2/3 of the carapace. Both valves bearing about three faint ridges, parallel to the anterior margin, as in *Q. brachypygaia*. Posterior end of dorsal margin obscured by a short ridge, which ends in a faint node at the posterior region, just in front of the posterior cardinal angle. Ventral ridge long, obscuring most of the ventral margin, less so in the RV, and ending in the middle of the posterior region. In dorsal view, carapace is generally lens-shaped, but irregular in the anterior end because of the discrete ridges and in the posterior end because of the projecting dorsal node. The ventral ridge projects only slightly. Greatest width in the middle region. Internal features typical of the genus.

Remarks: This species resembles *Quadracythere brachypygaia* van den Bold, 1965 in some aspects such as the dorsal region, in the presence of a prominent eye tubercle, and in size. However, *Q. limbimodesta* sp. nov. differs in dorsal view by being widest in the middle region and in the absence of raised ridges, particularly the sinuous ridges in the anteroventral area.

Occurrence: Aricuru (Maracanã bay), sample AR-01; B-17 quarry, Capanema, Pará (samples: B1A-B2, B5, B6, B8, B9 B12-B13 and B13B); Primavera FPR-160 core (samples: AM10, AM12 and AM14).

Distribution: Lower Miocene (N4 to N7 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

***Quadracythere fortisrobusta* sp. nov.**

Fig. 15: 21–24

Material: 14 carapaces and 8 valves.

Etymology: forte from Latin *fortis* = strong; referring to strong ornamentation; robusta from Latin *robustum*, *robustus* = robust, strong; referring to the strong ornamentation and heavy appearance of the carapace.

Holotype: MPEG-808-M, C; LV: L: 0.60 mm and H: 0.37 mm; RV: L: 0.58 mm and H: 0.35 mm.

Paratypes: MPEG-809-M, C; LV: L: 0.62 mm and H: 0.42 mm and W: 0.41 mm. MPEG-810-M, LV: L: 0.69 mm and H: 0.44 mm. MPEG-811-M, juvenile, C; LV: L: 0.53 mm and H: 0.35 mm; RV: L: 0.52 mm and H: 0.32 mm. MPEG-812-M, juvenile, C; LV: L: 0.50 mm and H: 0.30 mm.

Type locality: B17 Quarry, sample B11, Capanema town.

Diagnosis: This species is robust, thick-shelled and strongly reticulate; carapace subquadrate, highest 1/3 from anterior.

Description: Robust and subquadrate carapace, highest at the anterior cardinal angle. Dorsal margin slightly depressed behind the anterior cardinal angle, especially in the LV, otherwise almost straight in the RV. Ventral margin almost straight from the middle part to the posterior and slightly concave in the anteroventral end. Anterior margin obliquely rounded. Posterior margin very short, angular below the middle, quite straight above, subtruncate below, with irregular or sinuous margin at the posterior end. Surface strongly reticulate, with the fossae distributed

irregularly in the middle, dorsal and ventral regions. The row of fossae paralleling the anterior margin are considerably larger than those nearby. In the middle to the posterior end, the fossae are somewhat smaller. Three parallel and faint ridges: one ridge ventrolaterally, one small ridge in the middle region and another strong ridge running in parallel to the dorsal margin. There are 2–3 ridges in parallel to the anterior margin in the anteroventral region. The dorsal margin is obscured by a strong, diagonal ridge, which extends from the median region to the mid-posterior end. Ventral ridge long, obscuring the ventral margin. In dorsal view, carapace is biconvex with a narrowing in the mid-posterior region. Greatest width in the middle region. Hinge is as for the genus and, in the LV, comprises a large posterior socket, a smooth median bar with a stubby anterior tooth; bar thickens posteriorly. Complementary hinge in the RV. Other internal features were not observed due to sediment infill.

Remarks: The species is similar in shape to the other *Quadracythere* species described herein, but it differs in ornamentation pattern. Several specimens are poorly preserved (see figures 15: 23–24) making comparison difficult; these specimens are also small in size.

Occurrence: B-17 quarry, Capanema, Pará (samples: B11 and B12); Primavera FPR-160 core (samples: AM12, AM17 and AM19).

Distribution: Lower Miocene (N4 to N6 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Quadracythere? sp. 1

Fig. 15: 25–26

Material: 3 valves.

Dimensions: MPEG-813-M, LV: L: 0.55 mm and H: 0.31 mm. MPEG-814-M, LV: L: 0.53 mm and H: 0.30 mm.

Description: Carapace medium-sized and subrectangular in lateral view. Dorsal margin slightly convex to sinuous. Ventral margin sinuous, slightly concave in the middle. Anterior margin is very broadly and obliquely rounded. Posterior margin short, and concave above a small, posteroventral caudal process. LV with the anterior cardinal angle less evident than the posterior. Ornamentation reticulate with an irregular pattern of ridges among which the marginal ridge is most pronounced. Behind this ridge, in the anteromedian region, the carapace is strongly compressed.

Remarks: The outline and ornamentation pattern are mostly similar to genus *Quadracythere*, but the outline differs a little and the ridges are less pronounced. The rarity of this species does not allow for an unequivocal identification.

Occurrence: B-17 quarry, Capanema, Pará (sample: B1).

Distribution: Lower Miocene (N5/N6 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Quadracythere? sp. 2

Fig. 15: 27–29

Material: 114 carapaces and 3591 valves.

Dimensions: MPEG-815-M, adult, LV: L: 0.62 mm and H: 0.39 mm, RV: L: 0.60 mm and H: 0.38 mm MPEG-816-M, juvenile, LV: L: 0.60 mm and H: 0.35 mm. MPEG-817-M, juvenile, RV: L: 0.56 mm and H: 0.32 mm; W: 0.30 mm.

Description: Carapace medium-sized, robust and subtriangular to subquadrate in lateral view. Dorsal margin almost straight, sloping downwards posteriorly. Ventral margin slightly convex in both valves. Anterior margin subrounded. Posterior margin nearly truncate. Caudal process better developed in juvenile specimens. Surface pitted, more so in the median and porterdorsal regions. Ventral and subtle aliform process, below which run four concentric and longitudinal ridges parallel to the ventral margin and extending to the anterior margin; the top-most ridge terminates posteriorly in a spine, similar to the posterodorsal ridge. Eye tubercles present in adults, more prominent in juveniles. Muscle scars consist of four adductor scars, four frontal scars, and two mandibular scars

below. Hinge amphidont with a median bar and sockets in the extremities of LV; RV with a smooth tooth in the anterior end, a median groove and a slightly crenulate tooth in the posterior end.

Remarks: This species resembles juveniles of *Quadracythere brachypygaia* van den Bold, 1965 in the anteroventral longitudinal ridges; however, adults differ markedly in the ornamentation and also in the general carapace shape differing only in a more acute posterior end. *Quadracythere?* sp. 2 resembles also juveniles of *Pokornyella deformis?* (Reuss, 1850) described herein mainly in the ornamentation pattern.

Occurrence: Aricuru (Maracanã bay), samples AR-03 to AR-05; B-17 quarry, Capanema, Pará (samples: B11 and B12); Primavera FPR-160 core (samples: AM08).

Distribution: Lower Miocene (N4 to N6 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Family TRACHYLEBERIDIDAE Sylvester-Bradley, 1948

Genus *Carinocythereis* Ruggieri, 1956

Carinocythereis? sp.

Fig. 16: 1–3

Material: 16 carapaces and 1 valve.

Dimensions: MPEG-818-M, C; LV: L: 0.65 mm and H: 0.33 mm; RV: L: 0.67 mm and H: 0.33 mm.

Description: Carapace subrectangular in lateral view. Dorsal margin convex around the anterior cardinal angle and straight behind. Ventral margin slightly concave in the central-ventral region; dorsal and ventral margins almost parallel. Anterior margin broadly rounded. Posterior margin truncate in the LV with a dorsal slope in the RV. Surface strongly reticulate; arrangement of ridges follows the fossae, with a small dorsal ridge slightly arched behind the anterior cardinal angle; three or four spines present on the anterior margin and one spine in the posteroventral region of RV. Low subcentral tubercle. Internal view: inner lamella narrow; evident pore canals. Hinge holamphidont tending to hemiamphidont (the posterior tooth ranges from smooth to slightly crenulate).

Remarks: The species shares some features with the genus *Carinocythereis*, including shape and reticulate ornamentation, but differs in lacking three longitudinal carinae, and anterior and ventral marginal carinae. In addition, the eye tubercles, hingement and muscle scars are different.

Occurrence: Aricuru (Maracanã bay), sample AR-06; Ponta do Castelo, Fortaleza Island (samples: PC-00, PC-01, PC-02 and PC-04).

Distribution: Lower Miocene (N5/N6 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Genus *Costa* Neviani, 1928

Costa variabilocostata variabilocostata (van den Bold, 1950)

Fig. 16: 4–9

	1950	<i>Cythereis variabilocostata</i> van den Bold, n. sp. —Van den Bold: p. 83, pl. 18, fig. 3A–b.
<i>v. nov. comb.</i>	1957	<i>Costa variabilocostata</i> (van den Bold).—van den Bold: p. 241, pl. 2, fig. 4.
<i>v.</i>	1966d	<i>Costa variabilocostata variabilocostata</i> (van den Bold).—van den Bold: pl. 1, figs. 10a–b.
<i>v.</i>	1966e	<i>Costa variabilocostata variabilocostata</i> (van den Bold).—van den Bold: pl. 22, fig. 5.
<i>non</i>	1994b	<i>Costa variabilocostata</i> Bold, 1968.—Távora, p. 128–130, figs. 10, 11.

Material: 17 carapaces and 48 valves.

Dimensions: MPEG-819-M, Female, C; LV: L: 0.53 mm and H: 0.28 mm; W: 0.22 mm. MPEG-820-M, Female, C, RV: L: 0.64 mm and H: 0.31 mm. MPEG-821-M, Male?, C; LV: L: 0.52 mm and H: 0.27 mm; RV: L: 0.54 mm and H: 0.28 mm. MPEG-822-M, Male, C, W: 0.30 mm. MPEG-823-M, C, RV: L: 0.47 mm and H: 0.23 mm; W: 0.27 mm. MPEG-824-M, C, RV: L: 0.63 mm and H: 0.29 mm.

Diagnosis: Carapace small, thick-shelled, subquadrate, three-ribbed. Highest at anterior cardinal angle in left valve. Anterior end in right valve only very slightly higher than posterior cardinal angle. Dorsal and ventral margin almost straight and converging very slightly posteriorly. Anterior end obliquely rounded, bearing a row of spines and a marginal ridge, which continues parallel to the ventral margin, being most conspicuous at its posterior end, about the length from the posterior end of the carapace. Parallel to this ridge runs another one, joining it at its posterior end. A slightly curved dorsal ridge obscures the dorsal margin. A slightly oblique median ridge runs forward from just below the posterior cardinal angle. It divides in the center of the carapace into two slightly diverging ridges. The surface between the ridges is reticulate. Posterior end triangular, laterally compressed; dorsal part concave, ventral part rounded and bearing a few spines. Hinge typical of the genus. Marginal area moderately broad; line of concrescence and inner margin coincide; pore canals numerous in both ends. The species may show some variation in the pattern of the ridges. Sometimes these ridges are hardly raised at all, and appear as slightly thickened walls between the reticulations. Often the two bifurcated ridges in the middle are very faint. On the other hand, a small ridge may appear between these ridges and the two ventral ridges (van den Bold 1950).

Remarks: Comparative study with the figured specimen of *Costa variabilicostata variabilicostata* (van den Bold, 1950) (HVH No. 7935) recorded by van den Bold (1966e) of Lower to Middle Miocene of Pozón Formation (Venezuela) confirm that it is identical to the species recorded here. In addition, the present species is very similar to the figured specimen (HVH No. 8253) of *C. variabilicostata variabilicostata* of van den Bold (1966d) from the Recent of Colon Harbour, Panama mainly in the ornamentation pattern and shape, differing only in its larger size. The species group *C. variabilicostata* recorded by Távora (1994b, p.128, figs. 10, 11) is not the same species and is recorded in the present study as synonymy of *Cativella* sp. aff. *C. navis* (Fig. 16: 14–17). See remarks for that species.

Occurrence: Aricuru (Maracanã bay), samples AR-01, AR-03 and AR-05; B-17 quarry, Capanema, Pará (samples: B1A, B1, and B12); Primavera FPR-160 core (samples: AM08, AM12, AM13 and AM17).

Distribution: Miocene from Brasso, Cipero, Talparo and Springvale formations; seas around Trinidad (van den Bold 1957; 1963a); Cubagua Formation (Mio-Pliocene, Venezuela; van den Bold 1966c); Panamá (van den Bold 1966d); Pozón section, Venezuela (van den Bold 1966e). Lower Miocene (N4 to N6 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Costa spinaventralis sp. nov.

Fig. 16: 10–13

1994b *Neocaudites* cf. *N. triplistriatus* (Edwards, 1944).—Távora, p.130–131, fig.12.

Material: 7 carapaces and 5 valves.

Etymology: spina from Latin *spina*, *spinae* = spine; ventralis from Latin *ventralis*, *venter*, *ventris* = ventral; referring to the spine present in the extremity of the ventral ridge.

Holotype: MPEG-825-M, C; LV: L: 0.67 mm and H: 0.35 mm; RV: L: 0.62 mm and H: 0.29 mm; Dorsal view: L: 0.68 mm and H: 0.30 mm.

Paratypes: MPEG-826-M, C; RV: RV: L: 0.64 mm and H: 0.31 mm. MPEG-827-M, RV: length 0.62 mm and height 0.29 mm.

Type locality: Aricuru outcrop (Maracanã bay), sample AR-05, Aricuru town.

Diagnosis: A fragile species of *Costa* with a short pronounced and curved dorsal ridge; strongly reticulate in the anteromedian region; ventral ridge with a spine at the end.

Description: Carapace medium-sized and subtriangular, highest about 1/3 from the anterior end. Dorsal margin sinuous, convex in the middle and with two concavities in front of each extremity. Ventral margin nearly straight with a small concavity towards the posterior. Anterior margin broadly and somewhat obliquely rounded, very coarsely denticulate in the anteroventral margin. Posterior margin strongly compressed laterally, triangular in side view, slightly convex posterodorsally, concave and with four moderately large spines posteroventrally. Surface strongly reticulate and ornamented with three longitudinal ridges; anterior rim parallel to the margin. Transverse ridges project to a coarse marginal rim surrounding the whole carapace. Ventral ridge terminating with a distinct spine posteriorly. Median ridge bifurcates into two short ridges in the anteromedian region as a downward “v” shape. Dorsal ridge convex; bifurcated in the anterodorsal area and running along the margin in the posterodorsal area. Internal features were not observed.

Remarks: This species shares features such as the arrangement of median and ventral ridges characteristic of other members of the genus *Costa*. It resembles *Costa variabilocostata variabilocostata* (van den Bold, 1950) van den Bold, 1957, but the present species is longer, lower and has a more delicate ornamentation with a prominent spine in the end of the ventral ridge.

Occurrence: B-17 quarry, Capanema, Pará (sample: B11).

Distribution: Lower Miocene (N5/N6 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Genus *Cativella* Coryell & Fields, 1937

Cativella sp. aff. *C. navis* Coryell & Fields, 1937

Fig. 16: 14–17

- aff. 1937 *Cativella navis* **new species**.—Coryell & Field: p. 9, fig. 9a.
aff. 1994b Group *Costa variabilocostata* Bold, 1968.—Távora: p. 128–130, fig. 11.

Material: 5 carapaces and 16 valves.

Dimensions: MPEG-828-M, C, Female, LV: L: 0.64 mm and H: 0.33 mm; RV: L: 0.55 mm and H: 0.27 mm. MPEG-829-M, Female, RV: L: 0.62 mm and H: 0.28 mm; W: 0.22 mm. MPEG-830-M, Female, LV: L: 0.49 mm and H: 0.25 mm. MPEG-831-M, C, LV: L: 0.64 mm and H: 0.29 mm; W: 0.28 mm.

Description: Carapace medium-sized and subrectangular in lateral view. Highest point about 1/4 from the anterior of the carapace. Dorsal margin straight behind the anterior cardinal angle in LV and more arched in RV due to the projecting dorsal ridge. Ventral margin almost straight, slightly sinuous in the RV. Anterior margin broadly rounded, with 11–13 sharp denticles, which are concentrated subventrally. Posterior margin acutely extended, ventrally pointing and with six coarse marginal spines. Dorsal view subelongate, widest anterior of the median. Surface reticulate with a strongly arched dorsomarginal ridge that runs along the dorsal margin from the anteromedian region to the posteromedian region. A pronounced anteromarginal ridge extends parallel to the margin to the posteroventral region; median ridge very pronounced with about eight connecting, transverse short ridges above and below. The posteroventral margin bears a double row of about five heavy and short spines, truncated in the extremity. Intercostal areas with sparse pore conuli, especially in dorsal, median and ventral areas.

Remarks: The present species is very similar to *Cativella navis* Coryell & Fields, 1937 in size and shape; however, the figured specimen (HVH No. 8238) recorded by van den Bold (1967b) differs in the dorsal ridge, which continues into the anterodorsal region. In *C. navis*, the dorsal margin is also more curved and turned downwards towards the ventral margin. The species presented here is the same recorded by Távora (1994b) to the Group *Costa variabilocostata* (van den Bold 1968) from the Pirabas Formation. However, the studied specimens have diagnostic characteristics of *Cativella*, which differs from *Costa* mainly in the height of the ridges, in the median ridge that extends from the anterior to posterior regions, and in the absence of a bifurcate ridge in the anteromedian region (Coryell & Fields 1937; van den Bold 1970a). The present species is closest to *Cativella iyemojai* Omasola, 1972, referred to as *Chrysocythere iyemojai* (Omasola, 1972) by Dingle (1993). The dorsal ridge in that species also does not continue into the anterodorsal portion, which is also true in *Cativella reticulocostata* Coimbra *et al.* 2004.

Occurrence: Aricuru (Maracanã bay), samples AR-01, AR-04 and AR-05; B-17 quarry, Capanema, Pará (samples: B1, B7, B12, B11A, B13 and B13B); Primavera FPR-160 core (samples: AM17).

Distribution: Lower Miocene (N5 to N7 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Cativella sp. aff. *C. moriahensis* van den Bold, 1960

Fig. 16: 18–20

- aff. 1957 *Cativella* sp. cf. *Cativella semitranslucens* (Crouch).—van den Bold: p. 243, pl. 2, fig. 6.
non 1958 *Cativella* aff. *semitranslucens* (Crouch).—van den Bold: p. 404, pl. 3, fig. 3.

Material: 6 carapaces and 17 valves.

Dimensions: MPEG-832-M, LV: L: 0.56 mm and H: 0.30 mm. MPEG-833-M, C; LV: L: 0.58 mm and H: 0.32 mm; RV: L: 0.58 mm and H: 0.29 mm; W: 0.24 mm. MPEG-834-M, C; RV: L: 0.58 mm and H: 0.29 mm. MPEG-835-M, LV: L: 0.58 mm and H: 0.29 mm.

Description: Carapace subelongate to subtriangular, highest at about 1/3 of length from anterior end. Dorsal margin curved, converging posteriorly towards the ventral margin, but obscured by the dorsal ridge, mainly in the LV. Ventral margin is nearly straight, with a slight concavity anterior of mid-length. Anterior margin obliquely rounded, bearing 5–8 large spines. Posterior margin laterally compressed, angular and acute in the middle with a double row of elongated spines. Ornamentation consists of very high, longitudinal ridges; surface smooth between the ventral and median ridges. The ridges are ponticulate with diverse fenestra (approximately 6 in the ventral; 7 in the dorsal, and 8 in the anterior); except for the central ridge that is not fenestrated, similar to the specimen in figure 16, which has most of the structure eroded, appearing poroconulated rather than fenestrated. Median ridge is composed of blunt spines, closely spaced, rather than being a continuous ridge. Between median and dorsal ridges there are some irregular elevations connecting these ridges. Very high anterior ridge, projecting to outside of the carapace; very obliquely curved and extending from the anterodorsal to the posteroventral regions of the carapace. A thin, slightly alate ventral ridge runs obliquely down from just behind and above the anterior ridge towards the ventral margin, curving upward near its posterior end. A long median ridge extends from near the anterior ridge. It is slightly convex upward. A nearly straight dorsal ridge starts in the median region and extends to the posterodorsal region, obscuring the dorsal margin completely. Between the ridges, the valves are smooth, except for a lower ridge between the median and dorsal ridges and the presence of sparse and evident poroconuli. Subelongate in dorsal view. Marginal area broad at the anterior end, slightly less so in the posterior. Internal features typical of the genus.

Remarks: This species is closest to *Cativella moriahensis* van den Bold, 1960 in many features, including the distribution of ridges, outline of carapace and some internal features; however, it differs in size, distribution and number of fenestra and poroconuli in the posterior and anterior ends and in the absence of reticulation. In addition, in our species, the ventral ridge does not have a strong terminal spine and the median ridge does not extend as far posteriorly as in *C. moriahensis*. The species also shows similarities to *Cativella* sp. cf. *Cativella semitranslucens* van den Bold, 1957; but differs mainly in that the anterior ridge is continuous with the dorsal ridge in that species. This characteristic also differentiates this species from *Cativella navis* Coryell & Fields, 1937; however, that species has an ornamentation pattern closest to the species herein described.

Occurrence: Aricuru (Maracanã bay), sample AR-05; B-17 quarry, Capanema, Pará (samples: B1A, B1 and B12); Primavera FPR-160 core (samples: AM08, AM13, AM17 and AM19).

Distribution: Lower Miocene (N4 to N6 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Cativella primaveraensis sp. nov.

Fig. 16: 21–23

Material: 4 carapaces and 12 valves.

Etymology: Alluding to the type locality Primavera county of the Pará State (Bragantina region).

Holotype: MPEG-836-M, C; LV: L: 0.59 mm and H: 0.32 mm; RV: L: 0.60 mm and H: 0.31 mm; W: 0.36 mm.

Paratypes: MPEG-837-M, C; LV: L: 0.54 mm and H: 0.32 mm; RV: L: 0.55 mm and H: 0.29 mm; W: 0.32 mm. MPEG-838-M, RV: L: 0.54 mm and H: 0.29 mm.

Type locality: Aricuru outcrop (Maracanã bay), sample AR-05, Aricuru town.

Diagnosis: Species with very elongated and coarse spine projecting outward from the termination of the ventral ridge. The three longitudinal ridges are finer than other species of *Cativella*, with reticulation between them.

Description: Carapace subovate to subtriangular, highest at about 1/3 of length from anterior end. Dorsal margin obscured by the convex dorsal ridge. Ventral margin slightly convex. Anterior margin obliquely rounded,

with 10 or 11 long spines. Posterior margin laterally compressed, almost truncate and bearing three long and thick spines. Ornamentation consists of longitudinal ridges and reticulation of moderate thickness, mainly in the median region between the ridges. The muri of the reticulum connect to the ridges, which are very thin and sometimes composed of pore conuli. Anterior ridge very obliquely curved, more than the anterior margin. This ridge continues dorsally for a short distance beyond the eye tubercle, and ventrally parallel to the ventral margin, obscuring it as far as the posterior end. A thin, slightly alate ventral ridge, running obliquely down from just behind the anterior ridge towards the ventral margin, curves upward near its posterior end and terminates in a thick and long spine projecting away from the carapace. A long, slightly arcuate and upturned median ridge extends from near the anterior ridge. A dorsal ridge starts from just behind the eye tubercle and is convex upward, obscuring the dorsal margin completely and joining it in front of the posterior cardinal angle. Intercostal reticulation perpendicular to the longitudinal ridges. Depressed area just behind the marginal ridges. Subelongate in dorsal view and more convex in the middle, presenting the pronounced and long spine at the termination of the ventral ridges in both valves. Internal features were not observed.

Remarks: The species is similar to *Cativella moriahensis* van den Bold, 1960 mainly in shape, but it differs in ornamentation pattern, especially in the presence of more and longer marginal spines in *C. moriahensis* van den Bold, 1960 and in the disposition of the anterior ridge that is not parallel to the anterior margin in the specimens in this study. Among species of *Cativella* described herein, *C. sp.* is closest to *C. primaveraensis* **sp. nov.** regarding the long spines.

Occurrence: Aricuru (Maracanã bay), samples AR-02 to AR-05; B-17 quarry, Capanema, Pará (samples: B1 and B12); Primavera FPR-160 core (samples: AM08, AM12, AM13 and AM17).

Distribution: Lower Miocene (N4 to N6 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Cativella sp.

Fig. 16: 24–25

Material: 1 valve.

Dimensions: MPEG-839-M, C; LV: L: 0.63 mm and H: 0.30 mm.

Description: Valve subtriangular, highest at about 1/3 of length from anterior end. Dorsal margin almost straight. Ventral margin slightly convex. Anterior margin rounded, bearing 10 or 11 long and downturned spines. Posterior margin laterally compressed, angular at or slightly below the middle, concave above, convex below with two long and thick spines. Surface strongly ornamented by three perforated longitudinal ridges and one thick, short posterior spine in the ponticulate ventrolateral ridge. Anterior ridge very much flattened, more pronounced than the anterior margin and continuing dorsally a short distance beyond the eye tubercle, and parallel to the ventral margin. Scattered short ponticula between the ridges. A thin, slightly alate ventral ridge, running obliquely down from just behind the anterior ridge towards the ventral margin, curves upward near its posterior end and terminates in a strong and thick spine. A long and oblique median ridge extends from near the anterior ridge to the median region of the carapace. Anterior border extends from the anterodorsal to the posteroventral region. Surface ornamentation mainly consists of tubercles rather than reticulation. Weak reticulation in the posteroventral region. Locally small tubercles are raised between the ridges. Eye tubercle present. Internal view: hinge of LV consists of an anterior socket followed by a tooth with a median bar element and then a single posterior socket; inner margin with a narrow inner lamella and visible inner list separating inner lamella and outer lamella. Muscle scars with a row of 4 subelliptical adductors and a U-shaped frontal scar.

Remarks: The species is very similar to *Cativella* species described herein mainly in size and outline, but it differs in the presence of longer anterior spines, and in its thinner, less pronounced ridges. This species is distinct, but too rare in the present material to describe it formally.

Occurrence: Aricuru (Maracanã bay), sample AR-05.

Distribution: Lower Miocene (N5/N6 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Genus *Echinocythereis* Puri, 1953b

Echinocythereis sp.

Fig. 16: 26

Material: 3 valves.

Dimensions: MPEG-840-M, RV: L: 0.52 mm and H: 0.35 mm.

Description: Carapace inflated, medium-sized, subquadrate to subovate in lateral view. Dorsal margin nearly straight and arched at the anterior cardinal angle. Ventral margin sinuous, slightly concave in the middle part and convex upward posteroventrally. Anterior margin broadly rounded. Posterior margin subrounded in lateral view. Indistinctly plicate, with a well-developed eye tubercle. Valve surface covered by numerous strong, conjunctive, round, tubercle-like spines arranged in an approximately concentric configuration with faint reticulation and sieve pores in between. Short spines extend along the free margin. Internal features were not observed.

Remarks: The ornamentation of this specimen is more characteristic of the genus *Echinocythereis* than *Henryhowella*. It comprises rounded, concentrically arranged spines superimposed on the reticulate ornamentation, an inflated carapace, a rounded rather than triangular posterior end, and not lacking ridges (Moore 1961). *Echinocythereis garretti* (Howe & McGuirt) of Puri (1953b) is very similar to species herein described mainly in the ornamentation pattern and carapace shape but differs in size: *E. garretti* (L: 1.064 mm; H: 0.67 mm) is larger than *E. sp.*, which may be a juvenile specimen.

Occurrence: B-17 quarry, Capanema, Pará (sample: B11B); Primavera FPR-160 core (sample: AM17).

Distribution: Lower Miocene (N5/N6 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Superfamily CYTHERIDEOIDEA Liebau, 2005

Family CYTHERIDEIDAE Sars, 1925

Genus *Cyprideis* Jones, 1857

Cyprideis? carmoi sp. nov.

Fig. 16: 27–29; 35

Material: 5 carapaces and 9 valves.

Etymology: In honor of the Brazilian ostracodologist and professor at the University of Brasília, Dr. Dermeval Aparecido do Carmo.

Holotype: MPEG-841-M, Female, C, LV: L: 0.72 mm and H: 0.38 mm; RV: L: 0.71 mm and H: 0.36 mm; W: 0.31 mm.

Paratypes: MPEG-842-M, juvenile, Male?, C, LV: L: 0.62 mm and H: 0.30 mm. MPEG-843-M, RV: L: 0.73 mm and H: 0.32 mm.

Type locality: B17 Quarry, sample B11A, Capanema town.

Diagnosis: Ornamentation with large punctae distributed and arranged regularly and concentric ridges parallel to the anterior margin, which is crenulated.

Description: Large carapace, subtriangular in lateral view. LV overlaps the RV mainly along the dorsal margin. Dorsal margin subtriangular mainly in the RV. Ventral margin almost straight. Anterior margin rounded. Posterior margin truncate with a short slope downward. Surface ornamentation consisting of large punctae, distributed regularly, and concentric ridges parallel to the anterior margin. A deep median sulcus runs from the dorsomedian region to the center of the carapace. Anterior margin denticulate with two rows of fossae followed by punctae along the free margin. RV with short spine in the posteroventral extremity. Subelliptical in dorsal view, with posterior end subacute and prominent sulcus in the mid-anterior region. Internal view not observed.

Remarks: This species has an ornamentation pattern, carapace shape and median sulcus typical of *Cyprideis*, however, the internal features could not be observed to confirm the generic classification. *Cyprideis sulcosigmoidalis*

(Purper, 1979) recorded from the Miocene of Solimões Formation by Gross *et al.* (2014) resembles this species in some aspects such as the sulcus positioned in the mid-anterior to the center of the carapace and in the arrangement of parallel ridges on the anteroventral to anteromedial regions, but it differs in carapace shape and size, being shorter with an anteroventral region that is flattened and faces downward, and a ventral margin more truncated in the posterior region that is almost straight and a higher anterior cardinal angle. Originally recorded by van den Bold (1963a) from the Upper Miocene and Pliocene of Trinidad, *Cytheridea kollmanni* van den Bold, 1963a and *C. mediatena* van den Bold, 1963a also present features very similar to this species, such as carapace shape and median sulcus, but these species differ in the ornamentation from the present species. *Cyprideis rohri* van den Bold, 1963a is more similar in ornament, particularly in the alignment of the punctae mainly on the anteroventral region. The species described herein differs in having a flattened and short, single spine in the posterior end of the RV, more prominent overlap on the dorsal margin, and a slightly punctate area in the posterodorsal region.

Occurrence: Aricuru (Maracanã bay), sample AR-04; B-17 quarry, Capanema, Pará (samples B12, B11A and B11B).

Distribution: Lower Miocene (N5/N6 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Genus *Hemicyprideis* Malz & Triebel, 1970

Hemicyprideis sp.

Fig. 16: 30–31

Material: 1 valve.

Dimensions: MPEG-844-M, LV: L: 0.83 mm and H: 0.50 mm.

Description: Large valve, suboval in lateral view. LV with dorsal and ventral margins subparallel: dorsal margin slightly convex in the anterior region with a short and shallow median sulcus next to the dorsomedian region. Ventral margin slightly convex, sinuous internally. Anterior margin rounded with two rows of fossae followed by punctae along the free margin. Posterior margin truncate with a short slope downward. Surface ornamented with large punctae distributed and arranged regularly. Anterior region with two parallel furrows extending to the ventral margin. Hinge of LV consists of large anterior and posterior elements with grooves and apparently a median groove, however, this region is worn which makes this characterization uncertain. Narrow inner lamella and normal pore canals distributed internally. Muscle scars not preserved.

Remarks: This species is similar to *Hemicyprideis intercedens* Malz, 1978; *Hemicyprideis rhenana* (Lienenklaus, 1895), *Hemicyprideis* cf. *gilletae* (Stchepinsky, 1960) and *Hemicyprideis miocaenica* (Lienenklaus, 1895). Among those species, *Hemicyprideis rhenana* (Lienenklaus, 1895) is most similar in shape, in the presence of a mid-dorsal sulcus and bearing two furrows that run in parallel to the anterior margin extending to the ventral margin, and also in the ornamentation pattern of the anterior, posterior and ventral ridges. However, that species differs in its less prominent posterior cardinal angle.

Occurrence: Aricuru (Maracanã bay), sample AR-04.

Distribution: Aricuru Locality, Pirabas Formation (Lower Miocene—N5/N6 zones; Blow 1969), Pará, Brazil (Nogueira & Nogueira 2017).

Family KRITHIDAE Mandelstam, 1958

Genus *Pseudosammocythere* Carbonnel, 1966

Pseudosammocythere ex. gr. *vicksburgensis* (Howe & Law, 1936)

Fig. 16: 32–34

v 1963a *Parakrithella* sp.—van den Bold: p. 378, pl. 4, fig. 4.

. 1988 *Pseudosammocythere* ex. gr. *vicksburgensis* (Howe & Law).—van den Bold: p. 27–28, pl. 2, figs. 5–7, text-figure 8.

Material: 2 carapaces and 4 valves.

Dimensions: MPEG-845-M, C; LV: L: 0.43 mm and H: 0.18 mm; RV: L: 0.42 mm and H: 0.17 mm; W: 0.14 mm.

Diagnosis: Carapace small, elongate, of about equal height throughout. Shell thin, fragile, hyaline. Anterior end broadly rounded; dorsal margin straight; ventral margin almost straight and parallel, very slightly sinuate in front of the middle; posterior end obliquely rounded, narrowly rounded below the middle. Valves subequal. In dorsal view, carapace lanceolate, tapering in front, narrowly rounded behind, widest behind the middle. Inner lamella fairly broad in anterior end, narrow in the rest of the free margin; line of concrescence coincides with inner margin except in anterior end, where it forms a wide loop, indented where the radial pore canals occur (van den Bold 1963a).

Remarks: The present species is identical to *P. ex. gr. vicksburgensis* (Howe & Law, 1936) of van den Bold (1988) in its shape and size. However, it has similarities to the figured specimen of *Parakriithella* sp. van den Bold, 1963a (HVV No. 8221) in size (L: 0.51 mm; H: 0.23 mm) and in the shape of the rounded posterior end, but differs in being more slender, in having a prominent cardinal angle in the dorsal margin and in its more concave ventromedian region.

Occurrence: Aricuru (Maracanã bay), samples AR-01 to AR-06; B-17 quarry, Capanema, Pará (samples: B11A and B13B).

Distribution: This species was recorded from the Springvale Formation, Melajo Clay member, Upper Miocene from Trinidad. Oligocene to Recent: Trinidad, Mexican and United States Gulf Coast, Cuba, Hispaniola (van den Bold 1988). Lower Miocene (N5 to N7 zones; Blow 1969), Pirabas Formation, Pará, Brazil (Nogueira & Nogueira 2017).

Discussion

Micropaleontological analysis of samples from the Late Oligocene to Lower Miocene carbonate succession of the Pirabas Formation in Northern Brazil documented the occurrence of 119 ostracod species. The fact that 29 species described in the Pirabas succession were also recognized from the Caribbean, Atlantic and Pacific beyond North America reveal a greater than expected connectivity among ostracod populations. Twenty-seven of these species were previously recorded in the Caribbean region, with two additional species known from North America and the central Pacific (Easter Island). Although they occur in several countries from the Caribbean region, most of these 27 species are mainly recorded in Trinidad, in the southernmost portion of Caribbean Sea (Tab. 3). Other areas with occurrences of the species noted herein include (Tab. 3 and 4): Cuba, with nine species; Dominican Republic, eight species; Panamá, seven species; and Puerto Rico, with three species. Thirteen species have been reported previously from North America (Tab. 3). Thus, the occurrence of these species supports the similarity of the Pirabas Formation with other Neogene units from the Caribbean. With the exception of some species previously known only from North America and the Pacific region, most species recovered herein from the Pirabas Formation are compatible with the Neogene Caribbean ostracod fauna (Fig. 17).

The palaeobiogeography of Cenozoic ostracods from Central–South America has been studied previously (van den Bold 1977), and faunal provinces and dispersal mechanisms for selected genera have been described (van den Bold 1970b; 1974; Valicenti 1977). The present study reveals that different taxa show a variety of different biogeographic histories. Some genera such as *Pellucistoma*, *Neocaudites*, *Paracytheridea* and *Jugosocythereis* have had wide distributions around the Caribbean region, Gulf of Mexico, North America and Pacific from the Oligocene to the present (Fig. 17). For example, the species *Neocaudites? macertus* originated in the Oligocene in the North Atlantic Ocean and expanded its distribution during the Mio-Pliocene to the Caribbean Sea and to the north coast of South America. Conversely, *Paracytheridea tschoppi* was first recovered from the Caribbean region (Greater and Lesser Antilles) during the Miocene and later spread to the North Atlantic Ocean and throughout the Caribbean–Gulf Coast (Fig. 17). During the Oligocene, few genera dispersed northwards from South America into the Caribbean region, except for *Ambostracon* (*Ambostracon*) and *Coquimba*, which began to do so in the Miocene (van den Bold 1972b; 1973; Wood *et al.* 1999). Many species, including those of the genera *Caudites*, *Coquimba*, *Bairdoppilata*, *Paranesidea*, *Vandenboldina* and *Paradoxostoma* were restricted to the Caribbean region from the Oligocene to Recent. However, other species, such as those of the genera *Triebelina* and *Pokornyella* had distributions in the Miocene that spanned the Caribbean region and North and South America (Fig. 17).

TABLE 3. Previously reported occurrences of species found in the present study from countries in the Caribbean and nearby regions.

SPECIES RECORDED IN CARIBBEAN REGION AND NEARBY AREAS	REFERENCES												
	Trinidad	Guatemala	Belize	Bermuda	Honduras	Jamaica	St. Croix and Anguilla	Venezuela	Colombia	Cuba	Dominican Republic	Panama	Puerto Rico
<i>Cytherella staineri</i> van den Bold, 1960	X												
<i>Cytheropteron bichense</i> van den Bold, 1963a	X												
<i>Bythoceratina binodosa</i> van den Bold, 1966a	X							X	X				
<i>Aurila laevicula</i> (Edwards) Swain, 1968	X												X
<i>Neocaudites maceratus</i> (Stephenson, 1944)	X										X		X
<i>Coquimba congestocostata</i> (van den Bold, 1963)	X										X		X
<i>Paradoxostoma artum</i> van den Bold, 1966a	X							X					
<i>Costa varia. subs. variabilocostata</i> (van den Bold, 1950)	X							X					
<i>Xestoleberis? dactyloptypa</i> van den Bold, 1946)	X	X								X	X		X
<i>Bairdopillata oblongata</i> (van den Bold, 1946)										X	X		
<i>Loxocorniculatum antillum</i> (van den Bold, 1946)	X							X		X	X		
comb. nov.													
<i>Paranesidea elegantissima</i> (van den Bold, 1946)									X	X	X		
<i>Triebelina crumena</i> (Stephenson, 1944)	X	X							X	X	X		X
<i>Paracytheridea tschoppi</i> van den Bold, 1946	X	X	X	X					X	X	X		X
<i>Caudites medialis</i> Coryell and Fields, 1937	X										X	X	

....continued on the next page

TABLE 3. (Continued)

SPECIES RECORDED IN CARIBBEAN REGION AND NEARBY AREAS	REFERENCES													
	Trinidad	Guatemala	Belize	Bermuda	Honduras	Jamaica	St. Croix and Anguilla	Venezuela	Colombia	Cuba	Dominican Republic	Panama	Puerto Rico	Haiti
<i>Jugosocythereis pamosa</i> (Brady, 1869)	X										X	X	X	X
<i>Puriana rugipunctata</i> (Ulrich and Bassler, 1904)	X	X							X		X	X	X	X
<i>Loxocorniculium fischeri</i> (Brady, 1869)	X	X							X	X	X	X	X	X
<i>Bairdopillata anillea</i> (van den Bold, 1946) com. nov.											X	X	X	
<i>Quadracythere brachypygata</i> van den Bold, 1965											X	X	X	
<i>Macrocypis gracilis</i> (Brady, 1890)	X	X					X				X		X	X
<i>Pellucistoma magniventra</i> Edwards, 1944											X			X
<i>Cytheropteron? yorktownensis</i> (Malkin, 1953)														X
<i>Kangarina quellita</i> Coryell and Fields, 1937	X					X	X	X	X		X	X	X	X
<i>Cornucoquimba hornibrooki</i> (Puri, 1960) comb. nov.			X								X		X	X
<i>Neocaudites triplistriatus</i> (Edwards, 1944)	X			X	X									X
<i>Pokorniyella deformis</i> ? (Reuss, 1850)	X	X							X	X	X	X	X	X
<i>Munseyella minuta</i> (van den Bold, 1946)	X													X
<i>Pseudosammocythere</i> ex. gr. <i>vicksburgensis</i> (Howe and Law, 1936)	X						X		X	X	X	X	X	X

The presence of the genus *Orionina* in the present study may provide new insight about its distribution pattern. *Orionina* originated in the Oligocene in the Caribbean region as documented by van den Bold in 1963c (Van den Bold 1963a, Wood *et al.* 1999). Along with *Orionina*, other ‘equatorial’ genera, such as *Bairdoppilata* and *Pellucistoma*, were also found in the Miocene from northern and southern Brazil. This southward dispersal during the early Miocene may be related to the gradual development of the circum-Antarctic oceanic circulation system, which intensified the warmer current circulation southward (Kennet 1980; Gross *et al.* 2015).

Although there are many genera common to North America and Southern Brazil (Wood *et al.* 1999), the fauna of the Pirabas Formation is more correlated to that of the Caribbean Sea and North America than it is to that of Southern Brazil (Fig. 17). Similarity of the Pirabas Formation to more northern faunas reached its acme in the Miocene (Carreño 1985; Ramos *et al.* 2004; Nogueira *et al.* 2011; Fig.17).

Data about the distribution of ostracod populations in the Equatorial Atlantic since the Neogene can potentially provide insight into paleoceanographical events. Oceanography and climate both play important roles in the migratory success of benthic ostracods. One particularly important event was the localized shoaling of the Caribbean Sea, which promoted the appearance of filters and corridor pathways, and may have accelerated the evolution, dispersion and diversification of ostracods (Barron 1987; Perfit & Williams 1989; Coates & Obando 1996; Tarling 1972; 1980; Smith & Briden 1977; Golonka *et al.* 1995; Wood *et al.* 1999). In addition, the separation of Antarctica from South America, and the subsequent development of the Drake Passage during the Oligo-Miocene and the partial uplift and total emergence of the Central America Isthmus during the Mio-Pliocene influenced ostracod distributions (Duque-Caro 1990; Coates & Obando, 1996; van den Bold 1968; 1988; Steineck *et al.* 1984; Whatley *et al.* 1996; 1998; Jackson *et al.* 1996).

These events induced ocean current changes, which influenced the dispersal potential of taxa in the southwestern Atlantic Ocean resulting in ostracod provinciality (Kennett 1980; Duque-Caro 1990). During the Late Pliocene, the Isthmus of Panama emerged, separating partially the Caribbean from Pacific faunas (Coates & Obando 1996; Jackson *et al.* 1996; van den Bold 1968; 1988; Keller & Barron 1983; Steineck *et al.* 1984). However, during the late Oligocene and early Miocene, this connection was still open and there were no ostracod genera endemic to the Pacific coast or Caribbean–Gulf Coast ostracod communities (van den Bold 1963a; 1968). The present work documents, in part, baseline conditions before the connection between the eastern Pacific and the Caribbean Sea was severed.

Overlaid on this tectonic setting are secular changes in global and regional climate. Cenozoic global climate warmed during the late Oligocene and reached a climatic optimum in the late early Miocene (the warmest interval of the Neogene and the warmest since the late Eocene), then underwent rapid cooling during the middle Miocene (Shackleton & Kennett 1975; Savin *et al.* 1975; Miller *et al.* 1987; Hornibrook 1992; Flower & Kennett 1994). Thus, warm climates in the Oligocene/Miocene probably allowed for the establishment of many Neotropical ostracod genera and species in northern Brazil at this time (Fig.17). This event could explain why some Caribbean genera could have reached southern Brazil during the Miocene (i.e., Sanguinetti 1979; 1980; Kotzian & Eilert 1985; Carreño *et al.* 1999).

The correlation between the Atlantic/Caribbean and Pacific marine ostracods reveals interesting examples of dispersal and connectivity (Cronin 1988). Widespread species can show very little intraspecific variability in carapace morphology among disparate populations and taxonomic studies of faunas from different regions have not always revealed the supposed endemism of shallow marine water ostracods (Cronin 1988). Although many fossil species exhibit morphological stasis through their history (Hunt *et al.* 2015), in other cases, isolated populations have diverged markedly from ancestral forms. Several species described herein from the Pirabas Formation bear close morphological similarities to species already known from the region. For example, *Cytherelloidea quasilenisa* **sp. nov.** presents very close similarities to *C. obliquecostata* van den Bold, 1963a from Miocene Caribbean successions. These species exhibit only a few differences in the ornamentation pattern of ridges and are presumably closely related. A similar situation occurs with *Hemicytherura bradyisimilis* **sp. nov.** and *Hemicytherura bradyi* (Puri, 1960) Coimbra *et al.* 1995, which also differ only in few characteristics of the ornamentation pattern.

Many of the species documented here are restricted stratigraphically (e.g., *Cytherella stainforthi*, *Neocaudites macertus*, *Munseyella minuta* and *Paranesidea elegantissima*) and can be used to refine previous biostratigraphic zonation using ostracods (Nogueira & Nogueira 2017). Others, however, have a long temporal range and presumably represent examples of long-term morphological stasis (Fig. 17). Five species of ostracods, including

Pseudopsammocythere ex. gr. *vicksburgensis* and *Jugosocythereis pannosa* are recognized from the Oligocene through the Recent in American carbonate successions and are currently restricted to the Caribbean-Gulf Coast region (Holden 1976; Machain-Castillo 1986; van den Bold 1988).

Finally, we emphasize that the succession evaluated here is not sufficient to obtain a complete paleoenvironmental reconstruction and history of this region during the Miocene. Therefore, we hope that this work motivates additional work that can be synthesized to understand the dispersal events of the ostracod fauna during the Neogene on the carbonate platform in northern South America.

Conclusions

A total of 119 species were identified and illustrated from five sections (one from each core) from the Pirabas Formation, Pará state, Northeastern Brazil. Of these, 27 were already recorded from the Caribbean region and two from the Pacific Ocean and North America. The occurrence of these species supports the similarity between the Pirabas Formation and other Neogene units from the Caribbean and Lesser Antilles, especially Trinidad and Cuba. The distribution of ostracod populations in the Equatorial Atlantic since the Neogene can potentially provide insight into paleoceanographical events. Oceanography and climate both play important roles in the migratory success of benthic ostracods. One particularly important event was the localized shoaling of the Caribbean Sea, which promoted the appearance of filters and corridor pathways, and may have accelerated the evolution and dispersal of ostracods. The species identified in this work contribute to biostratigraphic and paleobiogeographic studies of Ostracoda of the Neogene of South America. Although this study presents many species in open nomenclature, numerous species are described as new to science and thus provide new opportunities for correlation with related units and for understanding geological and paleoceanographical events related to the evolution and radiation of ostracods.

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References

- Andreu, B. (1996) Nouvelles espèces d'ostracodes du Turonien supérieur (?)-Coniacien (?)-Santonien de la région de Boulmane, Moyen Atlas, Maroc. Systématique, biostratigraphie et paléoécologie, paléobiogéographie des associations. In: Jardiné, S., De Klasz, I. & Debena, Y.J.-P. (Eds.), *Géologie de l'Afrique et de l'Atlantique Sud. Vol. 16. Bulletin des Centres de Recherche Exploration-Production Elf-Aquitaine, Pau*, Mémoire, pp. 483–509.
- Andreu, B., Lebedel, V., Wallez, M.-J., Lézin, C. & Ettachfini, M. (2013) The upper Cenomanian-lower Turonian carbonate platform of the Preafrican Trough, Morocco: Biostratigraphic, paleoecological and paleobiogeographical distribution of ostracods. *Cretaceous Research*, 45, 216–246.
<https://doi.org/10.1016/j.cretres.2013.04.005>
- Alexander, C.I. (1927) The stratigraphic range of the Cretaceous ostracod of *Bairdia subdeltoidea* and its allies. *Journal of Paleontology*, 1, 29–33.

- Babinot, J.-F., Moullade, M. & Tronchetti, G. (2007) The upper Bedoulian and lower Gargasian Ostracoda of the Aptian stratotype: Taxonomy and biostratigraphic correlation. *Carnets de Géologie/Notebooks on Geology*, 5, 1–35.
<https://doi.org/10.4267/2042/8877>
- Barron, E.J. (1987) Eocene equator to pole surface ocean temperatures: a significant climate problem? *Paleoceanography*, 2, 729–739.
<https://doi.org/10.1029/PA002i006p00729>
- Bertels, A., Kotzian, S.B. & Madeira-Falcetta, M. (1982) Micropaleontologia (Foraminiferos Y Ostracodos del Cuaternario de Palmares do Sul (Formacion Chui), Brasil. *Ameghiniana*, 19 (1–2), 125–156.
- Benson, R.H. & Coleman, G.L. (1963) Recent marine Ostracoda from the eastern Gulf of Mexico. *University of Kansas Paleontological Contributions*, Arthropoda, 2, 1–52.
- Benson, R.H. (1972) The *Bradleya* problem, with descriptions of two new psychrospheric ostracode genera, *Agrenocythere* and *Poseidonamicus* (Ostracode: Crustacea). *Smithsonian Contribution Paleobiology*, 12, 1–137.
<https://doi.org/10.5479/si.00810266.12.1>
- Blake, D.B. (1950) Gosport Eocene Ostracoda from Little Stave Creek, Alabama. *Journal of Paleontology*, 24, 174–184.
- Blow, W.H. (1969) Late middle Eocene to Recent planktonic foraminiferal biostratigraphy. In: Brönnimann, P. & Renz, H.H. (Eds.), *Proceedings First International Conference Planktonic Microfossils, Geneva, 1967. Vol. 1*. E.J. Brill, Leiden, pp. 199–422.
- Bold, W.A. van den (1946) *Contribution to the study of Ostracoda with special reference to the tertiary and cretaceous microfauna of the Caribbean region*. Thesis, Universiteit of Utrecht, DeBussy, J.H., Amsterdam, 167 pp.
- Bold, W.A. van den (1950) Miocene Ostracoda from Venezuela. *Journal of Paleontology*, Tulsa, 24 (1), 76–88.
- Bold, W.A. van den (1957) Oligo-Miocene Ostracoda from southern Trinidad. *Micropaleontology*, 3 (3), 231–254.
<https://doi.org/10.2307/1484109>
- Bold, W.A. van den (1958) Ostracoda of Brasso Formation of Trinidad. *Micropaleontology*, New York, 4 (4), 391–418.
<https://doi.org/10.2307/1484268>
- Bold, W.A. van den (1960) Eocene and Oligocene Ostracoda of Trinidad. *Micropaleontology*, 6 (2), 145–196.
<https://doi.org/10.2307/1484466>
- Bold, W.A. van den (1963a) Upper Miocene and Pliocene Ostracoda of Trinidad. *Micropaleontology*, 9 (4), 361–424.
<https://doi.org/10.2307/1484501>
- Bold, W.A. van den (1963b) Anomalous hinge structure in a new species of *Cytherelloidea*. *Micropaleontology*, 9 (1), 75–78.
<https://doi.org/10.2307/1484609>
- Bold, W.A. van den (1963c) The Ostracode Genus *Orionina* and its Species. *Journal of Paleontology*, 37 (1), 33–50.
<https://doi.org/10.2307/1484554>
- Bold, W.A. van den (1965) Middle Tertiary Ostracoda from northwestern Puerto Rico. *Micropaleontology*, 11 (4), 381–414.
<https://doi.org/10.2307/1484777>
- Bold, W.A. van den (1966a) Miocene and Pliocene Ostracoda from northeastern Venezuela. *Verhandelingen der Koninklijke Nederlandse Akademie van Wetenschappen, Afdeling Natuurkunde, Serie 1*, 23 (3), 1–43.
- Bold, W.A. van den (1966b) Ostracode zones in Caribbean Miocene. *Bulletin of the American Association of Petroleum Geologists*, 50, 1029–1031.
- Bold, W.A. van den (1966c) Upper Miocene Ostracoda from the Tubará Formation (northern Colombia). *Micropaleontology*, 12 (3), 360–364.
- Bold, W.A. van den (1966d) Ostracoda from Colon Harbour, Panama. *Caribbean Journal of Science*, 6 (1–2), 43–64.
- Bold, W.A. van den (1966e) Ostracoda of the Pozón Section, Falcón, Venezuela. *Journal of Paleontology*, 40 (1), 177–185.
- Bold, W.A. van den (1967a) Miocene Ostracoda from Costa Rica. *Micropaleontology*, 13 (1), 75–86.
<https://doi.org/10.2307/1484807>
- Bold, W.A. van den (1967b) Ostracoda of the Gatún Formation, Panama. *Micropaleontology*, 13 (3), 306–318.
<https://doi.org/10.2307/1484832>
- Bold, W.A. van den (1968) Ostracoda of the Yaque Group (Neogene) of the northern Dominican Republic. *Bulletin American Paleontology*, 54 (239), 1–106.
- Bold, W.A. van den (1970a) The genus *Costa* (Ostracoda) in the Upper Cenozoic of the Caribbean Region. *Micropaleontology*, 16 (1), 61–75.
<https://doi.org/10.2307/1484848>
- Bold, W.A. van den (1970b) Ostracoda of the Lower and Middle Miocene of St. Croix, St. Martin and Anguilla. Louisiana State University. March-June. *Caribbean Journal of Science*, 10, 35–61.
- Bold, W.A. van den (1971) Ostracoda of the Coastal Group of Formations of Jamaica, Transactions of the Gulf Coast. *Gulf Coast Association of Geological Societies Transactions*, 21, 325–39.
- Bold, W.A. van den (1972a) Ostracoda of the La Boca Formation, Panama Canal Zone. *Micropaleontology*, 18 (4), 410–422.
<https://doi.org/10.2307/1485049>
- Bold, W.A. van den (1972b) Ostracodos del Post-Eoceno de Venezuela y regiones vecinas. *Boletín de Geología*, Ministerio de Energía e Hidrocarburos, publicacion Especial (Memoria del 4º Congreso Geológico Venezolano), 2, 5, 999–1071.
- Bold, W.A. van den (1973) Distribution of Ostracoda in the Oligocene and Lower and Middle Miocene of Cuba. *Caribbean Journal of Science*, 13, 145–167.

- Bold, W.A. van den (1974) Ostracode association in the Caribbean Neogene. *Verhandlungen der Naturforschenden Gesellschaft Basel*, 84 (1), 214–221.
- Bold, W.A. van den (1975) Ostracoda from the late Neogene of Cuba. *Bulletins of American Paleontology, Ithaca, New York*, 68 (289), 119–167.
- Bold, W.A. van den (1977) Cenozoic Marine Ostracoda Of The South Atlantic. In: Swain, F.M (Ed.), *Stratigraphic Micropaleontology of Atlantic Basin and Borderlands*. Elsevier, Amsterdam, pp. 495–519.
[https://doi.org/10.1016/S0920-5446\(08\)70365-0](https://doi.org/10.1016/S0920-5446(08)70365-0)
- Bold, W.A. van den (1981) Distribution of Ostracoda in the Neogene of Central Haiti. *Bulletins of American Paleontology*, 79 (312), 1–136.
- Bold, W.A. van den (1988) Neogene paleontology in the northern Dominican Republic. The subclass Ostracoda (Arthropoda: Crustacea). *Bulletins of American Paleontology*, 94 (329), 1–105.
- Bonaduce, G., Ruggieri, G., Russo, A. & Bismuth, H. (1992) Late Miocene ostracods from the Ashtart 1 well (Gulf of Gabes, Tunisia). *Bollettino della Società Paleontologica Italiana*, 31, 3–93.
- Brady, G.S. (1866) On New or imperfectly known Species of Marine Ostracoda. *Transactions of the Zoological Society of London*, 5, 359–393.
<https://doi.org/10.1111/j.1096-3642.1866.tb00649.x>
- Brady, G.S. (1868) A synopsis of the recent British Ostracoda. *The Intellectual Observer*, 12, 110–130.
- Brady, G.S. (1869) Description of Ostracoda. In: Folin, L.D. & Périer, L. (Eds.), *Les Fonds de la Mer*, livr. 8–11, pp. 113–176.
- Brady, G.S. (1880) Report on the Ostracoda dredged by H.M.S. Challenger during the Years 1873–1876. In: *Report on the scientific results of the voyage of H.M.S. Challenger*, Zoology, 1, 1–184.
- Brady, G.S. (1890) On Ostracoda collected by H.B. Brady, Esq., L.L.D., F.R.S., in the South Sea Islands. *Transactions of the Royal Society of Edinburgh: Earth Sciences*, 35 (2), 489–525.
<https://doi.org/10.1017/S0080456800017749>
- Brandão, S.N., Angel, M.V., Karanovic, I., Parker, A., Perrier, V., Sames, B. & Yasuhara, M. (2014) *World Ostracoda Database*. World Register of Marine Species. Available from: <http://www.marinespecies.org/aphia.php?p=taxdetails&id=1078> (accessed 18 August 2015)
- Brent, W. (2010) *Vandenboldina* n. gen., a new name for *Pseudoceratina* van den Bold, 1965. *Journal of Micropaleontology*, 29 (2), 187.
<https://doi.org/10.1144/0262-821X10-011>
- Brown, P.M. (1958) Well logs from the coastal plain of North Carolina, North Carolina. *Department of Conservation and Development Bulletin*, 72, 1–68.
- Butler, E.A. (1963) Ostracoda and correlation of the Upper and Middle Frio from Louisiana to Florida. *Louisiana, Department of Conservation, Louisiana Geological Survey, Geological Bulletin*, 39, 1–100.
- Carreño, A.L. (1985) Biostratigraphy of the late Miocene to Pliocene on the Pacific island of Maria Madre, Mexico. *Micropaleontology*, 31 (2), 139–166.
<https://doi.org/10.2307/1485482>
- Carreño A.L., Coimbra, J.C. & Do Carmo, D.A. (1999) Late Cenozoic sea level changes evidenced by ostracodes in the Pelotas basin, southernmost Brazil. *Marine Micropaleontology*, 37 (2), 117–129.
[https://doi.org/10.1016/S0377-8398\(99\)00014-6](https://doi.org/10.1016/S0377-8398(99)00014-6)
- Coates, A.G. & Obando, F.A. (1996) The geologic evolution of the Central American Isthmus. In: Jackson, J.B.C., Budd, A.N. & Coates, A.G. (Eds.), *Evolution and Environments in Tropical America*. University Chicago Press, Chicago, IL, pp. 21–56.
- Concheyro, G.A. & Távora, V.A. (1992) Ocorrência de nanofósseis calcários na Formação Pirabas (Mioceno Inferior) no furo CB-UFPA-P1 (85), Município de Capanema, Estado do Pará. *Anais da Academia Brasileira de Ciências*, 64, 421.
- Coimbra, J.C., Carreño, A.L. & Michelli, M.J. (1999) Taxonomía y zoogeografía de la familia Cytheruridae (Ostracoda) de la plataforma continental ecuatorial de Brasil. *Ilheringia, Série Zoologia*, 87, 117–142.
- Coimbra, J.C., Sanguinetti, Y.T. & Bittencourt-Calcagno, V.M. (1995) Taxonomy and distribution patterns of modern species of *Callistocythere* Ruggieri, 1953 (Ostracoda) in the shelf seas of Brazil. *Revista Española de Micropaleontología*, 27 (3), 117–136.
- Coimbra, J.C., Ramos, M.I.F., Whatley, R.C. & Bergue, C.T. (2004) The taxonomy and zoogeography of the family Trachyleberididae (Crustacea: Ostracoda) from the Equatorial Continental Shelf of Brazil. *Journal of Micropaleontology*, 23 (2), 107–118.
<https://doi.org/10.1144/jm.23.2.107>
- Coryell, H.N., Sample, C.H. & Jennings, P.H. (1935) Bairdoppilata, a new genus of Ostracoda, with two new species. *American Museum Novitates*, 777, 1–5.
- Coryell, H.N. & Fields, S. (1937) A Gatun Ostracode fauna from Cativa, Panama. *American Museum Novitates*, 956, 1–18.
<https://doi.org/10.7202/1000066ar>
- Cronin, T.M. (1979) Late Pleistocene Marginal Marine Ostracodes from the Southeastern Atlantic Coastal Plain and their Paleoenvironmental Implications. *Géographie Physique et Quaternaire*, 33 (2), 121–173.
<https://doi.org/10.7202/1000066ar>
- Cronin, T.M. (1988) Geographical isolation in marine species: evolution and speciation in Ostracoda. In: Hanai, T., Ikeya, N. &

- Ishizaki, K. (Eds.), *Evolutionary Biology of Ostracoda: Its Fundamentals and Applications. Proceedings of the Ninth International Symposium on Ostracoda*. Kodansha/Elsevier, Tokyo and Amsterdam, pp. 871–889.
[https://doi.org/10.1016/S0920-5446\(08\)70227-9](https://doi.org/10.1016/S0920-5446(08)70227-9)
- Curtis, D.M. (1960) Relation of environmental energy levels and ostracod biofacies in east Mississippi delta area. *Bulletin of the American Association of Petroleum Geologists*, 44 (4), 471–494.
<https://doi.org/10.1306/Obda6002-16bd-11d7-8645000102c1865d>
- Deltel, B. (1964) Nouveaux ostracodes de l'Éocène et de l'Oligocène de l'Aquitaine méridionale. *Actes de la Société linnéenne de Bordeaux*, 100 (1962–1963), 127–221.
- Dingle, R.V. (1993) Quaternary ostracods from the continental margin off southwestern Africa. Part 2. Minor taxa. *Annals of the South African Museum*, 103, 1–165.
- Dung, L.D. & Tsukagoshi, A. (2014) Three new species of the genus *Loxococoncha* (Crustacea, Ostracoda, Podocopida) from the Okinawa Islands, southern Japan. *Zootaxa*, 3796 (1), 147–165.
<https://doi.org/10.11646/zootaxa.3796.1.7>
- Duque-Caro, H. (1990) Neogene stratigraphy, paleoceanography and paleobiology in the northwest South America and the evolution of the Panama Seaway. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 77, 203–234.
[https://doi.org/10.1016/0031-0182\(90\)90178-A](https://doi.org/10.1016/0031-0182(90)90178-A)
- Edwards, R.A. (1944) Ostracoda from the Duplin Marl (Upper Miocene) of North Carolina. *Journal of Paleontology*, 18, 505–528.
- Ellis, S.J. & Messina, A.R. (1952 to date) *Catalogue on ostracoda. Supplement 3. Special Publications*. American Museum of Natural History, New York. [no consecutive pagination]
- Esker, G.L. (1968) Danian ostracodes from Tunisia. *Micropaleontology, New York*, 14.3, 319–333.
<https://doi.org/10.2307/1484692>
- Fernandes, J.M.G. (1984) Paleocology of Formation Pirabas, Pará State. In: 33° Brazilian Congress of Geology. *Anais da Academia Brasileira de Ciências, Sociedade Brasileira de Geologia*, 1, 330–340. [in Portuguese]
- Fernandes, J.M.G. (1988) Bioestratigrafia da Formação Pirabas, Estado do Pará. In: 35° Congresso Brasileiro De Geologia. *Anais da Academia Brasileira de Ciências, Sociedade Brasileira de Geologia*, 6, 2376–2382.
- Fernandes, M.J.G. & Távora, V.A. (1990) Estudos Dos Foraminíferos Da Formação Pirabas Procedentes Do Furo Cb-Ufpa-PI (85), Município De Capanema, Estado Do Pará. In: 36° Congresso Brasileiro De Geologia, Rio De Janeiro. *Anais da Academia Brasileira de Ciências, Sociedade Brasileira de Geologia*, 1, 470–475.
- Ferreira, C.S. (1966) Características Lito-Paleontológicas Na Formação Pirabas, Estado Do Pará. In: Conferência Geológica Das Guianas, *Anais da Academia Brasileira De Ciências, Conselho Nacional de Pesquisa*, 6, 101–111.
- Ferreira, C.S. (1977) Fácies Da Formação Pirabas (Mioceno Inferior): Novos Conceitos e Ampliações. *Anais da Academia Brasileira De Ciências*, 49 (2), 353.
- Ferreira, C.S., Macedo, A.C.M. & Assis, J.E.P. (1978) A Formação Pirabas no Estado do Pará-novo registro de subsuperfície: Belém (furo 4BE-01-PA, CPRM), *Anais da Academia Brasileira de Ciências*, 50, 427.
- Ferreira, C.S. & Fernandes, A.C.S. (1987) Indicadores de possível ambiente reci-fal na Formação Pirabas, Oligo-Mioceno, N-NE do Brasil. 10. *Congresso Brasileiro de Paleontologia, Resumos das Comunicações, Sociedade Brasileira de Paleontologia*, 1, 38.
- Ferreira, C.S.M., Vicalvi, A. & Macedo, A.C.M. (1981) Nota sobre a seqüência sedimentar ao sul do rio Guamá, Estado do Pará. Evidências do Oligo-Mioceno marinho, através dos resultados preliminares da sondagem feita em Vila Mãe do Rio, (“48”), BR-010, Município de Irituia. *Anais da Academia Brasileira de Ciências*, 53, 208–209.
- Ferreira, C.S., Vicalvi, M.A. & Macedo, A.C.M. (1984) Os limites meridionais da bacia de Pirabas. In: 33° Congresso Brasileiro De Geologia, Rio de Janeiro. *Anais da Academia Brasileira de Ciências. Vol. 1. Sociedade Brasileira de Geologia*, Rio de Janeiro, pp. 326–329.
- Flower, B.P. & Kennett, J.P. (1994) The middle Miocene climatic transition: East Antarctic ice sheet development, deep ocean circulation and global carbon cycling. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 108, 537–555.
[https://doi.org/10.1016/0031-0182\(94\)90251-8](https://doi.org/10.1016/0031-0182(94)90251-8)
- Forester, R.M. (1980) A Systematic Revision of the Ostracode Species Described by Ulrich and Bassler and by Malkin from the Chesapeake Group in Maryland and Virginia. *U.S. Geological Survey Professional Paper*, 1128, 1–25.
<https://doi.org/10.3133/pp1128>
- Garbett, E. & Maddocks, R.F. (1979) Zoogeography of Holocene Cytheracean ostracodes in the bays of Texas. *Journal of Paleontology*, 53 (4), 841–919.
- Góes, A.M., Rossetti, D.F., Nogueira, A.C.R. & Toledo, P.M. (1990) Modelo Depositional Preliminar Da Formação Pirabas No Nordeste Do Estado Do Pará. *Boletim Do Museu Paraense Emilio Goeldi, Série Ciências Da Terra*, 2, 3–15.
- Golonka, J., Ross, M.I. & Scotese, C.R. (1995) Phanerozoic paleogeographic and paleoclimatic modeling maps. In: Embry, A.F., Beauchamp, B. & Glass, D.J. (Eds.), *Pangea Global Environments and Resources. Canadian Society of Petroleum Geologists Memoir*, 17, pp. 1–47.
- Gross, M. (2006) Mittelmiozäne Ostracoden aus dem Wiener Becken (Badenium/Sarmatium, Österreich). *Österreichische Akademie der Wissenschaften, Schriftenreihe der Erdwissenschaftlichen Kommissionen*, 1 (Special Volume), 1–224.
- Gross, M., Ramos, M.I.F., Piller, W.E. (2015) A minute ostracod (Crustacea: Cytheromatidae) from the Miocene Solimões Formation (western Amazonia, Brazil): evidence for marine incursions? *Journal of Systematic Paleontology*, 14 (7), 581–

- Gross, M., Ramos, M.I.F. & Piller, W.E. (2014) On the Miocene *Cyprideis* species flock (Ostracoda; Crustacea) of Western Amazonia (Solimões Formation): Refining taxonomy on species level. *Zootaxa*, 3899 (1), 1–69.
<https://doi.org/10.11646/zootaxa.3899.1.1>
- Hartmann, G. (1959) Zur Kenntnis der lotischen Lebensbereiche der pazifischen Küste von El Salvador unter besonderer Berücksichtigung seiner Ostracodenfauna. *Kieler Meeresforschungen*, 15, 187–241.
- Harlton, B.H. (1929) Pennsylvanian Ostracoda from Menard County, Texas. *University of Texas Bulletin*, 2901, 139–161.
- Hazel, J.E. & Holden, J. (1971) Ostracoda of Late Eocene Age from Eua, Tonga. *U.S. Geological Survey Professional Paper*, 640-D, 1–11.
<https://doi.org/10.3133/pp640D>
- Holden, J.C. (1967) Late Cenozoic ostracodes from the Drowned Terraces in the Hawaiian Island. *Pacific Science*, 21, 1–50.
- Holden, J.C. (1976) Late Cenozoic Ostracoda from Midway Island drill holes. *U.S. Geological Survey Professional Paper*, 680-F, 1–7.
<https://doi.org/10.3133/pp680F>
- Hornibrook, N. de B. (1952) Tertiary and Recent marine Ostracoda of New Zealand. Their origin, Affinities and Distribution. *New Zealand Geological Survey, Paleontological Bulletin*, 18, 1–82.
- Hornibrook, N.d.B. (1992) New Zealand Cenozoic marine paleoclimates: a review based on the distribution of some shallow water and terrestrial biota. In: Tsuchi, R. & Ingle, J. (Eds.), *Pacific Neogene Environments, Evolution and Events*. University of Tokyo Press, Tokyo, pp. 83–106
- Howe, H.V. & Chambers, J. (1935) Louisiana Jackson Eocene Ostracoda. *Louisiana Geological Survey Geological Bulletin*, 5, 1–65.
- Howe, H.V. & Laurencich, L. (1958) Introduction to the study of Cretaceous Ostracoda. *Louisiana State University Press*. Baton Rouge, Louisiana, 536 pp.
- Howe, H.V. & Law, J. (1936) Louisiana Vicksburg Oligocene Ostracoda. *Louisiana Geological Survey Geological Bulletin*, 7, 1–96.
- Howe, H.V., Chambers, J., Brown, B., McGuirt, J., Neill, W., Hough, L., Ellis, A.D., Stephenson, M., Spurgeon, J., Pyeatt, L., Dohm, C., Hadley, V., Taylor, R. & Johnson, T.J. (1935) Ostracoda of the Arca Zone of the Choctawatchee Miocene of Florida. *State of Florida Department of Conservation, Geological Bulletin*, 13, 7–37. Available from: http://publicfiles.dep.state.fl.us/FGS/FGS_Publications/B/BPRIDE/B13_1935.pdf (Accessed 28 Mar. 2019)
- Hunt, G., Hopkins, M.J. & Lidgard, S. (2015) Simple versus complex models of trait evolution and stasis as a response to environmental change. *Proceedings of the National Academy of Sciences*, 112 (16), 4885–4890.
<https://doi.org/10.1073/pnas.1403662111>
- Jackson, J.B.C., Budd, A.F. & Coates, A.G. (1996) *Evolution and Environment in Tropical America*. University Chicago Press, Chicago, 425 pp.
- Ishizaki, K. & Gunther, F. J. (1976). Ostracoda of the family Loxoconchidae from the Gulf of Panama. *Science Reports of the Tohoku University, Sendai, Series 2 (Geology)*, 46, 11–26.
- Kajiyama, E. (1913) On the Ostracoda of Misaki. Part 3. *Zoological magazine (Dobutugaku-zasshi)*, 25, 1–6.
- Keij, A.J. (1954) Distribution of Faunal Remains: Microfauna. Ostracoda: Identification and Description of Species. In: Van Andel, Tj. & Postma, H. (Eds.), *Recent Sediments of the Gulf of Paria. Reports of the Orinoco Shelf Expedition 1., Verhandelingen der Koninklijke Nederlandse Akademie van Wetenschappen, Afdeling Natuurkunde, Series 1*, 20 (5), 117–134.
- Keij, A.J. (1957) Eocene and Oligocene Ostracoda of Belgium. *Mémoires de l'Institut Royal des Sciences Naturelles de Belgique=Verhandelingen van het Koninklijk—Belgisch Instituut voor Natuurwetenschappen*, 136. *Institut Royal des Sciences Naturelles de Belgique*, 136, 1–210.
- Keller, G. & Barron, J.A. (1983) Paleooceanographic implications of Miocene deep-sea hiatuses. *Geological Society of American Bulletin*, 94, 590–613.
[https://doi.org/10.1130/0016-7606\(1983\)94<590:PIOMDH>2.0.CO;2](https://doi.org/10.1130/0016-7606(1983)94<590:PIOMDH>2.0.CO;2)
- Kellett, B. (1935) Ostracodes of the Upper Pennsylvanian and the Lower Permian strata of Kansas: III. Bairdiidae (concluded), Cytherellidae, Cypridinidae, Entomoconchidae, Cytheridae, and Cypridae. *Journal of Paleontology*, 9 (2), 132–166.
- Kempf, E.K. (1986a) Index and Bibliography of Marine Ostracoda: Index A. *Sonderveröffentlichungen des Geologischen Instituts der Universität zu Köln*, 50, 1–762.
- Kempf, E.K. (1986b) Index and Bibliography of Marine Ostracoda: Index B. *Sonderveröffentlichungen des Geologischen Instituts der Universität zu Köln*, 51, 1–712.
- Kennett, J.P. (1980) Paleooceanographic and biogeographic evolution of the southern ocean during the Cenozoic, and Cenozoic microfossil datums. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 31, 123–152.
[https://doi.org/10.1016/0031-0182\(80\)90017-6](https://doi.org/10.1016/0031-0182(80)90017-6)
- Key, A.J. (1953) Preliminary note on the Recent Ostracoda of the Snellius Expedition. *Proceedings, Koninklijke Nederlandse Akademie van Wetenschappen. Series B Physical Sciences*, 56, 155–168.
- Kingma, J.T. (1948) *Contributions to the knowledge of the Young-Cenozoic Ostracoda from the Malayan region*. Proefschrift, Rijks-Universiteit Utrecht, Utrecht, 118 pp.

- Kornicker, L.S. (1961) Ecology and taxonomy of Recent Bairdiidae (Ostracoda). *Micropaleontology*, 7, 55–70.
<https://doi.org/10.2307/1484143>
- Kotzian, S.B. & Eilert, V. (1985) Ostracodes Mio-Pleistocênicos da Perfuração Chuí, nº 364 (Bacia de Pelotas), Uruguai. *Acta Geologica Leopoldensia*, 9, 81–94.
- Krstić, N. & Stancheva, M. (1967) *Pontoleberis* gen. n. (Ostracoda) from the Neogene of Bulgaria and Yugoslavia. *Bulgarian Academy of Science, Bulletin of the Geological Institute*, 16, 17–18 + 3.
- Krutak, P.R. (1982) Modern Ostracodes of the Veracruz-Anton Lizardo Reefs, Mexico. *Micropaleontology*, 28 (3), 258–288.
<https://doi.org/10.2307/1485182>
- Liebau, A. (2005) A revised classification of the higher taxa of the Ostracoda (Crustacea). *Hydrobiologia*, 538, 115–137.
<https://doi.org/10.1007/PL00021865>
- Lienenklaus, E. (1895) Die Ostrakoden des Mittel-Oligocäns von Jeurre bei Étampes im Pariser Becken. *Jahresbericht des naturwissenschaftlichen Vereins Osnabrück*, 10 (1893–1894), 127–156.
- Macedo, A.C.M. (1970) *Sobre a distribuição de Ostracoda no Mioceno caribeano com um estudo especial sobre os ostracodes da Formação Pirabas, Pará, Brasil. Rio de Janeiro*. Dissertação de Mestrado em Geologia. Programa de Pós-Graduação em Geologia, Universidade Federal do Rio de Janeiro, Rio de Janeiro, 62 pp.
- Macedo, A.C.M. (1971) Considerações sobre os ostracodes do Mioceno marinho do Estado do Pará. *Anais da Academia Brasileira de Ciências, Rio de Janeiro*, 43, 523–528.
- Machado, C.P., Coimbra, J.C. & Carreño, A.L. (2005) The Ecological and Zoogeographical Significance of the Sub-Recent Ostracoda off Cabo Frio, Rio de Janeiro, State, Brazil. *Marine Micropaleontology*, 55 (3–4), 235–253. <https://doi.org/10.1016/j.marmicro.2005.03.002>
- Machain-Castillo, M.L. (1986) Ostracode biostratigraphy and paleoecology of the Pliocene of the Isthmian Salt Basin, Veracruz, Mexico. *Tulane Studies in Geology and Paleontology*, 19 (3), 123–139.
- Machain-Castillo, M.C., Pérez-Guzmán, A.M., Maddocks, R.F. (1990) Ostracoda of the terrigenous continental platform of the southern Gulf of Mexico. In: Whatley, R.C. & Maybury, C. (Eds.), *Ostracoda and Global Events*. Chapman & Hall, London, pp. 341–353.
https://doi.org/10.1007/978-94-009-1838-2_26
- Machain-Castillo, M.L., Gío Argáez, F.R. (1991) Comparacion Faunistica de los Ostracodos presentes en la Laguna de Terminos y las costas adyacentes de la Bahia de Campeche. *Revista de la Sociedad Mexicana de Historia Natural*, 40, 35–48.
- Machain-Castillo, M.L., Gío Argáez, F.R. (1992) Ostracodos de la plataforma occidental de Yucatan. *Revista de la Sociedad Mexicana de Historia Natural*, 41, 15–22.
- Maddocks, R.F. (1969) Revision of recent Bairdiidae (Ostracoda). *Smithsonian Institution U.S. National Museum Bulletin*, 296, 1–126.
<https://doi.org/10.5479/si.03629236.295.1>
- Maddocks, R.F. (1974) Ostracodes. In: Bright, T.S. & Pequegnat, L.H. (Eds.), *Biota of the West Flower Garden Bank*. Gulf Publishing, Houston, pp. 199–229.
- Maddocks, R.F., Machain-Castillo, M.L. & Gío-Argáez, F.R. (2009) Podocopan Ostracoda (Crustacea) of the Gulf of Mexico. In: Felder, D.L. & Camp, D.K. (Eds.), *Gulf of Mexico Origin, Waters, and Biota. Vol. 1. Biodiversity*. Texas A&M University Press, College Station, TX, pp. 877–894.
- Malkin, D.S. (1953) Biostratigraphic study of Miocene Ostracoda of New Jersey, Maryland and Virginia. *Journal of Paleontology*, 27, 761–799.
- Malz, H. (1981) Paläozäne Ostracoden von den Emperor Seamounts NW-Pazifik. *Zitteliana*, 7, 3–29.
- Malz, H. (1978) Neue *Hemicyprideis*-Arten (Ostracoda; Tertiär) aus dem Mainzer Becken und seinen Randgebieten. *Senckenbergiana lethaea*, 59, 71–91.
- Martinez-Garcia, B., Pascual, A., Rodriguez-Lazaro, J., Martin-Rubio, M., Rofes, J., (2013) The Ostracoda (Crustacea) of the Tina Menor estuary (Cantabria, southern Bay of Biscay): distribution and ecology. *Journal of Sea Research*, 83, 111–122.
<https://doi.org/10.1016/j.seares.2013.03.014>
- Mathews, S.C. (1973) Notes on Open Nomenclature and Synonymy Lists. *Paleontology*, 16 (4), 713–719.
- Maur, C.J. (1925) Fósseis terciários do Brasil com descrições de novas formas cretáceas. *Monografia do Serviço Geológico Mineralógico do Brasil. Rio de Janeiro*, 4, 665 pp.
- Miller, K.G., Fairbanks, R.G. & Mountain, G.S. (1987) Tertiary oxygen isotope synthesis, sea level history, and continental margin erosion. *Paleoceanography*, 2 (1), 1–19.
<https://doi.org/10.1029/PA002i001p00001>
- Moore, R.C. (1961) *Treatise on Invertebrate Paleontology. Part Q. Arthropoda 3, Crustacea, Ostracoda*. Geological Society of America and University Kansas Press, Lawrence, 442 pp.
- Morales, F.G.A. (1966) Ecology, distribution and taxonomy of recent Ostracoda of the lagoon de Terminos. Campeche, Mexico. *Universidad Nacional Autónoma de México, Instituto de Geología, Boletín*, 81, 1–102.
- Müller, G.W. (1884) Zur näheren Kenntnis der Cytheriden. *Archiv für Naturgeschichte*. 50, 1–22.
- Müller, G.W. (1894) Die Ostracoden des Golfes von Neapel und der angrenzenden Meeres-Abschnitte. Zoologische Station zu Neapel. Fauna und Flora des Golfes von Neapel und der angrenzenden Meeres-Abschnitte. Zoologische Station zu Neapel.

- Nogueira, A.A.E., Ramos, M.I.F. & Puckett, T.M. (2011) The genera *Haplocytheridea* Stephenson, 1936 and *Cytheridea* Bosquet, 1852 (Subphylum Crustacea, Class Ostracoda) from the Early Miocene Pirabas Formation, Brazil. *Revue de Micropaléontologie*, 54 (4), 215–235.
<https://doi.org/10.1016/j.revmic.2011.10.003>
- Nogueira, A.A.E., & Ramos, M.I.F. (2016) The genus *Perissocytheridea* Stephenson, 1938 (Crustacea: Ostracoda) and evidence of brackish water facies along the Oligo-Miocene, Pirabas Formation, Eastern Amazonia, Brazil. *Journal of South American Earth Sciences*, 65, 101–121.
<https://doi.org/10.1016/j.jsames.2015.11.007>
- Nogueira, A.A.E. & Nogueira, A.C.R. (2017) Ostracods biostratigraphy of the Oligocene-Miocene carbonate platform in the Northeastern Amazonia coast and its correlation with the Caribbean region. *Journal of South American Earth Sciences*, 80, 389–403.
<https://doi.org/10.1016/j.jsames.2017.10.006>
- Omatsola, M.E. (1972) Recent and Sub-Recent Trachyleberididae and Hemicytheridae (Ostracoda, Crustacea) from the Western Niger Delta, Nigeria. *Bulletin of the Geological Institutions of the University of Uppsala*, 3 (5), 37–120.
- Palacios-Fest, M.R., Gio-Argaez, R. & Krutak, P.R. (1983) Los ostrácodos (Crustacea) Recientes del Caribe Mexicano y su significación faunística. *Anales Instituto de Ciencias del Mar y Limnología, Universidad Nacional Autónoma, México*, 10 (1), 195–208.
- Perfit, M.R. & Williams, E.E. (1989) Geological constraints and biological reproduction in the evolution of the Caribbean Sea and its islands. In: Woods, C.A. (Ed.), *Biogeography of the West Indies*. Sandhill Crane Press, Gainesville, FL, pp. 47–102.
- Petri, S. (1952) Ocorrências de Foraminíferos Fósseis no Brasil. *Boletim da Faculdade de Filosofia, Ciências e Letras, USP*, 134 (7), 21–42.
<https://doi.org/10.11606/issn.2526-3862.bffcluspgeologia.1952.121680>
- Petri, S. (1954) Foraminíferos fósseis da Bacia do Marajó. *Boletim da Faculdade de Filosofia, Ciências e Letras da Universidade de São Paulo, Geologia*, 134, 1–172.
<https://doi.org/10.11606/issn.2526-3862.bffcluspgeologia.1954.128537>
- Petri, S. (1957) Foraminíferos Miocênicos da Formação Pirabas. *Boletim da Faculdade de Filosofia, Ciências e Letras, Universidade de São Paulo*, 216 (16), 1–79.
<https://doi.org/10.11606/issn.2526-3862.bffcluspgeologia.1957.121843>
- Puri, H.S. (1953a) The ostracode genus *Hemicythere* and its allies. *Journal of The Washington Academy of Sciences*, 43, 169–179.
- Puri, H.S. (1953b) Contribution to the study of the Miocene of the Florida Panhandle. Part 3. Ostracoda. *Florida Geological Survey Bulletin*, 36, 215–345. Available from: http://publicfiles.dep.state.fl.us/FGS/FGS_Publications/B/BPRIDE/B36_1953.pdf (Accessed 28 Mar. 2019)
- Puri, H.S. (1960) Recent Ostracoda from the west coast of Florida. *Gulf Coast Association of Geological Societies, Transactions*, 10, 107–149.
- Puri, H.S. & Hulings, N.C. (1957) Recent ostracode facies from Panama City to Florida Bay area. *Gulf Coast Association of Geological Societies, Transactions*, 7, 167–190.
- Puri, H.S. & Hulings, N.C. (1976) Designation of lectotypes of some ostracods from the Challenger expedition. *Bulletin of the British Museum (Natural History)*, Zoology, 29, 251–315.
- Purper, I. (1979) Cenozoic ostracodes of the upper Amazon Basin, Brazil. *Pesquisas*, 12, 209–281.
- Purper, I. & Ornellas, L.P. (1987a) *Paracytheridea tschoppi* van den Bold, 1946 and its species *Paracytheridea batei* Purper and Ornellas, sp. nov. in the Brazilian continental shelf. In: *Congresso Brasileiro de Paleontologia X, Rio de Janeiro, Anais. Vol. 1. Sociedade Brasileira de Petróleo, Rio de Janeiro*, pp. 747–759.
- Purper, I. & Ornellas, L.P. (1987b) The genus *Paracytheridea* (Ostracoda) in the northern/northwestern Brazilian continental shelf. *Pesquisas*, 20, 103–124.
- Ramos, M.I.F. (1996) Taxonomy and zoogeography the ostracod genera *Nanocoquimba* and *Cornucoquimba* Ohmert, 1968 from Recent sediments on the Brazilian continental shelf. *Revista Española de Micropaleontología*, 28, 105–128.
- Ramos, M.I.F., Coimbra, J.C., Whatley, R.C. & Moguilevsky, A. (1999) Taxonomy and ecology of the family Cytheruridae (Ostracoda) in recent sediments from the northern Rio de Janeiro coast, Brazil. *Journal of Micropalaeontology*, 18, 1–16.
<https://doi.org/10.1144/jm.18.1.1>
- Ramos, M.I.F., Távora, V.A., Pinheiro, M.P. & Baia, N.B. (2004) Microfósseis. In: Rossetti, F.R. & Góes, A.M (Eds.), *O Neógeno Da Amazônia Oriental, Coleção Friedrich Katzer*. Museu Paraense Emílio Goeldi, Belém, pp. 93–107.
- Ramos, M.I.F., Coimbra, J.C., Bergue, C.T. & Whatley, R.C. (2012) Recent Ostracods (Family Trachyleberididae) from the Southern Brazilian Continental Shelf. *Ameghiniana*, 49 (1), 3–16.
[https://doi.org/10.5710/AMGH.v49i1\(418\)](https://doi.org/10.5710/AMGH.v49i1(418))
- Reuss, A.E. (1850) Die fossilen Entomostraceen des österreichischen Tertiärbeckens. *Naturwissenschaftliche Abhandlungen*, 3, 41–92.
- Rodrigues, G.B., Bom, M.H.H. & Fauth, G. (2011) Recovery of ostracods in Cretaceous dolomitic carbonate: The efficiency of acetolysis. *Marine Micropaleontology*, 92–93, 81–86.
- Rossetti, D.F. (2006) Evolução Sedimentar Miocênica nos Estados do Pará e Maranhão. *Revista do Instituto de Geociências*,

Universidade de São Paulo, 6 (2), 7–18.

<https://doi.org/10.5327/S1519-874X2006000300003>

- Rossetti, D.F. & Góes, A.M. (2004) *O Neógeno da Amazônia Oriental. Coleção Friedrich Katzer*. Museu Paraense Emílio Goeldi, Belém, 225 pp.
- Rossetti, D.F., Bezerra, F.H. & Dominguez, J.M.L. (2013) Late Oligocene-Miocene transgressions along the equatorial and eastern margins of Brazil. *Earth-Science Reviews*, 123, 87–112.
<https://doi.org/10.1016/j.earscirev.2013.04.005>
- Sanguinetti, Y.T. (1979) Miocene ostracodes of the Pelotas Basin, State of Rio Grande do Sul, Brasil. Universidade Federal do Rio Grande do Sul Instituto de Geociências *Pesquisas*, 12, 119–187.
- Sanguinetti, Y.T. (1980) Biostratigrafia (Ostracodes) do Mioceno da bacia de Pelotas, Rio Grande do Sul. *Pesquisas*, 13, 7–34.
- Sanguinetti, Y.T., Ornellas, L.P. & Coimbra, J.C. (1991) Post Miocene Ostracodes from Pelotas Basin, Southern Brazil. Taxonomy. Part I. *Pesquisas*, 18 (2), 138–155.
- Savin, S.M., Douglas, R.G. & Stehli, F.G. (1975) Tertiary marine paleotemperatures. *Geological Society of America Bulletin*, 86, 1499–1510.
[https://doi.org/10.1130/0016-7606\(1975\)86<1499:TMP>2.0.CO;2](https://doi.org/10.1130/0016-7606(1975)86<1499:TMP>2.0.CO;2)
- Sciuto, F. (2014) Ostracods of the Upper Pliocene-Pleistocene Punta Mazza succession (NE Sicily) with special focus on the Family Trachyleberididae Sylvester-Bradley, 1948, and description of a new species. *Carnets de Géologie*, 14 (1), 1–13.
<https://doi.org/10.4267/2042/53172>
- Sciuto, F., Rosso, A., Sanfilippo, R. & Di Martino, E. (2015) Ostracods from Mid-Outer Shelf bottoms from Ciclopi Islands Marine Protected Area (Eastern Sicily, Ionian Sea). *Bollettino della Società Paleontologica Italiana*, 54 (2), 134–146.
<https://doi.org/10.4435/BSPI.2015.09>
- Seguenza, G. (1880) Le formazioni terziarie nella provincia di Reggio (Calabria). *Atti della Reale Accademia dei Lincei, Serie 3* (Memorie Classe di Scienze Fisiche, Matematiche e Naturali), 6, 3–446.
- Sexton, J.V. (1951) The ostracode genus *Cytherelloidea* in North America. *Journal of Paleontology*, 25, 808–816.
- Shackleton, N.J. & Kennett, J.P. (1975) Paleotemperature history of the Cenozoic and initiation of Antarctic glaciation: oxygen and carbon isotopic analyses in DSDP Sites 77, 279 and 281. *Initial Reports of the deep-sea drilling project (DSDP)*, 29, 743–755.
<https://doi.org/10.2973/dsdp.proc.29.117.1975>
- Smith, A.C. & Briden, J.C. (1977) *Mesozoic and Cenozoic Continental Maps*. Cambridge University Press, Cambridge.
- Stephenson, M.B. (1944) New Ostracoda from Subsurface Middle Tertiary Strata of Texas. *Journal of Paleontology*, 18 (2), 156–161.
- Stephenson, M.B. (1946) *Glyptobairdia*, a new genus of Ostracoda. *Journal of Paleontology*, 20 (4), 345–347.
- Stchepinsky, A. (1960) Étude des Ostracodes du Sannoisien de l'Alsace. *Bulletin du Service de la carte géologique d'Alsace et de Lorraine*, 13, 11–33.
<https://doi.org/10.3406/sgeol.1960.1209>
- Steineck, P., Breen, M., Nevins, N. & O'Haro, P. (1984) Middle Eocene and Oligocene deep-sea Ostracoda from the Oceanic Formation, Barbados. *Journal of Paleontology*, 58 (6), 1463–1496.
- Swain, F.M. (1951) Ostracoda from wells in North Carolina, Part I. Cenozoic Ostracoda: *United States Geological Survey Professional Paper*, 234-A, 1–58.
- Swain, F.M. (1968) Ostracoda from the Upper Tertiary Waccamaw Formation of North Carolina and South Carolina. *United States Geological Survey Professional Paper* 573D, 1–37.
<https://doi.org/10.3133/pp573D>
- Swain, F.M. (1974) Some Upper Miocene and Pliocene (?) Ostracoda of Atlantic coastal region for use in hydrogeologic studies. *United States Geological Survey Professional Paper*, 821, 1–50.
<https://doi.org/10.3133/pp821>
- Swain, F.M. & Gilby, J.M. (1967) Recent Ostracoda from Corinto Bay, western Nicaragua, and their relationship to some other assemblages of the Pacific Coast. *Journal of Paleontology*, 41, 306–334.
- Swain, F.M. & Gilby, J.M. (1974) Marine Holocene Ostracoda from the Pacific Coast of North and Central America. *Micropaleontology*, 20, 257–352.
<https://doi.org/10.2307/1484940>
- Tarling, D.H. (1972) Another Gondwanaland. *Nature*, 238, 92–93.
<https://doi.org/10.1038/238092a0>
- Tarling, D.H. (1980) The geologic evolution of South America with special reference to the last 200 million years. In: Ciochon, R.L. & Chiarelli, A.B. (Eds.), *Evolutionary Biology of the New World Monkeys and Continental Drift*. Academic Press, London, pp. 1–41.
https://doi.org/10.1007/978-1-4684-3764-5_1
- Távora, V.A. (1994a) Bythocytheridae, Cytherideidae e Cytheruridae (Crustácea-Ostracoda) na Formação Pirabas (Eomioceno)—Estado do Pará. *Boletim do Museu Paraense Emílio Goeldi, Rio de Janeiro, Série Ciências da Terra*, 6, 91–113.
- Távora, V.A. (1994b) Hemicytheridae, Loxoconchidae, Paradoxostomatidae, Pectocytheridae e Trachyleberididae (Crustácea-Ostracoda) na Formação Pirabas (Eomioceno)—estado do Pará. *Boletim do Museu Paraense Emílio Goeldi, Rio de*

- Távora, V.A. (1994c) Ostracodes da formação Pirabas (Mioceno Inferior) no Estado do Pará. *Acta Geológica Leopoldensia, São Leopoldo*, 17 (39/1), 119–129.
- Távora, V.A. (1998) Ocorrência de uma nova espécie de ostracoda na Formação Pirabas (Eomioceno)—Estado do Pará. *Boletim do Museu Paraense Emílio Goeldi, Série Ciências da Terra*, 10, 3–15.
- Távora, V.A. & Fernandes, J.M.G. (1999) Estudio de los foraminíferos de la Formación Pirabas (Mioceno Inferior), Estado de Pará, Brasil y su correlación con faunas del Caribe. *Revista Geológica de América Central, San Jose*, 22, 63–74.
- Távora, V.A., Lima Junior, R.F. & Leite, A.S. (2001) A zona *Pokornyella* “*saginata*” (sensu Bluter)/*P. laresensis* (Bold) na Formação Pirabas (Eomioceno)—Estado do Pará. *Revista Brasileira de Paleontologia, Rio de Janeiro*, 2, 102.
- Távora, V.A., Silveira, E.S.F. & Milhomem Neto, J.M. (2007) Mina B-17, Capanema, PA Expressivo Registro de uma Paleolaguna do Cenozóico Brasileiro. In: Winge, M., Schobbenhaus, C., Berbert-Born, M., Queiroz, E.T., Campos, D.A., Souza, C.R.G. & Fernandes, A.C.S. (Eds.), *Sítios Geológicos e Paleontológicos do Brasil, Brasília*, 2 (2009), 363–370. http://sigep.cprm.gov.br/sitio121/sitio121_impresso.pdf
- Teeter, J.W. (1975) Distribution of Holocene marine Ostracoda from Belize. In: Wantland, K.F. & Pusey, W.C. (Eds.), *Belize Shelf Carbonate Sediments and Ecology. Studies in Geology. No. 2*. American Association of Petroleum Geologists, pp. 400–499.
- Titterton, R. & Whatley, R.C. (1988) Recent Bairdiinae (Crustacea, Ostracoda) from the Solomon Islands, *Journal of Micropalaeontology*, 7 (2), 111–142. <https://doi.org/10.1144/jm.7.2.111>
- Triebel, E. (1948) Zur Kenntnis der Ostracoden-Gattung *Triebelina*. *Senckenbergiana*, 29, 17–22.
- Tsukagoshi, A. & Kamiya, T. (1996) Heterochrony of the ostracod hingement and its significance for taxonomy. *Biological Journal of the Linnean Society*, 57, 343–370. <https://doi.org/10.1111/j.1095-8312.1996.tb01855.x>
- Ulrich, E.O. & Bassler, R.S. (1904) Systematic paleontology of the Miocene deposits of Maryland. Ostracoda. *Maryland Geological Survey*, 1, 98–130.
- Valicenti, V.H. (1977) Some Hemicytherinae from the Tertiary of Patagonia (Argentina), their morphological relationship and stratigraphical distribution. In: Löffler, H. & Danielopol, D. (Eds.), *Aspects of Ecology and Zoogeography of Recent and Fossil Ostracoda. Proceedings of the Sixth European Symposium on Ostracoda, Saalfelden*. Junk, The Hague, pp. 93–106.
- Wagner, C.W. (1957) Sur les Ostracodes du Quaternaire récent des Pays-Bas et leur utilisation dans l'étude géologique des dépôts holocènes. *Université de Paris A.*, 707, 1–259.
- Weaver, P.P.E. (1982) Ostracoda from the British Lower Chalk and Plenus Marls. *Monograph of the Palaeontographical Society London*, 135, 1–127.
- Whatley, R.C. & Maybury, C.A. (1991) On *Hemingwayella pumilio* (Brady). *Stereo-Atlas of Ostracod Shells*, 18, 45–48.
- Whatley, R.C., Chadwick, J., Coxill, D. & Toy, N. (1988) The ostracod family Cytheruridae from the Antarctic and South-West Atlantic. *Revista Española de Micropaleontología*, 20, 171–203.
- Whatley, R.C., Staunton, M., Kaesler, R.L. & Moguilevsky, A. (1996) The taxonomy of Recent Ostracoda from the southern part of the Strait of Magellan. *Revista Española de Micropaleontología*, 28 (3), 51–76.
- Whatley, R.C., Moguilevsky, A., Chadwick, J., Toy, N. & Ramos, M.I.F. (1997) Ostracoda from the South West Atlantic. Part III. The Argentinian, Uruguayan and southern Brazilian continental shelf. *Revista Española de Micropaleontología*, 30 (2), 87–116.
- Whatley, R.C., Ramos, M.I.F., Moguilevsky, A. & Chadwick, J. (1998) The provincial distribution of benthonic Recent littoral and shelf Ostracoda in the SW Atlantic. *Bulletin des Centres de Recherches Exploration Production Elf Aquitaine*, 20, 83–96.
- Whatley, R.C., Chadwick, J., Coxill, D. & Toy, N. (1988) The ostracod family Cytheruridae from the Antarctic and South-West Atlantic. *Revista Española de Micropaleontología*, 20, 171–203.
- Wood, A.M., Ramos, M.I.F. & Whatley, R.C. (1999) The paleozoogeography of Oligocene to Recent marine Ostracoda from the Neotropics (mid- and South America) and Antarctica. *Marine Micropaleontology*, 37 (3–4), 345–364. [https://doi.org/10.1016/S0377-8398\(99\)00024-9](https://doi.org/10.1016/S0377-8398(99)00024-9)
- Yamada, S., Tsukagoshi, A. & Ikeya, N. (2005) Taxonomy, morphology and speciation of the *Semicytherura henryhowei* group. *Hydrobiologia*, 538, 243–265. <https://doi.org/10.1007/s10750-004-4970-4>

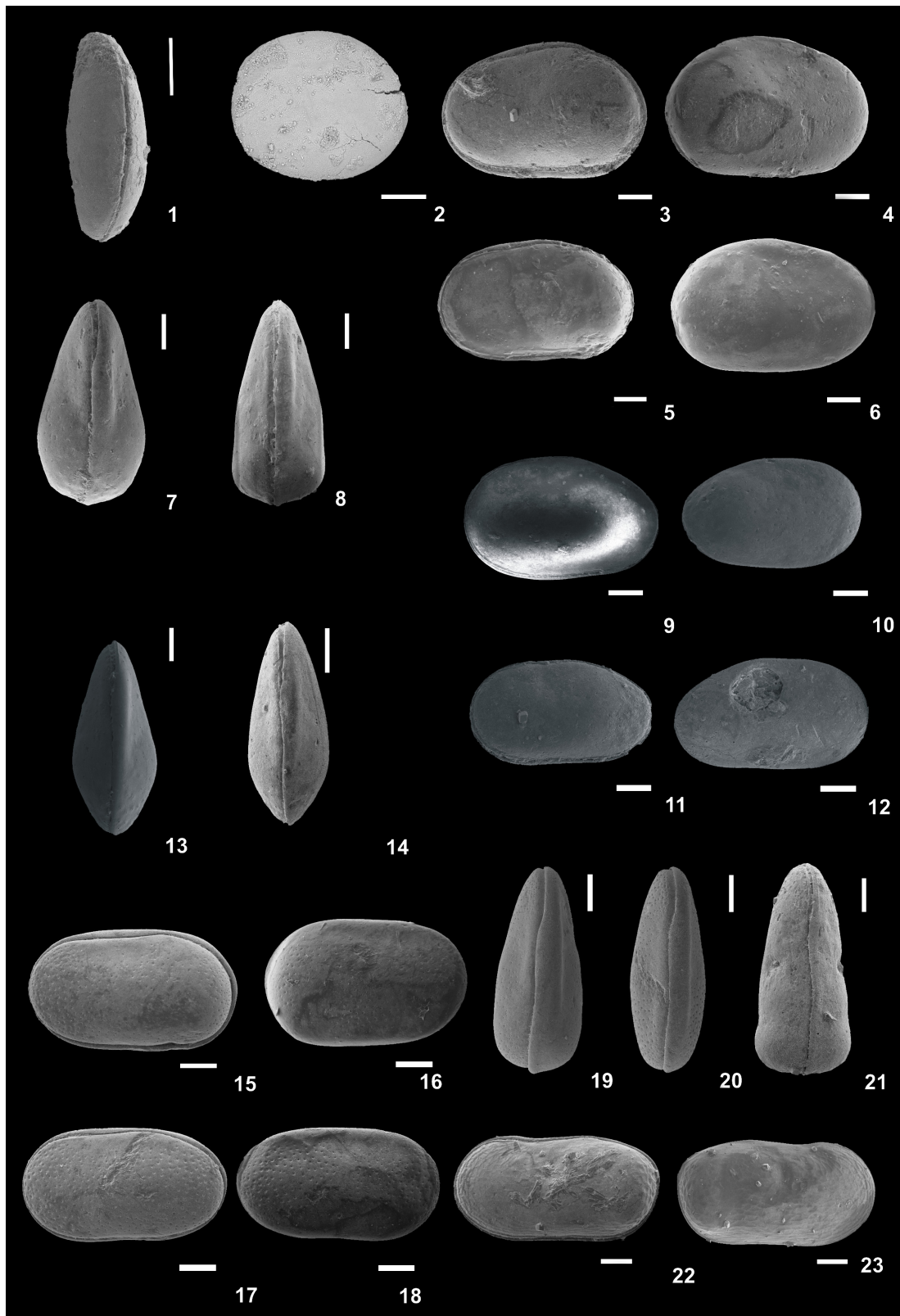


FIGURE 2. Scale bar: 100μm: C: Carapace; L: Left Valve; R: Right Valve; E: External View; I: Internal View; D: Dorsal View; A: Adult; (MPEG-000-M) = (000). 1–2. *Polycope* sp. 1. D (549). 2. C, E (549). 3–8. *Cytherella stainforthi*. 3. Female, C, L, E (550). 4. Female, C, R, E (550). 7. Female, D (550). 5 Male, C, L, E (551). 6. Male, C, R, E (551). 8. Male, D (551). 9–14. *Cytherella kempfi* sp. nov. 9. Female, C, L, E (552). 10. Female, C, R, E (552). 11. Male, C, L, E (553). 12. Male, C, R, E (553). 13. Female, D (552). 14. Male, D (553). 15–20. *Cytherella altacaelateralis* sp. nov. 15. Female, C, L, E (555). 16. Female, C, R, E (555). 17. Male, C, L, E (556). 18. Male, R, E (556). 19. Female, D, (555). 20. Male, D (556). 21–23. *Cytherella notossinuosa* sp. nov. 21. D (558). 22. C, L, E (558). 23. C, R, E (558).

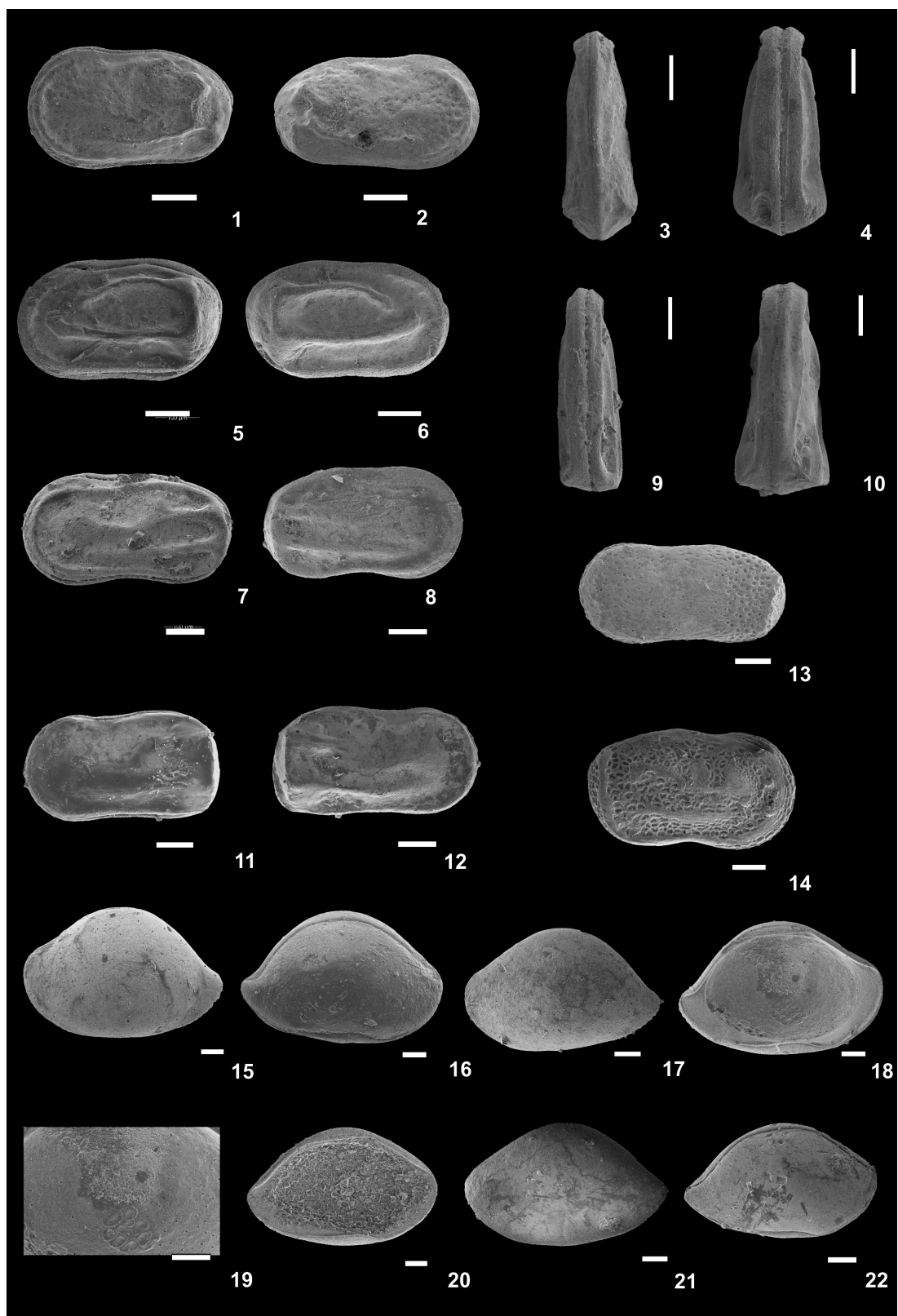


FIGURE 3. Scale bar: 100µm: C: Carapace; L: Left Valve; R: Right Valve; E: External View; I: Internal View; D: Dorsal View; J: Juvenile; A: Adult; (MPEG-000-M) = (000). 1–3. *Cytherelloidea colini* **sp. nov.** 1. D (560). 2. C, L, E (560). 3. C, R, E (560). 4–6. *Cytherelloidea cumpassorobusta* **sp. nov.** 4. D (564). 5. C, L, E (564). 6. C, R, E (564). 7–9. *Cytherelloidea mediocythara* **sp. nov.** 7. C, L, E (568). 8. C, R, E (568). 9. D (568). 10–12. *Cytherelloidea quasilenisa* **sp. nov.** 10. D (573). 11. C, L, E (573). 12. C, R, E (573). 13. *Cytherelloidea* cf. *C. vanveenae*. 13. L, E (575). 14. *Keijcyoidea* sp. 14. R, E (577). 15–19. *Bairdoppilata antillea*. 15. C, L, E (578). 16. C, R, E (578). 17. L, E (579). 18. L, I (580). 19. Detail of the muscle scars, R (580). 20–22. *Bairdoppilata oblongata*. 20. L, I (583). 21. C, L, E (581). 22. C, R, E (581).

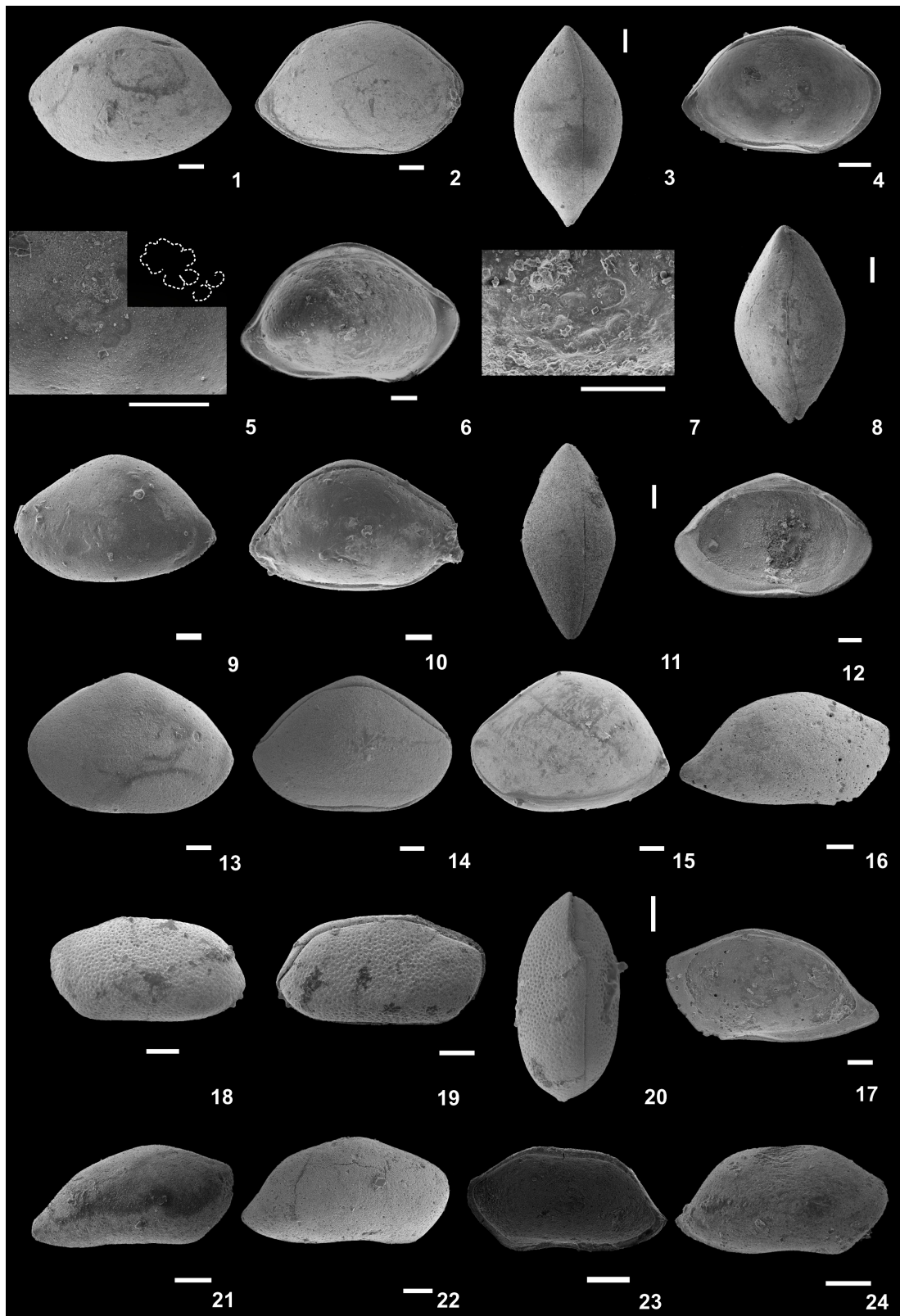


FIGURE 4. Scale bar: 100µm: C: Carapace; L: Left Valve; R: Right Valve; E: External View; I: Internal View; D: Dorsal View; J: Juvenile; A: Adult; (MPEG-000-M) = (000). 1–7. *Bairdoppilata pintoii* **sp. nov.** 1. A, C, L, E (584). 2. A, C, R, E (584). 3. A, D (584). 4. L, I (587). 5. Detail of the muscle scars, R (587). 6. L, I (585). 7. Details of muscle scars, L (585). 8–10. *Bairdoppilata vandenboldi* **sp. nov.** 8. L, E (588). 9. R, E (588). 10. D (588). 11–14. *Bairdoppilata dorsoarcuata* **sp. nov.** 11. D (590). 12. C, L, E (590). 13. C, R, E (590). 14. L, I (591). 15. *Bairdoppilata* sp. 15. C, L, E (592). 16–17. *Neonesidea* sp. 1. 16. R, E (595). 17. R, I (595). 18–20. *Mydionobairdia cauladelicata* **sp. nov.** 18. C, L, E (593). 19. C, R, E (593). 20. D (593). 21. *Neonesidea* sp. 2. 21. R, E (598). 22–24. *Neonesidea* sp. 3. 22. A, R, E (599). 23. J, R, I (600). 24. J, R, E (600).

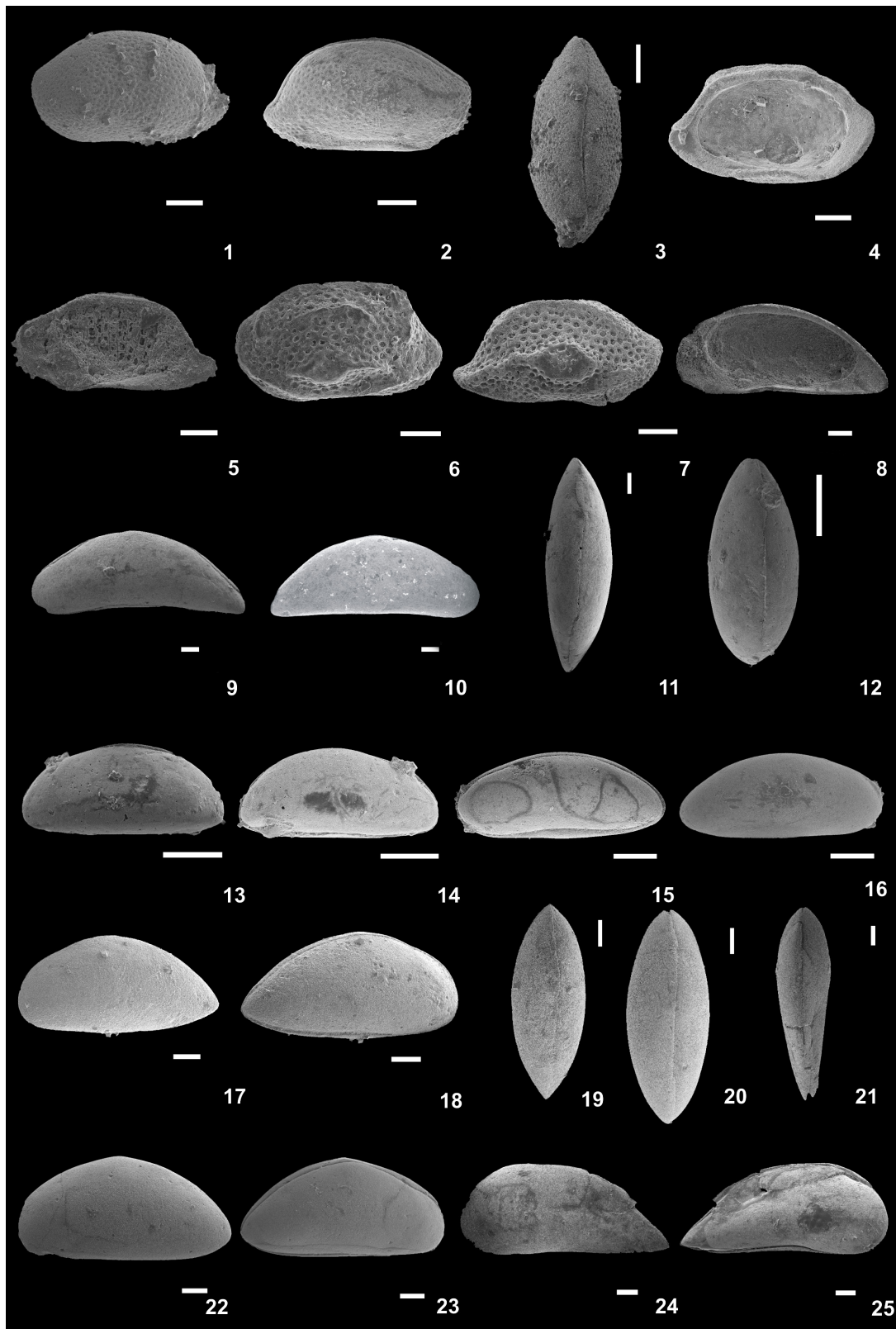


FIGURE 5. Scale bar: 100µm: C: Carapace; L: Left Valve; R: Right Valve; E: External View; I: Internal View; D: Dorsal View; A: Adult; (MPEG-000-M) = (000). 1–3. *Paranesidea elegantissima*. 1. L, E, (602). 2. R, E (603). 3. D (603). 4–7. *Triebelina crumena*. 4. L, I (606). 5. R, I (606). 6. L, E (606). 7. R, E (606). 8–11. *Macrocypris gracilis*. 14. R, I (609). 15. C, L, E (608). 16. C, R, E (608). 12–14. *Argilloecia?* sp. 1. 12. D (610). 13. L, E (610). 14. R, E (610). 15–16. *Argilloecia* sp. 2. 15. L, E (611). 16. R, E (611). 17–19. *Pontocypris aguilerai* **sp. nov.** 17. C, L, E (612). 18. C, R, E (612). 19. D (612). 20, 22–23. *Pontocypris* sp. 1. 20. D (614). 22. C, L, E (614). 23. C, R, E (614). 21, 24–25. *Pontocypris* sp. 2. 21. D (615). 24. C, L, E (615). 25. C, R, E (615).

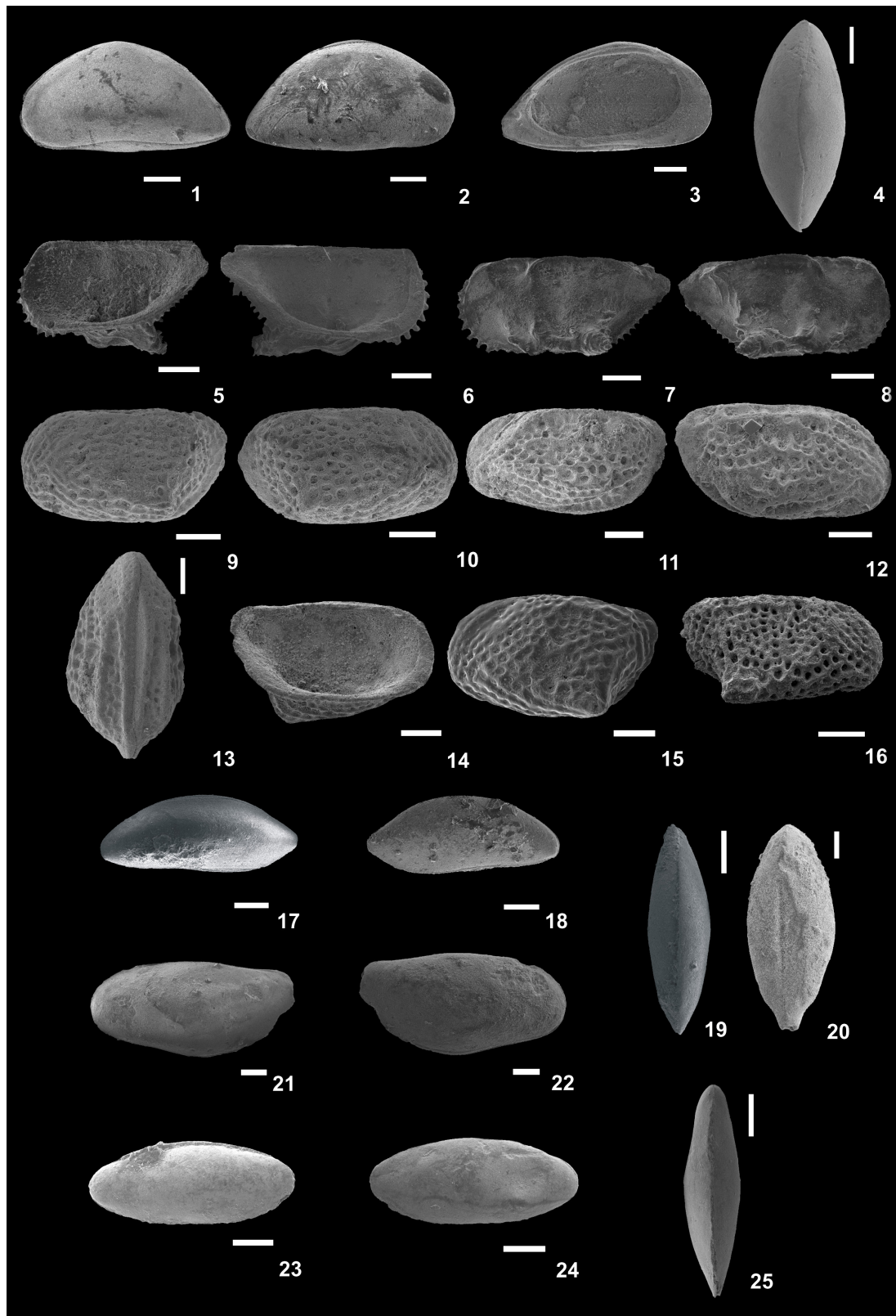


FIGURE 6. Scale bar: 100µm: C: Carapace; L: Left Valve; R: Right Valve; E: External View; I: Internal View; D: Dorsal View; A: Adult; (MPEG-000-M) = (000). 1–4. *Propontocypris*? cf. *M.?* *dimorpha*. 1. C, L, E (616). 2. C, R, E (616). 3. L, I (617). 4. D (616). 5–8. *Bythoceratina binodosa*. 5. L, I (618). 6. R, I (618). 7. L, E (618). 8. R, E (618). 9–10. *Bythoceratina? asulcata* **sp. nov.** 9. L, E (619). 10. R, E (619). 11–13. *Bythoceratina? sinuocostata* **sp. nov.** 11. D (626). 12. C, R, E (626). 13. C, L, E (626). 14–15. *Bythoceratina?* sp. 1. 14. L, I (630). 15. L, E (630). 16. *Bythoceratina?* sp. 2. 16. R, E (631). 17–19. *Paradoxostoma artum*. 17. C, L, E (632). 18. C, R, E (632). 19. D (632). 20–22. *Paradoxostoma?* sp. 20. D (633). 21. C, L, E (633). 22. C, R, E (633). 23–25. *Cytherois?* sp. 23. D (636). 24. C, L, E (636). 25. C, R, E (636).

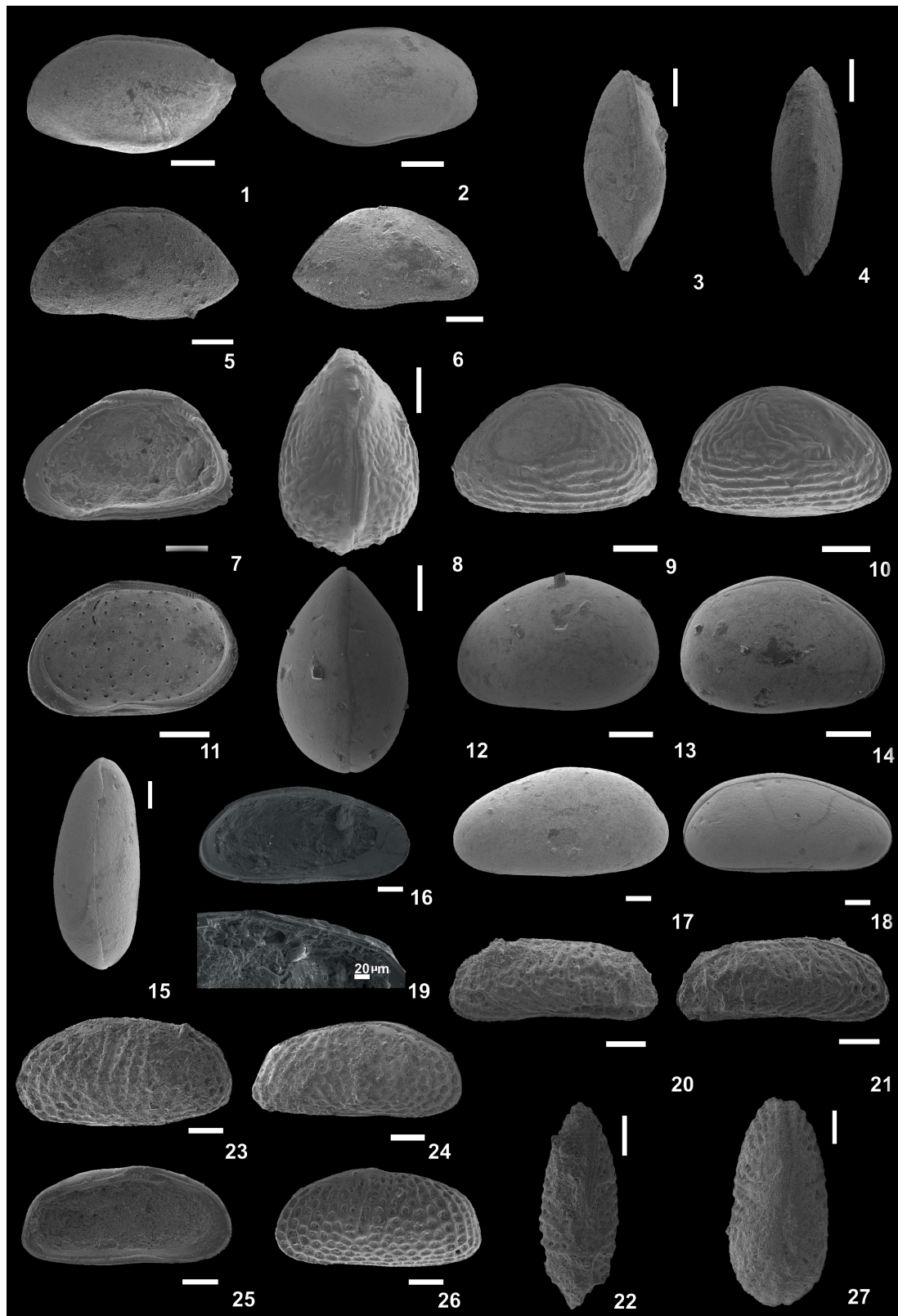


FIGURE 7. Scale bar: 100µm: C: Carapace; L: Left Valve; R: Right Valve; E: External View; I: Internal View; D: Dorsal View; A: Adult; (MPEG-000-M) = (000). 1–3. *Pellucistoma magniventra*. 1. C, L, E (637). 2. C, R, E (637). 3. D (637). 4–6. *Pellucistoma* sp. aff. *P.?* *kingmai*. 4. C, L, E (638). 5. C, R, E (638). 6. D (638). 7–10. *Xestoleberis? dactylotypa*. 7. R, I (640). 8. D (639). 9. C, L, E (639). 10. C, R, E (639). 11–14. *Xestoleberis* sp. 11. R, I (645). 12. D (642). 13. C, L, E (642). 14. C, R, E (642). 15–18. *Cushmanidea? bragantinaensis* **sp. nov.** 15. D (646). 16. L, I (648). 17. C, L, E (646). 18. C, R, E (646). 19–22. *Hulingsina reticulorugosa* **sp. nov.** 19. R, I (652). 20. C, L, E (649). 21. C, R, E (649). 22. D (649). 23–27. *Hulingsina? lorensmithae* **sp. nov.** 23. C, L, E (653). 24. C, R, E (653). 25. L, I (654). 26. L, E (654). 27. D (653).

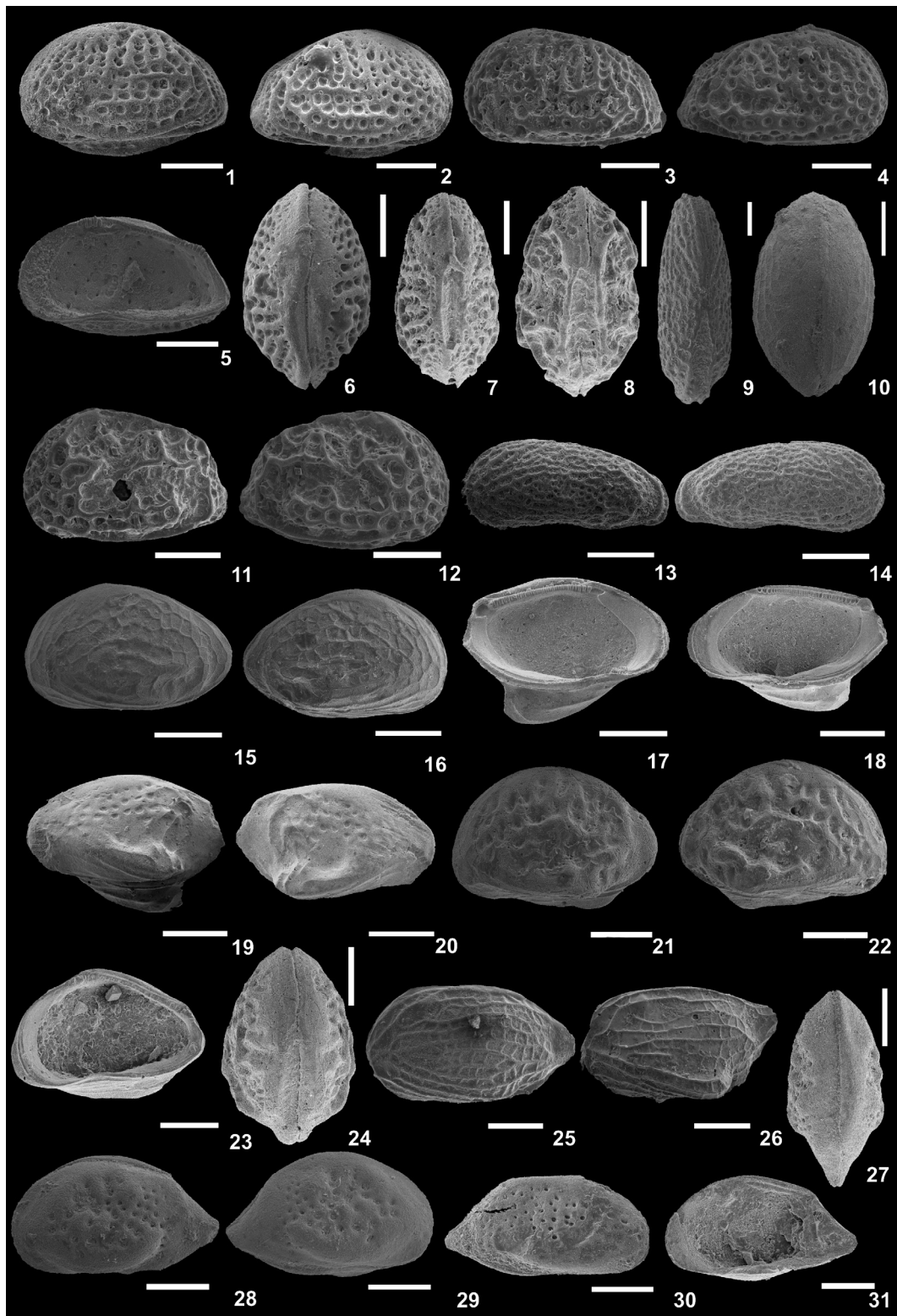


FIGURE 8. Scale bar: 100µm: C: Carapace; L: Left Valve; R: Right Valve; E: External View; I: Internal View; D: Dorsal View; A: Adult; (MPEG-000-M) = (000). 1–7. *Gangamocytheridea macedoi*. 1. Female, C, L, E (656). 2. Female, C, R, E (656). 3. Male, C, L, E (657). 4. Male, C, R, E (657). 5. Female, R, I (656). 6. Female, D (656). 7. Male, D (657). 8, 11–12. *Gangamocytheridea* sp. 8. D (659). 11. C, L, E (659). 12. R, E (659). 9, 13–14. *Pumilocytheridea* sp. 9. D (660). 13. C, L, E (660). 14. C, R, E, (660). 10, 15–16. *Cytheropteron?* *yorktownensis*. 10. D (661). 15. C, L, E (661). 16. C, R, E (661). 17–20. *Cytheropteron bichense*. 17. C, L, I (663). 18. C, R, I, (663). 19. C, L, E (663). 20. C, R, E (663). 21–24. *Oculocytheropteron* cf. *Oculocytheropteron reticulopunctata*. 21. C, L, E (664). 22. C, R, E (664). 23. C, R, I (664). 24. D (664). 25. *Cytherura?* sp. 1. 25. L, E (666). 26. *Cytherura* sp. 2. 26. L, E (667). 27–31. *Cytherura punctocentrata* **sp. nov.** 27. D (668). 28. Female, C, L, E (668). 29. Female, C, R, E (668). 30. Male, C, R, E (669). 31. R, I (670).

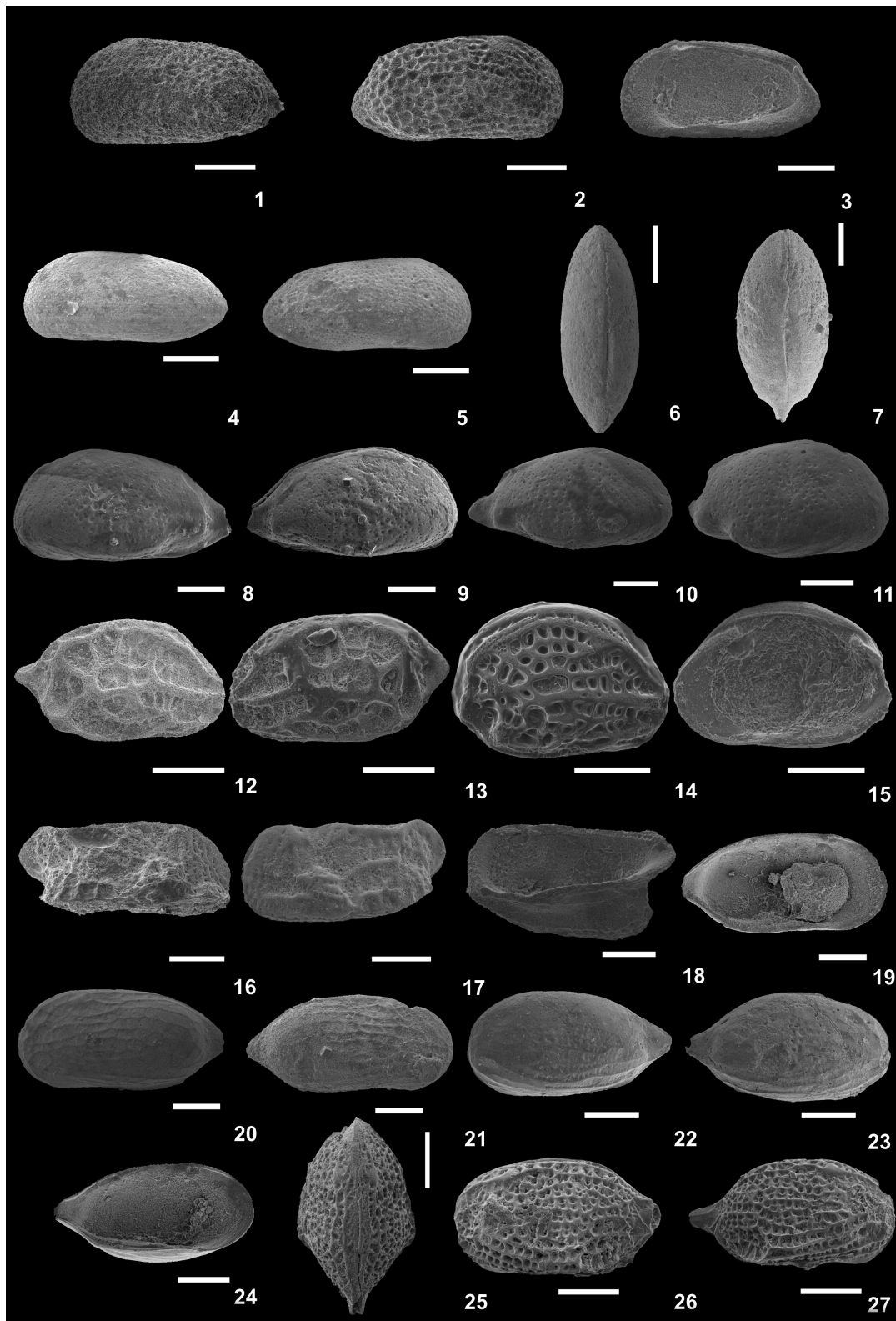


FIGURE 9. Scale bar: 100µm: C: Carapace; L: Left Valve; R: Right Valve; E: External View; I: Internal View; D: Dorsal View; A: Adult; (MPEG-000-M) = (000). 1–3. *Cytherura? ornatareticulum* **sp. nov.** 1. C, R, E (671). 2. C, L, E (671). 3. R, I (673). 4–6. *Cytherura? quasilenisa* **sp. nov.** 4. C, L, E (675). 5. C, R, E (675). 6. D (675). 7–11. *Cytherura?* sp. aff. *C. cybaea*. 7. Female, D (677). 8. Female, L, E (677). 9. Female, R, E (677). 10. Male, R, E (678). 11. Female, R, E (677). 12–13. *Hemicytherura bradyisimilis* **sp. nov.** 12. Female, R, E (679). 13. Female, L, E (679). 14–15. *Hemicytherura* sp. 14. R, E (681). 15. R, I (681). 16–18. *Hemingwayella* sp. 16. R, E (682). 17. L, E (683). 18. R, I (682). 19–21. *Semicytherura* sp. aff. *S. clavata*. 19. L, I (684). 20. L, E (684). 21. R, E (685). 22–24. *Semicytherura* sp. 22. L, E (686). 23. R, E (686). 24. L, I (686). 25–27. *Semicytherura? fortisreticulata* **sp. nov.** 25. Female, D (687). 26. Female, C, L, E (687). 27. Female, C, R, E (687).

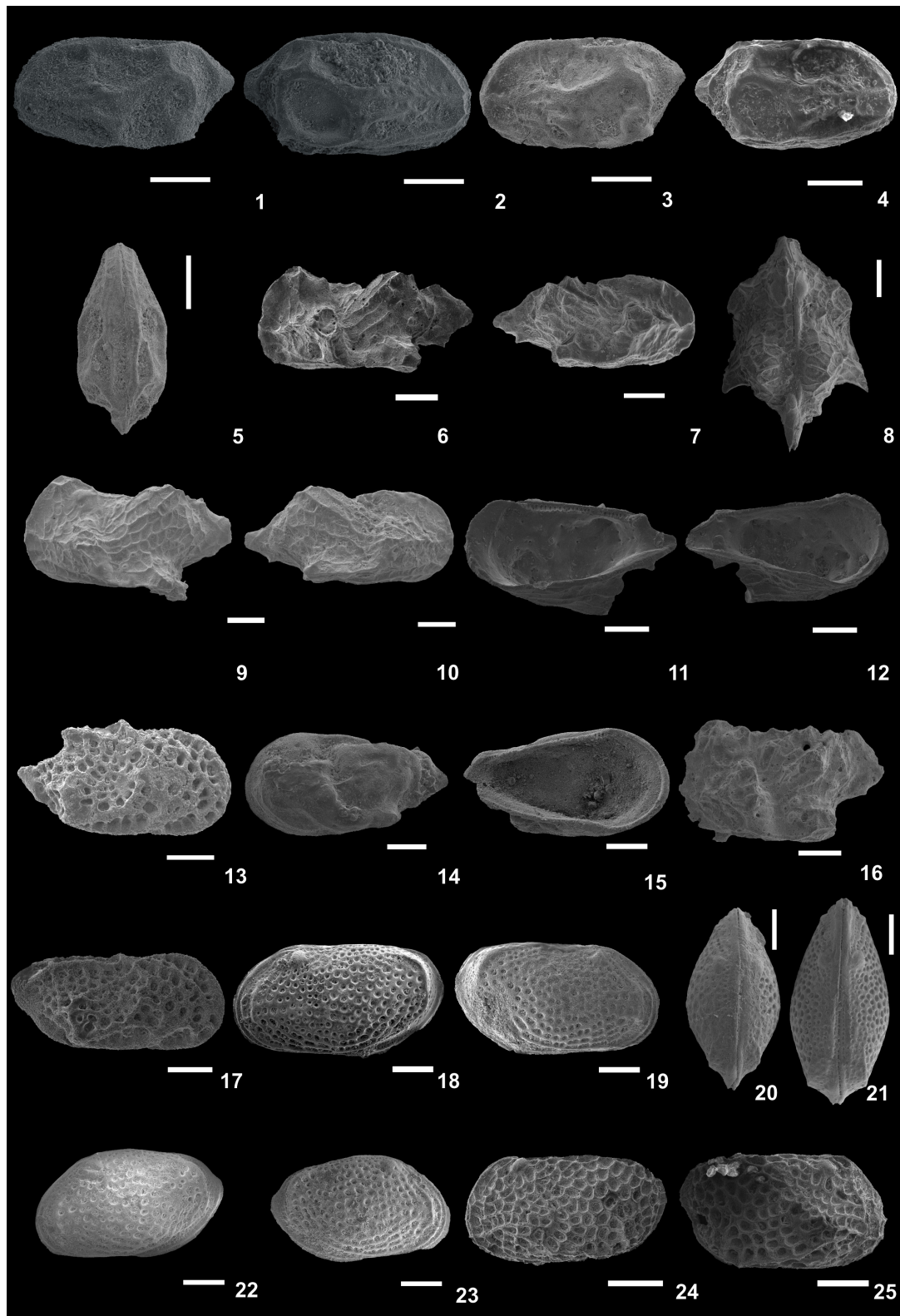


FIGURE 10. Scale bar: 100µm: C: Carapace; L: Left Valve; R: Right Valve; E: External View; I: Internal View; D: Dorsal View; A: Adult; (MPEG-000-M) = (000). 1–5. *Kangarina quellita*. 1. Male C, L, E (692). 2. Male, C, R, E (693). 3. Female C, L, E (690). 4. Female, C, R, E (691). 5. Female, C, D (691). 6–7. *Paracytheridea tschoppi*. 6. L, E (694). 7. R, E (694). 8–12. *Paracytheridea* sp. aff. *P. altita*. 8. D (697). 9. L, E (697). 10. R, E (697). 11. R, I (697). 12. L, I (697). 13. *Paracytheridea* sp.1. 13. R, E (698). 14–15. *Paracytheridea* sp.2. 14. L, E (699). 15. L, I (699). 16. *Paracytheridea* sp.3. 16. L, E (700). 17. *Paracytheridea?* sp. 4. 17. R, E (701). 18–23. *Loxoconcha* sp. aff. *L. cyrton*. 18. Male, C, L, E (703). 19. Male, C, R, E (703). 20. Female, D (702). 21. Male, D (703). 22. Female, C, L, E (702). 23. Female, C, R, E (702). 24–25. *Loxoconcha* sp. 24. C, L, E (704). 25. C, R, E (705).

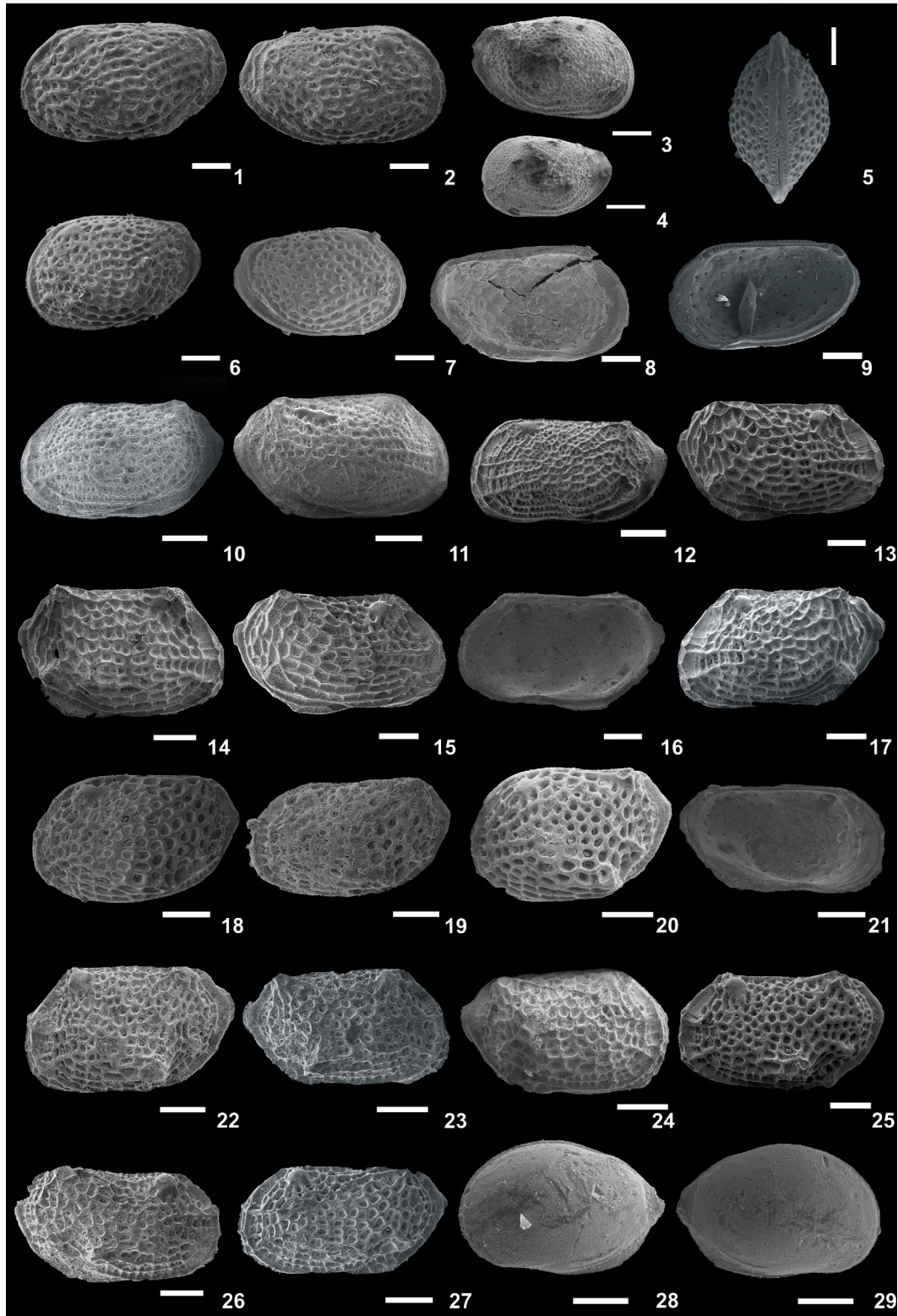


FIGURE 11. Scale bar: 100µm: C: Carapace; L: Left Valve; R: Right Valve; E: External View; I: Internal View; D: Dorsal View; A: Adult; (MPEG-000-M) = (000). 1–9. *Loxoconcha corpulenta* sp. nov. 1. Male, C, L, E (707). 2. Male, C, R, E (707). 3. J, R, E (712). 4. J, L, E (713). 5. D (709). 6. Female, C, L, E (706). 7. Female, C, R, E (706). 8. Female, L, I (706). 9. Female, R, I (708). 10–12. *Loxocorniculum* sp. aff. *Loxoconcha rugosa*. 10. Female, C, L, E (715). 11. Female, C, R, E (715). 12. Male, L, E (716). 13–16. *Loxocorniculum fischeri*. 13. Male, R, E (718). 14. Female, R, E (717). 15. Male, R, E (719). 16. R, I (719). 17. *Loxocorniculum antillum*. 17. C, L, E (721). 18–20. *Loxocorniculum* sp. aff. *Loxoconcha longispina*. 18. Female, L, E (722). 19. Male, L, E (724). 20. Female, L, E (723). 21–27. *Loxocorniculum* sp. 21. Male, L, I (729). 22. Female, L, E (725). 23. Female, R, E (726). 24. Female, L, E (725). 25. Male, R, E (728). 26. Male, R, E (728). 27. Male, L, E (729). 28–29. *Phlyctocythere* sp. 28. C, L, E (730). 29. C, R, E (730).

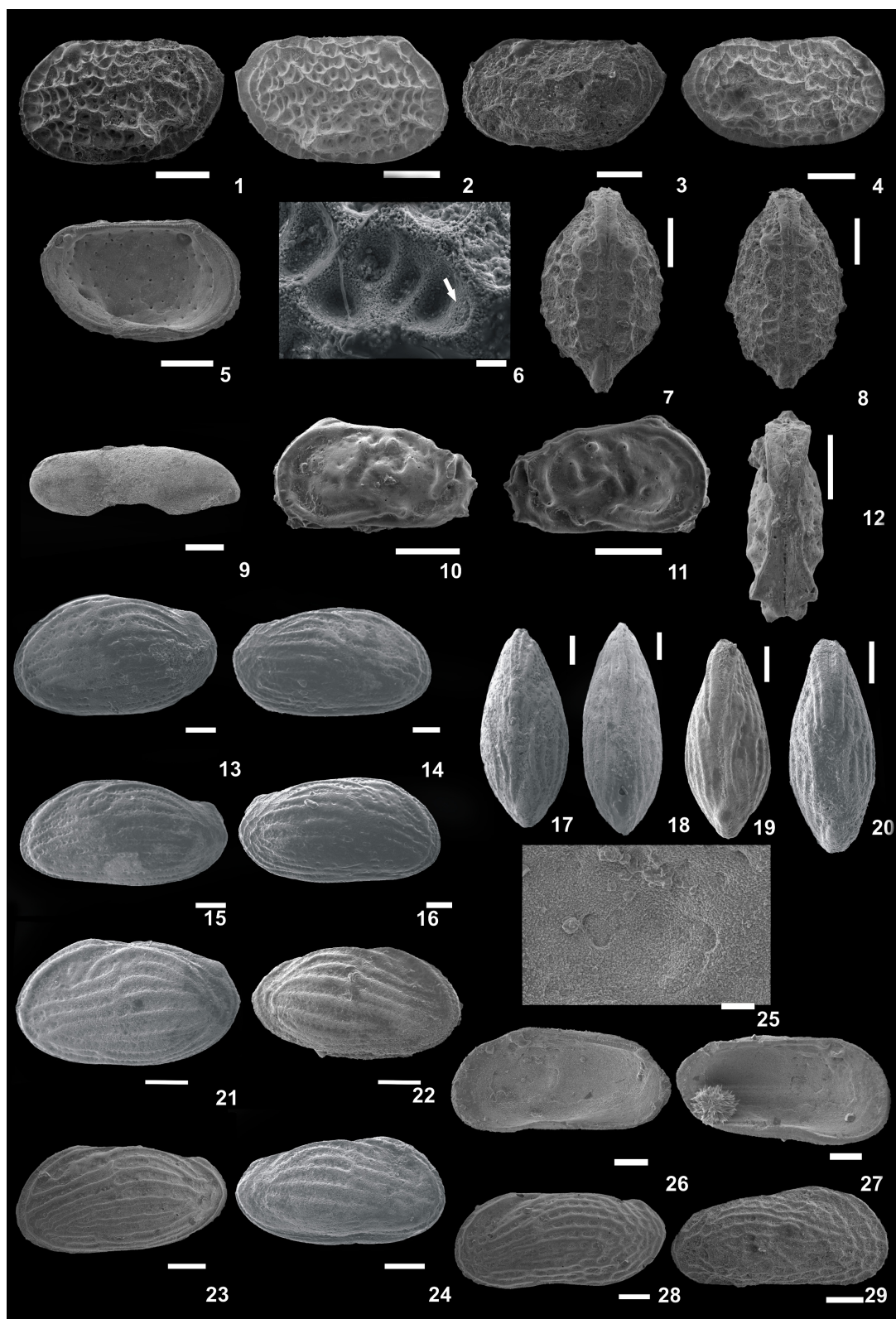


FIGURE 12. Scale bar: 100µm: C: Carapace; L: Left Valve; R: Right Valve; E: External View; I: Internal View; D: Dorsal View; A: Adult; (MPEG-000-M) = (000). 1–8. *Touroconcha ishizakii* sp. nov. 1. Female, L, E (731). 2. Female, R, E (731). 3. Male, R, E (732). 4. Male, C, L, E (732). 5. Female, L, I (731). 6. Detail of Pore canal. Male, C, L, E (731). 7. Female, D (731). 8. Male, D (732). 9. *Copytus* sp. 9. L, E (735). 10–12. *Munseyella minuta*. 10. D (737). 11. C, L, E (737). 12. C, R, E (737). 13–18. *Cytheretta* cf. *C. punctata*. 13. Female, C, L, E (739). 14. Female, C, R, E (739). 15. Male, C, L, E (740). 16. Male, C, R, E (740). 17. Female, D (742). 18. Male, D (743). 19–24. *Cytheretta fortiscostata* sp. nov. 19. Female, D (747). 20. Male, D (748). 21. Female, C, L, E (744). 22. Female, C, R, E (744). 23. Male, C, L, E (745). 24. Male, C, R, E (745). 25–29. *Cytheretta petrii* sp. nov. 25. Detail of muscle scars, L (750). 26. C, L, E (749). 27. C, R, E (749). 28. R, I (752). 29. L, I, (750).

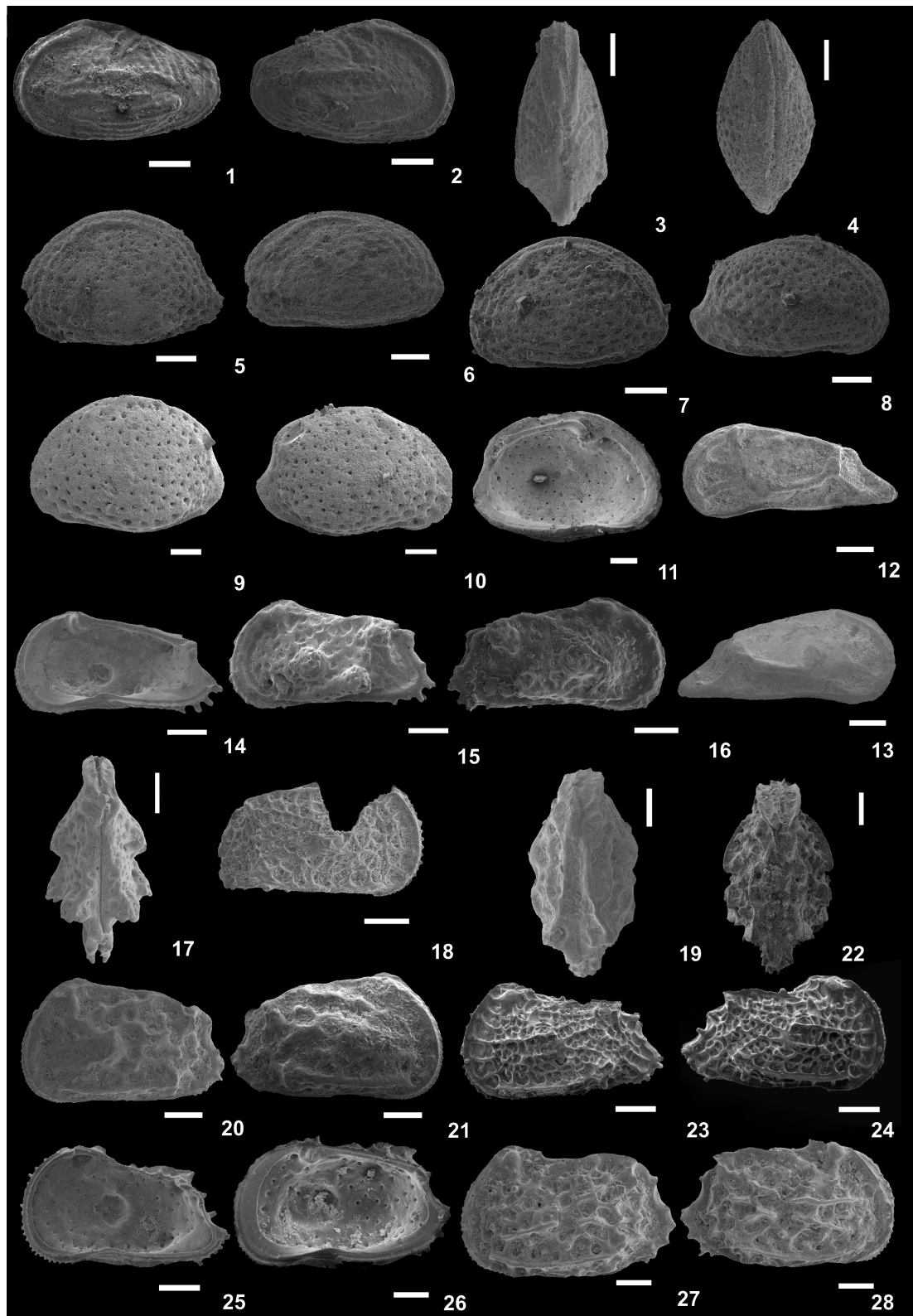


FIGURE 13. Scale bar: 100µm: C: Carapace; L: Left Valve; R: Right Valve; E: External View; I: Internal View; D: Dorsal View; A: Adult; (MPEG-000-M) = (000). 1–3. *Quasibuntonia?* sp. 1. C, L, E (753). 2. C, R, E (753). 3. D (753). 4–8. *Aurila laevicula*. 4. Female, D (754). 5. Female, L, E (756). 6. Male, L, E (755). 7. Female, L, E (754). 8. Female, R, E (754). 9–11. *Aurila* cf. *A. cicatricosa* (Reuss, 1980). 9. L, E (758). 10. R, E (758). 11. L, I (758). 12–13. *Caudites medialis*. 12. C, L, E (761). 13. C, R, E (761). 14–17. *Cornucoquimba hoornibrooki*. 14. R, I (762). 15. C, L, E (762). 16. C, R, E (762). 17. D (762). 18. *Hermanites* sp. 18. R, E (763). 19–21. *Tenedocythere? rugosocostata* **sp. nov.** 19. D (764). 20. C, L, E (764). 21. C, R, E (764). 22–28. *Jugosocythereis pannosa*. 22. A, D (766). 23. J, L, E (768). 24. J, R, E (768). 25. J, I, R (768). 26. A, R, I (766). 27. A, C, L, E (766). 28. A, C, R, E (766).

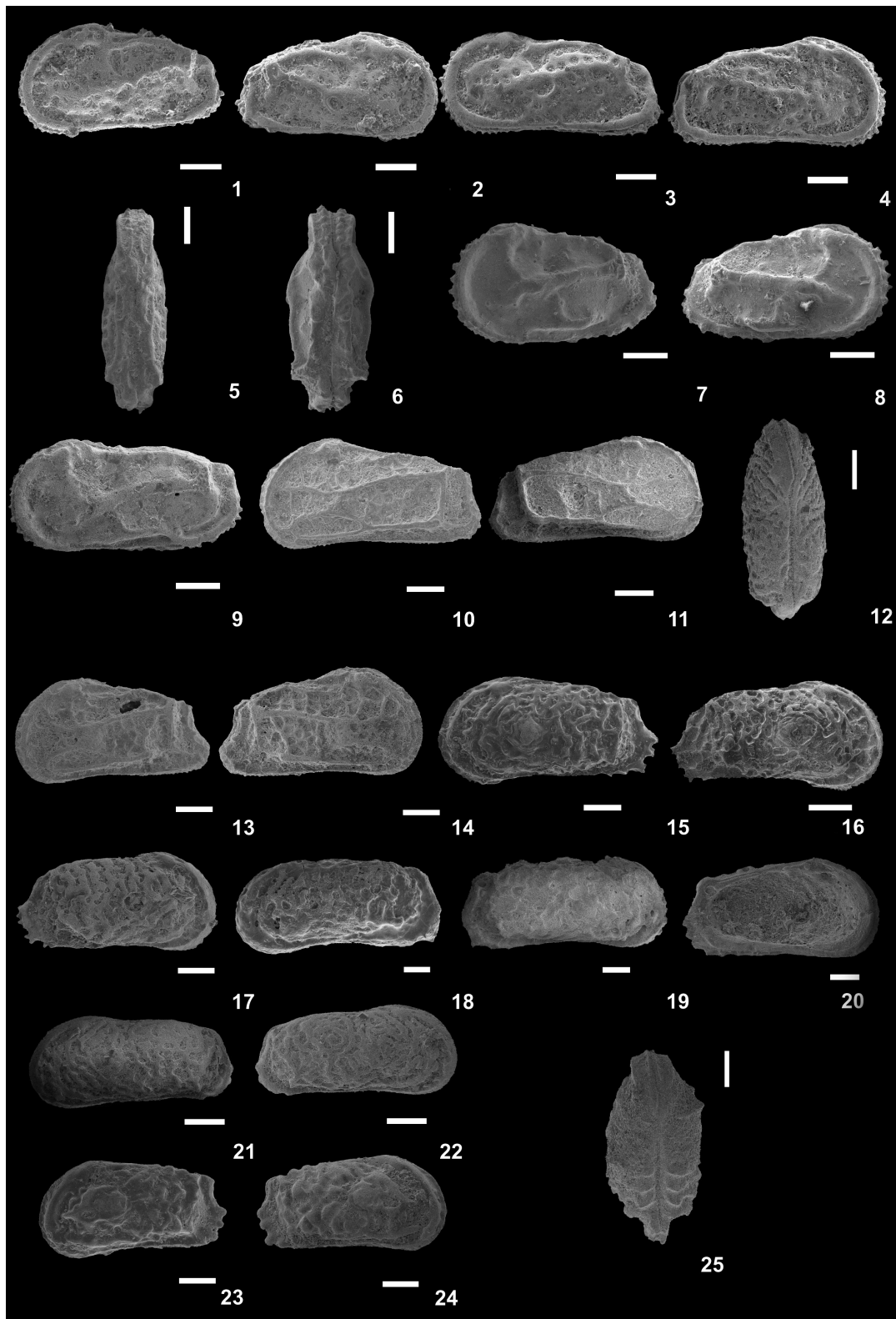


FIGURE 14. Scale bar: 100µm: C: Carapace; L: Left Valve; R: Right Valve; E: External View; I: Internal View; D: Dorsal View; A: Adult; (MPEG-000-M) = (000). 1–5. *Neocaudites macertus*. 1. Female, C, L, E (773). 2. Female, C, R, E (773). 3. Male, C, L, E (774). 4. Male, C, R, E (774). 5. Male, D (774). 6–9. *Neocaudites triplistriatus*. 6. Female, D (775). 7. Female, C, L, E (775). 8. Female, C, R, E (775). 9. Male, C, L, E (776). 10–11. *Orionina* sp. 10. C, L, E (777). 11. C, R, E (777). 13–14. *Orionina* sp. aff. *O. similis*. 13 C, L, E (778). 14. C, R, E (778). 12, 15–22. *Coquimba congestocostata* 12. Male, D, R (736). 15. Female, C, L, E (779). 16. Female, C, R, E (779). 17. Female, R, E (780). 18. Male, C, L, E (783). 19. Male, C, R, E (783). 20. L, I (779). 21. Male, C, L, E (784). 22. Male, C, R, E (784). 23–25. *Puriana rugipunctata*. 23. C, L, E (785). 24. C, R, E (785). 25. D (785).

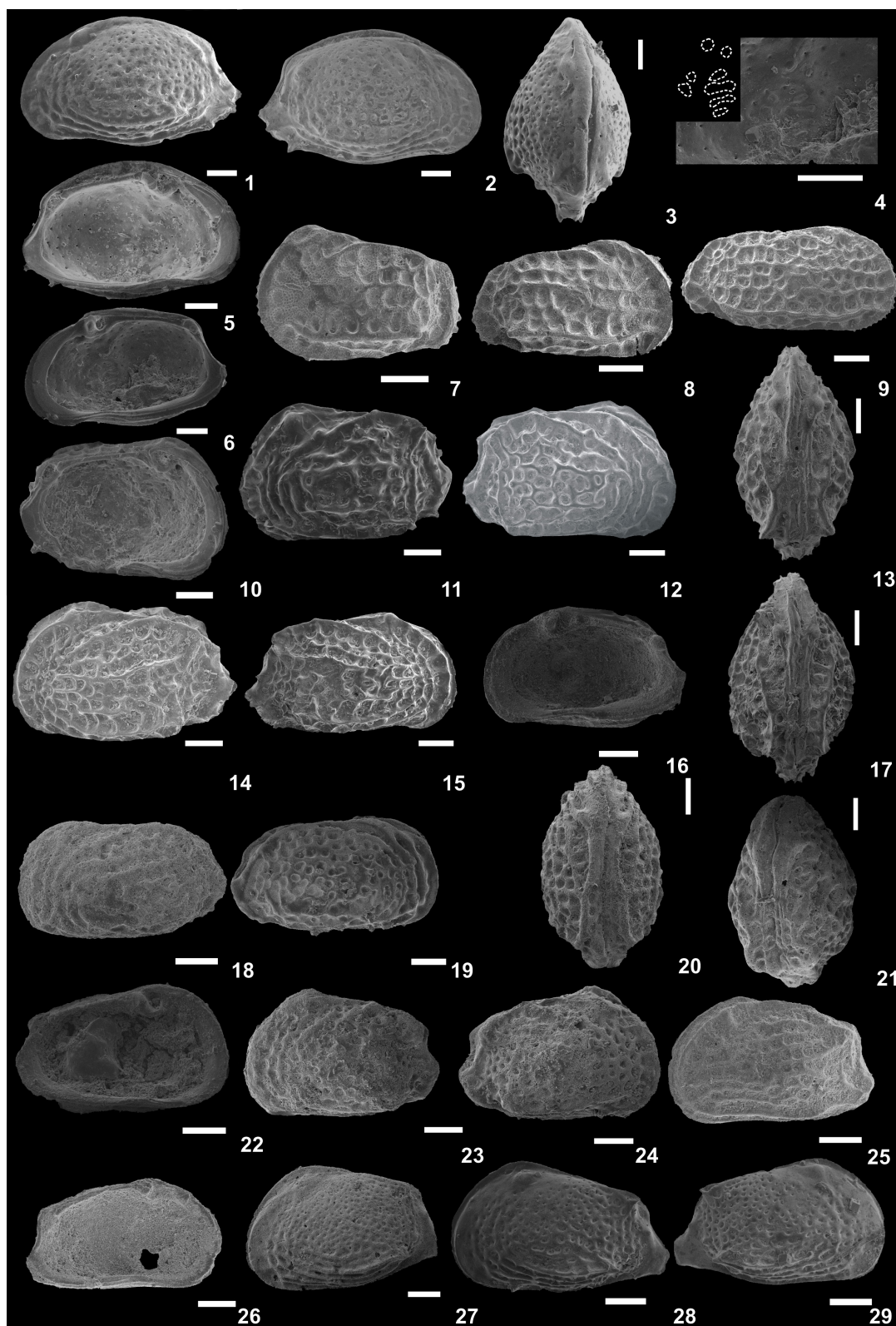


FIGURE 15. Scale bar: 100µm: C: Carapace; L: Left Valve; R: Right Valve; E: External View; I: Internal View; D: Dorsal View; J: Juvenile; A: Adult; (MPEG-000-M) = (000). 1–6. *Pokornyella deformis*? 1. C, L, E (786). 2. C, R, E (786). 3. D (786). 4. Detail of the muscle scars, R (788). 5. L, I (787). 6. R, I (788). 7–8. *Bradleya*? sp.1. 7. L, E (789). 8. R, E (790). 9. *Bradleya* sp. 9. R, E (791). 10–13. *Quadracythere brachypygia*. 10. L, I, (794). 11. C, L, E (792). 12. C, R, E (792). 13. D (793). 14–17. *Quadracythere adornata* sp. nov. 14. C, L, E (795). 15. C, R, E (795). 16. R, I (797). 17. D (795). 18–20. *Quadracythere limbimodesta* sp. nov. 18. L, E (799). 19. C, R, E (800). 20. D (799). 21–24. *Quadracythere fortisrobusta* sp. nov. 21. D (809). 22. L, I (810). 23. C, L, E (808). 24. C, R, E (808). 25–26. *Quadracythere*? sp. 1. 25. L, E (813). 26. L, I (814). 27–29. *Quadracythere*? sp.2. 27. A, L, E (815). 28. J, L, E (816). 29. J, R, E (817).

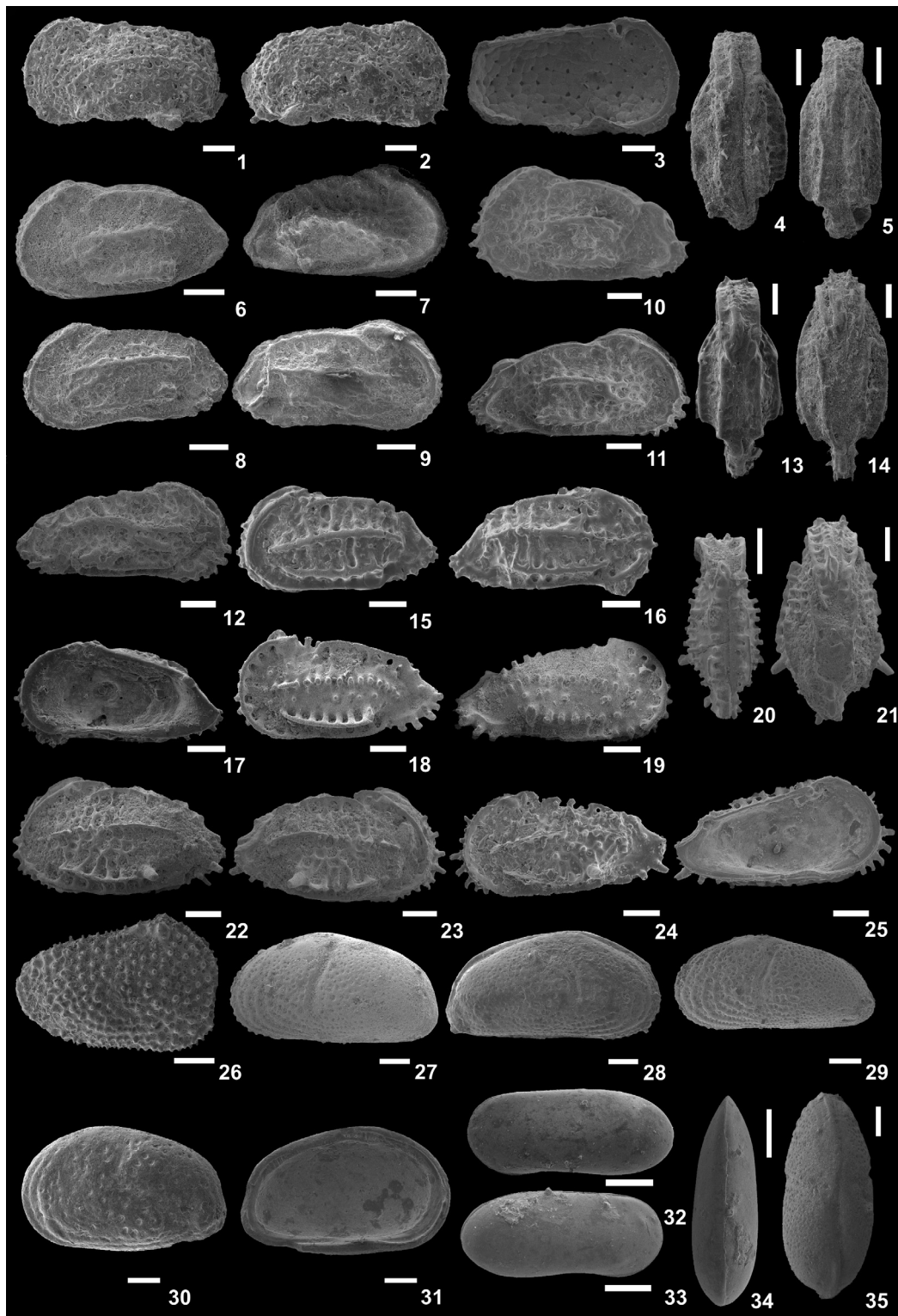


FIGURE 16. Scale bar: 100µm; C: Carapace; L: Left Valve; R: Right Valve; E: External View; I: Internal View; D: Dorsal View; A: Adult; (MPEG-000-M) = (000). 1–3. *Carinocythereis?* sp. 1. L, E (818). 2. R, E (818). 3. L, I (818). 4–9. *Costa variabilocostata variabilocostata*. 4. Female, D (819). 5. Male, D (822). 6. Female, C, L, E (819). 7. Female, C, R, E (820). 8. Male, C, L, E (821). 9. Male, C, R, E (821). 10–13. *Costa spinaventralis* sp. nov. 10. C, L, E (825). 11. C, R, E (825). 12. R, E (826). 13. D (825). 14–17. *Cativella* sp. aff. *C. navis*. 14. D (829). 15. L, E (828). 16. R, E (828). 17. R, I (828). 18–20. *Cativella* sp. aff. *C. moriahensis*. 18. C, L, E (833). 19. C, R, E (833). 20. D (833). 21–23. *Cativella primaveraensis* sp. nov. 21. D (836). 22. C, L, E (836). 23. C, R, E (836). 24–25. *Cativella* sp. 24. L, E (839). 25. L, I (839). 26. *Echinocythereis* sp. 26. R, E (840). 27–29, 35. *Cyprideis? carmoi* sp. nov. 27. Female, C, L, E (641). 28. Female, C, R, E (641). 29. Male?, juvenile, L, E (642). 35. Female, D (641). 30–31. *Hemicyprideis* sp. 30. C, L, E (644). 31. L, I (644). 32–34. *Pseudopsammocythere* ex. gr. *vicksburgensis*. 32. C, L, E (745). 33. C, R, E (745). 34. D (745).

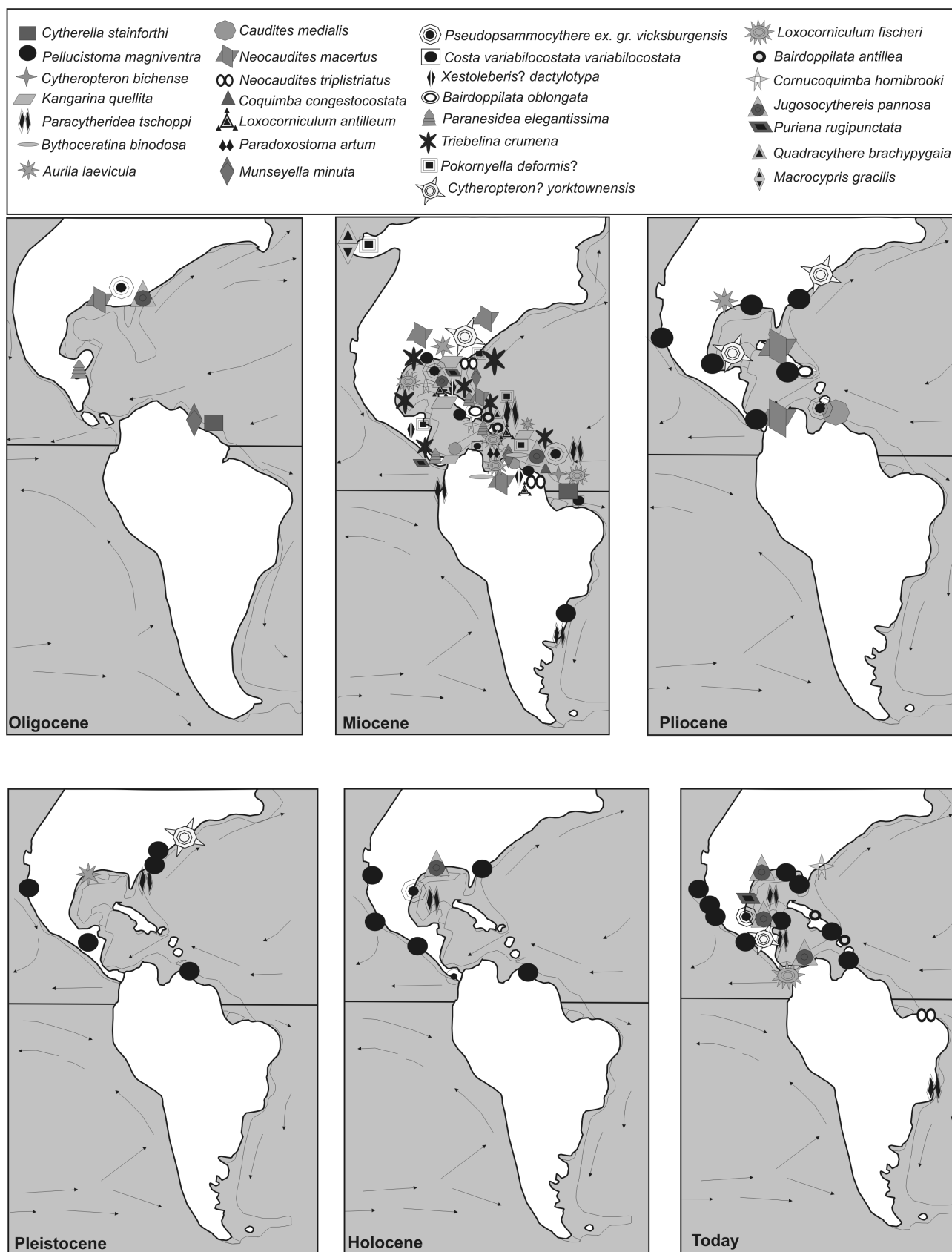


FIGURE 17. Distribution of the 29 species recorded in the Caribbean region, East Pacific Ocean, South and North America, separately by geological epoch, including this work.