Journal of Paleontology, 92(4), 2018, p. 661–680

0022-3360/18/0088-0906
doi: 10.1017/jpa.2018.1

JOURNAL OF PALEONTOLOGY
A PUBLICATION OF THE Paleontological SOCIETY

Taxonomy of limnic Ostracoda (Crustacea) from the Quiricó Formation, Lower Cretaceous, São Francisco basin, Minas Gerais State, Southeast Brazil

Amanda Moreira Leite,[1] Dermeval Aparecido Do Carmo,[1] Caio Bussaglia Ress,[1] Murilo Pessoa,[1] Guilherme Miranda Caixeta,[1] Matheus Denezine,[1] Rodrigo Rodrigues Adorno,[2] and Lucas Silveira Antonietto[3]

[1]University of Brasilia, Institute of Geosciences, Micropaleontology Laboratory, Brasília, DF, Zip Code 73105-909, Brazil ⟨amanda_mleite@hotmail.com⟩, ⟨derme@unb.br⟩, ⟨caio_ress@hotmail.com⟩, ⟨murilopessoa_@hotmail.com⟩, ⟨gui.mcaixeta@gmail.com⟩, ⟨matheusdenezine@yahoo.com.br⟩
[2]Geological Survey of Brazil – Serviço Geológico do Brasil, DEGEO/DIPALE-CPRM/REPO, Porto Velho, RO, Zip Code 76801-581, Brazil ⟨rodrigo.adorno@cprm.gov.br⟩
[3]University of Connecticut, Department of Geography, Mansfield, CT, USA ⟨antoniettols@gmail.com⟩

Abstract.—The present work presents a detailed taxonomic study on Ostracoda from the Quiricó Formation, Areado Group, São Francisco Basin, Brazil. The samples were collected from three outcrops in the Minas Gerais State: Tereza Farm (João Pinheiro Municipality), and from the banks of the São José and Quiricó creeks (Presidente Olegário Municipality). Sixteen ostracode species were recovered: *Harbinia alta*, *Harbinia* aff. *H. angulata*, *Harbinia* aff. *H. crepata*, *Harbinia* aff. *H. salitrensis*, *Harbinia symmetrica*, *Brasacypris fulfaroi*, *Brasacypris ovum*, *Cypridea conjugata*, *Cypridea hystrix*, *Cypridea infima*, *Cypridea jequiensis*, *Neuquenocypris* (*Protoneuquenocypris*) *antiqua*, *Penthesilenula martinsi*, *Penthesilenula pintoi* new species, *Alicenula longiformis* new species, and *Timiriasevia sanfranciscanensis* new species. With the recovery of well-preserved specimens, it was possible to observe new characteristics in *Brasacypris ovum*, *Cypridea conjugata*, *C. hystrix*, and *C. infima*, and propose emendments to them. Additionally, three new species are described: *Penthesilenula pintoi* n. sp., *Alicenula longiformis*, n. sp., and *Timiriasevia sanfranciscanensis* n. sp. To date, the genus *Timiriasevia* had not been recorded in strata from Brazil. Also, *Darwinula martinsi* is reassigned to the genus *Penthesilenula*. Several species herein recorded are also found in other Brazilian continental basins, as well as in African and Argentinian basins, contributing to the knowledge of Brazilian Cretaceous continental deposits.

Introduction

The usage of limnic ostracodes in the study of sedimentary basins is largely based on their bioestratigraphic potential (Milhomem et al., 2001). Continental ostracodes are present in the pre-salt interval of Atlantic basins, especially on the Brazilian coast, and constitute important tools for the understanding of rift lacustrine systems related to the opening of the proto-South Atlantic Ocean, during the Early Cretaceous (Poropat and Colin, 2012b).

Ostracodes are small crustaceans with mean size of 1 mm that have a calcitic bivalve carapace and inhabit practically all types of aquatic environments, from marine to humid terrestrial (Horne et al., 2002). They are among the most diverse group of living crustaceans, and possess a rich fossil record due to their calcified valves being easily preserved in sediments and rocks (Cohen et al., 1998).

This work represents a detailed taxonomic study on Ostracoda from the Quiricó Formation, Lower Cretaceous of the São Francisco Basin, in the Minas Gerais State, Brazil. The samples are from three outcrops: (1) Tereza Farm, in João Pinheiro Municipality; (2) from the banks of São José creek, Presidente Olegário Municipality; and (3) from the banks of Quiricó creek, Presidente Olegário Municipality (Fig. 1).

The Quiricó Formation is the only Mesozoic unit of the São Francisco Basin that contains ostracodes (Do Carmo et al., 2004a; Campos and Do Carmo, 2005; Bittencourt et al., 2015). The taxonomy, paleoecology, and stratigraphic and geographic distribution of the ostracode species herein identified can supply information on the chronostratigraphic positioning of the Quiricó Formation. These data contribute to the knowledge on the Cretaceous biodiversity in Brazilian continental deposits, improving the biostratigraphic correlation with other Cretaceous basins, especially those on the South America and Africa continental margins, for the Berremian–Aptian interval.

Geologic setting

The intracratonic São Francisco Basin has little deformation in its central portion, despite being somewhat deformed on the borders due to the Brasília and Araçuaí compressional mobile belts, in the

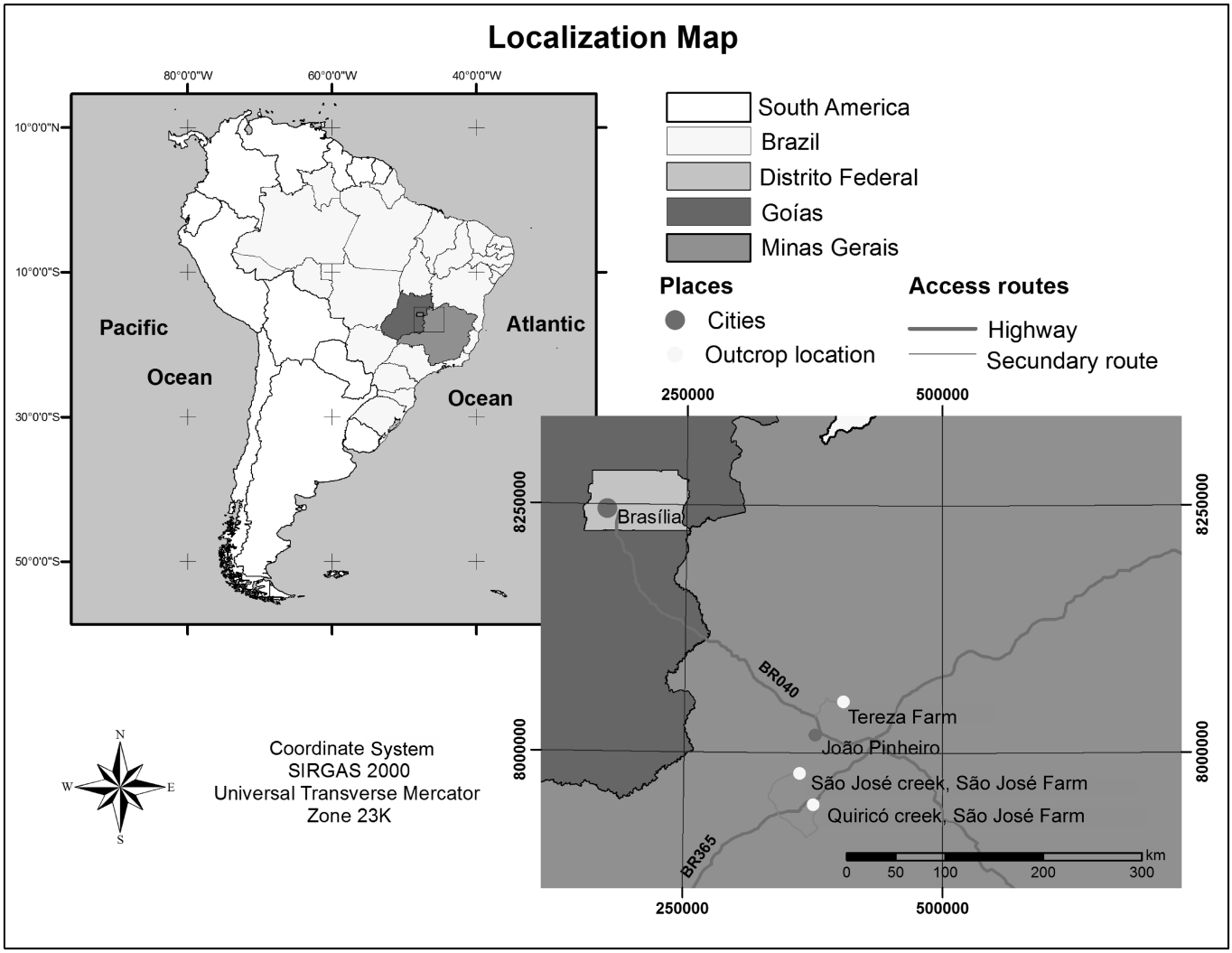


Figure 1. Locality map and access routes of the studied outcrops.

west and in the east, respectively. The Proterozoic sedimentary rocks are covered by Phanerozoic ones, the latter composed of remaining sedimentary spots of Permian–Carboniferous age, Early Cretaceous sedimentary rocks, Late Cretaceous volcanic rocks, and a plateau composed of Late Cretaceous sandstones. From base to top, the São Francisco Basin was filled in by four supersequences: (1) rift, (2) intracratonic, (3) intracratonic/foreland, and (4) sanfranciscan (Zalán and Silva, 2007).

The rift supersequence (Paleoproterozoic–Mesoproterozoic) consists of the Espinhaço Supergroup and Arai Group. In the Neoproterozoic, the intracratonic supersequence consists of two groups, Macaúbas and Paranóa, and the Bambuí Group forms the intracratonic/foreland supersequence (Zalán and Silva, 2007).

The Phanerozoic sequence spreads among the Minas Gerais, Bahia, and Piauí states. It is composed, from base to top, by the Santa Fé (Permian–Carboniferous), Areado (Lower Cretaceous), Mata da Corda (Upper Cretaceous), and Urucuia (Upper Cretaceous) groups (Fig. 2) (Campos and Do Carmo, 2005; Zalán and Silva, 2007). The Santa Fé Group consists of glacial records with fluvial-glacial, glacial-lacustrine, and eolic periglacial facies. The Areado Group consists of sedimentary rocks. The Mata da Corda Group consists of pyroclastic alkaline volcanic rocks and epiclastic proximal sedimentary rocks. The Urucuia Group consists of eolic sandstones and fluvial sandstones, conglomerates, and pelitic rocks (Campos and Do Carmo, 2005).

The Areado Group is distributed throughout the basin, and its wide lateral variation of lithofacies results from simultaneous action of several depositional environments. Its formations, from base to top, are Abaeté, Quiricó, and Três Barras. To the south, the Abaeté Formation is composed of alluvial fan deposits, which produced immature matrix-supported conglomerates; in the rest of the basin, the Abaeté Formation consists of mature clast-supported conglomerates, deposited by interlaced rivers. The Quiricó Formation was deposited in a lacustrine system, with interstratified siltstones that prevail at the base of the sequence, besides fine-, medium-, and coarse-grained sandstones, and more frequently in the upper part of the sequence, shales and limestones. Locally, in the region of Presidente Olegário, the Quiricó Formation is a dark, fossiliferous, calcareous, papyraceous shale that is rich in organic matter. The Três Barras Formation has more lithological diversity and rock volume. It was deposited in fluvial, fluvial-deltaic, and eolic systems and is composed of heterogeneous sandstones (Campos and Dardenne, 1997; Campos and Do Carmo, 2005).

https://doi.org/10.1017/jpa.2018.1 Published online by Cambridge University Press

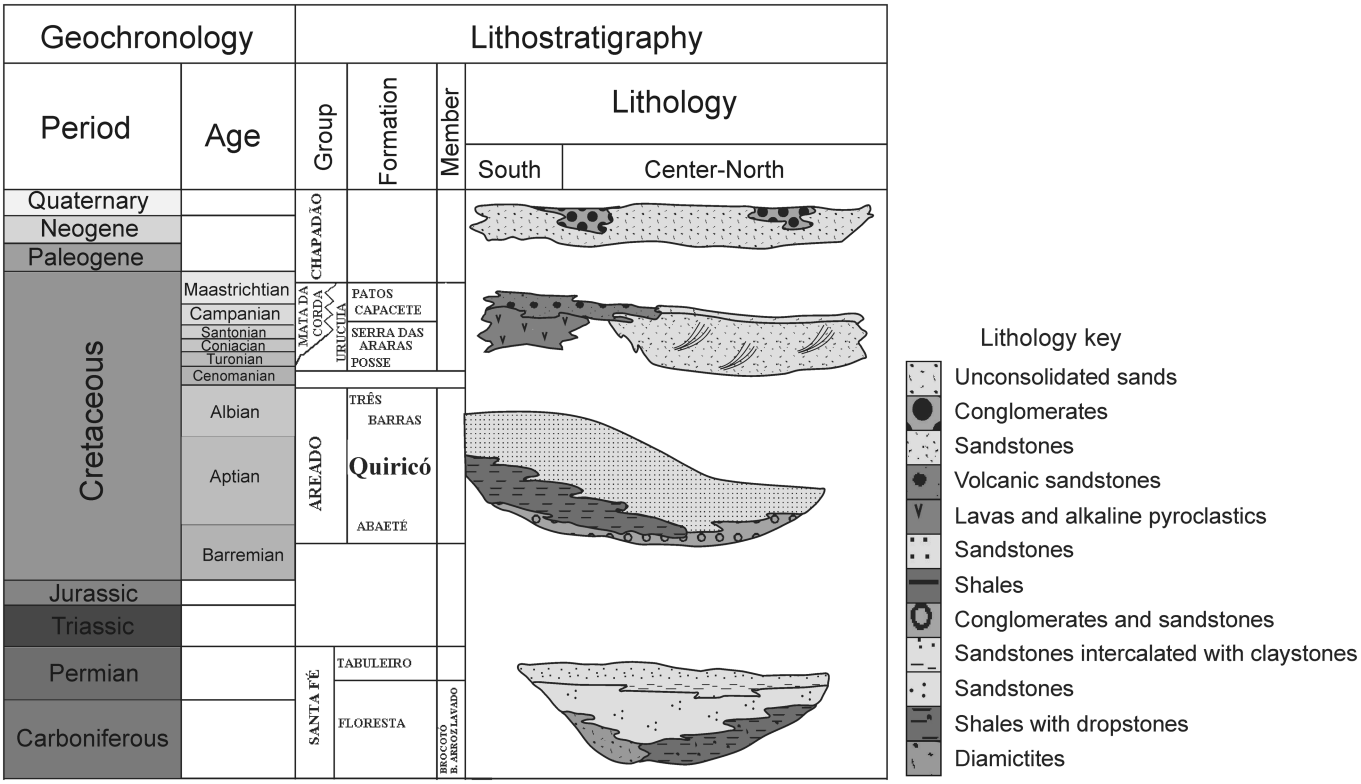


Figure 2. Chronostratigraphic column representing the Phanerozoic sequence of the São Francisco Basin (Do Carmo et al., 2004a, adapted according to Campos and Dardenne, 1997).

About nine genera of ostracodes are known from the Quiricó Formation, all of which are from the Sono River, in João Pinheiro, and Carmo do Paranaíba municipalities (Do Carmo et al., 2004a; Campos and Do Carmo, 2005; Bittencourt et al., 2015). In these localities, conchostacans and coelacanthiform fishes from the genus *Mawsonia* Woodward in Mawson and Woodward, 1907, were also recorded, in pelitic rocks (Carvalho and Maisey, 2008; Bittencourt et al., 2015). Palynomorphs and amorphous organic matter were also found in dark fossiliferous shale from the region of Presidente Olegário, together with the fish species *Dastilbe moraesi* Silva-Santos in Scorza and Santos, 1955 and leaf impressions. *Dastilbe moraesi* is restricted to the Lower Cretaceous, and commonly is considered a fresh-water dweller (Davis and Martill, 1999). The palynomorphs present in the shale layers indicate a Barremian Age, or earlier (Campos and Do Carmo, 2005), while pollen found in upper levels indicates an Aptian Age (Bittencourt et al., 2015).

Materials and methods

We collected and analyzed 168 samples. The rocks described in the Tereza farm correspond to a lower portion of the Quiricó Formation and are predominantly composed of sandstones. The other two outcrops (São José farm, on the banks of the São José and Quiricó rivers) correspond to an upper portion, with the presence of shale layers. During fieldwork, complete lithostratigraphic columns were made for each outcrop, with detailed sampling.

The samples were processed in the Micropaleontology Laboratory, according to the following protocol: (1) they were fragmented into small parts, and further with the help of hydrogen peroxide; (2) washed through a sequence of sieves, with opening of 600, 250, 150, 90, and 53 µm, withsediments <53 µm also retained; and (3) material from each sieve was oven dried and picked under stereomicroscope.

Repository and institutional abbreviation.—The samples are housed in the Micropaleontology Collection (MP) of the Geosciences Museum of the University of Brasília. The specimens illustrated are part of the Research Collection (CP) of the Geosciences Museum of the University of Brasília.

Systematic paleontology

Suprageneric taxonomy follows Hou et al. (2002), Liebau (2005), and Sames (2009, 2011). The morphological terminology is based on Kesling (1951) and Do Carmo et al. (2013). Sixteen ostracode species were recovered from the Quiricó Formation.

Subclass Ostracoda Latreille, 1802
Order Podocopida Sars, 1866
Suborder Cypridocopina Jones, 1901
Superfamily Cypridoidea Baird, 1845
Family Quadracyprididae Hou et al., 2002
Subfamily Quadracypridinae Hou et al., 2002

Genus *Harbinia* Tsao, 1959 emend. Hou, 1984

Type species.—*Harbinia hapla* Tsao, 1959.

https://doi.org/10.1017/jpa.2018.1 Published online by Cambridge University Press

Remarks.—The suprafamilial classification follows Liebau (2005); for family and other infrafamilial taxa, classification follows Hou et al. (2002), who proposed the family Quadracyprididdae, subfamily Quadracypridinae, encompassing the genera *Quadracypris*, *Nanxiongium*, *Harbinia*, and *Sinocypris*. The genus *Harbinia* is widely discussed by Do Carmo et al. (2008) due to its similarity to *Pattersoncypris* Bate, 1972. The type species *Pattersoncypris micropapillosa* Bate, 1972 is considered a junior synonym of *Harbinia* Tsao, 1959. The subspecies described by Krömmelbein and Weber (1971) belonging to *Hourcqia* Krömmelbein, 1965b (i.e., *Hourcqia angulata angulata* Krömmelbein and Weber, 1971; *Hourcqia angulata salitrensis* Krömmelbein and Weber, 1971; *Hourcqia angulata sinuata* Krömmelbein and Weber, 1971; and *Hourcqia angulata symmetrica* Krömmelbein and Weber, 1971) were reassigned to *Harbinia* and elevated to the level of species. A revision of *Hourcqia* Krömmelbein, 1965b, *Pattersoncypris* Bate, 1972, and *Harbinia* Tsao, 1959 by Poropat and Colin (2012a) led to revalidation of the genus *Pattersoncypris*, encompassing the species *Harbinia micropapillosa*, *H. salitrensis*, and *H. sinuata*. They also proposed the new genus *Kroemmelbeincypris* Poropat and Colin, 2012a, including in it the species *Harbinia angulata* and *H. symmetrica*. That proposal was based on the inclined posterior margin, which would differentiate those species from *Harbinia*. Several characteristics described for *Kroemmelbeincypris* (e.g., valve overlap, outline, and ornamentation pattern) are also present in *Harbinia*. Tomé et al., (2014) invalidated the genus *Kroemmelbeincypris* due to the small variation associated with polymorphism present in some species of *Harbinia*, and accepted the validity of *Pattersoncypris*.

Harbinia aff. *Harbinia angulata* (Krömmelbein and Weber, 1971)
Figure 3.1–3.3

1971? *Hourcqia angulata angulata* Krömmelbein and Weber, p. 81, pl. 6, figs. 23–26.
2002? *Pattersoncypris angulata angulata* (Krömmelbein and Weber); Coimbra et al., p. 691, fig. 4.29.
2008? *Harbinia angulata* (Krömmelbein and Weber); Do Carmo et al., p. 795, fig. 6.11.
2012b? *Kroemmelbeincypris angulata* (Krömmelbein and Weber); Poropat and Colin, p. 709, fig. 4.5.
2014? *Pattersoncypris angulata* (Krömmelbein and Weber); Tomé et al., p. 165, fig. 10G–I.

Holotype.—A carapace (BfB, type Nr. 7795) from the Post-Bahia Series, Riachuelo layers, Alagoas State, Brazil (Krömmelbein and Weber, 1971).

Occurrence.—Brazil: Sergipe-Alagoas Basin, Riachuelo Formation, upper Aptian (Krömmelbein and Weber, 1971); Araripe Basin, Santana Formation, Romualdo Member, Aptian (Poropat and Colin, 2012b); Cedro Basin, deposits correlated to the Crato Formation, Aptian (Tomé, 2007); Jatobá Basin, Serra Negra, in deposits correlated to the Crato Formation, upper Aptian (Tomé et al., 2014); São Francisco Basin, Quiricó Formation, Lower Cretaceous, Aptian.

Materials.—Four intervals from São José creek, São José Farm, Presidente Olegário, Minas Gerais State, southeastern Brazil: MP-2882, two carapaces; MP-2883, 40 carapaces; MP-2889, 35 carapaces; MP-2922, six carapaces.

Remarks.—This species is easily identified by the marked posterior cardinal angle that coincides with the greatest length of the carapace, forming also a posterior lump in some instars (Tomé et al., 2014). The recovered individuals are poorly preserved, with evidence of dissolution.

Harbinia symmetrica (Krömmelbein and Weber, 1971)
Figure 3.4–3.6

1971 *Hourcqia angulata symmetrica* Krömmelbein and Weber, p. 81, pl. 6, fig. 25.
1990 *Cultella* sp. 1 Dépêche et al., p. 308, pl. 2, fig. 2.
1990 *Pattersoncypris* cf. *angulata angulata* (Krömmelbein and Weber); Musacchio, p. 564, pl. 1, fig. 4.
1990 *Hourcqia angulata symmetrica* Krömmelbein and Weber; Silva-Telles and Viana, p. 325, pls. 1, 3, fig. 8.
1999 *Pattersoncypris angulata symmetrica* (Krömmelbein and Weber, 1971); Bate, p. 289.
2002 *Pattersoncypris angulata symmetrica* (Krömmelbein and Weber); Coimbra et al., p. 691, Fig. 4.30.
2004a *Harbinia symmetrica* (Krömmelbein and Weber); Do Carmo et al., p. 144, fig. 4.1.
2004a *Harbinia* sp. 1 Do Carmo et al., p. 144, fig. 4.2.
2006 *Harbinia* aff. *Harbinia symmetrica* (Krömmelbein and Weber); Ramos et al., p. 344, fig. 4M–P.
2008 *Harbinia symmetrica* (Krömmelbein and Weber); Do Carmo et al., p. 795, fig. 6.9.
2012b *Kroemmelbeincypris symmetrica* (Krömmelbein and Weber); Poropat and Colin, p. 709, fig. 4.4.

Holotype.—A carapace (BfB, type Nr. 7797), from the Codó layers, Maranhão State, Brazil (Krömmelbein and Weber, 1971).

Occurrence.—Brazil: Araripe Basin, Rio da Batateira Formation, and Santana Formation, Crato, Ipubi, and Romualdo members, Aptian (Coimbra et al., 2002), *Harbinia* spp. 201–218 Zone, coded as NRT-O11 (Do Carmo et al., 2008), Alagoas Stage (Schaller, 1968; Moura, 1987), upper Aptian–lower Albian (Antonietto et al., 2012); Parnaíba Basin, Codó Formation (Krömmelbein and Weber, 1971; Ramos et al., 2006); São Francisco Basin, Quiricó Formation, Lower Cretaceous, Aptian. Africa: Gabon Basin, Gamba Formation; Congo and Cabinda basins, Chela Formation (Grosdidier et al., 1996; Bate, 1999).

Materials.—Four levels from Quiricó creek, São José Farm, Presidente Olegário, Minas Gerais State, southeastern Brazil: MP-2879, five carapaces; MP-2882, two carapaces; MP-2883, 50 carapaces; MP-2885, two carapaces.

Remarks.—Poropat and Colin (2012b) included this species in the genus *Kroemmelbeincypris* based on its outline. However, Tomé et al. (2014) invalidated this genus, justifying that these differences resulted from environmentally induced polymorphism.

https://doi.org/10.1017/jpa.2018.1 Published online by Cambridge University Press

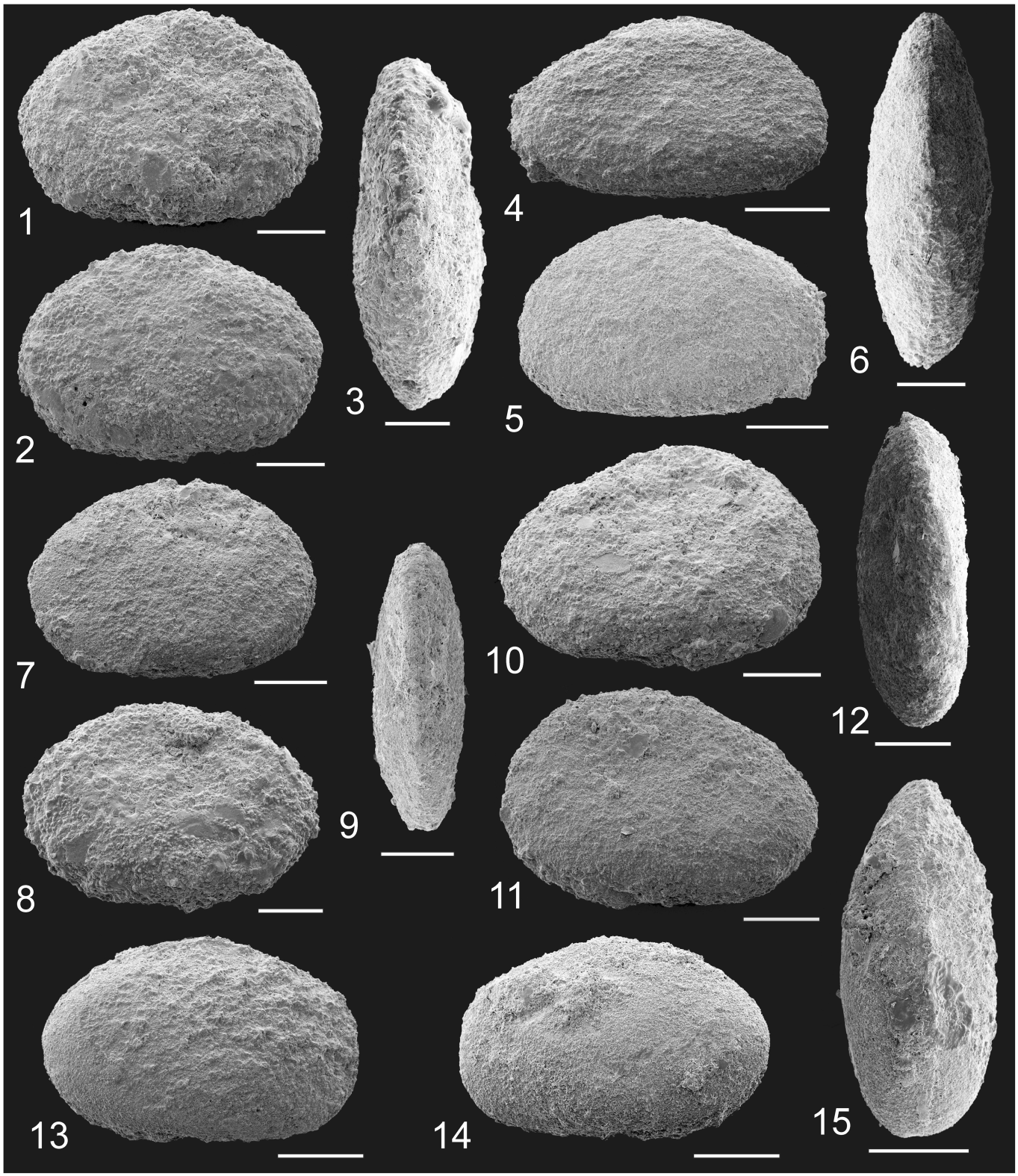


Figure 3. Species of the genus *Harbinia* Tsao, 1959 emend. Hou, 1984 from the outcrop by the São José River, São José Farm, Presidente Olegário municipality, Minas Gerais State, southeastern Brazil. (**1–3**) *Harbinia* aff. *H. angulata* (Krömmelbein and Weber, 1971), adult (CP-855), right lateral view (RLV), left lateral view (LLV), and dorsal view (DV). (**4–6**) *Harbinia symmetrica* (Krömmelbein and Weber, 1971), adult (CP-859), right lateral view (RLV), left lateral view (LLV), and dorsal view (DV). (**7–9**) *Harbinia* aff. *H. salitrensis* (Krömmelbein and Weber, 1971); (**7, 9**) adult (CP-857), right lateral view (RLV), and dorsal view (DV); (**8**) adult (CP-858), left lateral view (LLV). (**10–12**) *Harbinia alta* Antonietto et al., 2012, adult (CP-854), right lateral view (RLV), left lateral view (LLV), and dorsal view (DV). (**13–15**) *Harbinia* aff. *H. crepata* Do Carmo et al., 2013, adult (CP-856), left lateral view (LLV), right lateral view (RLV), and dorsal view (DV). Scale bars are 200 μm.

https://doi.org/10.1017/jpa.2018.1 Published online by Cambridge University Press

Harbinia aff. *H. salitrensis* (Krömmelbein and Weber, 1971)
Figure 3.7–3.9

1971? *Hourcqia angulata salitrensis* Krömmelbein and Weber, p. 81, pl. 6, fig. 26.
1972? *Pattersoncypris angulata salitrensis* (Krömmelbein and Weber); Bate, p. 389, Fig. 11.
2006? *Harbinia salitrensis* (Krömmelbein and Weber); Ramos et al., p. 344, fig. 4Q–T.
2008? *Harbinia salitrensis* (Krömmelbein and Weber); Do Carmo et al., p. 795, fig. 6.8.
2012? *Harbinia salitrensis* (Krömmelbein and Weber); Antonietto et al., p. 662, fig. 4.1–4.10.
2012b? *Pattersoncypris salitrensis* (Krömmelbein and Weber); Poropat and Colin, p. 709, fig. 4.3.
2014? *Pattersoncypris salitrensis* (Krömmelbein and Weber); Tomé et al., p. 165, fig. 10G–I.

Holotype.—A carapace (BfB, type Nr. 7798), from the Santana layers, Pernambuco State, Brazil (Krömmelbein and Weber, 1971).

Occurrence.—Brazil: Araripe Basin, Santana Formation, Romualdo Member, Aptian (Krömmelbein and Weber, 1971; Poropat and Colin, 2012b; Antonietto et al., 2012; Tomé et al., 2014); Grajaú Basin, Codó Formation, Aptian (Do Carmo et al., 2008); São Francisco Basin, Quiricó Formation, Lower Cretaceous, Aptian.

Materials.—Five levels from São José creek, São José Farm, Presidente Olegário, Minas Gerais State, southeast Brazil: MP--2879, 17 carapaces; MP-2882, two carapaces; MP-2883, 25 carapaces; MP-2890, two carapaces; MP-2922, six carapaces.

Remarks.—*Harbinia salitrensis* was redescribed by Antonietto et al. (2012) due to the absence of illustrations and incomplete description in Krömmelbein and Weber (1971), because the holotype was deformed. The individuals herein studied are deformed and with dissolution.

Harbinia alta Antonietto et al., 2012
Figure 3.10–3.12

1989 *Hourcqia angulata angulata* Krömmelbein and Weber; Viana et al., p. 216, fig. 2a–c.
1990 *Hourcqia angulata angulata* Krömmelbein and Weber; Dépêche et al., p. 304, pl. 1, figs. 1, 2.
1990 *Hourcqia angulata angulata* Krömmelbein and Weber; Silva-Telles and Viana, p. 320, pl. 3. Fig. 3.
2006 *Harbinia angulata* (Krömmelbein and Weber); Ramos et al., p. 344, fig. 4E–H.
2006 *Harbinia* sp. Ramos et al., p. 344, fig. 4U–Y.
2012 *Harbinia alta* Antonietto et al., p. 662, fig. 4.11–4.20.
2013 *Harbinia alta* Antonietto et al.; Do Carmo et al., p. 94, fig. 3.5–3.8.

Holotype.—A carapace (CP-584) from the Romualdo Member, Santana Formation, Pernambuco State, Brazil (Antonietto et al., 2012).

Occurrence.—Brazil: Grajaú Basin, Codó Formation, upper Aptian (Ramos et al., 2006); Araripe Basin, Santana Formation, Crato, Ipubi, and Romualdo members, Aptian–Albian (Viana et al., 1989; Silva-Telles and Viana, 1990; Antonietto et al., 2012), *Harbinia* spp. 201–218 Zone, coded as NRT-O11 (Do Carmo et al., 2008), Alagoas Stage (Schaller, 1968; Moura, 1987), upper Aptian–lower Albian (Antonietto et al., 2012); Potiguar Basin, Alagamar Formation, middle–upper Aptian (Do Carmo et al., 2013); São Francisco Basin, Quiricó Formation, Lower Cretaceous, Aptian.

Materials.—Three levels from São José creek, São José Farm, Presidente Olegário, Minas Gerais State, southeastern Brazil: MP-2879, 50 carapaces; MP-2881, four carapaces; MP-2889, 40 carapaces.

Remarks.—Species identified as *Hourcqia angulata angulata* Krömmelbein and Weber, 1971 in Viana et al. (1989), Dépêche et al. (1990), and Silva-Telles and Viana (1990), and *Harbinia angulata* (Krömmelbein and Weber, 1971) identified in Ramos et al. (2006) belong to *Harbinia alta*. They are different from the species described by Krömmelbein and Weber (1971), especially in the height-length ratio and ornamentation. The specimens recovered are either dissolved or poorly preserved, and represented by several ontogenetic instars.

Harbinia aff. *H. crepata* Do Carmo et al., 2013
Figure 3.13–3.15

1990 Gen. indet. sp. aff. 207 Silva-Telles and Viana, p. 326, pl. 2, figs. 1, 3.
2013? *Harbinia crepata* Do Carmo et al., p. 96, fig. 3.9–3.18.

Holotype.—A carapace (MP-O-1579), from the Alagamar Formation, Ceará State, Brazil (Do Carmo et al., 2013).

Occurrence.—Brazil: Araripe Basin, Santana Formation, Crato Member, Aptian (Silva-Telles and Viana, 1990); Potiguar Basin, Alagamar Formation, middle–upper Aptian (Do Carmo et al., 2013); São Francisco Basin, Quiricó Formation, Lower Cretaceous, Aptian.

Materials.—Two intervals from São José creek, São José Farm, Presidente Olegário, Minas Gerais State, southeastern Brazil: MP-2883, 20 carapaces; MP-2889, 35 carapaces.

Remarks.—*Harbinia crepata* Do Carmo et al., 2013 differs from *H. sinuata* (Krömmelbein and Weber, 1971), *H. salitrensis* (Krömmelbein and Weber, 1971), and *H. micropapillosa* (Bate, 1972) in its subtriangular elongated outline and its less-inclined hinge line (Do Carmo et al., 2013). The recovered specimens are better preserved than *Harbinia alta* and *Harbinia* aff. *H. angulata*, however they also show some degree of dissolution.

https://doi.org/10.1017/jpa.2018.1 Published online by Cambridge University Press

Family Cyprididae Baird, 1845
Subfamily Cypridinae Baird, 1845

Genus *Brasacypris* Krömmelbein, 1965b

Type species.—*Brasacypris ovum* Krömmelbein, 1965b.

Diagnosis.—Large carapace, with length ~ 1.2 mm. Oval shape in lateral view. Dorsal margin nearly straight to smoothly convex; ventral margin smoothly convex. Normal overlap. Surface smooth. In dorsal view, greatest width posterior to mid length.

Remarks.—The suprafamiliar classification follows Liebau (2005). Originally, this genus was left in Incertae Family. *Brasacypris* differs from *Cyprinotus* Brady, 1886, another member of the Subfamily Cypridinae, in the oval outline in lateral view and the convex margin (Do Carmo et al., 2004a; Do Carmo et al., 2013). However, *Brasacypris* is placed into the same suprageneric position as *Cyprinotus*. Krömmelbein (1965b) considered the diagnosis of *Brasacypris ovum* as the genus' diagnosis, since it was until then monospecific. The sexual dimorphism was not taken into account as well, in spite of some variation in dorsal view in females and males. The original diagnosis also does not include variations in the carapace outline, mainly in the dorsal margin, considering that it might be nearly straight and the cardinal angles pronounced, although some species do not show these characteristics. The present work proposes a new diagnosis for the genus, emended from Krömmelbein (1965b), assuming that in lateral view, the dorsal margin shows variations, and in dorsal view, the greatest width is posterior to the mid length.

Brasacypris ovum Krömmelbein, 1965b emend.
Figure 4.1–4.6

1965a *Brasacypris ovum* Krömmelbein, p. 213, pl. 15, fig. 19.
2004a *Brasacypris ovum*?; Do Carmo et al., p. 144, fig. 4.4.

Holotype.—A carapace (SMF Xe 5369) from the Itaparica and Candeias formations, Bahia State, Brazil (Krömmelbein, 1965a).

Diagnosis.—Large carapace, with rounded to oval shape in lateral view, and greatest length ventromedianly. Anterior cardinal angle rounded. Posterior cardinal angles slightly rounded and visible only in right lateral view. Left valve larger than right valve, overlapping it at all margins. Smooth surface. Biconvex in dorsal view, with greatest width in the posterior third.

Occurrence.—Brazil: Tucano Basin, Itaparica and Candeias formations, Lower Cretaceous (Krömmelbein, 1965a), Itaparica Formation–Lower Candeias Formation interval (Krömmelbein, 1966), Rio da Serra Stage, Berriasian (Caixeta et al., 1994; Costa et al., 2007); São Francisco Basin, Quiricó Formation, Lower Cretaceous, Valanginian–Aptian.

Description.—Large carapace, rounded to oval in lateral view, with greatest height antero-medianly, and greatest length at mid-height. Left valve larger than right valve, overlapping all the margins of the carapace, more pronounced in the ventral and posterior margins. Dorsal margin smoothly convex, inclined to the posterior end, and ventral margin convex. Anterior cardinal angle curved; posterior cardinal angle smoothly curved, visible only in right lateral view. Anterior margin rounded and broader than the posterior one. Posterior margin sub-rounded, with inconspicuous convexity in the posteroventral region. Surface smooth. Inflated in dorsal view, with greatest width posteriorly to mid-length. Sexual dimorphism present, with males less inflated than females in dorsal view, and more elongated in lateral view.

Materials.—Two levels from São José creek, São José Farm, Presidente Olegário, Minas Gerais State, southeastern Brazil: MP-2895, four carapaces; MP-2960, three carapaces. One level from Quiricó creek, São José Farm, Presidente Olegário, Minas Gerais State, southeastern Brazil: MP-3421, 12 carapaces. Fourteen levels from Tereza Farm, João Pinheiro, Minas Gerais State, southeastern Brazil: MP-3318, five carapaces; MP-3326, 35 carapaces; MP-3327, one carapace; MP-3335, two carapaces; MP-3426, one carapace; MP-3428, one carapace; MP-3429, six carapaces; MP-3431, 22 carapaces; MP-3434, 31 carapaces; MP-3436, four carapaces; MP-3437, 11 carapaces; MP-3438, four carapaces; MP-3442, two carapaces; MP-3443, two carapaces.

Remarks.—The recovered specimens are of two morphotypes: one that is short in lateral view, with the greatest height, and in dorsal view, with the greatest width; the other one is elongated in lateral view, with a smaller height, when compared to the first morphotype, and a smaller width in dorsal view. Considering the occurrence of two morphotypes, the first one is attributed to females, while the second one to males. We provide a new description for the species, as well as a new diagnosis. The specimens attributed to younger instars are in an advanced state of dissolution and/or deformed.

Brasacypris fulfaroi Dias-Brito et al., 2001
Figure 4.7–4.9

1960 Gen. et sp. indet Grekoff, p. 32, pl. 6, figs. 37, 38.
2001 *Brasacypris fulfaroi* Dias-Brito et al., p. 295, pl. 6, figs. 9–14.

Holotype.—A carapace (UNESPλ-BU45) from the Adamantina Formation, São Paulo State, Brazil (Dias-Brito et al., 2001).

Occurrence.—Brazil: Paraná Basin, Bauru Group, Adamantina Formation, Upper Cretaceous (Dias-Brito et al., 2001); São Francisco Basin, Quiricó Formation, Lower Cretaceous, Valanginian–Aptian?

Materials.—One level from Quiricó creek, São José Farm, Presidente Olegário, Minas Gerais State, southeastern Brazil: MP-3421, 26 carapaces; ten levels from Tereza Farm, João Pinheiro, Minas Gerais State, southeastern Brazil: MP-3318, two carapaces; MP-3322, one carapace; MP-3326, 17 carapaces; MP-3333, one carapace; MP-3429, four carapaces; MP-3431, 10 carapaces; MP-3434, two carapaces; MP-3436, one carapace; MP-3442, three carapaces; MP-3443, four carapaces.

https://doi.org/10.1017/jpa.2018.1 Published online by Cambridge University Press

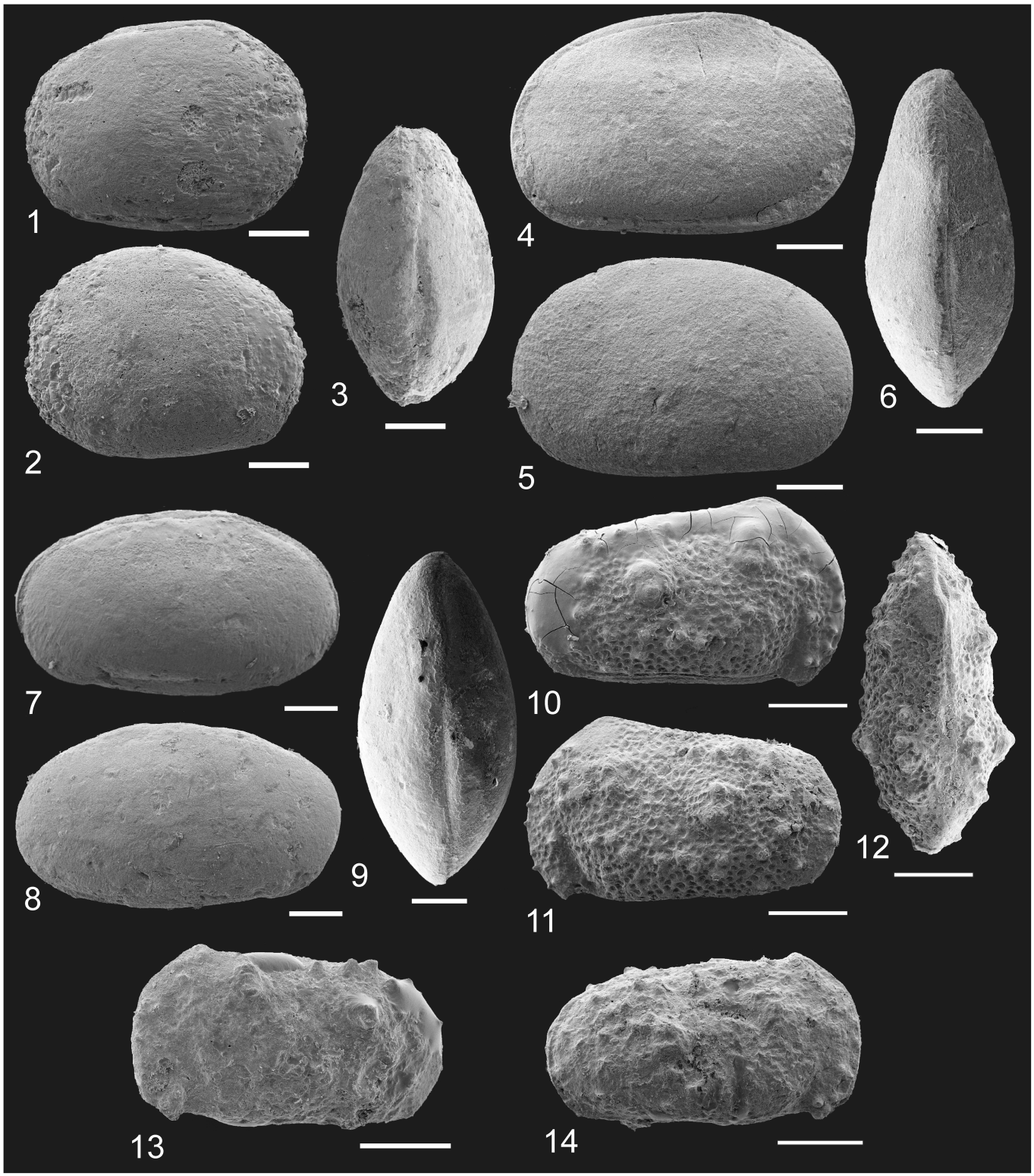


Figure 4. Species of the genus *Brasacypris* Krömmelbein, 1965b from the outcrop on the banks of the São José and Quiricó rivers, São José Farm, Presidente Olegário municipality, and species of the genus *Cypridea* Bosquet, 1852 from the outcrop at Tereza Farm, João Pinheiro municipality, Minas Gerais State, southeastern Brazil. (**1–6**) *Brasacypris ovum* Krömmelbein 1965b emend. (**1–3**) Female adult (CP-861), right lateral view (RLV), left lateral view (LLV), and dorsal view (DV); (**4–6**) male adult (CP-862), right lateral view (RLV), left lateral view (LLV), and dorsal view (DV). (**7–9**) *Brasacypris fulfaroi* Dias-Brito et al., 2001, adult (CP-860), right lateral view (RLV), left lateral view (LLV), and dorsal view (DV). (**10–14**) *Cypridea hystrix* Krömmelbein, 1962 emend. (**10–12**) Female adult (CP-865), right lateral view (RLV), left lateral view (LLV), and dorsal view (DV). (**13, 14**) Male adult (CP-866), left lateral view (LLV) and right lateral view (RLV). Scale bars are 200 μm.

https://doi.org/10.1017/jpa.2018.1 Published online by Cambridge University Press

Remarks.—The recovered specimens are well preserved; however, they are smaller than specimens described by Dias-Brito et al. (2001). It is important to mention, however, that according to the original illustration (pl. 6, figs. 9–14), the holotype length is ~1.683 mm.

Family Cyprideidae Baird, 1845 emend. Martin, 1940
Subfamily Cyprideinae Martin, 1940

Genus *Cypridea* Bosquet, 1852

Type species.—*Cypridea granulosa* Sowerby, 1836 (designated by Sylvester-Bradley, 1949).

Remarks.—The suprafamilial classification follows Liebau (2005), and Sames (2011) for family and other infrafamilial taxa. When Bosquet (1852) proposed the genus, he did not provide a diagnosis, indicating only the ventral beak as the main characteristic. Jones (1885) described the genus in greater detail, and determined a diagnosis based on the ventral beak, notch, and carapace ornamentation. During the following years, several authors (Anderson, 1939; Sylvester-Bradley, 1949; Martin, 1958; Moore and Pitrat, 1961; Van Morkhoven, 1963; Horne and Colin, 2005; Do Carmo et al., 2008; Sames, 2011) proposed diagnoses for the genus, with some variability, as well as several subgenera and subspecies. Sylvester-Bradley (1949), particularly, determined the ventral beak in each valve, as well as the ventral notch, as a distinct diagnostic characteristic. Do Carmo et al. (2008), following Van Morkhoven (1963), included the genus *Hourcqia* Krömmelbein, 1965a as a synonym of *Cypridea*. On the other hand, Sames (2011) followed Moore and Pitrat (1961), where several subgenera are included.

Cypridea hystrix Krömmelbein, 1962 emend.
Figure 4.10–4.14

1962 *Cypridea hystrix* Krömmelbein, p. 507, pl. 55, fig. 18.
1962 *Cypridea hystricoides* Krömmelbein, p. 507, pl. 55, fig. 19.

Holotype.—A carapace (SMF Xe 4173) from the lower Ilha Formation layers, upper portion, Bahia State, Brazil (Krömmelbein, 1962).

Diagnosis.—Medium-size carapace, with trapezoidal shape. Pronounced anterior cardinal angle. Ventral beak and notch well developed. Pronounced nodules, mainly in the ocular region and posterior regions. Smaller nodules throughout the carapace, mainly in the anterior region. Porecanals spread throughout the surface of the carapace.

Occurrence.—Brazil: Recôncavo Basin, Ilhas Formation, Rio da Serra Stage, Lower Cretaceous (Krömmelbein, 1962; Poropat and Colin, 2012a); *Paracypridea brasiliensis* Zone, coded as NRT-O04, with occurrence well marked in the *Paracypridea bicallosa* and *Paracypridea maacki* subzones, coded as NRT-O04.3 and NRT-O04.4, respectively (Viana et al., 1971; Cunha and Moura, 1979; Regali and Viana, 1989), Valanginian (Caixeta et al., 1994); São Francisco Basin, Quiricó Formation, Lower Cretaceous, Valanginian.

Description.—Medium-size carapace, sub-oval to sub-rectangular in lateral view, with greatest height anteriorly and greatest length at mid-height. Left valve larger than right valve, overlapping all the margins of the carapace. Dorsal margin nearly straight, with inconspicuous anterior hump; ventral margin nearly straight, with both ventral beak and notch pronounced. Anterior margin rounded. Posterior margin sub-rounded, slightly smaller than the anterior one. Reticulated ornamentation. Two pronounced nodules in each valve, in posterior to mid-height region. Smaller nodules lined and concentrated on the anterior margin. Smaller nodules scattered throughout the surface. In dorsal view, greatest width posteriorly. Sexual dimorphism present: males longer in lateral view, with lower anterior margin, and narrower compared to the females.

Materials.—Seven intervals from Tereza Farm, João Pinheiro, Minas Gerais State, southeastern Brazil: MP-3323, one carapace; MP-3324, one carapace; MP-3325, one carapace; MP--3326, six carapaces; MP-3428, two carapaces; MP-3434, two carapaces; MP-3437, two carapaces.

Remarks.—*Cypridea hystrix* has an outline and dimensions similar to *Cypridea hystricoides* Krömmelbein, 1962, however in dorsal view, *Cypridea hystrix* is broader. The nodules are similar in both species, as well as the outline and size. These similarities may indicate sexual dimorphism, and that both species are one and the same (i.e., *Cypridea hystrix* would be the female and *C. hystricoides*, the male) (Leite et al., 2016). Krömmelbein (1962) noted that *Cypridea hystricoides* and *Cypridea hystrix* are very similar, and some type of relationship can be established, however their stratigraphical occurrences are different: *Cypridea hystricoides* occurs in the upper layers of the upper portion in Ilhas Formation, while *Cypridea hystrix* occurs in the upper layers of the lower portion in Ilhas Formation, Recôncavo Basin. In the present work, considering the good preservation of the specimens, as well as the presence of narrower and broader individuals, a new description and diagnosis are presented, emended from Krömmelbein (1962), placing *Cypridea hystricoides* as a junior synonym of *Cypridea hystrix*.

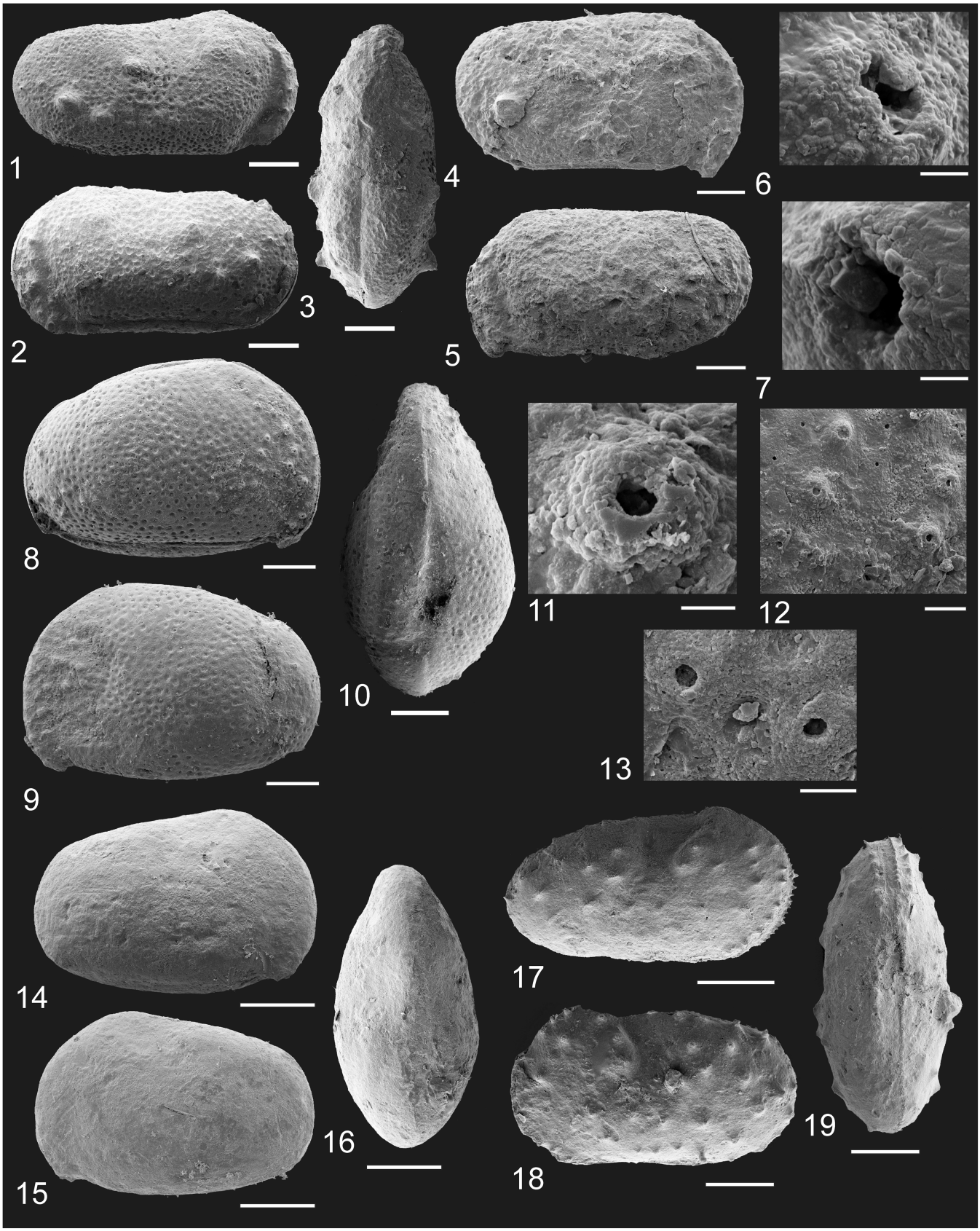
Cypridea conjugata Krömmelbein and Weber, 1971 emend.
Figure 5.1–5.7

1971 *Cypridea conjugata* Krömmelbein and Weber, p. 71, pl. 1, figs. 4, 5.

Holotype.—A left valve (BfB, type Nr. 7772) from the São Sebastião layers, Bahia State, Brazil (Krömmelbein and Weber, 1971).

Diagnosis.—Medium-size carapace. Straight and pronounced beak, exceeding the ventral margin. Reticulated ornamentation all through the surface. Right valve larger than left valve. Surface with or without nodules. When present, nodules are in ocular region, positioned dorsally to medianly. Smaller nodules distributed along the surface.

https://doi.org/10.1017/jpa.2018.1 Published online by Cambridge University Press



https://doi.org/10.1017/jpa.2018.1 Published online by Cambridge University Press

Occurrence.—Brazil: Recôncavo Basin, São Sebastião Formation, Lower Cretaceous (Krömmelbein and Weber, 1971; Poropat and Colin, 2012a), Barremian (Silva et al., 2007). São Francisco basin, Quiricó Formation, Lower Cretaceous, Valanginian.

Description.—Medium-size carapace, sub-rectangular in lateral view, with greatest height anteriorly, and greatest length along mid-height. Right valve larger than left valve, overlapping the anterior, posterior, and ventral margins of the carapace. Dorsal margin nearly straight, with inconspicuous hump anteriorly; ventral margin nearly straight, sub-parallel to the dorsal margin. Anterior margin rounded; posterior margin sub-rounded. Reticulated ornamentation all through the carapace. May exhibit nodules along the surface of the carapace, a smaller number of nodules, or complete absence of them. When present, nodules are in the ocular region, dorsally to medianly, and smaller ones scattered. Normal porecanals present in eye region, rounded. In dorsal view, larger nodules are evident, with greatest width posteriorly to mid-length.

Materials.—Four levels from Tereza Farm, João Pinheiro, Minas Gerais State, southeastern Brazil: MP-3324, two carapaces; MP-3326, four carapaces; MP-3431, one carapace; MP-3434, 25 carapaces.

Remarks.—Due to the presence of specimens with and without nodules, it is necessary to propose a new diagnosis and description to *Cypridea conjugata*. Leite et al. (2016) discussed the similarity between specimens with and without nodules, in outline and in size, as well as valve relation. However, specimens with poorly developed nodules were not recovered. In the present work, such middle-ground specimens are recorded for the first time. Besides the small quantity, they always occur in specific regions of the carapace, and show marked normal porecanals. Do Carmo et al. (1999) suggested that the growth of nodules in *Theriosynoecum kirtlingtonense* Bate, 1965 indicates high salinity, caused by the reinforcement of the excretory system to maintain osmoregulation. In the same way, some porecanals in ostracodes are part of the excretory system, when present in nodule region, indicating that nodules are of phenotypical origin as in *Cyprideis torosa* (Jones, 1850) (Do Carmo et al., 1999). In the present work, considering the good preservation, the presence of individuals with and without nodules, a new description and diagnosis are proposed, emended from Krömmelbein (1962).

Cypridea infima Krömmelbein and Weber, 1971 emend.
Figure 5.8–5.13

1971 *Cypridea infima* Krömmelbein and Weber, p. 71, pl. 1, fig. 3.

Holotype.—A carapace (BfB, type Nr. 7770) from the Candeias layers, lower and middle portions, Bahia State, Brazil (Krömmelbein and Weber, 1971).

Diagnosis.—Very small carapace, with oval outline in lateral view. Reticulated surface, with normal porecanals throughout the carapace. Left valve with prominent angular projection in the posteroventral region.

Occurrence.—Brazil: Recôncavo Basin, Candeias Formation, lower and middle portions, Lower Cretaceous, (Krömmelbein and Weber, 1971; Poropat and Colin, 2012a), Berriasian–Valanginian (Silva et al., 2007); São Francisco Basin, Quiricó Formation, Lower Cretaceous, Valanginian–Hauterivian/Aptian?

Description.—Very small carapace, sub-oval in lateral view, with greatest height antero-medianly, and greatest length in mid-height. Left valve larger than right valve, overlapping all the margins of the carapace, especially the ventral margin. Left valve with prominent angular projection in the posteroventral region. Dorsal margin convex, inclined posteriorly; ventral margin nearly straight to smoothly convex. Pronounced ventral beak and notch without exceeding the ventral margin. Anterior margin rounded. Posterior margin sub-rounded and smaller than the anterior one. Punctate ornamentation. Small nodules present throughout the carapace. Surface covered by very tiny rounded porecanals, also present in nodule region. In dorsal view, greatest width posteriorly.

Materials.—Nine levels from Tereza Farm, João Pinheiro, Minas Gerais State, southeastern Brazil: MP-3318, two carapaces; MP-3322, three carapaces; MP-3427, five carapaces; MP-3428, five carapaces; MP-3431, three carapaces; MP-3433, two carapaces; MP-3434, three carapaces; MP-3444, two carapaces.

Remarks.—Krömmelbein and Weber (1971) described only the porecanals through the carapace. In the present work, the good preservation of material allowed observation of a punctate ornamentation, and that the porecanals are present along the carapace and in the small nodules. For this reason, a new description and diagnosis are herein presented, emended from Krömmelbein and Weber (1971).

Cypridea jequiensis Krömmelbein and Weber, 1971
Figure 5.14–5.16

1971 *Cypridea jequiensis* Krömmelbein and Weber, p. 75, pl. 3, fig. 11.

Figure 5. Species of the genus *Cypridea* Bosquet, 1852 and *Neuquenocypris* Musacchio, 1973, from the outcrop at Tereza Farm, João Pinheiro municipality, Minas Gerais State, southeastern Brazil. (**1–7**) *Cypridea conjugata* Krömmelbein and Weber, 1971 emend. (**1–3**) Adult with nodules (CP-863), right lateral view (RLV), left lateral view (LLV), and dorsal view (DV); (**4, 5**) adult without nodules (CP-864), right lateral view (RLV) and left lateral view (LLV); (**6, 7**) adult with nodules (CP-863), porecanals details. (**8–13**) *Cypridea infima* Krömmelbein and Weber, 1971 emend. (**8–10**) Adult (CP-867), right lateral view (RLV), left lateral view (LLV), and dorsal view (DV); (**11–13**) adult (CP-867), detail of the porecanals in nodule region and detail of porecanals on the surface of the carapace. (**14–16**) *Cypridea jequiensis* Krömmelbein and Weber, 1971, adult (CP-868), right lateral view (RLV), left lateral view (LLV), and dorsal view (DV). (**17–19**) *Neuquenocypris* (*Protoneuquenocypris*) *antiqua* Musacchio and Simeoni, 1991, adult (CP-869), right lateral view (RLV), left lateral view (LLV), and dorsal view (DV). (**1–5, 14–19**) Scale bars are 200 μm; (**6, 7**) scale bars are 5 μm; (**8–10**) scale bars are 100 μm; (**11–13**) scale bars are 20 μm.

https://doi.org/10.1017/jpa.2018.1 Published online by Cambridge University Press

Holotype.—A carapace (BfB, type Nr. 7781) from the Post-Bahia Series, Jiquiá layers, Alagoas State, Brazil (Krömmelbein and Weber, 1971).

Occurrence.—Brazil: Sergipe-Alagoas Basin, Jiquiá Formation, Post-Bahia Series, Lower Cretaceous (Krömmelbein and Weber, 1971; Poropat and Colin, 2012a; Antonietto, 2015), Penedo Formation?, Barremian?–Aptian, *Cypridea faveolata* Subzone, coded as BRT-O09.3, upper portion of *Petrobrasia diversicostata* Zone, coded as NRT-O09 (Moura, 1987; Rangel et al., 1994); São Francisco Basin, Quiricó Formation, Lower Cretaceous, Valanginian.

Materials.—Four levels from Tereza Farm, João Pinheiro, Minas Gerais State, southeastern Brazil: MP-3318, four carapaces; MP-3324, 15 carapaces; MP-3325, one carapace; MP-3327, four carapaces.

Remarks.—After extensive revision of the *Cypridea* Bosquet, 1852 species occurring in Brazil, the species found in the Quiricó Formation are attributed to *Cypridea jequiensis* Krömmelbein and Weber, 1971 due to the smooth surface and trapezoidal shape. However, it must be noticed that in the São Francisco Basin, these occurrences are of Valanginian age.

Family Ilyocyprididae Kaufmann, 1900

Genus *Neuquenocypris* Musacchio, 1973

Type species.—*Ilyocypris* (*Neuquenocypris*) *calfucurensis* Musacchio, 1973

Remarks.—The classification follows Liebau (2005). Originally, *Neuquenocypris* was described as a subgenus of *Ilyocypris* Brady and Norman, 1889. Posteriorly, *Neuquenocypris* was repositioned to genus level, and three subgenera were described: *Neuquenocypris* (*Neuquenocypris*), *Neuquenocypris* (*Protoneuquenocypris*), and *Neuquenocypris* (*Alleniella*) (Musacchio and Simeoni, 1991). Species of *Neuquenocypris* usually have the right valve larger than the left one, smooth anterodorsal sulcus and nodules, and carapace well ornamented with spines, nodules, pustules, papillae, and denticles (Musacchio and Simeoni, 1991).

Neuquenocypris (*Protoneuquenocypris*) *antiqua* Musacchio and Simeoni, 1991
Figure 5.17–5.19

1991 *Neuquenocypris* (*Protoneuquenocypris*) *antiqua* Musacchio and Simeoni, p. 368, figs. 9, 11, 14–17.

2011 *Neuquenocypris antiqua* (Musacchio and Simeoni); Ballent et al., p. 545, figs. 3.1, 3.6.

2017 *Neuquenocypris* (*Protoneuquenocypris*) *antiqua* Musacchio and Simeoni; Carignano et al., 2017, p. 211, fig. 5A-B.

Holotype.—A carapace (BA-G-CM 91/1) from Pozo D-129 Formation, Cerro Chenques, in Chubut Province, Argentina (Musacchio and Simeoni, 1991).

Occurrence.—Argentina: Pozo D-129 Formation in Cerro Chenques, Chubut Province, Barremian–Aptian (Musacchio and Simeoni, 1991; Carignano et al., 2017); Austral Basin, Piedra Clavada Formation, Santa Cruz, lower to upper Albian (Ballent et al., 2011). Brazil: São Francisco Basin, Quiricó Formation, Lower Cretaceous, Valanginian.

Materials.—Three intervals from Tereza Farm, João Pinheiro, Minas Gerais State, southeastern Brazil: MP-3318, three carapaces; MP-3429, three carapaces; MP-3434, two carapaces.

Remarks.—All the characteristics of *Neuquenocypris antiqua* recognized from the Quiricó Formation correspond to those described in the type material (Musacchio and Simeoni, 1991; Ballent et al., 2011). There is no mention of a taxonomic reassignment for *Neuquenocypris* (*Protoneuquenocypris*) *antiqua* in Ballent et al. (2011); however, the species is mentioned as *Neuquenocypris antiqua*. Due to the absence of this reassignment, the species is herein maintained as *Neuquenocypris* (*Protoneuquenocypris*) *antiqua*.

Suborder Darwinulocopina Sohn, 1988
Superfamily Darwinuloidea Brady and Norman, 1889
Family Darwinulidae Brady and Norman, 1889

Genus *Penthesilenula* Rossetti and Martens, 1998

Type species.—*Darwinula incae* Delachaux, 1928 (Rossetti and Martens, 1998).

Remarks.—The classification follows Liebau (2005). A taxonomic review of *Darwinulidae* from Recent and Holocene resulted in the description of three new genera (Rossetti and Martens, 1998). The genus *Penthesilenula* Rossetti and Martens, 1998 differs from both *Darwinula* Brady and Robertson, 1870 and *Alicenula* Rossetti and Martens, 1998 on the square shape of the valves in lateral view, and the presence of internal teeth on the left valve. The height-length ratio shows that the greatest height corresponds to almost half of the length, giving a less elongate and more sub-quadrate outline compared to other darwinulids.

Penthesilenula martinsi (Silva, 1978) emend. Do Carmo et al., 2004b
Figure 6.1–6.3

1978 *Darwinula martinsi* Silva, p. 1031, pl. 1, figs 1, 2.

2004a *Darwinula* sp. 4 Do Carmo et al., p. 144, fig. 4.13–4.18.

2004b *Darwinula martinsi* Silva; Do Carmo et al., p. 155, fig. 3.21–3.27.

Holotype.—A carapace (Number 42) from the Santana Formation, Crato municipality, Ceará State, Brazil (Silva, 1978).

Occurrence.—Brazil: Araripe Basin, Santana Formation, Crato Member, and the base of Ipubi Member (Silva, 1978; Silva-Telles and Viana, 1990; Colin and Dépêche, 1997), Aptian (Coimbra et al., 2002); Potiguar Basin, Alagamar Formation, middle to upper Aptian (Do Carmo et al., 2013); São Francisco Basin, Quiricó Formation, Lower Cretaceous, Valanginian.

https://doi.org/10.1017/jpa.2018.1 Published online by Cambridge University Press

Description.—Small carapace, sub-squarish in lateral view, with height increasing evenly to the posterior margin, and greatest length at mid height. Left valve larger than right valve, overlapping all the margins of the carapace, with a well-marked overlap at the ventral region. Dorsal margin nearly straight to smoothly curvilinear, and ventral margin with a small concavity at the end of the first third of the carapace. Anterior margin sub-rounded and lower than the posterior margin. Posterior margin rounded. Smooth surface. In dorsal view, greatest width at the posterior end.

Materials.—Three levels from Tereza Farm, João Pinheiro, Minas Gerais State, southeastern Brazil: MP-3318, 50 carapaces; MP-3428, 34 carapaces; MP-3436, 13 carapaces.

Remarks.—Considering that the type material for *Darwinula martinsi* Silva, 1978 is misplaced, this species was redescribed by Do Carmo et al. (2004b) based on neotypes from the type locality. Tomé et al. (2014) considered this species as a junior synonym for *Alicenula leguminella* (Forbes in Lyell, 1855). However, the material illustrated by Tomé et al. (2014) is different from the material designated as neotype for *Darwinula martinsi* by Do Carmo et al. (2004b), due to the carapace contour, height/length ratio, and other diagnostic characteristics. Additionally, the specimens illustrated by Tomé et al. (2014) are different from *Alicenula leguminella* due to the anterior margin, which is slimmer, the posterior margin, which is wider, and the marked inclination of the ventral margin to the anterior margin. Therefore, when reviewing the neotypes that once were identified as *Darwinula martinsi*, it was verified that the species can be transferred to *Penthesilenula martinsi* (Silva, 1978). This reassignment to the genus *Penthesilenula* is based on the sub-quadrate shape in lateral view, a diagnostic characteristic that distinguishes it from *Darwinula* Brady and Robertson in Jones, 1885 emend. Pinto and Kotzian, 1961, associated with the height/length ratio ~0.5 (Ballent and Díaz, 2012). Such characteristics are observed in *Darwinula martinsi*, justifying the reassignment to *Penthesilenula martinsi*.

Penthesilenula pintoi new species
Figure 6.4–6.6

Holotype.—A carapace (CP-871), length 0.680 mm, height 0.310 mm, width 0.240 mm. Type level 23.57 m from the base of the outcrop, Quiricó Formation, Areado Group, São Francisco Basin, Lower Cretaceous, Aptian, from the banks of the São José River, São José Farm, Presidente Olegário municipality, Minas Gerais State, Brazil.

Paratypes.—Research Collection, Museum of Geosciences, Institute of Geosciences, Brasília, Brazil: carapace CP-875, length 0.730 mm, height 0.320 mm, width 0.320 mm; carapace CP-894, length 0.680 mm, height 0.300 mm, width 0.250 mm; carapace CP-895, length 0.680 mm, height 0.310 mm, width 0.220 mm; carapace CP-896, length 0.680 mm, height 0.300 mm, width 0.210 mm; carapace CP-897, length 0.660 mm, height 0.290 mm, width 0.200 mm.

Diagnosis.—Small carapace, oblong. Left valve larger than right valve. Dorsal margin smoothly curved, with well-marked inclination to the anterior margin. Ventral margin nearly straight with small concavity by the end of the first third. Anterior margin sub-rounded and low. Posterior margin rounded and broad.

Occurrence.—Brazil: Tereza Farm, João Pinheiro municipality and São José Farm, on the banks of the São José and Quiricó rivers, Minas Gerais State, southeastern Brazil, Quiricó Formation, Areado Group, São Francisco Basin, Lower Cretaceous, Valanginian to Aptian.

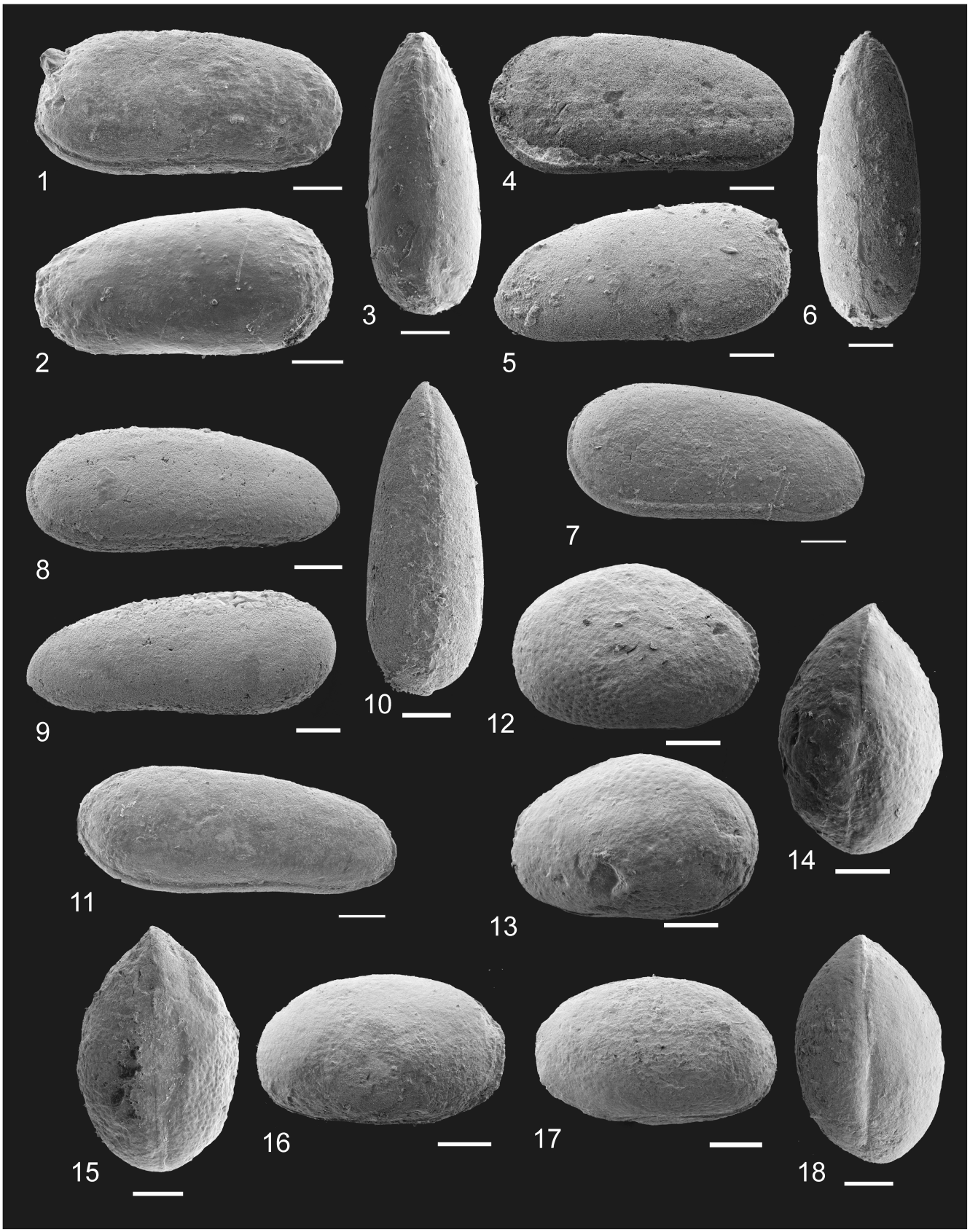
Description.—Small carapace, sub-oval to sub-quadrate in lateral view, with height increasing evenly to the posterior margin, and greatest length at mid-height. Left valve larger than right valve, overlapping all the margins of the carapace. Dorsal margin nearly straight, inclined to the anterior margin, and ventral margin nearly straight, with small convexity anteriorly. Anterior margin sub-rounded and low. Posterior margin rounded and broader than the anterior one. Smooth surface. In dorsal view, width increasing evenly towards the posterior end.

Etymology.—In honor of Professor Ricardo Lourenço Pinto, Institute of Geosciences of the University of Brasília, for rich discussions on the Darwinulidae Family.

Materials.—Three levels from the São José creek, São José Farm, Presidente Olegário, Minas Gerais State, southeastern Brazil: MP-2884, four carapaces; MP-2895, 30 carapaces; MP-2960, 100 carapaces; one level from Quiricó creek, São José Farm, Presidente Olegário, Minas Gerais State, southeastern Brazil: MP-3421, three carapaces; 22 levels from Tereza Farm, João Pinheiro, Minas Gerais State, southeastern Brazil: MP-3322, one carapace; MP-3323, four carapaces; MP-3325, three carapaces; MP-3326, 200 carapaces; MP-3327, 100 carapaces; MP-3328, two carapaces; MP-3333, one carapace; MP-3335, seven carapaces; MP-3340, 14 carapaces; MP-3427, three carapaces; MP-3428, 40 carapaces; MP-3429, 40 carapaces; MP-3431, 80 carapaces; MP-3433, six carapaces; MP-3434, 200 carapaces; MP-3436, 29 carapaces; MP-3437, 60 carapaces; MP-3438, two carapaces; MP-3439, 17 carapaces; MP-3442, 40 carapaces; MP-3443, 18 carapaces; MP-3448, two carapaces.

Remarks.—This species is more elongated and has the anterior margin broader than *Penthesilenula martinsi* (Silva, 1978). The taxonomic revision by Rossetti and Martens (1998) resulted in the description of three new genera, and a new diagnosis for *Darwinula*, whose right valve overlaps the left one, through the entire margin, except in the hinge region. Additionally, in lateral view, *Darwinula* is more elongated, with greatest height in the posterior quarter; posterior margin more broadly rounded than the anterior one; anterior margin narrower and slightly curved towards the ventral margin; ventral margin nearly straight, and dorsal margin curved. The genus *Penthesilenula* is sub-rectangular in lateral view, as discussed above. The closed carapaces herein studied did not allow observation of internal characteristics. However, due to its oval to sub-rectangular

https://doi.org/10.1017/jpa.2018.1 Published online by Cambridge University Press



https://doi.org/10.1017/jpa.2018.1 Published online by Cambridge University Press

shape in lateral view, and a more broadly rounded anterior margin, the specimens are attributed to *Penthesilenula*. Additionally, the recovered specimens are similar to *Penthesilenula sarytirmenensis* (Sharapova) sensu Mandelstam, 1947, identified in Argentina by Ballent and Díaz (2012), mainly in the inclination of the dorsal margin towards the anterior, the outline of the anterior, and ventral margins. However, there is a difference in size, because *Penthesilenula sarytirmenensis* has a very large carapace (1.080 mm length). This species was described from the Middle Jurassic in Mangishlaka Peninsula, former USSR (Mandelstam, 1947) and in several localities in China (Li, 1985; Zheng, 1995) and India (Govidan, 1975), as well as in the Early Jurassic of Argentina (Ballent and Díaz, 2012).

Genus *Alicenula* Rossetti and Martens, 1998 emend.

Type species.—*Darwinula serricaudata* Klie, 1935 (Rossetti and Martens, 1998).

Diagnosis.—Carapace small and elongated, with internal teeth at left valve, one anteroventral tooth near the interior margin, and one posterior caudal tooth. Adont hinge. Right valve overlapping the left valve, or left valve overlapping the right valve. Dorsal margin evenly inclined, not rounded or straight, in part of its length. Central muscle scar situated at the anterior region in adult specimens. Brood chamber wide and externally visible.

Remarks.—The classification follows Liebau (2005). Although the genus *Alicenula* was not described with the presence of teeth on the internal surface of the left valve, it was later demonstrated that, in fact, there is one anteroventral tooth near the interior margin and one tooth at the posterior caudal internal surface of the left valve (Martens et al., 2003; Ballent and Díaz, 2012). Therefore, we propose a new diagnosis for the genus, including teeth on the internal surface of the left valve. *Alicenula* and *Darwinula* are elongated in lateral view, however the species differ in size and internal characteristics, considering that *Alicenula* has internal teeth on the left valve.

Alicenula longiformis new species
Figure 6.7–6.9

Holotype.—A carapace (CP-872), length 0.690 mm, height 0.260 mm, width 0.250 mm. Type level 7.35 m from the base of the outcrop, Quiricó Formation, Areado Group, São Francisco Basin, Lower Cretaceous, Aptian, from the Tereza Farm, João Pinheiro municipality, Minas Gerais State, Brazil.

Paratypes.—Research Collection, Museum of Geosciences, Institute of Geosciences, Brasília, Brazil: carapace CP-876, length 0.710 mm, height 0.270 mm, width 0.230 mm; carapace CP-898, length 0.750 mm, height 0.280 mm, width 0.270 mm; carapace CP-899, length 0.640 mm, height 0.260 mm, width 0.250 mm; carapace CP-900, length 0.700 mm, height 0.270 mm, width 0.230 mm; carapace CP-889, length 0.710 mm, height 0.280 mm, width 0.240 mm.

Diagnosis.—Small carapace, oblong and elongated. Left valve larger than right valve. Dorsal and ventral margins nearly straight and sub-parallel. Anterior margin narrow and sub-rounded. Posterior margin sub-rounded.

Occurrence.—Brazil: Tereza Farm, João Pinheiro municipality and São José Farm, on the banks of the Quiricó River, Minas Gerais State, southeast Brazil, Quiricó Formation, Areado Group, São Francisco Basin, Lower Cretaceous, Valanginian to Berriasian?.

Description.—Small carapace, suboval elongated in lateral view, with height increasing evenly towards the posterior margin, and greatest length at mid-height. Left valve larger than right valve, overlapping all the margins of the carapace. Dorsal and ventral margins nearly straight and sub-parallel. Anterior margin sub-rounded, narrow, and low. Posterior margin rounded and broader than anterior margin. Smooth surface. In dorsal view, width increasing evenly towards the posterior end.

Etymology.—From the Latin *logum forma*, which means "with elongated form."

Materials.—One level from Quiricó creek, São José Farm, Minas Gerais State, southeastern Brazil: MP-3421, two carapaces; nine levels from Tereza Farm, João Pinheiro, Minas Gerais State, southeastern Brazil: MP-3318, 14 carapaces; MP-3327, 100 carapaces; MP-3428, 23 carapaces; MP-3431, 23 carapaces; MP 3433, six carapaces; MP-3434, 40 carapaces; MP-3439, seven carapaces; MP-3443, nine carapaces; MP-3448, two carapaces.

Remarks.—This species differs from *Penthesilenula martinsi* (Silva, 1978) in its more elongated shape, and anterior margin more narrowly rounded. The genus *Alicenula*, in external view, is very similar to *Darwinula*, due to its elongated shape, and the overlap of the left margin over the right one, or right margin over the left margin. Internally, the genus *Alicenula* has teeth in the left valve. Although the studied specimens are closed carapaces, the valve overlap and the elongated shape, with a more narrowly rounded anterior margin, allowed their identification as *Alicenula*.

Suborder Cytherocopina Gründel, 1967
Superfamily Limnocytheroidea Liebau, 2005

Figure 6. Species of the genus *Penthesilenula* Rossetti and Martens, 1998, *Alicenula* Rossetti and Martens, 1998, and *Timiriasevia* Mandelstam, 1947 from outcrops on the banks of the São José and Quiricó rivers, São José Farm, Presidente Olegário municipality, and the outcrop at Tereza Farm, João Pinheiro municipality, Minas Gerais State, southeastern Brazil. (**1–3**) *Penthesilenula martinsi* (Silva, 1978) emend. Do Carmo et al., 2004b, adult (CP-870), right lateral view (RLV), left lateral view (LLV), and dorsal view (DV). (**4–7**) *Penthesilenula pintoi* n. sp. (**4–6**) Holotype, carapace (CP-871), right lateral view (RLV), left lateral view (LLV), and dorsal view (DV); (**7**) paratype, carapace (CP-875), right lateral view (RLV). (**8–11**) *Alicenula longiformis* n. sp. (**8–10**) Holotype, carapace (CP-872), right lateral view (RLV), left lateral view (LLV), and dorsal view (DV); (**11**) paratype, carapace (CP-876), right lateral view (RLV). (**12–18**) *Timiriasevia sanfranciscanensis* n. sp. (**12–15**) Holotype female adult (CP-873), right lateral view (RLV), left lateral view (LLV), dorsal view (DV), and ventral view (VV); (**16–18**) paratype male adult (CP-874), left lateral view (LLV), right lateral view (RLV), and dorsal view (DV). (**1–11**) Scale bars are 100 μm; (**12–18**) scale bars are 200 μm.

https://doi.org/10.1017/jpa.2018.1 Published online by Cambridge University Press

Family Limnocytheridae Klie, 1938
Subfamily Timiriaseviinae Mandelstam, 1947

Genus *Timiriasevia* Mandelstam, 1947

Type species.—*Timiriasevia epidermiformis* Mandelstam, 1947.

Remarks.—The supra-subfamilial classification follows Liebau (2005). Sames (2009, 2011) is followed for subfamily and other categories. The genus *Timiriasevia* Mandelstam, 1947, common in Cretaceous limnic deposits worldwide, has not been documented or recorded in Cretaceous sediments from the United States yet, however, it is found in Upper Jurassic sediments. This absence might result from misidentifications as *Metacypris* Brady and Robertson, 1870, due to the morphological similarities of young specimens of both genera (Sames, 2009, 2011). The genera *Timiriasevia* Mandelstam, 1947, *Theriosynoecum* Branson, 1936, and *Metacypris* Brady and Robertson, 1870 are members of the subfamily Timiriaseviinae, due to the presence of simple porecanals, and an evident egg pouch in females. The nonsulcate genera *Gomphocythere* Sars, 1924 and *Timiriasevia* Mandelstam, 1947, as well as some species of the monosulcate *Metacypris* Brady and Robertson, 1870, usually have some indication of sulcus, such as a wide and shallow depression, causing a lateral constriction anteriorly in dorsal view. Females of *Timiriasevia* and *Metacypris* differ in dorsal view. *Metacypris* has a cordiform shape, while *Timiriasevia* is elongated oval to piriform with a small lateral constriction anteriorly. Moreover, *Metacypris* has a weak sulcus, which is absent in *Timiriasevia.*

Timiriasevia sanfranciscanensis new species
Figure 6.10–6.16

Holotype.—A female carapace (CP-843), length 1.070 mm, height 0.650 mm, width 0.740 mm. Type level at 90 cm from the base of the Quiricó Formation, Areado Group, São Francisco Basin, Lower Cretaceous, Valanginian, João Pinheiro municipality, Minas Gerais State, Brazil.

Paratype.—Research Collection, Museum of Geosciences, Institute of Geosciences, Brasília, Brazil, male carapace CP-874, length 1.010 mm, height 0.600 mm, width 0.600 mm.

Diagnosis.—Oval carapace, rounded in lateral view. Left valve slightly larger than right valve, with overlap of the left valve over the right one, mainly in the anterior margin, and overlap of right over left valve in the posterior margin. Ventral margin straight. Surface covered by punctuations, more evident near the margin. In dorsal view, highly inflated and piriform.

Occurrence.—Tereza Farm, João Pinheiro municipality, Minas Gerais State, southeast Brazil, Quiricó Formation, Areado Group, São Francisco Basin, Lower Cretaceous, Valanginian.

Description.—Medium to large carapace, oval to rounded in lateral view, with greatest height at mid length, and greatest length ventral-medianly. Left valve slightly larger than right one, overlapping it mainly in the anterior margin; right valve overlapping the left one in the posterior margin. Dorsal margin convex, inclined anteriorly; ventral margin straight, with a smooth inclination towards the anterior margin. Anterior margin sub-rounded. Posterior margin broadly rounded. Surface poorly punctuated, with ornamentation more evident near the margins, mainly in the ventral region. In dorsal view, strongly inflated and piriform, with subtle constriction anteriorly. In ventral view, broad and straight. Sexual dimorphism present: males with less-convex dorsal margin compared to the females, and narrower in dorsal view.

Etymology.—After the name of the basin wherein it was described.

Materials.—Four levels from Tereza Farm, João Pinheiro, Minas Gerais State, southeast Brazil: MP-3318, three carapaces; MP-3322, three carapaces; MP-3427, seven carapaces; MP-3433, one carapace.

Remarks.—The genus *Timiriasevia*, according to Sames (2009, 2011), has a rounded oblong shape in lateral view; in dorsal view, the females are piriform, with slight constriction anteriorly; there are no sulci or nodules; the ornamentation can be concentrically striated, sometimes combined with punctuation. Additionally, the recovered specimens have the ventral margin flattened and wide, in accordance to the Limnocytheridae. *Timiriasevia sanfranciscana* n. sp. is the first species of the genus *Timiriasevia* formally described in the Cretaceous deposits in Brazil.

Discussion

The species studied in the present work are important for future research on the geographic and stratigraphic distribution, as well as the correlation between Argentinian, African, and Brazilian continental and marginal basins. Aptian deposits of the marginal basins are important for oil exploration, since source rocks and/or reservoirs are present in them. Additionally, the presence of species from the Valanginian, as well as from the Barremian–Aptian interval, can lead to a new age interpretation for the Quiricó Formation and, therefore, to a new interpretation for continental Cretaceous in Brazil.

Of the 16 species identified for the Lower Cretaceous from the São Francisco Basin, 13 occur in other basins from Brazil, Argentina, and Africa: *Harbinia alta*, *Harbinia angulata*, *Harbinia crepata*, *Harbinia salitrensis*, *Harbinia symmetrica*, *Brasacypris fulfaroi*, *Brasacypris ovum*, *Cypridea conjugata*, *Cypridea hystrix*, *Cypridea infima*, *Cypridea jequiensis*, *Neuquenocypris* (*Protoneuquenocypris*) *antiqua*, and *Penthesilenula martinsi*.

In the Grajaú Basin: *H. alta* (upper Aptian) and *H. salitrensis* (Aptian) (Ramos et al., 2006; Do Carmo et al., 2008).

In the Araripe Basin: *H. alta* and *H. salitrensis*, both from the upper Aptian (Krömmelbein and Weber, 1971; Viana et al., 1989; Silva-Telles and Viana, 1990; Do Carmo et al., 2008; Poropat and Colin, 2012a; Antonietto et al., 2012; Tomé et al., 2014); *H. symmetrica* (Aptian) (Coimbra et al., 2002); *H. crepata* (Aptian) (Silva-Telles and Viana, 1990); *P. martinsi* (Aptian); *H. angulata* (Aptian) (Poropat and Colin, 2012a).

https://doi.org/10.1017/jpa.2018.1 Published online by Cambridge University Press

In the Potiguar Basin: *H. alta*, *H. crepata* and *P. martinsi*, all from the middle–upper Aptian (Do Carmo et al., 2013). In the Jatobá Basin: *H. angulata* (upper Aptian) (Tomé et al., 2014). In the Sergipe-Alagoas Basin: *H. angulata* (upper Aptian) (Krömmelbein and Weber, 1971); *C. jequiensis* (Barremian) (Krömmelbein and Weber, 1971; Poropat and Colin, 2012a; Antonietto, 2015).

In the Recôncavo Basin: *C. conjugata* (Barremian) (Krömmelbein and Weber, 1971; Poropat and Colin, 2012a); *C. hystrix* (Berriasian to Valanginian) (Krömmelbein, 1962; Poropat and Colin, 2012a); *C. infima* (Berriasian) (Krömmelbein and Weber, 1971; Poropat and Colin, 2012a).

In the Cedro Basin: *H. angulata* (upper Aptian) (Tomé, 2007). In the Paraná Basin: *B. fulfaroi* (Upper Cretaceous) (Dias-Brito et al., 2001). In the Tucano Basin: *B. ovum* (Berriasian) (Krömmelbein, 1965b; Poropat and Colin, 2012b).

In Argentina, Pozo D-129 Formation in Cerro Chenques: *N.* (*Protoneuquenocypris*) *antiqua*, Aptian (Musacchio and Simeoni, 1991) and Barremian-Aptian (Carignano et al., 2017). In the Austral Basin: *N.* (*Protoneuquenocypris*) *antiqua* (lower to upper Albian) (Ballent et al., 2011).

In Africa, Gabon Basin and Congo and Cabinda Basin: *H. symmetrica* (Barremian) (Grosdidier et al., 1996; Bate, 1999).

Additionally, the Zone *Harbinia* spp. 201–218, coded as NRT-011 (Do Carmo et al., 2008) was defined from the Araripe Basin, and comprises the Alagoas Floor (Schaller, 1968; Moura, 1987), upper Aptian–lower Albian (Antonietto et al., 2012), where the genus *Harbinia* plays an important role in dating Brazilian basins, both continental and marginal (Antonietto et al., 2012). The *Paracypridea brasiliensis* Zone, coded as NRT-O04, was defined from the Recôncavo Basin, where the occurrence of *Cypridea hystrix* is well marked in the *Paracypridea bicallosa* (NRT-O04.3) and *Paracypridea maacki* (NRT-O04.4) subzones (Viana et al., 1971; Cunha and Moura, 1979; Regali and Viana, 1989), of Valanginian age (Caixeta et al., 1994).

The Tereza Farm outcrop has 11 species, which is the most diversified. Ostracode assemblages occur with up to eight species at the richest levels, and when this abundance lessens, ostracode assemblages occur with up to four species per level. The São José creek outcrop has seven species, where ostracode assemblages occur with up to four species at the richest levels, and with up to two species at most levels. Additionally, the abundance of specimens is less, when compared to Tereza Farm. The Quiricó creek outcrop has four species, all of them in one single level.

Only *B. ovum* and *P. pintoi* n. sp. occur at the Tereza Farm and São José and Quiricó creeks. At the São José creek outcrop there is a predominance of *Harbinia* species, which occur in assemblage with *B. ovum* and *P. pintoi* n. sp. only at the middle portion of the sequence. At the Quiricó creek outcrop, *B. ovum* and *P. pintoi* n. sp. occur in assemblage with *A. longiformis* n. sp. and *B. fulfaroi*.

At the Tereza Farm outcrop, *C. hystrix* occurrance determines a chronostratigraphic attribution of Valanginian age for the basal portion of the sequence. The species that are in assemblage with *C. hystrix*, and therefore are of Valanginian age, are: *P. martinsi*, *C. conjugata*, *C. jequiensis*, *N.* (*Protoneuquenocypris*) *antiqua*, and *T. sanfranciscanensis* n. sp. The middle portion of the sequence is of Hauterivian age, possibly up to Aptian age. The species that are either at the basal portion and the middle portion, and of Valanginian–Aptian age are: *P. pintoi* n. sp., *A. longiformis* n. sp., *B. fulfaroi*, *B. ovum*, and *C. infima*.

At São José creek, the occurrences of *Harbinia* indicate a chronostratigraphic attribution of Aptian age for the top of the basal portion and the middle and upper portions. Therefore, *B. ovum* and *P. pintoi* n. sp. occur from Valanginian to Aptian.

At Quiricó creek, there is the level of papyraceous shale where the fish fossil *Dastilbe moraesi* occurs, along with leaf impressions. Associated with this level, according to Lima (1979) and Arai et al. (1995), there is the *Transitoripollis crisopolensis* Palynozone, coded as P-230, indicating a Barremian age. The ostracode assemblage of *P. pintoi* n. sp., *A. longiformis* n. sp., *B. ovum*, and *B. fulfaroi* occurs below the papyraceous shale level, attributed possibly to the Valanginian–Barremian interval.

Conclusions

This study analyzed 168 samples from three outcrops encompassing the São Francisco Basin, in the State of Minas Gerais, southeastern Brazil. Sixteen species were identified, of which five are unprecedented for the Quiricó Formation, and consequently for the Cretaceous of the São Francisco Basin. There is also the identification of the genus *Timiriasevia*, unprecedented in the paleontological record of Brazil, as well as the description of three new species: *Penthesilenula pintoi* n. sp., *Alicenula longiformis* n. sp., and *Timiriasevia sanfranciscanensis* n. sp. Additionally, considering the recovery of well-preserved material, new descriptions and emended diagnoses are proposed for four species: *Brasacypris ovum*, *Cypridea conjugata*, *Cypridea hystrix*, and *Cypridea infima*. The genus *Alicenula* is given a new diagnosis, due to the bibliographic confirmation of the presence of internal teeth on the left valve, which is a characteristic not present in the original diagnosis.

The species *Brasacypris fulfaroi*, *Penthesilenula martinsi*, *Cypridea conjugata*, *Cypridea jequiensis*, and *Neuquenocypris* (*Protoneuquenocypris*) *antiqua* represent herein their oldest record. The stratigraphic distribution is: *B. fulfaroi*, Valanginian to Upper Cretaceous; *P. martinsi*, Valanginian to Albian; *C. conjugata*, Valanginian to Barremian; *C. jequiensis*, Valanginian to Barremian-Aptian; *N.* (*Protoneuquenocypris*) *antiqua*, Valanginian to Albian. The species *Brasacypris ovum* presents the most recent record, with stratigraphic distribution from Berriasian to Aptian. *Timiriasevia sanfranciscanensis* n. sp., due to its occurrence exclusively at the Tereza Farm, is only attributed to the Valanginian. *Penthesilenula pintoi* n. sp. has a stratigraphic distribution from Valanginian to Aptian, and *Alicenula longiformis* n. sp. ranges from Valanginian to possibly Barremian. *Harbinia* species, recovered only at the São José creek outcrop, are of Aptian age. Therefore, the Quiricó Formation becomes attributed to the Valanginian–Aptian interval.

The new data on ostracode taxonomy presented herein improve the current understanding of distribution of limnic ostracodes from the Cretaceous of Brazil, Argentina, and Africa because it is possible to develop a correlation study with 13 other basins: Grajaú, Araripe, Potiguar, Jatobá, Sergipe-Alagoas, Recôncavo, Cedro, Paraná, and Tucano, from Brazil; Gabon, Congo, and Cabinda basins in Africa; and the Austral Basin, in Argentina. From this study, it is possible to infer that the Quiricó Formation began its deposition during the Valanginian.

https://doi.org/10.1017/jpa.2018.1 Published online by Cambridge University Press

Acknowledgments

The authors are grateful to "Fundação de Apoio à Pesquisa do Distrito Federal" FapDF (Research Support Foundation of the Federal District) for providing the financial aid for all the fieldwork expeditions (Notice 03/2013—Spontaneous Demand), as well as the Master's Degree scholarship (Notice ProMD/UnB/FAPDF—Master's and Doctoral Scholarship 2015/2016). Special thanks to Professor R. Lourenço Pinto for his great contribution during the revision on darwinulids, and especially for his contribution during the initial phase of revision. We also thank the reviewers, for the great intellectual contribution to the present work.

References

Anderson, F.W., 1939, Purbeck and Wealden Ostracoda: Annals and Magazine of Natural History, v. 11, p. 291–319.

Antonietto, L.S., 2015, Taxonomia, paleoecologia e bioestratigrafia de ostracodes da Formação Riachuelo, bacia de Sergipe-Alagoas, Nordeste do Brasil [Ph.D. thesis]: Brasília, Universidade de Brasília, 91 p.

Antonietto, L.S., Gobbo, S.R., Do Carmo, D.A., Assine, M.L., Fernandes, M.A. M.C.C., and Lima e Silva, J.E., 2012, Taxonomy, ontogeny and paleoecology of two species of *Harbinia* Tsao, 1959 (Crustacea, Ostracoda) from the Santana Formation, Lower Cretaceous, Northeastern Brazil: Journal of Paleontology, v. 86, p. 659–668.

Arai, M., Dino, R., Milhomen, P.S., and Sgarbi, G.N.C., 1995, Micropaleontologia da Formação Areado, Cretáceo da Bacia Sanfranciscana: Estudos de Ostracodes e Palinologia: 14th Congresso Brasileiro de Paleontologia, p. 2–3.

Baird, W., 1845, Arrangement of the British Entomostraca, with a list of species, particularly noticing those which have as yet been discovered within the bounds of the Club: History Berwickshire Naturalists' Club, v. 2, p. 145–158.

Ballent, S., Carignano, A.P., Iglesias, A., and Poiré, D.G., 2011, Microfósiles calcáreos no marinos y semillas de la Formación Piedra Clavada (Albiano) en su área tipo, provincia de Santa Cruz, Argentina: Ameghiniana, v. 48, p. 541–555. doi: 10.5710/AMGH.v48i4(419).

Ballent, S.C., and Díaz, A.R., 2012, Contribution to the taxonomy, distribution and paleoecology of the early representatives of Penthesilenula Rossetti & Martens, 1998 (Crustacea, Ostracoda, Darwinulidae) from Argentina, with the description of a new species: Hydrobiologia, v. 688, p. 125–138. doi: 10.1007/s10750-011-0658-8.

Bate, R.H., 1965, Freshwater ostracods from the Bathonian of Oxfordshire: Palaeontology, v. 8, p. 749–759.

Bate, R.H., 1972, Phosphatized ostracods with appendages from the Lower Cretaceous of Brazil: Palaeontology, v. 15, p. 379–393. doi: 10.1038/230397a0.

Bate, R.H., 1999, Non-marine ostracod assemblages of the Pre-Salt rift basins of West Africa and their role in sequence stratigraphy: Geological Society, London, Special Publications, v. 153, p. 283–292. doi: 10.1144/GSL.SP.1999.153.01.17.

Bittencourt, J.S., Kuchenbecker, M., Vasconcelos, A.G., and Meyer, K.E.B., 2015, O registro fóssil das coberturas sedimentares do Cráton Do São Francisco Em Minas Gerais: Revista Geonomos, v. 23, p. 39 doi: 10.18285/geonomos.v23i2.710.

Bosquet, J., 1852, Description des entomostracés fossiles des Terrains Tertiaires de la France et de la Belgique: Mémoires Couronnés et Mémoires des Savants Étrangers, v. 24, p. 1–142.

Brady, G.S., 1886, Notes on Entomostraca collected by Mr. A. Haly in Ceylon: The Journal of the Linnean Society, Zoology, v. 19, p. 293–316.

Brady, G.S., and Norman, A.M., 1889, A monograph of the marine and freshwater Ostracoda of the North-Western Europe; Section 1—Podocopa: Journal of the Royal Dublin Society, v. 4, p. 63–270.

Brady, G.S., and Robertson, D., 1870, The Ostracoda and Foraminifera of tidal rivers: with analysis and descriptions of the Foraminifera: The Annals and Magazine of Natural History, v. 6, p. 1–33.

Branson, C.C., 1936, New name for a Morrison ostracode genus: Journal of Paleontology, v. 10, p. 323.

Caixeta, J.M., Bueno, G. V., Magnavita, L.P., and Feijó, F.J., 1994, Bacias do Recôncavo, Tucano e Jatobá: Boletim de Geociências da Petrobras, v. 8, p. 167–172.

Campos, J.E.G., and Dardenne, M.A., 1997, Estratigrafia e sedimentação da Bacia Sanfranciscana: uma revisão: Revista Brasileira de Geociências, v. 27, p. 269–282.

Campos, J.E.G., and Do Carmo, D.A., 2005, Bacia Sanfranciscana: Phoenix, v. 73, p. 1–5.

Carignano, A.P., Paredes, J.M., Olazábal, S.X., and Valle, M.N., 2017, Ostracoda (Crustacea) from the Pozo D-129 Formation (upper Barremian?–Aptian), Golfo San Jorge basin, Patagonia, Argentina: taxonomic descriptions, palaeoenvironments and palaeogeographical implications: Cretaceous Research, v. 78, p. 206–220. doi: 10.1016/j.cretres.2017.06.015.

Carvalho, M.S.S., and Maisey, J.G., 2008, New occurrence of *Mawsonia* (Sarcopterygii: Actinistia) from the Early Cretaceous of the Sanfranciscana Basin, Minas Gerais, southeastern Brazil: Geological Society, London, Special Publications, v. 295, p. 109–144. doi: 10.1144/SP295.8.

Cohen, A.C., Martin, J.W., and Kornicker, L.S., 1998, Homology of Holocene ostracode biramous appendages with those of other crustaceans: the protopod, epipod, exopod and endopod: Lethaia, v. 31, p. 251–265. doi: 10.1111/j.1502-3931.1998.tb00514.x.

Coimbra, J.C., Arai, M., and Carreño, A.L., 2002, Biostratigraphy of Lower Cretaceous microfossils from the Araripe basin, northeastern Brazil: Geobios, v. 35, p. 687–698. doi: 10.1016/S0016-6995(02)00082-7.

Colin, J.-P., and Dépêche, F., 1997, Faunes d'ostracodes lacustres des bassins intra-cratoniques d'âge albo-aptien en Afrique de l'Ouest (Cameroun, Tchad) et au Brésil: considérations d'ordre paléoécologique et paléobiogéographique: Africa Geoscience Review, v. 4, p. 431–450.

Costa, I.P., Milhomem, P. da S., Bueno, G.V., Lima e Silva, H.S.R., and Kosin, M.D., 2007, Sub-bacia de Tucano Norte e Bacia de Jatobá: Boletim de Geociências da Petrobras, v. 15, p. 445–454.

Cunha, M.d.C., and Moura, J., 1979, Espécies novas de Ostracodes nao-marinhos da série do Recôncavo: paleontologia e bioestratifrafia: Boletim Técnico da PETROBRÁS, v. 22, p. 87–100.

Davis, S.P., and Martill, D.M., 1999, The gonorynchiform fish *Dastilbe* from the Lower Cretaceous of Brazil: Palaeontology, v. 42, p. 715–740. doi: 10.1111/1475-4983.00094.

Delachaux, T., 1928, Faune invertébrée d´eau douce des hauts plateaux du Pérou: Bulletin de la Société Neuchateloise des Sciences Naturalles, v. 1, p. 45–77.

Dépêche, F., Bérthou, P.Y., and Campos, D.A., 1990, Quelques observations sur les faunes d´ostracodes du Cretácé du Bassin d´Araripe (NE du Brésil): 1st Simpósio sobre a Bacia do Araripe e Bacias Interiores do Nordeste, Crato, p. 293–308.

Dias-Brito, D., Musacchio, E.A., Castro, J.C., Maranhão, M.S.A.S., Suárez, J. M., and Rodrigues, R., 2001, Grupo Bauru: uma unidade continental do Cretáceo no Brasil—concepções baseadas em dados micropaleontológicos, isótopos e estratigráficos: Revue Paléobiologique, v. 20, p. 245–304.

Do Carmo, D.A., Whatley, R.C., and Timberlake, S., 1999, Variable noding and palaeoecology of a Middle Jurassic limnocytherid ostracod: implications for modem brackish water taxa: Palaeogeography, Palaeoclimatology, Palaeoecology, v. 148, p. 23–35. doi: 10.1016/S0031-0182(98)00173-4.

Do Carmo, D.A., Tomassi, H.Z., and Oliveira, S.B.S.G., 2004a, Taxonomia e distribuição estratigráfica dos ostracodes da Formação Quiricó, Grupo Areado (Cretáceo inferior), bacia Sanfranciscana, Brasil: Revista Brasileira de Paleontologia, v. 7, p. 139–149. doi: 10.4072/rbp.2004.2.06.

Do Carmo, D.A., Rafael, R.M., Vilhena, R.M., and Tomassi, H.Z., 2004b, Redescrição de *Theriosynoecum silvai* e *Darwinula martinsi*, Membro Crato (Formação Santana), Cretáceo Inferior, bacia do Araripe, NE, Brasil: Revista Brasileira de Paleontologia, v. 7, p. 151–158.

Do Carmo, D.A., Whatley, R., Queiroz Neto, J.V., and Coimbra, J.C., 2008, On the validity of two Lower Cretaceous non-marine ostracode genera: biostratigraphic and paleogeographic implications: Journal of Paleontology, v. 82, p. 790–799.

Do Carmo, D.A., Coimbra, J.C., Whatley, R.C., Antonietto, L.S., and De Paiva Citon, R.T., 2013, Taxonomy of Limnic Ostracoda (Crustacea) from the Alagamar Formation, Middle–Upper Aptian, Potiguar Basin, Northeastern Brazil: Journal of Paleontology, v. 87, p. 91–104. doi: 10.1666/11-108R.1.

Govidan, A., 1975, Jurassic freshwater ostracods from the Kota Limestone of India: Palaeontology, v. 18, p. 207–216.

Grekoff, N., 1960, Ostracodes du Bassin du Congo. II. Crétacé: Annales du Musée Royal du Congo Belge, v. 35, p. 1–70.

Grosdidier, E., Braccini, E., Dupont, G., and Moron, J.-M., 1996, Biozonation du Crétacé Inférieur non marin des bassins du Gabon et du Congo: Géologie de l' Afrique et de l' Atlantique Sud: Bulletin Recherches Exploration-Production Elf Aquitaine, Mémoire 16: Angers, Elf Aquitaine, p. 67–82.

Gründel, J., 1967, Zur Großgliederung der Ordnung Podocopida G.W. Müller, 1894 (Ostracoda): Neues Jahrbuch für Geologie und Paläontologie, Monatshefte, v. 1967, p. 321–332.

Horne, D.J., and Colin, J.-P., 2005, The affinities of the ostracod genus *Cypridea* Bosquet, 1852, and its allies, with consideration of implications for the phylogeny of nonmarine cypridoidean ostracods: Revue de Micropaléontologie, v. 48, p. 25–35. doi: 10.1016/j.revmic.2004.12.003.

Horne, D.J., Cohen, A., and Martens, K., 2002, Taxonomy, morphology and biology of Quaternary and living Ostracoda, *in* Holmes, J.A., and Chivas, A. The Ostracoda: Applications in Quaternary Research: Washington, American Geophysical Union, p. 5–36. doi: 10.1029/131GM02.

Hou, Y., 1984, Problems concerning the classification of the genera *Harbinia*, *Sinocypris*, *Quadracypris* and *Nanxiongium* (Ostracoda): Nanjing Institute of Geology and Palaeontology, Academia Sinica Micropaleontology, v. 9, p. 17–34.

Hou, Y.T., Gōu, Y.X., and Chén, D.Q., 2002, Zhōngguó jiè xíng lèi huàshí—dì yī juàn 1—Cypridacea hé Darwinulidacea: Pequim, Science Press, 1090 p.

Jones, T.R., 1850, Description of the Entomostraca of the Pleistocene beds of Newbury, Copford, Clacton and Grays: Annals and Magazine of Natural History, v. 6, p. 25–28.

Jones, T.R., 1885, On the Ostracoda of the Purbeck Formation; with notes on the Wealden species: Quarterly Journal of the Geological Society, v. 41, p. 311–353. doi: 10.1144/GSL.JGS.1885.041.01-04.31.

Jones, T.R., 1901, On some Carboniferous shale from Siberia: Geological Magazine, v. 8, p. 435.

Kaufmann, A., 1900, Cypriden und Darwinuliden der Schweiz: Revue Suisse de Zoologie, v. 8, p. 209–423.

Kesling, R.V., 1951, Terminology of ostracod carapaces: Contributions from the Museum of Paleontology—University of Michigan, v. 9, p. 93–171.

Klie, W., 1935, Ostracoda aus dem tropischen Westafrica: Archiv für Hydrobiologie, v. 28, p. 35–68.

Klie, W., 1938, Krebstiere oder Crustacea—III: Ostracoda, Muschelkrebse: Jena, Verlag von Gustav Fischer, 230 p.

Krömmelbein, K., 1962, Zur Taxionomie und Biochronologie stratigraphisch wichtiger Ostracoden-Arten aus der oberjurassich?—unterkretazischen Bahia-Serie (Wealden-Fazies) NE-Brasiliens: Senckenbergiana Lethaea, v. 43, p. 437–527.

Krömmelbein, K., 1965a, Neue, für Vergleiche mit West-Afrika wichtige Ostracoden-Arten der brasilianischen Bahia-Serie (Ober-Jura?/Unter-Kreide in Wealden-Fazies): Senckenbergiana Lethaea, v. 46a, p. 177–213.

Krömmelbein, K., 1965b, Ostracoden aus der nicht-marinen Unter-Kreide ("Westafrikanischer Wealden") des Congo-Küstenbeckens: Meyniana, v. 15, p. 59–74.

Krömmelbein, K., 1966, On "Gondwana Wealden" Ostracoda from N.E. Brazil and West Africa: Proceedings of the Second West African Micropaleontological Colloquium, Ibadan, p. 113–119.

Krömmelbein, K., and Weber, R., 1971, Ostrakoden des "Nordoste-Brasilianischen Wealdean": Geologisches Jahrbuch, v. 115, p. 1–93.

Latreille, P.A., 1802, Histoire Naturelle, Generale et Particulière, des Crustacés et des Insectes: Paris, F. Dufart, 837 p.

Leite, A.M., Do Carmo, D.A., and Antonietto, L.S., 2016, Taxonomy of *Cypridea* Bosquet 1852 (Crustacea, Ostracoda) from Quiricó Formation, Lower Cretaceous from São Francisco Basin, State of Minas Gerais, Brazil: new relative dating and remarks on nodding, *in* 35th International Geological Congress, Cape Town, Paper number 4875, 2 p. [https://www.americangeosciences.org/sites/default/files/igc/4875.pdf].

Li, Z.W., 1985, Middle Jurassic ostraods from the Longjiagou Formation of Gahai, Gansu: Acta Micropaleontologica Sinica, v. 2, p. 257–279.

Liebau, A., 2005, A revised classification of the higher taxa of the Ostracoda (Crustacea): Hydrobiologia, v. 538, p. 115–137. doi: 10.1007/s10750-004-4943-7.

Lima, M.R.de, 1979, Palinologia dos calcarios laminados da Formação Areado, Cretáceo de Minas Gerais, *in* Atas do 2nd Simpósio Regional de Geologia, Rio Claro: Sociedade Brasileira de Geologia, v. 1, p. 203–216.

Lyell, C., 1855, Manual of Elementary Geology, 5th Edition., London, John Murray, 655 p.

Mandelstam, M.I., 1947, Ostracoda from the Middle Jurassic deposits of the Mangyshlak Peninsula, *in* Microfauna of the oil fields of the Caucasus, Emba, and Central Asia: Leningrad, Gostoptekhizdat, p. 239–259.

Martens, K., Rossetti, G., and Horne, D.J., 2003, How ancient are ancient asexuals? Proceedings of the Royal Society of London, B, v. 270, p. 723–729. doi: 10.1098/rspb.2002.2270.

Martin, V.G.P.R., 1940, Ostracoden des norddeutschen Purbeck und Wealden: Senckenbergiana, v. 22, p. 275–361.

Martin, V.G.P.R., 1958, Über die systematische Stellung der Gattung *Cypridea* Bosquet (Ostracoda), nebst Beschreibung der Wealden-Basis-Ostracode *C. buxtorfi* n. sp.: Neues Jahrbuch für Geologie und Paläontologie, Monatshefte, v. 1958, p. 312–320.

Mawson, J., and Woodward, A.S., 1907, On the Cretaceous Formation of Bahia (Brazil) and on vertebrate fossils collected therein: Quarterly Journal of the Geological Society, v. 63, p. 128–139.

Milhomem, P.da S., Viviers, M.C., and Galm, P.C., 2001, Os fósseis da bacia de Sergipe- Alagoas: Phoenix, v. 28, p. 3–5. [http://phoenix.org.br/Phoenix28_Abr01.htm].

Moore, R.C., and Pitrat, C.W., eds., 1961, Treatise on Invertebrate Paleontology, Part Q [Arthropoda 3 Crustacea Ostracoda]: Boulder, CO and Lawrence, KS, Geological Society of America and University of Kansas Press, 464 p.

Moura, J.A., 1987, Biocronoestratigrafica da sequencia não marinha do Cretáceo Inferior da Bacia de Campos, Brasil: ostracodes, *in* Anais do 10th Congresso Brasileiro de Paleontologia, p. 717–732.

Musacchio, E.A., 1973, Charophytas y ostracodos no marinos del Grupo Neuquen (Cretacio Superior) en algunos afloramentos de las provincias de Rio Negro y Neuquen, Republica Argentina: Revista del Museo de La Plata, v. 8, p. 1–39.

Musacchio, E.A., 1990, Non-marine Cretaceous ostracods from Argentina and their palaeobiogeographical relationships, *in* Whatley, R.C., and Maybury, C., eds., Ostracoda and Global Events: London, Chapmann and Hall, p. 557–569.

Musacchio, E.A., and Simeoni, M., 1991, Taxonomy of some Cretaceous non-marine ostracods of palaeobiogeographical interest: Neues Jahrbuch für Geologie und Paläeontologie. Abhandlungen, v. 180, p. 349–389.

Pinto, I.D., and Kotzian, S.B., 1961, New ostracods of the Family Darwinulidae and the variations in their muscle scars: Boletim do Instituto de Ciências Naturais, v. 11, p. 5–54.

Poropat, S.F., and Colin, J.-P., 2012a, Early Cretaceous ostracod biostratigraphy of eastern Brazil and western Africa: an overview: Gondwana Research, v. 22, p. 772–798. doi: 10.1016/j.gr.2012.06.002.

Poropat, S.F., and Colin, J.-P., 2012b, Reassessment of the Early Cretaceous non-marine ostracod genera *Hourcqia* Krömmelbein, 1965 and *Pattersoncypris* Bate, 1972 with the description of a new genus, *Kroemmelbeincypris*: Journal of Paleontology, v. 86, p. 700–720.

Ramos, M.I., Rossetti, D.de F., and Paz, J.D.S., 2006, Caracterização e significado paleoambiental da fauna de ostracodes da Formação Codó (Neoaptiano), leste da bacia de Grajaú, MA, Brasil: Revista Brasileira de Paleontologia, v. 9, p. 339–348. doi: 10.4072/rbp.2006.3.09.

Rangel, H.D., Esteves, F.R., Feijó, F.J., and Martins, F.A.L., 1994, Bacia de Campos: Boletim de Geociências da Petrobrás, v. 8, p. 203–217.

Regali, M.S.P., and Viana, C.F., 1989, Sedimentos do Neojurássico–Eocretáceo do Brasil: idade e correlação com a Escala Internacional: Rio de Janeiro, Petrobrás/Sedes, 95 p.

Rossetti, G., and Martens, K., 1998, Taxonomic revision of the Recent and Holocene representatives of the Family Darwinulidae (Crustacea, Ostracoda), with a description of three new genera: Bulletin de L'Institut Royal Des Sciences Naturelles de Belgique, v. 68, p. 55–110.

Sames, B., 2009, Taxonomy and systematics of non-marine Late Jurassic and Early Cretaceous ostracods: their phylogeny and application to biostratigraphy with emphasis on the Early Cretaceous of the North American Western Interior foreland basin [Ph.D. thesis]: Berlin, Freie Universität Berlin, 365 p. [http://www.diss.fu-berlin.de/diss/servlets/MCRFileNodeServlet/FUDISS_derivate_000000008354/Sames_B_2010_Dissertation_Onlineversion.pdf?hosts=.].

Sames, B., 2011, Early Cretaceous *Cypridea* Bosquet 1852 in North America and Europe: Micropaleontology, v. 57, p. 345–431.

Sars, G.O., 1866, Oversigt af Norges marine Ostracoder: Christiania Videnskaba-Selskabs Forhandlinger, v. 7, p. 1–130.

Sars, G.O., 1924, The fresh-water Entomostraca of the Cape Province (Union of South Africa). Part 2. Ostracoda: Annals of the South African Museum, v. 20, p. 105–193.

Schaller, H., 1968, Revisão estratigráfica da bacia de Sergipe/Alagoas: Boletim Técnico da Petrobrás, v. 12, p. 21–86.

Scorza, E.P., and Silva-Santos, R.S., 1955, Ocorrências de folhelho fossilífero cretácio no município de Presidente Olegácio: Minas Gerais, Boletim DNPM/DGM, p. 1–27.

Silva, M.D., 1978, Ostracodes da Formação Santana (Cretáceo Inferior—Grupo Araripe) Nordeste do Brasil 3: nova espécie do gênero *Darwinula* Brady & Robertson, 1885: Anais do 30th Congresso Brasileiro de Geologia, v. 2, p. 1028–1031.

Silva, O.B.d., Caixeta, J.M., Milhomem, P.d.S., and Kosin, M.D., 2007, Bacia do Recôncavo, *in* Bacias Sedimentares Brasileiras—Cartas Estratigráficas, p. 423–432.

Silva-Telles, A.C. Jr., and Viana, M.S.S., 1990, Paleoecologia dos ostrácodes da Formação Santana (bacia do Araripe): um estudo ontogenético de populações: 1st Simpósio sobre a bacia do, Araripe e bacias interiores do Nordeste, Crato, Proceedings, p. 309–328.

Sohn, I.G., 1988, Darwinulocopina (Crustacea: Podocopa), a new suborder proposed for nonmarime Paleozoic to Holocene Ostracoda: Proceedings of the Biological Society of Washington, v. 101, p. 817–824.

Sowerby, J.d.C., 1836, Appendix A, descriptive notes respecting the shells figured in plates 11 to 23, *in* Fitton, W.H., ed., Observations on some of the strata between the Chalk and the Oxford Oolite in the South-East of England: Transactions of the Geological Society of London, v. 2, p. 103–390.

Sylvester-Bradley, P.C., 1949, The ostracod genus *Cypridea* and the zones of the Upper and Middle Purbeckian: Proceedings of the Geologists' Association, v. 60, p. 125–153. doi: 10.1016/S0016-7878(49)80003-4.

Tomé, M.E.T.R., 2007, Taxonomia e paleoecologia de ostracodes do Aptiano, bacia de Cedro, Estado de Pernambuco, NE-Brasil: implicações paleoambientais e bioestratigráficas [Masters thesis]: Recife, Universidade Federal de Pernambuco, 138 p.

Tomé, M.E.T.R., Lima Filho, M.F., and Neumann, V.H.M.L., 2014, Taxonomic studies of non-marine ostracods in the Lower Cretaceous (Aptian–lower Albian) of post-rift sequence from Jatobá and Araripe basins (Northeast Brazil): stratigraphic implications: Cretaceous Research, v. 48, p. 153–176. doi: 10.1016/j.cretres.2013.12.007.

Tsao, L.P., 1959, *Harbinia* Tsao, 1959, *in* Nechayeva, M.A. et al., eds., Ostracodes of Lower chalk deposit of valley Sunlyao: Monographs of the Institute of Geology, Ministry of Geology, People's Republic of China, Series B (Stratigraphy and Palaeontology), v. 1, p. 48–49.

Van Morkhoven, F.P.C.M., 1963, Post-Palaeozoic Ostracoda: Their Morphology, Taxonomy, and Economic Use—Volume 2, Generic Descriptions: Amsterdam, Elsevier, 478 p.

Viana, C.F., Gama Junior, E.G., Simões, I.A., Moura, J.A., Fonseca, J.R., and Alves, R.J., 1971, Revisão estratigráfica da bacia Recôncavo/Tucano: Boletim Técnico da Petrobrás, v. 14, p. 157–192.

Viana, M.S.S., Brito, P.M., and Silva-Telles, A.C. Jr., 1989, Paleontologia de uma camada de folhelhos pirobetuminosos do Membro Romualdo: Formação Santana, na mina Pedra Branca, Município de Nova Olinda, Ceará, *in* Anais do 11th Congresso Brasileiro de Paleontologia, Curitiba, p. 207–217.

Zalán, P.V., and Silva, P.C.R., 2007, Bacia do São Francisco: Boletim de Geociencias da Petrobrás, v. 15, p. 561–571.

Zheng, S., 1995, Non marine Triassic and Jurassic ostracods from Tarim Basin: Acta Paleontologica Sinica, v. 34, p. 729–730.

Accepted 3 January 2018