



WHAT, IF ANYTHING, IS *CYPRIDEIS MULTIDENTATA* HARTMANN, 1955 (OSTRACODA: CRUSTACEA)?

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ABSTRACT – The species *Cyprideis riograndensis* Pinto & Ornellas is considered by some authors a junior synonym to *Cyprideis multidentata* Hartmann. A restudy of the type-series of the former, as well as the analysis of living and fossil specimens from the northern Rio Grande do Sul coastal plain, however, demonstrated significant morphological differences between both species. This study sustains the validity of *C. riograndensis* and the necessity of reevaluating *C. multidentata*.

Keywords: Brazil, curatorship, *Cyprideis riograndensis*, paleontological species concept, systematics.

RESUMO – A espécie *Cyprideis riograndensis* Pinto & Ornellas é considerada por alguns autores como sinônimo júnior de *Cyprideis multidentata* Hartmann. Entretanto, o reestudo de sua série-tipo e de espécimes viventes e fósseis provenientes da porção norte da Planície Costeira do Rio Grande do Sul, demonstrou significativas diferenças morfológicas entre ambas as espécies. Este estudo propõe a validade de *C. riograndensis* bem como a necessidade de revisão da espécie *C. multidentata*.

Palavras-chave: Brasil, curadoria, *Cyprideis riograndensis*, conceito paleontológico de espécie, sistemática.

INTRODUCTION

The cytherideid genus *Cyprideis* Jones, 1857 spans in age from the upper Oligocene to the recent and is a typical inhabitant of mixohaline environments, with pandemic occurrences (Sandberg, 1964; Malz & Triebel, 1970). Several species may exhibit environmentally-influenced variations of carapace morphology as expressed in the size, punctuation, thickness, and shape of normal porecanals (van den Bold, 1976; Boomer *et al.*, 2017; Frenzel *et al.*, 2017). Nodulation, yet not observed in all species of the genus, is common in some species, such as *C. torosa* (Jones, 1850) (Vesper, 1975; Keyser & Aladin, 2004; Keyser, 2005; Meyer *et al.*, 2017) and in the oldest known species of the genus, *C. traisensis* Malz & Triebel, 1970. Research in the Solimões Formation (Solimões Basin, Brazil) has shown that this taxon is crucial

for reconstructing Late Miocene Amazonian environments (Linhares *et al.*, 2011, 2017; Gross *et al.*, 2013, 2014; Linhares & Ramos, 2022; Santos & Ramos, 2023; Sousa & Ramos, 2023).

In Neogene and Quaternary sediments of the Rio Grande do Sul coastal plain (RSCP), the study of the genus *Cyprideis* begun in the 1960s with Pinto & Ornellas (1965), who proposed *C. riograndensis* Pinto & Ornellas, 1965, based on living specimens from the Tramandaí-Armazém Lagoon. Later, Sanguinetti *et al.* (1992), studying post-Miocene sections of the Pelotas Basin, described the following new species: *C. maxipunctata*, *C. mostardensis*, *C. posteroinflata* and *C. sparsopunctata*. Besides these papers, occurrences of *Cyprideis* in the RSCP are presented, *inter alia*, by Ornellas & Würdig (1983), Würdig (1988), Albertoni & Würdig (1996), Würdig *et al.* (1998), Campos *et al.* (2021), and Bergue *et al.* (2022).

One of the main issues concerning the systematics of *Cyprideis* in southern Brazil is the status of the species *C. riograndensis*, which is considered by some authors as a junior synonym to *C. multidentata* Hartmann, 1955 (see “Concluding remarks in this paper”). This taxonomic note discusses this subject based on a bibliographic review, reexamination of collections and type-material, as well as analysis of new samples.

MATERIAL AND METHODS

This work is based mainly on the restudy of fossil material examined by Campos *et al.* (2021) and Bergue *et al.* (2022), as well as sediment samples from the Quadros Lake (Capão da Canoa municipality) (Figure 1). Living specimens from the Tramandaí-Armazém Lagoon (Tramandaí and Imbé municipalities) were collected using either an Eckman sampler (in deeper areas) or a plastic syringe (at the margins). Females were chosen among individuals with eggs and A-8 to A-7 instars inside the carapaces to ensure their adulthood. All living specimens are registered at the *Sistema Nacional de Gestão do Patrimônio Genético e Conhecimento Tradicional Associado* (SisGen nº A64C134).

Several records ascribed either to *Cyprideis multidentata* or *C. riograndensis* which have not been figured by the authors and are not mentioned in the synonymies herein proposed, being the following: Bertels-Psotka & Laprida (1998a,b), Würdig *et al.* (1998), Laprida (2001), Martínez (2005), Fontana (2005), Cusminsky *et al.* (2006), Coimbra *et al.* (2007). All figured specimens except ZMH K-28433 are housed at the Museu de Paleontologia Irajá Damiani Pinto, Universidade Federal do Rio Grande do Sul, Brazil, to which the abbreviation MP-O refers to. **Morphological abbreviations:** C=carapace, LV=left valve, RV=right valve.

SYSTEMATIC PALEONTOLOGY

Order PODOCOPIDA Sars, 1866
Superfamily CYTHEROIDEA Baird, 1850
Family CYTHERIDEIDAE Sars, 1925

Cyprideis Jones, 1857

Type-species. *Candona torosa* Jones, 1850.

Cyprideis multidentata Hartmann, 1955
(Figure 2A–L)

1955 *Cyprideis multidentata* Hartmann, p. 119, 121–123, figs. 24–34.

1964 *Cyprideis multidentata* Hartmann. Sandberg, p. 128, pl. 19, figs. 1–4, 9.

1977 *Cyprideis* sp. Vicalvi *et al.*, p. 91, pl. 3, fig. 3.

1983 *Cyprideis multidentata* Hartmann. Würdig, p. 599, pl. 1, fig. 1

?1983 *Cyprideis multidentata* Hartmann. Würdig, p. 599, pl. 1, fig. 2

1996 *Cyprideis multidentata* Hartmann. Ferrero, p. 218, pl. 1, figs. 5a,b.

1997 *Cyprideis multidentata* Hartmann. Whatley *et al.*, p. 159, pl. 2, figs. 20–21.

1998 *Cyprideis multidentata* Hartmann. Whatley *et al.*, p. 94, pl. 1, figs. 22–23.

Non 2006 *Cyprideis multidentata* Hartmann. Coimbra *et al.*, p. 299, fig. 2F–G.

Non 2006 *Cyprideis multidentata* Hartmann. Laprida, fig. 3B–C.

Non 2017 *Cyprideis multidentata* Hartmann. Kihn *et al.*, p. 95, fig. 3D.

2020 *Cyprideis multidentata* Hartmann. Machado *et al.*, p. 9, fig. 6N.

Non 2021 *Cyprideis multidentata* Hartmann. Campos *et al.*, p. 84, figs. 4J–K.

2022 *Cyprideis multidentata* Hartmann. Bergue *et al.*, p. 296, fig. 3R.

Type-material. Although a type-series was not determined for this species, the material studied by Hartmann (1955) was deposited at the Zoologische Museum Hamburg (now Museum der Natur Hamburg) under the following curatorial numbers: ZMH K-28249 (Itanhaém, May 17th 1952, bridge), ZMHK-28250 (Itanhaém, May 17th 1952, estuary), and ZMHK-28251 (Porto Novo, June 7th 1952, margin).

Type-locality and age. Itanhaém/Caraguatatuba, São Paulo State, Brazil. Coordinates of the collected sites are not available in the original description. Recent.

Figured specimens. ZMH K-28433 C (dimensions unknown), LV (Figure 2I); RV (Figure 2J); MP-O-3190 male C, RV l= 1.25 mm, h= 0.54 mm (Figure 2A,C); LV l= 1.23 mm, h= 0.59 mm (Figure 2B,D); MP-O-3191 female C, RV l= 1.09 mm, h= 0.54 mm (Figure 2E,G); LV l= 1.10 mm; h= 0.58 mm (Figure 2F,H); MP-O-3192 male C, l= 1.15 mm; h= 0.57 mm, w= 0.50 mm (Figure 2L); MP-O-3193 female C, l= 1.05 mm; h= 0.54 mm, w= 0.48 mm (Figure 2K).

Locality. ZMH K-28433: Ubatuba, São Paulo State, Brazil; MP-O-3190–3193: Tramandaí-Armazém Lagoon, Rio Grande do Sul State, Brazil.

Age. Recent.

Stratigraphic and geographic distributions. Holocene: Southeast-South Brazilian shelf (Vicalvi *et al.*, 1977), Buenos Aires Province, Argentina (Ferrero, 1996), RSCP (Bergue *et al.*, 2022); Recent: Itanhaém/Caraguatatuba, São Paulo State, Brazil (Hartmann, 1955; Sandberg, 1964); Argentinian, Uruguayan and southern Brazilian shelves (Whatley *et al.*, 1997, 1998); Southeast-South Brazilian shelf (Machado *et al.*, 2020); Tramandaí-Armazém Lagoon (Würdig, 1983; this study).

Remarks. The specimen identified by Campos *et al.* (2021, figs. 4J–K) has a symmetrically rounded posterior margin, sinuous dorsal margin (behind the anterior cardinal angle) and feeble subparallel anteroventral ribs. Although the

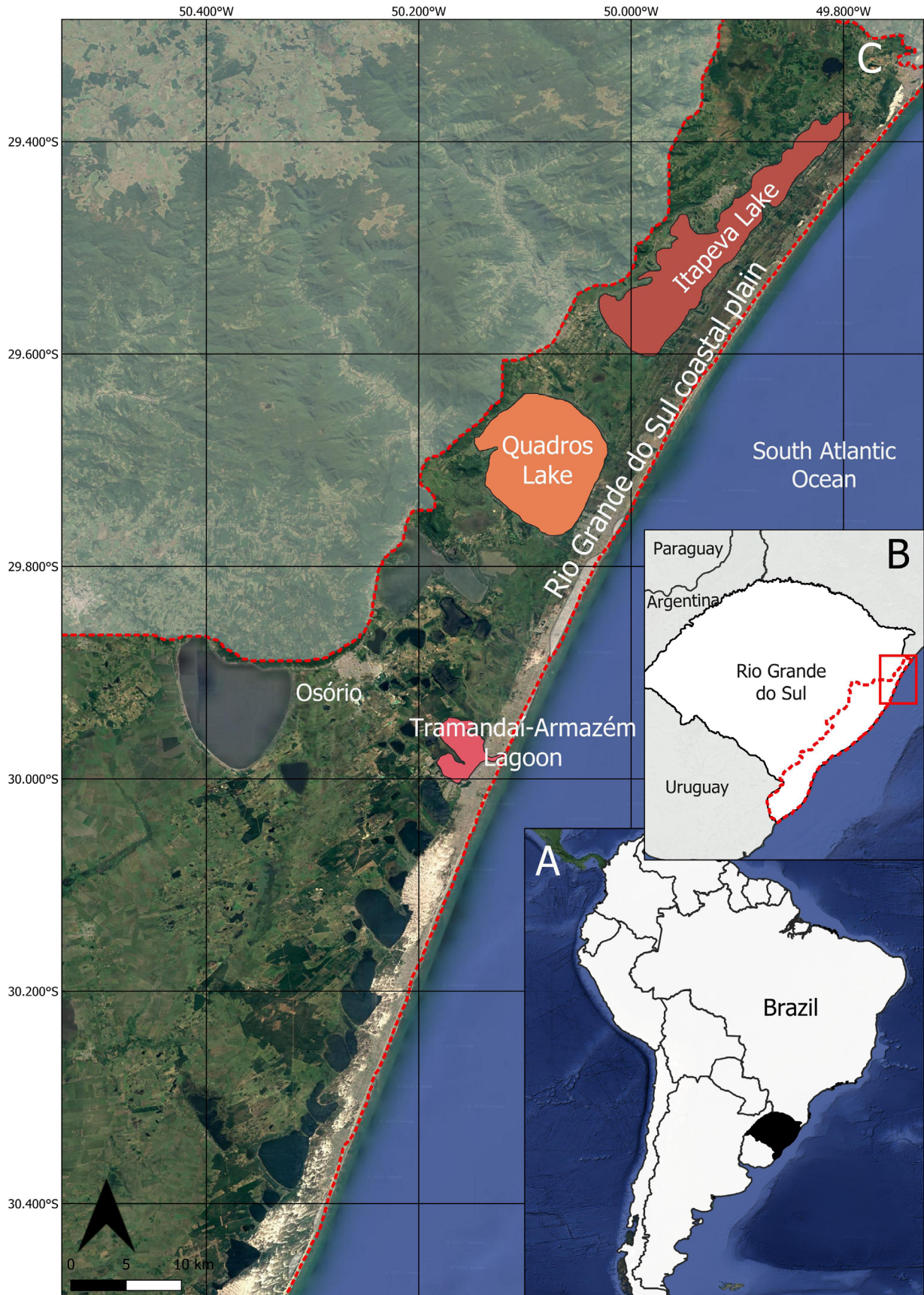


Figure 1. Study area showing the locality of the Tramandaí-Armazém Lagoon, Quadros Lake and Itapeva Lake in the RSCP. Base map modified from Google Earth (October, 2023).

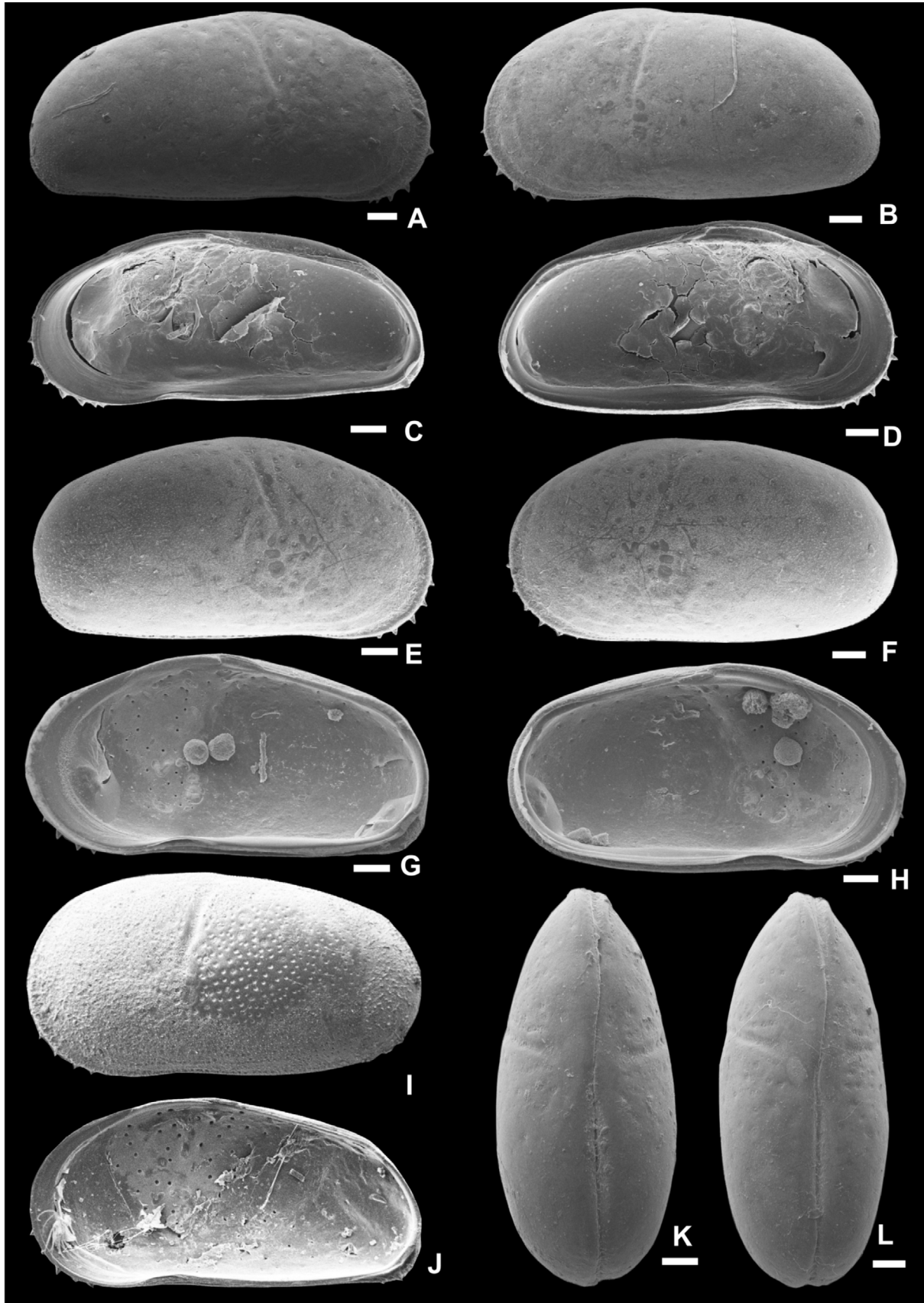


Figure 2. *Cyprideis multidentata* Hartmann, 1955; A–D, male C (MP-O-3190). A, RV external view. B, LV external view. C, RV internal view. D, LV internal view. E–H, female C (MP-O-3191). E, RV external view. F, LV external view. G, RV internal view. H, LV internal view. I, male LV external view (ZMH K-28433). J, male RV internal view (ZMH K-28433). K, male C dorsal view (MP-O-3192). L, female C dorsal view (MP-O-3193). Scale bars = 0.1 mm.

outline is similar to *Cyprideis mostardensis*, the anterior submarginal reticulum is missing, so we believe Campos *et al.* (2021) record should be referred to as *Cyprideis* sp. cf. *C. mostardensis* until further investigation. Although Coimbra's *et al.* (2007) record has not been illustrated, considering the geographic proximity between Cananéia/Iguape and the type-locality, it probably corresponds to *C. multidentata*. The female specimen figured by Bergue *et al.* (2022, fig. 3R) has the typically well-marked anterior cardinal angle of *C. multidentata* but is probably an A-2 instar. The specimens figured by Laprida (2006, fig. 3B–C) in the Buenos Aires Province, Argentina, differ in outline and might correspond to a different species. Based on the concavity of the ventral margin it could be a male of the same species figured by Kihn *et al.* (2017, fig. 3D).

Carapace ZMH K-28433 (Figure 2I–J) was collected on April 20th, 1964, and identified as *Cyprideis multidentata* by Gerd Hartmann (Dietmar Keyser, personal communication in September 2023). However, it is remarkably different in surface sculpture and outline from the remaining specimens herein identified – and elsewhere – as *C. multidentata*. While we sustain that they differ from *C. riograndensis*, differences between the specimens in Figure 2A–H and the 2I–J, raise the question: to which of them should the epithet *multidentata* actually refer to?

Cyprideis riograndensis Pinto & Ornellas, 1965
(Figure 3A–J)

1965 *Cyprideis riograndensis* Pinto & Ornellas, p. 14, pl. 1–14.

Non 1988 *Cyprideis riograndensis* Pinto & Ornellas. Dias-Brito *et al.*, p. 479, pl. 1, figs. 5–6.

1990 *Cyprideis riograndensis* Pinto & Ornellas. Bertels & Martínez, p. 152, pl. 2, fig. 13.

2006 *Cyprideis multidentata* Hartmann. Coimbra *et al.*, p. 299, fig. 2F–G.

Holotype. MP-O-195, female C.

Type-locality and age. Tramandaí-Armazém Lagoon, Rio Grande do Sul State, Brazil (approximate coordinates: lat. 29°59'S; long. 50°08'W). Recent.

Figured specimens. MP-O-3194 male C, RV l= 1.15 mm, h= 0.57 mm; LV l= 1.18 mm, h= 0.60 mm (Figure 3 A, B); MP-O-3195 male C, RV l= 1.15 mm, h= 0.55 mm; LV l= 1.19 mm, h= 0.58mm (Figure 3 C, D); MP-O-3196 female C, RV l= 1.03 mm, h= 0.50 mm; LV l= 1.05 mm, h= 0.55 mm (Figure E, F); MP-O-3197 female C, RV l= 1.00 mm, h= 0.50 mm; LV l= 1.00 mm, h= 0.55 mm (Figure G, H); MP-O-3198 female C l= 1.00 mm, h= 0.51 mm, w= 0.45 mm (Figure 3I); MP-O-3199 male C l= 1.10 mm, h= 0.53 mm, w= 0.45 mm (Figure 3J).

Locality. Tramandaí-Armazém Lagoon, Rio Grande do Sul State, Brazil.

Age. Recent.

Stratigraphic and geographic distributions. Late Quaternary: Holocene: Buenos Aires Province, Argentina

(Bertels & Martínez, 1990); Imaruí Lagoon/D'Una River, Santa Catarina State, Brazil (Coimbra *et al.*, 2006). Recent: Tramandaí-Armazém Lagoon, Rio Grande do Sul State, Brazil (Pinto & Ornellas, 1965; this work).

Remarks. Sandberg & Plusquellec (1974) synonymized *Cyprideis multidentata* and *C. riograndensis* based on two main arguments. Firstly, they concluded that the copulatory apparatus of both species is identical, and the differences in the ventilatory plates, observed by Pinto & Ornellas (1965) in the specimens from the Tramandaí-Armazém Lagoon, resulted from damage during dissection. However, no damage is visible in figures 12.3 and 13.3 of Pinto & Ornellas (1965). Moreover, the appendages of the type-material of *C. riograndensis* differ from that of figure 29 of Hartmann (1955), wherein a group of three setae in the mandibular plate are oblique to a longer one. In *C. riograndensis* this group is composed of four setae and placed differently towards the longer seta.

Secondly, the only RV depicted with pen and ink by Hartmann (1955, fig. 24) conspicuously shows an angulose anterodorsal outline, which does not occur in *Cyprideis riograndensis*. Sandberg & Plusquellec (1974) considered the differences in outline observed by Pinto & Ornellas (1965) as resulting from the decalcification of Hartmann's specimens. Sandberg & Plusquellec's proposal of synonymy is based on a paratype (as none has been formally proposed, maybe they meant topotype instead) of *C. multidentata*, which had been supplied by Hartmann. They also make no mention of any comparisons with *C. riograndensis* specimens.

In terms of carapace morphology, *Cyprideis multidentata* and *C. riograndensis* differ in three main aspects: outline, accommodation groove, and hinge sockets. These differences are more easily seen in the male RV, where the dorsal outline of *C. riograndensis* is evenly convex (Figure 3A), whereas in *C. multidentata* the anterior cardinal angle is more conspicuous (Figure 2A). The accommodation groove in *C. multidentata* is more developed than in *C. riograndensis*, as seen in internal and dorsal views (Figures 2C and 2L; 3C and 3J). Concerning the hinge sockets, both the anterior and posterior are more developed in *C. multidentata* than in *C. riograndensis* (Figures 2D and 3D).

The specimens recorded by Dias-Brito *et al.* (1988, pl. 1, figs. 5–6) in the Sepetiba Bay, Rio de Janeiro State, Brazil, are strongly punctate and differ in outline from the holotype, being a different species. The only fossil record of *C. riograndensis* in Brazil is by Coimbra *et al.* (2006) (Holocene: Imaruí Lagoon/D'Una River, Santa Catarina State). In Argentina, this species is recorded as a fossil (Bertels & Martínez, 1990) in the Quaternary sediments of the Buenos Aires Province.

CONCLUDING REMARKS

The examination of the type-series of *Cyprideis riograndensis*, allied to a comprehensive bibliographic review and analysis of new material, demonstrated that the synonymy of *C. riograndensis* to *C. multidentata* proposed by Sandberg & Plusquellec (1974) cannot be upheld. Moreover, this review

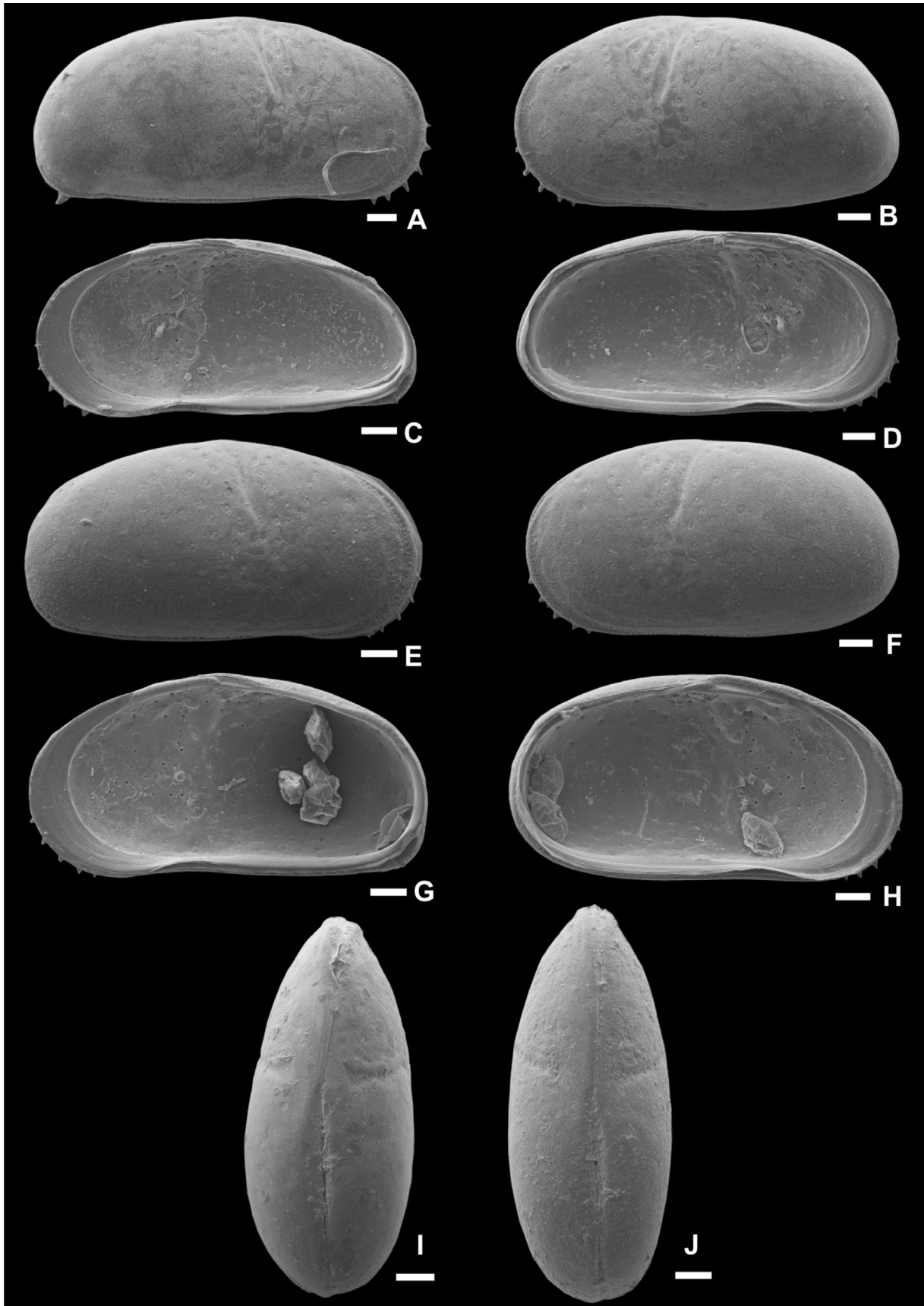


Figure 3. *Cyprideis riograndensis* Pinto & Ornellas, 1965; **A–B**, male C (MP-O-3194). **A**, male RV external view. **B**, male LV external view. **C–D**, male C (MP-O-3195). **C**, RV internal view. **D**, LV internal view. **E–F**, female C (MP-O-3196). **E**, RV external view. **F**, LV external view. **G–H**, female C (MP-O-3197). **G**, RV internal view. **H**, LV internal view. **I**, female C dorsal view (MP-O-3198). **J**, male C dorsal view (MP-O-3199). Scale bars = 0.1 mm.

revealed a taxonomic enigma concerning *C. multidentata* that goes beyond the simple acceptance or refusal of this synonymy. The arguments presented to propose the synonymy are probably rooted in the biogeographic conceptions of Sandberg (1964), who emphasized the role of migratory birds in the dispersal of *Cyprideis*. This theory would explain, for example, the presence of *C. salebrosa* van den Bold, 1963 in both the Caribbean and South America. Therefore, according to Sandberg (1964), it was more parsimonious to consider similar individuals from distant regions as conspecific rather than splitting them into different taxa. This possibly influenced Sandberg & Plusquellec (1974) to synonymize *C. multidentata* with *C. riograndensis*, yet they were aware of the differences between both species.

Based on the results of the present investigation, we conclude that there are significant differences between the morphotypes herein examined. The carapace morphology of one of them fits satisfactorily with the diagnosis of *Cyprideis riograndensis*. The taxonomic complexity of this subject is due to the heterogeneity observed in the other morphotypes. The male specimen MP-O-3190 (Figure 2A, C) has morphologic characteristics similar to those found in specimens commonly identified as *C. multidentata*. However, it differs significantly from the male specimen ZMH K-28433 (Figures 2I, J), which Gerd Hartmann identified as *C. multidentata*.

In turn, it also differs in outline from the specimen illustrated in the original description of the species (Hartmann, 1955, p. 120, fig. 24). Such strong differences prompt the question: what, if anything, is *C. multidentata*? Considering that ZMH K-28433 has been identified by the author of the species, it can be assumed to be a reliable specimen of that taxon. In this case, what has been herein and elsewhere identified as *Cyprideis multidentata* would correspond to a different species. A matter to be deeply investigated in future studies.

Considering the abundant record of these species, it is very probable that the differences herein pointed out and discussed have already been observed previously. Those who followed Sandberg & Plusquellec (1974) considered these differences to be environmentally induced morphological modifications. Except for one case (Dias Brito *et al.*, 1988), the records of *Cyprideis riograndensis* and *C. multidentata* illustrate similar specimens. Although morphologic variation occurs among individuals in a population, it is advisable in this discussion to consider that the opposite, *i.e.*, sibling species (*sensu* Mayr, 1942), also occurs. The possibility of sympatric populations of distinct but morphologically similar species appears to be relevant in this case. It reinforces the hypothesis that the material from the Rio Grande do Sul examined in this study corresponds to two different species.

The paleontological approach adopted in this work did not investigate whether the morphotypes from the Tramandaí-Armazém Lagoon, Itapeva Lake and Quadros Lake are reproductively isolated (sibling species) or populations of a species with intraspecific morphologic variability. We therefore maintain that, based on the morphological concept of species used in palaeontology, *Cyprideis riograndensis* is

a valid taxon and not a junior synonym of *C. multidentata*. Yet the validity of *C. multidentata* cannot be questioned based on the available data, the revision of this species with more emphasis on carapace morphology is recommended.

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