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## Research article

urn:lsid:zoobank.org:pub:10F0CC31-6B9D-4F67-B5E8-C2E72D560643

# A new tribe, two new genera and three new species of Cypridopsinae (Crustacea, Ostracoda, Cyprididae) from Brazil

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**Abstract.** We describe one new tribe, two new genera and three new species of the subfamily Cypridopsinae Kaufmann, 1900 from Brazilian floodplains. *Brasilodopsis* gen. nov. belongs in the nominal tribe Cypridopsini, and both new species in this new genus were found in both sexual and asexual populations. *Brasilodopsis baiabonita* gen. et sp. nov. has a wide distribution and was found in three of the four major Brazilian floodplains. *Brasilodopsis amazonica* gen. et sp. nov. was recorded only from the Amazon floodplain. *Brasilodopsis baiabonita* gen. et sp. nov. has a subtriangular shape in lateral view, whereas *Brasilodopsis amazonica* gen. et sp. nov. is more elongated and has more rounded dorsal margins in both valves, as well as more pronounced external valve ornamentation, consisting of rimmed pores in shallow pits. *Paranadopsis reducta* gen. et sp. nov. was found in asexual populations in the Upper Paraná River floodplain only and differs from other Cypridopsinae in the more elongated carapace, an A1 with strongly reduced chaetotaxy (hence the specific name) and the total absence of caudal rami in females. Because of these strong reductions in valve and limb morphology, Paranadopsini trib. nov. is created within the Cypridopsinae for this intriguing new genus and species.

**Keywords.** Microcrustaceans, morphological characters, reduced chaetotaxy, Cyprididae, Neotropical.

Almeida N.M., Higuti J., Ferreira V.G. & Martens K. 2021. A new tribe, two new genera and three new species of Cypridopsinae (Crustacea, Ostracoda, Cyprididae) from Brazil. *European Journal of Taxonomy* 762: 1–48. <https://doi.org/10.5852/ejt.2021.762.1451>

## Introduction

There are approximately 2330 species and 270 genera of living non-marine ostracods described. The most diverse family is the Cyprididae Baird, 1845, which has more than 20 subfamilies and comprises 43% of all species (Meisch *et al.* 2019). One of these subfamilies is the Cypridopsinae Kaufmann, 1900, which thus far comprises 20 genera. This subfamily is primarily common in the Afrotropical region, but it also occurs on all other continents, except for the Antarctic mainland (Meisch *et al.* 2019). The main characteristics that unite the species of this subfamily are the small carapace size (ca 0.3–0.9 mm length) and especially the reduced caudal ramus, usually with the shape of a flagellum in the females and fully absent in males (Meisch 2000).

Four tribes are thus far distinguished in this subfamily. The nominal tribe Cypridopsini is the most diverse with thus far 15 recognised genera. It now also comprises one of the two new genera described here, bringing it up to 16 nominal genera. The most speciose genus within this subfamily is *Cypridopsis* Brady, 1867, the type genus, with 66 nominal species, but most likely several of these would deserve a different generic assignment.

Here, we describe one new tribe, two new genera and three new species of Cypridopsinae from Brazilian floodplains. For one new genus and species, *Paranadopsis reducta* gen. et sp. nov., a new tribe Paranadopsini trib. nov. is erected, because of the strong reductions in size and chaetotaxy of segments on most limbs, mostly in the A1, which makes it unique in the subfamily. The present contribution brings the number of known cypridopsine tribes to five, and the number of genera to 21.

## Material and methods

### Study area

The study area covers the four largest Brazilian floodplains: Amazon (3°02'–3°34' S, 60°50'–60°10' W), Araguaia (12°50'–13°20' S, 50°40'–50°30' W), Pantanal (18°50'–19°30' S, 57°40'–57°00' W) and Upper Paraná (22°40'–24°00' S, 54°20'–53°00' W) (Fig. 1).

### The Amazon River floodplain

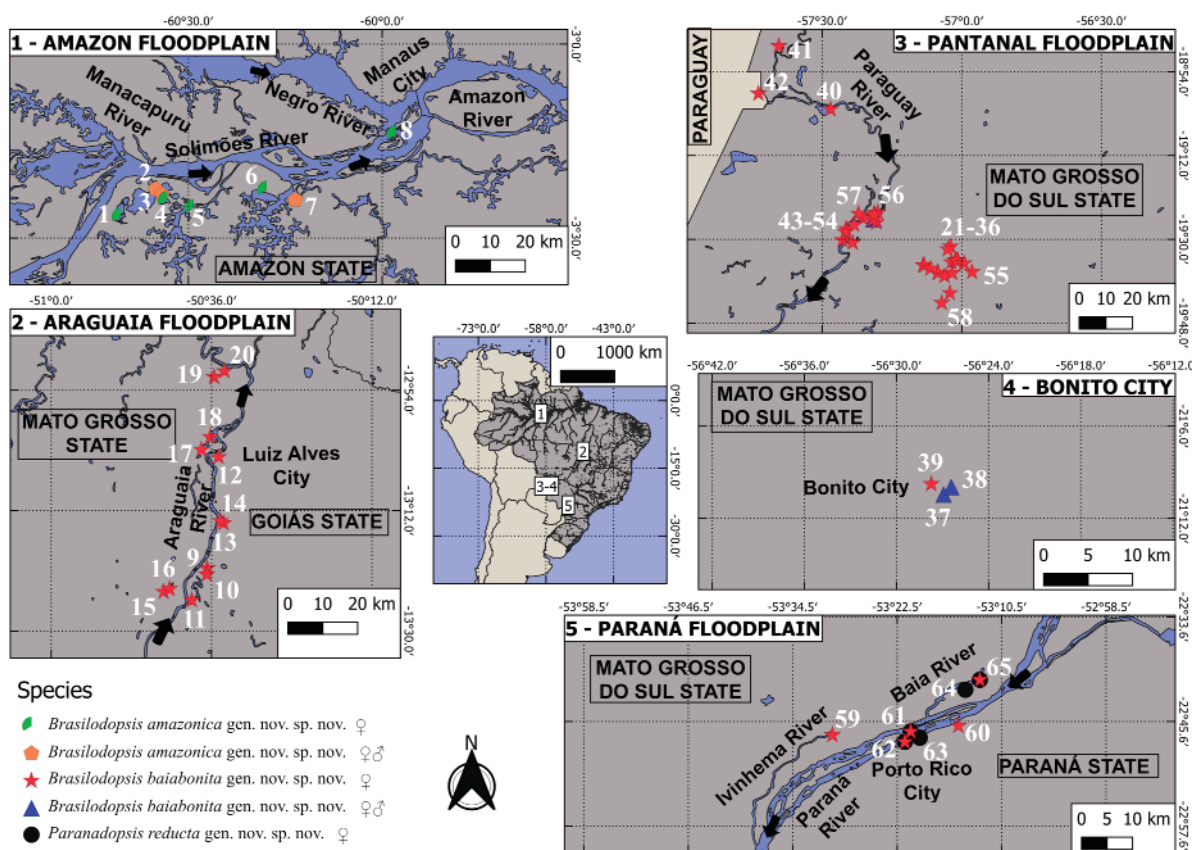
The Amazon River is the second longest river in the world and the largest in water volume, with an average flow rate of approximately 214 million litre per second. The Amazon River and its tributaries are accompanied along its middle and lower courses by large floodplains covering an area of about 300 000 km<sup>2</sup>. Each year, the river rises more than nine meters, flooding the surrounding forests, known as the Várzea (Irion *et al.* 1997). The lakes sampled from the Amazon floodplain (03°14' S, 59°58' W) are located near (ca 100 km or less of) the city of Manaus.

### The Araguaia River floodplain

The Araguaia River has a length of 2110 km and can be divided into three units: high, medium and low Araguaia (Latrubesse & Stevaux 2002). The upper Araguaia extends from the upper course (Serra dos Caiapós) to the city of Registro do Araguaia and has a length of 450 km. The medium Araguaia, about 1160 km long, is located between the cities of Registro do Araguaia and Conceição do Araguaia. The lower Araguaia runs 500 km to its confluence with the Tocantins River (Aquino *et al.* 2008, 2009). The climate encompasses two well-defined seasons, rainy and dry, which control the variations of the discharge into the Araguaia River (Latrubesse & Stevaux 2006). The sampling area is located in the middle region of Araguaia River (13°21' S, 50°36' W).

### The Pantanal Sul Matogrossense and adjacent areas

The Paraguay River is the most important tributary of the Paraná River and one of the main rivers of the La Plata Basin, the fifth largest basin in the world. The Pantanal is located in central South America in the Upper Paraguay River basin, which encompasses most of its area in Brazil (the State of Mato



**Fig. 1.** Localities where *Brasilodopsis amazonica* gen. et sp. nov., *Brasilodopsis baiabonita* gen. et sp. nov. and *Paranadopsis reducta* gen. et sp. nov. were found. Locality names are in Table 4.

Grosso, known as the Pantanal of Mato Grosso, and the State of Mato Grosso do Sul, known as the Pantanal Sul Matogrossense) and extends into parts of Bolivia and Paraguay. The Upper Paraguay basin, in Brazilian territory, covers 393 600 km<sup>2</sup>, of which 140 000 km<sup>2</sup> are floodplains and 253 600 km<sup>2</sup> are plateaus (Por 1995). In 2000, the Pantanal was officially named a Biosphere Reserve by UNESCO and awarded the World Heritage Certificate. The lakes sampled in the Pantanal (19°02' S, 57°28' W) and adjacent areas (Bonito) are located in the State of Mato Grosso do Sul.

### The Upper Paraná River floodplain

The Upper Paraná River floodplain (13°13' S, 50°34' W) is located between the Porto Primavera and Itaipu Reservoir and is approximately 230 km long and 20 km wide. In this area, three units of conservation were created, owing to their high biodiversity and environmental heterogeneity: i) Área de Proteção Ambiental das Ilhas e Várzeas do Rio Paraná (100 310 ha), ii) the Parque Nacional de Ilha Grande (78 800 ha), and iii) the Parque Estadual do Ivinhema (70 000 ha) (Agostinho *et al.* 2004).

### Material

The samples of ostracods used in this study were collected between 2004 and 2018.

Periphytic (associated with aquatic macrophytes) and benthic ostracods were collected from various types of environments (lentic and lotic) from four floodplains: Amazon, Araguaia, Pantanal Sul Matogrossense and Paraná (see above). The aquatic macrophytes: *Azolla* sp.; *Eichhornia azurea* (Sw.) Kunth, *Eichhornia crassipes* (Mart.) Solms, *Lemna* sp., *Limnobium* sp.; *Ludwigia* sp., *Paspalum* sp., *Pistia* sp.; *Pistia stratiotes* L., *Ricciocarpos* sp., *Salvinia* sp.; *Salvinia auriculata* Aubl., *Salvinia minima*

Baker, *Utricularia* sp. were manually sampled, placed in plastic buckets (see Higuti *et al.* 2007; Campos *et al.* 2017) and washed to remove the ostracods associated with macrophytes. The samples were filtered in a net (160 µm mesh size) and were fixed in alcohol, buffered with sodium tetraborate. The ostracods were sorted under a stereoscopic microscope and stored in 70% alcohol.

### **Morphological analyses**

The valves were opened with entomological needles, the soft parts were removed from the carapace and the appendages separated and mounted on a slide in a drop of glycerine, covered with cover slip and sealed with nail polish. The separated valves and the illustrated carapaces were stored dry in micropalaeontological slides.

The illustrations (drawings) of the appendages of the ostracods were made with the aid of a camera lucida (Olympus UDA) attached to transmission light microscope (Olympus CX-41). The valves were illustrated with scanning electron microscopy (SEM, Fei Qanta ESEM, RBINS, Brussels) in different views (valves: internal and details; carapaces: lateral, dorsal, ventral and details). Illustrations of limbs for each species were made from different specimens, because no single dissection had all limbs in the right position, owing to the very small size of the animals.

### **Abbreviations used in text, tables and figures**

A1	=	antennula
A2	=	antenna
Cp	=	carapace
CpD	=	carapace dorsal view
CpRl	=	carapace right lateral view
CpV	=	carapace ventral view
CR	=	caudal ramus
cr	=	chitinous rings in Zenker's organ
ct	=	central tube of Zenker's organ
dep	=	distal end plate of Zenker's organ
H	=	height
L	=	length
Lpp	=	left prehensile palp
ls	=	lateral shield of hemipenis
LV	=	left valve
LVi	=	left valve inner view
Md	=	mandibula
Md-coxa	=	mandibular coxa
Md-palp	=	mandibular palp
ms	=	medial shield of hemipenis
Mx1	=	maxillula
ns	=	natatory seta on A2
pep	=	proximal end plate of Zenker's organ
Rpp	=	right prehensile palp
RV	=	right valve
RVi	=	right valve inner view
sw	=	spiny whorls in Zenker's organ
T1	=	first thoracopod
T2	=	second thoracopod
T3	=	third thoracopod
V	=	valve
W	=	width



The type material and all illustrated specimens are stored in the Museum of Zoology of the University of São Paulo (MZUSP), São Paulo, Brazil. Some non-type and non-illustrated specimens will be stored at the State University of Maringá (UEM).

The nomenclature of the chaetotaxy of the limbs follows the model proposed by Broodbakker & Danielopol (1982), revised for the A2 by Martens (1987) and for the T3 by Meisch (2000). Higher taxonomy of the Ostracoda follow the synopsis by Horne *et al.* (2002).

## Results

Class Ostracoda Latreille, 1802  
Subclass Podocopa G.O. Sars, 1866  
Order Podocopida G.O. Sars, 1866  
Suborder Cypridocopina Baird, 1845  
Superfamily Cypridoidea Baird, 1845  
Family Cyprididae Baird, 1845  
Subfamily Cypridopsinae Kaufmann, 1900  
Tribe Cypridopsini Kaufmann, 1900

*Brasilodopsis* gen. nov.

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### Type species

*Brasilodopsis baiabonita* gen. et sp. nov. (here described and designated).

### Other species

*Brasilodopsis amazonica* gen. et sp. nov. (here described).

### Etymology

The name of the new genus is a contraction of ‘*Brasilo*’, after Brazil, the country from which it is here described, and ‘*dopsis*’, referring to the stem of *Cypridopsis*.

### Diagnosis

Cp sub-triangular in lateral view, with LV mildly overlapping RV along all sides. LV anteriorly, ventrally and posteriorly with a well-developed, largely inwardly displaced inner list, anteriorly with a submarginal selvage. RV anteriorly with submarginal inner list, posteriorly with one inner list and a marginal selvage. A2 with natatory setae well-developed, reaching well beyond the end claws. T1 in female with two short setae a; seta d present in female, absent in male; setae b absent in both sexes. T2 with one short seta d2, seta d1 absent. T3 distally with incompletely developed pincer organ, fourth segment fused with third segment. CR in female with cylindrical base.

### Differential diagnosis

*Brasilodopsis* gen. nov. belongs to the cypridopsine genera where the LV overlaps the RV; only six other genera belong to that group (see Table 1). The new genus differs from *Austrocypridopsis* McKenzie, 1982, *Cavernocypris* Hartmann, 1964 and *Pseudocypridopsis* Karanovic, 1999 by the long natatory setae on the A2 (short to very short in the other three genera). It further differs from *Austrocypridopsis* in the shape of the base of the CR, (triangular in *Austrocypridopsis*, cylindrical in *Brasilodopsis* gen. nov.) and in the shape of the valves in lateral view (rectangular in *Austrocypridopsis*). *Cavernocypris* also has a triangular base of the CR and furthermore lacks all inner lists and selvages on both valves, while the T1 has a seta b (missing in *Brasilodopsis* gen. nov.). *Pseudocypridopsis* also lacks inner lists and

**Table 1.** Present list of tribes and genera in the subfamily Cypridopsinae Kaufmann, 1900. New tribe and new genera here described are in bold.

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Tribe Cypridopsini Kaufmann, 1900

Genera with species with RV overlapping LV

- Bryocypris* Røen, 1956
- Kapcypridopsis* McKenzie, 1977
- Klieopsis* Martens *et al.*, 1991
- Martenscypridopsis* Karanovic & Pesce, 2000
- Plesiocypridopsis* Rome, 1965
- Sarscypridopsis* McKenzie, 1977
- Siamopsis* Savatnalinton, 2017
- Tanganyikacypridopsis* Martens, 1985
- Thermopsis* Kulköylüoğlu *et al.*, 2003

Genera with species with LV overlapping RV

- Austrocypridopsis* McKenzie, 1982
- Brasilodopsis* gen. nov.**
- Cavernocypris* Hartmann, 1964
- Cypridopsis* Brady, 1867
- Neocypridopsis* Klie, 1940
- Pseudocypridopsis* Karanovic, 1999
- Tungucypridopsis* Victor, 1983

**Tribe Paranadopsinae trib. nov.**

***Paranadopsis* gen. nov.**

Tribe Potamocypridini Ghetti & McKenzie, 1981

- Potamocypris* Brady, 1870

Tribe Zonocypridini Higuti & Martens, 2012

- Cabelodopsis* Higuti & Martens, 2012
  - Thaicypridopsis* Savatnalinton, 2018
  - Zonocypris* G.W. Müller, 1898
- 

selvages; while the CR is missing in both males and females. *Brasilodopsis* gen. nov. further differs from *Cypridopsis* s. str. Brady, 1867 by the general shape of the Cp (much broader in dorsal view in *Cypridopsis*), while the posteroventral inner list in the LV does not run (sub-)parallel to the valve margin in this latter genus (it does so in *Brasilodopsis* gen. nov.), while the anterior inner list in this valve runs less than halfway the anterior valve margin (all the way to the dorsal margin in *Brasilodopsis* gen. nov.). The base of the CR in *Cypridopsis* is triangular, while it is elongated in *Brasilodopsis* gen. nov. *Neocypridopsis* Klie, 1940 has a very different shape of the Cp (rather high and swollen in dorsal view), but more importantly has the fourth segment of the T3 separate from the third segment, much like in Candonidae. *Tungucypridopsis* Victor, 1983, finally, is ill-described which makes a comparison with the present new genus difficult. It appears to lack the inner lists on both valves, which are moreover much larger than in *Brasilodopsis* gen. nov. (0.6 mm versus 0.4 mm – see Table 2).

*Cyprettadopsis* Savatnalinton, 2020 (placed in a separate tribe by this author) has a similar valve shape, including inner lists, but has (incomplete) marginal septae and a series of large ventral pores along the outer lists, which are both absent in *Brasilodopsis* gen. nov., while the T3 also has a separate fourth segment (fused into an incomplete pincer in *Brasilodopsis* gen. nov.).

**Table 2** (continued on next page). Measurements of specimens of *Brasilodopsis baiabonita* gen. et sp. nov., *Brasilodopsis amazonica* gen. et sp. nov. and *Paranadopsis reducta* gen. et sp. nov.

Species	Floodplain/city	Locality name	Sample nr	Sex	Code	V/Cp	L (µm)	H (µm)	W (µm)	
<i>Brasilodopsis baiabonita</i> gen. et sp. nov.	Bonito	Baía Bonita River	PAN 36	♂	MZUSP 41825	LVi	431	226		
					MZUSP 41825	RVi	430	222		
	Formoso River	Formoso River	PAN 33	♂	MZUSP 41826	LVi	441	232		
					MZUSP 41826	RVi	430	231		
					MZUSP 41836	LVi	427	226		
					MZUSP 41836	RVi	413	222		
					MZUSP 41837	CpRI	417	225		
					MZUSP 41838	CpD	402		216	
	<i>Brasilodopsis amazonica</i> gen. et sp. nov.	Araguaia	Crixas IV Lake	ARA 05	♀	MZUSP 41839	CpV	428		230
						MZUSP 41840	LVi	462	244	
MZUSP 41840						RVi	451	242		
MZUSP 41841						CpRI	452	248		
<i>Paranadopsis reducta</i> gen. et sp. nov.	Araguaia	Crixas IV Lake	ARA 05	♀	MZUSP 41842	CpD	433		241	
					MZUSP 41843	CpV	438		235	
					MZUSP 41844	LVi	438	234		
					MZUSP 41844	RVi	429	223		
					MZUSP 41845	CpRI	435	238		
					MZUSP 41846	CpD	444		245	
					MZUSP 41847	CpV	441		242	

Table 2 (continued).

Species	Floodplain/city	Locality name	Sample nr	Sex	Code	V/Cp	L (µm)	H (µm)	W (µm)
<i>Brasilodopsis baiaonita</i> gen. et sp. nov.	Paraná	Pombas Lake	PAR 1520	♀	MZUSP 41848	LVi	438	227	
					MZUSP 41848	RVi	425	226	
					MZUSP 41849	CpRI	442	231	
					MZUSP 41850	CpD	445		241
					MZUSP 41851	CpV	438		224
<i>Brasilodopsis amazonica</i> gen. et sp. nov.	Amazon	Castanho Lake	AMA 79	♂	MZUSP 41856	LVi	447	223	
					MZUSP 41857	CpRI	439	221	
					MZUSP 41858	CpD	453		232
					MZUSP 41859	CpV	427		218
					MZUSP 41862	LVi	471	248	
					MZUSP 41862	RVi	472	252	
					MZUSP 41863	CpRI	493	252	
					MZUSP 41864	CpD	510		264
					MZUSP 41865	CpV	476		252
					<i>Paranadopsis reducta</i> gen. et sp. nov.	Paraná	Manezinho Backwater	EC1	♀
MZUSP 41872	RVi	360	176						
MZUSP 41873	CpRI	384	171						
MZUSP 41874	CpD	376		160					
JH490 (lost)	CpV	386		162					

***Brasilodopsis baiabonita* gen. et sp. nov.**

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Figs 2–12

“*Cypridopsis*” n.gen. 1 n.sp. – Higuti *et al.* 2009: 664, table 1; 2010: 267, table 2; 2017b: 7, table 2. — Matsuda *et al.* 2015a: 326, table 1. — Pereira *et al.* 2017: 327, 329, table 2, fig. 5. — Conceição *et al.* 2018: 184, table 3.

“*Cypridopsis*” n. gen. n.sp. 2 – Campos *et al.* 2017: 38, table 2.

“*Cypridopsis*” n. gen. 2 n. sp. – Higuti *et al.* 2017a: 5, appendix 1.

“*Cypridopsis*” sp. 1 n.gen. n.sp. – Campos *et al.* 2018: 6, table 2; 2019: 375, table 1.

“*Cypridopsis*” n. gen. 1 n. sp. 1 – Higuti *et al.* 2020: 2, table S1.

**Diagnosis**

Cp in dorsal view with LV overlapping RV at anterior and posterior sides. LV and RV with well-developed anterior calcified inner lamella, with the greatest height in both valves situated in the middle of the dorsal margin. A2 with the natatory setae reaching beyond the tip of the end claws; seta g absent. T1 with seta d absent in males, present in females. CR present only in female. Male prehensile palps asymmetrical. Rpp with first segment elongated and second segment with triangular lobe, Lpp with first segment elongated and second segment sickle shaped. Hemipenis with ventral lobe of ms rounded and ventral lobe of ls bird head-shaped and with two loops in the post-labyrinthal spermiduct.

**Etymology**

The species is named after its type locality, Baía Bonita River in the State of Mato Grosso do Sul (Brazil).

**Type material examined**

**Holotype**

BRAZIL • ♂; Bonito, State of Mato Grosso do Sul, Baía Bonita River; 21°9'57.4" S, 56°26'26" W; 10 Jun. 2003; J. Higuti and K. Martens leg.; with soft parts dissected in glycerine in a sealed slide, valves stored dry in a micropalaeontological slide; sample PAN 36; MZUSP 41825.

**Allotype**

BRAZIL • ♀; Bonito, State of Mato Grosso do Sul, Baía Bonita River; 21°9'57.4" S, 56°26'26" W; 10 Jun. 2003; J. Higuti and K. Martens leg.; with soft parts dissected in glycerine in a sealed slide, valves stored dry in a micropalaeontological slide; sample PAN 36; MZUSP 41826.

**Paratypes**

BRAZIL • 2 ♂♂; Bonito, State of Mato Grosso do Sul, Baía Bonita River; 21°9'57.4" S, 56°26'26" W; 10 Jun. 2003; J. Higuti and K. Martens leg.; with soft parts dissected in glycerine in sealed slides, valves stored dry in micropalaeontological slides; sample PAN 36; MZUSP 41827, MZUSP 41828 • 1 ♂; Bonito, State of Mato Grosso do Sul, Baía Bonita River; 21°9'57.4" S, 56°26'26" W; 10 Jun. 2003; J. Higuti and K. Martens leg.; with soft parts dissected in glycerine in a sealed slide, LV stored dry in a micropalaeontological slide (RV lost); sample PAN 36; MZUSP 41829 • 2 ♂♂; Bonito, State of Mato Grosso do Sul, Baía Bonita River; 21°9'57.4" S, 56°26'26" W; 10 Jun. 2003; J. Higuti and K. Martens leg.; with soft parts dissected in glycerine in sealed slides, valves stored dry in micropalaeontological slides (both LV lost); sample PAN 36; MZUSP 41830, MZUSP 41831 • 3 ♀♀; Bonito, State of Mato Grosso do Sul, Baía Bonita River; 21°9'57.4" S, 56°26'26" W; 10 Jun. 2003; J. Higuti and K. Martens leg.; with soft parts dissected in glycerine in sealed slides, valves stored dry in micropalaeontological slides; sample PAN 36; MZUSP 41832 to MZUSP 41834 • 1 ♀; Bonito, State of Mato Grosso do Sul, Baía Bonita River; 21°9'57.4" S, 56°26'26" W; 10 Jun. 2003; J. Higuti and K. Martens leg.; with soft parts dissected in glycerine in a sealed slide, RV stored dry in a micropalaeontological slide (LV lost); sample PAN 36; MZUSP 41835.



### **Other material illustrated**

BRAZIL • 4 ♂♂; Bonito, State of Mato Grosso do Sul, Formoso River; 21°10'26.5" S, 56°26'56" W; 10 Jun. 2003; J. Higuti and K. Martens leg.; with valves and carapaces stored dry in micropalaeontological slides after use for SEM; sample PAN 33; MZUSP 41836 to MZUSP 41839 • 4 ♀♀; Bonito, State of Mato Grosso do Sul, Formoso River; 21°10'26.5" S, 56°26'56" W; 10 Jun. 2003; J. Higuti and K. Martens leg.; valves and carapaces stored dry in micropalaeontological slides after use for SEM; sample PAN 33; MZUSP 41840 to MZUSP 41843 • 1 ♀; Araguaia River floodplain, Crixas IV Lake; 13°20'37.5" S, 50°36'40" W; 2 Nov. 2011; J. Higuti leg.; with soft parts dissected in glycerine in a sealed slide, valves stored dry in a micropalaeontological slide after use for SEM; sample ARA 05; MZUSP 41844 • 3 ♀♀; Araguaia River floodplain, Crixas IV Lake; 13°20'37.5" S, 50°36'40" W; 2 Nov. 2011; J. Higuti leg.; carapaces stored dry in micropalaeontological slides after use for SEM; sample ARA 05; MZUSP 41845 to MZUSP 41847 • 1 ♀; Upper Paraná River floodplain, Pombas Lake; 22°47'56.8" S, 53°21'36.6" W; 22 Mar. 2018; J. Higuti, K. Martens and students leg.; with soft parts dissected in glycerine in a sealed slide, valves stored dry in a micropalaeontological slide after use for SEM; sample PAR 1520; MZUSP 41848 • 3 ♀♀; Upper Paraná River floodplain, Pombas Lake; 22°47'56.8" S, 53°21'36.6" W; 22 Mar. 2018; J. Higuti, K. Martens and students leg.; carapaces stored dry in micropalaeontological slides after use for SEM; sample PAR 1520; MZUSP 41849 to MZUSP 41851.

### **Other material examined**

BRAZIL • 4 ♀♀; South Matogrossense Pantanal, Corumba Road, pool 2; 19°35'38" S, 57°8'3" W; 4 Jun. 2003; J. Higuti, K. Martens and K.F. Roche leg.; UEM-PAN 14; JH326 to JH329 • 3 ♀♀; South Matogrossense Pantanal, BEP wetland 1; 19°34'38" S, 57°1'11" W; 7 Jun. 2003; J. Higuti, K. Martens and K.F. Roche leg.; UEM-PAN 26; JH540, JH541, NA028 • 1 ♀, male specimen subsequently lost; South Matogrossense Pantanal, Miranda I River; 19°25'38.2" S, 57°18'58.4" W; 23 Aug. 2011; L.F.M. Velho and L.C. Rodrigues leg.; UEM-PAN 63; NA030 • 6 ♀♀; South Matogrossense Pantanal, Miranda III River; 19°26'23.1" S, 57°18'21.4" W; 23 Aug. 2011; L.F.M. Velho and L.C. Rodrigues leg.; UEM-PAN 69; JH1060 to JH1065 • 1 ♀; South Matogrossense Pantanal, Corumba Road, lake 1; 19°35'33" S, 57°8'19" W; 4 Jun. 2003; J. Higuti, K. Martens and K.F. Roche leg.; UEM-PAN 12; JH338 • 3 ♀♀; Araguaia River floodplain, Comprido II Lake; 12°51'8.8" S, 50°34'4.8" W; 12 Mar. 2012; J. Higuti and K. Martens leg.; UEM-ARA 99; JH1479 to JH1481 • 4 ♀♀; Upper Paraná River floodplain, Caracu Stream; 22°46'6" S, 53°15'28" W; 17 Mar. 2004; J. Higuti and K. Martens leg.; UEM-PAR 100; JH701, KM3453 to KM3455.

### **Measurements of illustrated specimens**

See Table 2.

### **Description**

#### **Male**

LVi (Figs 2A, C–D, 3A, C–D) with well-developed anterior calcified inner lamella, posterior calcified inner lamella narrow; a well-developed inner list running along and parallel to anterior, ventral and posterior valve margin, largely inwardly displaced anteriorly and posteriorly; anterior inner list running almost to the dorsal margin, posterior inner list elevated and running to the dorsal margin. Anteriorly with a submarginal selvage.

RVi (Figs 2B, E–F, 3B, E–F) with well-developed anterior calcified inner lamella, posterior calcified inner lamella narrow; short anteroventral trace of an inner list and posteroventrally with an elevated inwardly displaced inner list and a submarginal selvage, both running parallel to the valve margin.

Greatest height in both valves situated in the middle of the dorsal margin, indicated by a blunt corner.

CpR1 (Fig. 3G) with a triangular shape, with greatest height in the middle. CpD (Fig. 3H) external surface sparsely set with shallow pits and short setae and CpV (Fig. 3I) sub-ovate, with greatest width slightly behind the middle; anterior margin more pointed, posterior margin more rounded; LV overlapping RV along anterior, ventral and posterior margins, with an extended flap in the middle of the ventral side.

A1 (Fig. 4A) with seven segments. First segment large, ventrally with two long apical hirsute setae; dorsally with one short subapical hirsute seta, and with small Wouter's organ (Wo). Second segment subquadrate, with one short dorsal seta and a small ventral Rome organ (R). Third segment with two apical setae (the shorter ventral seta almost reaching the tip of the fourth segment; the longer dorsal seta slightly shorter than the length of the fifth segment). Fourth segment with three apical setae, two long dorsal ones, and one ventral seta, the latter slightly shorter than the length of the fifth segment. Fifth segment with three apical setae, two long dorsal setae and one short ventral seta, the latter reaching half the length of the terminal segment. Sixth segment with four long apical setae. Terminal segment with two unequally long setae, aesthetasc Ya and one shorter seta, the latter almost the same length of the aesthetasc Ya.

A2 (Fig. 4C–D) with protopodite, exopodite and three-segmented endopodite. Protopodite ventrally with three setae: two unequal but short setae, one long apical seta reaching beyond the tip of the terminal segment. Exopodite reduced to a small plate with one long seta (reaching beyond the tip of the terminal segment) and two sub-equal short setae. First endopodal segment ventrally with aesthetasc Y (more than  $\frac{1}{3}$  of the length of this segment), one long hirsute ventral seta (reaching beyond the tip of the terminal segment), and five natatory setae, reaching beyond the tip of the end claws, and one short accompanying seta, about  $\frac{1}{2}$  of the length of the second endopodal segment. Second endopodal segment with two unequal but long dorsal setae, one short hirsute ventral seta t; apically with three claws (G1, G2, z1) and three setae (G3, z2, z3). Terminal segment (Fig. 4D) with two claws, one long (GM) and one short (Gm) and one aesthetasc y3 with accompanying seta (slightly longer than the aesthetasc y3). Seta g absent.

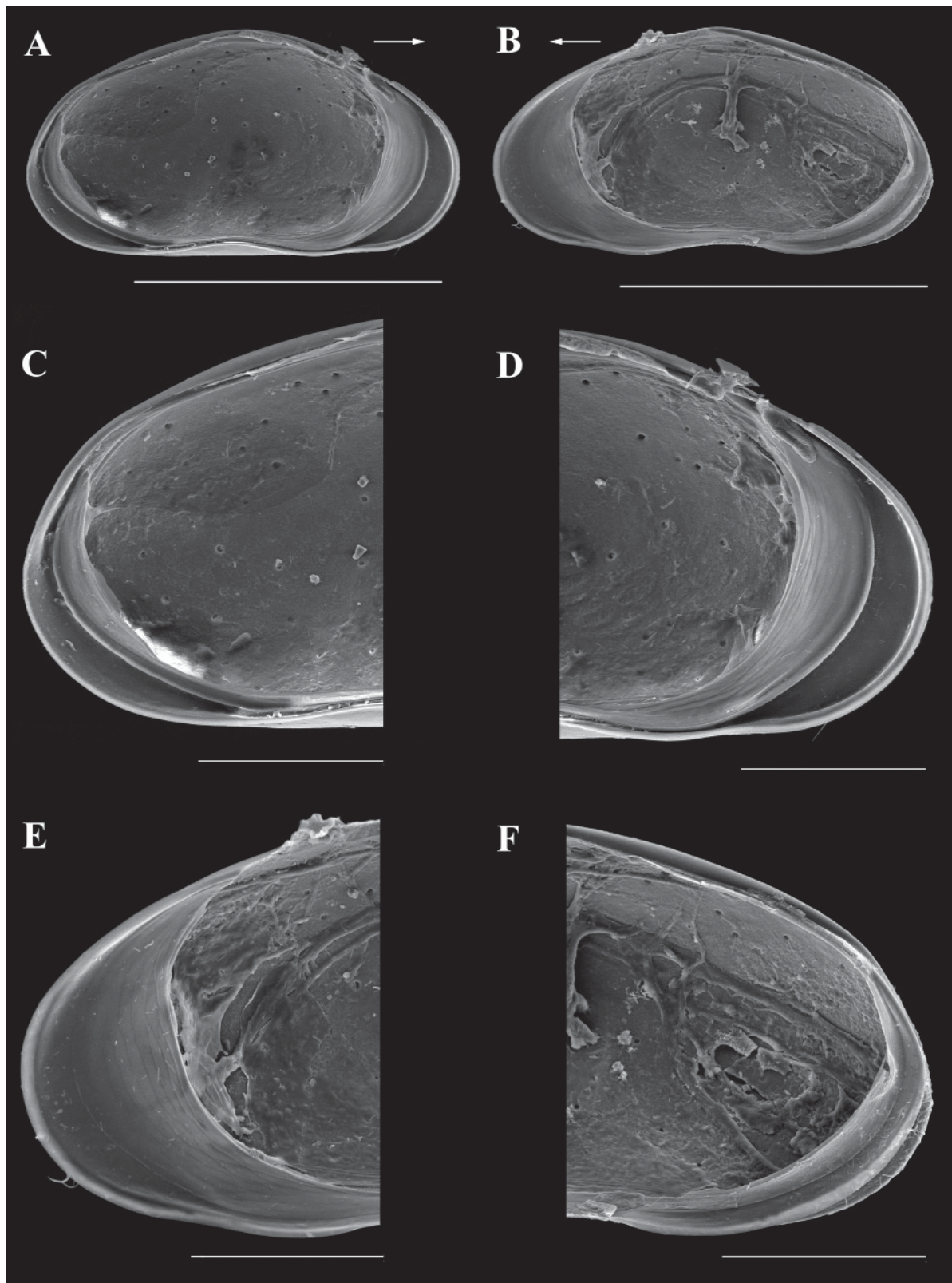
Rake-like organ (Fig. 4B) stout, solid, T-shaped, with seven apical teeth.

Md-palp (Fig. 5B) with four segments. First segment with two long plumose setae ( $S_1$  and  $S_2$ ), one long smooth seta and one short smooth seta  $\alpha$ . Second segment with three dorsal setae (two long and one shorter, ca  $\frac{2}{3}$  the length of the two longer ones); ventrally with one hirsute seta  $\beta$  and four long setae (three equally long, and one slightly shorter). Third segment with three groups of setae: dorsally one group of three unequal but long setae; laterally with one hirsute and stout apical seta  $\gamma$  and three smooth setae; ventrally with three unequal shorter setae. Terminal segment with three claws and three setae.

Md-coxa (Fig. 5A) elongated, dorsally with a short seta, and with strong and apical teeth, interspaced with some setae.

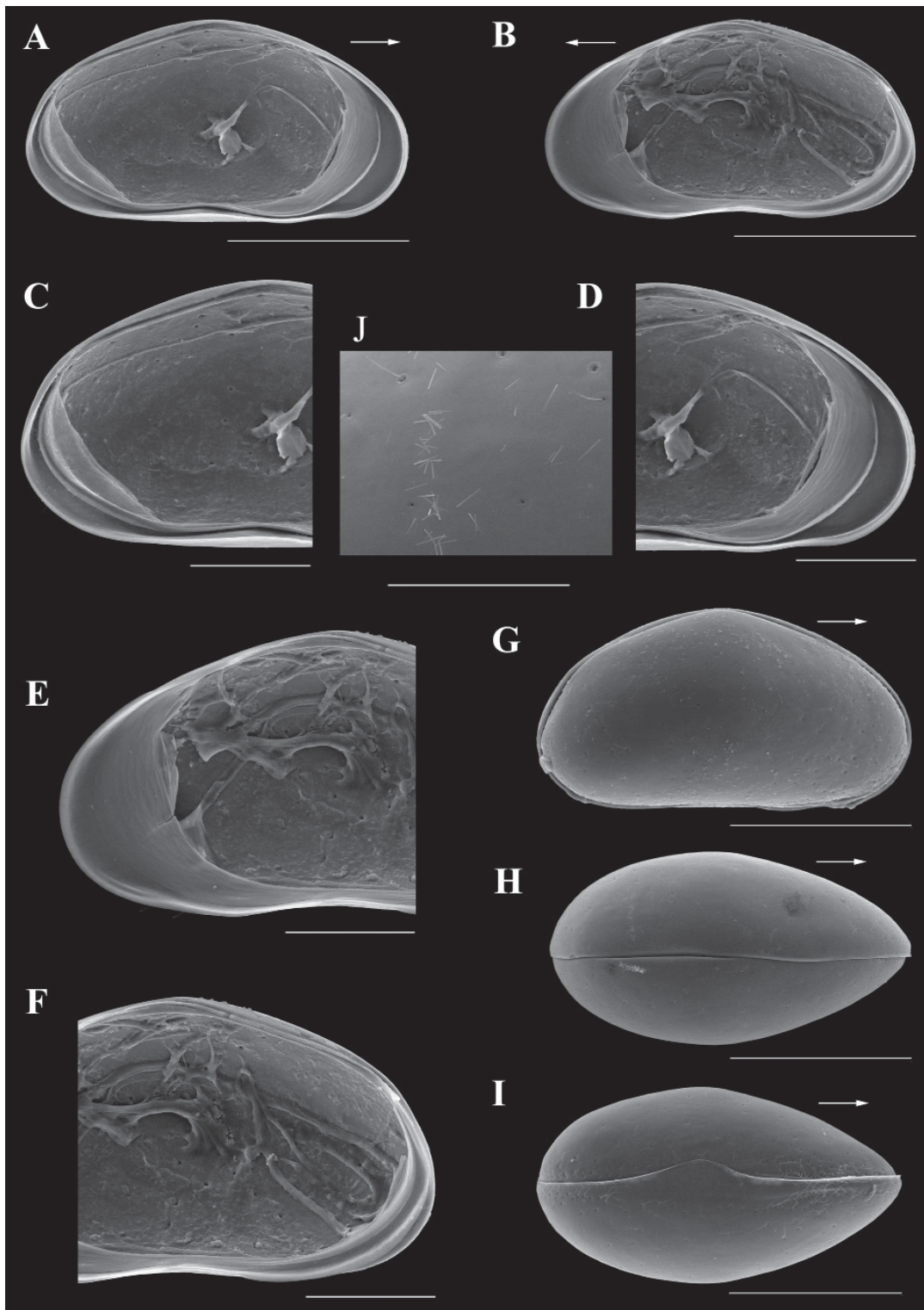
Mx1 (Fig. 5C – chaetotaxy not complete) consisting of three masticatory lobes (endites), a two-segmented palp and a large branchial plate (not illustrated). Branchial plate elongated, with ca 16 respiratory rays, some quite short, others longer. First segment of palp with five setae (four unequal but long setae and one short subapical seta, about  $\frac{1}{4}$  of the longest one). Terminal segment of palp ca twice as long as basal width, apically with two claw-like setae and two setae. Third endite apically with two serrated claws and several setae. First endite at its base with two unequal setae and apically with ca five unequal, sideways directed bristles.

T1 (Fig. 6A–C) protopodite apically with a group of eight hirsute setae, and two short setae a inserted in the middle, seta d absent. Endopodites (Fig. 6B–C) asymmetrical prehensile palps: Rpp (Fig. 6B) with first segment elongated, with two subapical spines, second segment with triangular lobe, with uneven dorsal and straight distal margin. Lpp (Fig. 6C) with first segment elongated, with two sub-apical spines, second segment sickle-shaped, with swollen basis and bluntly pointed distal part.

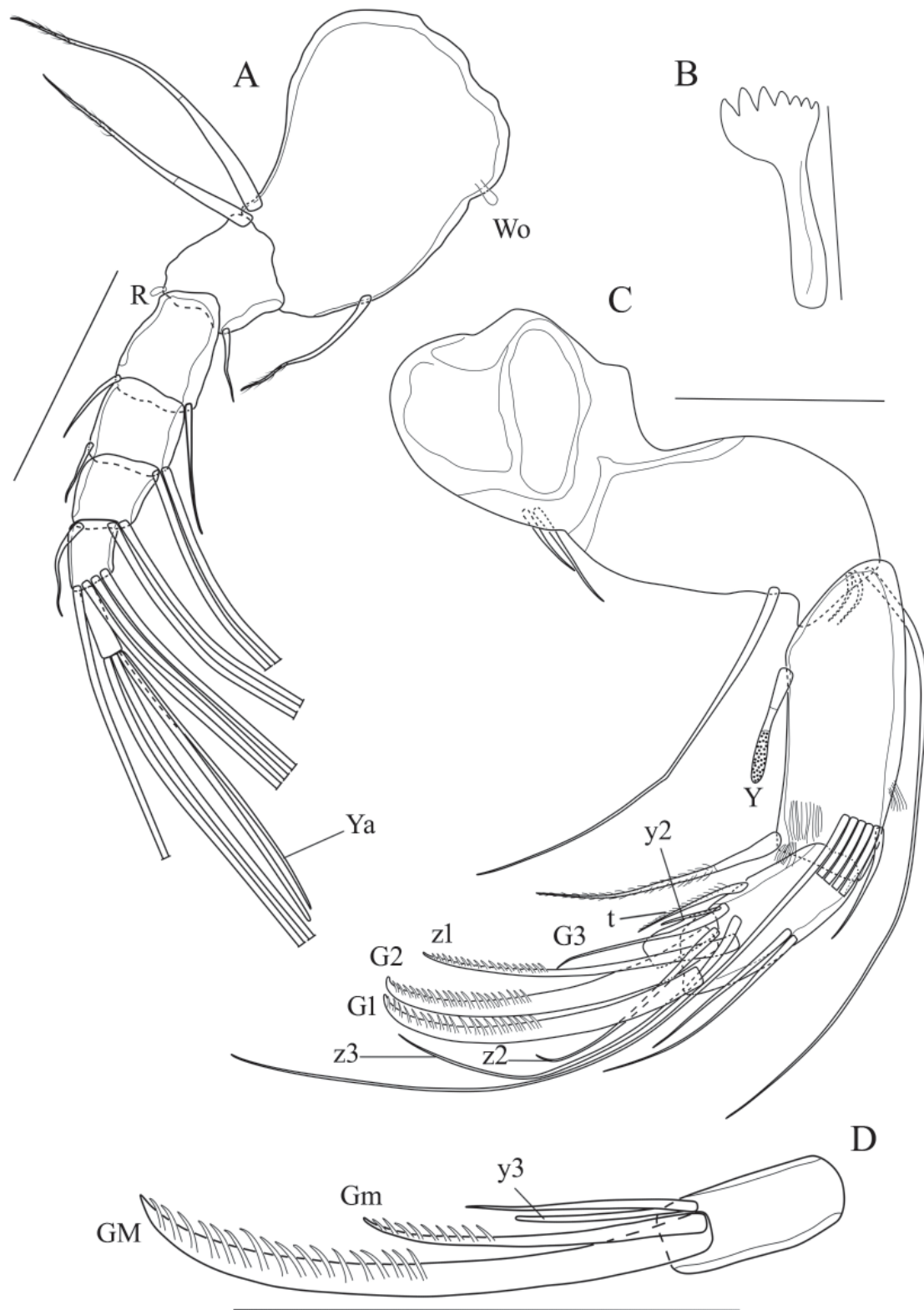


**Fig. 2.** *Brasilodopsis baiabonita* gen. et sp. nov. from Bonito, State of Mato Grosso do Sul, ♂. **A.** LVi (MZUSP 41825). **B.** RVi (MZUSP 41825). **C.** LVi, detail of posterior part (MZUSP 41825). **D.** LVi, detail of anterior part (MZUSP 41825). **E.** RVi, detail of anterior part (MZUSP 41825). **F.** RVi, detail of posterior part (MZUSP 41825). Scale bars: A–B = 300  $\mu$ m; C–F = 100  $\mu$ m.



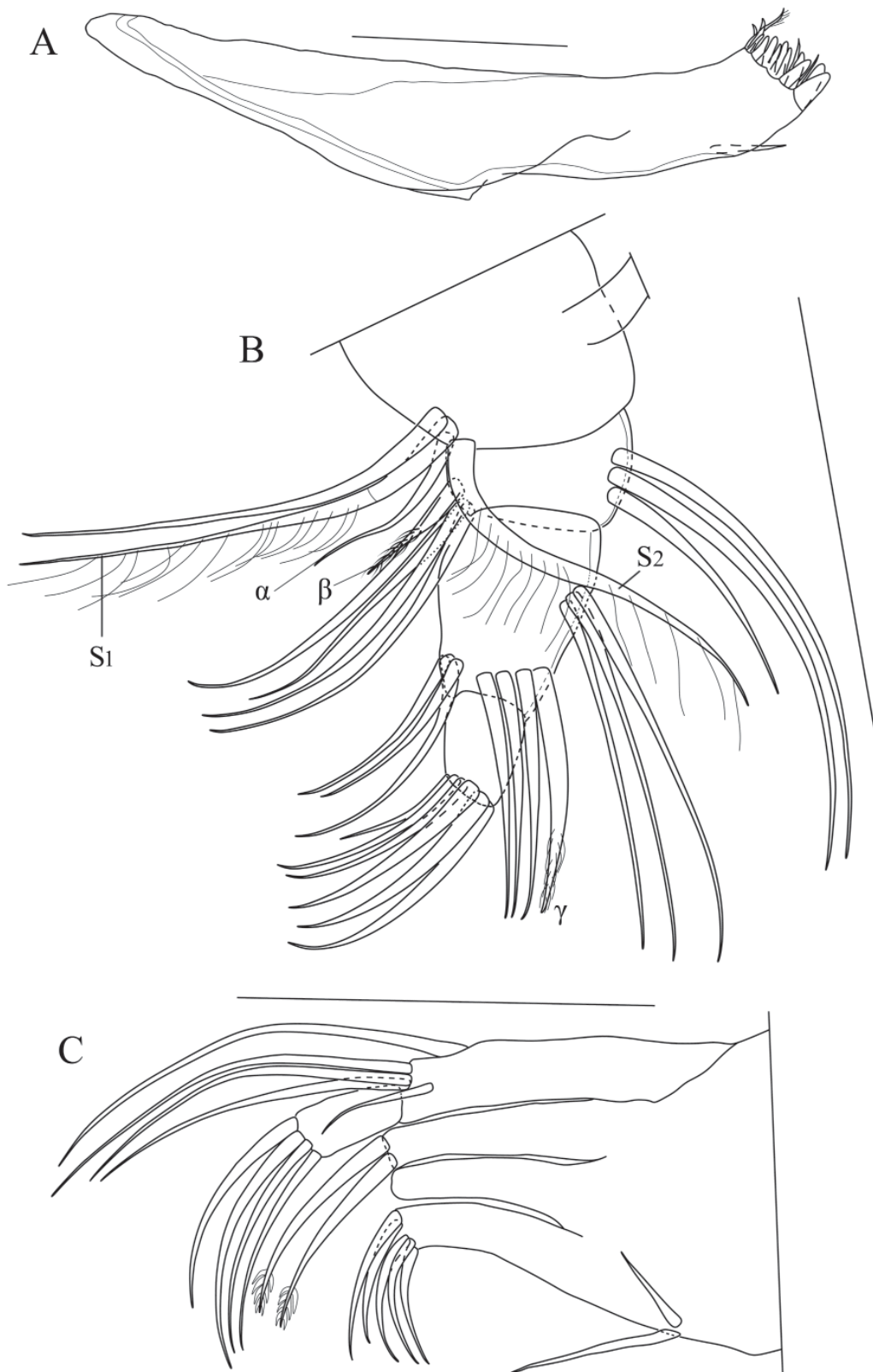


**Fig. 3.** *Brasilodopsis baiabonita* gen. et sp. nov. from Bonito, State of Mato Grosso do Sul, ♂. **A.** LVi (MZUSP 41836). **B.** RVi (MZUSP 41836). **C.** LVi, detail of posterior part (MZUSP 41836). **D.** LVi, detail of anterior part (MZUSP 41836). **E.** RVi, detail of anterior part (MZUSP 41836). **F.** RVi, detail of posterior part (MZUSP 41836). **G.** CpR1 (MZUSP 41837). **H.** CpD (MZUSP 41838). **I.** CpV (MZUSP 41839). **J.** CpD, detail of pores and setae (MZUSP 41838). Scale bars: A–B, G–I = 300  $\mu$ m; C–F = 100  $\mu$ m; J = 50  $\mu$ m.

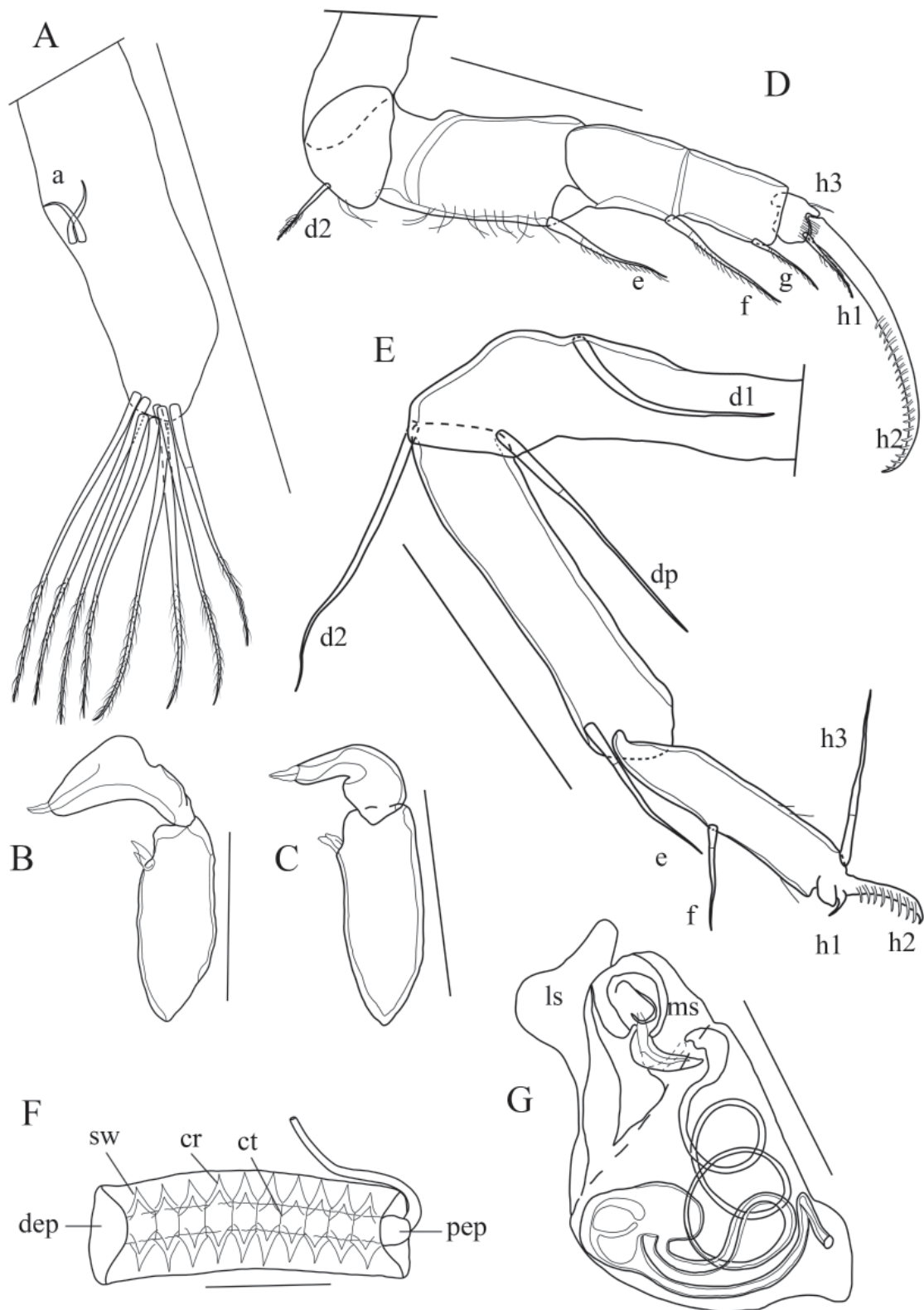


**Fig. 4.** *Brasilodopsis baiabonita* gen. et sp. nov. from Bonito, State of Mato Grosso do Sul, ♂. **A.** A1 (MZUSP 41825). **B.** Rake-like organ (MZUSP 41825). **C.** A2, without the terminal segment (MZUSP 41827). **D.** A2, terminal segment (MZUSP 41827). Abbreviations: see text and Material and methods. Scale bars: A, C–D = 50 µm; B = 20 µm.





**Fig. 5.** *Brasilodopsis baiabonita* gen. et sp. nov. from Bonito, State of Mato Grosso do Sul, ♂. **A.** Md (MZUSP 41827). **B.** Md-palp (MZUSP 41825). **C.** Mx1 (MZUSP 41825). Abbreviations: see text and Material and methods. Scale bars: A–C = 50  $\mu$ m.



**Fig. 6.** *Brasilodopsis baiabonita* gen. et sp. nov. from Bonito, State of Mato Grosso do Sul, ♂. **A.** T1 (MZUSP 41825). **B.** Rpp (MZUSP 41827). **C.** Lpp (MZUSP 41827). **D.** T2 (MZUSP 41825). **E.** T3 (MZUSP 41827). **F.** Zenker's organ (MZUSP 41827). **G.** Hemipenis (MZUSP 41827). Abbreviations: see text and Material and methods. Scale bars: 50  $\mu$ m.

T2 (Fig. 6D) with protopodite, a ‘knee’-segment and four endopodite segments. Protopodal segment without seta d1. ‘Knee’-segment with one short subapical seta d2. First endopodal segment with one apical hirsute seta e, reaching the tip of the second endopodal segment. Second endopodal segment with one apical hirsute seta f, reaching beyond the tip of the terminal segment. Third endopodal segment with one subapical hirsute seta g, approximately half of the length of the seta f. Terminal segment with one apical serrated claw h2, one short hirsute subapical seta h1 and a very short seta h3.

T3 (Fig. 6E) with three segments. First segment with two unequal long (d2, dp) and one shorter setae d1. Second segment with one subapical seta e, reaching the middle of the third segment. Third segment medially with one seta f, about  $\frac{1}{2}$  the length of the third segment. Distal part of third segment with a pincer structure, one small spine-like structure (h1), one long subapical seta h3, about twice of the length of the broad seta h2, the latter set with spine-like setulae.

Zenker’s organ (Fig. 6F) about four times as long as wide, with ca 10 sw.

Hemipenis (Fig. 6G) with distal lobe of ms rounded, distal lobe of ls bird head-shaped, with rounded margins, and a bluntly pointed distal beak.

### Female

LVi (Figs 7A, C–D; 8A, C–D), RVi (Figs 7B, E–F; 8B, E–F), CpRl (Fig. 8G), CpD (Fig. 8H) and CpV (Fig. 8I) as in the male.

A1, Rake-like organ, Md-coxa and Mx1 (not illustrated) as in the male.

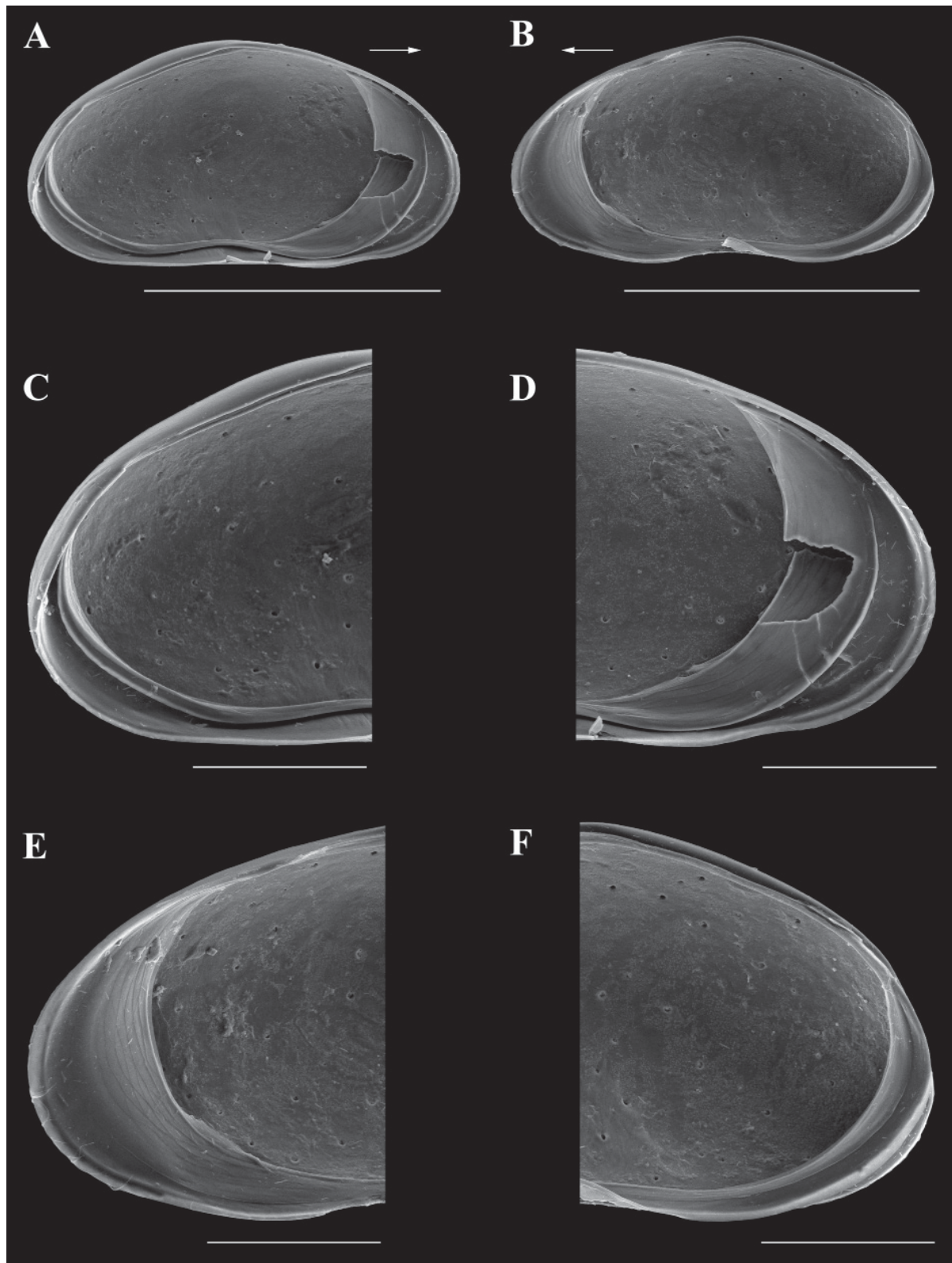
A2 (Fig. 9A–B) with protopodite, exopodite and three-segmented endopodite. Protopodite ventrally with three setae: two unequal but short setae, one long apical seta reaching beyond the tip of the terminal segment. Exopodite reduced to a small plate with one long seta (reaching beyond the tip of the terminal segment) and two sub-equal short setae. First endopodal segment ventrally with aestethasc Y (more than  $\frac{1}{3}$  of the length of this segment), one long hirsute ventral seta (reaching beyond the tip of the terminal segment), and five natatory setae, reaching beyond the tip of the end claws, and one short accompanying seta, about  $\frac{1}{2}$  of the length of the second endopodal segment. Second endopodal segment with two unequal, but long dorsal setae, four ventral setae t (two unequal but long, one ca half of the length of the longest setae, and one short, approximately  $\frac{1}{4}$  of longest setae); apically with three claws (G1, G2, G3) and three setae (z1, z2, z3). Terminal segment (Fig. 9B) with two claws, one long (GM) one short (Gm) and one aesthetasc y3 with accompanying seta, slightly longer than y3. Seta g absent.

T1 (Fig. 9C) Protopodite apically with a group of eight hirsute setae; two short setae a and one long seta d. Endopodite apically with three subequal long and plumose setae.

T2 (Fig. 10A) largely as in the male, with protopodite, a ‘knee’-segment and four endopodite segments. Protopodal segment without seta d1. ‘Knee’ segment with one short subapical seta d2. First endopodal segment with one apical hirsute seta e, reaching the tip of the second endopodal segment. Second endopodal segment with one apical hirsute seta f, just reaching the tip of the fifth segment. Third endopodal segment with one subapical hirsute seta g, approximately  $\frac{2}{3}$  of the length of the seta f. Terminal segment with one apical serrated claw h2, one short hirsute subapical seta h1 and a very short seta h3 (not visible here).

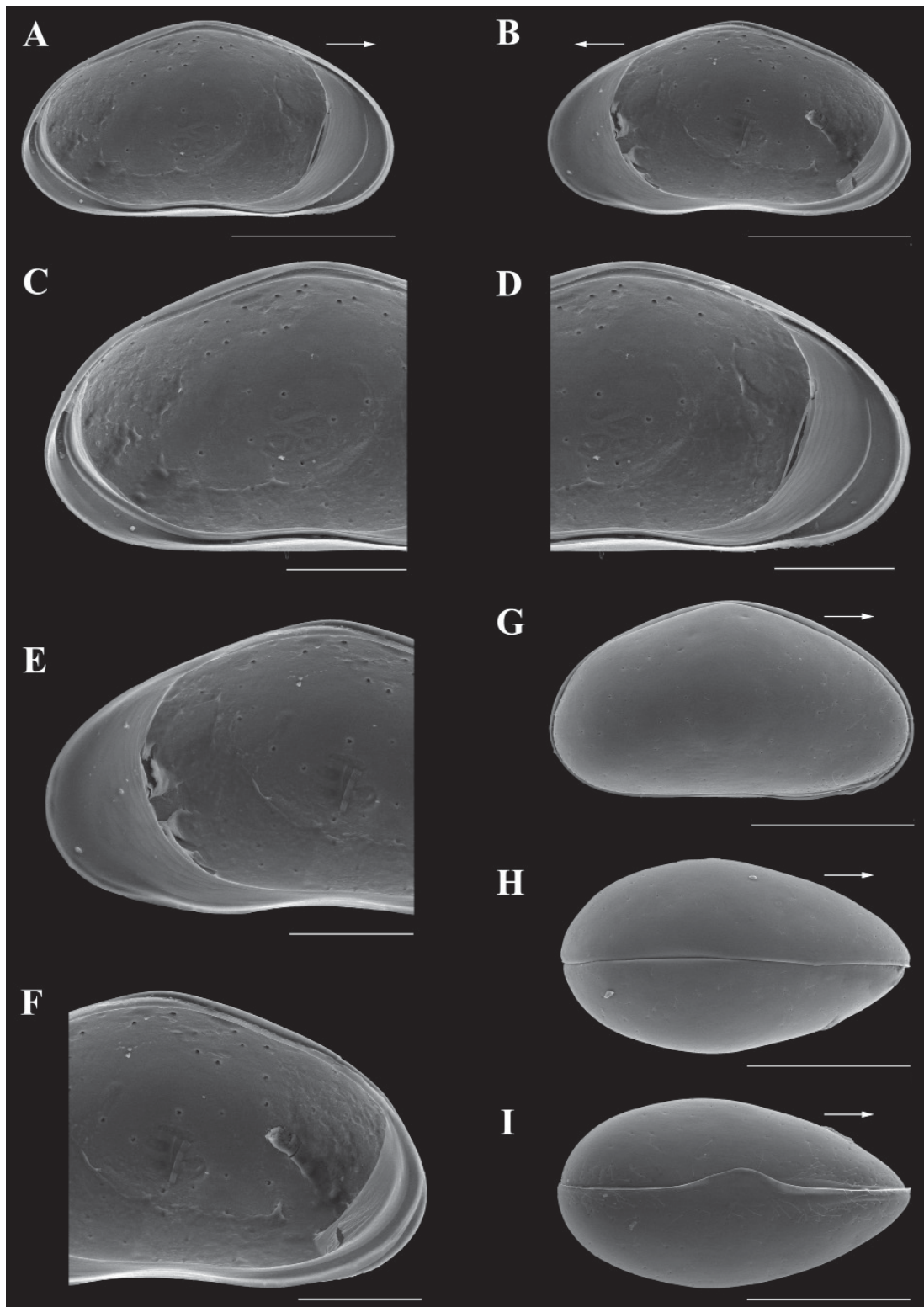
T3 (Fig. 10B) largely as in the male, with three segments. First segment with two unequal long (d2, dp) and one shorter setae d1. Second segment with one subapical seta e, reaching the middle of the third segment. Third segment medially with one seta f, about  $\frac{1}{2}$  the length of the third segment. Distal part of third segment with a pincer structure, one small spine-like structure (h1), one long subapical seta h3, about twice the length of the broad seta h2, the latter set with spine-like setulae.

CR (Fig. 10C) with cylindrical base, one subapical short seta and one long apical seta (ca 3 times the length of the base).



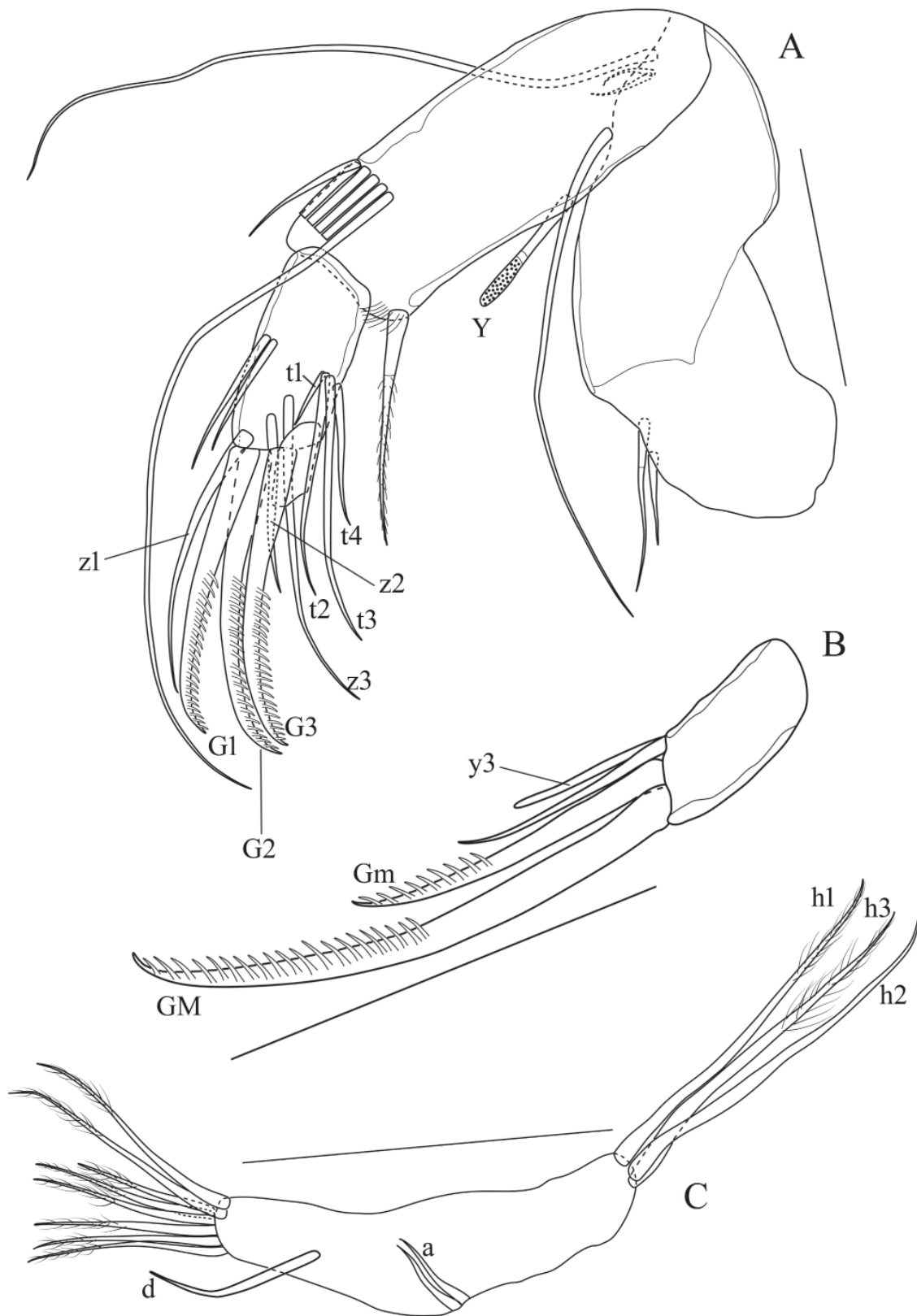
**Fig. 7.** *Brasilodopsis baiabonita* gen. et sp. nov. from Bonito, State of Mato Grosso do Sul, ♀. **A.** LVi (MZUSP 41826). **B.** RVi (MZUSP 41826). **C.** LVi, detail of posterior part (MZUSP 41826). **D.** LVi, detail of anterior part (MZUSP 41826). **E.** RVi, detail of anterior part (MZUSP 41826). **F.** RVi, detail of posterior part (MZUSP 41826). Scale bars: A–B = 300  $\mu$ m; C–F = 100  $\mu$ m.



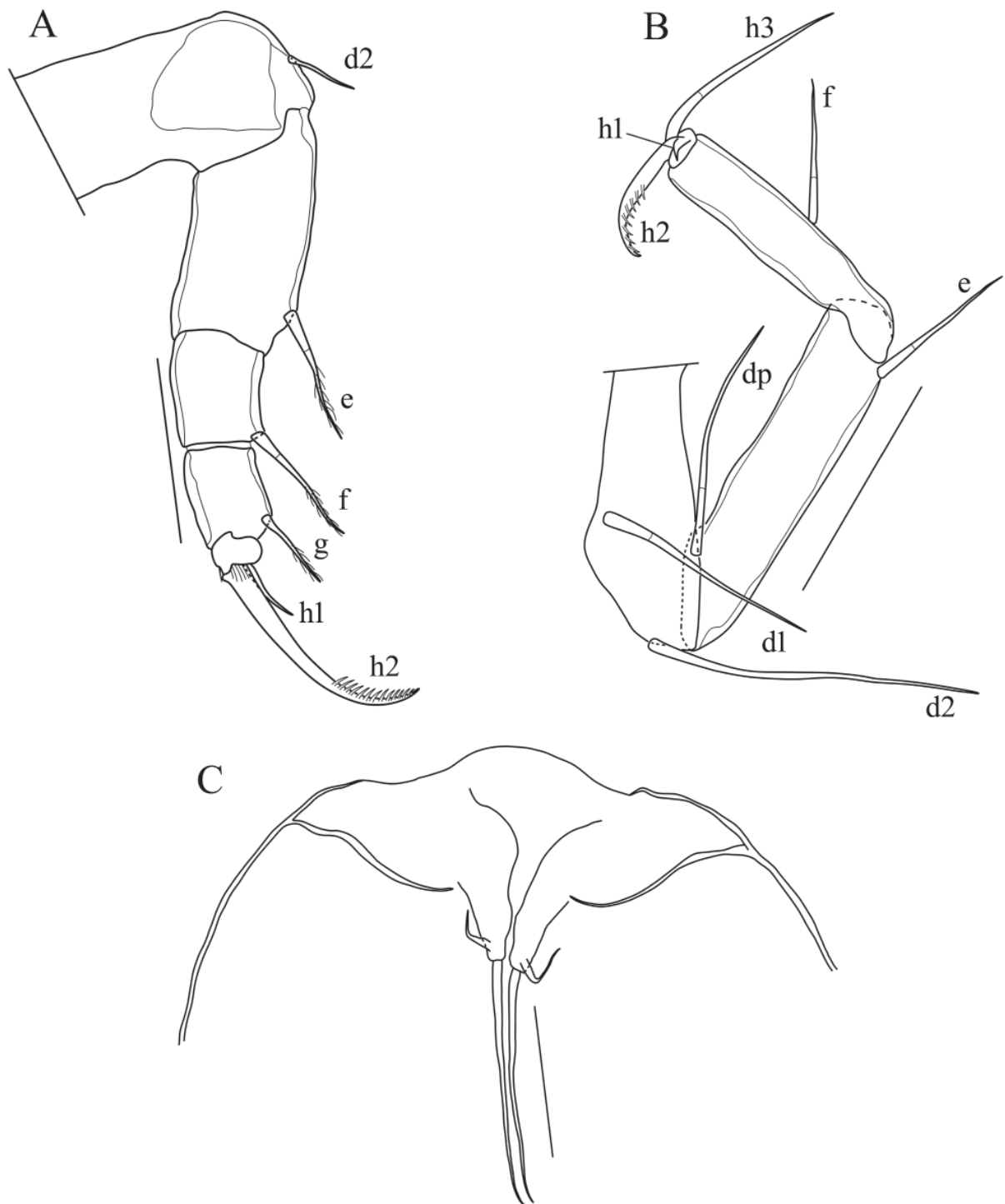


**Fig. 8.** *Brasilodopsis baiabonita* gen. et sp. nov. from Bonito, State of Mato Grosso do Sul, ♀. **A.** LVi (MZUSP 41840). **B.** RVi (MZUSP 41840). **C.** LVi, detail of posterior part (MZUSP 41840). **D.** LVi, detail of anterior part (MZUSP 41840). **E.** RVi, detail of anterior part (MZUSP 41840). **F.** RVi, detail of posterior part (MZUSP 41840). **G.** CpR1 (MZUSP 41841). **H.** CpD (MZUSP 41842). **I.** CpV (MZUSP 41843). Scale bars: A–B, G–I = 300 µm; C–F = 100 µm.

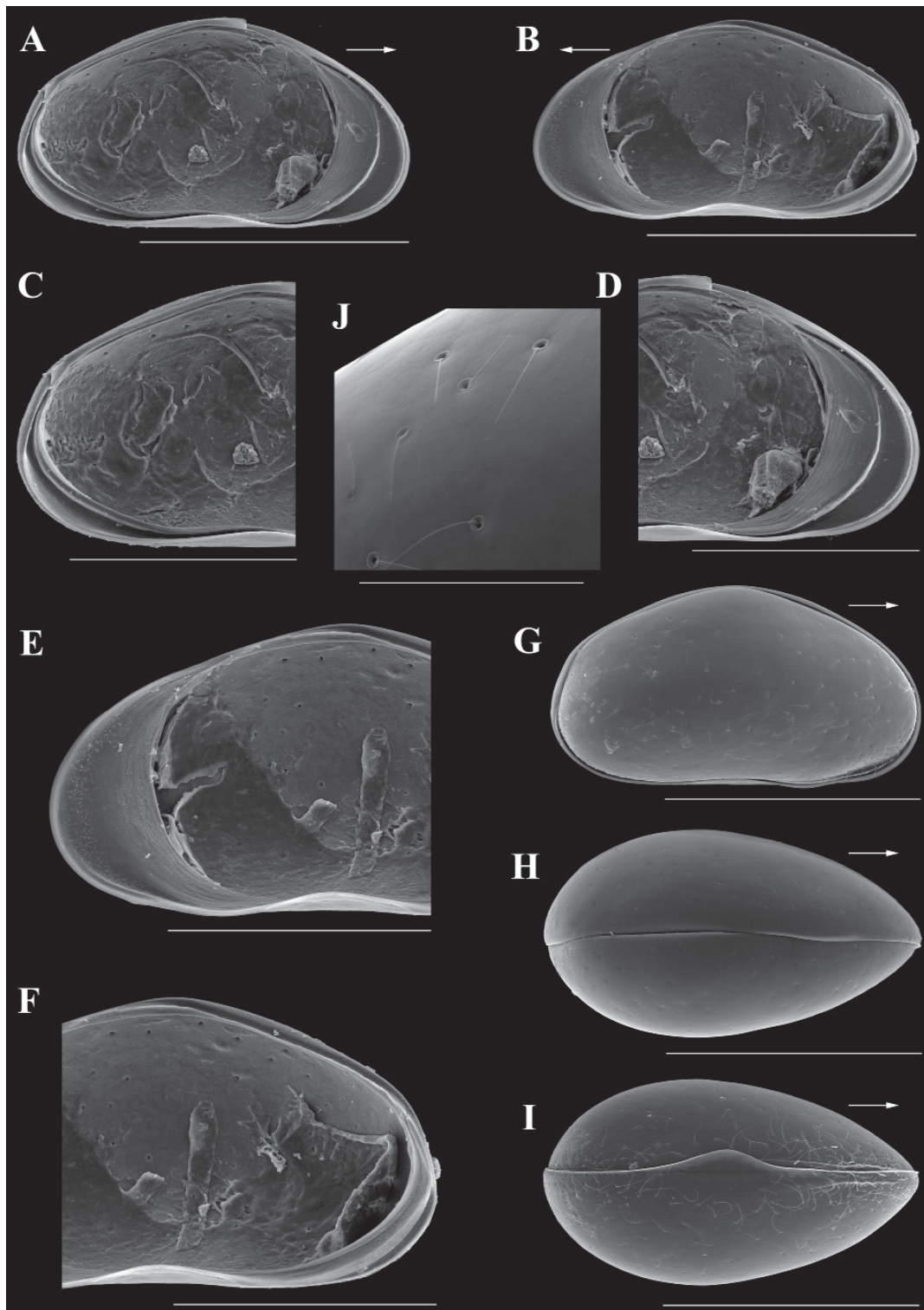




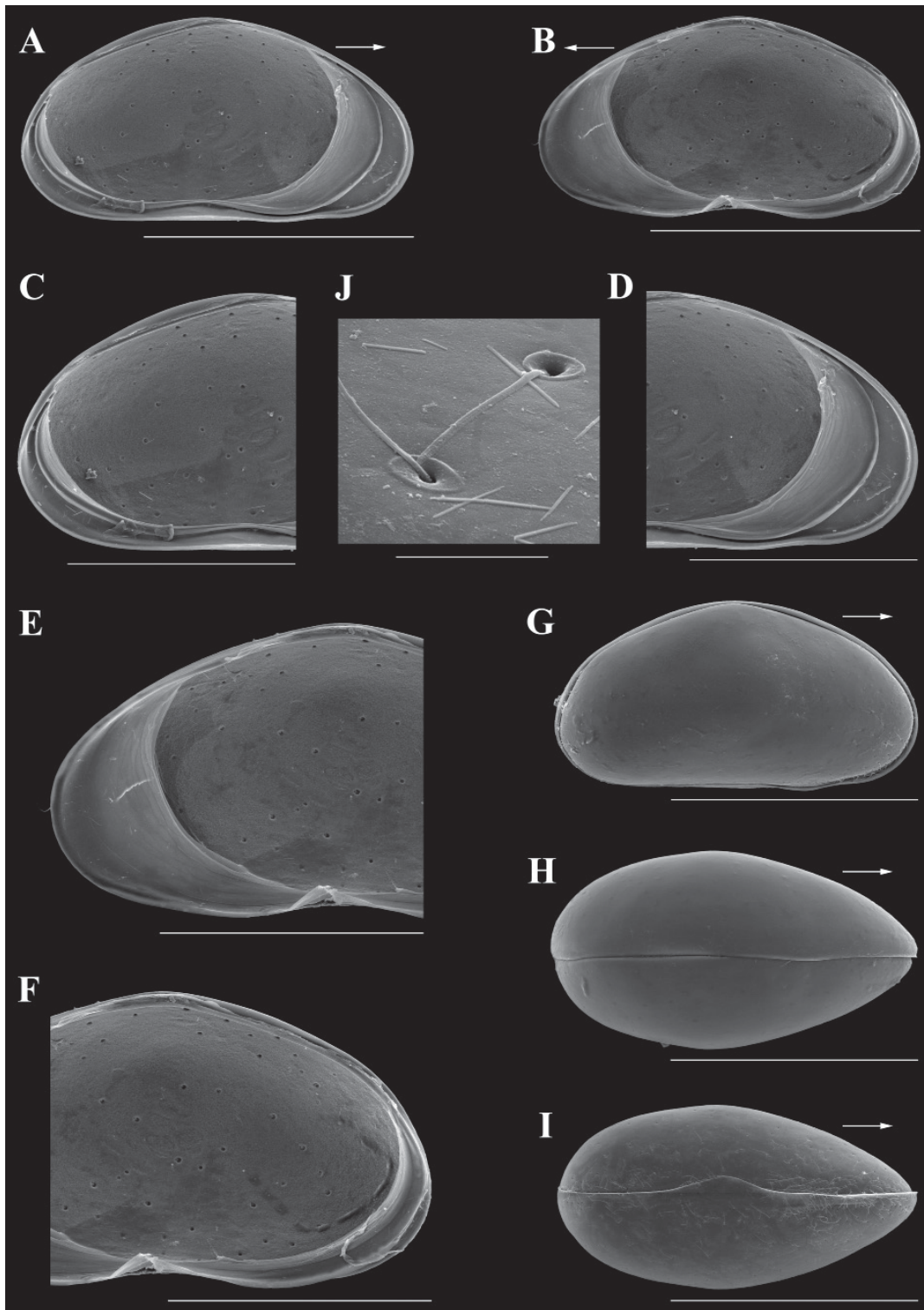
**Fig. 9.** *Brasilodopsis baiabonita* gen. et sp. nov. from Bonito, State of Mato Grosso do Sul, ♀. **A.** A2, without the terminal segment (MZUSP 41832). **B.** A2, terminal segment (MZUSP 41832). **C.** T1 (MZUSP 41826). Abbreviations: see text and Material and methods. Scale bars: 50  $\mu$ m.



**Fig. 10.** *Brasilodopsis baiabonita* gen. et sp. nov. from Bonito, State of Mato Grosso do Sul, ♀. **A.** T2 (MZUSP 41832). **B.** T3 (MZUSP 41832). **C.** CR (MZUSP 41826). Abbreviations: see text and Material and methods. Scale bars: 50  $\mu$ m.



**Fig. 11.** *Brasilodopsis baiabonita* gen. et sp. nov. from Araguaia River floodplain, ♀. **A.** LVi (MZUSP 41844). **B.** RVi (MZUSP 41844). **C.** LVi, detail of posterior part (MZUSP 41844). **D.** LVi, detail of anterior part (MZUSP 41844). **E.** RVi, detail of anterior part (MZUSP 41844). **F.** RVi, detail of posterior part (MZUSP 41844). **G.** CpRl (MZUSP 41845). **H.** CpD (MZUSP 41846). **I.** CpV (MZUSP 41847). **J.** CpD, detail of Cp surface (MZUSP 41846). Scale bars: A–B, G–I = 300 µm; C–F = 200 µm; J = 50 µm.



**Fig. 12.** *Brasilodopsis baiabonita* gen. et sp. nov. from Upper Paraná River floodplain, ♀. **A.** LVi (MZUSP 41848). **B.** RVi (MZUSP 41848). **C.** LVi, detail of posterior part (MZUSP 41848). **D.** LVi, detail of anterior part (MZUSP 41848). **E.** RVi, detail of anterior part (MZUSP 41848). **F.** RVi, detail of posterior part (MZUSP 41848). **G.** CpRl (MZUSP 41849). **H.** CpD (MZUSP 41850). **I.** CpV (MZUSP 41851). **J.** CpV, detail of Cp surface (MZUSP 41851). Scale bars: A–B, G–I = 300 µm; C–F = 200 µm; J = 10 µm.



**Table 3.** Comparative morphology of the two new genera described in this paper.

Species/Character	LV inner list	RV post. inner list	A2 nat. setae	Mx1, setae on 1 <sup>st</sup> palp segment	T1, d1 seta	T1, d2 seta	CR
<i>Brasilodopsis baiabonita</i> gen. et sp. nov.	Strong	Present	Long	4+1	Absent	Present	Flagellate
<i>Brasilodopsis amazonica</i> gen. et sp. nov.	Strong	Present	Long	4+1	Absent	Present	Flagellate
<i>Paranadopsis reducta</i> gen. et sp. nov.	Weak	Absent	Absent	2	Absent	Absent	Absent

### Differential diagnosis

Cp sub-ovate, slightly higher and with blunt point in the middle of the dorsal margin (smoothly rounded in *B. amazonica* gen. et sp. nov.). Posterior inner list in LV more robust than in *B. amazonica* gen. et sp. nov. (see Table 3). External valve surface smooth, with sparse setae and pores in *Brasilodopsis baiabonita* gen. et sp. nov., (densely set with rimmed pores in shallow pits in *B. amazonica* gen. et sp. nov.). Hemipenis outline similar in both species, but distal segments of prehensile palps with subtle differences.

### Ecology and distribution

*Brasilodopsis baiabonita* gen. et sp. nov. was recorded from three tropical Brazilian floodplains (Araguaia, Pantanal and Paraná), associated with different species of macrophytes and sediment (mud, sand). The water temperature ranged between 18.5 and 32.6°C. The pH ranged from acid (5) to basic (8.9). The range of electrical conductivity was between 14 and 415  $\mu\text{S}\cdot\text{cm}^{-1}$  and the values of dissolved oxygen varied from 0.1 to 7.8  $\text{mg}\cdot\text{L}^{-1}$  (see Table 4).

### Remarks

In order to show that valve and Cp morphologies are similar in all three floodplains, we here also illustrate this in Figs 11 (Araguaia) and 12 (Paraná), albeit for all-female populations only.

#### *Brasilodopsis amazonica* gen. et sp. nov.

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Figs 13–17

“*Cypridopsis*” n. gen. 1 n.sp. – Higuti & Martens 2016: appendix 1.

### Diagnosis

LV and RV with well-developed anterior calcified inner lamella, with greatest height in both valves situated in the middle of the smoothly curved dorsal margin. A2 with the natatory setae reaching beyond the tip of the end claws and seta g absent. Valve surface densely set with rimmed pores in shallow pits. T1 with seta d present in female, absent in male. CR present in female only. Male prehensile palps asymmetrical; Rpp with first segment rather stout and second segment with triangular lobe; Lpp with first segment elongated and second segment sickle shaped. Hemipenis with ventral lobe of ms rounded and ventral lobe of ls bird head-shaped; with two loops in post-labyrinthal spermiduct.



**Table 4** (continued on next page). Localities (and some environmental characteristics) where the new genera and new species were collected. Bold represents the type localities of the new species. Abbreviations: WT = water temperature; EC = electrical conductivity; DO = dissolved oxygen; nd = no data; Bb = *Brasilodopsis baiabonita* gen. et sp. nov.; Ba = *Brasilodopsis amazonica* gen. et sp. nov.; Pr = *Paranadopsis reducta* gen. et sp. nov.; Az = *Azolla* sp.; Ea = *Eichhornia azurea* Kunth.; Ec = *Eichhornia crassipes* (Mart.); Le = *Lemna* sp.; Li = *Limnium* sp.; Lu = *Ludwigia* sp.; Pa = *Paspalum* sp.; Pi = *Pistia* sp.; Ps = *Pistia stratiotes* L.; Ri = *Ricciocarpus* sp.; Sap = *Salvinia* spp.; Sa = *Salvinia auriculata* Aubl.; Sm = *Salvinia minima* Baker; Ut = *Utricularia* sp.

Locality name	Sample nr	S°	S'	S"	W°	W'	W"	Floodplain	Date	Substrate type	WT (°C)	EC (µS.cm <sup>-1</sup> )	pH	DO (mg.L <sup>-1</sup> )	Bb	Ba	Pr
1. Monte Cristo Lake	AMA 42	3	6	43.4	60	40	28	Amazon	15 May 2012	Ec	31.7	67.1	6.5	0.4			♀
2. Grande Lake	AMA 56	3	22	24.8	60	35	4.7	Amazon	16 May 2012	Ec, Pi, Sa, Az	31.5	54.1	6.6	1.2			♂ ♀
3. Poço Curuçá Lake	AMA 59	3	3	17.6	60	34	6	Amazon	16 May 2012	Ec, Sap, Lu, Le, Az	31.5	51.8	6.6	1.4			♂ ♀
4. Cadete Lake	AMA 63	3	24	9.7	60	33	19.1	Amazon	16 May 2012	Pa, Az, Li, Sa	32	48.9	6.6	1.7			♀
5. Fuxico Lake	AMA 69	3	25	21.5	60	29	13	Amazon	16 May 2012	Ec	32.9	41.5	6.5	1.31			♀
6. Grande II Lake Jamaucá	AMA 73	3	22	33.1	60	17	55.1	Amazon	17 May 2012	Ec, Sm, Az	32.3	42.5	6.5	3			♀
7. <b>Castanho Lake</b>	<b>AMA 79</b>	<b>3</b>	<b>24</b>	<b>4.6</b>	<b>60</b>	<b>13</b>	<b>26.9</b>	<b>Amazon</b>	<b>17 May 2012</b>	<b>Az, Sa, Lu</b>	<b>32.5</b>	<b>43.5</b>	<b>6.4</b>	<b>0.9</b>			♂ ♀
8. Comprido Lake	AMA 82	3	14	0.3	59	57	53.8	Amazon	17 May 2012	Ec	31.5	65.1	6.7	1.8			♀
9. Crixas IV Lake	ARA 05	13	20	37.5	50	36	40	Araguaia	2 Nov. 2011	Pa, Pi, Ri	30	54.4	6.7	6.7			♀
10. Japonês Lake	ARA 09	13	21	33.1	50	36	42.9	Araguaia	3 Nov. 2011	Ec, Pa	29.8	38.8	6.8	5.4			♀
11. Japonês II Lake	ARA 63	13	25	23.6	50	38	57.4	Araguaia	10 Mar. 2012	Ec	29.8	50.2	6.9	5.8			♀
12. Piratinga Lake	ARA 24	13	3	58.9	50	34	57.6	Araguaia	4 Nov. 2011	Pa	29.5	26.5	7	6.8			♀
13. Luiz Alves I Lake	ARA 35	13	13	52.1	50	34	12.3	Araguaia	6 Nov. 2011	Pa, Sa, Az	29.2	33.8	6.7	5.9			♀
14. Luiz Alves II Lake	ARA 38	13	13	34.2	50	34	39.8	Araguaia	6 Nov. 2011	Pa	29.4	44.1	6.4	1.7			♀
15. Montaria I Lake	ARA 66	13	24	7.9	50	43	10.2	Araguaia	10 Mar. 2012	Pa	30.9	31.1	7	7.6			♀
16. Montaria II Lake	ARA 72	13	23	43.1	50	42	17.3	Araguaia	10 Mar. 2012	Pa	30.9	33.4	6.9	7.8			♀
17. Piranha Lake	ARA 77	13	2	53.5	50	37	32.2	Araguaia	11 Mar. 2012	Ut	29.3	46.5	6.8	3.8			♀
18. Varal Lake	ARA 80	13	0	58.4	50	36	12	Araguaia	11 Mar. 2012	Pa	28.5	39.1	6.6	3.9			♀
19. Comprido I Lake	ARA 93	12	52	2.3	50	35	37.9	Araguaia	12 Mar. 2012	Pa	28.9	21.8	6.5	4.3			♀
20. Comprido II Lake	ARA 99	12	51	8.8	50	34	4.8	Araguaia	12 Mar. 2012	Pa	29.5	27.6	6.64	6.24			♀
21. Curva Doleque Road, lake 4	PAN 8	19	31	34	57	2	27	Pantanal	3 Jun. 2003	Macrophytes	24	161	6	nd			♀
22. Carenda Forest Road, lake 1	PAN 9	19	43	39	57	4	19	Pantanal	4 Jun. 2003	Macrophytes	20.5	215	7	nd			♀
23. Carenda Forest Road, lake 2	PAN 11	19	41	33	57	2	34	Pantanal	4 Jun. 2003	Macrophytes	21	215	7	nd			♀
24. Corumba Road, lake 1	PAN 12	19	35	33	57	8	19	Pantanal	4 Jun. 2003	nd	20.8	185	7	nd			♀
25. Corumba Road, pool 2	PAN 14	19	35	38	57	8	3	Pantanal	4 Jun. 2003	nd	19.2	292	7	nd			♀
26. Corumba Road, lake 2	PAN 15	19	37	9	57	5	11	Pantanal	4 Jun. 2003	nd	18.5	nd	7	nd			♀
27. Corumba Road, pool 3	PAN 16	19	36	17	57	6	46	Pantanal	5 Jun. 2003	nd	21.1	nd	7	nd			♀
28. Corumba Road, lake 4	PAN 18	19	37	13	57	5	3	Pantanal	5 Jun. 2003	Macrophytes	22.8	415	7	nd			♀
29. Corumba Road, lake 5	PAN 20	19	37	53	57	3	43	Pantanal	5 Jun. 2003	Ec	23.5	235	7	nd			♀
30. Curva Doleque Road, lake 5	PAN 21	19	37	15	57	2	4	Pantanal	5 Jun. 2003	Macrophytes	24	225	7	nd			♀

Table 4 (continued).

Locality name	Sample nr	S°	S'	S"	W°	W'	W''	Floodplain	Date	Substrate type	WT (°C)	EC ( $\mu\text{S}\cdot\text{cm}^{-1}$ )	pH	DO ( $\text{mg}\cdot\text{L}^{-1}$ )	Bb	Ba	Pr
31. Curva Doleque Road, cattle pond	PAN 22	19	34	55	57	2	14	Pantanal	5 Jun. 2003	Mud	24	269	7	nd	♀		
32. Vermelho River	PAN 23	19	37	2	56	57	48	Pantanal	5 Jun. 2003	Ea	20	59	6	nd	♀		
33. Medalha Lake	PAN 25	19	34	32	57	0	51	Pantanal	7 Jun. 2003	Ea, Sap	24	155	6	nd	♀		
34. BEP wetland 1	PAN 26	19	34	38	57	1	11	Pantanal	7 Jun. 2003	Macrophytes	24	192	7	nd	♀		
35. Camp Road, pool 2	PAN 29	19	34	30	57	1	23	Pantanal	7 Jun. 2003	Grass	25	210	7.5	nd	♀		
36. Camp Road, pool 4	PAN 31	19	34	34	57	1	7	Pantanal	7 Jun. 2003	Macrophytes	23	209	7	nd	♀		
37. Formoso River	PAN 33	21	10	26.5	56	26	56	Bonito	10 Jun. 2003	Sand, mud	nd	nd	nd	nd	♂	♀	
38. Baía Bonita River	PAN 36	21	9	57.4	56	26	26	Bonito	10 Jun. 2003	Macrophytes	nd	nd	nd	nd	♂	♀	
39. Roadside pool	PAN 41	21	9	45.7	56	27	44.2	Pantanal	10 Jun. 2003	nd	nd	38	5	nd	♀		
40. Arrozal Lake	PAN 43	19	2	3.7	57	28	13.9	Pantanal	20 Aug. 2011	Sa, Ea	24.9	84.8	7.4	0.3	♀		
41. Tuiuiu Lake	PAN 45	18	48	30.2	57	39	20.4	Pantanal	21 Aug. 2011	Ec, Sa, Pi	21	54.3	7	5.1	♀		
42. Caeres Lake	PAN 48	18	58	42.3	57	43	43.3	Pantanal	21 Aug. 2011	Ec, Sa, Pi	21.1	82.7	8.9	5.8	♀		
43. Odila I Lake	PAN 52	19	27	47.6	57	24	52.6	Pantanal	22 Aug. 2011	Ec, grass, Sm, Pi	19.9	59.2	7.5	0.1	♀		
44. Odila II / Jaburu Lake	PAN 54	19	28	28.5	57	24	57.7	Pantanal	22 Aug. 2011	Pi, Sa, Ec	22	56.9	7.5	4.8	♀		
45. Baía Ponte Lake	PAN 58	19	30	11.7	57	25	39.1	Pantanal	22 Aug. 2011	Ec, Sa, Lu	21.3	57.7	7.5	3.5	♀		
46. Baía Bugre Lake	PAN 60	19	30	43.3	57	23	27.3	Pantanal	22 Aug. 2011	Ec, Ea, Sap	20.4	119.4	7.6	4.6	♀		
47. Miranda I River	PAN 63	19	25	38.2	57	18	58.4	Pantanal	23 Aug. 2011	Ea, Ec	20.1	162.2	8	4.9	♂	♀	
48. Miranda II River	PAN 66	19	25	7.7	57	18	49	Pantanal	23 Aug. 2011	Ea, Pi, Sap, Lu	19.7	140	8.1	4.5	♀		
49. Miranda III River	PAN 69	19	26	23.1	57	18	21.4	Pantanal	23 Aug. 2011	Ec	20.3	162	7.9	3.9	♀		
50. Miranda IV River	PAN 72	19	25	49	57	19	12	Pantanal	23 Aug. 2011	Sap, Ec	21	162.1	7.8	3.6	♀		
51. Mirandinha Lake	PAN 75	19	24	16.6	57	18	3.5	Pantanal	24 Aug. 2011	Ec, Ea	20.3	51.1	7.3	4.1	♀		
52. Figueira Lake	PAN 78	19	24	24	57	18	49.3	Pantanal	24 Aug. 2011	Sap, Ec	20.9	52.8	7.4	4.2	♀		
53. Ilha Grande Lake	PAN 81	19	25	33.3	57	21	11.7	Pantanal	24 Aug. 2011	Ec	21.5	53.5	7.5	4	♀		
54. Piuva Lake	PAN 87	19	26	52.7	57	23	9.9	Pantanal	24 Aug. 2011	Sap, Ec	21.4	63.8	7.8	4.5	♀		
55. Corixão Lake	PAN 90	19	32	9.7	57	3	3.3	Pantanal	25 Aug. 2011	Ea, Pi, Li	21.5	102.1	7.8	1.5	♀		
56. Paraguay River	PAN 130	19	24	48.9	57	18	51.3	Pantanal	27 Mar. 2012	Ec	nd	nd	nd	nd	♀		
57. Albuquerque Lake	PAN 137	19	24	29.1	57	22	12.9	Pantanal	27 Mar. 2012	Ec	26.5	58.2	6	5.5	♀		
58. Rebojão Lake	PAN 153	19	35	9.9	56	59	29.7	Pantanal	29 Mar. 2012	Lu	24.7	118.5	6.5	1.6	♀		
59. Jacare Lake	PAR 21	22	47	10	53	29	56	Paraná	13 Mar. 2004	Litoral	27.3	48.6	6.4	5.3	♀		
60. Caracu Stream	PAR 100	22	46	6	53	15	28	Paraná	17 Mar. 2004	Sand	27.2	54.3	6.9	6.4	♀		
61. Manezinho Backwater	EC1	22	46	45.3	53	20	56.4	Paraná	2 Mar. 2007	Ec	28.9	52.6	6.8	4.1	♀		♀
62. Pombas Lake	PAR 1520	22	47	56.8	53	21	36.6	Paraná	22 Mar. 2018	Az	28.3	61	7	7.6	♀		♀
63. Ilha Pacu Lake	PAR 1522	22	47	28.3	53	19	53.6	Paraná	22 Mar. 2018	Ec	29	57	6.3	3.1	♀		♀
64. Porcos Lake	PAR 1499	22	41	57.6	53	14	39.4	Paraná	21 Mar. 2018	Ec	31.3	20	6	1.5	♀		♀
65. Gavião Lake	PAR 1514	22	40	49.3	53	12	59.8	Paraná	21 Mar. 2018	Ec	32.6	14	5.8	2.3	♀		♀

### Etymology

The species is named after the area from which it is here described, namely Amazonia, Brazil.

### Material examined

#### Holotype

BRAZIL • ♂; Amazon River floodplain, Castanho Lake; 3°24'4.6" S, 60°13'26.9" W; 17 May 2012; J. Higuti leg.; with soft parts dissected in glycerine in a sealed slide, valves stored dry in a micropalaeontological slide; sample AMA 79; MZUSP 41852.

#### Allotype

BRAZIL • ♀; Amazon River floodplain, Castanho Lake; 3°24'4.6" S, 60°13'26.9" W; 17 May 2012; J. Higuti leg.; with soft parts dissected in glycerine in a sealed slide, valves stored dry in a micropalaeontological slide; sample AMA 79; MZUSP 41853.

#### Paratypes

BRAZIL • 2 ♂♂; Amazon River floodplain, Castanho Lake; 3°24'4.6" S, 60°13'26.9" W; 17 May 2012; J. Higuti leg.; with soft parts dissected in glycerine in sealed slides, LV and RV lost; sample AMA 79; MZUSP 41854, MZUSP 41855 • 1 ♂; Amazon River floodplain, Castanho Lake; 3°24'4.6" S, 60°13'26.9" W; 17 May 2012; J. Higuti leg.; with soft parts dissected in glycerine in a sealed slide, LV stored dry in a micropalaeontological slide after use for SEM; sample AMA 79; MZUSP 41856 • 3 ♂♂; Amazon River floodplain, Castanho Lake; 3°24'4.6" S, 60°13'26.9" W; 17 May 2012; J. Higuti leg.; carapaces stored dry in micropalaeontological slides after use for SEM; sample AMA 79; MZUSP 41857 to MZUSP 41859 • 1 ♀; Amazon River floodplain, Castanho Lake; 3°24'4.6" S, 60°13'26.9" W; 17 May 2012; J. Higuti leg.; with soft parts dissected in glycerine in a sealed slide, both LV and RV lost; sample AMA 79; MZUSP 41861 • 1 ♀; Amazon River floodplain, Castanho Lake; 3°24'4.6" S, 60°13'26.9" W; 17 May 2012; J. Higuti leg.; with soft parts dissected in glycerine in sealed slides, valves stored dry in micropalaeontological slides; sample AMA 79; MZUSP 41860 • 1 ♀; Amazon River floodplain, Castanho Lake; 3°24'4.6" S, 60°13'26.9" W; 17 May 2012; J. Higuti leg.; with soft parts dissected in glycerine in sealed slides, valves stored dry in micropalaeontological slides after use for SEM; sample AMA 79; MZUSP 41862 • 3 ♀♀; Amazon River floodplain, Castanho Lake; 3°24'4.6" S, 60°13'26.9" W; 17 May 2012; J. Higuti leg.; carapaces stored dry in micropalaeontological slides after use for SEM; sample AMA 79; MZUSP 41863 to MZUSP 41865.

### Other material examined

BRAZIL • 2 ♀♀; Amazon River floodplain, Fuxico Lake; 3°25'21.5" S, 60°29'13" W; 16 May 2012; J. Higuti leg.; UEM-AMA 69; JH729, JH730 • 3 ♀♀; Amazon River floodplain, Jamauacá Lake; 3°22'33.1" S, 60°17'55.1" W; 17 May 2012; J. Higuti leg.; UEM-AMA 73; JH731 to JH733.

### Measurements of illustrated specimens

See Table 2.

### Description

Remark: most of the material was slightly to considerably decalcified, so that dissections and SEM illustrations were difficult. The holotype male has two intact valves, but these were not used for SEM, because of the risk of damaging them. Other specimens were used for illustration, but no intact RV was available.

#### Male

LVi (Fig. 13A–C – slightly distorted owing to decalcification) with well-developed anterior calcified inner lamella, posterior calcified inner lamella narrow; an inner list running along and parallel to anterior,

ventral and posterior valve margin, inwardly displaced anteriorly and posteriorly; anterior inner list running almost to the dorsal margin, posterior inner list running to the dorsal margin.

RVi (not illustrated) with well-developed anterior calcified inner lamella, posterior calcified inner lamella narrow; short anteroventral trace of an inner list and posteroventrally with an elevated inwardly displaced inner list and a submarginal selvage, both running parallel to the valve margin.

Greatest height in both valves situated in the middle of the smoothly curved dorsal margin. CpRl (Fig. 13E) elongated; dorsal margin smoothly arched; with the greatest height in the middle; external valve surface densely set with rimmed pores in shallow pits (Fig. 13D). CpD (Fig. 13F, H) and CpV (Fig. 13G) sub-ovate; with greatest width situated behind the middle; anterior margin pointed, posterior margin rounded; LV overlapping RV along the anterior, ventral and posterior margins, with a broad flap in the middle.

A1 (not illustrated) with seven segments. First segment large, ventrally with two long apical hirsute setae; dorsally with one short subapical hirsute seta, and with small Wouter's organ. Second segment subquadrate, with one short dorsal seta and a small ventral Rome organ. Third segment with two apical setae (the shorter ventral seta almost reaching the tip of the fourth segment; the longer dorsal seta reaching the edge of the fifth segment). Fourth segment with three apical setae, two long dorsal ones, and one ventral seta, the latter slightly shorter than the length of the fifth segment. Fifth segment with three apical setae, two long dorsal setae and one short ventral seta, the latter reaching half the length of the sixth segment. Sixth segment with four long apical setae. Terminal segment with two long setae, one shorter, but still elongated, aesthetasc Ya and one shorter seta, the latter almost the same length of the aesthetasc Ya.

A2 (Fig. 14A–B) with protopodite, exopodite and three-segmented endopodite. Protopodite ventrally with three setae: two unequal but short setae, one long apical seta reaching beyond the tip of the terminal segment. Exopodite reduced to a small plate with one long seta (reaching beyond the tip of the terminal segment) and two sub-equal short setae. First endopodal segment ventrally with aesthetasc Y (more than  $\frac{1}{3}$  of the length of this segment), one long hirsute ventral seta (reaching beyond the tip of the terminal segment), and five hirsute natatory setae, reaching beyond the tip of the end claws, and one short accompanying seta, about  $\frac{1}{2}$  of the length of the second endopodal segment. Second endopodal segment with two unequal but long dorsal setae, one short hirsute ventral seta t; apically with three claws (G1, G2, z1) and three setae (G3, z2, z3). Terminal segment (Fig. 14B) with two claws, one long (GM) and one short (Gm) and one aesthetasc y3 with accompanying seta (slightly longer than the aesthetasc y3). Seta g absent.

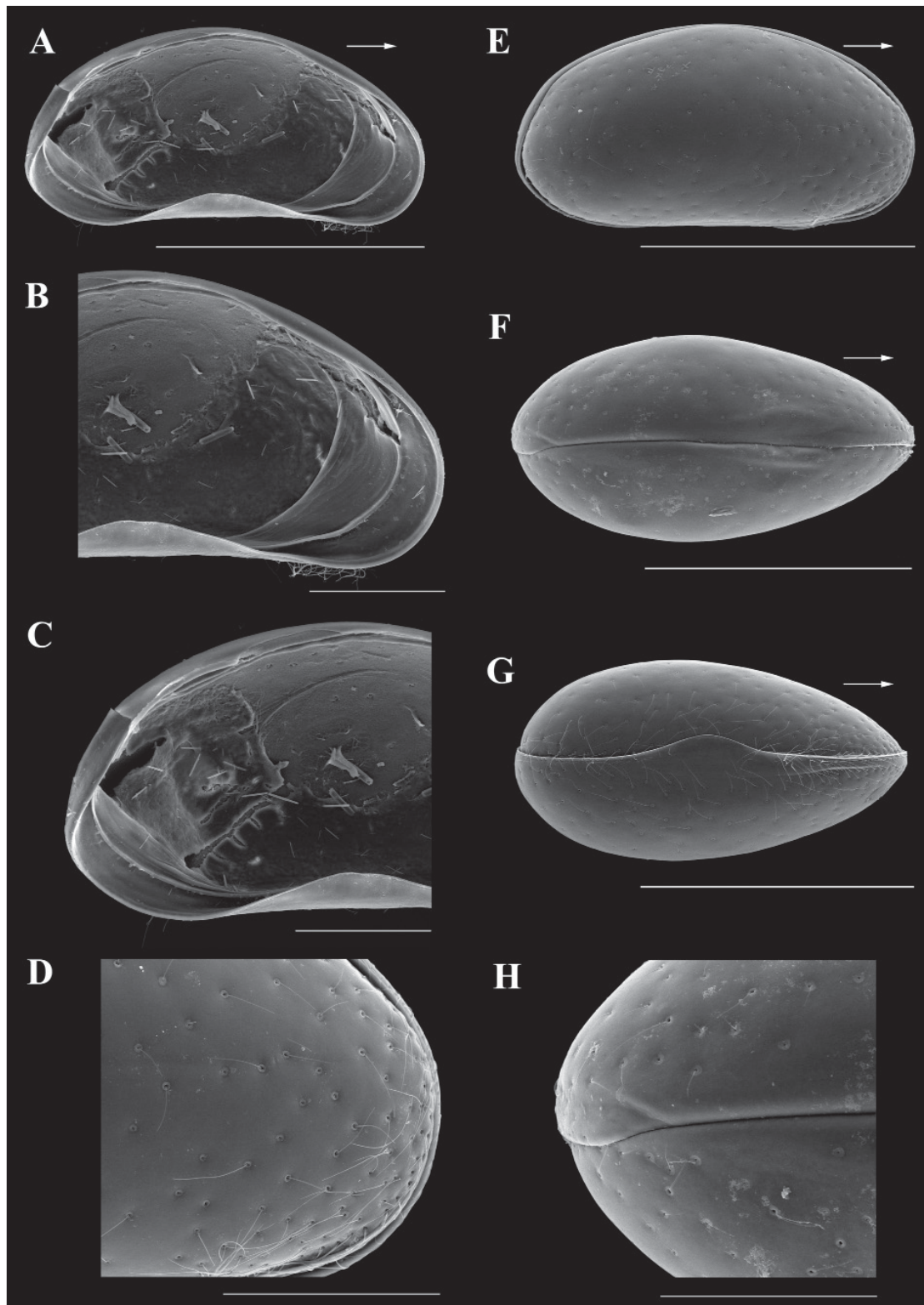
Rake-like organ (not illustrated) stout, solid, T-shaped, with seven apical teeth.

Md-palp (not illustrated) with four segments. First segment with two long plumose setae ( $S_1$  and  $S_2$ ), one long smooth seta and one short smooth seta  $\alpha$ . Second segment with three dorsal setae (two long and one shorter, ca  $\frac{2}{3}$  the length of the two longer ones); ventrally with one hirsute seta  $\beta$  and four long setae (three equally long, and one slightly shorter). Third segment with three groups of setae; dorsally one group of three unequal but long setae; laterally with one hirsute and stout apical seta  $\gamma$  and three smooth setae; ventrally with three unequal shorter setae. Terminal segment with three claws and three setae.

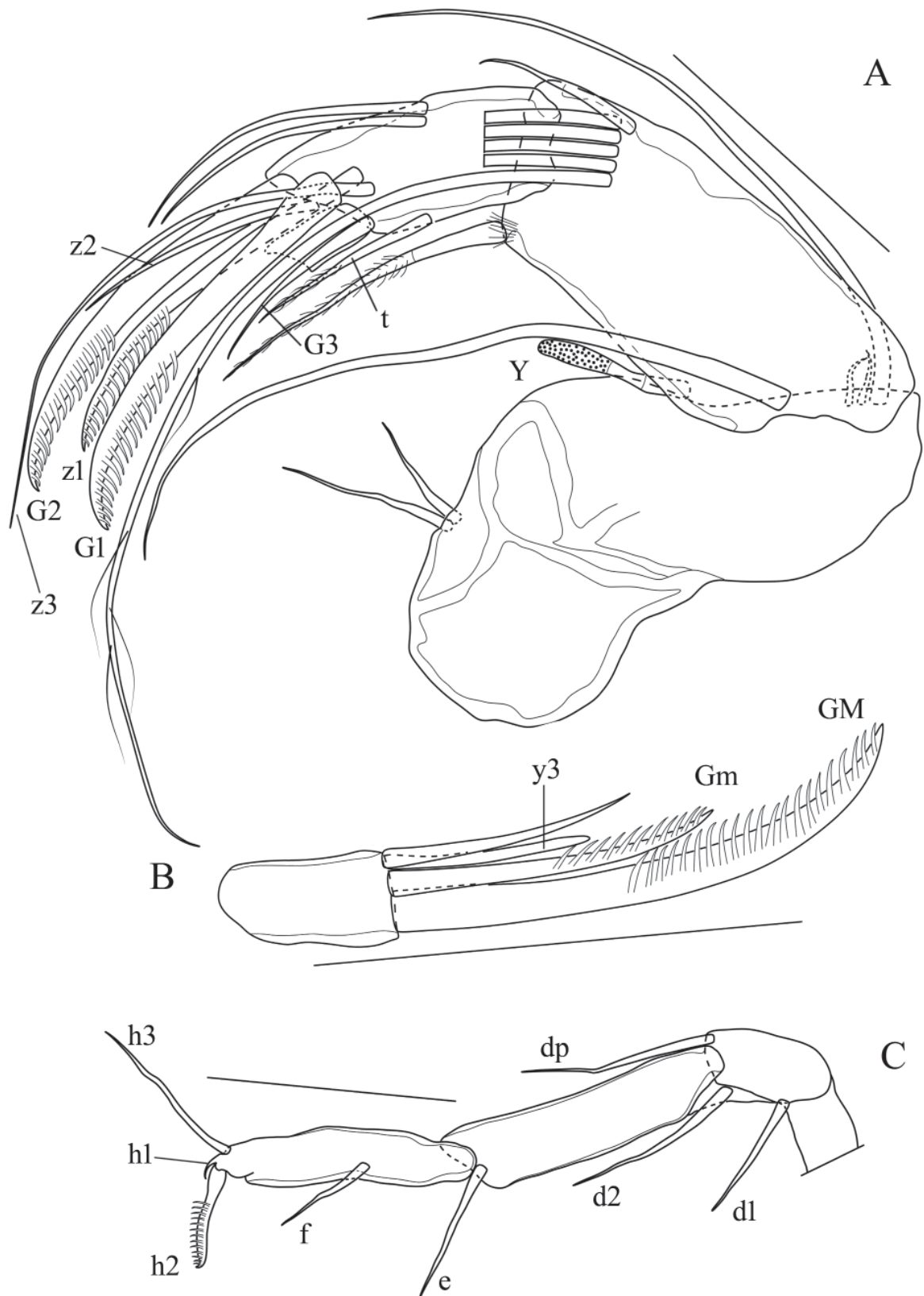
Md-coxa (not illustrated) elongated, dorsally with a short seta, and with strong and apical teeth, interspaced with some setae.

Mx1 (not illustrated) consisting of three masticatory lobes (endites), a two-segmented palp and a large branchial plate (not illustrated). Branchial plate elongated, with ca 16 respiratory rays, some quite short,





**Fig. 13.** *Brasilodopsis amazonica* gen. et sp. nov. from Amazon River floodplain, ♂. **A.** LVi (MZUSP 41856). **B.** LVi, detail of anterior part (MZUSP 41856). **C.** LVi, detail of posterior part (MZUSP 41856). **D.** CpR1, detail of Cp surface (MZUSP 41857). **E.** CpR1 (MZUSP 41857). **F.** CpD (MZUSP 41858). **G.** CpV (MZUSP 41859). **H.** CpD, detail of Cp surface (MZUSP 41858). Scale bars: A, E–G = 300  $\mu$ m; B–D, H = 100  $\mu$ m.



**Fig. 14.** *Brasilodopsis amazonica* gen. et sp. nov. from Amazon River floodplain, ♂. **A.** A2, without the terminal segment (MZUSP 41854). **B.** A2, terminal segment (MZUSP 41854). **C.** T3 (MZUSP 41854). Abbreviations: see text and Material and methods. Scale bars: 50  $\mu$ m.

others longer. First segment of palp with five setae (apically with four unequal but long setae and one short subapical seta, about  $\frac{1}{4}$  of the longest one). Terminal segment of palp ca twice as long as basal width, apically with two claw-like setae and two setae. Third endite apically with two serrated claws and several setae. First endite at its base with two unequal setae and apically with ca five unequal, sideways directed bristles.

T1 protopodite (Fig. 15A–C) apically with a group of eight hirsute setae, and two short setae a inserted in the middle, seta d absent. Endopodites (Fig. 15B–C) asymmetrical prehensile palps: Rpp (Fig. 15B) with first segment rather stout, with two small subapical spines, second segment with triangular lobe, with uneven dorsal and slightly curved distal margin. Lpp (Fig. 15C) with first segment elongated, with two sub-apical spines, second segment sickle-shaped, with swollen basis and blunt distal part.

T2 (not illustrated) with protopodite, a ‘knee’-segment and four endopodite segments. Protopodal segment without seta d1. ‘Knee’-segment with one short subapical seta d2. First endopodal segment with one apical hirsute seta e, reaching the middle of the second endopodal segment. Second endopodal segment with one apical hirsute seta f, reaching beyond the tip of the fifth segment. Third endopodal segment with one subapical hirsute seta g, approximately half of the length of the seta f. Terminal segment with one apical serrated claw h2, one short hirsute subapical seta h1 and a very short seta h3.

T3 (Fig. 14C) with three segments. First segment with two unequal long setae d2 and dp and one shorter seta d1. Second segment with one subapical seta e, reaching beyond the middle of the third segment. Third segment medially with one seta f, about  $\frac{1}{2}$  the length of the third segment. Distal part of third segment with a pincer structure, one small spine-like structure (h1), one long subapical seta h3, about  $1.5 \times$  the length of the broad seta h2, the latter set with spine-like setulae.

Zenker’s organ (Fig. 15D) about 4 times as long as wide, with approximately 10 series of sw.

Hemipenis (Fig. 15E–M) with ventral lobe of ms rounded, ventral lobe of ls bird head-shaped with bluntly pointed distal beak. Post-labyrinthal spermiduct with two loops: one large, one much smaller (Fig. 15E).

Remark: the outline of the hemipenis can show some variability within one specimen and between specimens. Therefore, the hemipenis outlines of four males have been illustrated in Fig. 15F–M.

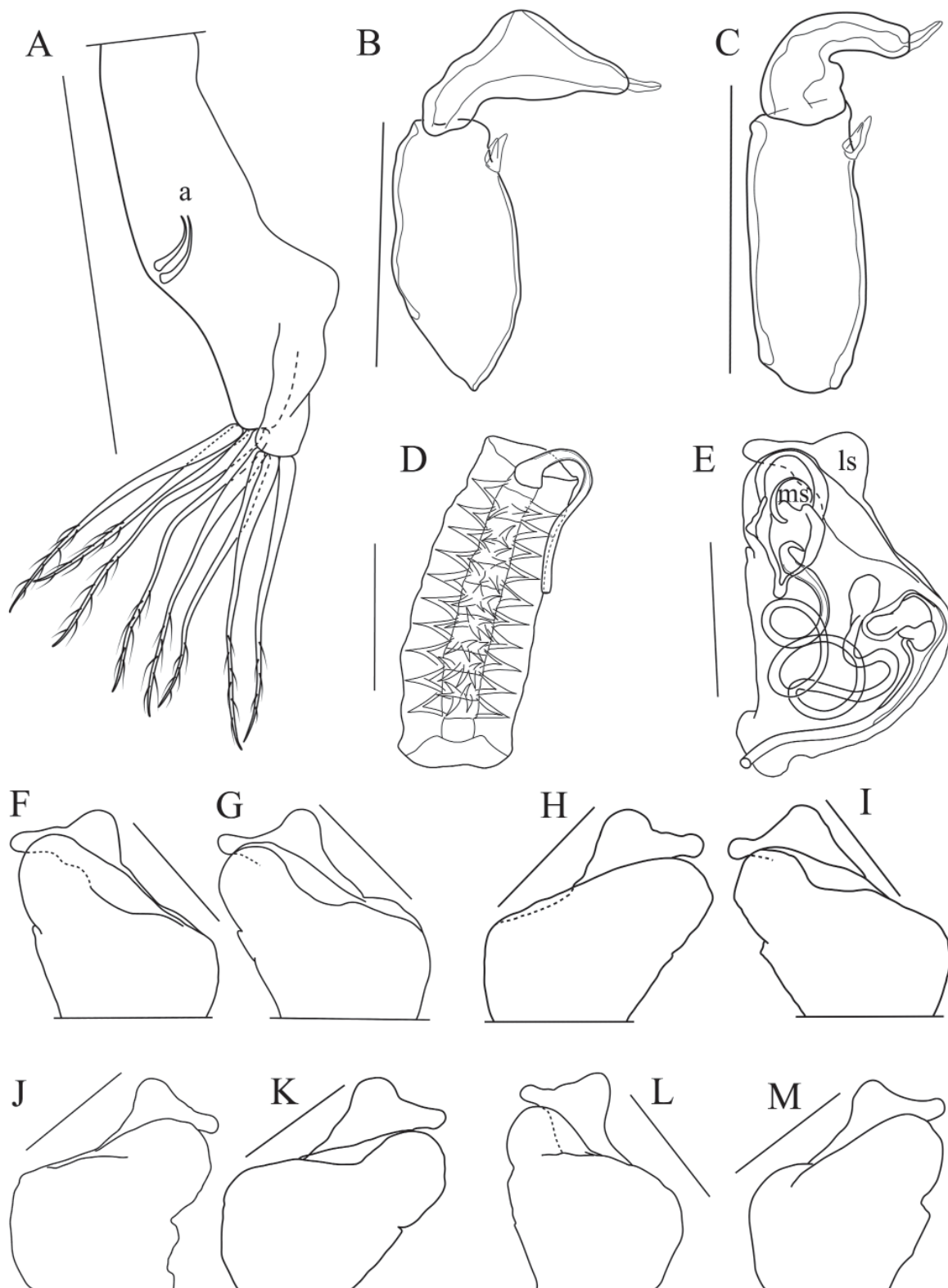
### **Female**

Remark: also here, some specimens were decalcified and this caused some distortion of the single valves in the SEM illustrations.

LVi (Fig. 16A, C–D), RVi (Fig. 16B, E–F), CpRl (Fig. 16G), CpD (Fig. 16H) and CpV (Fig. 16I) as in the male.

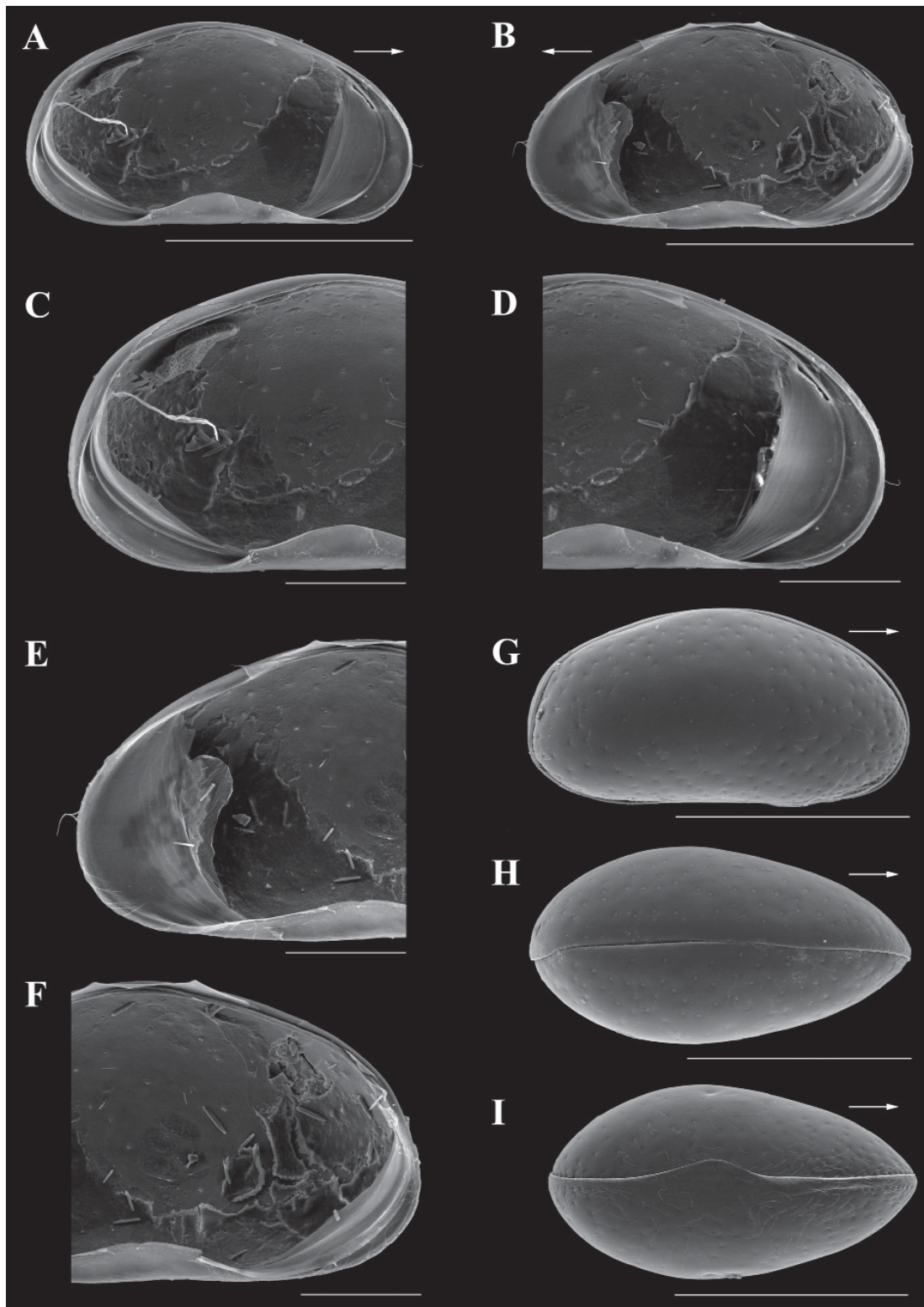
A1, Rake-like organ, Md-coxa, Mx1 and T2 (not illustrated) as in the male.

A2 (Fig. 17A–B) with protopodite, exopodite and three-segmented endopodite. Protopodite ventrally with three setae: two unequal but short setae, one long apical seta reaching beyond the tip of the terminal segment. Exopodite reduced to a small plate with one long seta (reaching beyond the tip of the terminal segment) and two sub-equal short setae. First endopodal segment ventrally with aestethasc Y (ca  $\frac{1}{4}$  of the length of this segment), one long hirsute ventral seta (reaching beyond the tip of the terminal segment), and five hirsute natatory setae, reaching beyond the tip of the end claws, and one short accompanying seta, about  $\frac{1}{2}$  of the length of the second endopodal segment. Second endopodal segment with two unequal, but long dorsal setae, four ventral setae t (two unequal but long, one ca e half of the length of the longest setae, and one short, approximately  $\frac{1}{4}$  of longest setae); apically with three claws (G1, G2, G3) and three setae (z1, z2, z3). Terminal segment (Fig. 17B) with two claws, one long (GM) one short (Gm) and one aesthetasc y3 with accompanying seta, slightly longer than y3. Seta g absent.

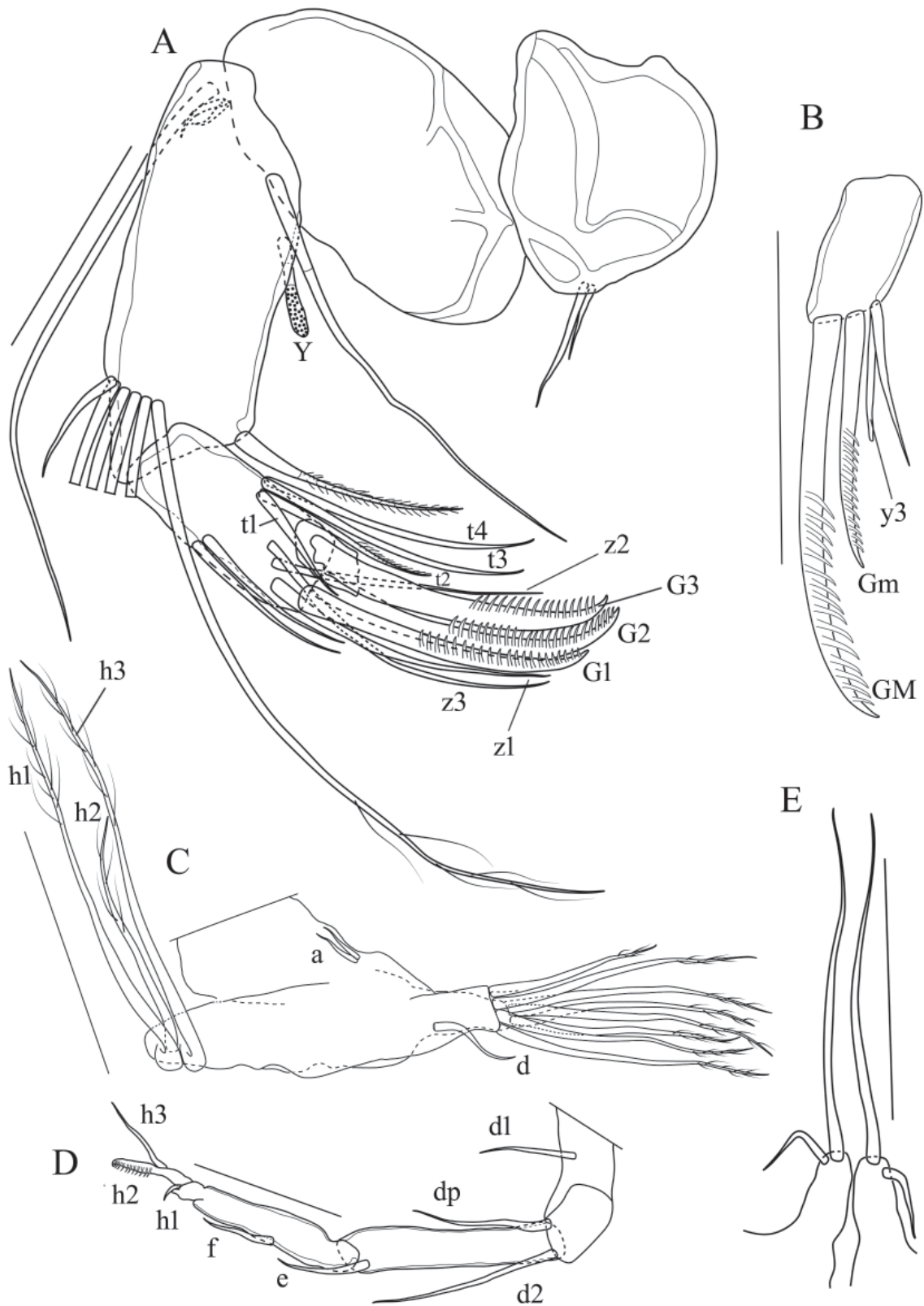


**Fig. 15.** *Brasilodopsis amazonica* gen. et sp. nov. from Amazon River floodplain, ♂. **A.** T1 (MZUSP 41852). **B.** Rpp (MZUSP 41852). **C.** Lpp (MZUSP 41852). **D.** Zenker's organ (MZUSP 41852). **E–G.** Hemipenis (MZUSP 41852). **H–I.** Hemipenis (MZUSP 41856). **J–K.** Hemipenis (MZUSP 41854). **L–M.** Hemipenis (MZUSP 41855). Abbreviations: see text and Material and methods. Scale bars: 50  $\mu$ m.





**Fig. 16.** *Brasilodopsis amazonica* gen. et sp. nov. from Amazon River floodplain, ♀. **A.** LVi (MZUSP 41862). **B.** RVi (MZUSP 41862). **C.** LVi, detail of posterior part (MZUSP 41862). **D.** LVi, detail of anterior part (MZUSP 41862). **E.** RVi, detail of anterior part (MZUSP 41862). **F.** RVi, detail of posterior part (MZUSP 41862). **G.** CpR1 (MZUSP 41863). **H.** CpD (MZUSP 41864). **I.** CpV (MZUSP 41865). Scale bars: A–B, G–I = 300 µm; C–F = 100 µm.



**Fig. 17.** *Brasilodopsis amazonica* gen. et sp. nov. Amazon River floodplain, ♀. **A.** A2, without the terminal segment (MZUSP 41853). **B.** A2, terminal segment (MZUSP 41853). **C.** T1 (MZUSP 41861). **D.** T3 (MZUSP 41862). **E.** CR (MZUSP 41861). Abbreviations: see text and Material and methods. Scale bars: 50 µm.

T1 (Fig. 17C) protopodite with a group of eight hirsute setae; two short seta a, one long seta d. Endopodite consisting of three long plumose setae.

T3 (Fig. 17D) with three segments. First segment with two unequal long setae d2 and dp and one shorter seta d1. Second segment with one subapical seta e, almost smaller than the half of the third segment. Third segment medially with one seta f, about  $\frac{1}{3}$  the length of the third segment. Distal part of third segment with a pincer structure, one small spine-like structure h1, one long subapical seta h3, slightly longer than the broad seta h2, the latter set with spine-like setulae.

CR (Fig. 17E) with elongated base (2–3 times as long as wide), one subapical short seta and one long apical seta (ca 3–5 times the length of the base).

### Differential diagnosis

Cp sub-ovate, slightly more elongated and with smoothly curved dorsal margin (with blunt dorsal corner in *Brasilodopsis baiabonita* gen. et sp. nov.). Posterior inner list in LV more slender than in *B. baiabonita* gen. et sp. nov. (see Table 3). External valve surface densely set with rimmed pores in shallow pits (smooth, with sparse setae and pores in *B. baiabonita* gen. et sp. nov.). Hemipenis outline similar in both species, but distal segments of prehensile palps with subtle differences.

### Ecology and distribution

*Brasilodopsis amazonica* gen. et sp. nov. was recorded only from the Amazon River floodplain, in association with several aquatic macrophytes. The range of the water temperature was between 31.5 and 32.9°C. The pH range remained slightly acid (6.4 and 6.7 – hence possibly the decalcified valves). The ranges of electrical conductivity and dissolved oxygen were from 41.5 to 67.1  $\mu\text{S}\cdot\text{cm}^{-1}$ , and from 0.4 to 3  $\text{mg}\cdot\text{L}^{-1}$ , respectively (see Table 4).

Tribe **Paranadopsini** trib. nov.

urn:lsid:zoobank.org:act:E3A91D7A-CDF0-47FF-92A7-ADBBE6431FFC

### Type genus

*Paranadopsis* gen. nov. (here described).

### Diagnosis

Cp elongated and bean-shaped, with curved ventral margin. LV largely overlapping RV, especially along the anterior side. LV with weak anterior and ventral inner list, posterior inner list fully absent. RV without anterior inner list, posteriorly with weakly inwardly displaced selvage. Several limbs with segments reduced in length and/or in chaetotaxy: A1 with four distal segments highly reduced in both length and chaetotaxy; A2 with one short natatory seta (or its accompanying seta) only and reduced length of two distal segments. Idem for Md-palp, Mx1, T1 and T2 (where both setae d1 and d2 are missing). Male unknown.

### Remarks

Because of the structural reduction in both valves (inner lists mostly absent) and the limbs (especially in the A1, but also in most other limbs) it is clear that this new genus and its species do not belong in the tribe Cypridopsini and require a new tribe, which might in time even be elevated to the rank of subfamily.

*Paranadopsis* gen. nov.

urn:lsid:zoobank.org:act:D8BF39A1-2843-4C13-9230-1AA6A3F71EE5

**Type species**

*Paranadopsis reducta* gen. et sp. nov. (here designated).

**Diagnosis**

As for the new tribe.

**Etymology**

The new genus is named after the state and the river from which it is here described, namely Paraná, and ‘*dopsis*’, referring to the stem of *Cypridopsis*.

**Differential diagnosis**

*Paranadopsis* gen. nov. can be distinguished from all other cypridopsine genera by the combination of the valve and limb morphology, including the strong reduction of size and chaetotaxy of segments in various limbs, especially in the A1 (see above, diagnosis of new tribe) (see Table 3).

*Paranadopsis reducta* gen. et sp. nov.

urn:lsid:zoobank.org:act:8F976A25-DBBF-4F8C-AD42-EA8BCF527C7B

Figs 18–21

‘*Cypridopsis*’ nov. gen. nov. sp. – Higuti *et al.* 2007: 1935, table 2.

“*Cypridopsis*” n. gen. 2 n. sp. – Matsuda *et al.* 2015a: 326–327, tables 1–2. — Conceição *et al.* 2017: 329, table 2; 2018: 184, table 3. — Higuti *et al.* 2017b: 327, table 2.

*Cypridopsis* n.gen. 2 n.sp. – Matsuda *et al.* 2015b: 118, 123, table 1, fig. 5.

“*Cypridopsis*” sp. 2 n.gen. n.sp. – Campos *et al.* 2018: 6, table 2; 2019: 375, table 1.

*Cypridopsis* n.gen. 2 n.sp.1 – Higuti *et al.* 2020: 2, table S1.

**Diagnosis**

As for the tribe and genus. As the tribe is monogeneric and the genus is monospecific, it is difficult to allocate the different characters and character states to the different taxonomic levels. It is expected that other species in this genus and other genera in this tribe will have basically the same body plan, with slight modifications in shape, size and chaetotaxy of segments in various limbs.

**Etymology**

The new species is named after the fact that much of the size, shape and chaetotaxy of the segments in the limbs is reduced, especially in the A1.

**Type material examined**

**Holotype**

BRAZIL • ♀; Upper Paraná River floodplain, Manezinho Backwater; 22°46'45.3" S, 53°20'56.4" W; 2 Mar. 2007; J. Higuti leg.; with soft parts dissected in glycerine in a sealed slide, valves stored dry in a micropalaeontological slide; sample EC1; MZUSP 41866.

**Paratypes**

BRAZIL • 1 ♀; Upper Paraná River floodplain, Manezinho Backwater; 22°46'47.3" S, 53°21.1'57" W; 3 May 2010; J. Higuti leg.; with soft parts dissected in glycerine in a sealed slide; valves stored dry in a micropalaeontological slide; sample EC3; MZUSP 41867 • 1 ♀; Upper Paraná River floodplain, Manezinho Backwater; 22°46'46.5" S, 53°20'59" W; 2 Mar. 2007; J. Higuti leg.; with soft parts dissected in glycerine in a sealed slide, valves stored dry in a micropalaeontological slide; sample EC2;



MZUSP 41868 • 1 ♀; Upper Paraná River floodplain Manezinho Backwater; 22°46'47.3" S, 53°21.1'57" W; 6 Jul. 2011; J. Higuti leg.; with soft parts dissected in glycerine in a sealed slide, valves stored dry in a micropalaeontological slide; sample EC3; MZUSP 41869 • 1 ♀; Upper Paraná River floodplain, Manezinho Backwater; 22°46'46.5" S, 53°20'59" W; 8 Dec. 2010; J. Higuti leg.; with soft parts dissected in glycerine in a sealed slide, valves stored dry in a micropalaeontological slide; sample EC2; MZUSP 41870 • 1 ♀; Upper Paraná River floodplain, Manezinho Backwater; 22°46'47.3" S, 53°21.1'57" W; 8 Dec. 2010; J. Higuti leg.; with soft parts dissected in glycerine in a sealed slide, valves stored dry in a micropalaeontological slide; sample EC3; MZUSP 41871 • 1 ♀; Upper Paraná River floodplain, Manezinho Backwater; 22°46'46.5" S, 53°20'59" W; 2 Mar. 2007; J. Higuti leg.; with valves stored dry in a micropalaeontological slide after use for SEM; sample EC2; MZUSP 41872 • 2 ♀♀; Upper Paraná River floodplain, Manezinho Backwater; 22°46'46.5" S, 53°20'59" W; 2 Mar. 2007; J. Higuti leg.; carapaces stored dry in micropalaeontological slides after use for SEM; sample EC2; MZUSP 41873, MZUSP 41874 • 1 ♀; Upper Paraná River floodplain, Manezinho Backwater; 22°46'46.5" S, 53°20'59" W; 3 May 2010; J. Higuti leg.; carapace lost after use for SEM; sample EC2; JH490.

### Measurements of illustrated specimens

See Table 2.

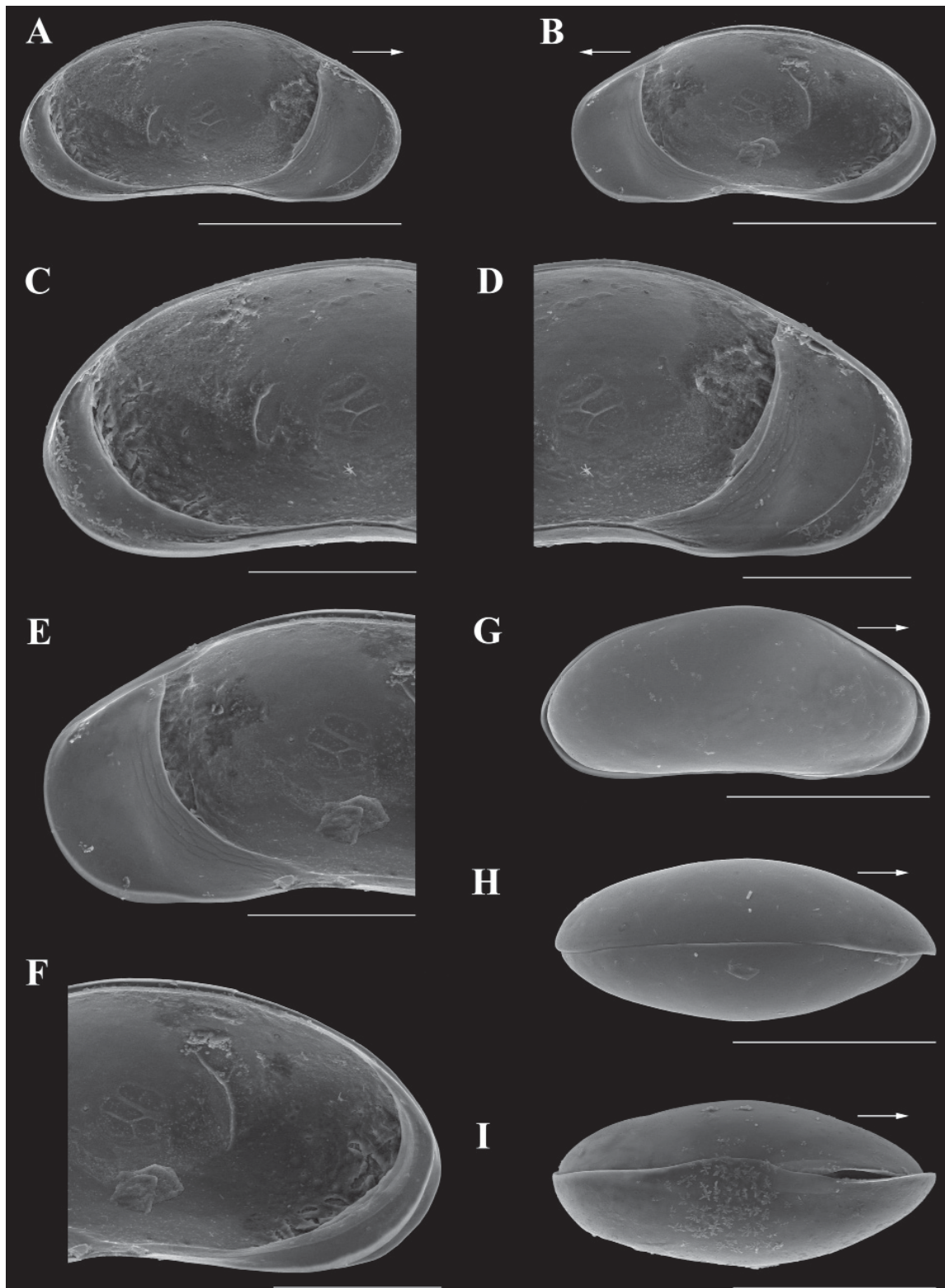
### Description

#### Female

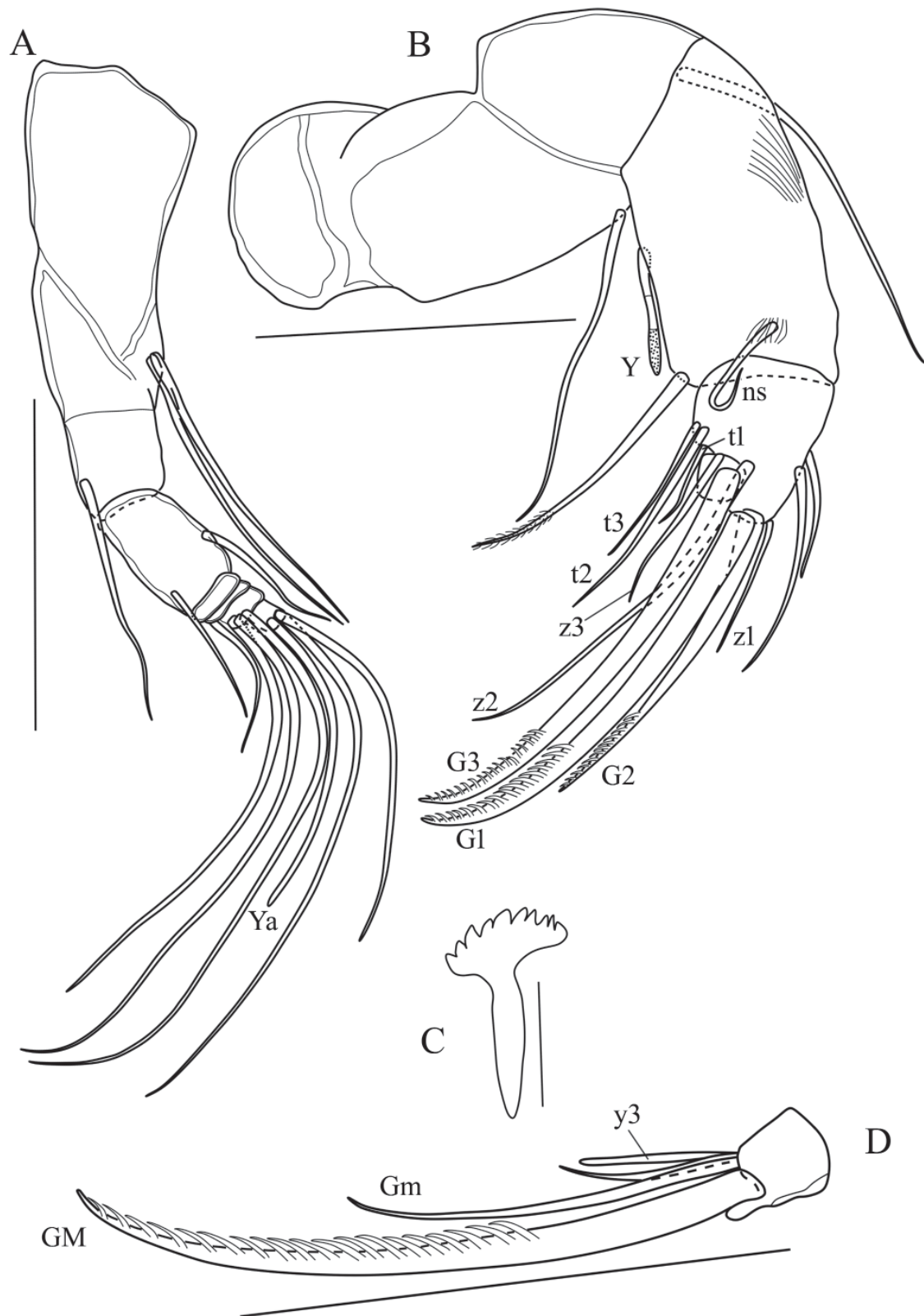
LVi (Fig. 18A, C–D) with broad anterior calcified inner lamella and narrower posterior calcified inner lamella; weak inner list present anteriorly and ventrally, absent posteriorly. RVi (Fig. 18B, E–F) with broad anterior calcified inner lamella and narrower posterior calcified inner lamella; inner list fully absent, posteriorly with an inwardly displaced selvage. Both valves elongated and bean-shaped, with curved ventral margin, evenly rounded dorsal margin and with anterior margin more broadly rounded than posterior one. CpRI (Fig. 18G) elongated; with the greatest height situated in front of the middle; LV overlapping RV anteriorly (widely so) and posteriorly. External valve surface smooth and set with isolated setae. CpD (Fig. 18H) sub-ovate; with greatest width in the middle, and with LV widely overlapping RV anteriorly and less so posteriorly. CpV (Fig. 18I) also sub-ovate; with the greatest width in the middle; LV overlapping RV especially anteriorly, but also ventrally and posteriorly and with a gap between the two valves in the anterior third of the length, immediately followed by a central flap of the LV extending beyond the RV.

A1 (Fig. 19A) with seven segments. First segment with two long subapical ventral setae; Wouter's organ not seen. Second segment with one long dorso-lateral seta; Rome organ not seen. Third segment with one ventro-lateral and one dorso-apical setae, the latter slightly shorter than the former one. Fourth to seventh segment greatly reduced in length and chaetotaxy. Fourth segment without setae. Fifth segment with one dorso-apical seta. Sixth segment with three long apical setae. Terminal (seventh) segment with two apical setae, one long and one half that length, and one aesthetasc Ya, about  $\frac{2}{3}$  of the shorter seta.

A2 (Fig. 19B, D) with prodopodite, exopodite and three-segmented endopodite. First segment with one long subapical seta reaching well beyond the tip of the terminal segment. Exopodite reduced to a small plate (not illustrated), with only one long seta reaching the tip of the first endopodal segment; two short accompanying setae missing. First endopodal segment with a ventral aesthetasc Y (approximately half the length of the segment), one subapical long seta, about  $2.5 \times$  the length of aesthetasc Y and hirsute in its distal one fifth, and medially with one short (natatory) seta, almost reaching the tip of the second endopodal segment. Second endopodal segment ventrally with three setae t (one short seta, about twice the length of the terminal segment; one long ca twice the length of the shortest setae, and one of ca  $\frac{3}{4}$  the length of the longest seta); medio-dorsally with two setae, one short and one long (ca twice the length of the short one); apically with three claws (G1, G2, G3) and three setae (z1, z2, z3). Terminal segment (Fig. 19D) with two claws, one long (GM), one short (Gm) and one aesthetasc y3 with one accompanying seta, the first one slightly shorter than the latter; seta g missing.



**Fig. 18.** *Paranadopsis reducta* gen. et sp. nov. from the Upper Paraná River floodplain, ♀. **A.** LVi (MZUSP 41872). **B.** RVi (MZUSP 41872). **C.** LVi, detail of posterior part (MZUSP 41872). **D.** LVi, detail of anterior part (MZUSP 41872). **E.** RVi, detail of anterior part (MZUSP 41872). **F.** RVi, detail of posterior part (MZUSP 41872). **G.** CpRl (MZUSP 41873). **H.** CpD (MZUSP 41874). **I.** CpV (JH490). Scale bars: A–B, G–I = 200 µm; C–F = 100 µm.



**Fig. 19.** *Paranadopsis reducta* gen. et sp. nov. from the Upper Paraná River floodplain, ♀. **A.** A1 (MZUSP 41866). **B.** A2, without the terminal segment (MZUSP 41868). **C.** Rake-like organ (MZUSP 41869). **D.** A2, terminal segment (MZUSP 41868). Abbreviations: see text and Material and methods. Scale bars: A–B, D = 50 µm; C = 10 µm.

Rake-like organ (Fig. 19C) stout, solid, T-shaped, with ca ten apical teeth.

Md-palp (Fig. 20B) with four segments. First segment with two long plumose setae ( $S_1$  and  $S_2$ ), one long smooth seta and one short smooth seta  $\alpha$ . Second segment with two unequal, but long dorsal setae; ventrally with one seta  $\beta$ , and one long seta (ca  $2 \times$  the length of seta  $\beta$ ). Third segment with three groups of setae; dorsally with one group of three long setae and one short (hirsute) seta; apically with a group of three setae, one of which being seta  $\gamma$ ; ventro-apically with two unequal setae. Terminal segment with three claws and three setae.

Md-coxa (Fig. 20A) elongated, with strong apical teeth, interspaced with some setae.

Mx1 (Fig. 20C – chaetotaxy not completely illustrated) consisting of three masticatory lobes (endites), a two-segmented palp and a large branchial plate (the latter not illustrated). Branchial plate elongated, with ca 12 respiratory rays, some quite short, others long. First segment of palp subapically with two long setae. Terminal segment of palp with two claw-like setae and two short setae. Third endite apically with several setae, two with a distal tuft of setulae, and one basal, long seta. First endite apically with one basal seta and ca four sideways directed bristles.

T1 (Fig. 21A) protopodite with a group of six hirsute setae and two short setae a; setae b and d absent. Endopodite consisting of two apical plumose setae (one long and one short about  $\frac{1}{2}$  the length of the long one).

T2 (Fig. 21B) with one protopodite segment, one ‘knee’ segment and four endopodite segments. Protopodite and knee-segment with setae d1 and d2 absent. First endopodal segment with one subapical seta e, not reaching the tip of the second endopodal segment. Second endopodal segment with one apical seta f, reaching beyond the tip of the fifth segment. Third endopodal segment with one sub-apical seta g. Terminal endopodal segment with one apically serrated claw h2; setae h1 and h3 absent.

T3 (Fig. 21C) with three segments. First segment with three long setae (d1, d2, dp). Second segment with one apical seta e, reaching the middle of the third segment. Third segment medially with one seta f, about  $\frac{1}{3}$  of the length of the third segment. Distal part of third segment fused with fourth segment into a pincer structure, with a claw h2, one short seta h1 and one long seta h3, about  $2 \times$  the length of seta h2.

CR absent.

#### Male

Unknown.

#### Ecology and distribution

*Paranadopsis reducta* gen. et sp. nov. was found associated with the root system of *E. crassipes*, located in some lakes of the Upper Paraná River floodplain. The temperature range of these lakes at the time of sampling was 28.3 to 32.6°C, while the pH range was 5.8 to 7. The electrical conductivity range was 14 to 61  $\mu\text{S}\cdot\text{cm}^{-1}$ , and the dissolved oxygen range was 1.5 to 7.6  $\text{mg}\cdot\text{L}^{-1}$  (see Table 4).

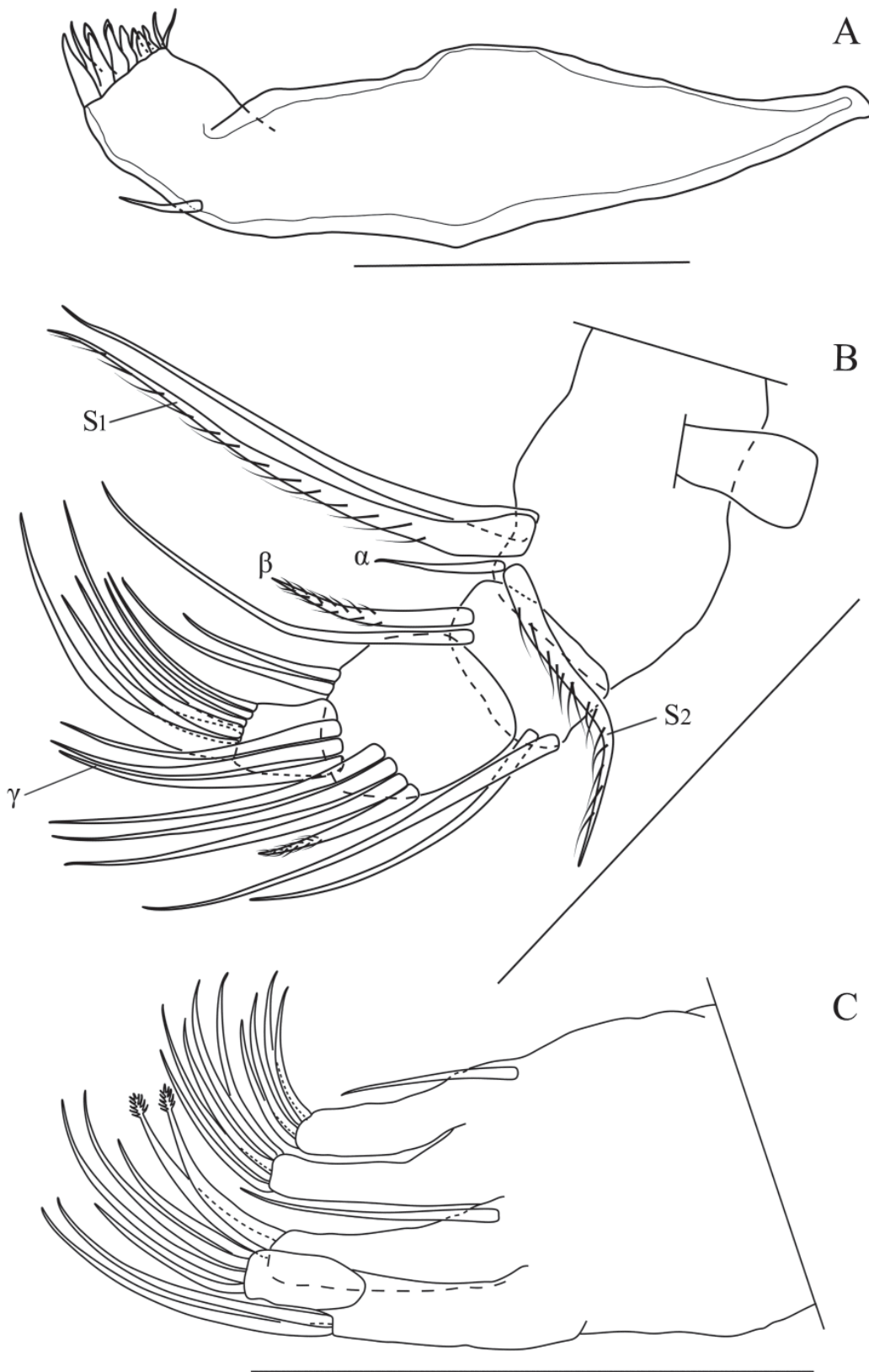
The species can be considered as rare in the area.

#### Discussion

##### Taxonomic position of the Cypridopsinae

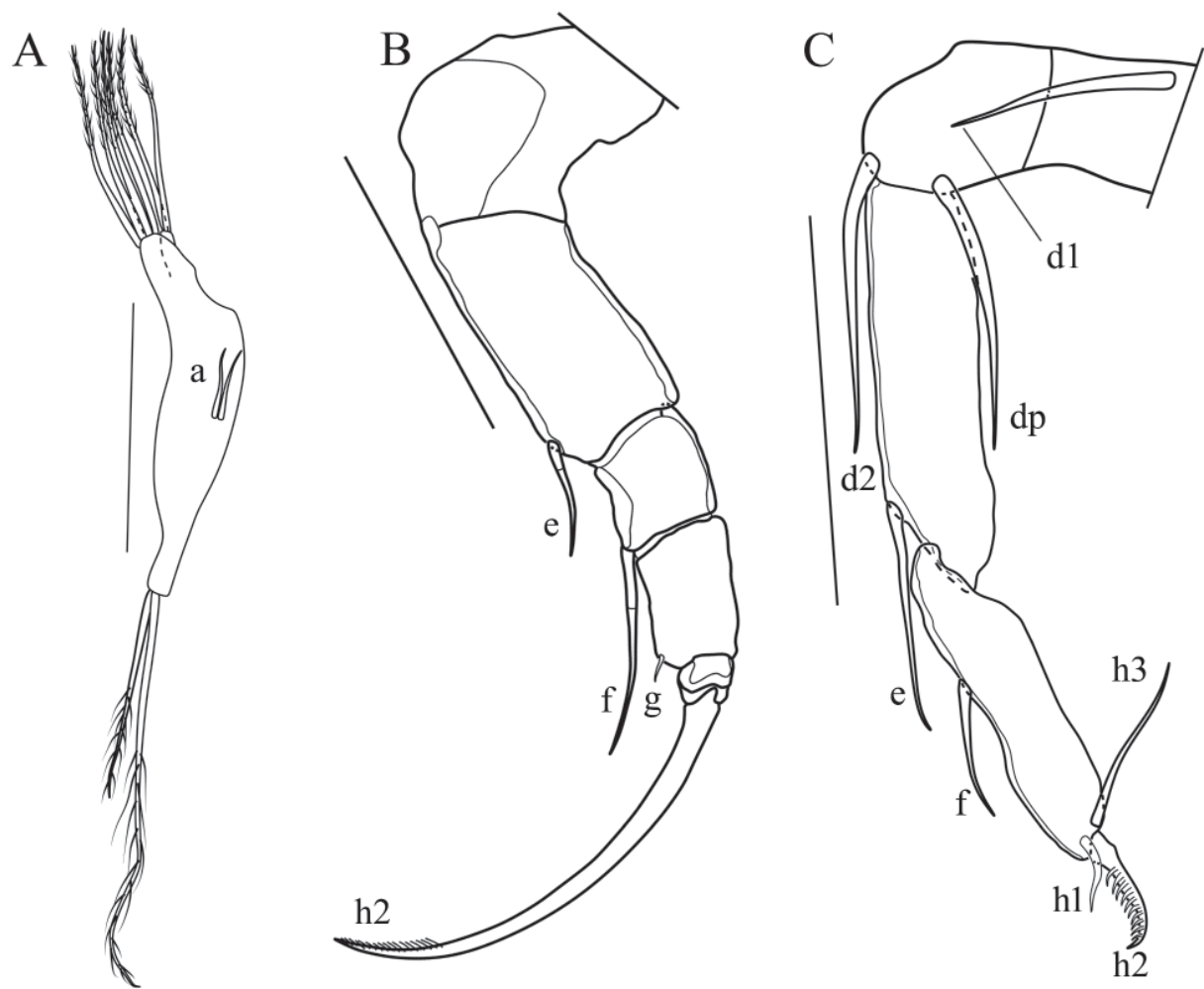
Kaufmann (1900) described the subfamily Cypridopsinae in the family Cyprididae, based mainly on the presence of a flagellum-like CR. Hartmann & Puri (1974) escalated this taxon to the family Cypridopsidae, in which they included, following Hartmann (1963), both the original Cypridopsinae, with CR reduced to a flagellum, and the Cypridinae Hartmann, 1963, in which the CR shows various





**Fig. 20.** *Paranadopsis reducta* gen. et sp. nov. from the Upper Paraná River floodplain, ♀. **A.** Md (MZUSP 41869). **B.** Md-palp (MZUSP 41867). **C.** Mx1 (MZUSP 41867). Abbreviations: see text and Material and methods. Scale bars: 50  $\mu$ m.





**Fig. 21.** *Paranadopsis reducta* gen. et sp. nov. from the Upper Paraná River floodplain, ♀. **A.** T1 (MZUSP 41868). **B.** T2 (MZUSP 41867). **C.** T3 (MZUSP 41869). Abbreviations: see text and Material and methods. Scale bars: 50 µm.

degrees of reduction, but never to the state of a flagellum. In the nominal subfamily Cypridopsinae, they included genera such as *Cypridopsis* Brady, 1867, *Potamocypris* Brady, 1870 and *Zonocypris* G.W. Müller, 1898, presently still considered as belonging to this subfamily, but also *Oncocypris* G.W. Müller, 1898 and *Pseudocypretta* Klie, 1932, both of which also have a flagellar CR. *Oncocypris* has meanwhile been transferred to the subfamily Oncocypridinae De Deckker, 1979 in the family Notodromadidae Kaufmann, 1900 by De Deckker (1979a, 1979b), while *Pseudocypretta* has meanwhile been transferred to the Cyprettinae, but might belong in the Cyprettadopsini Savatentalinton, 2020. Because at that stage, at least one other family in the Cypridoidea, the Notodromadidae, comprised a genus with flagellar CR, the main characteristic of the family Cypridopsidae was no longer unique to this family, and therefore De Deckker (1979a) argued (albeit implicitly) that this family should be merged (lowered to the rank of subfamily) in the family Cyprididae. Other researchers had already taken that position (McKenzie 1977 and others), however without further justification. One year later, Shornikov (1980) described the terrestrial genus *Callistocypris* Shornikov, 1980 with reduced CR and placed it in a separate subfamily, the Callistocypridinae in the family Cypridopsidae. Meanwhile, this subfamily is placed outside of the Cypridopsinae in the Cyprididae (see Meisch *et al.* 2019). The CR in *Callistocypris* is also not flagellar

but reduced to a clear ramus and one claw-like seta (Shornikov 1980; Pinto *et al.* 2005), as in some species of *Cypretta* Vavra, 1895.

Within the Cypridoidea, the flagellar CR is rather an exception, as most species in this superfamily have a solid CR, consisting of a stout ramus and (generally) two claws and two setae. However, the other two superfamilies with representatives in non-marine habitats (Cytheroidea and Darwinuloidea) all have flagellar caudal rami, so either flagellar caudal rami in the Cypridoidea are the plesiomorphic character state, or they are an apomorphic condition resulting from a secondary reduction. The fact that several cypridoid lineages have such flagellar caudal rami does not help in deciding between these two evolutionary scenarios, as these lineages could either have retained the plesiomorphic state independently from each other or could have experienced parallel secondary reduction, or both processes could have been active. Either way, the presence of flagellar caudal rami is not a good character state on which to base a higher taxon, and even at the level of a subfamily, the monophyletic nature of the Cypridopsinae remains doubtful.

### Taxonomy of the Cypridopsinae

An overview of the present generic taxonomy of the Cypridopsinae is given in Table 1. Five tribes (including Paranadopsini trib. nov.) and 21 genera (including *Brasilodopsis* gen. nov. and *Paranadopsis* gen. nov.) are presently included in this subfamily. The largest, and without doubt polyphyletic, tribe is still the Cypridopsini with 16 genera, divided in two groups: genera comprising species where the RV overlaps the LV and genera in which species have the LV overlapping the RV; the latter comprising the nominate genus *Cypridopsis* Brady, 1867. The Potamocypridini, rather obscurely defined in Ghetti & McKenzie (1981), only comprise the genus *Potamocypris* Brady, 1870, the only cypridopsine genus with a spatulate second segment of the Mx1-palp (all other genera have a cylindrical segment there). Higuti & Martens (2012) erected the tribe Zonocypridini, to comprise the genera *Zonocypris* G.W. Müller, 1898, mainly from Africa, and *Cabelodopsis* Higuti & Martens, 2012 from Brazil. This tribe is characterised by a hyper developed claw G2 in the female A2. Savatentalinton (2018) added the genus *Thaicypriodopsis* to this tribe. Recently, Savatentalinton (2020) added the tribe Cyprettadopsini for the enigmatic genus *Cyprettadopsis* Savatentalinton, 2020, which combines features of Cypridopsinae (flagellar CR), Cyprettinae (marginal septae) and even Candonidae (separate terminal segment of the T3). The relevance of the latter character will be discussed elsewhere, but *Cyprettadopsis* is probably a result of parallel evolution.

The above summary shows that delineating taxa in the Cypridopsinae, even at the level of tribes, generally relies on small differences in valve and/or soft part morphology, although there are exceptions, such as the remarkable species *Thaicypriodopsis longispinosa* Savatentalinton, 2018 with unique spatulate and distally hirsute setae on all three endites of the Mx1. *Siamopsis* Savatentalinton, 2017, on the other hand is a case in point, where a species flock of five species in South East Asia is (correctly) united by a small 'plate' (expansion of the posterior calcified lamella) in the LV (Savatentalinton 2017). Also, the description of *Brasilodopsis* gen. nov. mainly relies on valve characters, nl. the presence /absence of inner lists in the valves.

### Position of *Paranadopsis* gen. nov.

The situation of *Paranadopsis* gen. nov., however, is completely different as it shows reductions in size and chaetotaxy of segments in almost all limbs, but especially in the A1, whereas the CR is completely absent.

In the A1, segments 4 to 7 are reduced to tiny segments, with only a few setae. This is unique in the Cypridopsinae, and even in the Cyprididae. Such drastic reductions with loss of segments and setae, on the other hand, is not uncommon in interstitial Candonidae (for example Danielopol (1978); Martens

(1992) on *Namibcypris* from Namibia; and Karanovic (2007) on interstitial candonids from the Pilbara regions in Western Australia), but are very rare in Cyprididae.

The A2 has only one natatory seta, which is again unique in this group. Natatory setae on the A2 are reduced in several other cypridopsine genera (e.g., *Bryocypris* Roen, 1956 (see redescription by Martens 1989), *Klieopsis* Martens, Meisch, Marmonier, 1991 (Martens *et al.* 1991) and *Cavernocypris* Hartmann, 1964 (redescribed by Marmonier *et al.* 1989)), but never in such a way where only one seta remains and the others disappeared without at least a trace. Most likely this one remaining seta is actually the accompanying seta to the natatory setae, so that in effect only the latter are fully reduced.

In the Md-palp, the seta  $\beta$  has only one accompanying seta, while there are only two apical setae on the first segment of the Mx1-palp. The T1 palp has only two (not three) apical setae, both setae d1 and d2 are missing from T2 and the caudal rami are fully lacking, as is also the case in *Martenscypridopsis* Karanovic & Pesce, 2000 and *Pseudocypridopsis* Karanovic, 1999. It should also be noted that the cypridopsine CR can in general only be found in females, as it is merged with the hemipenis in males (Martens & Meisch 1985).

The genus *Paranadopsis* gen. nov. and the tribe Paranadopsini trib. nov. are thus very different from other Cypridopsinae and it is possible that this new genus actually deserves its own subfamily, much as *Callistocypris* is ranked outside of the Cypridopsinae. Future findings will show at which rank *Paranadopsis* gen. nov. should be classified, but at this stage we think it is important that the link with other cypridopsine genera is established by including it in the Cypridopsinae.

#### **Functional morphology of *Paranadopsis reducta* gen. et sp. nov.**

As mentioned above, a reduction of segments and setae is not uncommon in interstitial ostracods, especially in the Candonidae (Hartmann 1973; Danielopol 1978; Danielopol & Hartmann 1986; Martens 1992). Nothing is known about the subterranean ostracod fauna from the Neotropical (Martens & Behen 1994; Higuti & Martens 2020), apart from some islands in the Caribbean (Broodbakker 1984) and we therefore do not know if this species, or other representatives of the genus and tribe, occur in interstitial or other subterranean habitats. However, *Paranadopsis reducta* gen. et sp. nov. was thus far only found in the pleuston of the root systems of floating plants such as *Eichhornia crassipes*, which are very common in South America. Dozens of other ostracod species can be found in the pleuston of this and other floating plants (Higuti *et al.* 2010) and none show similar morphological reductions. Therefore, life in pleuston does not seem to require such drastic morphological changes, hence we must assume that the observed reductions in size and chaetotaxy of segments on various limbs must either be adaptations to other habitat types or be the result of sexual selection (Tsukagoshi 1988; Martens 2000). Since parallel evolutions in other (mostly candonid) clades primarily occurred in subterranean habitats, explorations of these habitats in likely geological settings, such as karstic areas, are urgently required.

#### **Acknowledgments**

The samples of ostracods used in this study (from 2004 to 2018) result from the Long-Term Ecological Research (LTER - site 6, Long-Term Ecological Research) and National System of Biodiversity Research (SISBIOTA) programmes, supported by the Ministry of Science and Technology (MCT)/ National Council for Scientific and Technological Development (CNPq)/Fundação Araucária, and (from June 2003) result from Microbiota Biodiversity of Aquatic Ecosystems of the Nhecolândia Pantanal 2003–2004 project, supported by Foundation for the Support and Development of Education, Science and Technology of Mato Grosso do Sul (Fundação de Apoio e Desenvolvimento do Ensino, Ciência e Tecnologia do Mato Grosso do Sul - Fundect).

We thank the Graduate Programme in Ecology of Inland Water Ecosystems (PEA), Centre of Research in Limnology, Ichthyology and Aquaculture (Nupélia) of the State University of Maringá (UEM), and USACUCAR, CORIPA, ICMBio for the logistic support. We thank Dr Kennedy Francis Roche and the Federal University of Mato Grosso do Sul for logistic support during sampling. NMA (scientific initiation's scholarship) and VGF (PhD's scholarship) would like to thank CNPq and CAPES for granting their scientific research, respectively. JH thanks CNPq for the research productivity scholarships. Mr Julien Cillis (Brussels, Belgium) assisted with the scanning electron microscope illustrations. The State University of Maringá and the Royal Belgian Institute of Natural Sciences (RBINS, Brussels) have a bilateral Memorandum of Understanding regarding collaborative Scientific Research.

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*Manuscript received: 18 December 2020*

*Manuscript accepted: 20 May 2021*

*Published on: 4 August 2021*

*Topic editor: Rudy C.A.M. Jocqué*

*Desk editor: Kristiaan Hoedemakers*

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Autor(en)/Author(s): Almeida Nadingy Martins de, Higuti Janet, Ferreira Vitor Gois, Martens Koen

Artikel/Article: [A new tribe, two new genera and three new species of Cypridopsinae \(Crustacea, Ostracoda, Cyprididae\) from Brazil 1-48](#)