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## Taxonomic revision of *Strandesia* s.s. (Crustacea, Ostracoda) from four Brazilian floodplains, with the description of three new species

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VITOR GÓIS FERREIRA, JANET HIGUTI & KOEN MARTENS  
**TAXONOMIC REVISION OF *STRANDESIA* S.S. (CRUSTACEA, OSTRACODA) FROM FOUR  
BRAZILIAN FLOODPLAINS, WITH THE DESCRIPTION OF THREE NEW SPECIES**  
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## Abstract

The present paper is a contribution to the taxonomy of the genus *Strandesia*. Here, we describe three new species: *S. thomazi* nov. sp., *S. galeati* nov. sp. and *S. nakatanii* nov. sp. We also describe the male of *Strandesia obtusata* (Sars, 1901); this is the first record of sexual populations of a Brazilian *Strandesia* species. Nine other *Strandesia* species from the Amazon, Araguaia, Pantanal and Paraná river floodplains are redescribed. We also propose that *Strandesia trichosa* Roessler, 1990 is a synonym of *Strandesia psittacea* Sars, 1901. Most of the species analyzed here are endemic to the Neotropical region, with the exception of *Strandesia bicuspis* (Claus, 1892) G.W. Müller, which occurs also (as an alien invasive species) in the Palaearctic. This genus occurs in water bodies with a wide range of abiotic variables and in many different aquatic macrophyte species. The species analyzed here have a highly conservative soft part morphology, but an impressive variety of carapace shapes.

**Keywords:** Cypricercinae, Cyprididae, morphology, taxonomy, distribution, Neotropics, aquatic macrophytes

## Introduction

There are currently 2330 species of extant non-marine Ostracoda described worldwide. Approximately 43% of these belong to the family Cyprididae (Meisch *et al.* 2019). Of the ca. 333 Neotropical species, more than 50% belongs to this family (Meisch *et al.* 2019). The subfamily Cypricercinae is one of the most diverse of the Cyprididae. This subfamily has several doubtful genera and species (Savatentalinton & Martens 2009a). However, all genera (and species) of the Cypricercinae have a common synapomorphic feature in the attachment of caudal ramus, namely the presence of a loop at the distal end, called “Triebel’s loop”, which thus far, is unique to this subfamily (Savatentalinton & Martens 2009a).

*Strandesia* is the most diverse genus of the Cypricercinae, with 97 species worldwide, although most of its species are recorded from the (sub-) tropics (Broodbakker, 1983). There are 32 *Strandesia* species recorded from the Neotropical region, of which seventeen species were thus far recorded from Brazil (Martens & Behen 1994; Martens *et al.* 1998b; Higuti *et al.* 2010, 2013, 2017). Most of these were described in the first half of the 20th century by Sars (1901), based on specimens hatched from dried mud from São Paulo and Rio Grande do Sul states, and Tressler (1950) with samples from northeastern and southern Brazil. The only recent taxonomic studies regarding *Strandesia* species of Brazil include Higuti *et al.* (2013), who described three new species of *Strandesia* (*S. lansactohai* Higuti & Martens, 2013, *S. velhoi* Higuti & Martens, 2013 and *S. nupelia* Higuti & Martens, 2013) and redescribed *S. tolimensis* Roessler, 1990 from the Upper Paraná River floodplain, applying both molecular and morphological analyses. More recently, Schön *et al.* (2018), using material of a *Strandesia* species complex from four Brazilian floodplains, showed that this species cluster actually consists of 13 cryptic species and a fourth morpho-species. This latter species was provisionally referred to as “*S. nupelia* II” and was thus far only found in the Araguaia River floodplain. Meanwhile, this species has been identified as the real *Strandesia obtusata* (Sars, 1901), which was moreover also found in both parthenogenetic and sexual populations. In addition, two further new species of *Strandesia* were found in the Araguaia River floodplain and one in Paraná River floodplain, neither of which belongs to the *S. obtusata*-lineage.

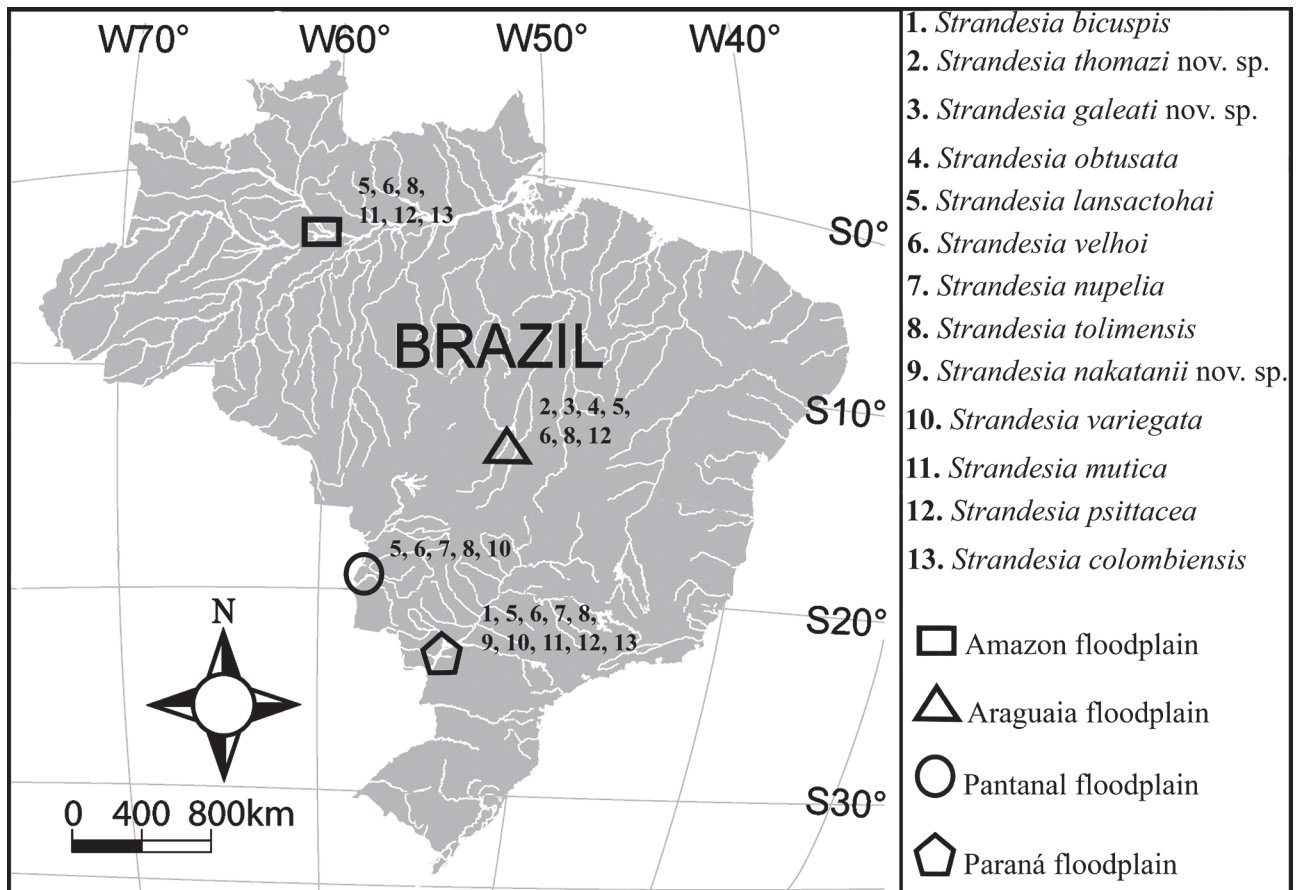
The presence of unknown species of *Strandesia* in two of the major floodplains of Brazil, the lack of more detailed descriptions of species described by Sars (1901) and Tressler (1950), which sometimes do not provide taxonomic relevant characters, and the scarce literature about these species, lead us to the present revision and (re-) description of Brazilian *Strandesia* species. Here, we describe three new species of *Strandesia*: *S. thomazi* nov. sp., *S. galeati* nov. sp. and *S. nakatanii* nov. sp. and we redescribe the following extant species: *Strandesia bicuspis* (Claus, 1892) G.W. Müller 1912; *S. obtusata* (Sars, 1901) G.W. Müller 1912; *S. lansactohai* Higuti & Martens, 2013; *S. velhoi* Higuti & Martens, 2013; *S. nupelia* Higuti & Martens, 2013; *S. tolimensis* Roessler, 1990; *S. variegata* (Sars, 1901) G.W. Müller 1912; *S. mutica* (Sars, 1901) G.W. Müller 1912; *S. psittacea psittacea* (Sars, 1901) Roessler 1990b; *S. psittacea colombiensis* Roessler, 1990. We did not review the species described by Tressler (1950) here, as these will be discussed elsewhere.



## Material and Methods

### Study area

The present study was conducted in four Brazilian river-floodplain systems: Amazon; Araguaia; South Matogrossense Pantanal and Paraná (Fig. 1). These floodplains are all large and cover distinct regions of Brazil. The greatest distance between two of these floodplains is 2300 km. River-floodplain systems comprise different types of habitats, such as open and closed lakes, backwaters, temporary pools and lakes (lentic environments), streams, connecting channels and main channels of the river and tributaries (lotic environments). High environmental heterogeneity is also a characteristic of such ecosystems, mostly owing to the hydrological regime, which drives the ecological patterns and biodiversity in these areas (Agostinho *et al.* 2004; Thomaz *et al.* 2007; Conceição *et al.* 2017).



**FIGURE 1** Distribution map of *Strandesia* species of the Amazon, Araguaia, Pantanal and Paraná floodplains.

The Amazon River floodplain is located in the northern region of Brazil and covers an area of 6.8 million km<sup>2</sup>, the largest draining basin in the world. The rainfall is evenly distributed temporally and spatially (Irion *et al.* 1997; Goulding *et al.* 2003).

The Araguaia River floodplain is located in central Brazil, in an area of tropical savanna (“Cerrado”). It has a drainage area of 377,000 km<sup>2</sup> and the river is 2,110 km long (Morais *et al.* 2005). This floodplain is the object of political and environmental discussions owing to the extensive damages caused by farming activities (Latrubesse & Stevaux 2002; Latrubesse *et al.* 2009).

The South Matogrossense Pantanal floodplain is located in the Paraguay River basin in the centre of South America. The Paraguay River basin has a drainage area of approximately 1 million km<sup>2</sup>. Most of the Pantanal is in Brazil while it also extends into parts of Bolivia and Paraguay. The Pantanal was named as a Biosphere Reserve by UNESCO and was granted the World Heritage Certificate (Barros *et al.* 2004).

The Paraná River floodplain has a drainage area covering 280,000 km<sup>2</sup>. The first third of this basin, the Upper Paraná River floodplain, is located between the Porto Primavera Reservoir and Itaipu Reservoir and is about 230 km long and 20 km wide. This section is the last undammed stretch of Paraná River (Agostinho *et al.* 2004).

## Sampling

Sampling was performed between 2004 and 2018 in the river-floodplain system of the Upper Paraná River, and between 2011 and 2012 in Amazon, Araguaia and Pantanal floodplains. Ostracods were collected from aquatic vegetation, with different life forms: **Free floating**: *Azolla* sp.; *Eichhornia crassipes* (Mart.) Solms; *Limnobium laevigatum* (Humb. & Bonpl. ex Willd.) Heine; *Limnobium* sp.; *Lindernia* sp.; *Salvinia auriculata* Aubl.; *Salvinia herzogii* de la Sota; *Salvinia minima* Baker; *Salvinia* spp; *Pistia stratiotes* L. and *Ricciocarpus* sp. **Emergent**: *Ludwigia* sp. and *Paspalum notatum* Flugge. **Epiphytic**: *Oxycaryum cubense* (Poepp. & Kunth) Palla. **Rooted floating-leaved**: *Nymphaea amazonum* Mart. & Zucc. **Rooted submerged**: *Cabomba furcata* Schult. & Schult. f. and *Egeria najas* Planch. **Free submerged**: *Utricularia foliosa* L. **Rooted floating-stemmed**: *Eichhornia azurea* (Sw.) Kunth; *Hydrocotyle ranunculoides* L. f.; *Hydrocotyle* sp.; *Paspalum repens* P.J. Bergius; *Polygonum acuminatum* Kunth; *Polygonum ferrugineum* Wedd.; *Polygonum stelligerum* Cham; *Polygonum* sp. (according to Pott & Pott 2000; Souza *et al.* 2017). The vegetation was hand-collected, and the whole plants or roots were washed in a bucket (Campos *et al.* 2017). This material was filtered in a net of 160µm mesh size, and then preserved in 70% ethanol buffered with sodium tetraborate. Ostracods were also collected from littoral sediments using a rectangular hand net (28cm x 14cm, mesh size ~160 µm).

Water temperature (WT) and dissolved oxygen (DO) concentration (YSI 550A oxymeter), pH (pHmeter Digimed) and electrical conductivity (EC) (conductivimeter-Digimed), were measured *in situ* close to the macrophytes.

**TABLE 1** Environment type, substrate type and abiotic variables (mean and standard deviation; minimum and maximum values in parenthesis) where *Strandesia* species were recorded in the river-floodplain systems of Amazon, Araguaia, Pantanal and Paraná. WT, water temperature; EC, electrical conductivity; DO, dissolved oxygen. Az, *Azolla* sp.; Ec, *Eichhornia crassipes* (Mart.) Solms; Ll, *Limnobium laevigatum* (Humb. & Bonpl. ex Willd.) Heine; Lm, *Limnobium* sp.; Sa, *Salvinia auriculata* Aubl.; Sh, *Salvinia herzogii* de la Sota; Sm, *Salvinia minima* Baker; Sp, *Salvinia* spp; Ps, *Pistia stratiotes* L. Rc, *Ricciocarpus* sp.; Lw, *Ludwigia* sp.; Pn, *Paspalum notatum* Flugge.; Oc, *Oxycaryum cubense* (Poepp. & Kunth) Palla.; Na, *Nymphaea amazonum* Mart. & Zucc.; Cf, *Cabomba furcata* Schult. & Schult. f.; En, *Egeria najas* Planch.; La, *Lindernia* sp. Uf, *Utricularia foliosa* L.; Ea, *Eichhornia azurea* (Sw.) Kunth; Hr, *Hydrocotyle ranunculoides* L. f.; Hy, *Hydrocotyle* sp.; Pr, *Paspalum repens* P.J. Bergius; Pa, *Polygonum acuminatum* Kunth; Pf, *Polygonum ferrugineum* Wedd.; Pt, *Polygonum stelligerum* Cham; Pl, *Polygonum* sp; Li, Littoral

Species	Floodplain (number of environment)	Environment type	Substrate type	WT (°C)	pH	EC (µS.cm <sup>-1</sup> )	DO (mg. L <sup>-1</sup> )
<i>Strandesia bicuspis</i> (Claus, 1892)	Paraná (3)	river, closed lake	Sp, Ec, Li	26.3±2.6 (23.6- 29.9)	6.4±0.9 (5.6-7.8)	76.7±32.7 (41.3-114.9)	4.5±2.8 (1.8-7.9)
<i>Strandesia thomazi</i> nov. sp.	Araguaia (2)	open lake	Pn	30±0.7 (29.6- 30.5)	6.4±0.3 (6.2-6.7)	42.9±0.9 (42.3-43.6)	2.4±0.6 (1.9-2.9)
<i>Strandesia galeati</i> nov. sp.	Araguaia (1)	open lake	Li	30.5	6.6	39	7.2
<i>Strandesia obtusata</i> (Sars, 1901)	Araguaia (10)	open lake	Pn, Uf, Az, Lm, Ps, Sa, Li	28.8±0.9 (27.6- 30.2)	6.5±0.3 (6.1-6.9)	40.9±7.4 (28.5-53.4)	3.4±1.9 (1.0-6.5)
<i>Strandesia lansactohai</i> Higuti & Martens, 2013	Paraná (31)	open and closed lakes, river, channel, backwater	Ec, Li, Oc, Ea, Sp, Ps, Hr, Sh, Na, Sm, En, Uf, Lm, Pl, Cf, Pr, La	27.9±4.5 (12.4- 34.1)	6.2±0.6 (4.4-8.1)	45.7±18.8 (12-123.8)	3.7±2.2 (0.1-10.2)

....Continued next page

TABLE 1 (Continued)

Species	Floodplain (number of environment)	Environment type	Substrate type	WT (°C)	pH	EC ( $\mu\text{S}\cdot\text{cm}^{-1}$ )	DO ( $\text{mg}\cdot\text{L}^{-1}$ )
	Amazon (15)	open lake	Pn, Ec, Sm, Ps, Sa, Az, Lm, Lw	32.7±1.6 (31-37.2)	7.4±1.5 (5.4-9.7)	65.8±45 (17.8-222.5)	3.4±3.2 (0.4-11.8)
	Araguaia (16)	open lake	Pn, Ps, Rc, Ec, Sa, Az, Uf, Li	29.7±0.6 (28.5- 30.9)	6.8±0.1 (6.4-7.1)	37.5±9.2 (21.8-54.4)	5.8±1.6 (1.7-7.9)
	Pantanal (16)	open lake	Ec, Sa, Ps, Lw, Ea, Hy	25.0±4.6 (19.7- 33.1)	7.1±0.6 (6-8.1)	88.5±46.4 (48.5-166)	3.5±1.7 (0.07-6.1)
<i>Strandesia velhoi</i> Higuti & Martens, 2013	Paraná (18)	open and closed lakes	Li, Ea, Ec, Sh, Pl, Ll	28.1±4.4 (14.3- 34.1)	5.9±0.9 (4.2-7.8)	40.6±17.9 (11-72)	3.4±2.5 (0.6-8.3)
	Amazon (15)	open lake	Pn, Ec, Ps, Oc, Sm, Az, Sa, Lw, Lm	32.6±1.5 (31-37.2)	6.9±1 (5.4-9.5)	62.3±36.7 (17.8-222.5)	3±3 (0.4-11.8)
	Araguaia (11)	open lake	Pn, Ps, Rc, Ec, Sa, Az, Uf, Oc, Sa	29.9±0.7 (28.5- 30.9)	6.8±0.2 (6.4-7.0)	38.1±7.8 (26.5-54.4)	5.6±2.1 (1.8-7.9)
	Pantanal (1)	open lake	Ec	26.5	6.04	58.2	5.5
<i>Strandesia nupelia</i> Higuti & Martens, 2013	Paraná (31)	open and closed lakes, river, channel, backwater	Ec, Li, Oc, Ea, Sp, Ps, Hr, Sh, Na, Sm, En, Uf, Lm, Pl, Cf, Pr, La	25.9±5.2 (14.3- 34.1)	6.2±0.8 (3.8-8.4)	42.4±17.7 (11-96.6)	3.9±2.1 (0.2-8.7)
	Pantanal (5)	open lake	Ec, Sa, Ps, Ea, Lw	20.5±0.7 (19.7- 21.4)	7.8±0.4 (7.05-8.1)	120.4±48.6 (54.3-162.2)	4.5±0.5 (3.6-5.1)
<i>Strandesia tolimensis</i> Roessler, 1990	Paraná (22)	open and closed lakes, river	Ec, Li, Fl, Ea, Uf, Lm, Pl, Cf, Pr, Pf, En, Sh	29.8±3.2 (18.4- 34.1)	5.7±0.4 (4.7-6.5)	34.2±16.3 (12-67.5)	2.8±2.1 (0.2-8.3)
	Amazon (5)	open lake	Sa, Ps, Lw, Az, Ec, Uf, Ln, Pn, Lm	32.4±1.2 (31.5- 34.3)	7±1 (6.4-9.5)	54±8.9 (43.5- 67.8)	2±0.9 (0.9-3.1)
	Araguaia (10)	open lake	Pn, Uf, Ec	29.9±0.7 (28.5- 30.9)	6.8±0.1 (6.6-7.0)	35.0±6.8 (26.5-46.6)	6.4±1.3 (3.9-8.0)
	Pantanal (3)	open lake	Ec, Lw, Ps	22.8±2.2 (20.3- 24.7)	7.1±0.7 (6.5-7.9)	113.1±44.7 (53.5-162.2)	2.7±1.3 (1.6-4.0)
<i>Strandesia nakatanii</i> nov. sp.	Paraná (4)	river and lake	Ea, Ec, Sa	25.2±4.6 (17.1- 30.0)	7.4±0.4 (6.4-8.3)	56.2±10.9 (35.0-68.8)	5.0±3.1 (1.4-12.2)

....Continued next page

TABLE 1 (Continued)

Species	Floodplain (number of environment)	Environment type	Substrate type	WT (°C)	pH	EC ( $\mu\text{S}\cdot\text{cm}^{-1}$ )	DO ( $\text{mg}\cdot\text{L}^{-1}$ )
<i>Strandesia variegata</i> (Sars, 1901)	Paraná (23)	open and closed lakes, river.	Ec, Li, Fl, Ps, Sa, Ll, Ea, Sh, Uf, Pf, Pr	29.1±3.5 (18.5- 33.1)	5.7±0.5 (4.2-6.9)	33.3±12.4 (11-67.1)	2.6±1.9  (0.2-8.3)
	Pantanal (1)	open lake	Sa, Ea	24.9	7.4	84.8	0.33
<i>Strandesia mutica</i> (Sars, 1901)	Paraná (30)	open lake	Ec, Li, Ea, Ps, Md, Sh, Sa, Hr, Ll, Lm, Sh, Sm, Pl, Pf	27.7±4.1 (14.3- 33.7)	5.9±0.7 (4.2-8.3)	43.3±21.4 (11.0-123.8)	3.0±2.1  (0.1-9.8)
	Amazon (3)	open lake	Ec, Sa, Ps, Pn	31.9±0.8 (31.5- 32.9)	6.5±0.1 (6.5-6.6)	49.9±7.2 (41.5-54.1)	1.2±0.06 (1.2-1.3)
<i>Strandesia psittacea</i> (Sars, 1901)	Paraná (24)	open and closed lakes, river, backwater	Ec, Li, Oc, Ea, Ps, Sa, Ll, Uf, Sh, Lm, Hr, Pl, Pa, Ll, La, Po, Pr, Cf, En	28.3±4.8 (15.4- 33.6)	6.2±0.6 (4.7-8.3)	32.7±16.2 (12-80.4)	3.26±1.9  (0.2-8.2)
	Amazon (8)	open lake	Ec, Ps, Oc, Sm, Pn, Sa	32.2±0.8 (31-34.3)	7.8±1.63 (5.4-9.7)	52.2±11.8 (17.8-67.8)	3.1±1.2 (0.4-5.1)
	Araguaia (1)	open lake	Pn	30.9	6.93	33.4	7.9
<i>Strandesia colombiensis</i> Roessler, 1990	Paraná (12)	open lake	Ec, Ps, Ea, Ll, Sm, Pr, Pa, Ps, Uf, En	30.3±2.3 (21.7- 33.6)	5.7±0.7 (4.2-7.7)	27.2±15.4 (11-63.0)	2.5±1.4  (0.4-6.1)
	Amazon (3)	open lake	Ec, Sa, Ps, Pn	31.4±0.3 (31-31.9)	8.7±1.8 (5.4-9.7)	44.6±15 (17.8-51.5)	2.7±1.3 (2.1-5.1)

#### Preparation and illustration of soft parts and valves

Soft parts were separated from the valves using dissection needles and were then put in a drop of glycerine for the dissection of the appendages. The dissection was covered with cover-slip and sealed with transparent nail polish. Valves were stored dry in micropaleontological slides. Drawings of soft parts were made using a camera lucida (Olympus U-DA) attached to a microscope (Olympus CX-41). Carapace and valves were illustrated and measured using Scanning Electron Microscopy (SEM, Fei Qanta 200 ESEM, in the Royal Belgian Institute of Natural Sciences, Brussels, Belgium) in different views (valves: internal and external views, carapaces: lateral, dorsal, ventral, and frontal views and details). Some species are fully illustrated, for others only some limbs are illustrated for comparative purposes.

The type material and illustrated specimens of the new species are stored in the Museum of Zoology of the University of São Paulo (MZUSP).

#### Abbreviations used in text and figures

RV, right valve; LV, left valve; LVi, left valve inner view; RVi, right valve inner view; Cp, carapace; CpLl, carapace left lateral view; CpRl, carapace right lateral view; CpD, carapace dorsal view; CpV, carapace ventral view; CpFr, carapace frontal view; L, length; H, height; W, width; A1, antennula; A2, antenna; CR, caudal ramus; Md,

mandibula; Mx1, maxillula; T1, first thoracopod; T2, second thoracopod; T3, third thoracopod; db, dorsal branch of caudal ramus attachment; vb, ventral branch of caudal ramus attachment; RO, Rome Organ on A1; WO, Wouters Organ on A1; ms, medial shield of hemipenis; ls, lateral shield of hemipenis; cr, chitinous rings in Zenker organ; ct, central tube of Zenker organ; dep, distal end plate of Zenker organ; pep, proximal end plate of Zenker organ; sw, spiny whorls in Zenker organ; Lpp, left prehensile palp (male T1); Rpp, right prehensile palp (male T1).

## Results

### Class OSTRACODA Latreille, 1802

#### Subclass PODOCOPA Sars, 1866

#### Order PODOCOPIDA Sars, 1866

#### Suborder CYPRIDOCOPINA G.O. Sars, 1866

#### Superfamily CYPRIDOIDEA Baird, 1845

#### Family CYPRIDIDAE Baird, 1845

#### Subfamily CYPRICERCINAE McKenzie, 1971

#### Tribe Cypricercini McKenzie, 1971

#### Genus *Strandesia* Stuhlmann, 1888

*Type species: Strandesia mercatorum* (Vávra, 1895)

*Diagnosis:* see Savatnalinton & Martens (2009a).

Remark: The present grouping of the 13 species into four species-groups is for convenience and no taxonomic value should be attached to them (see discussion).

#### The *Strandesia bicuspis* group

The *Strandesia bicuspis* species group is here composed of three species: *Strandesia bicuspis*, *Strandesia thomazi* nov. sp. and *Strandesia galeati* nov. sp. A common feature of these species is the presence of a dorsal protuberance on the RV, which can vary in size, shape and position.

#### 1. *Strandesia bicuspis* (Claus, 1892) G.W. Müller 1912

(Figs. 2–4)

1892 *Acanthocypris bicuspis*—Claus: 53, Plate VII, Figs. 1-12; Plate VIII, Figs. 1-6; Plate XI.

1892 *Strandesia bicuspis* var. *mucronata* (Claus): 53 (fide G.W. Müller 1912)

1892 *Acanthocypris bicuspis* var. *mucronata* Claus: 53 (fide G.W. Müller 1912)

1901 *Neocypris gladiator* n. sp.—Sars: 29, Plate VII, Figs. 1-7 (fide Martens & Behen 1994)

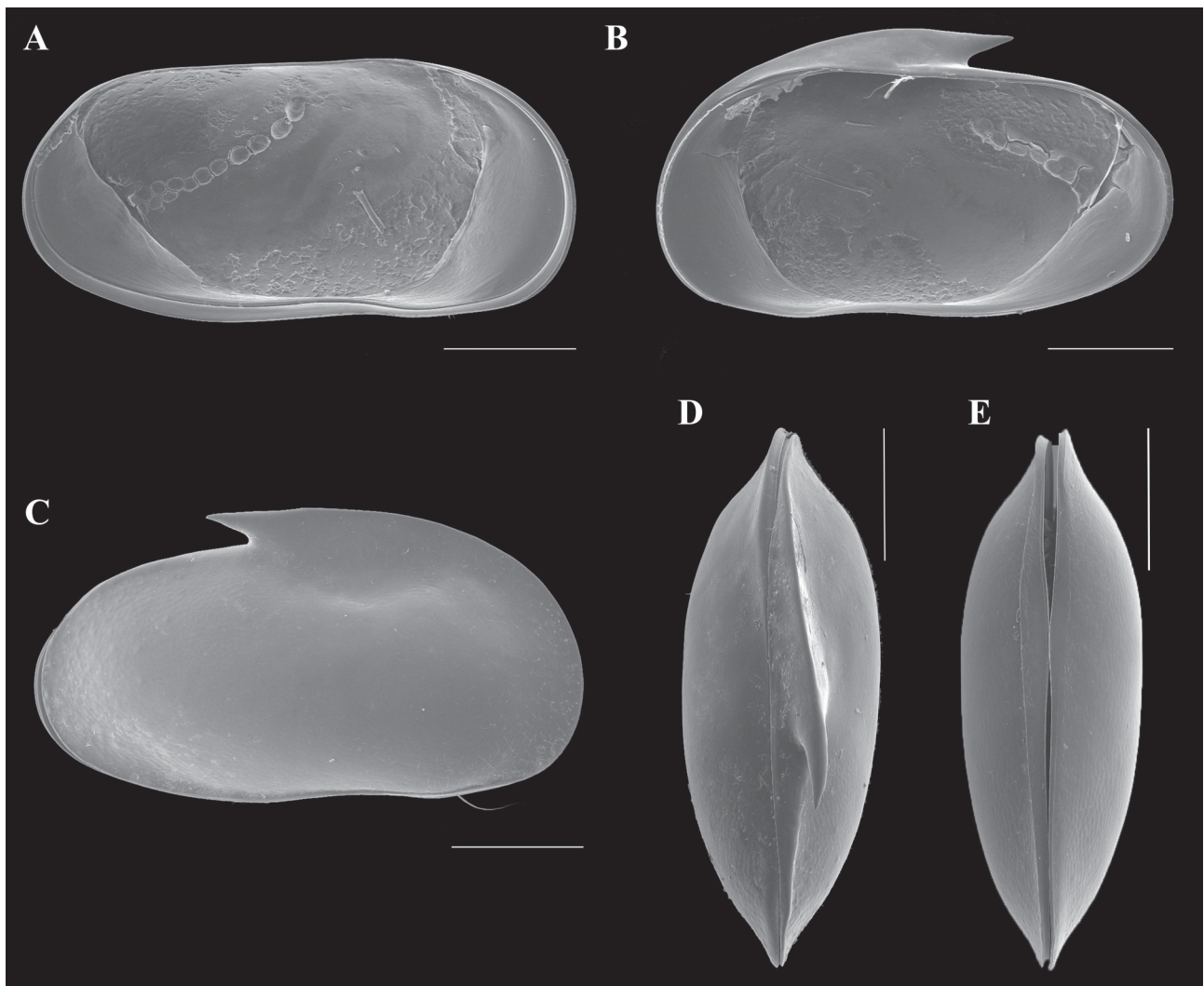
1950 *Strandesia denticulata*. new species—Tressler: 75, Fig. 13q-s, Fig. 14c (juveniles, fide Martens *et al.* 1998b)

#### *Type locality and material*

This species was first described by Claus (1892) from an unknown location. Sars (1901) described *Neocypris gladi-*



ator, a synonym of *S. bicuspis*, based on specimens hatched from dried mud from Itatiba (Brazil) and Argentina. No holotype was designated for *S. bicuspis* (Claus), the repository of potential type materials is unknown (Karanovic 2012).



**FIGURE 2** Carapace and valves of *Strandesia bicuspis*. A, LVi (MZUSP 40402); B, RVi (MZUSP 40402); C, CpRl (MZUSP 40399); D, CpD (MZUSP 40401); E, CpV (MZUSP 40400). Scale bars, 500  $\mu$ m.

#### *Material examined*

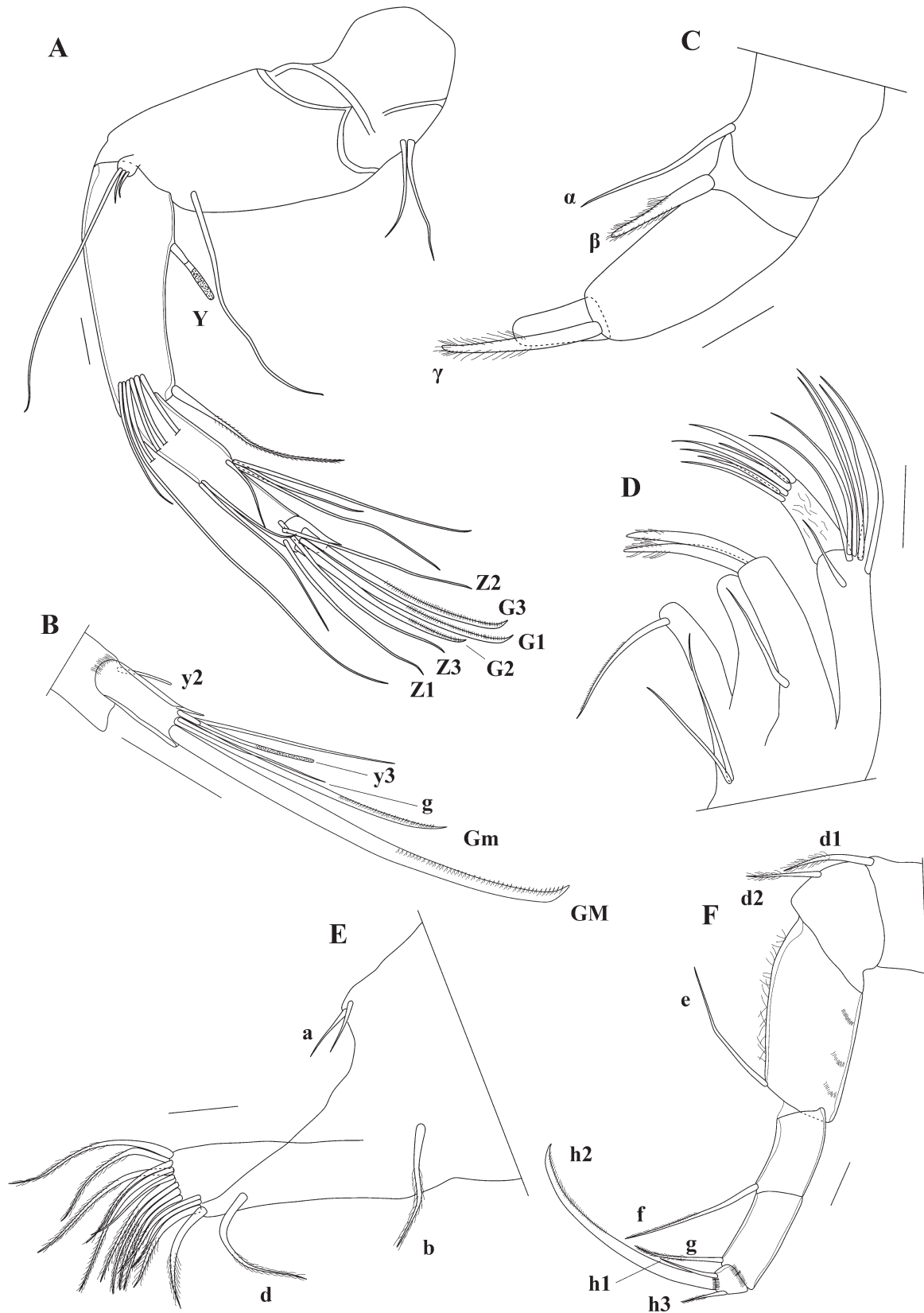
Two females (MZUSP 40397, MZUSP 40398) were used for soft part illustrations and four females (MZUSP 40399, MZUSP 40400, MZUSP 40401, MZUSP 40402) were used for SEM, all collected from Pontal Lake (22°45'6.2"S, 53°25'24.6"W) in the Upper Paraná River floodplain.

#### *Measurements of illustrated specimens (in mm)*

L (n=2): 2.046–2.102, H (n=1): 0.971, W (n=2): 0.649–0.660.

#### *Diagnosis*

Cp elongated. In dorsal view, Cp with a blunt anterior and posterior beak. LV with straight dorsal margin, and internal groove along ventral margin. RV dorsally with a helmet-like protuberance from the anterior to the middle region (anterior end softly curved, posterior end pointed). A2 with natatory setae reaching to half the length of apical claws. Caudal ramus slender and strongly serrated, its attachment with a sub-triangular Triebel's loop in the main branch.



**FIGURE 3** *Strandesia bicuspis*. A, A2 except last segment (MZUSP 40397); B, A2 last segment (MZUSP 40397); C, Md palp showing  $\alpha$ ,  $\beta$ ,  $\gamma$  setae (MZUSP 40397); D, Mx1 (MZUSP 40397); E, T1 (MZUSP 40397); F, T2 (MZUSP 40397). Scale bars, 50  $\mu\text{m}$ .

LVi (Fig. 2A) elongated, with straight dorsal margin; calcified inner lamella wide along anterior and posterior margins and narrow along ventral margin; with a submarginal selvage along anterior, ventral and posterior margins; internal groove along ventral margin; greatest height in LVi well ahead of the middle.

RVi (Fig. 2B) with calcified inner lamella as in LVi; anteriorly, ventrally and posteriorly without selvage or inner list; dorsally with a helmet-shaped protuberance from anterior to middle region, anterior end softly curved, posterior end pointed; greatest height in RVi in the middle because of dorsal protuberance.

CpR1 (Fig. 2C) elongated; with a large dorsal protuberance on RV; greatest height situated in the middle. CpD (Fig. 2D), with LV slightly longer than RV, especially at the anterior margins, both anterior and posterior ends pointed, anterior end slightly skewed to the right side; greatest width situated in front of the middle. CpV (Fig. 2E), with LV slightly extending beyond RV, especially at the anterior end; both anterior and posterior margins with a blunt beak; RV with an outer list running from anterior to posterior edges.

A1 (not illustrated) with seven segments. First segment with one short subapical seta and two long apical setae; WO small. Second segment wider than long, with one short dorsal seta and a small ventral RO. Third segment with two setae (the smaller one with the length of the fourth segment). Fourth segment with two short and two long setae. Fifth segment with three long and one short setae. Sixth segment with four long setae. Seventh segment with one short and two long setae, and one aesthetasc *ya*, slightly longer than the shorter seta.

A2 (Figs. 3A, B) with protopodite, exopodite and three-segmented endopodite. Protopodite with two ventral setae; and one long ventro-distal seta. Exopodite reduced to a small plate, with one long and two unequal short setae. First endopodal segment with one ventral aesthetasc *Y*, one long apical seta (reaching the tip of the second endopodal segment), one group of five long and one short swimming setae (the five long setae almost reaching tips of apical claws; the short one reaching the middle of third segment). Second endopodal segment undivided, with two unequal but long dorsal setae and a group of four unequal ventral t setae; apically with three claws, G1 longer, G2 short, and G3 slightly shorter than G1, three equally long setae (*z1*, *z2* and *z3*) and a short apical aesthetasc *y2* (Fig. 3B). Terminal segment (Fig. 3B) with two claws (one long, GM; one short, Gm), an aesthetasc *y3* with an accompanying seta (seta longer than aesthetasc), fused over a short distance only, and a fine *g*-seta, the latter shorter than accompanying seta of aesthetasc *y3*, but longer than the aesthetasc *y3* itself.

First segment of Md palp (Fig. 3C—chaetotaxy not completely shown) with long (reaching beyond tip of  $\beta$ -seta) and smooth  $\alpha$ -seta. Second segment ventrally with long (but less so than alpha seta), stout and hirsute  $\beta$ -seta. Penultimate segment laterally with elongated cone-shaped, distally hirsute  $\gamma$ -seta. Terminal segment almost 3x as long as basal width, tapering towards the distal side. Md coxa (not illustrated) as typical of the family, elongated with an apical row of strong teeth of variable size, interspaced with some small setae.

Mx1 (Fig. 3D—chaetotaxy not completely shown) with three masticatory lobes, a two-segmented palp and a large respiratory plate (the latter not illustrated). Basal segment of palp with six apical setae, and one short subapical seta. Terminal palp segment elongated, ca. twice as long as basal width, slightly curved and tapering, apically with three claws and three setae. Third endite with two large, distally serrated bristles. Lateral seta on third endite, reaching almost the end of the endite. First endite with one sideways-directed bristle only, and two long, unequal basal setae.

T1 protopodite (Fig. 3E) with two short, a-setae; b and d-setae equally long. Apically with 10 hirsute setae, subapically with a group of four setae. Endopodite with three unequal, hirsute apical setae (not illustrated).

T2 (Fig. 3F) protopodite with seta *d1* relatively long and seta *d2* shorter, ca. 3/4 of the length of *d1*. First endopodal segment with one subapical hirsute seta (*e*). Second endopodal segment medially divided into a- and b-segments; segment “a” with one long apical hirsute seta (*f*); segment “b” with one shorter seta (*g*) almost reaching halfway along the long claw (*h2*). Third endopodal segment with one apical claw (*h2*) and two setae (one ventro-apical (*h1*) with 1/3 of *h2* and one dorso-apical (*h3*), slightly shorter than *h1*).

T3 (Fig. 4A—chaetotaxy not completely shown) with three segments. First segment with three long setae (*d1*, *d2*, *dp*). Second segment, longer than wide, with one subapical seta (*e*). Third segment, also longer than wide, with one lateral, hirsute seta (*f*); distal part of the third segment fused with fourth segment into a modified pincer, with one apical comb-like seta (*h2*), one small recurved seta, with 1/5 of the length of the comb-like seta, and one longer and distally hirsute seta (*h3*). Small tooth-like structures present at the base of the comb-like seta (arrowed in Figure 4A).



CR (Fig. 4B) slender and curved, with ventral margin strongly serrated in five distinct groups. Proximal claw half the length of distal claw. Proximal seta smooth, ca. 1/5 of length of distal seta.

CR attachment (Fig. 4C) stout, with Triebel's loop sub-triangular, situated in the main branch; vb long and curved; db short.

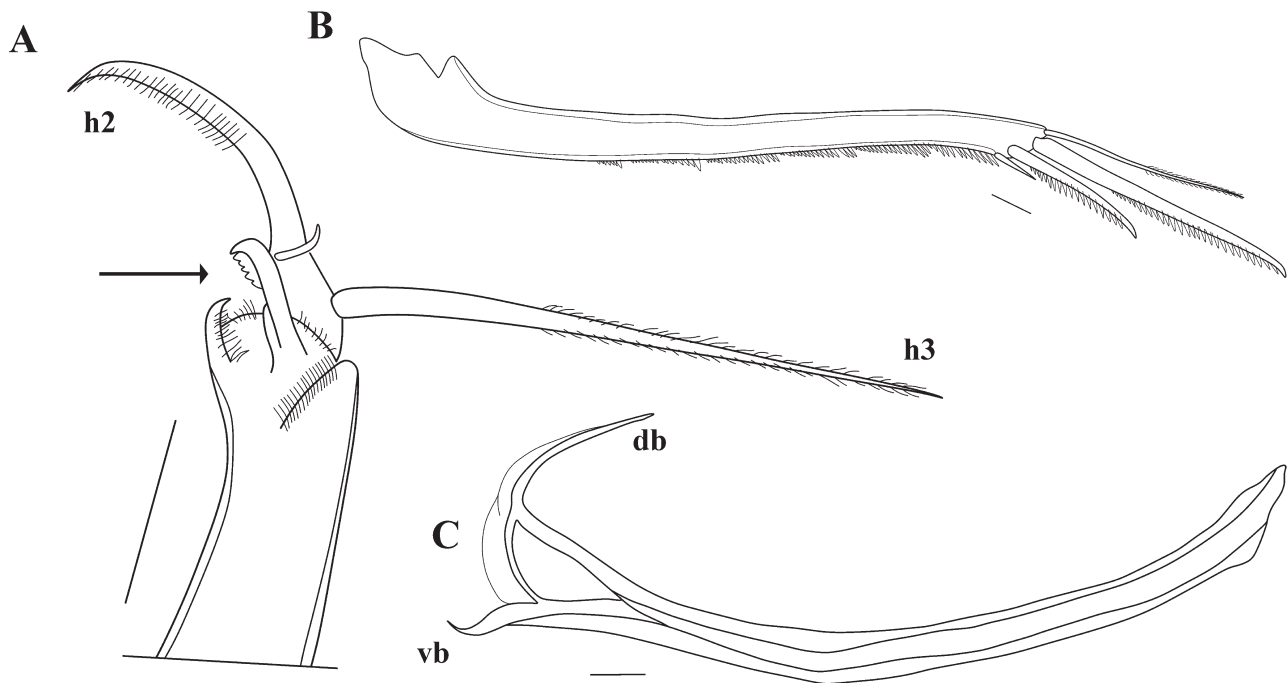
Male unknown.

#### *Differential diagnosis*

*Strandesia bicuspis* can be distinguished from other *Strandesia* species by the shape of the dorsal protuberance on the RV (more posteriorly pointed than in other *Strandesia* species with such a dorsal protuberance), and by the elongated LV.

#### *Ecology and distribution*

*Strandesia bicuspis* was recorded in lentic and lotic environments, associated with free-floating plants and on sediment, in the Paraná River floodplain. This species occurred in acidic to basic values, with a pH range of 5.6–7.8. Electrical conductivity and dissolved oxygen ranges were 41.3–114.9  $\mu\text{S}\cdot\text{cm}^{-1}$  and 1.8–7.9  $\text{mg}\cdot\text{L}^{-1}$ , respectively (see Table 1). Distribution: Neotropical: Argentina, Brazil, Colombia, Paraguay, Suriname and Venezuela. Palearctic (as alien invasive species): Germany (Matzke-Karasz et al. 2012).



**FIGURE 4** *Strandesia bicuspis*. A, T3 pincer (MZUSP 40398); B, CR (MZUSP 40397); C, CR attachment (MZUSP 40397). Scale bars, 50  $\mu\text{m}$ .

## **2. *Strandesia thomazi* nov. sp.**

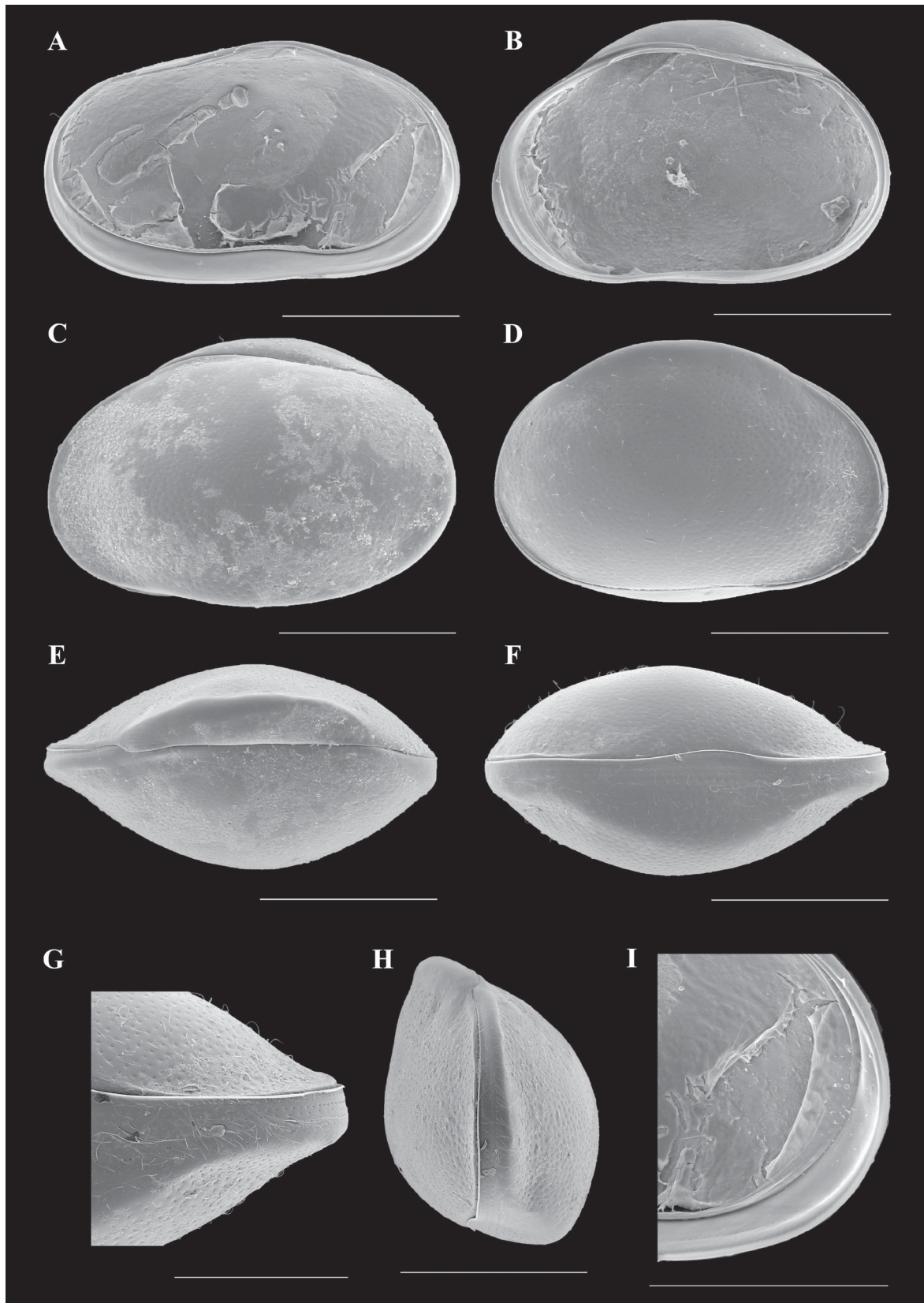
(Figs. 5–7)

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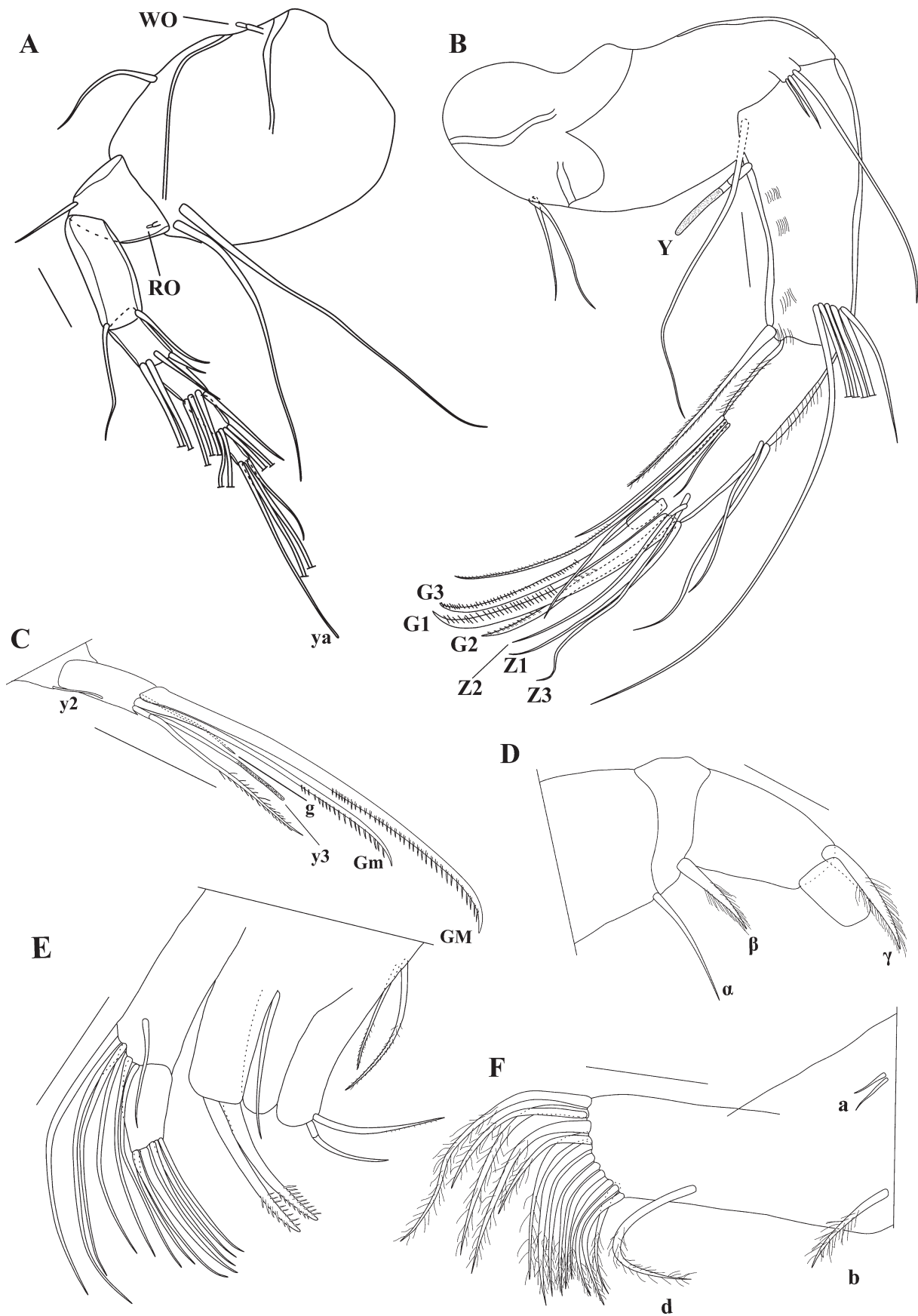
2017 *Strandesia* n. sp. 7—Pereira et al. : 327, Table 2.

*Measurements of illustrated specimens* (in mm)

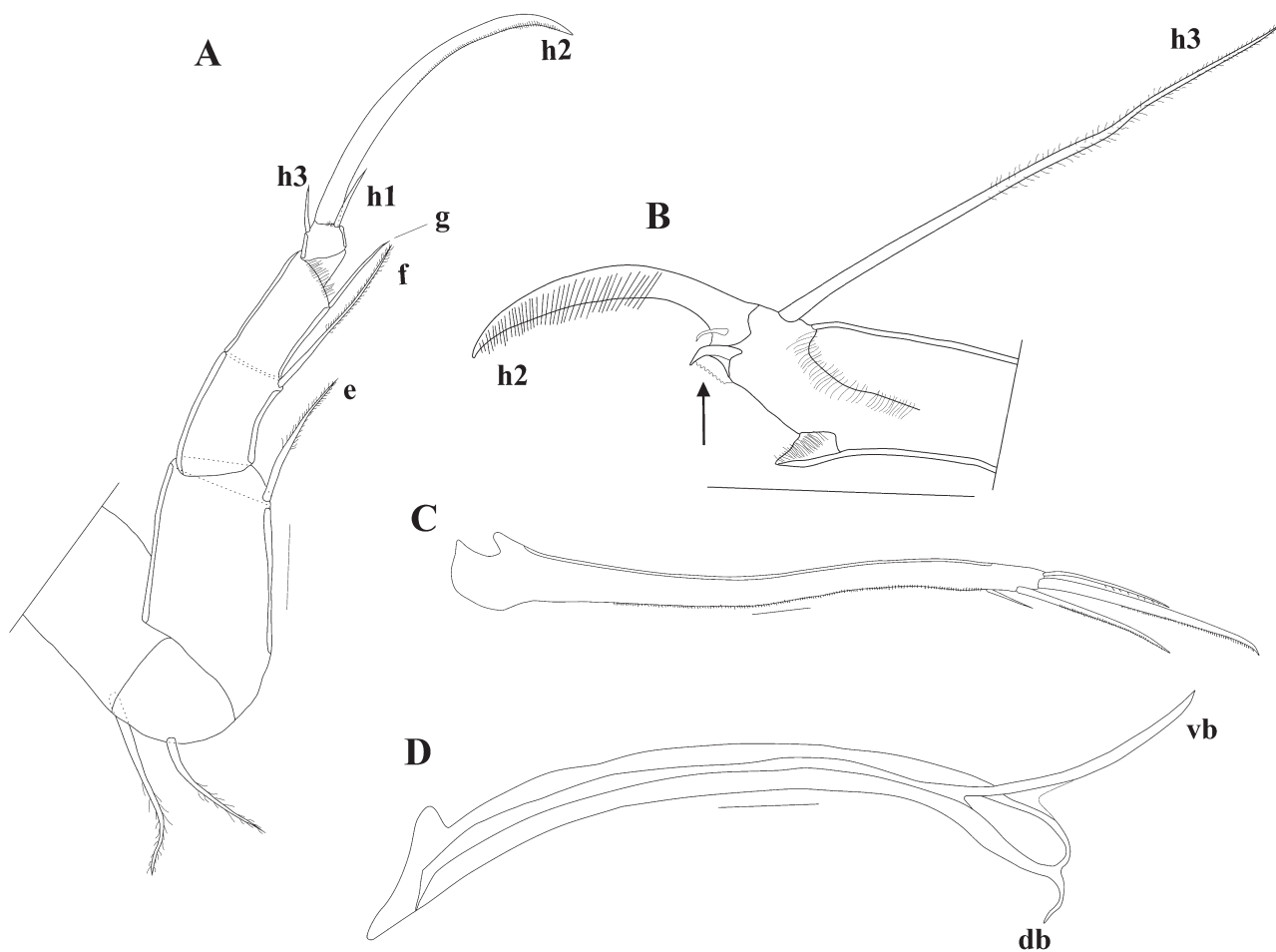
L (n=4): 1.110–1.115, H (n=2): 0.700–0.760, W (n=2): 0.578–0.594.



**FIGURE 5** Carapace and valves of *Strandesia thomazi* nov. sp. A, LVi (MZUSP 40406); B, RVi (MZUSP 40406); C, CpLl (MZUSP 40407); D, CpRl (MZUSP 40410); E, CpD (MZUSP 40408); F, CpV (MZUSP 40409); G, CpV detail of anterior part; H, CpFr (MZUSP 40408); I, LVi detail of posterior part (MZUSP 40409). Scale bars, A-F, H, 500  $\mu$ m; G, 300  $\mu$ m; I, 400  $\mu$ m.



**FIGURE 6** *Strandesia thomazi* nov. sp. A, A1 (MZUSP 40403); B, A2 except last segment (MZUSP 40403); C, A2 last segment (MZUSP 40403); D, Md palp showing  $\alpha$ ,  $\beta$ ,  $\gamma$  setae (MZUSP 40403); E, Mx1 (MZUSP 40403); F, T1 (MZUSP 40405). Scale bars, 50  $\mu$ m.



**FIGURE 7** *Strandesia thomazi* nov. sp. A, T2 (MZUSP 40403); B, T3 pincer (MZUSP 40403); C, CR (MZUSP 40403); D, CR attachment (MZUSP 40403). Scale bars, 50  $\mu$ m.

### *Diagnosis*

Cp subovate, with LV anteriorly, ventrally and posteriorly overlapping RV. RV overlapping LV dorsally with a rounded protuberance. LV with internal groove along ventral margin. CpFr asymmetrical, with RV higher than LV. CpD with a blunt anterior rostrum. RV with anterior selvage slightly inwardly displaced. A2 with natatory setae almost reaching tips of apical claws. T2 with d1 seta slightly longer than d2. Caudal ramus slender, its attachment with an oval Triebel's loop situated in the main branch.

### *Type locality*

Araguaia River floodplain, Montaria I Lake in roots of *Paspalum notatum*. Coordinates: 13°24'07.9"S, 50°43'10.2"W, central Brazil.

### *Type material*

Holotype: A female, with soft parts dissected in glycerine in a sealed slide and with valves stored dry in a micropaleontological slide (MZUSP 40403).

Paratypes: Three females dissected and stored as the holotype (MZUSP 40404, MZUSP 40405, MZUSP 40406). Four female carapaces stored dry in micropaleontological slides (MZUSP 40407-MZUSP 40410).



### *Etymology*

This species was named in honour of Prof. Dr Sidinei Magela Thomaz (State University of Maringá, Nupélia/PEA, Brazil) for his very significant contributions to the ecology and limnology of Brazilian inland waters and their macrophytes. Prof Sidinei “Nei” Thomaz has been most helpful in establishing ostracod studies at Nupelia and is a close personal friend of KM.

### *Description of female*

LVi (Fig. 5A, I) high, with calcified inner lamella relatively wide along anterior margin, narrow along ventral margin and absent on posterior margin; with an anterior inner list; inwardly displaced submarginal selvage; internal groove along ventral margin; greatest height situated in front of the middle.

RVi (Fig. 5B) high and with dorsal protuberance; with calcified inner lamella as in LVi, anteriorly and posteriorly with selvage slightly inwardly displaced, greatest height situated slightly behind the middle because of dorsal protuberance.

CpLI and CpRI (Fig. 5C, D) subovate; greatest height situated behind the middle; external valve surface set with few pits and setae. CpD (Fig. 5E) with LV overlapping RV along the anterior margin; this anterior margin a blunt beak, posteriorly bluntly rounded, also with asymmetrical overlap. CpV (Fig. 5F, G) with LV overlapping RV from posterior to anterior margin, centrally with a weak flap-like expansion. CpFr (Fig. 5H), with valves asymmetrical, RV higher than LV; LV with ventral projection over RV.

A1 (Fig. 6A) with seven segments. First segment with one short subapical seta and two long apical setae; WO small. Second segment wider than long, with one short dorsal seta and a small ventral RO. Third segment with two setae (the smaller almost reaching the tip of the fifth segment). Fourth segment with four setae (two short and two long). Fifth segment with three long and one short setae (twice the length of fifth segment). Sixth segment with four long setae. Seventh segment with one short and two long setae, and one aesthetasc ya, ca. 2x as long as the short seta.

A2 (Figs. 6B, C) with protopodite, exopodite and three-segmented endopodite. Protopodite with two ventral setae; and one long ventro-distal seta. Exopodite reduced to a small plate, with one long and two unequal short setae. First endopodal segment with one ventral aesthetasc Y, one long apical seta (reaching the tip of the second endopodal segment), one group of five long and one short swimming setae (the five long setae almost reaching tips of apical claws; the shortest almost reaching the middle of second endopodal segment). Second endopodal segment undivided, with two unequal dorsal setae and a group of four long and unequal ventral setae; apically with three claws, G1 longer, G2 shorter, and G3 slightly shorter than G1, three equally long setae (z1, z2 and z3) and a short aesthetasc y2 (Fig. 6B). Terminal segment (Fig. 6B) with two claws (one long GM; one short, Gm), an aesthetasc y3 with an accompanying seta (seta longer than aesthetasc), fused over a short distance only, and a fine g-seta, the latter shorter than the accompanying seta and aesthetasc y3.

First segment of Md palp (Fig. 6D—chaetotaxy not completely shown) with one long (reaching beyond tip of  $\beta$ -seta) and smooth  $\alpha$ -seta. Second segment ventrally with one long, stout and distally hirsute  $\beta$ -seta. Penultimate segment laterally with one cone-shaped, stout and distally hirsute  $\gamma$ -seta. Terminal segment sub-rectangular, ca. 1.5x as long as basal width. Md coxa (not illustrated) as typical of the family: elongated with an apical row of strong teeth of variable size, interspaced with some setae.

Mx1 (Fig. 6E—chaetotaxy not completely shown) with three masticatory lobes, a two-segmented palp and a large respiratory plate (the latter not illustrated). Basal segment of palp with six apical setae, and one shorter subapical seta. Terminal palp segment elongated, ca. twice as long as basal width, slightly curved and tapering, apically with three claws and three setae. Third endite with two large, distally serrated bristles. Subapical seta on third endite reaching beyond edge of the endite. First endite with two unequal sideways-directed bristles and two unequal basal setae.

T1 protopodite (Fig. 6F) with two short a-setae, one distally hirsute b-seta and one longer distally hirsute d-setae, almost twice as long as b-seta. Apically with 10 hirsute setae, subapically with a group of four setae. Endopodite with three unequal long hirsute apical setae (not illustrated).

T2 (Fig. 7A) protopodite with seta d1 long and seta d2 shorter, ca. 2/3 of the length of d1. First endopodal segment with one subapical hirsute seta (e). Second endopodal segment medially divided into a- and b-segments; segment “a” with one long apical hirsute seta (f); segment “b” with one shorter seta (g) reaching the tip of the terminal

segment. Third endopodal segment with one apical claw (h2) and two setae (one ventro-apical subapical (h1) with 1/4 the length of h2 and one dorso-apical (h3) slightly shorter than h1).

T3 (Fig. 7B—chaetotaxy not completely shown) with three segments. First segment with three long setae (d1, d2, dp). Second segment, longer than wide, with one subapical seta (e). Third segment, also longer than wide, with one lateral, hirsute seta (f); distal part of the third segment fused with fourth segment into a modified pincer, with one apical comb-like seta (h2), one small recurved seta, with 1/5 of the length of the comb-like seta and one longer and distally hirsute seta (h3). Small tooth-like structures present at the base of the comb-like seta (arrowed in Figure 7B).

CR (Fig. 7C) slender and curved, with ventral margin weakly serrated, not with distinct groups. Proximal claw 2/3 of the length of distal claw. Proximal seta smooth, ca. 1/3 of length of distal seta.

CR attachment (Fig. 7D) stout, with Triebel's loop oval-shaped, situated in the db; vb long.

Male unknown.

### *Differential diagnosis*

*Strandesia thomazi* nov. sp. can be distinguished from most other *Strandesia* species by the rounded dorsal protuberance on the RV and the blunt beak on the anterior end of the carapace in dorsal view. This species is most similar in lateral view to the African *S. elatior* (Vávra, 1897), but the carapace in this latter species has no anterior beak in dorsal view. In other species of the genus with a dorsal protuberance on the RV, this structure has a different shape: it has a straight margin and a posterior spine in the African type species of the genus, *S. mercatorum*. Of other such species, *S. bicuspis* (Claus, 1892) has a posteriorly pointed dorsal protuberance, the dorsal protuberance is semi-rectangular and larger in *S. feuerborni* Klie, 1932, small and sub-quadrate in *S. pistrix* Broodbakker, 1983, larger in *S. evae* Gauthier, 1951 and smaller and more symmetrically rounded in the *S. cyprinotooides* Klie, 1938. *Strandesia thomazi* nov. sp. differs from *Strandesia galeati* nov. sp. in that it is generally higher and less elongated (especially the LV) and that the dorsal protuberance is situated more posteriorly.

### *Ecology and distribution*

*Strandesia thomazi* nov. sp. was recorded in lentic environments, associated with emergent macrophytes, in the Araguaia River floodplain. This species occurred in slightly acidic environments, with a pH range of 6.2–6.7. Electrical conductivity and dissolved oxygen ranges were 42.3–43.6  $\mu\text{S}\cdot\text{cm}^{-1}$  and 1.9–2.9  $\text{mg}\cdot\text{L}^{-1}$ , respectively (see Table 1). Distribution: Brazil.

## **3. *Strandesia galeati* nov. sp.**

(Figs. 8–10)

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### *Measurements of illustrated specimens* (in mm)

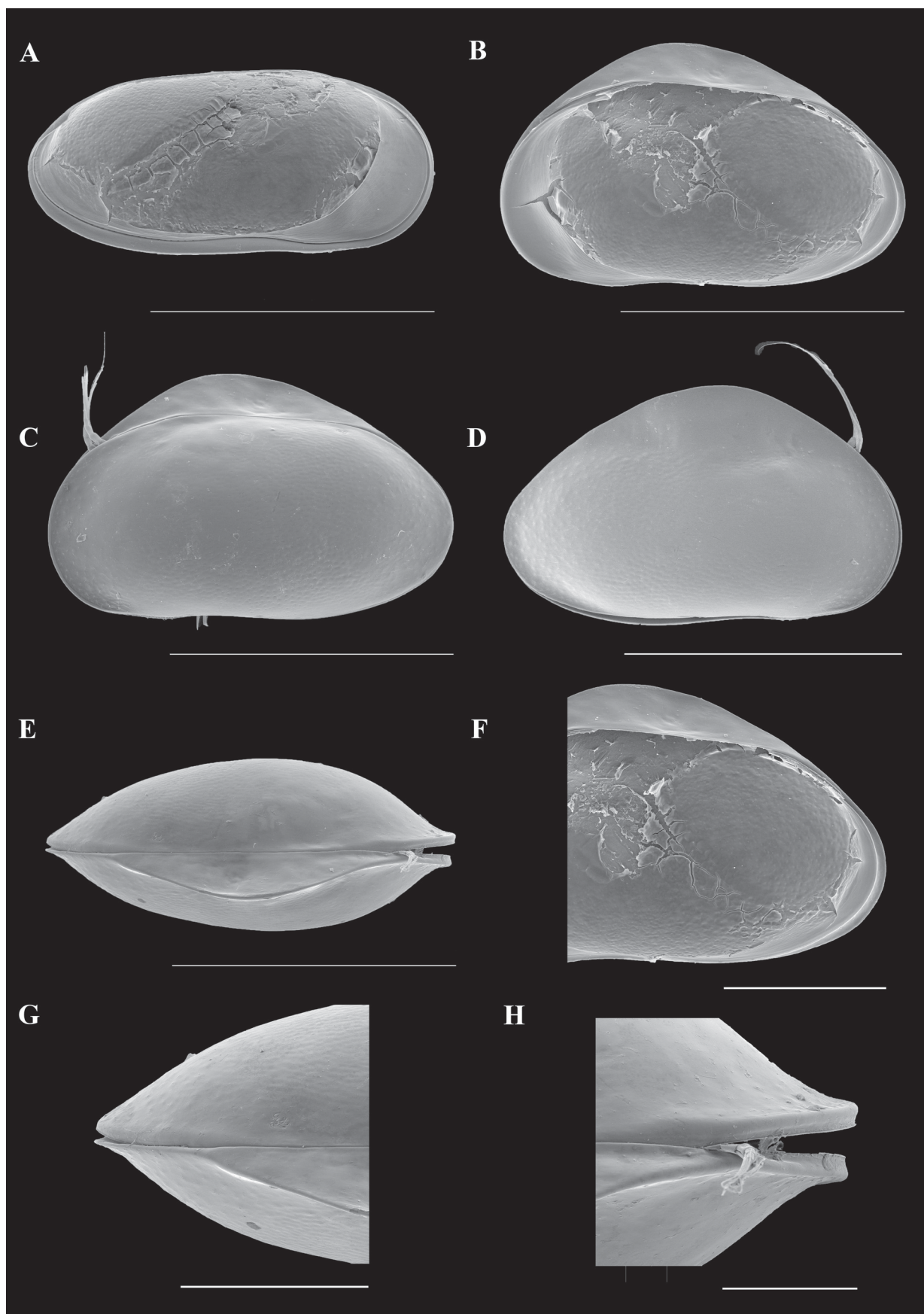
L (n=1): 1.431, H (n=1): 0.865, W (n=1): 0.606.

### *Diagnosis*

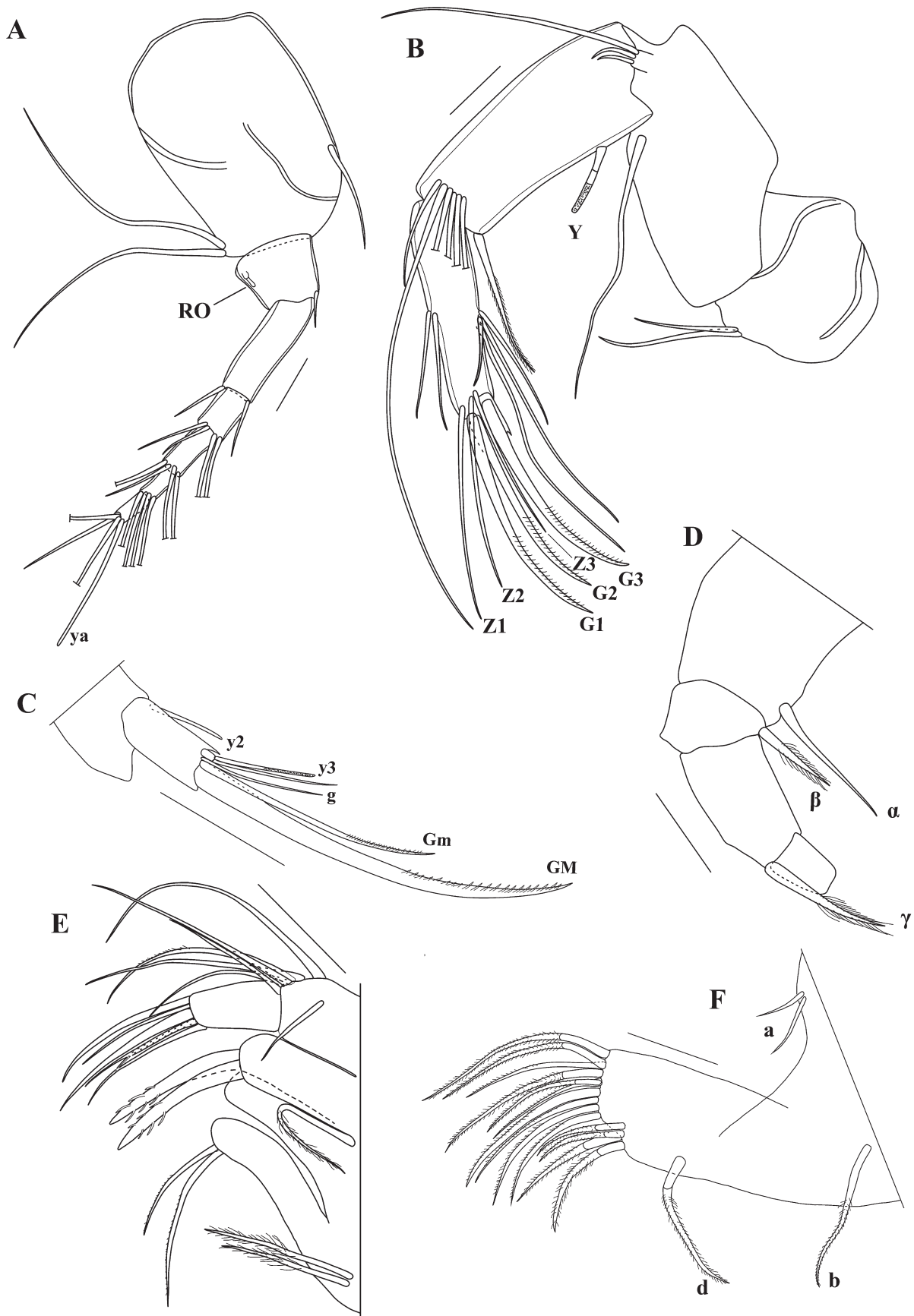
Cp in lateral views slightly triangular, with a big dorsal protuberance on RV. LV with internal groove along ventral margin. Greatest height in the middle; anterior region more broadly rounded than posterior one. Cp external surface with a few pits and setae. A2 with natatory setae almost reaching tips of apical claws. T2 with seta d2 ca. 3/4 the length of d1. Caudal ramus slender, and strongly serrated; its attachment with a triangular Triebel's loop in the main branch.

### *Type locality*

Araguaia River floodplain, Caixa de Emprestimo, temporary lake, in the littoral region with grass and algae. Coordinates: 13°2'54.3"S, 50°32'29.3"W, central Brazil.

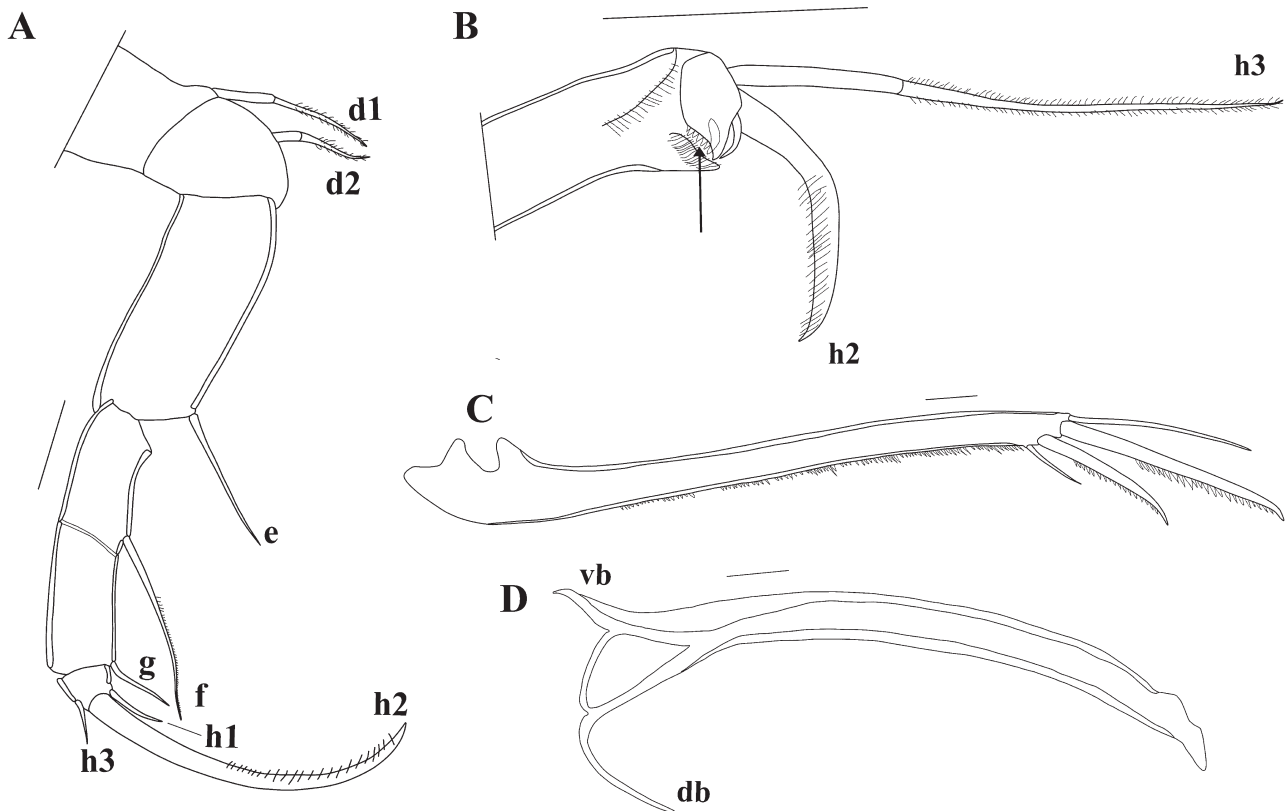


**FIGURE 8** Carapace and valves of *Strandesia galeati* nov. sp. A, LVi (MZUSP 40413); B, RVi (MZUSP 40413); C, CpLl (MZUSP 40413); D, CpRl (MZUSP 40413); E, CpD (MZUSP 40413); F, RVi detail of posterior part; G, CpD (MZUSP 40413) posterior margin; H, CpD (MZUSP 40413) anterior margin. Scales bars, A-E, 1.000  $\mu$ m; F, 500  $\mu$ m; G, 400  $\mu$ m; H, 200  $\mu$ m.



**FIGURE 9** *Strandesia galeati* nov. sp. A, A1 (MZUSP 40411); B, A2 except last segment (MZUSP 40412); C, A2 last segment (MZUSP 40412); D, Md palp showing  $\alpha$ ,  $\beta$ ,  $\gamma$  setae (MZUSP 40411); E, Mx1 (MZUSP 40412); F, T1 (MZUSP 40412). Scale bars, 50  $\mu\text{m}$ .





**FIGURE 10** *Strandesia galeati* nov. sp. A, T2 (MZUSP 40412); B, T3 pincer (MZUSP 40412); C, CR (MZUSP 40411); D, CR attachment (MZUSP 40411). Scale bar, 50  $\mu$ m.

*Type material*

Holotype: A female, with valves and dried soft parts stored in a micropaleontological slide (MZUSP 40413).

Paratypes: Two females with soft parts dissected in glycerine in a sealed slide, valves decalcified (MZUSP 40411, MZUSP 40412).

*Etymology*

This species was named after the helmet-like dorsal expansion (*galeati* is “helmet” in Latin).

*Description of female*

LVi (Fig. 8A) elongated, with almost straight but sloping dorsal margin; with calcified inner lamella wide along anterior margin, narrow along ventral and posterior margins; internal groove along ventral margin; greatest height well in front of the middle.

RVi (Fig. 8B) with anterior margin more broadly rounded than posterior margin, dorsally with a rounded, anteriorly situated protuberance; calcified inner lamella as in LVi; without anterior selvage but with inwardly displaced posterior selvage (Fig. 8F); greatest height in front of the middle.

CpLI (Fig. 8C) slightly triangular due the presence of dorsal protuberance on RV; RV higher than LV; greatest height situated in the middle; anterior region broader than posterior; with pustules on anterior and posterior sides. CpRI (Fig. 8D) slightly triangular; LV overlapping RV on ventral and anterior margin; with pustules on anterior and posterior sides. CpD (Fig. 8E) with greatest width in front of the middle; anterior margin with a blunt beak. CpD posterior and anterior margins (Fig. 8G, H) with pustules on the external surface.

A1 (9A) with seven segments. First segment with one short subapical seta and two long apical setae; WO not seen. Second segment wider than long, with one short dorsal seta and a small ventral RO. Third segment with two setae, slightly longer than fourth segment. Fourth segment with four setae (two short and two long). Fifth segment with three long and one short setae (the latter one reaching the tip of the last segment). Sixth segment with four long

setae. Seventh segment with one short and two long setae, and one aesthetasc ya, ca. 1/3 longer than the short seta. A2 (Figs. 9B, C) with protopodite, exopodite and three-segmented endopodite. Protopodite with two ventral setae; and one long ventro-distal seta. Exopodite reduced to a small plate, with one long and two unequal short setae. First endopodal segment with one ventral aesthetasc Y, one long apical seta (almost reaching the tip of the second endopodal segment), one group of five long and one short swimming setae (the five long setae almost reaching tips of apical claws; the short one almost reaching the middle of third segment). Second endopodal segment undivided, with two unequal dorsal setae and a group of four unequal ventral t setae; apically with three claws, G1 long, G2 slightly shorter than G1, and G3 same length as G1; three unequal long setae (z1 long, z2 slightly shorter than z1, and z3 the shortest) and a short apical aesthetasc y2 (Fig 9B). Terminal segment (Fig 9B) with two claws (one long GM; one short Gm), an aesthetasc y3 with an accompanying seta (seta longer than aesthetasc), fused over a short distance only, and a fine g-seta, the latter shorter than accompanying seta of aesthetasc y3, but longer than the aesthetasc y3 itself.

First segment of Md palp (Fig. 9D—chaetotaxy not completely shown) with one long (reaching beyond tip of  $\beta$ -seta) and smooth  $\alpha$ -seta. Second segment ventrally with one long (but less so than alpha seta), stout and hirsute  $\beta$ -seta. Penultimate segment laterally with one cone-shaped, distally hirsute  $\gamma$ -seta. Terminal segment of Md-palp sub-quadrangle, ca. 1.5x as long as basal width, slightly tapering. Md coxa (not illustrated) as typical of the family, elongated with an apical row of strong teeth of variable size, interspaced with some small setae.

Mx1 (Fig. 9E—chaetotaxy not completely shown) with three masticatory lobes, a two-segmented palp and a large respiratory plate (the latter not illustrated). Basal segment of palp with six apical setae, and one short subapical seta. Terminal palp segment elongated and tapering, ca. 2x as long as basal width, slightly curved, apically with three claws and three setae. Third endite with two large, distally serrated bristles. Lateral seta on third endite, reaching beyond tip of the endite. First endite with two unequal sideways-directed bristles, and two long, unequal basal setae.

T1 protopodite (Fig. 9F) with two short, unequal a-setae; b-seta slightly longer than d-setae. Apically with 10 hirsute setae, subapically with a group of four setae. Endopodite with three unequal long hirsute apical setae (not illustrated).

T2 (Fig. 10A) protopodite with seta d1 long and seta d2 shorter, ca. 3/4 of the length of d1. First endopodal segment with one subapical hirsute seta (e). Second endopodal segment medially divided into a- and b-segments; segment "a" with one long apical hirsute seta (f); segment "b" with one shorter seta (g) reaching beyond the end of the terminal segment. Third endopodal segment with one apical claw (h2) and two setae (one ventro-apical seta (h1) with 1/5 the length of h2 and one dorso-apical seta (h3) slightly shorter than h1).

T3 (Fig. 10B—chaetotaxy not completely shown) with three segments. First segment with three long setae (d1, d2 dp). Second segment, longer than wide, with one subapical seta (e). Third segment, also longer than wide, with one lateral, hirsute seta (f); distal part of the third segment fused with fourth segment into a modified pincer, with one apical comb-like seta (h2), one small recurved seta, ca. 1/5 of the length of the comb-like seta and one longer and distally hirsute seta (h3). Small tooth-like structures present at the base of the comb-like seta (arrowed in Figure 10A).

CR (Fig. 10C) slender and slightly curved, with ventral margin serrated in 4-5 groups. Proximal claw ca. 2/3 of the length of distal claw. Proximal seta smooth, ca. 1/3 of length of distal seta.

CR attachment (Fig. 10D) stout, with oval Triebel's loop in the main branch; db long and curved; vb short and stout.

Male unknown.

### *Differential diagnosis*

*Strandesia galeati* nov. sp. can be distinguished from other *Strandesia* species by the shape and position of the dorsal protuberance on the RV: it has a straight margin and a posterior spine in the African type species of the genus *S. mercatorum*; *S. bicuspis* (Claus, 1892) has a posteriorly pointed dorsal protuberance; the dorsal protuberance is semi-rectangular and larger in *S. feuerborni* Klie, 1932, small and sub-quadrangle in *S. pistrix* Broodbakker, 1983, larger in *S. evae* Gauthier, 1951 and smaller and more symmetrically rounded in the *S. cyprinotoides* Klie, 1938. *Strandesia galeati* nov. sp. differs from *Strandesia thomazi* nov. sp. in that the former is generally more elongated (especially the LV) and the dorsal protuberance is situated more anteriorly.

## Ecology and distribution

*Strandesia galeati* nov. sp. was recorded in the littoral region of a temporary artificial lake, in the Araguaia River Floodplain. This species occurred in slightly acidic environments with pH of 6.6. Electrical conductivity and dissolved oxygen were 39  $\mu\text{S}\cdot\text{cm}^{-1}$  and 7.2 mg  $\cdot\text{L}^{-1}$ , respectively (see Table 1). Distribution: Brazil.

## The *S. obtusata/elliptica* group

The *Strandesia obtusata/elliptica* group is composed of six species, *Strandesia obtusata*, *Strandesia lansactohai*, *Strandesia velhoi*, *Strandesia nupelia*, *Strandesia tolimensis* and *Strandesia nakatanii* nov. sp. These species share, with some degree of variation, similarities in the shape of valves and size.

## 4. *Strandesia obtusata* (Sars, 1901)

(Figs. 11–14)

- 1901 *Neocypris obtusata* n. sp.—Sars, 1901: 34, Plate VIII, Figs. 1-2.  
1936 *Strandesia obtusata*—Furtos, Figs. 111-112 (fide Broodbakker 1983: 356).  
1937 *Strandesia obtusata*—Tressler: 197 (fide Broodbakker 1983: 356).  
1983 *Strandesia obtusata* (Sars, 1901)—Broodbakker: 356.  
2017 *Strandesia* cf. *nupelia* n. sp. 6 Pereira *et al.*: 327.  
2018 *Strandesia nupelia* II—Schön *et al.*: 89.

### Measurements of illustrated specimens (in mm)

Male, L (n=3): 0.883–0.909, H (n=1): 0.555, W (n=2): 0.497–0.501.  
Female, L (n=3): 0.949–0.994, H (n=1): 0.615, W (n=2): 0.555–0.556.

### Diagnosis

Cp globular, with LV overlapping RV anteriorly. CpFr asymmetrically skewed with RV placed slightly higher than LV. RV with anterior selvage inwardly displaced, posteriorly with an obtuse projection reaching beyond the LV; LV with internal groove along margins. A2 with natatory setae almost reaching tips of apical claws. T2 with seta d1 almost twice as long as d2. Caudal ramus slender, its attachment with an oval Triebel's loop in the dorsal branch. Male prehensile palps asymmetrical, Rpp with slender first segment and large triangular second segment. Lpp with basal segment broad and distal segment sickle shaped. Hemipenis with slightly bilobed, broadly rounded ms and a protruding, bluntly pointed ls.

### Type locality and material

Itatiba, São Paulo State, Brazil. This species was described based on specimens hatched from dried mud by Sars (1901). Type material (lectotype and paralectotypes- slides and ethanol material) with n°: F19401a1, a2, b1, b2 in the Sars-collection of the Oslo Zoological Museum, Norway (A. Wilhelmsen, pers. comm. 7/8/2018).

### Material examined

Five males with soft parts dissected in glycerine in sealed slides, and with valves stored dry in micropaleontological slides (MZUSP 40414, MZUSP 40415, MZUSP 40416, MZUSP 40417, MZUSP 40418) and three males carapaces stored dry in micropaleontological slides (MZUSP 40419, MZUSP 40420, MZUSP 40421).

Three females with soft parts dissected in glycerine in sealed slides, and with valves stored dry in micropaleontological slides (MZUSP 40422, MZUSP 40423, MZUSP 40424) and three females carapaces stored dry in micropaleontological slides (MZUSP 40425, MZUSP 40426, MZUSP 40427).

## *Description of male*

LVi (Fig. 11A) with calcified inner lamella wide along anterior margin and narrower along ventral and posterior margins; internal groove from anterior to posterior margins; greatest height situated well in front of the middle.

RVi (Fig. 11B) with calcified inner lamella as in LVi; anteriorly with selvage slightly inwardly displaced and with a prominent posterior projection (flange). Greatest height situated well in front of the middle.

CpLI (Fig. 11C) rounded, with the prominent posterior projection (flange) on of the RV clearly visible; greatest height situated in front of the middle; external valve surface set with few pits and setae. CpD (Fig. 11D) with evenly rounded margins; LV anteriorly overlapping RV, but RV overlapping LV with one dorsal flap at about 1/6 of the length from the anterior tip; posterior flange projecting beyond the LV. CpV (Fig. 11E) with LV overlapping RV, centrally more so with a (very) weak expansion; posterior flange on RV projecting beyond LV (Fig. 11G). CpFr (Fig. 11F): with valves asymmetrical, RV higher than LV; dorsal flap of RV and ventral overlap of LV conspicuous.

A1 (Fig. 12A) with seven segments. First segment with one short subapical seta and two long apical setae; WO not seen. Second segment wider than long, with one short dorsal seta and a small ventral RO. Third segment with two setae (the smaller with the length of the fourth segment). Fourth segment with two short and two long setae. Fifth segment with three long and one short setae. Sixth segment with four long setae. Seventh segment with one short and two long setae, and one aesthetasc ya, ca. 2x longer than the short seta.

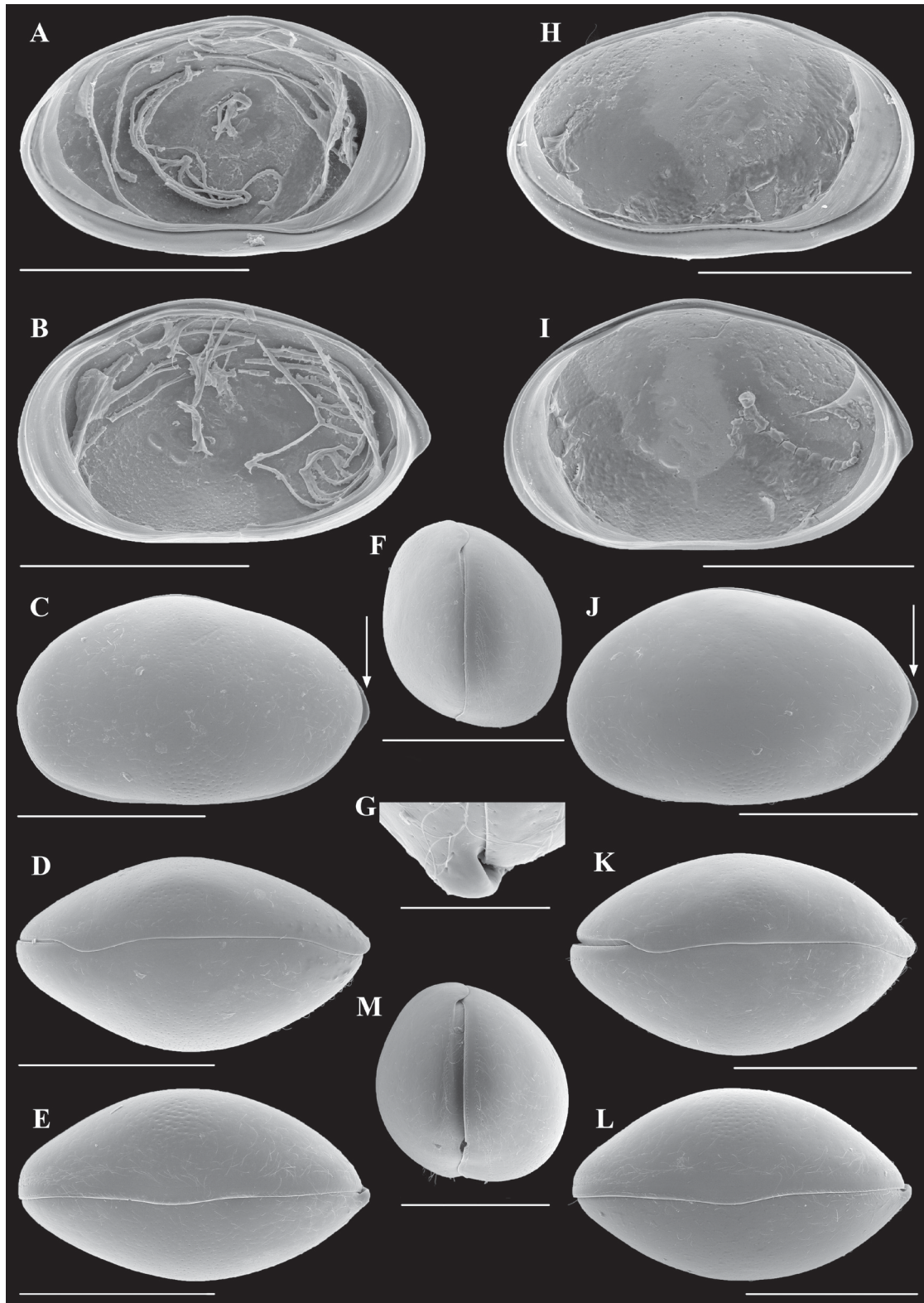
A2 (Figs. 12B, C) with protopodite, exopodite and three-segmented endopodite. Protopodite with two ventral setae (shorter one about 3/4 of the length of the longer seta); and one long and hirsute ventro-distal seta. Exopodite reduced to a small plate, with one long and two unequal short setae. First endopodal segment with one ventral aesthetasc Y, one long apical seta (reaching till halfway the end claws), one group of five long and one short swimming setae (the five long almost reaching tips of apical claws; the shortest almost reaching the middle of second endopodal segment). Second endopodal segment undivided, with two unequal dorsal setae and a group of four long and unequal ventral t setae; apically with three claws (G2 longest; z1 and z2 slightly shorter than G2), three setae (two long, z3 and G3; one short, G1) and a short aesthetasc y2 (Fig. 12C). Terminal segment (Fig. 12C) with two claws (one long, GM; one short, Gm), an aesthetasc y3 with an accompanying seta, fused over a short distance only, and a fine g-seta, the latter longer than accompanying seta of aesthetasc y3.

First segment of Md palp (Figs. 12E, F) with two long plumose setae (s1 and s2); long smooth seta and smooth  $\alpha$ -seta, just reaching tip of  $\beta$ -seta). Second segment dorsally with three setae (two unequal and long; one short, with the length about 1/3 of the longest), and ventrally with long, stout and distally hirsute  $\beta$ -seta; three long hirsute setae and one short seta, with length about 2/3 of the longest. Penultimate segment with two groups of setae, dorsally with a group of four unequal long and smooth setae; laterally with cone-shaped, stout and distally hirsute  $\gamma$ -seta and three smooth subapical setae; ventrally with one long and one short setae (half the length of terminal segment). Terminal segment small and almost as long as basal width, apically with three claws and three setae. Md coxa (Fig. 12D) as typical of the family, elongated with an apical row of strong teeth of variable size, interspaced with some setae.

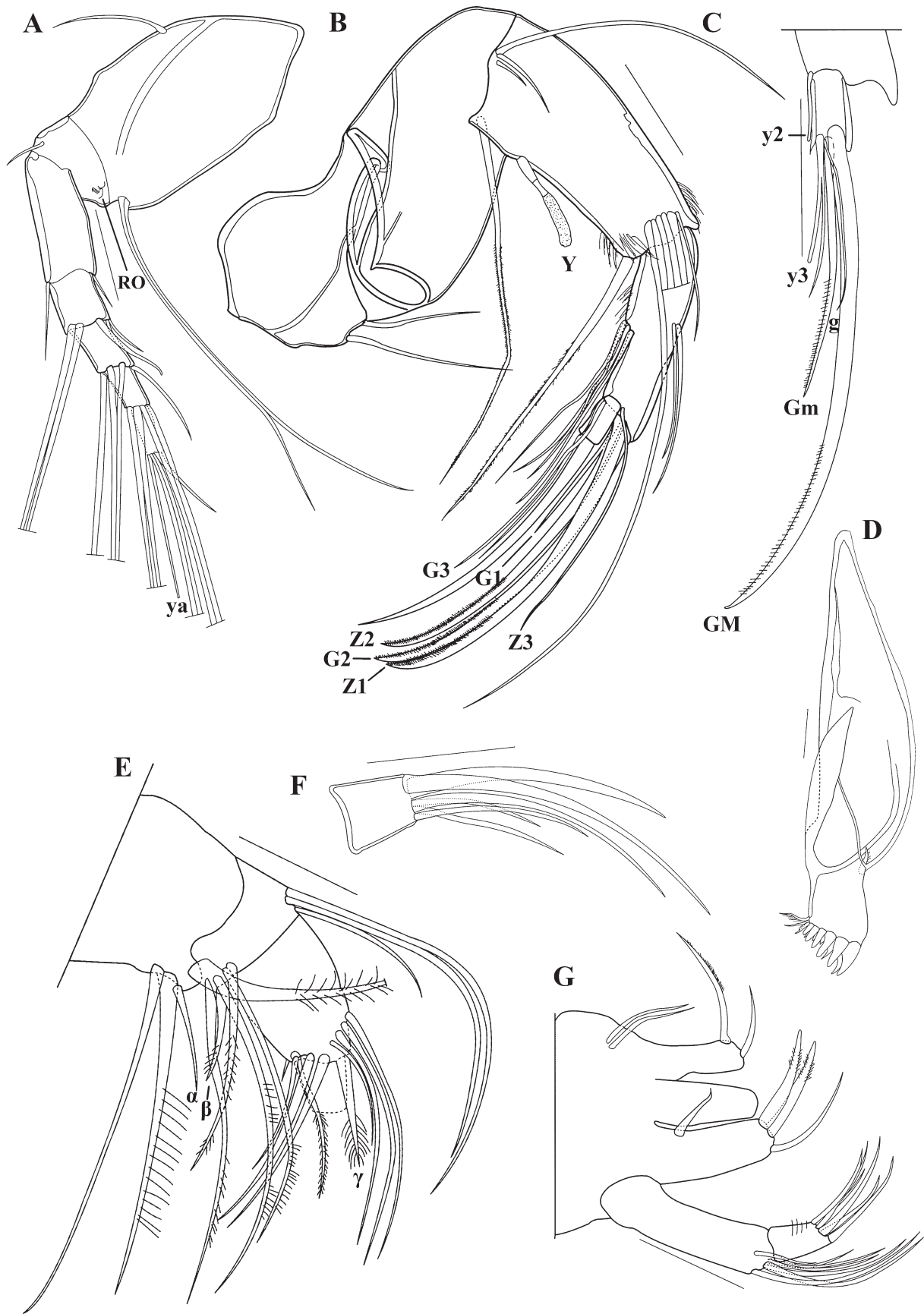
Mx1 (Fig. 12G—chaetotaxy not completely shown) consisting of three masticatory lobes (endites), a two-segmented palp and a large respiratory plate (the latter not illustrated). Basal segment of palp with six apical setae (five long and one short), and one shorter subapical seta. Terminal palp-segment with length ca. 1.5x basal width, slightly tapering, with three claws and three setae. Third endite with two large, weakly serrated bristles. Short subapical seta on third endite, almost reaching the tip of the endite. First endite with only one true side-ways directed bristle, and two unequal basal setae.

T1 protopodite (Fig. 13A) with two short a-setae, one distally hirsute b-seta and one longer d-setae. Apically with 10 hirsute setae, subapically with a group of four setae. Endopodite forming two-segmented, asymmetrical prehensile palps. Lpp with first segment broad and second segment sickle-shaped (Fig. 13C). Rpp with first segment slenderer than Lpp and second segment large and sub-triangular (Fig. 13B). Both palps with first segments carrying two (sub-) apical spines.

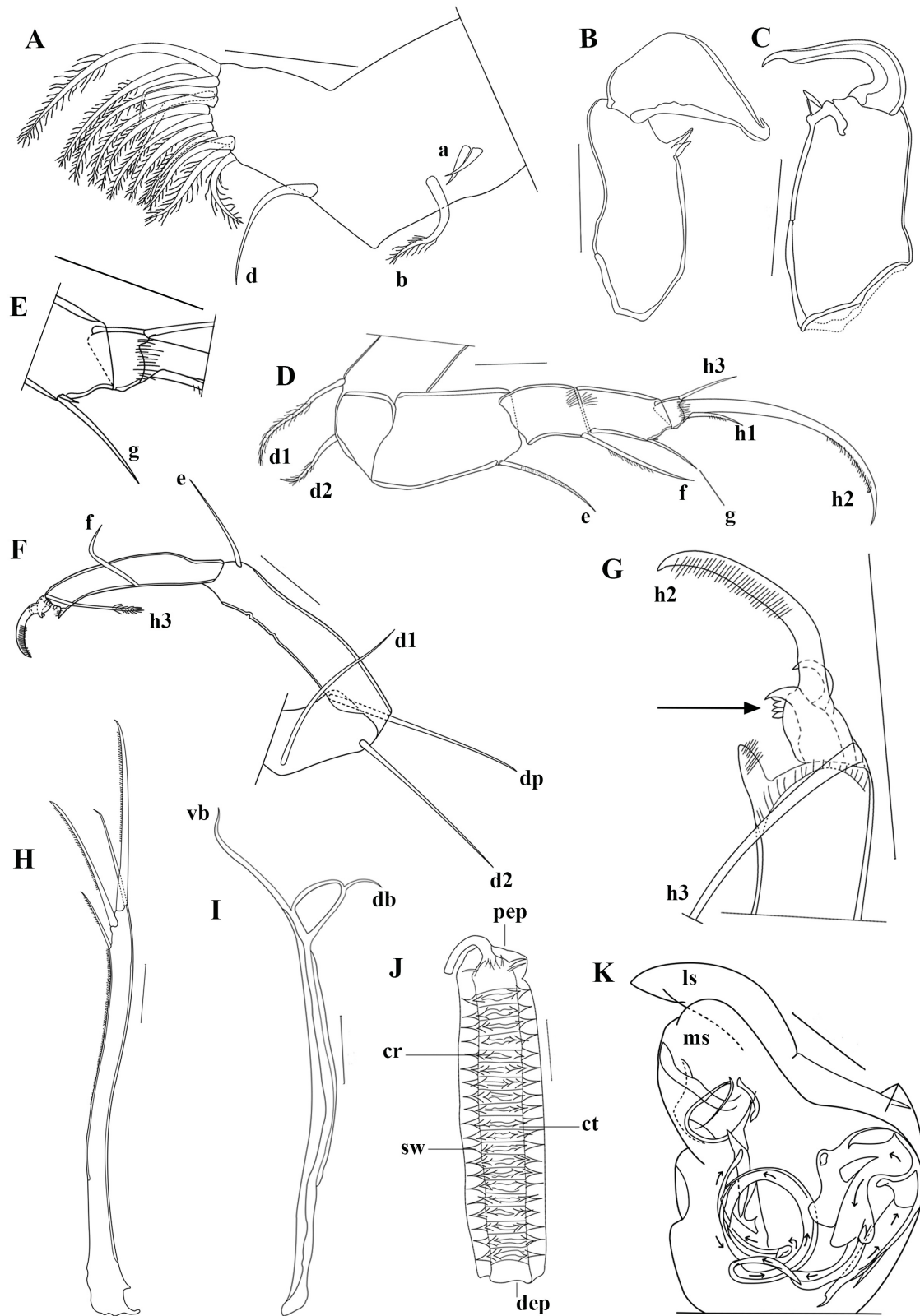




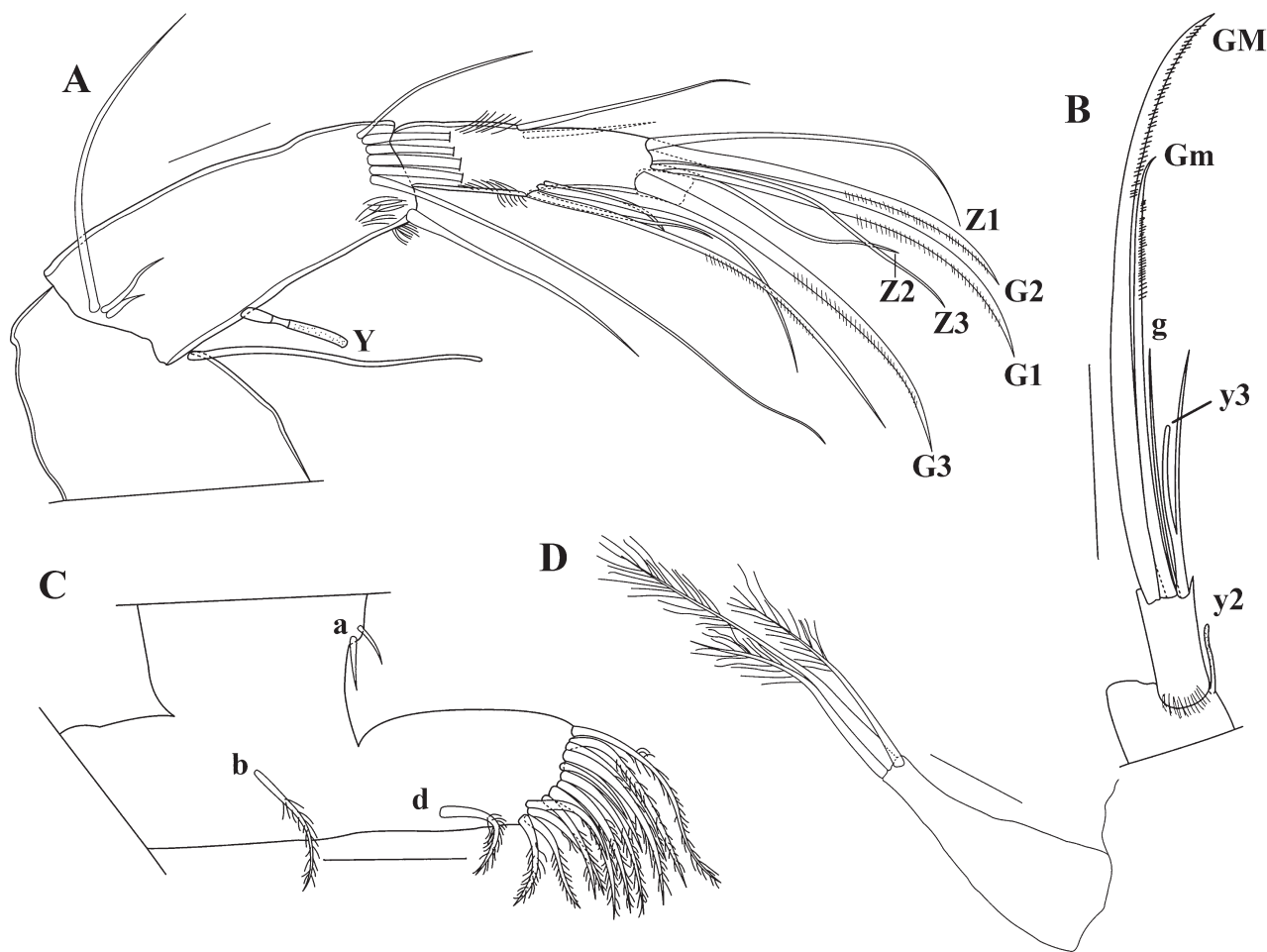
**FIGURE 11** Carapace and valves of *Strandesia obtusata*. A-G, male; H-M, female. A, LVi (MZUSP 40418); B, RVi (MZUSP 40418); C, CpLl (MZUSP 40419); D, CpD (MZUSP 40421); E, CpV (MZUSP 40420); F, CpFr (MZUSP 40420); G, Cp, detail of posterior right valve flap in ventral view (MZUSP 40420); H, LVi (MZUSP 40424); I, RVi (MZUSP 40424); J, CpLl (MZUSP 40425); K, CpD (MZUSP 40426); L, CpV (MZUSP 40427); M, CpFr (MZUSP 40426). Scale bars, A-F, 500  $\mu$ m; G, 100  $\mu$ m; H-L, 500  $\mu$ m; M, 300  $\mu$ m.



**FIGURE 12** *Strandesia obtusata*. Male. A, A1 (MZUSP 40416); B, A2 except last segment (MZUSP 40415); C, A2 last segment (MZUSP 40415); D, Md coxal plate (MZUSP 40414); E, Md palp (MZUSP 40415); F, Md palp last segment (MZUSP 40415); G, Mx1 (MZUSP 40416). Scale bars, 50  $\mu$ m.



**FIGURE 13** *Strandesia obtusata*. Male. A, T1 (MZUSP 40414); B, right prehensile palp (MZUSP 40415); C, left prehensile palp (MZUSP 40415); D, T2 (MZUSP 40414); E, T2 detail of short seta on the penultimate segment (MZUSP 40414); F, T3 (MZUSP 40415); G, T3 detail of pincer (MZUSP 40415); H, CR (MZUSP 40414); I, CR attachment (MZUSP 40414); J, Zenker organ (MZUSP 40414); K, hemipenis (MZUSP 40414). Scale bars, 50  $\mu$ m.



**FIGURE 14** *Strandesia obtusata*. Female. A, A2 except last segment (MZUSP 40422); B, A2 last segment (MZUSP 40422); C, T1 (MZUSP 40423); D, T1 endopodite (MZUSP 40423). Scale bars, 50  $\mu$ m.

T2 (Fig. 13D) protopodite with seta d1 long and seta d2 shorter, ca. half the length of seta d1. First endopodal segment with one subapical hirsute seta (e). Second endopodal segment medially divided into a- and b-segments; segment “a” with one long apical hirsute seta (f); segment “b” with one subapical seta reaching the end of the terminal segment (g), and the shorter one about 1/10 of the length of the longer seta (Fig. 13E). Third endopodal segment with one apical claw (h2) and two setae (one ventro-apical (h1) and dorso-apical (h3) with the same length, ca. 1/4 the length of h2).

T3 (Fig. 13F, G) with three segments. First segment with three long setae (d1, d2, dp). Second segment, longer than wide, with one subapical seta (e). Third segment, also longer than wide, with one lateral, hirsute seta (f); distal part of the third segment a modified pincer, with one apical comb-like seta (h2), one small recurved seta, with 1/5 of the length of the comb-like seta and one longer and distally hirsute seta (h3). Small tooth-like structures present at the base of the comb-like seta (arrowed in Figure 13G).

CR (Fig. 13H) slender and curved, with ventral margin weakly serrated. Proximal and distal claws also weakly serrated. Proximal claw ca. half of the length of distal claw. Proximal seta hirsute, about half of the length of distal seta. Distal seta smooth.

CR attachment (Fig. 13I) with oval Triebel’s loop in the middle of db; vb long and almost straight.

Zenker’s organ (Fig. 13J) longer than wide, comprising ca. 20 spinous whorls.

Hemipenis (Fig. 13K) with medial shield (ms) rounded and slightly bilobed. Ventral lobe of lateral shield (ls) elongated, with rounded dorsal and bluntly pointed distal margins. Postlabyrinthal spermiduct with one large additional loop.



### *Abbreviated redescription of female*

Carapace and valves (Figs. 11H-M) slightly larger than in the male (see diagnosis), but with shape and structure almost identical.

All characteristics of limbs as in the male, except for the distal chaetotaxy of A2 (Fig. 14A, B) and the endopodite of T1.

A2 (Figs. 14A, B) with protopodite, exopodite and three-segmented endopodite. Protopodite with two ventral setae (not shown); and one long ventro-distal seta. Exopodite reduced to a small plate, with one long and two unequal short setae. First endopodal segment with one ventral aesthetasc Y, one long apical seta (reaching beyond the tip of last endopodal segment), one group of five long and one short swimming setae (the five long reaching to 3/4 of the length of the apical claws; the shortest reaching beyond the middle of third segment). Second endopodal segment undivided, with two unequal dorsal setae and a group of four long ventral t setae; apically with three claws (G1 and G3 equally long, and G2 slightly shorter, reaching 4/5 of G1) and three unequally long setae (z1 and z3 longer, z2 slightly shorter, reaching to 3/4 of z3). Terminal segment (Fig. 14B) with two claws (one long GM; one short Gm), an aesthetasc y3 with an accompanying seta, fused over a short distance only, and a short g-seta, the latter the same size as accompanying seta of aesthetasc y3.

T1-protopodite (Figs. 14C, D) with two short a-setae and hirsute and subequal b-seta and d-seta; apically with a group of 10 hirsute setae, subapically with a group of four such setae. Endopodite with three unequal long and plumose setae (one long, and two about 2/3 of the longer one).

### *Differential diagnosis*

*Strandesia obtusata* can be distinguished from all other *Strandesia* species by the prominent obtuse projection (flange) on the posterior margin of the RV, apart from *S. nupelia* where the projection is much smaller and shallower and the carapace more elongated in lateral view. From those species in the genus where males are known it can be distinguished by the shape of the hemipenis and of the prehensile palps.

### *Ecology and distribution*

*Strandesia obtusata* was recorded in lentic environments, associated with free-floating and free-submerged aquatic macrophytes and littoral sediment (sand and mud), in the Araguaia River floodplain. Sexual populations occurred in four lakes, Crixas 2 (13°21'58.1"S 50°36'40.1"W), Crixas 4 (13°20'37.5"S 50°36'40"W), Japonesa 1 (13°25'15"S 50°38'2.4"W) and Luis Alves 2 (13°13'34.2"S 50°34'40"W). Asexual populations were recorded in three lakes, Luis Alves 1 (13°13'52.1"S 50°34'12"W), Piranha (13°3'49.1"S 50°37'38.1"W) and Caixa de Empréstimo (13°2'54.3"S 50°32'29.3"W). This species occurred in slightly acidic environments, with pH range of 6.1–6.9. Electrical conductivity and dissolved oxygen ranges were 28.5–53.4  $\mu\text{S}\cdot\text{cm}^{-1}$  and 1–6.5 mg. L<sup>-1</sup>, respectively (see Table 1). Distribution: Brazil and Colombia.

## **5. *Strandesia lansactohai* Higuti & Martens, 2013**

(Figs. 15–17)

- 2007 *Bradleystrandesia gr. elliptica* sp. 2—Higuti *et al.*: 1934, Table 2.
- 2007 *Bradleystrandesia gr. elliptica* sp. 3—Higuti *et al.*: 1934, Table 2.
- 2009 *Bradleystrandesia gr. elliptica* sp. 2—Higuti *et al.*: 664, Table 1.
- 2009 *Bradleystrandesia gr. elliptica* sp. 3—Higuti *et al.*: 664, Table 1.
- 2009 *Bradleystrandesia gr. obtusata* sp. 4—Higuti *et al.*: 664, Table 1.
- 2010 *Bradleystrandesia gr. elliptica* sp. 2—Higuti *et al.*: 267, Table 2.
- 2010 *Bradleystrandesia gr. elliptica* sp. 3—Higuti *et al.*: 267, Table 2.
- 2010 *Bradleystrandesia gr. obtusata* sp. 4—Higuti *et al.*: 267, Table 2.
- 2010 *Bradleystrandesia elliptica* species complex—Mormul *et al.*: 189.
- 2013 *Strandesia lansactohai* n. sp.—Higuti *et al.*: 199, Figs. 6, 9D.

### *Type locality and material*

Bilé Backwater, in washed roots of *Salvinia* spec., (PAR179), collected on 08.11.2004 by JH & KM. This is an open lake associated with the Paraná River System. Approximate coordinates: 22°45'15.4"S, 53°17'12"W.

Type material (Holotype) is stored in the Museum of Zoology of the University of São Paulo (MZUSP), n° MZUSP 27444. Paratypes are stored in the MZUSP, n° MZUSP 27445, MZUSP 27446 and Royal Belgian Institute of Natural Sciences n° OC.3280 (Higuti *et al.* 2013).

### *Material examined*

One female (MZUSP 40428) was used for soft part illustrations from Leopoldo Lake (22°45'27.6"S, 53°16'15.7"W). Two females (OC.3280, MZUSP 27445) were used for SEM from Bilé Backwater (22°45'15.4"S, 53°17'12"W). One female (MZUSP 27447) was used for SEM from Aurélio Lake (22°41'36.5"S, 53°13'52"W). All illustrated specimens are from the Paraná River floodplain.

### *Measurements of illustrated specimens (in mm)*

L (n=3): 0.863–0.929, H (n=1): 0.452, W (n=2): 0.438–0.459.

### *Diagnosis (after Higuti *et al.* 2013)*

Cp laterally elongated, with a small posterodorsal flange on RV; greatest height situated in front of the middle. RV without anterior selvage. LV with internal groove along ventral margin. A2 with natatory setae reaching the tips of apical claws. Md palp with unsegmented long  $\alpha$ -seta. CR with ventral margin weakly serrated, its attachment with an oval-triangular Triebel's loop in the main branch.

### *Abbreviated redescription of female (after Higuti *et al.* 2013)*

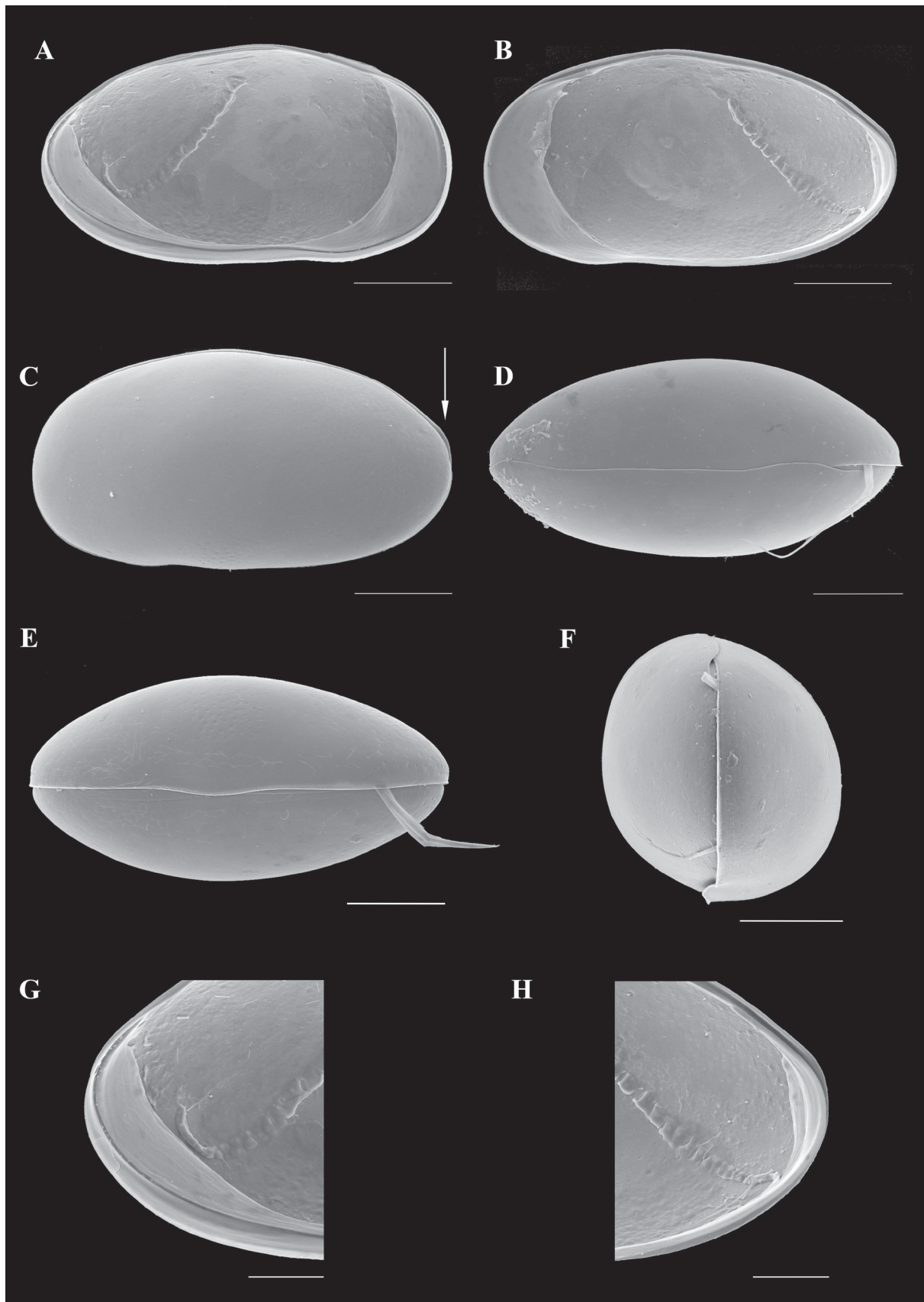
LVi (Fig. 15A, F) elongated in lateral view, with anterior margin rounded and posterior margin bluntly and almost symmetrically, pointed; internal groove along ventral margin; greatest height situated in front of the middle; without inner list on anterior calcified inner lamella.

RVi (Figs. 15B, H) without anterior selvage; posterior margin somewhat pointed and less broad than LV; with a narrow posterodorsal flange (Fig. 15H).

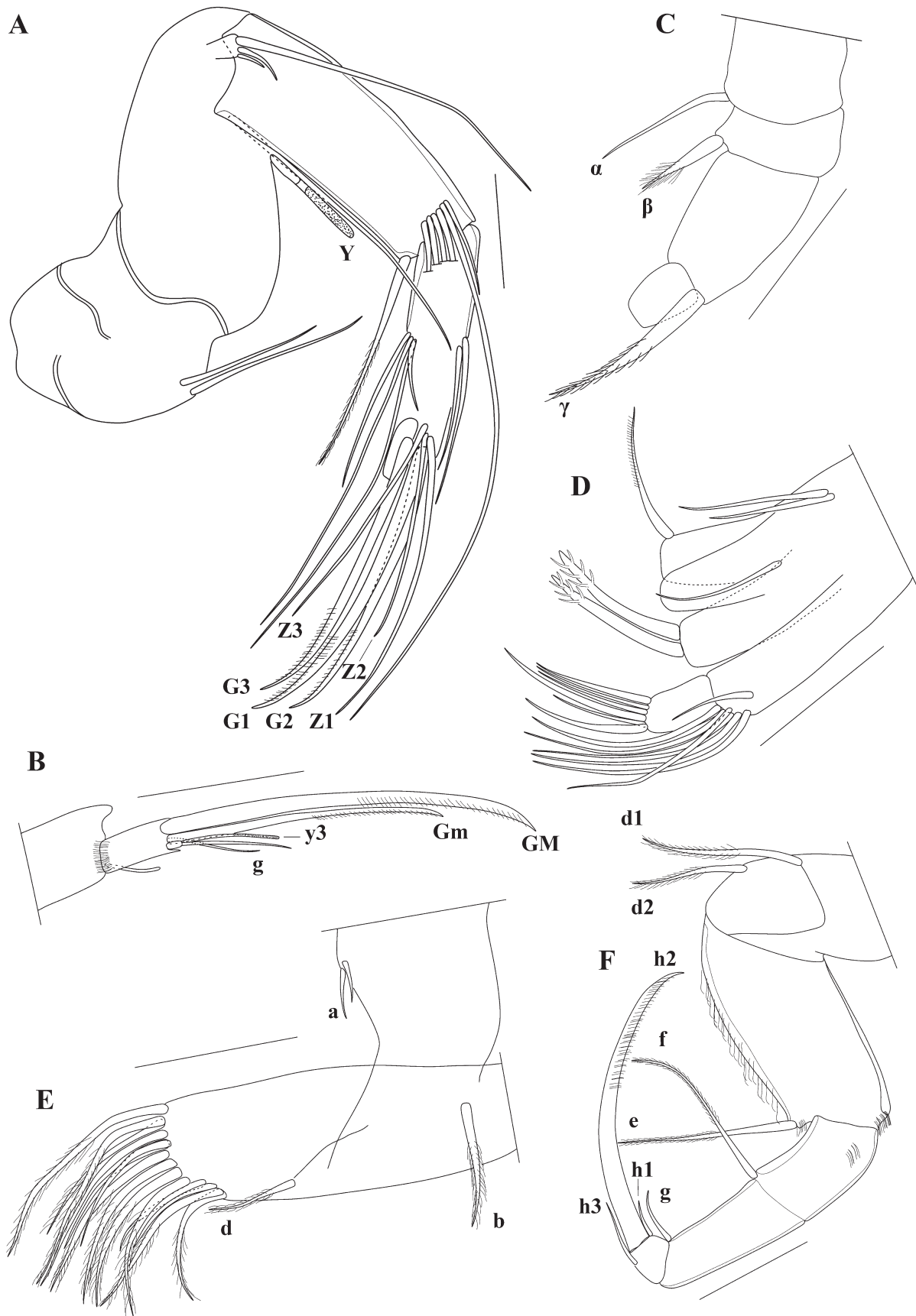
CpLI (Fig. 15C) elongated; postero-dorsal flange on RV slightly protruding past LV (indicated by the arrow). CpD (Fig. 15D) subovate, with LV overlapping RV anteriorly. CpV (Fig. 15E) with valve margin of LV very weakly sinuous in the middle. CpFr (Fig. 15F), clearly oblique, with LV being the lower one.

A1 (not illustrated) with seven segments. First segment with one short subapical seta and two long apical setae; WO not seen. Second segment wider than long, with one short dorsal seta and a small ventral RO. Third segment with two setae (the smaller with the length of the fourth segment). Fourth segment with two short and two long setae. Fifth segment with three long and one short setae. Sixth segment with four long setae. Seventh segment with one short and two long setae, and one aesthetasc  $y_1$  slightly shorter than the short seta.

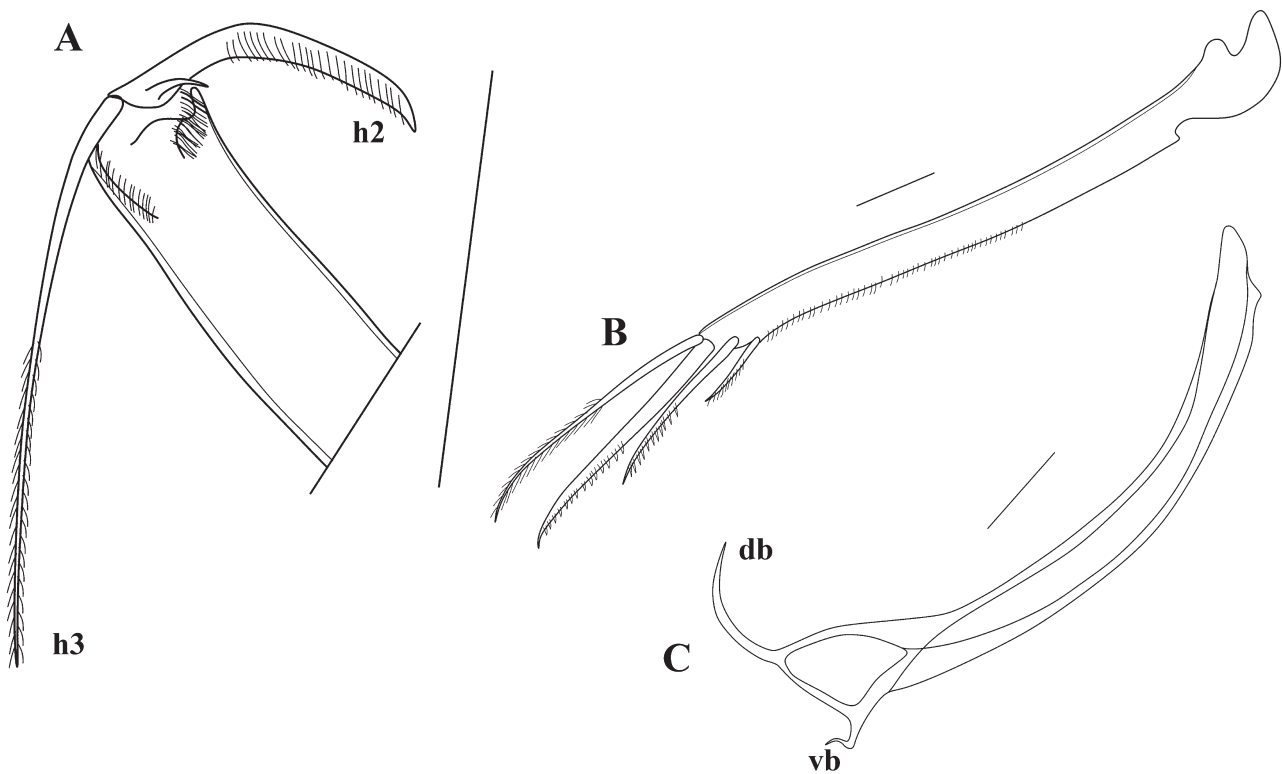
A2 (Figs. 16A, B) with protopodite, exopodite and three-segmented endopodite. Protopodite with two ventral setae; and one long ventro-distal seta. Exopodite reduced to a small plate, with one long and two unequal short setae. First endopodal segment with one long ventral aesthetasc  $Y$ , one long apical seta (reaching the tip of the last endopodal segment), one group of five long and one short swimming setae (the five long setae just reaching tip of apical claws; the short one almost reaching the middle of third segment). Second endopodal segment undivided, with two unequal dorsal setae and a group of four long ventral  $t$  setae; apically with three claws (G1 longest, G2 and G3 slightly shorter than G1); three setae ( $z_1$  longest,  $z_2$  and  $z_3$  shorter than  $z_1$ ) and a short apical aesthetasc  $y_2$  (Fig.16B). Terminal segment (Fig.16B) with two claws (one long GM; one short, Gm), an aesthetasc  $y_3$  with an accompanying seta (seta longer than aesthetasc), fused over a short distance only, and a fine  $g$ -seta, the latter shorter than aesthetasc  $y_3$  and its accompanying seta.



**FIGURE 15** Carapace and valves of *Strandesia lansactohai*. A, LVi (OC.3280); B, RVi (OC.3280); C, CpLl (MZUSP 27445); D, CpD (MZUSP 27447); E, CpV (MZUSP 27446); F, CpFr (MZUSP 27447); G, LVi detail of posterior margin (OC.3280); H, RVi detail of posterior margin (OC. 3280). Scale bars, A-F, 200  $\mu$ m; G-H, 100  $\mu$ m. Reproduced from Higuti *et al.* (2013) with permission from Brill.



**FIGURE 16** *Strandesia lansactohai*. A, A2 except last segment (MZUSP 40428); B, A2 last segment (MZUSP 40428); C, Md palp showing  $\alpha$ ,  $\beta$ ,  $\gamma$  setae (MZUSP 40428); D, Mx1 (MZUSP 40428); E, T1 (MZUSP 40428); F, T2 (MZUSP 40428). Scale bars, 50  $\mu\text{m}$ .



**FIGURE 17** *Strandesia lansactohai*. A, T3 pincer (MZUSP 40428); B, CR (MZUSP 40428); C, CR attachment (MZUSP 40428). Scale bars, 50  $\mu$ m.

First segment of Md palp (Fig. 16C—chaetotaxy not completely shown) with long (reaching beyond tip of  $\beta$ -seta) and smooth  $\alpha$ -seta. Second segment ventrally with long (but less so than  $\alpha$ -seta), stout and hirsute  $\beta$ -seta. Penultimate segment laterally with cone-shaped, hirsute  $\gamma$ -seta. Terminal segment ca. 1.5x as long as basal width. Md coxa (not illustrated) as typical of the family, elongated with an apical row of strong teeth of variable size, interspaced with some small setae.

Mx1 (Fig. 16D—chaetotaxy not completely shown) with three masticatory lobes, a two-segmented palp and a large respiratory plate (the latter not illustrated). Basal segment of palp with six long apical setae, and one short subapical seta. Terminal palp segment ca. 2x as long as basal width, slightly curved, apically with three claws (one clearly longer) and three setae. Third endite with two large, distally serrated bristles. Lateral seta on third endite reaching beyond tip of the endite. First endite with only one sideways-directed bristle, and two unequal basal setae.

T1 protopodite (Fig. 16E) with two shorta-setae; b-seta twice as long as d-seta. Apically with 10 hirsute setae, subapically with a group of four setae. Endopodite with three unequal long hirsute apical setae (not illustrated).

T2 (Fig. 16F) Protopodite with seta d1 long and seta d2 shorter, ca. 3/4 of the length of d1. First endopodal segment with one subapical hirsute seta (e). Second endopodal segment medially divided into a- and b-segments; segment “a” with one long apical hirsute seta (f); segment “b” with one shorter seta (g) reaching well beyond tip of terminal segment. Third endopodal segment with one apical claw (h2) and two setae (one ventro-apical seta (h1) with ca. 1/7 the length of h2 and one dorso-apical seta (h3) twice the length of h1).

T3 (Fig. 17A—chaetotaxy not completely shown) with three segments. First segment with three long setae (d1, d2 dp). Second segment, longer than wide, with one subapical seta (e). Third segment, also longer than wide, with one lateral, hirsute seta (f); distal part of the third segment fused with fourth segment into a modified pincer, with one apical comb-like seta (h2), one small recurved seta, with 1/5 of the length of the comb-like seta, and one longer and distally hirsute seta (h3). CR (Fig. 17B) slender and slightly curved, with ventral margin weakly serrated. Proximal claw 2/3 of the length of distal claw. Proximal seta hirsute, c 1/3 of length of distal seta. Distal seta long and hirsute, with the same length of distal claw.



CR attachment (Fig. 17C) stout, with oval-triangular Triebel's loop in the main branch; db long and curved; vb short.

Male unknown.

*Differential diagnosis* (after Higuti *et al.* 2013)

This species can be distinguished from the others in this group by the small size and elongated shape of the valves, the complete absence of the anterior selvage of the RV and the morphology of the attachment of the caudal ramus. The species resembles *S. elliptica* Sars, 1901, but differs at least in the more elongated shape and the more pointed posterior margin in lateral view.

*Ecology and distribution*

*Strandesia lansactohai* was recorded in lentic and lotic environments, associated with variety of macrophytes with different life forms, in the Amazon, Araguaia, Pantanal and Paraná floodplains. This species occurred in acidic to basic environments, with a pH range of 4.4–9.7. Electrical conductivity and dissolved oxygen ranges were 12–222.5  $\mu\text{S}\cdot\text{cm}^{-1}$  and 0.07–11.8 mg. L<sup>-1</sup>, respectively (see Table 1). Distribution: Brazil.

## 6. *Strandesia velhoi* Higuti & Martens, 2013

(Figs. 18–20)

2007 *Bradleystrandesia* sp. 3—Higuti *et al.*: 1934, Table 2.

2009 *Bradleystrandesia* sp. 3—Higuti *et al.*: 664, Table 1.

2009 *Bradleystrandesia* gr. *obtusata* sp. 3—Higuti *et al.*: 664, Table 1.

2010 *Bradleystrandesia* sp. 3—Higuti *et al.*: 267, Table 2.

2010 *Bradleystrandesia* gr. *obtusata* sp. 3—Higuti *et al.*: 267, Table 2.

2013 *Strandesia velhoi* n. sp.—Higuti *et al.*: 201, Figs. 7, 9A.

*Type locality and material*

Manezinho backwater, an open lake in the Paraná River system, in washed roots of *Eichhornia crassipes*, collected on 12.01.2011 by JH & KM. Approximate coordinates: 22°46'55"S, 53°20'59"W.

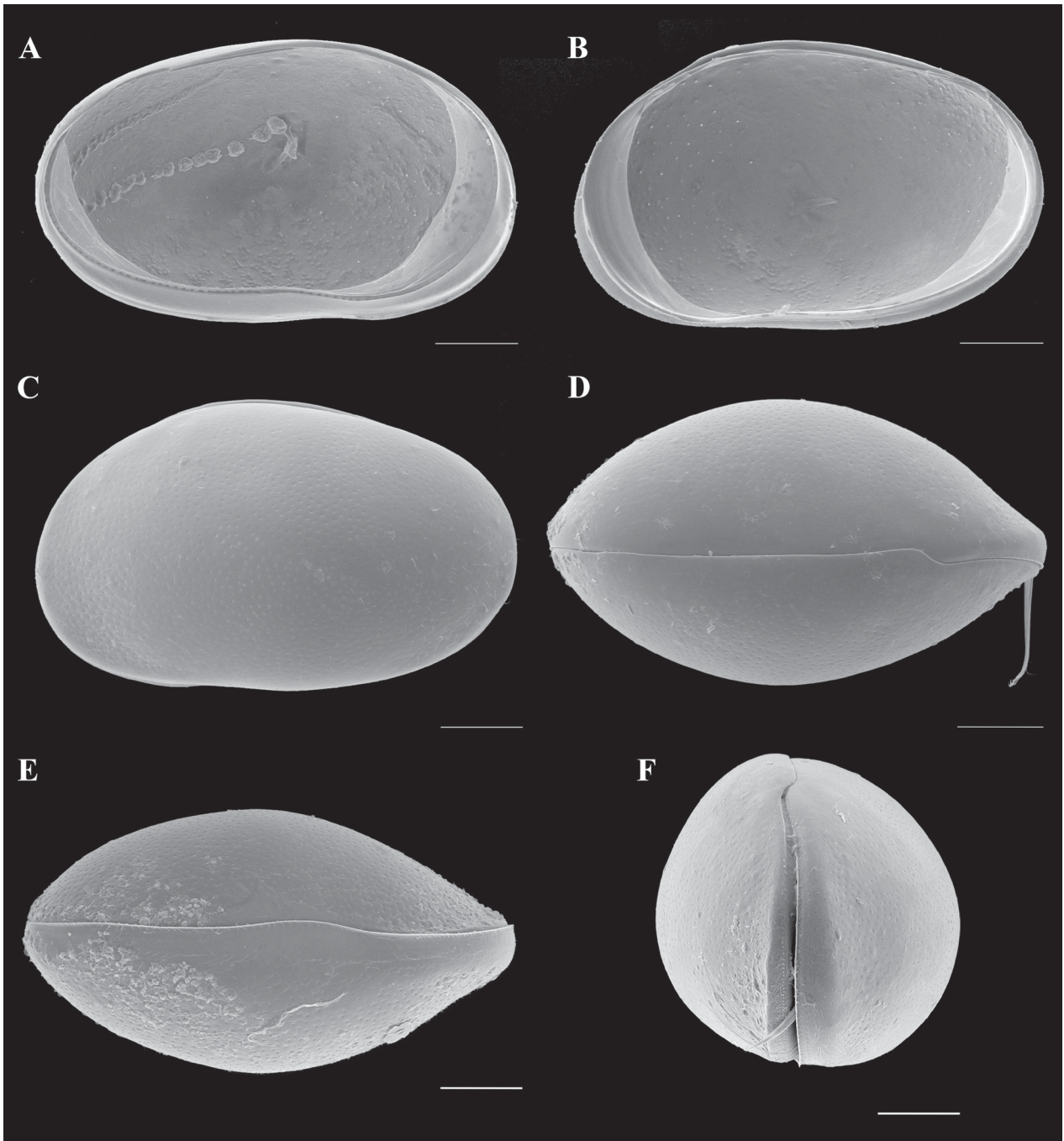
Type material (Holotype) is stored in the Museum of Zoology of the University of São Paulo (MZUSP), n° MZUSP 27452. The paratype is stored in the MZUSP, n° MZUSP 27457 (Higuti *et al.* 2013).

*Material examined*

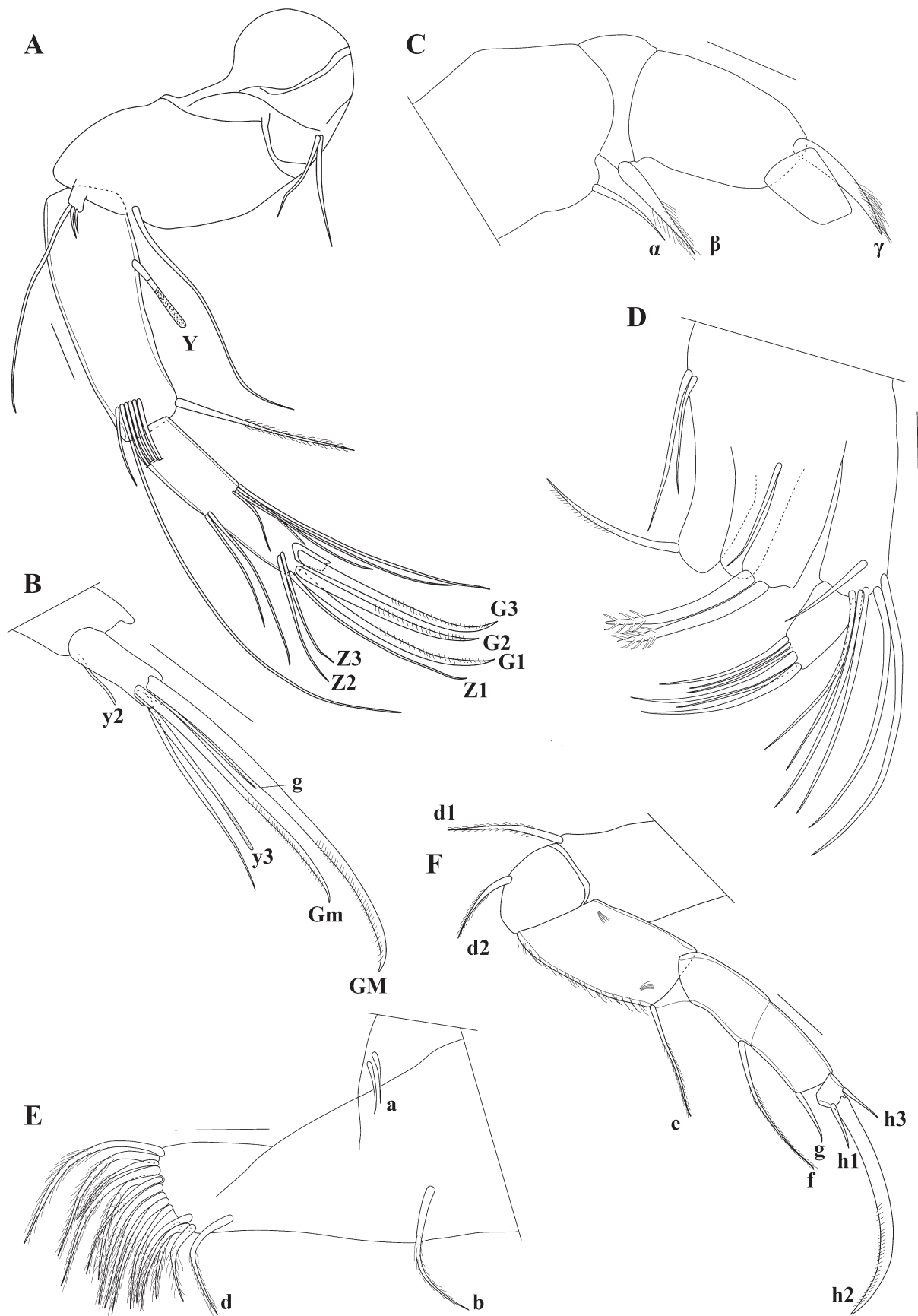
One female (MZUSP 40429) was used for soft part illustrations from Manezinho Backwater (22°46'44.9"S, 53°20'56.3"W). Three females (OC.3285, MZUSP 27453, MZUSP 27454) were used for SEM from Aurélio Lake (22°41'36.5"S, 53°13'52"W). All illustrated specimens are from Paraná River floodplain.

*Measurements of illustrated specimens* (in mm)

L (n=3): 1.167–1.204, H (n=1): 0.706, W (n=2): 0.648–0.670.



**FIGURE 18** Carapace and valves of *Strandesia velhoi*. A, LVi (OC.3285); B, RVi (OC.3285); C, CpLI (MZUSP 27453); D, CpD (MZUSP 27454); E, CpV (MZUSP 27455); F, CpFr (MZUSP 27454). Scale bars, 200  $\mu\text{m}$ . Reproduced from Higuti *et al.* (2013) with permission from Brill.



**FIGURE 19** *Strandesia velhoi*. A, A2 except last segment (MZUSP 40429); B, A2 last segment (MZUSP 40429); C, Md palp showing  $\alpha$ ,  $\beta$ ,  $\gamma$  setae (MZUSP 40429); D, Mx1 (MZUSP 40429); E, T1 (MZUSP 40429); F, T2 (MZUSP 40429). Scale bars, 50  $\mu$ m.



CpL1 high and short. CpD with a clear anterior rostrum and a bluntly rounded posterior margin. RV with anterior selvage clearly inwardly displaced. LV with internal groove along ventral margin, with pegs. A2 with natatory setae reaching 3/4 of length of apical claws. CR with ventral margin weakly serrated, its attachment with an oval Triebel's loop in the main branch.

*Abbreviated redescription of female* (after Higuti *et al.* 2013)

LVi (Fig. 18A) without inner list on anterior calcified inner lamella; inner lamella wider anteriorly than posteriorly; internal groove long ventral and posterior margin, with pegs distributed along ventral and posterior margins; greatest height situated in front of the middle.

RVi (Fig. 18B) with anterior selvage clearly inwardly displaced; anterior calcified inner lamella wider than posterior one; greatest height situated in front of the middle.

CpL1 (Fig. 18C) high and short; greatest height situated in front of the middle; both anterior and posterior margins bluntly rounded. CpD (Fig. 18D) with greatest width slightly in front of the middle; with anterior rostrum. CpV (Fig. 18E) with ventral valve margin of LV very weakly sinuous in the middle; with anterior rostrum. CpFr (Fig. 18F) view weakly oblique, with LV being the lower valve.

A1 (not illustrated) with seven segments. First segment with one short subapical seta and two long apical setae; WO not seen. Second segment wider than long, with one short dorsal seta; RO small. Third segment with two setae (the smaller with the length of the fourth segment). Fourth segment with two short and two long setae. Fifth segment with three long and one short setae. Sixth segment with four long setae. Seventh segment with one short and two long setae, and one aesthetasc *ya* slightly longer than the short seta.

A2 (Figs. 19A–B) with protopodite, exopodite and three-segmented endopodite. Protopodite with two ventral setae; and one long ventro-distal seta. Exopodite reduced to a small plate, with one long and two unequal short setae. First endopodal segment with one ventral aesthetasc *Y*, one long apical seta (reaching the tip of the second endopodal segment) one group of five long and one short swimming setae (the five long setae reaching 3/4 of the length of apical claws; the short one almost reaching the middle of third segment). Second endopodal segment undivided, with two unequal but long dorsal setae and a group of four long ventral t setae; apically with three claws (*G1* and *G3* equally long, *G2* slightly shorter), three setae (*z1* long, *z2* and *z3* short, with ca. 1/2 the length of *z1*) and a short aesthetasc *y2* (Fig. 19B). Terminal segment (Fig. 19B) with two claws (one long *GM*; one short, *Gm*), an aesthetasc *y3* with an accompanying seta (seta longer than aesthetasc), fused over a short distance only, and a fine *g*-seta, the latter shorter than accompanying seta and aesthetasc *y3*.

First segment of Md palp (Fig. 19C—chaetotaxy not completely shown) with short (not reaching beyond tip of  $\beta$ -seta) and smooth  $\alpha$ -seta. Second segment ventrally with long (longer than  $\alpha$ -seta), stout and hirsute  $\beta$ -seta. Penultimate segment laterally with cone-shaped, distally hirsute  $\gamma$ -seta. Terminal segment ca. 1.5x as long as basal width, slightly tapering. Md coxa (not illustrated) as typical of the family, elongated with an apical row of strong teeth of variable size, interspaced with some small setae.

Mx1 (Fig. 19D—chaetotaxy not completely shown) with three masticatory lobes, a two-segmented palp and a large respiratory plate (the latter not illustrated). Basal segment of palp with six long apical setae, and one short subapical seta. Terminal palp segment ca. 2x as long as basal width, slightly curved and tapering, apically with three claws and three setae. Third endite with two large, distally serrated bristles. Lateral seta on third endite reaching the end of the endite. First endite with one sideways-directed bristle.

T1 protopodite (Fig. 19E) with two short *a*-setae; *b*-seta longer than *d*-seta. Apically with 10 hirsute setae, subapically with a group of four setae. Endopodite with three unequal long hirsute apical setae (not illustrated).

T2 (Fig. 19F) protopodite with with seta *d1* relatively long and seta *d2* shorter, ca. half of the length of *d1*. First endopodal segment with one subapical hirsute seta (*e*). Second endopodal segment medially divided into *a*- and *b*-segments; segment “*a*” with one long apical hirsute seta (*f*); segment “*b*” with one shorter seta (*g*) reaching beyond tip of terminal segment. Third endopodal segment with one apical claw (*h2*) and two setae (one ventro-apical (*h1*) with 1/5 the length of *h2* and one dorso-apical (*h3*) slightly longer than *h1*).

T3 (Fig. 20A—chaetotaxy not completely shown) with three segments. First segment with three long setae (*d1*, *d2*, *dp*). Second segment, longer than wide, with one subapical seta (*e*). Third segment, also longer than wide, with

one lateral, hirsute seta (f); distal part of the third segment fused with fourth segment into a modified pincer, with one apical comb-like seta (h2), one small recurved seta, with 1/5 of the length of the comb-like seta, and one longer and distally hirsute seta (h3). Small tooth-like structures present at the base of the comb-like seta (arrowed in Figure 20A).

CR (Fig. 20B) stout and straight, with ventral margin weakly serrated. Proximal claw 2/3 of the length of distal claw. Proximal seta hirsute, ca. 1/3 of length of distal seta.

CR attachment (Fig. 20C) stout, with oval-triangular Triebel's loop in the main branch; vb long and straight; db short and curved.

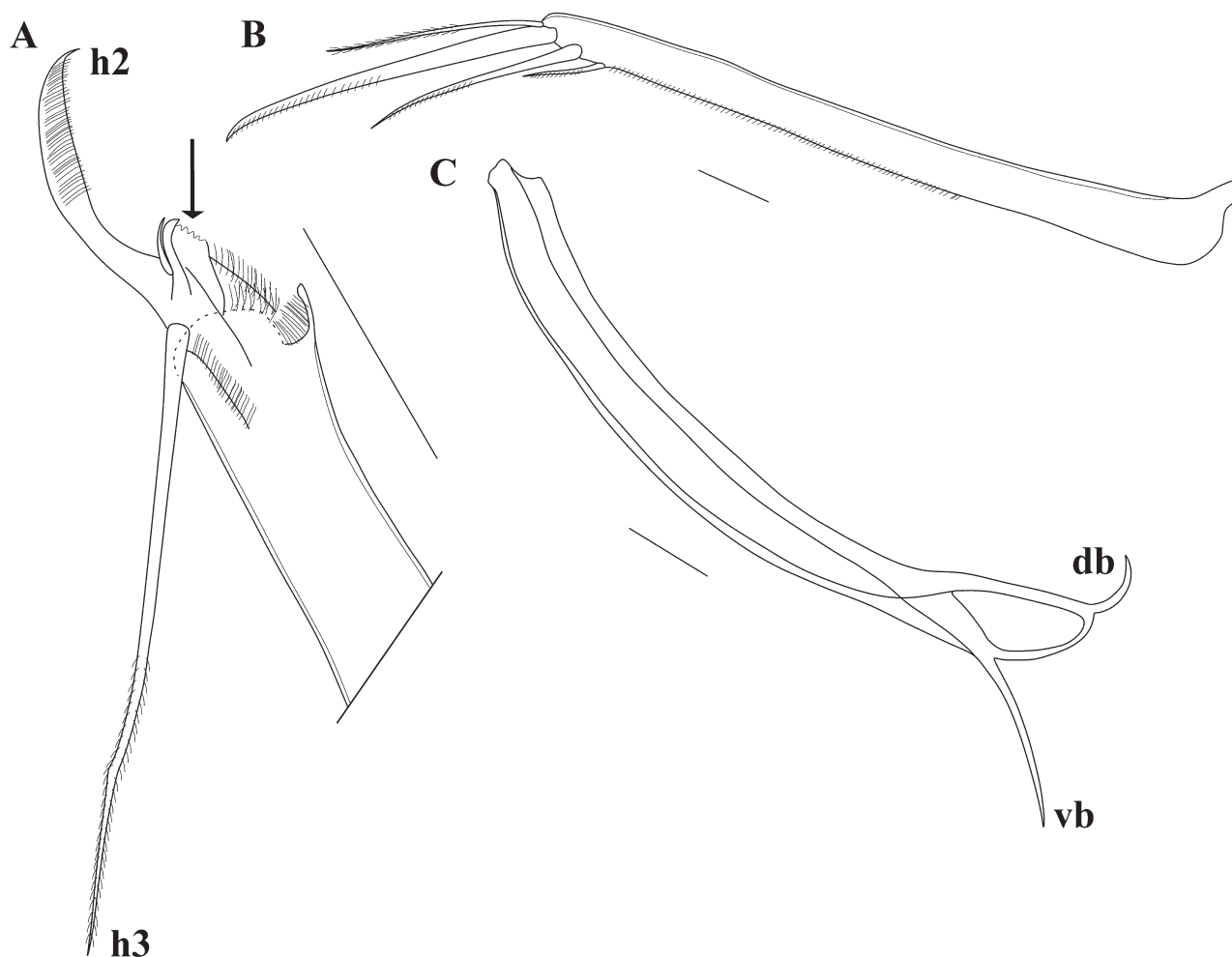
Male unknown

#### *Differential diagnosis* (after Higuti *et al.* 2013)

This species can be distinguished from the others in this lineage by the large size and the high and short shape of the valves, the presence of the large anterior selvage of the RV and the anterior rostrum, as well as by the absence of a posterior flange on the RV.

#### *Ecology and distribution*

*Strandesia velhoi* was recorded from lentic environments, associated with a variety of macrophytes with different life forms, in Amazon, Araguaia, Pantanal and Paraná floodplains. This species occurred in acidic to basic environments, with pH range of 4.2–9.5. Electrical conductivity and dissolved oxygen ranges were 11–222.5  $\mu\text{S}\cdot\text{cm}^{-1}$  and 0.4–11.8  $\text{mg}\cdot\text{L}^{-1}$ , respectively (see Table 1). Distribution: Brazil.



**FIGURE 20** *Strandesia velhoi*. A, T3 pincer (MZUSP 40429); B, CR (MZUSP 40429); C, CR attachment (MZUSP 40429). Scale bars, 50  $\mu\text{m}$ .

## 7. *Strandesia nupelia* Higuti & Martens, 2013

(Figs. 21–23)

- 2009 *Bradleystrandesia gr. elliptica* sp. 1—Higuti *et al.*: 664, Table 1.  
2009 *Bradleystrandesia obtusata*—Higuti *et al.*: 664, Table 1.  
2009 *Bradleystrandesia gr. obtusata* sp. 5—Higuti *et al.*: 664, Table 1.  
2009 *Bradleystrandesia gr. obliqua*—Higuti *et al.*: 664, Table 1.  
2010 *Bradleystrandesia gr. elliptica* sp. 1—Higuti *et al.*: 267, Table 2.  
2010 *Bradleystrandesia obtusata*—Higuti *et al.*: 267, Table 2.  
2010 *Bradleystrandesia gr. obtusata* sp. 5—Higuti *et al.*: 267, Table 2.  
2010 *Bradleystrandesia gr. obliqua*—Higuti *et al.*: 267, Table 2.  
2013 *Strandesia nupelia* n. sp.—Higuti *et al.*: 202, Figs. 8, 9C.

### *Type locality and material*

Baía River, main river of the system, in washed roots of *Pistia stratiotes*, (PAR193), collected on 10.11.2004 by JH & KM, approximate coordinates: 22°40'37.5" S 53°12'20" W.

Type material (holotype) is stored in the Museum of Zoology of the University of São Paulo (MZUSP), n° MZUSP 27458. The paratypes are stored in the MZUSP, n° MZUSP 27459, 27460, 27463 and Royal Belgian Institute of Natural Sciences n° OC.3287, 3288 (Higuti *et al.* 2013).

### *Material examined*

One female (MZUSP 40430) was used for soft part illustrations from Baía River (22°40'37.5"S, 53°12'29"W). One female (OC.3290) from Guaraná Lake (22°43'16.8"S, 53°18'12.9"W) and two females (MZUSP 27459, MZUSP 27460) from Baía River (22°40'37.5"S, 53°12'29"W) were used for SEM. All illustrated specimens are from the Paraná River floodplain.

### *Measurements of illustrated specimens* (in mm)

L (n=3): 1.006–1.044, H (n=1): 0.559, W (n=2): 0.523.

### *Diagnosis* (after Higuti *et al.* 2013)

CpL1 slightly elongated; with the greatest height situated in front of the middle. CpD and CpV with bluntly pointed anterior and posterior extremities. RV with anterior selvage slightly inwardly displaced, and with rounded protruding posterior flange. LV with internal groove along margins. A2 with natatory setae reaching well beyond the tips of the apical claws. CR slender and curved, with ventral margin weakly serrated; its attachment with a triangular Triebel's loop in the main branch; vb long and straight; db short and slightly curved.

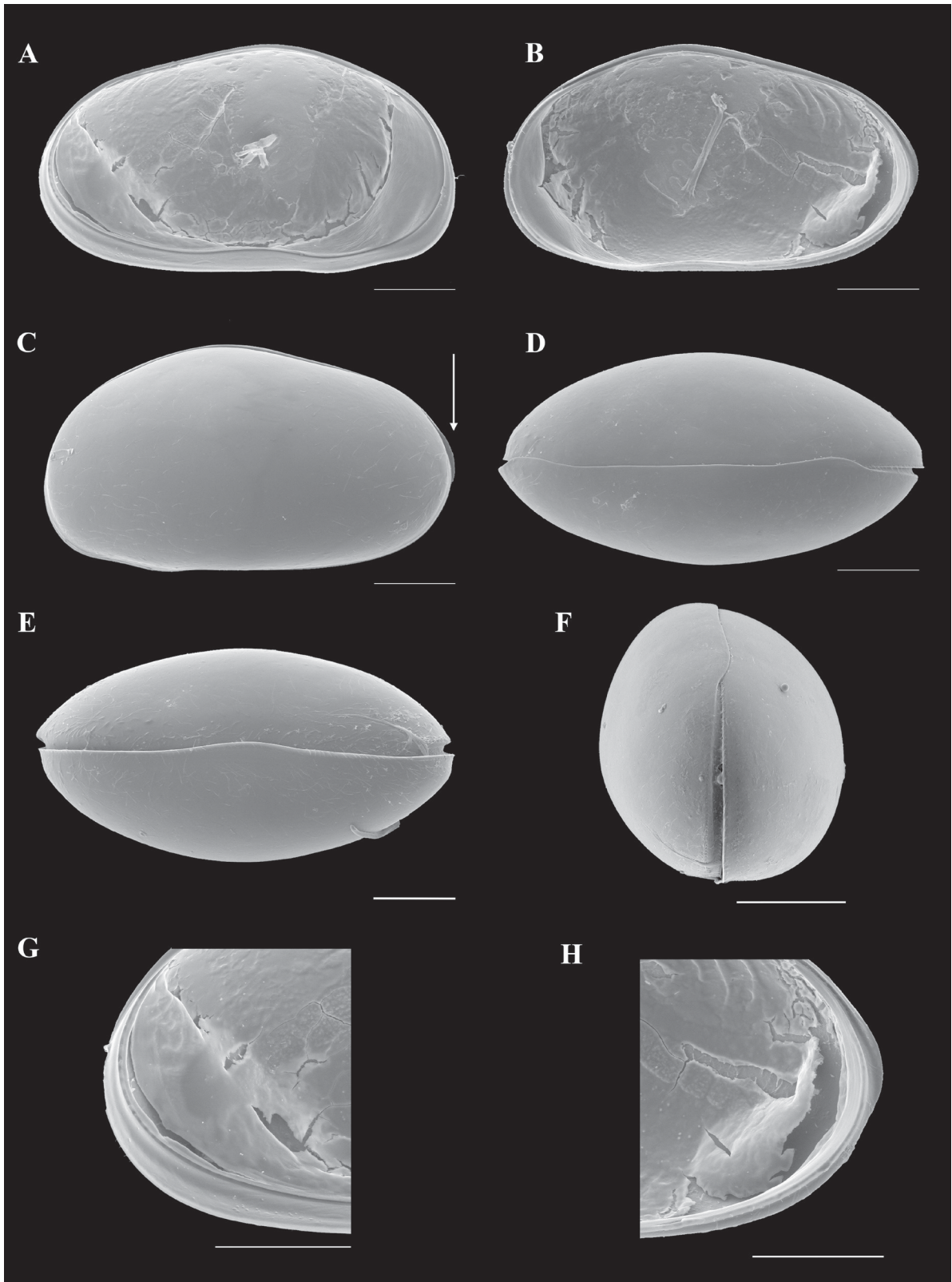
### *Abbreviated redescription of female* (after Higuti *et al.* 2013)

LVi (Fig. 21A, G) without inner list on anterior calcified inner lamella; internal groove from anterior to posterior margins greatest height situated at about 1/3 of the length from the anterior side; anterior margin more broadly rounded than posterior one.

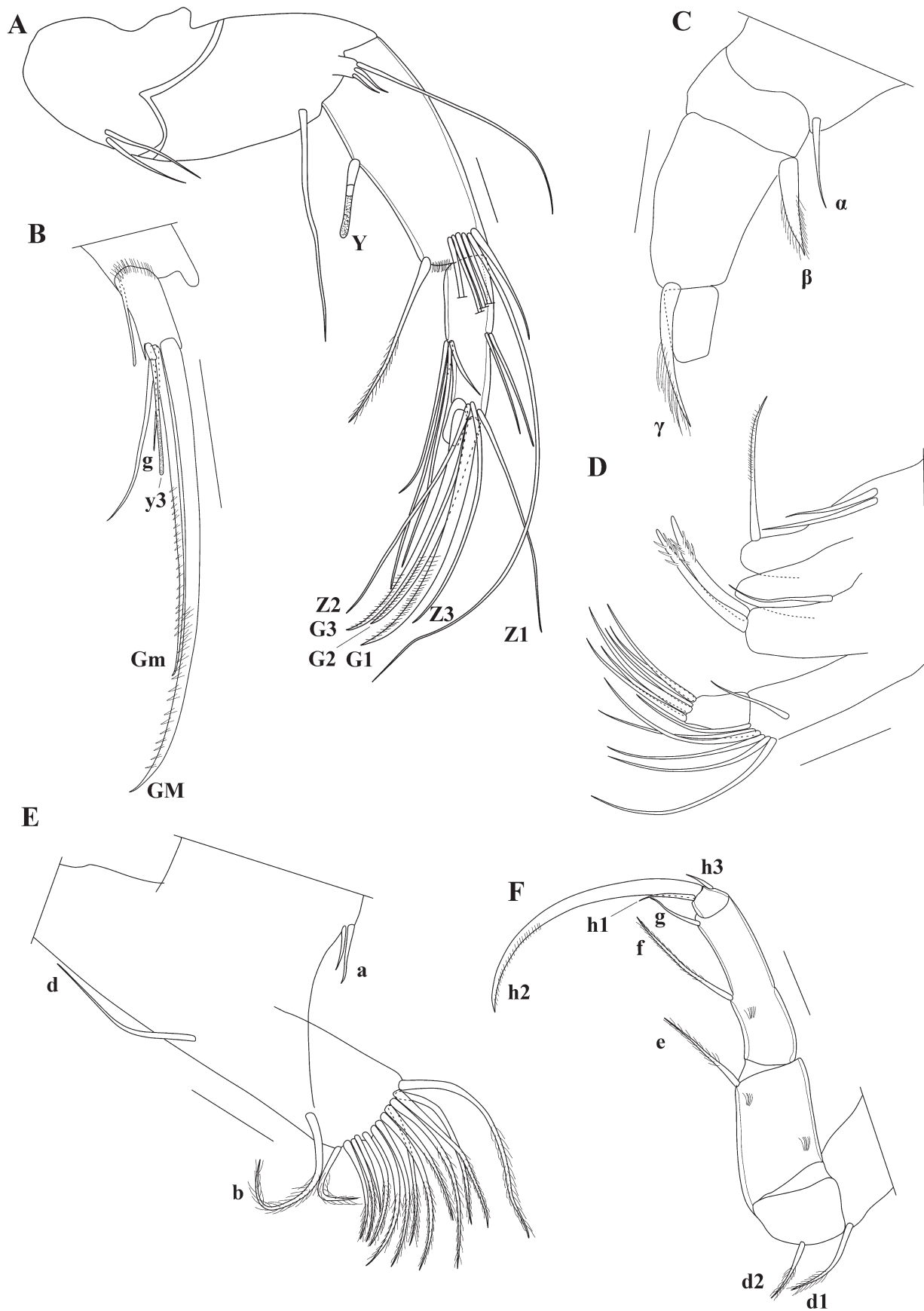
RVi (Fig. 21B, H) with anterior selvage slightly inwardly displaced, and with (small) protruding postero-dorsal flange (Fig. 21F); greatest height situated at about 1/3 of the length from the anterior side.

CpL1 (Fig. 21C) slightly elongated, with the greatest height situated in front of the middle.

CpD (Fig. 21D) with RV overlapping LV with two flaps, one situated at the anterior end of the hinge, the second at the posterior end of the hinge. CpV (Fig. E) with valve margin of LV very weakly sinuous in the middle. CpFr (Fig. F), weakly oblique, with LV being the lower one.

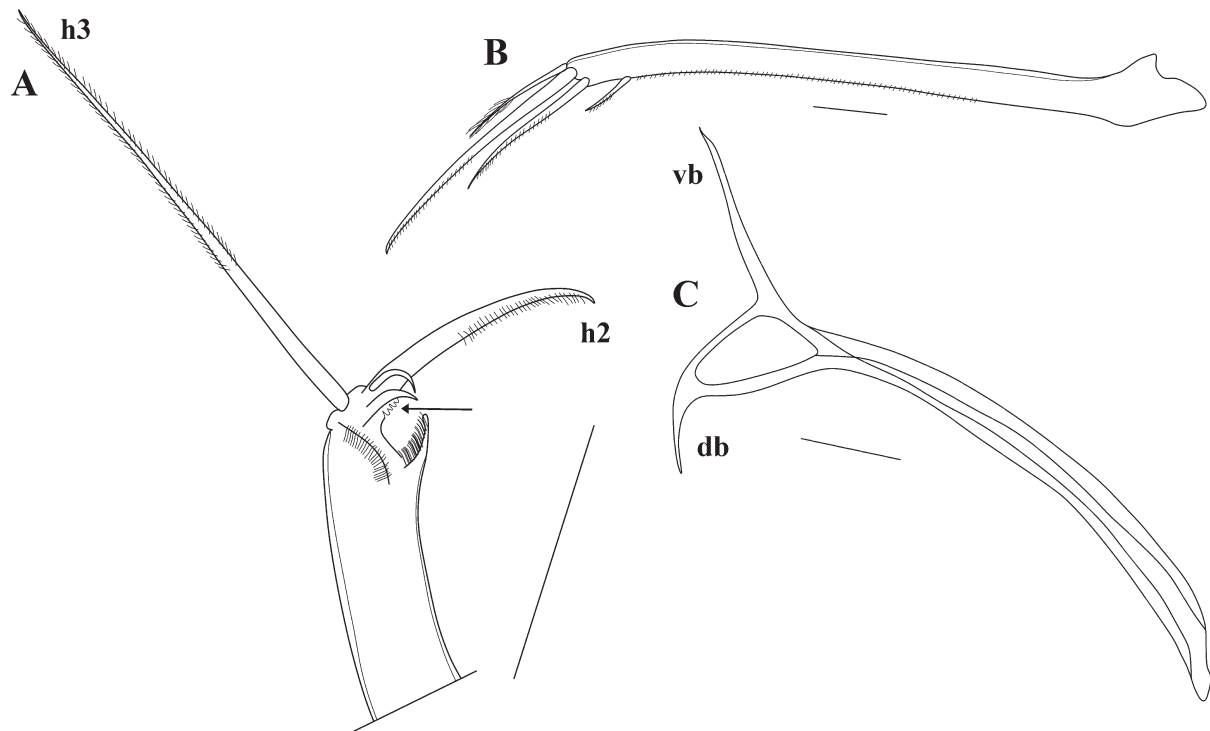


**FIGURE 21** Carapace and valves of *Strandesia nupelia*. A, LVi (OC.3290); B, RVi (OC.3290); C, CpLl (MZUSP 27459); D, CpD (MZUSP 27460); E, CpV (OC.3288); F, CpFr (MZUSP 27460); G, LVi detail of posterior margin (OC.3290); H, RVi detail of posterior margin (OC.3290). Scale bars, 200  $\mu$ m. Reproduced from Higuti *et al.* (2013) with permission from Brill.



**FIGURE 22** *Strandesia nupelia*. A, A2 except last segment (MZUSP 40430); B, A2 last segment (MZUSP 40430); C, Md palp showing  $\alpha$ ,  $\beta$ ,  $\gamma$  setae (MZUSP 40430); D, Mx1 (MZUSP 40430); E, T1 (MZUSP 40430); F, T2 (MZUSP 40430). Scale bars, 50  $\mu\text{m}$ .





**FIGURE 23** *Strandesia nupelia*. A, T3 pincer (MZUSP 40430); B, CR (MZUSP 40430); C, CR attachment (MZUSP 40430). Scale bars, 50  $\mu\text{m}$ .

A1 (not illustrated) with seven segments. First segment with one short subapical and two long apical setae; WO not seen. Second segment wider than long, with one short dorsal seta and a small ventral RO. Third segment with two setae (the smaller with the length of the fourth segment). Fourth segment with four setae (two short and two long). Fifth segment with three long and one short setae. Sixth segment with four long setae. Seventh segment with one short and two long setae, and one aesthetasc  $\gamma$  slightly longer than the short seta.

A2 (Fig. 22A-B) with protopodite, exopodite and three-segmented endopodite. Protopodite with two ventral setae; and one long distal seta, reaching beyond tip of first endopodal segment. Exopodite reduced to a small plate, with one long and two unequal short setae. First endopodal segment with one ventral aesthetasc  $\gamma$ , one long apical seta (reaching beyond the tip of the last endopodal segment), one group of five long and one short swimming setae (the five long setae reaching well beyond the tips of the apical claws; the short one reaching the middle of the third segment). Second endopodal segment undivided, with two unequal dorsal setae and a group of four unequal ventral setae; apically with three claws (G1 and G3 equally long, G2 slightly shorter than G1), three equally long setae ( $z1$ ,  $z2$  and  $z3$ ) and a short aesthetasc  $\gamma2$  (Fig. 22B). Terminal segment (Fig. 22B) with two claws (one long GM; one short, Gm), an aesthetasc  $\gamma3$  with an accompanying seta (seta longer than aesthetasc), fused over a short distance only, and a fine g-seta, the latter shorter than aesthetasc  $\gamma3$  and its accompanying seta.

First segment of Md palp (Fig. 22C—chaetotaxy not completely shown) with short (reaching only halfway the length of  $\beta$ -seta) and smooth  $\alpha$ -seta. Second segment ventrally with stout and hirsute  $\beta$ -seta. Penultimate segment laterally with elongated cone-shaped, distally hirsute  $\gamma$ -seta. Terminal segment almost 1.5x as long as basal width. Md coxa (not illustrated) as typical of the family, elongated with an apical row of strong teeth of variable size, interspaced with some small setae.

Mx1 (Fig. 22D—chaetotaxy not completely shown) with three masticatory lobes, a two-segmented palp and a large respiratory plate (the latter not illustrated). Basal segment of palp with six long apical setae, and one short subapical seta. Terminal palp segment, ca. 2x as long as basal width, slightly curved, apically with three claws and three setae. Third endite with two large, distally serrated bristles. Lateral seta on third endite, reaching the tip of the endite. First endite with one sideways-directed bristle, and two long unequal basal setae.

T1 protopodite (Fig. 22E) with two short a-setae; b and d-seta equally long. Apically with 10 hirsute setae, subapically with a group of four setae. Endopodite with three unequal long hirsute apical setae (not illustrated).

T2 (Fig. 22F) protopodite with seta d1 long and seta d2 shorter, ca. 3/4 of the length of d1. First endopodal seg-

ment with one subapical hirsute seta (e). Second endopodal segment medially divided into a- and b-segments; segment “a” with one apical hirsute seta of medium length (f); segment “b” with one shorter seta (g) reaching beyond the end of the terminal segment. Third endopodal segment with one apical claw (h2) and two setae (one ventro-apical seta (h1) with 1/4 the length of h2 and one dorso-apical (h3) seta with half the length of h3).

T3 (Fig. 23A—chaetotaxy not completely shown) with three segments. First segment with three long setae (d1, d2, dp). Second segment, longer than wide, with one subapical seta (e). Third segment, also longer than wide, with one lateral, hirsute seta (f); distal part of the third segment fused with fourth segment into a modified pincer, with one apical comb-like seta (h2), one small recurved seta, with 1/5 of the length of the comb-like seta, and one longer and distally hirsute seta (h3). Small tooth-like structures present at the base of the comb-like seta (arrowed in Figure 23A).

CR (Fig. 23B) slender and curved, with ventral margin weakly serrated. Proximal claw 2/3 of the length of distal claw. Proximal seta hirsute, ca. 1/2 of length of distal seta.

CR attachment (Fig. 23C) stout, with Triebel’s loop broadly triangular, situated in the main branch; vb long; db short and curved.

Male unknown.

#### *Differential diagnosis* (after Higuti *et al.* 2013)

*Strandesia nupelia* can be distinguished from the other species in this lineage by the elongated shape of the valves, and the presence of a marginal anterior selvage and a (small) posterior protruding flange on the RV.

#### *Ecology and distribution*

*Strandesia nupelia* was recorded in lentic and lotic environments, associated with a great variety of macrophytes, from different types of life forms, in the Pantanal and Paraná floodplains. This species occurred in acidic to basic environments, with pH range of 3.8–8.4. Electrical conductivity and dissolved oxygen ranges were 11–162.2  $\mu\text{S}\cdot\text{cm}^{-1}$  and 0.2–8.7  $\text{mg}\cdot\text{L}^{-1}$ , respectively (see Table 1). Distribution: Brazil.

### **8. *Strandesia tolimensis* Roessler, 1990**

(Figs. 24–26)

1990a *Strandesia tolimensis* n. sp.—Roessler: 802, Figs. 10, 11.

2009 *Bradleystrandesia* gr. *obtusata* sp. 2—Higuti *et al.*: 664, Table 2.

2010 *Bradleystrandesia* gr. *obtusata* sp. 2—Higuti *et al.*: 267, Table 2.

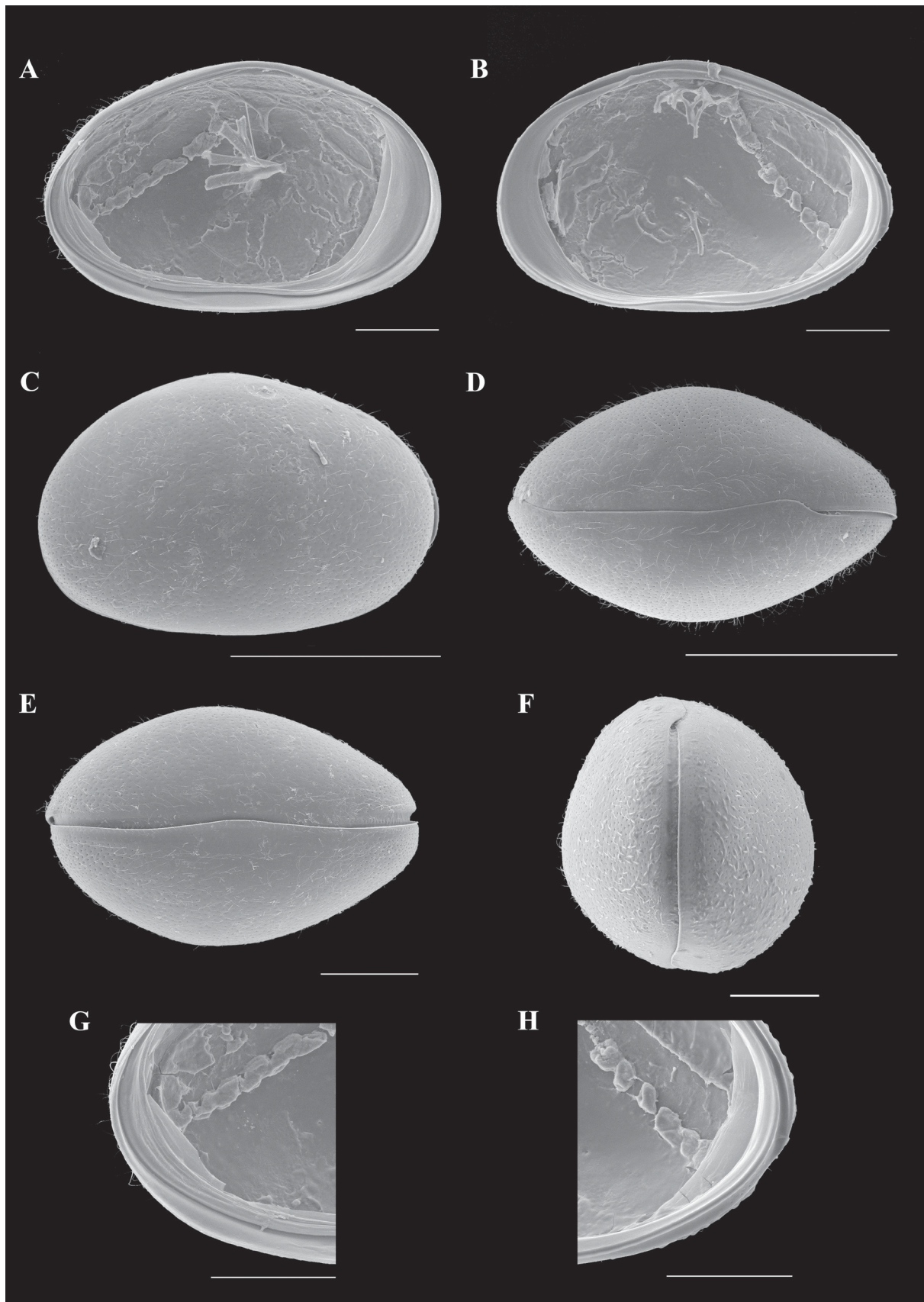
2013 *Strandesia tolimensis* Roessler, 1990—Higuti *et al.*: 196, Figs. 5, 9C.

#### *Type locality and material*

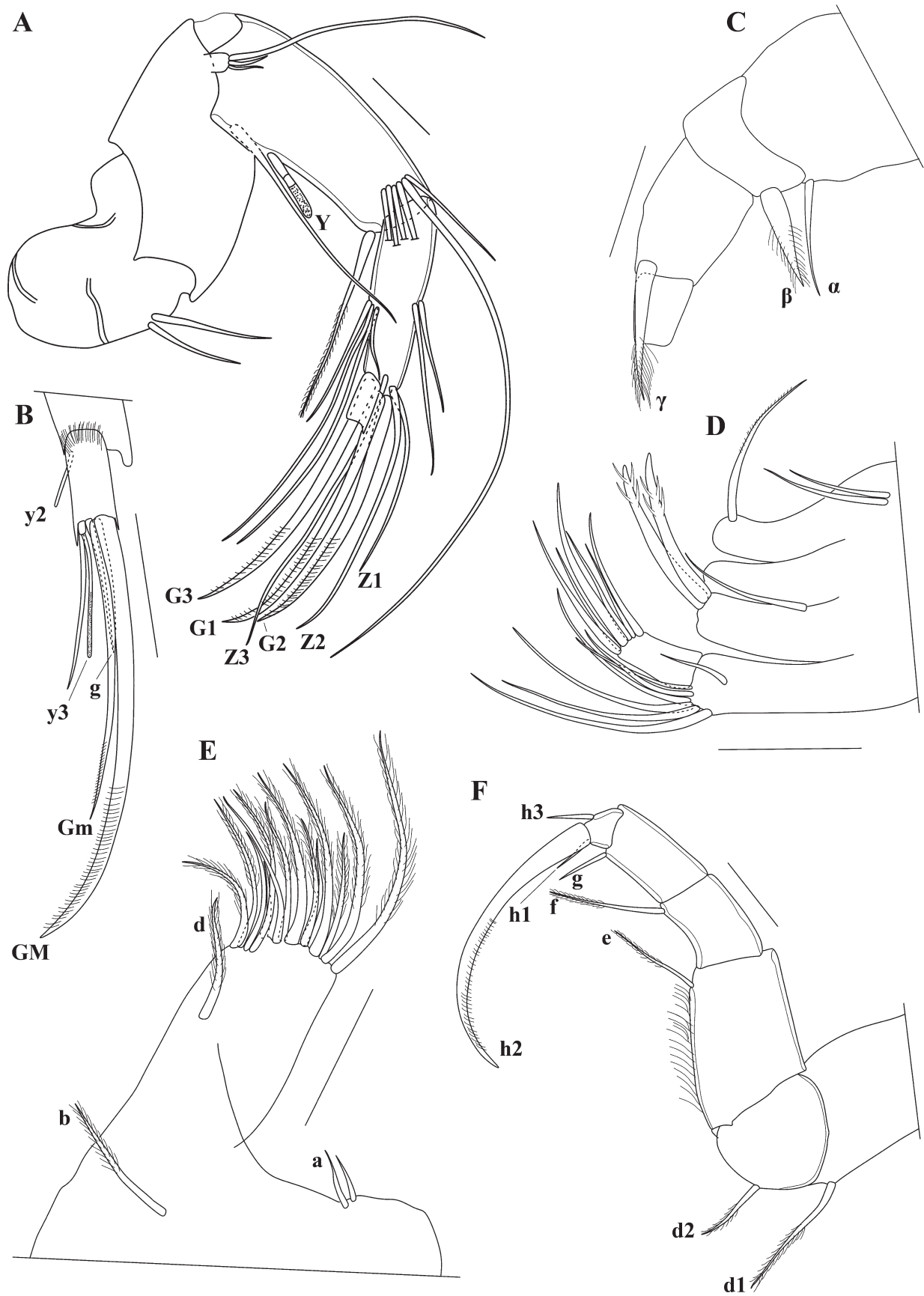
Tolima department, Colombia. This species was described from temporary and semi-permanent pools by Roessler (1990a). Type material (holotype) is stored in the Natural Sciences Institute of National University of Colombia (ICN-MHN), n° ICN-MHN-CR-146-85. The paratypes are stored in the ICN-MHN, n° ICN-CR-147-85 to ICN-CR-160-85, and in the Museum of Natural History of the Andes University n° MUA-CR-246-85 to MUA-CR-260-85 (Roessler, 1990a).

#### *Material examined*

One female (MZUSP40431) was used for soft part illustrations from Mané Cotia Lake (22°43′18.4″S, 53°17′03.6″W). One female (MZUSP27442) was used for SEM from Aurélio Lake (22°41′36.5″S, 53°13′52″W). One female (OC.3278) was used for SEM from Samambaia Lake 1 (22°36′16″S, 53°22′33″W). One female (OC.3279) was used for SEM from Campo Verde Lake 2 (22°39′37.5″S, 53°31′27.7″W). All illustrated specimens are from the Paraná River floodplain.

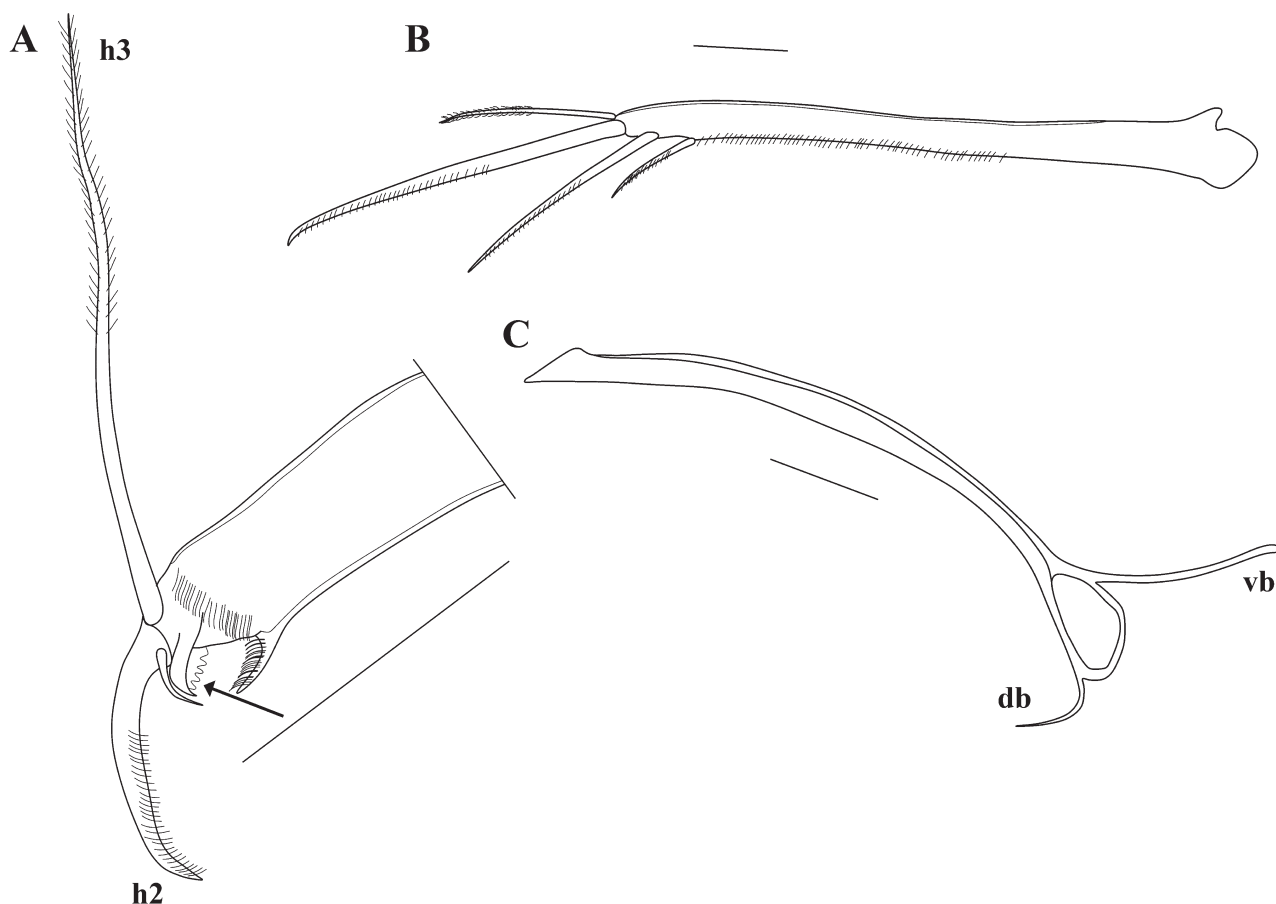


**FIGURE 24** Carapace and valves of *Strandesia tolimensis*. A, LVi (MZUSP 27442); B, RVi (MZUSP 27442); C, CpLl (OC.3278); D, CpD (OC.3279); E, CpV (OC.3278); F, CpFr (OC.3279); G, LVi detail of posterior margin (MZUSP 27442); H, RVi detail of posterior margin (MZUSP 27442). Scale bars, A-B, E-H, 200  $\mu$ m; C-D, 500  $\mu$ m. Reproduced from Higuti *et al.* (2013) with permission from Brill.



**FIGURE 25** *Strandesia tolimensis*. A, A2 except last segment (MZUSP 40431); B, A2 last segment (MZUSP 40431); C, Md palp showing  $\alpha$ ,  $\beta$ ,  $\gamma$  setae (MZUSP 40431); D, Mx1 (MZUSP 40431); E, T1 (MZUSP 40431); F, T2 (MZUSP 40431). Scale bars, 50  $\mu$ m.





**FIGURE 26** *Strandesia tolimensis*. A, T3 pincer (MZUSP 40431); B, CR (MZUSP 40431); C, CR attachment (MZUSP 40431). Scale bars, 50  $\mu$ m.

*Measurements of illustrated specimens (in mm)*

L (n=3): 0.924–0.959, H (n=1): 0.626, W (n=2): 0.559–0.613.

*Diagnosis (after Higuti et al. 2013)*

Cp broadly rounded, with greatest height and width situated in the middle. RV with anterior selvage submarginal, small protruding flange posteriorly; valve surface pitted and set with two types of setae, normal and stiff setae. LV with internal groove along ventral margin. A2 with natatory setae reaching the tips of apical claws; CR and its attachment slender, the last with a Triebel's loop sub-triangular in the main branch.

*Abbreviated redescription of female (after Higuti et al. 2013)*

LVi (Fig. 24A, G) with anterior margin more broadly rounded than posterior margin; with calcified inner lamella wide along anterior margin, narrow along ventral margin and wide on posterior margin (Fig. 24G); without inner list on anterior calcified inner lamella; internal groove along ventral margin; greatest height situated in the middle.

RVi (Fig. 24B, H) with anterior margin more broadly rounded than posterior margin; with submarginal anterior selvage, posteriorly with long and narrow flange (Fig. 24H); greatest height situated in the middle; inner lamella as in LVi.

CpL1 (Fig. 24C) broadly rounded; with greatest height situated in the middle; RV with postero-dorsal flange slightly protruding past LV; Cp surface pitted and set with 2 types of setae, normal and stiff setae. CpD (Fig. 24D) with greatest width in the middle; posterior and anterior extremities bluntly rounded; RV overlapping LV with a flap in the anterior region and in the posterior region. CpV (Fig. 24E) with posterior flap forming an opening in the



carapace, valve margin of LV very weakly sinuous in the middle. CpFr (Fig. 24F) slightly oblique, with LV being the lower one.

A1 (not illustrated) with seven segments. First segment with one short subapical seta and two long apical setae; WO not seen. Second segment wider than long, with one short dorsal seta and a small ventral RO. Third segment with two setae (the smaller one with the length of the fourth segment). Fourth segment with two short and two long setae. Fifth segment with three long and one short setae. Sixth segment with four long setae. Seventh segment with one short and two long setae, and one aesthetasc *ya* slightly shorter than the short seta.

A2 (Fig. 25A, B) with protopodite, exopodite and three-segmented endopodite. Protopodite with two ventral setae; and one long ventro-distal seta reaching the middle of the second endopodal segment. Exopodite reduced to a small plate, with one long and two unequal short setae. First endopodal segment with one ventral aesthetasc *Y*, one long apical seta (reaching beyond the tip of the last endopodal segment), one group of five long and one short swimming setae (the five long setae reaching to the tips of the apical claws; the short one almost reaching the middle of the penultimate segment). Second endopodal segment undivided, with two unequal dorsal setae and a group of four long ventral t setae; apically with three claws (*G1* and *G3* equally long, *G2* slightly shorter than *G1*), three setae (*z1* short with 3/4 of the length of *z3*, *z2* slightly shorter than *z3*, and *z3* longer, reaching the tip of *G1*) and a short apical aesthetasc *y2* (Fig. 25B). Terminal segment (Fig. 25B) with two claws (one long *GM*; one short, *Gm*), an aesthetasc *y3* with an accompanying seta (seta longer than aesthetasc), fused over a short distance only, and a fine *g*-seta, the latter shorter than accompanying seta of aesthetasc *y3*, and similar length to aesthetasc.

First segment of Md palp (Fig. 25C—chaetotaxy not completely shown) with long (reaching beyond tip of  $\beta$ -seta) and smooth  $\alpha$ -seta. Second segment ventrally with stout and hirsute  $\beta$ -seta. Penultimate segment laterally with cone-shaped, distally hirsute  $\gamma$ -seta. Terminal segment sub-rectangular, less than 1.5x as long as basal width. Md coxa (not illustrated) as typical of the family, elongated with an apical row of strong teeth of variable size, interspaced with some small setae.

Mx1 (Fig. 25D—chaetotaxy not completely shown) with three masticatory lobes, a two-segmented palp and a large respiratory plate (the latter not illustrated). Basal segment of palp with six apical setae, and one short subapical seta. Terminal palp segment elongated, ca. 2x as long as basal width, slightly curved, apically with three claws and three setae. Third endite with two large, distally serrated bristles. Lateral seta on third endite reaching beyond the end of the endite. First endite with one sideways-directed bristle only, and two long, unequal basal setae.

T1 protopodite (Fig. 25E) with two short, unequal *a*-setae; with *b* and *d*-seta hirsute and of sub-equal length. Apically with 10 hirsute setae, subapically with a group of four such setae. Endopodite with three unequal long hirsute apical setae (not illustrated).

T2 (Fig. 25F) protopodite with seta *d1* long, seta *d2* shorter, ca. half the length of *d1*. First endopodal segment with one subapical hirsute seta (*e*). Second endopodal segment medially divided into *a*- and *b*-segments; segment “*a*” with one long apical hirsute seta (*f*); segment “*b*” with one shorter seta (*g*) reaching beyond the end of the terminal segment. Third endopodal segment with one apical claw (*h2*) and two setae (one ventro-apical (*h1*) and one dorso-apical (*h3*) with the same length, both 1/5 the length of *h2*).

T3 (Fig. 26A—chaetotaxy not completely shown) with three segments. First segment with three long setae (*d1*, *d2*, *dp*). Second segment, longer than wide, with one subapical seta (*e*). Third segment, also longer than wide, with one lateral, hirsute seta (*f*); distal part of the third segment fused with fourth segment into a modified pincer, with one apical comb-like seta (*h2*), one small recurved seta, 1/5 of the length of the comb-like seta, and one longer and distally hirsute seta (*h3*). Small tooth-like structures present near the base of the comb-like seta (arrowed in Figure 26A).

CR (Fig. 26B) slender and curved, with ventral margin weakly serrated. Proximal claw 2/3 of the length of distal claw. Proximal seta hirsute, ca. 1/2 of length of distal seta.

CR attachment (Fig. 26C) slender, with Triebel’s loop sub-oval, situated in the main branch; *vb* long and weakly curved; *db* short and curved.

Male unknown.

*Differential diagnosis* (after Higuti *et al.*, 2013)

*Strandesia tolimensis* can be distinguished from the other species in this lineage by the rounded shape of the valves. The species resembles *S. obtusata*, but differs from it by being less high in lateral view, and wider in dorsal and ventral views, while the posterior protruding flange of the RV in left lateral view is of a different shape: short and rounded in *S. obtusata* and elongated and narrow in *S. tolimensis*.

#### *Ecology and distribution*

*Strandesia tolimensis* was recorded in lentic and lotic environments, associated with great variety of macrophytes, with different types of life forms, in the Amazon, Araguaia, Pantanal and Paraná floodplains. This species occurred in acidic to basic environments, with a pH range of 4.7–9.5. Electrical conductivity and dissolved oxygen ranges were 12–162.2  $\mu\text{S}\cdot\text{cm}^{-1}$  and 0.2–8.3 mg. L<sup>-1</sup>, respectively (see Table 1). Distribution: Brazil and Colombia.

### **9. *Strandesia nakatanii* nov. sp.**

(Figs. 27–29)

urn:lsid:zoobank.org:act:01BB076A-979A-4EF2-8FFF-D2AD0D2C8C0E

2017 *Strandesia* cf. *tolimensis* sp. 2—Higuti *et al.* : 7.

*Measurements of illustrated specimens* (in mm)

L (n=3): 0.784–0.792, H (n=1): 0.453, W (n=2): 0.446–0.455.

#### *Diagnosis*

Cp elongate with LV slightly overlapping RV anteriorly and posteriorly. RV and LV with greatest height situated well in front of the middle. CpV with LV overlapping RV from posterior to anterior margin, and centrally with a weakly developed flap. RV without anterior inwardly displaced selvage, with a posterior inner list and without postero-dorsal flange. LV with internal groove along margins. A2 with natatory setae reaching the tips of apical claws. T2 with d1 seta twice as long as d2. Caudal ramus slender and its attachment with a semi-oval Triebel's loop, situated in the main branch.

#### *Type material*

*Holotype*: Female, soft parts dissected in glycerine and stored in a sealed slide. Valves stored in micropaleontological slide (MZUSP 40432).

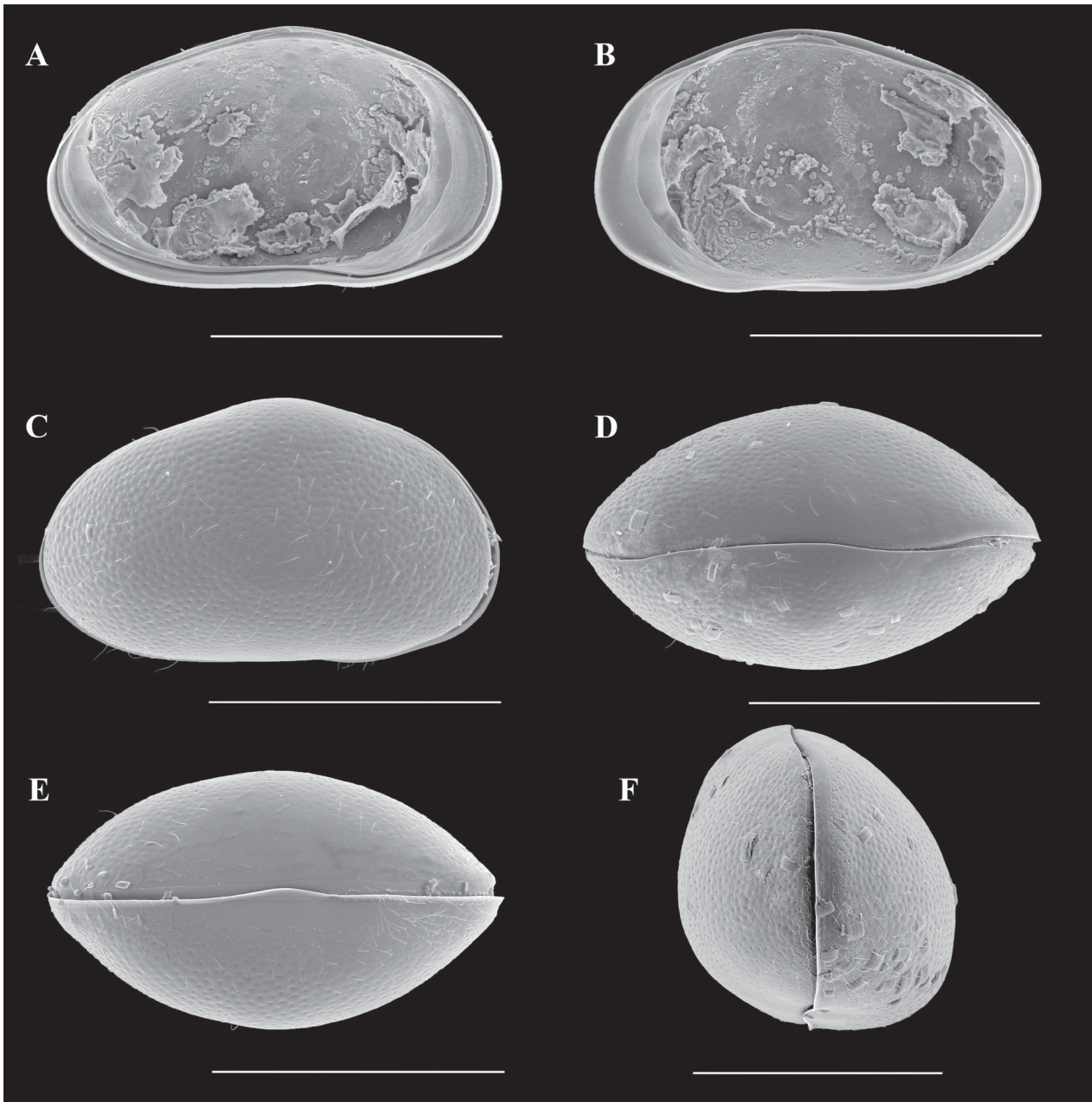
*Paratypes*: Three dissected females stored as the holotype (MZUSP 40433, MZUSP 40434, MZUSP 40435). Three females, with carapaces stored in micropaleontological slides (MZUSP 40436, MZUSP 40437, MZUSP 40438).

#### *Type locality*

Upper Paraná River floodplain, Xirica Lake in roots of *Eichhornia azurea*. Coordinates: 22° 46' 46" S, 53° 22' 47.3" W, south Brazil.

#### *Etymology*

This species is named after the late Dr. Keshiyu Nakatani (State University of Maringá, Nupélia/PEA, Brazil), to acknowledge him as one of the founding fathers of Nupélia (Centre of Research in Limnology, Ichthyology and Aquaculture).



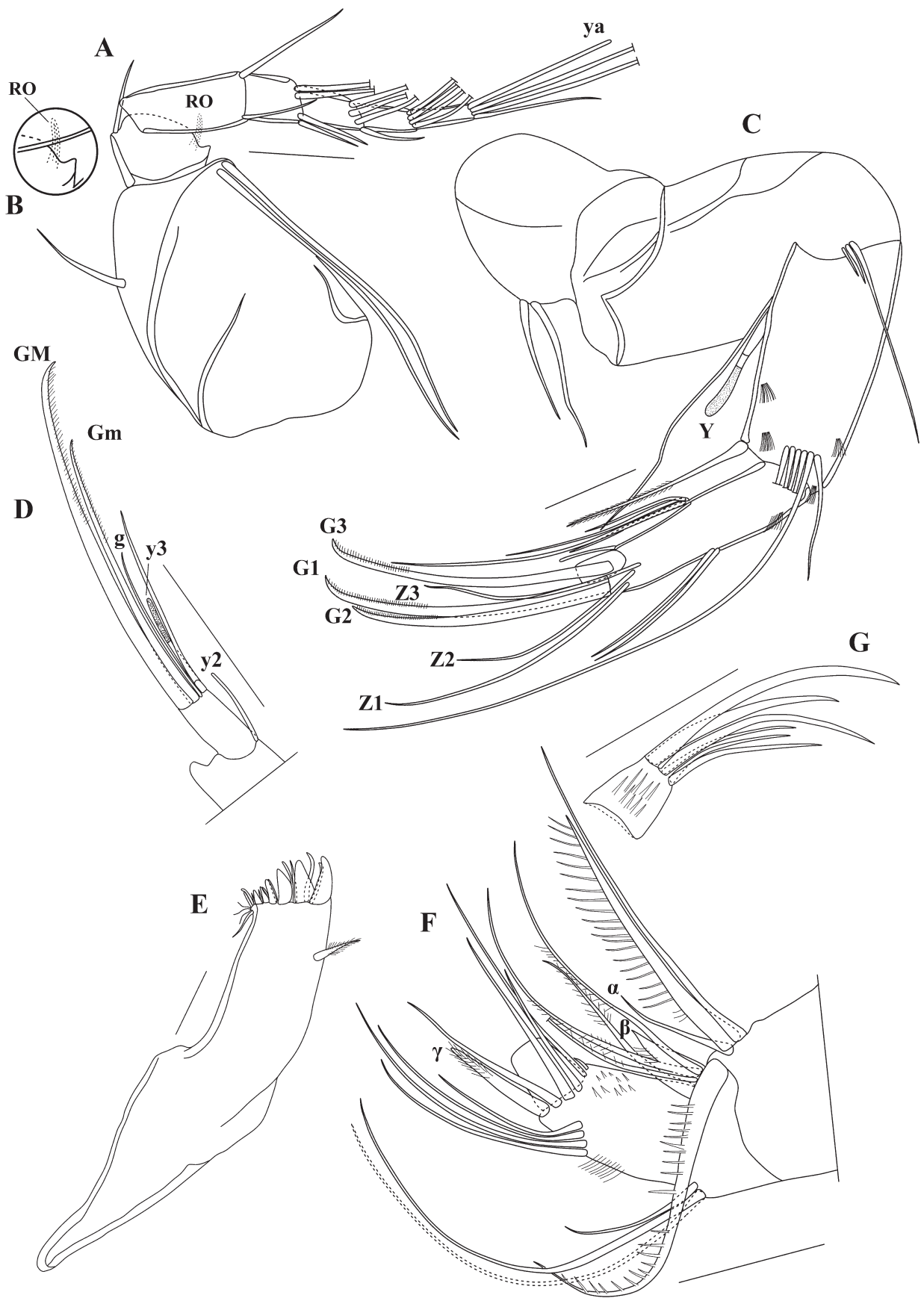
**FIGURE 27** Carapace and valves of *Strandesia nakatanii* nov.sp. A, LVi (MZUSP 40435); B, RVi (MZUSP 40435); C, CpRl (MZUSP 40436); D, CpD (MZUSP 40437); E, CpV (MZUSP 40438); F, CpFr (MZUSP 40437). Scale bars: A-E, 500  $\mu$ m; F, 100  $\mu$ m.

#### *Description of female*

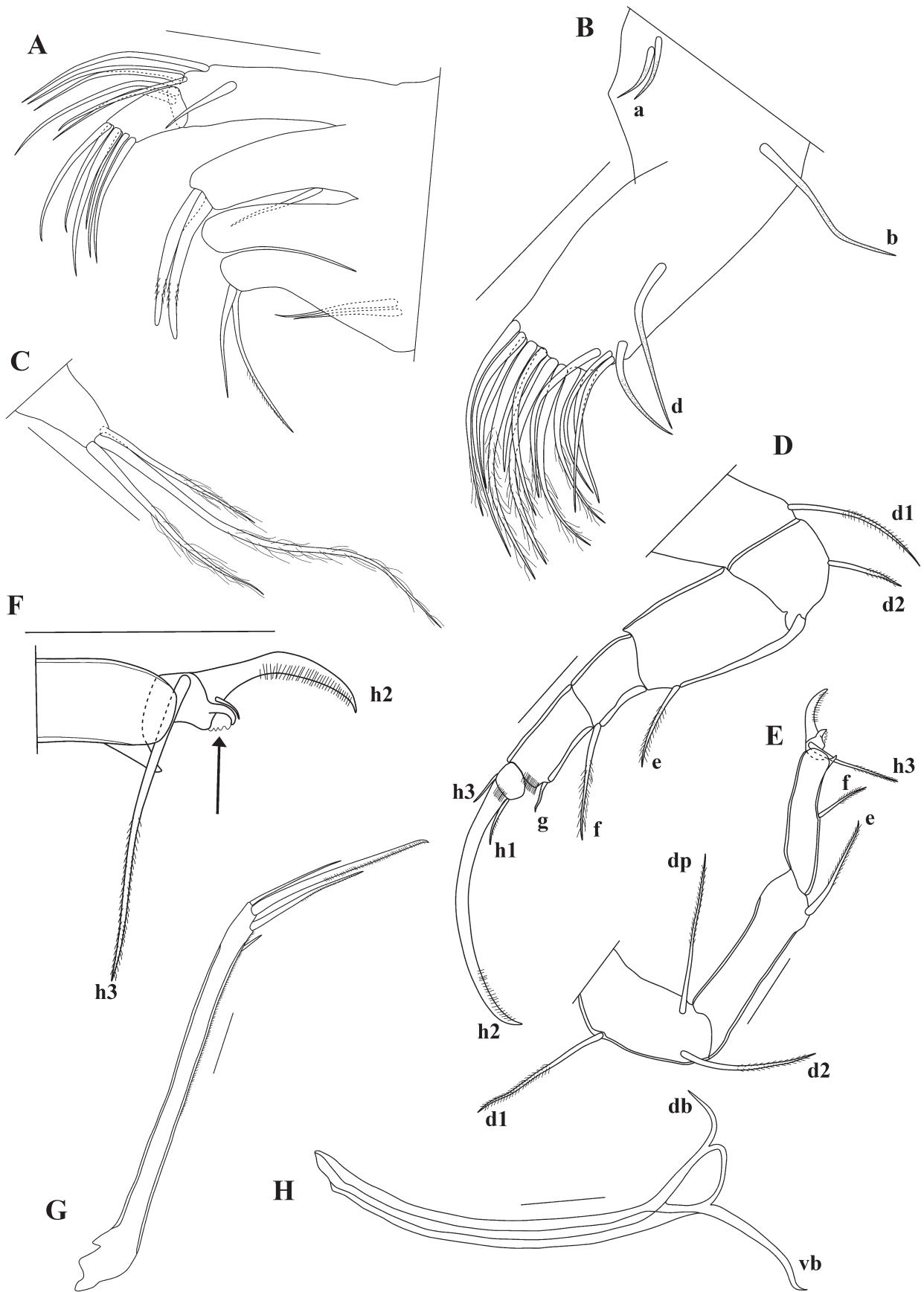
LVi (Fig. 27A) elongate; anterior margin more broadly rounded than posterior one; greatest height situated well in front of the middle; with calcified inner lamella wide along anterior margin, narrow along ventral and posterior margins; internal groove from anterior to posterior margins.

RVi (Fig. 27B) elongate; anterior margin more broadly rounded than posterior one; greatest height situated well in front of the middle; calcified inner lamella as in LVi; with posterior inner list; without anterior selvage and postero-dorsal flange.

CpRl (Fig. 27C) with greatest height situated in front of the middle; LV overlapping RV along anterior and posterior margins; external valve surface with many pits and setae. CpD (Fig. 27D) subovate; LV overlapping RV anteriorly; greatest width in the middle. CpV (Fig. 27E) with LV overlapping RV anteriorly, and centrally with a weakly developed flap. CpFr (Fig. 27F), with valves asymmetrical, RV placed higher than LV.



**FIGURE 28** *Strandesia nakatanii* nov.sp. A, A1 (MZUSP 40434); B, A1 Rome Organ, detail (MZUSP 40434); C, A2 except last segment (MZUSP 40433); D, A2 last segment (MZUSP 40433); E, Md coxal plate (MZUSP 40432); F, Md palp (MZUSP 40432); G, Md palp last segment (MZUSP 40432). Scale bars, 50  $\mu$ m.



**FIGURE 29** *Strandesia nakatanii* nov.sp. A, Mx1 (MZUSP 40432); B, T1 (MZUSP 40432); C, T1 endopodite (MZUSP 40432); D, T2 (MZUSP 40432); E, T3 (MZUSP 40432); F, T3 detail of pincer (MZUSP 40432); G, CR (MZUSP 40433); H, CR attachment (MZUSP 40433). Scale bars, 50 µm.



A1 (Fig. 28A, B) with seven segments. First segment with one short subapical seta and two long apical setae; WO not seen. Second segment wider than long, with one short dorsal seta and a long ventral RO (Fig. 28B). Third segment with two setae. Fourth segment with two short and two long setae. Fifth segment with three long and one short setae. Sixth segment with four long setae. Seventh segment with one short and two long setae, and one aesthetasc Ya slightly longer than the short seta. A2 (Fig. 28C, D) with protopodite, exopodite and three-segmented endopodite. Protopodite with two ventral setae (one longer; one shorter) and one long ventro-distal seta reaching the tip of the second endopodal segment. Exopodite reduced to a small plate, with one long and two unequal short setae. First endopodal segment with one ventral aesthetasc Y, one long apical seta (reaching the tip of the last endopodal segment), one group of five long and one short swimming setae (the five long setae reaching to the tips of apical claws, the short one almost reaching the middle of second endopodal segment), and one long apical seta (reaching the tip of the last segment). Second endopodal segment undivided, with two unequal dorsal setae and a group of four long ventral t setae; apically with three claws (G1 slightly longer than G2 and G3; G2 and G3 equally long), three setae (z1 long, almost reaching the tip of G1; z2 and z3 equally long, with 3/4 of the length of z1) and a short y2 (Fig. 28D). Terminal segment (Fig. 28D) with two claws (one long, GM; one short, Gm), an aesthetasc y3 with an accompanying seta (almost twice as long as the aesthetasc), fused over a short distance only, and a fine g-seta, the latter longer than aesthetasc y3 and shorter than its accompanying seta.

First segment of Md palp (Fig. 28F, G—respiratory plate not shown) with two long plumose setae, one long smooth seta, and long (reaching beyond tip of  $\beta$ -seta) and smooth  $\alpha$ -seta. Second segment dorsally with three setae (two unequal but long; one short, with the length about 1/3 of the longest), and ventrally with long (but less so than  $\alpha$ -seta) and hirsute  $\beta$ -seta, three long hirsute and one short setae, the latter with length about 2/3 of the longest. Penultimate segment with two groups of setae, dorsally with a group of four unequal but long and smooth setae, laterally with cone-shaped, distally hirsute  $\gamma$ -seta and three smooth subapical setae; ventrally with one long and one short setae. Terminal segment with three claws and three setae. Md coxa (Fig. 28E) as typical of the family, elongated with an apical row of strong teeth of variable size, interspaced with some small setae.

Mx1 (fig. 29A chaetotaxy not completely shown) with three masticatory lobes (endites), a two-segmented palp and a large respiratory plate (the later not illustrated). Basal segment of palp with six long apical setae and one short subapical seta. Terminal palp-segment elongated, ca. 1.5x as long as basal width, slightly curved, apically with three claws and three setae. Third endite with two large, serrated bristles. Short subapical seta on third endite, almost reaching the tip of the endite. First endite with two unequal sideways directed bristles, and two long, unequal basal setae.

T1 protopodite (Fig. 29B, C) with two short a-setae, one b-seta slightly longer than d-setae. Apically with 10 hirsute setae, subapically with a group of four such setae. Endopodite (Fig. 29C) with three unequally long hirsute setae.

T2 (Fig. 29D) protopodite with seta d1 long, seta d2 shorter, ca. half of the length of d1. First endopodal segment with one subapical hirsute seta (e). Second endopodal segment medially divided into a- and b-segments; segment “a” with one long apical hirsute seta (f), segment “b” with one seta (g). Third endopodal segment with one apical claw (h2) and two setae (one ventro-apical (h1) with 1/5 the length of h2 and one dorso-apical (h3) with 3/4 the length of h1).

T3 (Fig. 29E, F) with three segments. First segment with three long setae (d1, d2, dp). Second segment, longer than wide, with one apical seta (e). Third segment, also longer than wide, with one lateral, hirsute seta (f; distal); distal part of the third segment fused with fourth segment into a modified pincer, with one apical comb-like seta (h2), one small recurved seta, with 1/5 of the length of the comb-like seta, and one longer and distally hirsute seta (h3). Small tooth-like structures present at the base of the comb-like seta (arrowed in Figure 29F).

CR (Fig. 29G) slender, with ventral margin weakly serrated. Proximal claw 2/3 of the length of distal claw. Proximal seta smooth, ca. 1/4 of the length of distal seta.

CR attachment (Fig. 29H) stout, with a semi-oval Triebel's loop, situated in the main branch; vb long and slightly curved; db short and curved

Male unknown.

### *Differential diagnosis*

*Strandesia nakatanii* nov. sp. resembles *Strandesia tolimensis* (Roessler, 1990), but can be distinguished from it by

the more elongated shape, the smaller size and the absence of an anterior selvage and of a postero-dorsal flange on the RV.

#### *Ecology and distribution*

*Strandesia nakatanii* nov.sp. was recorded in lentic and lotic environments, associated with free-floating and rooted floating-stemmed plants, in the Paraná River floodplain. This species occurred in environments with a pH range of 6.4–8.3. Electrical conductivity and dissolved oxygen ranges were 35–68.8  $\mu\text{S}\cdot\text{cm}^{-1}$  and 1.4–12.2  $\text{mg}\cdot\text{L}^{-1}$ , respectively (see Table 1). Distribution: Brazil.

#### **The *Strandesia variegata* group**

The *Strandesia variegata* group is composed of two species, *Strandesia variegata* and *Strandesia mutica*. Both species are characterized by the large and elongated carapace size (more than 1,300 $\mu\text{m}$ ) and the broadly rounded shape of the carapace in dorsal and ventral views.

#### **10. *Strandesia variegata* (Sars, 1901) G.W. Müller 1912**

(Figs. 30–32)

1901 *Neocypris variegata* n. sp.—Sars: 33, Plate VII, Figs. 14–16.

1912 *Strandesia variegata* (Sars, 1901)—G.W. Müller, 1912: 189.

#### *Type locality and material*

São Paulo, São Paulo State, Brazil. This species was described based on specimens hatched from mud by Sars (1901). Type material: lectotype nr F19405a1/2 in the Natural History Museum, Oslo, Norway.

#### *Material examined*

One female (MZUSP 40439), used for soft part illustrations, and two females (MZUSP 40440, MZUSP 40441), used for SEM, were from Maria Luiza Lake (22°40'29.4"S, 53°13'5.8"W). Two females (MZUSP 40442, MZUSP 40443) from Aurélio Lake (22°41'37.7"S, 53°13'54.3"W) were used for SEM. All illustrated specimens are from the Paraná River floodplain.

#### *Measurements of illustrated specimens (in mm)*

L (n=2): 1.329–1.372, H (n=1): 0.670, W (n=1): 0.677.

#### *Diagnosis*

Cp subovate, with posterior margin more broadly rounded than anterior margin; RV without anterior selvage and postero-dorsal flange. LV with inner groove along ventral margin. A2 with natatory setae reaching beyond the tips of the apical claws. CR with ventral margin serrated, its attachment with a narrow oval-triangular Triebel's loop, situated in the main branch.

#### *Abbreviated redescription of female*

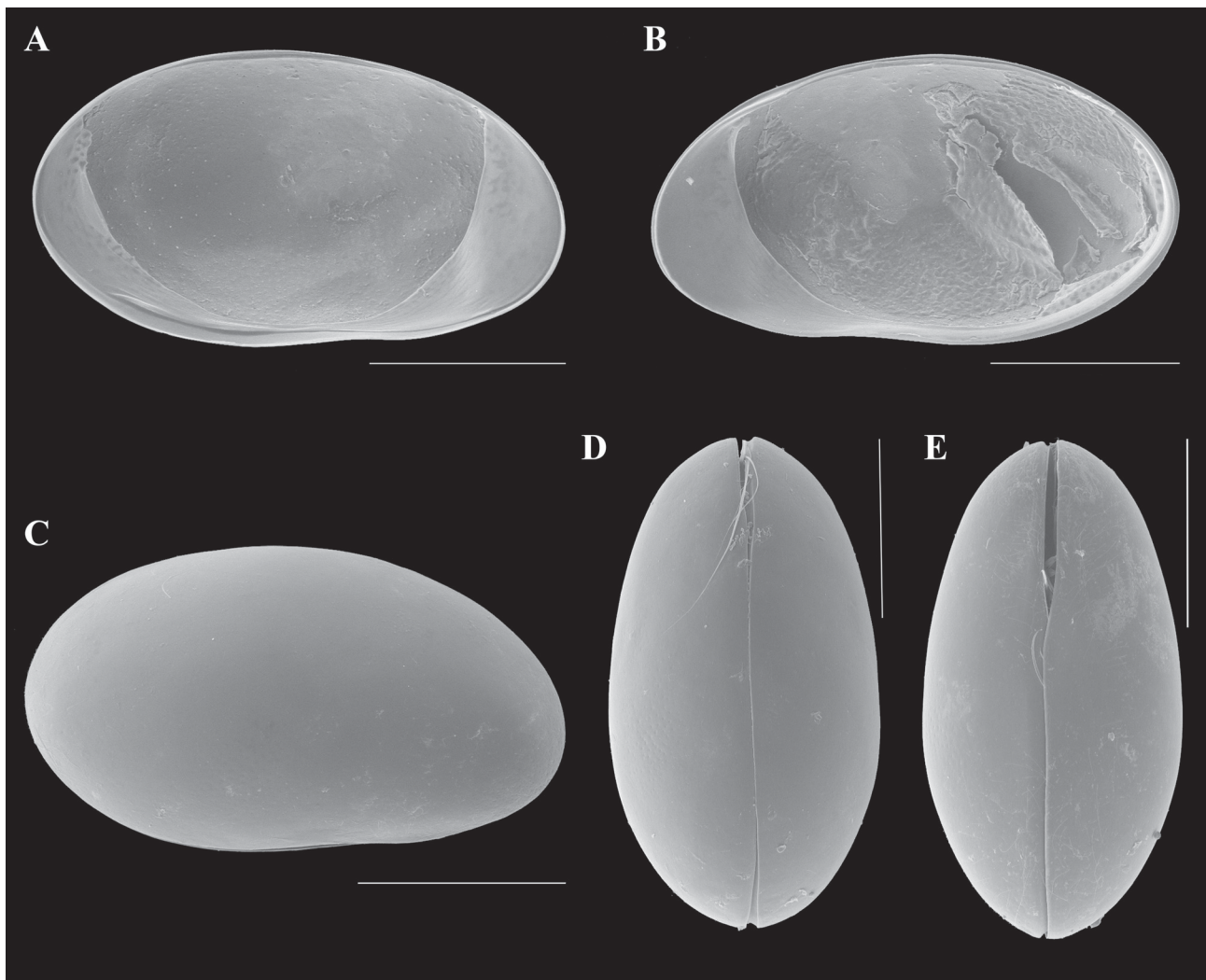
LVi (Fig. 30A) subovate and with broadly rounded margins; with inner groove along ventral margin; with greatest height situated behind the middle, making the posterior section broader than the anterior part; with calcified inner lamella wide along anterior margin, narrow along ventral and posterior margins.

RVi (Fig. 30B) subovate; with greatest height behind the middle, with calcified inner lamella as in the LV; without anterior selvage and postero-dorsal flange.

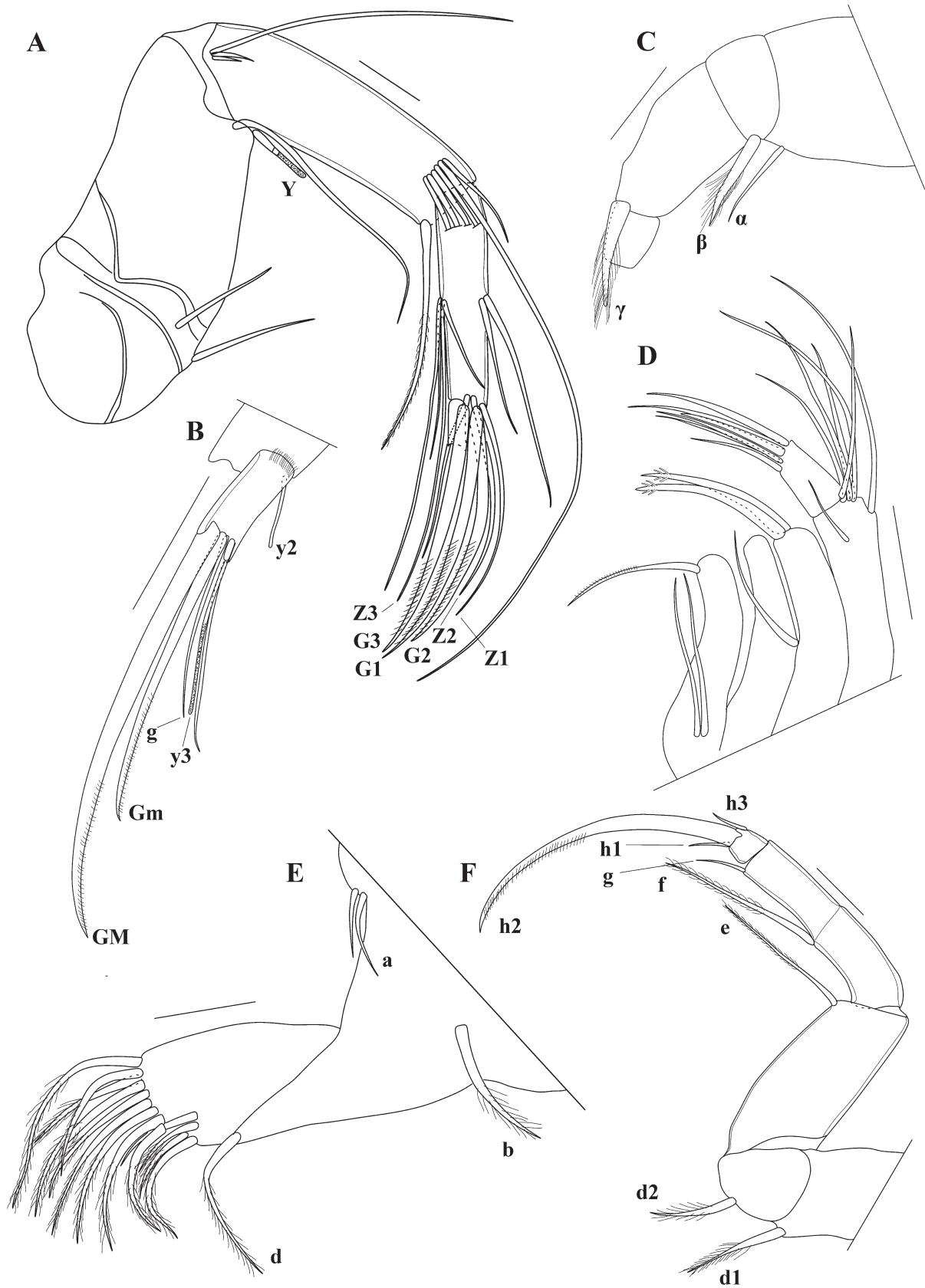
CpR1 (Fig. 30C) subovate; with greatest height situated behind the middle; posterior region broader than anterior. CpD (Fig. 30D) subovate; both extremities broadly rounded. CpV (Fig. 30E) subovate; with both extremities broadly rounded, no flaplike overlap of LV by RV.

A1 (not illustrated) with seven segments. First segment with one short subapical and two long apical setae; WO not seen. Second segment wider than long, with one short dorsal seta and a small ventral RO. Third segment with two setae (the smaller one with the length of the fourth segment). Fourth segment with two short and two long, setae. Fifth segment with three long and one short setae. Sixth segment with four long setae. Seventh segment with one short and two long setae, and one short aesthetasc ya, the latter slightly longer than the short seta.

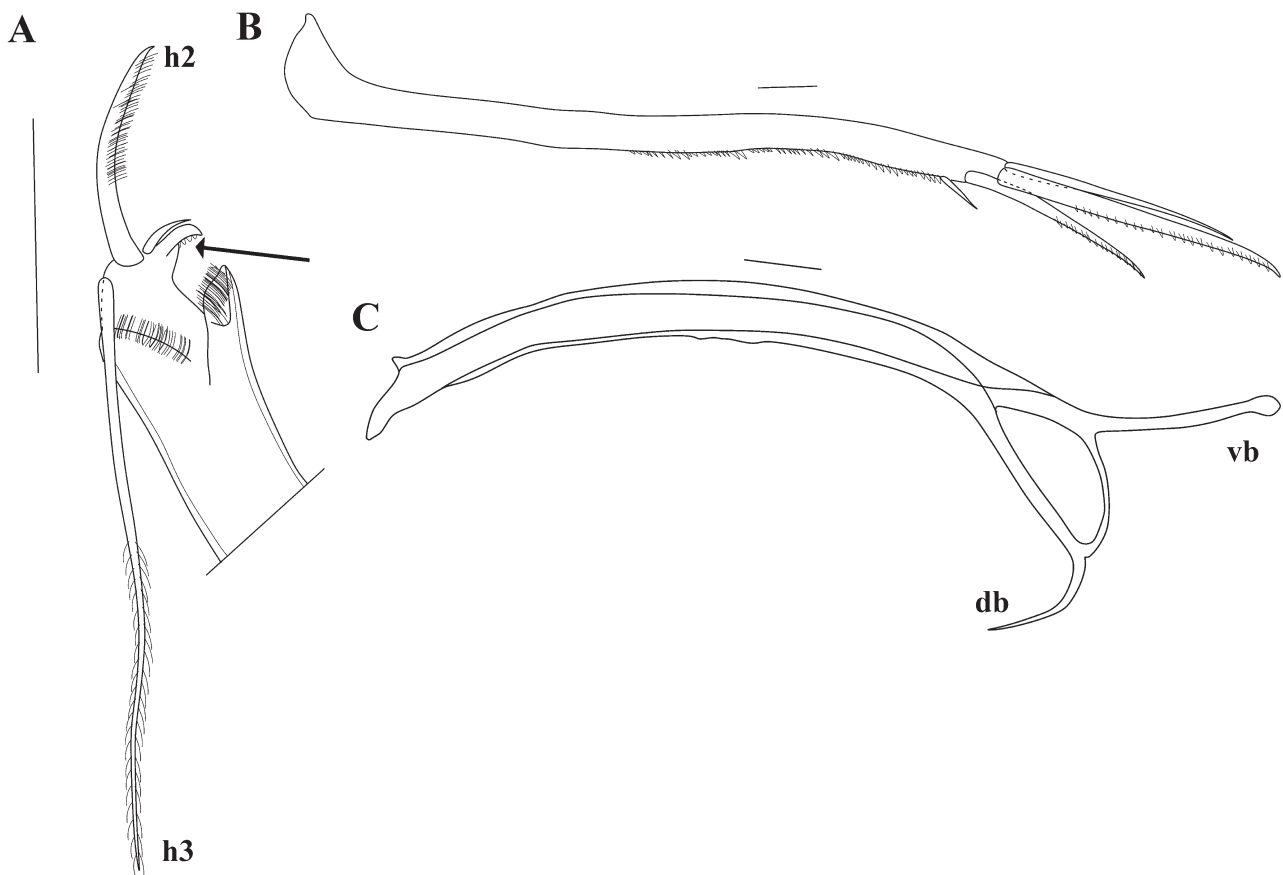
A2 (Fig. 31A, B) with protopodite, exopodite and three-segmented endopodite. Protopodite with two ventral setae; and one long distal seta, the latter passing the middle of the second endopodal segment. Exopodite reduced to a small plate, with one long and two unequal short setae. First endopodal segment with one ventral aesthetasc Y, one long apical seta (reaching beyond the tip of the last endopodal segment), one group of five long and one short swimming setae (the five long setae reaching beyond tips of apical claws; the short one almost reaching 1/4 the length of second endopodal segment). Second endopodal segment undivided, with two unequal dorsal setae and a group of four long ventral t setae; apically with three claws (G1 longest, G2 slightly shorter than G1 and G3; G3 slightly shorter than G1), three setae (z1 and z3 equally long and z2 slightly shorter than both) and a short apical aesthetasc y2 (Fig. 31B). Terminal segment (Fig. 31B) with two claws (one long, GM; one short, Gm), an aesthetasc y3 with an accompanying seta (seta longer than aesthetasc), fused over a short distance only, and a fine g-seta, the latter shorter than accompanying seta of aesthetasc y3, but slightly longer than the aesthetasc y3 itself.



**FIGURE 30** Carapace and valves of *Strandesia variegata*. A, LVi (MZUSP 40440); B, RVi (MZUSP 40440); C, CpR1 (MZUSP 40441); D, CpD (MZUSP 40442); E, CpV (MZUSP 40443). Scale bars, 500  $\mu$ m.



**FIGURE 31** *Strandesia variegata*. A, A2 except last segment (MZUSP 40439); B, A2 last segment (MZUSP 40439); C, Md palp showing  $\alpha$ ,  $\beta$ ,  $\gamma$  setae (MZUSP 40439); D, Mx1 (MZUSP 40439); E, T1 (MZUSP 40439); F, T2 (MZUSP 40439). Scale bars, 50  $\mu\text{m}$ .



**FIGURE 32** *Strandesia variegata*. A, T3 pincer (MZUSP 40439); B, CR (MZUSP 40439); C, CR attachment (MZUSP 40439). Scale bars, 50  $\mu$ m.

First segment of Md palp (Fig. 31C—chaetotaxy not completely shown) with short (not reaching beyond tip of  $\beta$ -seta) and smooth  $\alpha$ -seta. Second segment ventrally with long (longer than  $\alpha$ -seta), stout and hirsute  $\beta$ -seta. Penultimate segment laterally with cone-shaped, distally hirsute  $\gamma$ -seta. Md coxa (not illustrated) as typical of the family, elongated with an apical row of strong teeth of variable size, interspaced with some small setae.

Mx1 (Fig. 31D—chaetotaxy not completely shown) with three masticatory lobes, a two-segmented palp and a large respiratory plate (the latter not illustrated). Basal segment of palp with six long apical setae, and one short subapical seta. Terminal palp segment elongated, ca. 1.5x as long as basal width, slightly curved and tapering, apically with three claws and three setae. Third endite with two large, serrated bristles; lateral seta on third endite, reaching beyond the end of the endite. First endite with one sideways-directed bristle only, and two equally long basal setae.

T1 protopodite (Fig. 31E) with two short, unequal a-setae, b-seta slightly shorter than d-seta, both hirsute. Apically with 10 hirsute setae, subapically with a group of four such setae. Endopodite with three unequal long hirsute apical setae (not illustrated).

T2 (Fig. 31F) protopodite with seta d1 relatively long and seta d2 shorter, ca. 3/4 of the length of d1. First endopodal segment with one subapical hirsute seta (e). Second endopodal segment medially divided into a- and b-segments; segment “a” with one long apical hirsute seta (f); segment “b” with one shorter seta (g) reaching beyond last segment. Third endopodal segment with one apical claw (h2) and two setae (one ventro-apical (h1) with 1/6 the length of h2 and one dorso-apical (h3) slightly shorter than h1).

T3 (Fig. 32A—chaetotaxy not completely shown) with three segments. First segment with three long setae (d1, d2, dp). Second segment, longer than wide, with three subapical seta (e). Third segment, also longer than wide, with three lateral, hirsute seta (f); distal part of the third segment fused with fourth segment into a modified pincer, with apical comb-like seta (h2), small recurved setae, with 1/5 of the length of the comb-like seta and one longer and distally hirsute seta (h3). Small tooth-like structures present at the base of the comb-like seta (arrowed in Figure 32A).



CR (Fig. 32B) slender and curved, with ventral margin serrated. Proximal claw 2/3 of the length of distal claw. Proximal seta smooth, ca. 1/5 of length of distal seta.

CR attachment (Fig. 32C) stout, with Triebel's loop oval-triangular, situated in the main branch; vb long and straight; db short and curved.

Male unknown

#### *Differential diagnosis*

*Strandesia variegata* is similar to *Strandesia mutica*, but it has a broader posterior region in lateral and dorsal view.

#### *Ecology and distribution*

*Strandesia variegata* was recorded from lentic and lotic environments, associated with a variety of macrophytes, with different life forms, in the Pantanal and Paraná floodplains. This species occurred in acidic to neutral environments, with pH range of 4.2–7.4. Electrical conductivity and dissolved oxygen ranges were 11–84.8  $\mu\text{S}\cdot\text{cm}^{-1}$  and 0.2–8.3  $\text{mg}\cdot\text{L}^{-1}$ , respectively (see Table 1). Distribution: Brazil, Paraguay and West Indies.

### **11. *Strandesia mutica* (Sars, 1901) G.W. Müller, 1912**

(Figs. 33–35)

1901 *Neocypris mutica* n. sp.—Sars: 32, Plate VII, Figs. 8–13.

1905 *Eucypris (Eucypris) mutica* (Sars, 1901)—Daday: 243.

1912 *Strandesia mutica* (Sars, 1901)—G.W. Müller: 189.

#### *Type locality and material*

Itatiba, São Paulo State, Brazil. This species was described based on specimens hatched from dried mud by Sars (1901). Type material: lectotype nr F19400a1/2 in the Natural History Museum, Oslo (Norway).

#### *Material examined*

One female (MZUSP 40444) used for soft part illustrations and two females (MZUSP 40445, MZUSP 40446) used for SEM from Aurélio Lake (22°41'36.5"S, 53°13'52.9"W). Two females (MZUSP 40447, MZUSP 40448) used for SEM from Ivinhema River (22°54'37.6"S, 53°38'19.4"W). All illustrated specimens are from the Paraná River floodplain.

#### *Measurements of illustrated specimens (in mm)*

L (n=2): 1.426–1.429, H (n=1): 0.654, W (n=1): 0.588.

#### *Diagnosis*

Cp subovate, with posterior margin more broadly rounded than anterior margin. RV with anterior selvage and large postero-dorsal flange, and ventrally with an outer list. LV with inner groove along margins. A2 with natatory setae reaching beyond the tips of the apical claws. CR with ventral margin serrated, its attachment with an oval-triangular Triebel's loop, situated in the main branch.

### *Abbreviated redescription of female*

LVi (Fig. 33A) with posterior margin more broadly rounded than anterior margin; calcified inner lamella wide along anterior margin and posterior margins, and absent along ventral margin; internal groove from anterior to posterior margin; greatest height situated well behind the middle.

RVi (Fig. 33B) with calcified inner lamella wide along anterior margin, absent on ventral margin and narrow along posterior margin. Greatest height situated well behind the middle. Posterior margin more broadly rounded than anterior margin. Anterior selvage inwardly displaced, but not running parallel to valve margin. Postero-dorsal flange large, elongated, relatively wide at the ventral side. Ventrally with outer list (Fig. 33E).

CpLI (Fig. 33C) with greatest height situated well behind the middle. CpD (Fig. 33D) and CpV (Fig. 30E) with evenly rounded lateral margins; LV overlapping RV anteriorly, and RV overlapping LV posteriorly; both ends truncated. CpV (Fig. 33E) showing weak flap-like overlap of LV by RV.

A1 (not illustrated) with seven segments. First segment with one short subapical seta and two long apical setae; WO not seen. Second segment wider than long, with one short dorsal seta and a small ventral RO. Third segment with two setae (the smaller with the length of the fourth segment). Fourth segment with two short and two long setae. Fifth segment with three long and one short setae. Sixth segment with four long setae. Seventh segment with one short and two long setae, and one aesthetasc ya, with approximately the same length of the shorter seta.

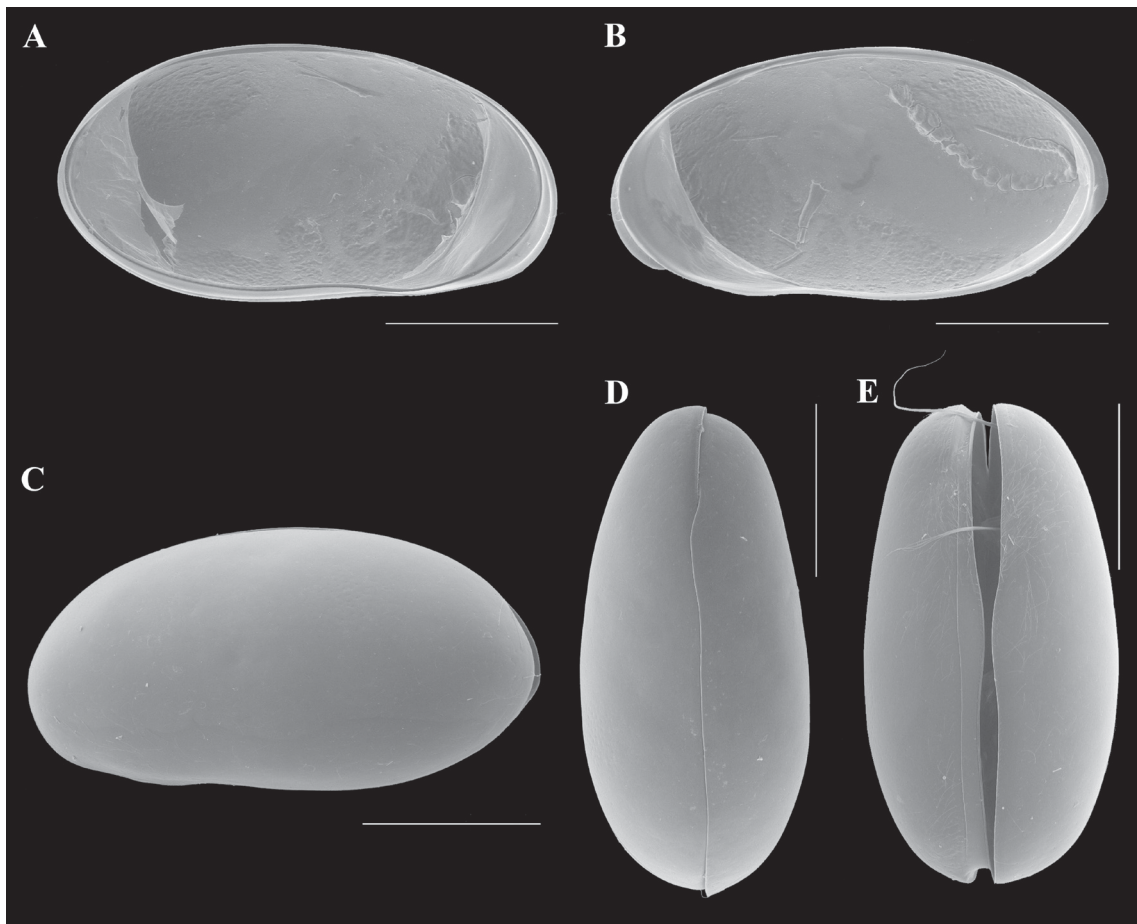
A2 (Fig. 34A, B) with protopodite, exopodite and three-segmented endopodite. Protopodite with two ventral setae; and one long ventro-distal seta (this seta reaching just beyond tip of first endopodal segment). Exopodite reduced to a small plate, with one long and two unequal short setae. First endopodal segment with one ventral aesthetasc Y, one long apical seta (reaching beyond the tip of the last endopodal segment), one group of five long and one short swimming setae (the five long setae just reaching the tips of apical claws; the short one almost reaching the middle of third segment). Second endopodal segment undivided, with two unequal dorsal setae and a group of four long ventral t setae; apically with three claws (G1 longest, G2 and G3 equally long and slightly shorter than G1), three setae (z1 and z2 equally long, and z3 with 3/4 the length of z1) and a short apical aesthetasc y2 (Fig. 34B). Terminal segment (Fig. 34B) with two claws (one long, GM; one short, Gm), an aesthetasc y3 with an accompanying seta (seta slightly longer than aesthetasc), fused over a short distance only, and a fine g-seta, the latter shorter than the accompanying seta and aesthetacs y3.

First segment of Md palp (Fig. 34C—chaetotaxy not completely shown) with short (not reaching tip of  $\beta$ -seta) and smooth  $\alpha$ -seta. Second segment ventrally with stout and hirsute  $\beta$ -seta, slightly longer than  $\alpha$ -seta. Penultimate segment laterally with elongated cone-shaped, stout, distally hirsute  $\gamma$ -seta. Terminal segment almost 1.5x as long as basal width. Md coxa (not illustrated) as typical of the family, elongated with an apical row of strong teeth of variable size, interspaced with some small setae.

Mx1 (Fig. 34D—chaetotaxy not completely shown) with three masticatory lobes, a two-segmented palp and a large respiratory plate (the latter not illustrated). Basal segment of palp with six apical setae, and one short subapical seta. Terminal palp segment more than twice as long as basal width, slightly curved and tapering, apically with three claws and three setae. Third endite with two large, distally serrated bristles. Lateral seta on third endite, reaching beyond the end of the endite. First endite with one sideways-directed bristle only, and two long, unequal basal setae.

T1 protopodite (Fig. 34E) with two short, unequal a-setae; one hirsute b-seta and one long d-seta, ca. 1/4 longer than b-seta. Apically with 10 hirsute setae, subapically with a group of four such setae. Endopodite with three unequal long hirsute apical setae (not illustrated).

T2 (Fig. 34F) protopodite with seta d1 relatively long and seta d2 shorter, ca. 2/3 of the length of d1. First endopodal segment with one subapical hirsute seta (e). Second endopodal segment medially divided into a- and b-segments; segment "a" with one long apical hirsute seta (f); segment "b" with one shorter seta (g) reaching beyond the last segment. Third endopodal segment with one apical claw (h2) and two setae (one ventro-apical (h1) with 1/5 the length of h2, and one dorso-apical (h3) slightly shorter than h1).



**FIGURE 33** Carapace and valves of *Strandesia mutica*. A, LVi (MZUSP 40445); B, RVi (MZUSP 40445); C, CpL1 (MZUSP 40446); D, CpD (MZUSP 40447); E, CpV (MZUSP 40448). Scale bars, 500  $\mu$ m.

T3 (Fig. 35A—chaetotaxy not completely shown) with three segments. First segment with three long setae (d1, d2, dp). Second segment, longer than wide, with one subapical seta (e). Third segment, also longer than wide, with one lateral, hirsute seta (f); distal part of the third segment fused with fourth segment into a modified pincer, with one apical comb-like seta (h2), one small recurved seta, with 1/5 of the length of the comb-like seta, and one longer and distally hirsute seta (h3). Small tooth-like structures present at the base of the comb-like seta (arrowed in Figure 35A).

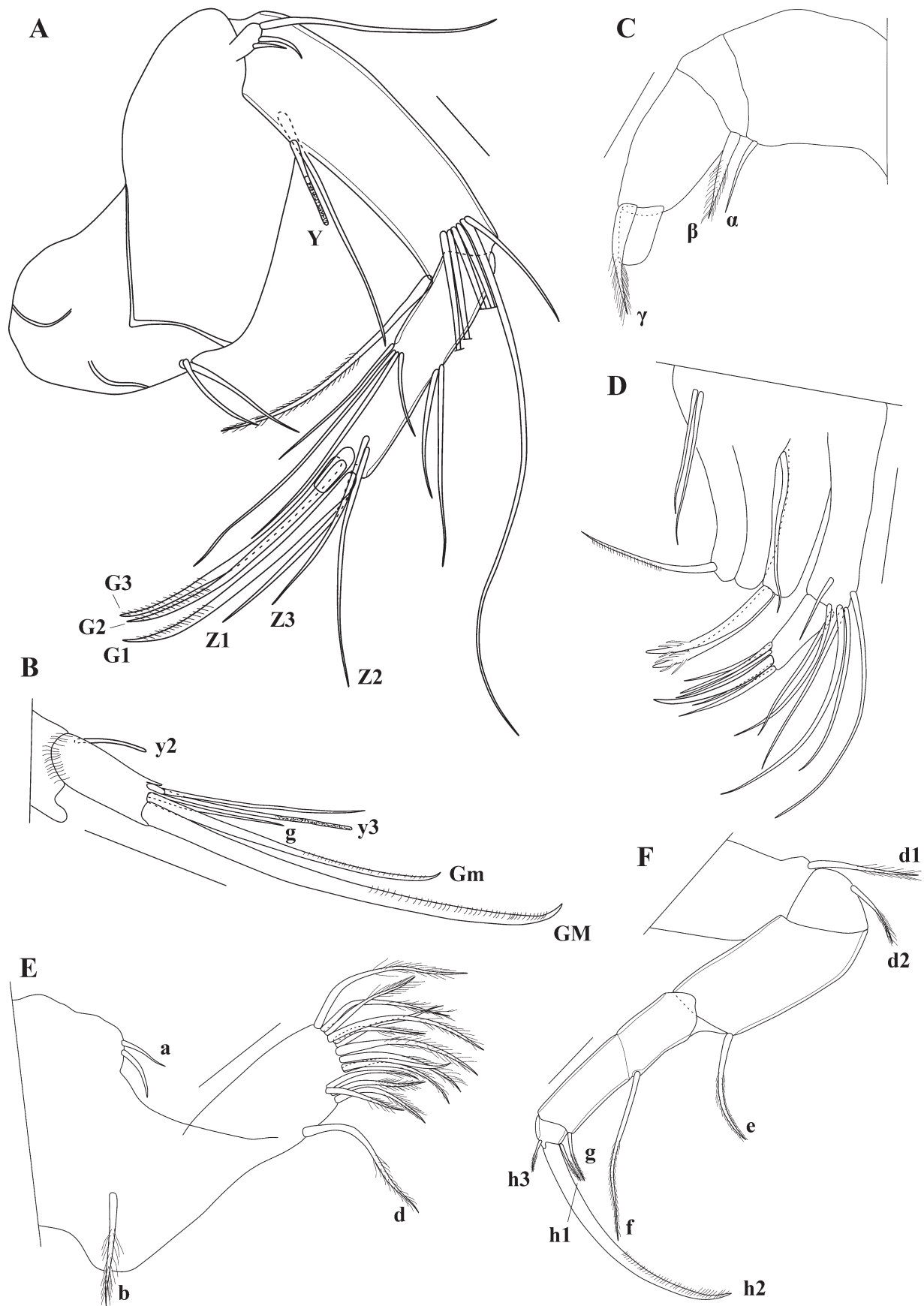
CR (Fig. 35B) stout and straight, with ventral margin serrated. Proximal claw 2/3 of the length of distal claw. Proximal seta hirsute, ca. 1/4 of length of distal seta.

CR attachment (Fig. 35C) stout, with Triebel's loop oval-triangular, situated in the main branch; vb long and weakly curved; db atypically long and curved.

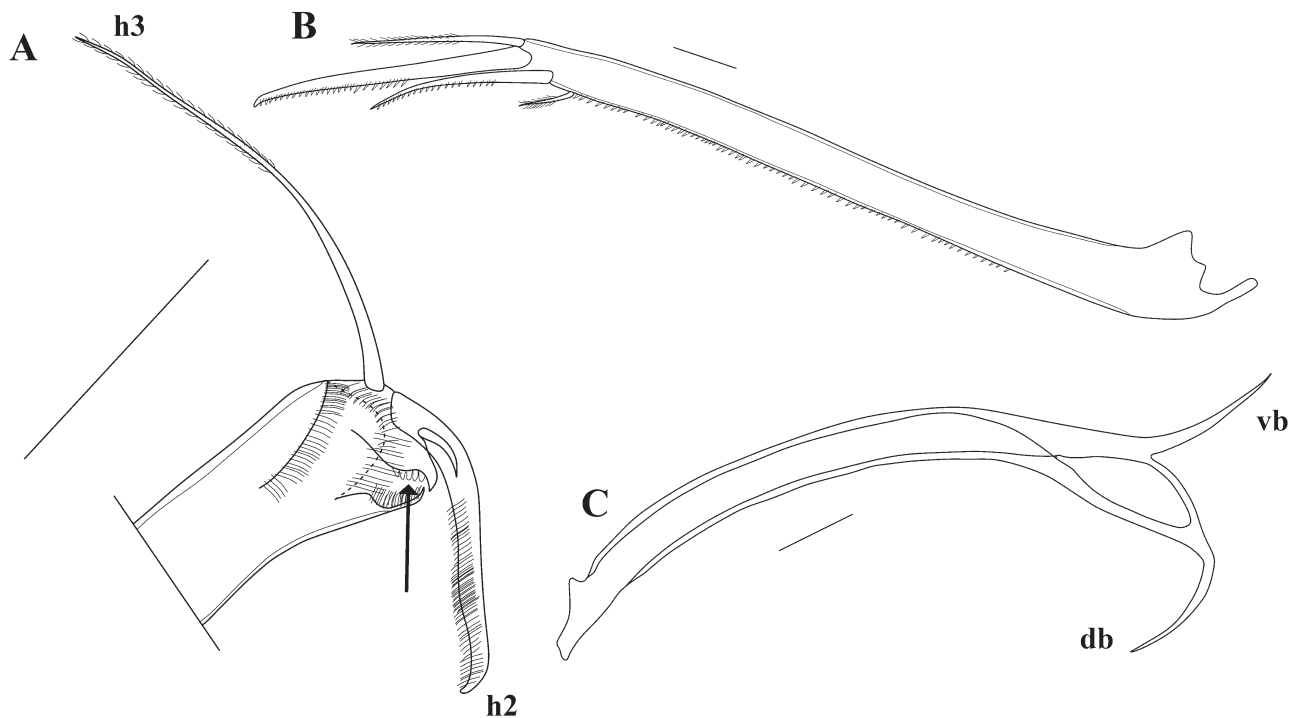
Male unknown.

#### *Differential diagnosis*

*Strandesia mutica* is similar to *Strandesia variegata*, but it is more elongated and less high than *S. variegata*. Also, the RVi in *S. mutica* has an anterior inwardly displaced selvage and a postero-dorsal flange which are missing in *S. variegata*. In dorsal view, *S. mutica* has a sub-rectangular shape, whereas *S. variegata* has a subovate shape and broader posterior region. Still in dorsal view, there are no anterior or posterior overlaps in *S. variegata*, while in *S. mutica* the LV overlaps the RV anteriorly, while the RV overlaps the LV posteriorly.



**FIGURE 34** *Strandesia mutica*. A, A2 except last segment (MZUSP 40444); B, A2 last segment (MZUSP 40444); C, Md palp showing  $\alpha$ ,  $\beta$ ,  $\gamma$  setae (MZUSP 40444); D, Mx1 (MZUSP 40444); E, T1 (MZUSP 40444); F, T2 (MZUSP 40444). Scale bars, 50  $\mu$ m.



**FIGURE 35** *Strandesia mutica*. A, T3 pincer (MZUSP 40444); B, CR (MZUSP 40444); C, CR attachment (MZUSP 40444). Scale bars, 50  $\mu\text{m}$ .

#### *Ecology and distribution*

*Strandesia mutica* was recorded only from lentic environments, and was found associated with a variety of macrophytes, with different life forms, in the Amazon and Paraná floodplains. This species occurred in acidic to basic environments, with pH range of 4.2–8.3. Electrical conductivity and dissolved oxygen ranges were 11–123.8  $\mu\text{S}\cdot\text{cm}^{-1}$  and 0.1–9.8  $\text{mg}\cdot\text{L}^{-1}$ , respectively (see Table 1). Distribution: Brazil, Paraguay and West Indies.

#### *The Strandesia psittacea group*

The *Strandesia psittacea* group is composed of two species, *Strandesia psittacea* and *Strandesia colombiensis* nov. comb. Both species are characterized by an anterior beak-like projection, a posterior spine on the RV and also by a carapace densely set with setae. They also share a similar body length of ca. 1,500 $\mu\text{m}$ .

#### **12. *Strandesia psittacea* (Sars, 1901) Roessler 1990**

(Figs. 36–38)

1901 *Cypris psittacea* n. sp.—Sars: 24, Plate V, Figs. 13–15.

1990b *Strandesia psittacea* (Sars, 1901)—Roessler: 216, Figs. 1–4.

1990b *Strandesia trichosa* n.sp.—Roessler: 221, Fig. 1c, f, k, Fig. 2g, h, i, Figs. 5, 6 **nov. syn.** (see below ‘remarks’).

#### *Type locality and material*

São Paulo and Ipiranga, Brazil. This species was described based on specimens hatched from dried mud by Sars (1901) from these two locations. Repository of type material unknown (Karanovic 2012).



### *Material examined*

One female (MZUSP 40449) used for soft part illustrations and five females (MZUSP 40450, MZUSP 40451–MZUSP 40454) used for SEM, all from Gavião Lake (22°40'48.6"S, 53°12'58.6"W). All illustrated specimens are from the Paraná River floodplain.

### *Measurements of illustrated specimens (in mm)*

L (n=3): 1.478–1.543, H (n=2): 0.803–0.838, W (n=2): 0.717–0.785.

### *Diagnosis*

Cp elongated, dorsal region smoothly curved; with greatest height situated in front of the middle. RV with an antero-ventral, bluntly pointed beak-like projection; postero-ventrally with one to two spines; with a widely inwardly displaced anterior selvage, not running parallel to the valve margin. Both valves with calcified inner lamella wide along anterior margin, narrow along ventral and posterior margins. LV with inner groove along ventral margin. A2 with natatory setae reaching 3/4 of the length of of apical claws. CR ventrally weakly serrated; its attachment with a triangular Triebel's loop, situated in the main branch.

### *Abbreviated redescription of female*

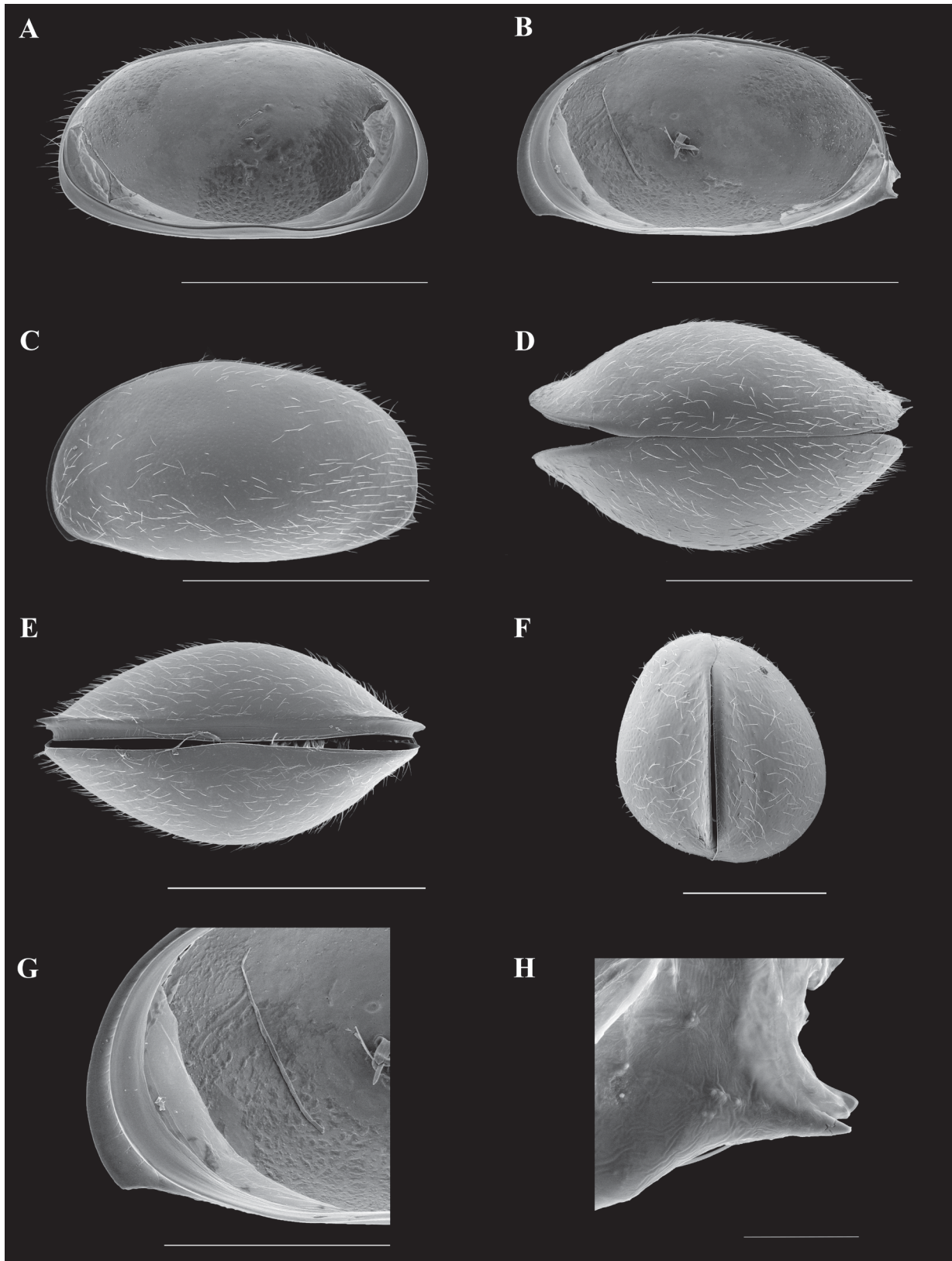
LVi (Fig. 36A) elongated, with calcified inner lamella wide along anterior margin, narrow along ventral and posterior margins; internal groove along ventral margin; greatest height situated well in front of the middle.

RVi (Fig. 36B, 36G) elongated, with calcified inner lamella as in LVi; antero-ventrally with a bluntly pointed beak (Fig. 36G) and posteriorly with one spine (Fig. 36H—slightly broken in this view); anteriorly with a widely inwardly displaced selvage, not running parallel to the valve margin; reatest height situated well in front of the middle.

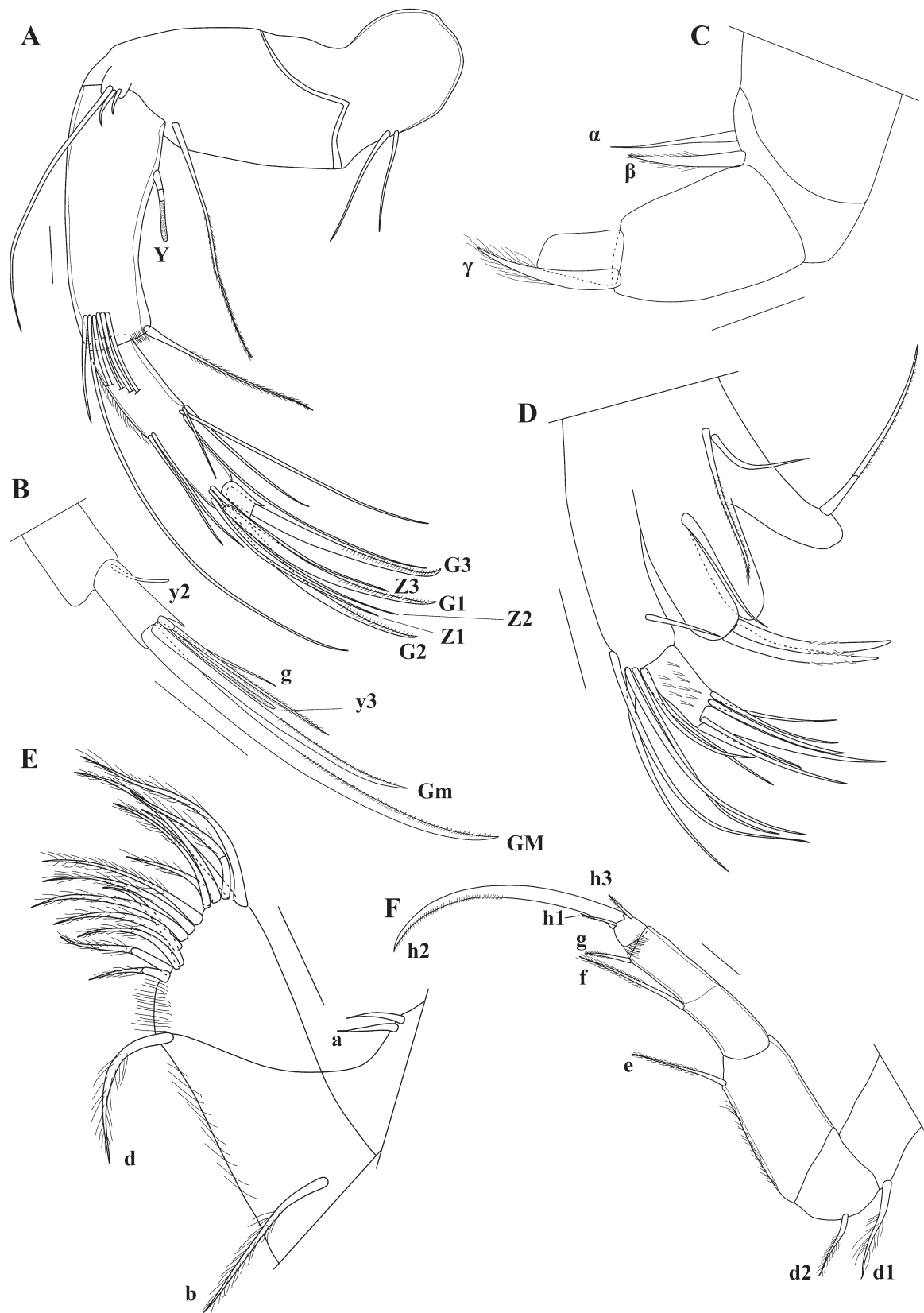
CpLI (Fig. 36C) with dorsal region smoothly curved; with greatest height situated in front of the middle; external valve surface densely set with setae; antero-ventrally with a bluntly-pointed beak and postero-ventrally with one spine. CpD (Fig. 36D) and CpV (36E) views subovate; greatest width situated in the middle, anteriorly with a pointed rostrum, posterior margin more evenly rounded. CpFr (36F) slightly oblique, with LV being the lower valve.

A1 (not illustrated) with seven segments. First segment with one short subapical seta and two long apical setae. Second segment wider than long, with one short dorsal seta and a small ventral RO. Third segment with two setae (the smaller one with the length of the fourth segment). Fourth segment with two short and two long setae. Fifth segment with three long and one short setae. Sixth segment with four long setae. Seventh segment with one short and two long setae, and one aesthetasc ya slightly longer than the short seta.

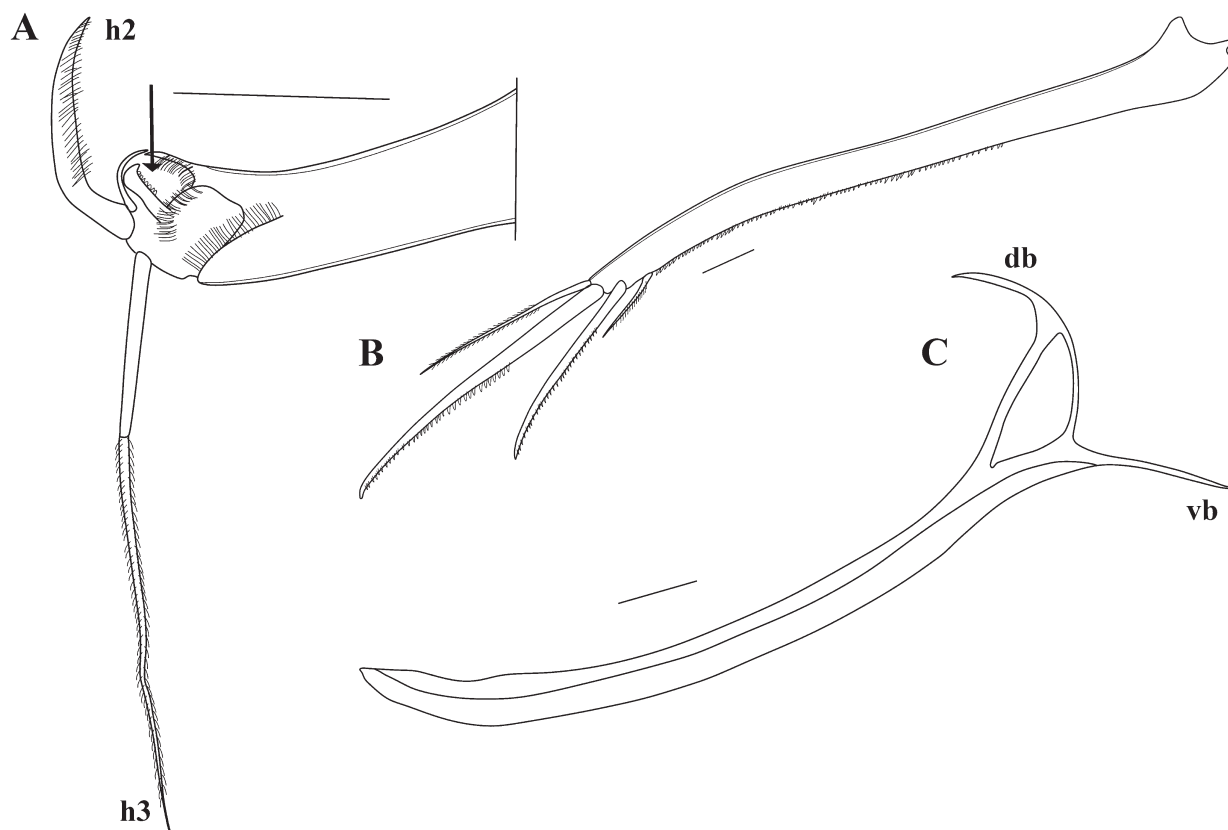
A2 (Fig. 37A-B) with protopodite, exopodite and three-segmented endopodite. Protopodite with two ventral setae, and one long ventro-distal seta, the latter reaching just beyond tip of first endopodal segment. Exopodite reduced to a small plate, with one long and two unequal short setae. First endopodal segment with one ventral aesthetasc Y, one long apical seta (reaching the tip of the second endopodal segment), and a group of five long and one short swimming setae (the five long setae just reaching 3/4 of the length of the apical claws; the short one almost reaching the middle of third segment). Second endopodal segment undivided, with two unequal dorsal setae and a group of four ventral t setae; apically with three claws (G1, G2, and G3 equally long), three setae (z1 and z3 slightly shorter than z2, and z2 almost reaching the tip of G2) and a short apical aesthetasc y2 (Fig. 37B). Terminal segment (Fig. 37B) with two claws (one long, GM; one short, Gm), an aesthetasc y3 with an accompanying seta (seta longer than aesthetasc), fused over a short distance only, and a fine g-seta, the latter shorter than aesthetasc y3 and its accompanying seta.



**FIGURE 36** Carapace and valves of *Strandesia psittacea*. A, LVi (MZUSP 40450); B, RVi (MZUSP 40450); C, CpL1 (MZUSP 40453); D, CpD (MZUSP 40451); E, CpV (MZUSP 40452); F, CpFr (MZUSP 40454); G, RVi detail of anterior margin (MZUSP 40450); H, RVi detail of spine (broken) (MZUSP 40450). Scale bars, A-E, 1,000  $\mu\text{m}$ ; F-G, 500  $\mu\text{m}$ ; H, 50  $\mu\text{m}$ .



**FIGURE 37** *Strandesia psittacea*. A, A2 except last segment (MZUSP 40450); B, A2 last segment (MZUSP 40450); C, Md palp showing  $\alpha$ ,  $\beta$ ,  $\gamma$  setae (MZUSP 40449); D, Mx1 (MZUSP 40449); E, T1 (MZUSP 40449); F, T2 (MZUSP 40449). Scale bars, 50  $\mu$ m.



**FIGURE 38** *Strandesia psittacea*. A, T3 pincer (MZUSP 40450); B, CR (MZUSP 40449); C, CR attachment (MZUSP 40449). Scale bars, 50  $\mu$ m.

First segment of Md palp (Fig. 37C—chaetotaxy not completely shown) with long (reaching beyond tip of  $\beta$ -seta) and smooth  $\alpha$ -seta. Second segment ventrally with long (slightly longer than  $\alpha$ -seta), stout and hirsute  $\beta$ -seta. Penultimate segment laterally with cone-shaped, stout and distally hirsute  $\gamma$ -seta. Terminal segment ca. 1.5x as long as basal width, tapering. Md coxa (not illustrated) as typical of the family, elongated with an apical row of strong teeth of variable size, interspaced with some small setae.

Mx1 (Fig. 37D—chaetotaxy not completely shown) with three masticatory lobes, a two-segmented palp and a large respiratory plate (the latter not illustrated). Basal segment of palp with six long apical setae and one short subapical seta. Terminal palp segment ca. twice as long as basal width, slightly curved and tapering, apically with three claws and three setae. Third endite with two large, distally serrated bristles. Lateral seta on third endite, reaching beyond the end of the endite. First endite with one sideways-directed bristle only and two long, unequal basal setae.

T1 protopodite (Fig. 37E) with two short  $a$ -setae;  $b$ -seta and  $d$ -seta equally hirsute, with  $d$ -seta slightly shorter than  $b$ -seta. Apically with 10 hirsute setae, subapically with a group of four such setae. Endopodite with three unequal long hirsute apical setae (not illustrated).

T2 (Fig. 37F) protopodite with seta  $d1$  relatively long and seta  $d2$  shorter, ca. 2/3 of the length of  $d1$ . First endopodal segment with one subapical hirsute seta ( $e$ ). Second endopodal segment medially divided into  $a$ - and  $b$ -segments; segment “ $a$ ” with one long apical hirsute seta ( $f$ ); segment “ $b$ ” with one shorter seta ( $g$ ) reaching beyond the terminal segment. Third endopodal segment with one apical claw ( $h2$ ) and two setae (one ventro-apical ( $h1$ ) with 1/7 the length of  $h2$ , and one dorso-apical ( $h3$ ) slightly shorter than  $h1$ ).

T3 (Fig. 38A—chaetotaxy not completely shown) with three segments. First segment with three long setae ( $d1$ ,  $d2$ ,  $dp$ ). Second segment, longer than wide, with one subapical seta ( $e$ ). Third segment, also longer than wide, with one lateral, hirsute seta ( $f$ ); distal part of the third segment fused with fourth segment into a modified pincer, with one apical comb-like seta ( $h2$ ), one small recurved seta, with 1/3 of the length of the comb-like seta, and one longer and distally hirsute seta ( $h3$ ). Small tooth-like structures present near the base of the comb-like seta (arrowed in Figure 38A).

CR (Fig. 38B) slender and curved, with ventral margin serrated. Proximal claw 3/4 of the length of distal claw. Proximal seta hirsute, ca. 2/5 of length of distal seta.

CR attachment (Fig. 38C) stout, with Triebel's loop triangular, situated in the main branch; vb long and straight; db short and curved.

Male unknown.

#### *Remarks*

*Strandesia trichosa* Roessler, 1990, a Colombian species, resembles *Strandesia psittacea* (Sars, 1901) in the general shape, the presence of a postero-ventral spine and an antero-ventral bluntly rounded beak on the RV. The size is also quite similar, L: 1.540 µm, H: 800 µm, W: 785 µm for *S. psittacea*, and, L: 1.530 µm, H: 804 µm, W: 840 µm for *S. trichosa*. Roessler (1990b) considered the difference between these two species was based on the caudal ramus, more specifically in the curves of the claws. Here, comparing the morphology of the Brazilian specimens to the description of Roessler (1990b), we do not agree with this decision and thus consider *Strandesia trichosa* (Roessler, 1990) a junior synonym of *Strandesia psittacea* (Sars, 1901).

#### *Differential diagnosis*

*Strandesia psittacea* is similar to *Strandesia colombiensis* (see below), but the valves are less high. Both species are well defined by the hirsute external valve surfaces, the bluntly pointed antero-ventral beak and the postero-ventral spine.

#### *Ecology and distribution*

*Strandesia psittacea* was recorded from lentic and lotic environments, associated with a variety of macrophytes with different life forms, in the Amazon, Araguaia and Paraná floodplains. This species occurred in acidic to basic environments, with a pH range of, 4.7–9.7. Electrical conductivity and dissolved oxygen ranges were 12–80.4 µS.cm<sup>-1</sup> and 0.2–8.2 mg. L<sup>-1</sup>, respectively (see Table 1). Distribution: Brazil and Colombia.

### **13. *Strandesia colombiensis* Roessler, 1990 change of rank**

(Figs. 39–41)

1990b *Strandesia psittacea colombiensis* n. subsp.—Roessler: 216, Fig. 1b, g, j, Fig. 2d, e, f, Figs. 3–4.

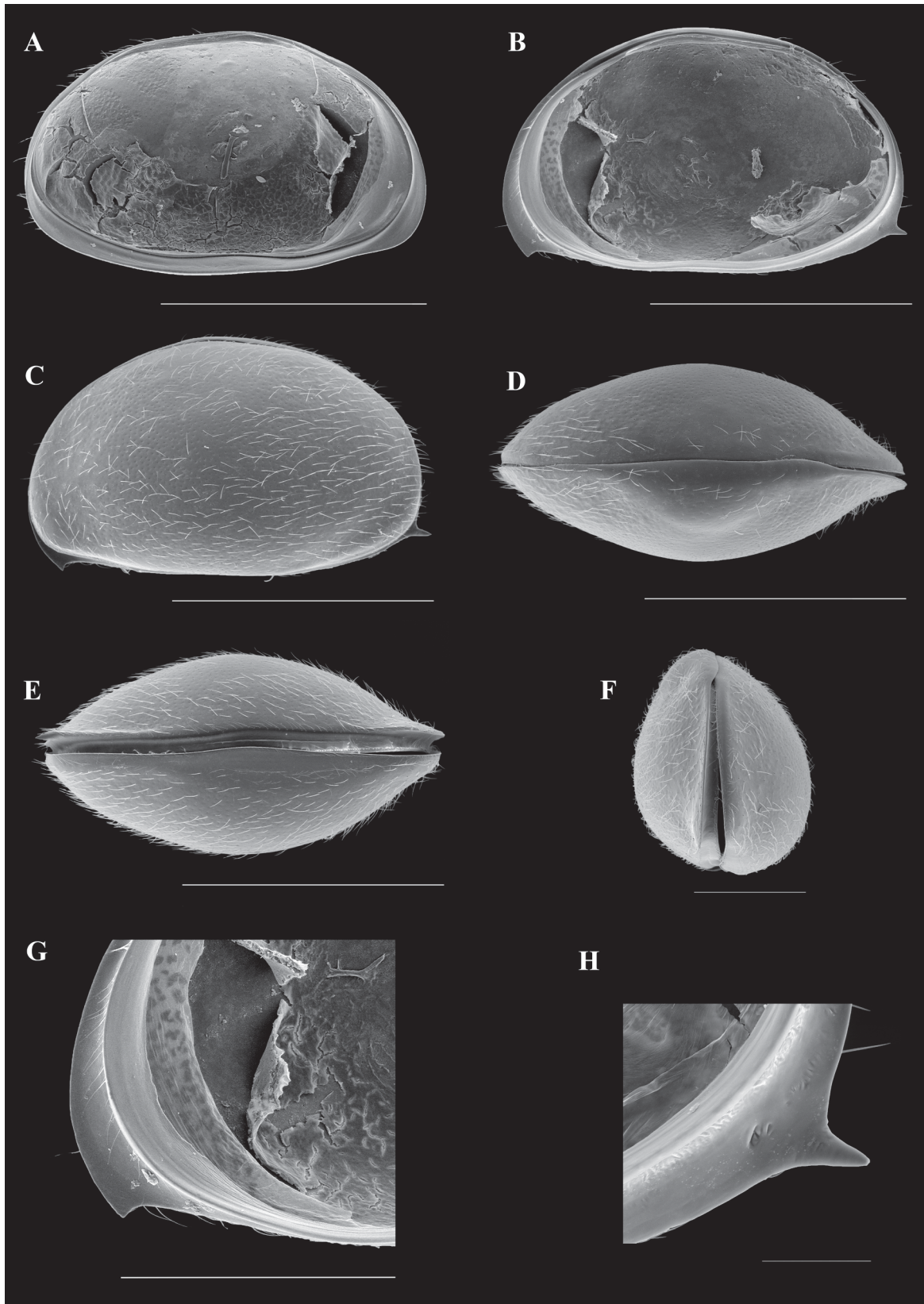
#### *Type locality and material*

Villavicencio (4°4'N-73°39'W), Meta department, Colombia. This species was described from temporary pools and lagoons by Roessler (1990b). Type material (holotype and paratypes) is stored in the Natural Sciences Institute of National University of Colombia, n°: ICN-MHN-CR-1157 and ICN-MHN-CR 1158,1159, respectively (Roessler, 1990b).

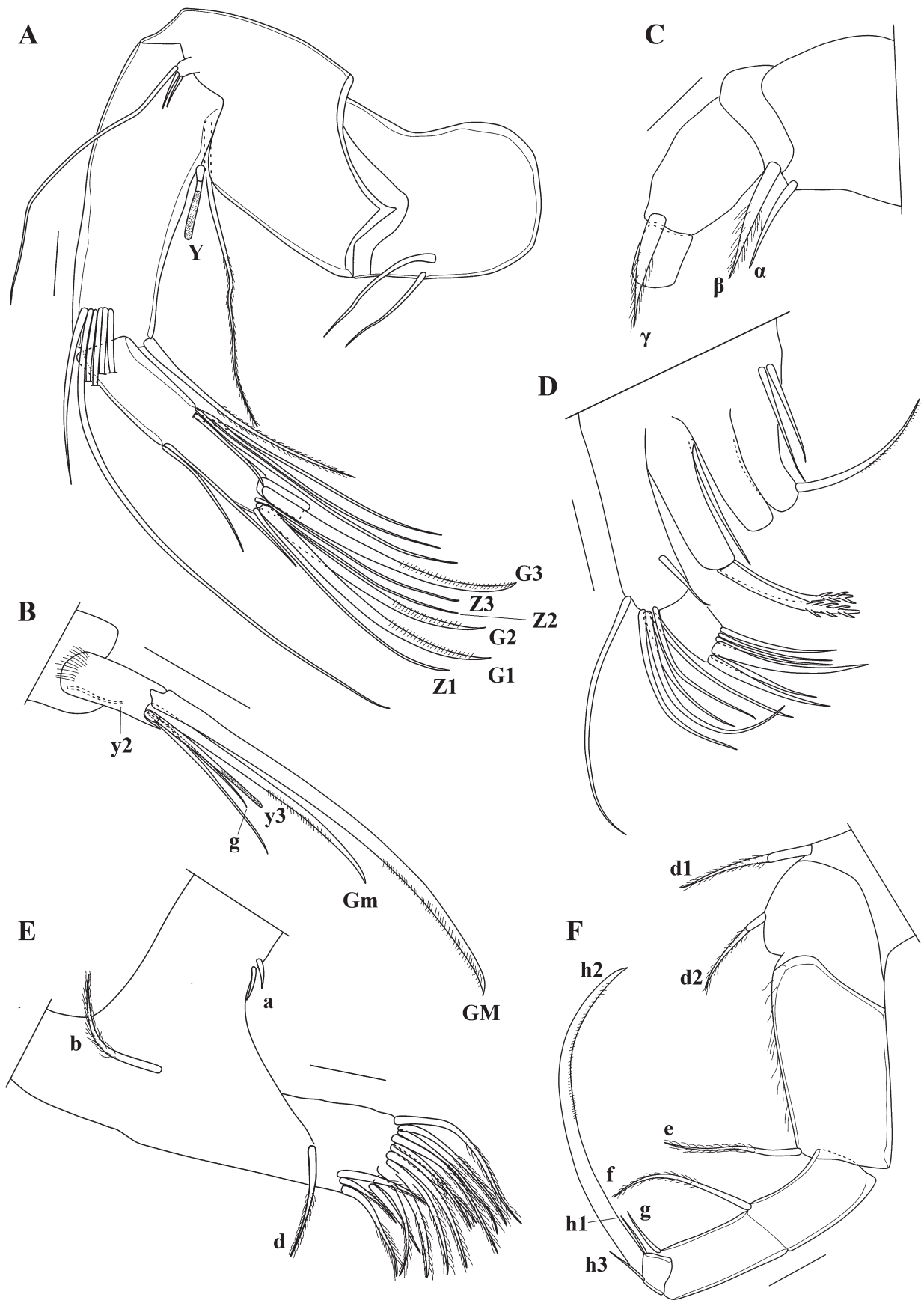
#### *Material examined*

One female (MZUSP 40455) used for soft part illustrations and five females (MZUSP 40456, MZUSP 40457-MZUSP 40460) used for SEM from Gavião Lake (22°40'48.6"S, 53°12'58.6"W). All illustrated specimens are from the Paraná River floodplain.

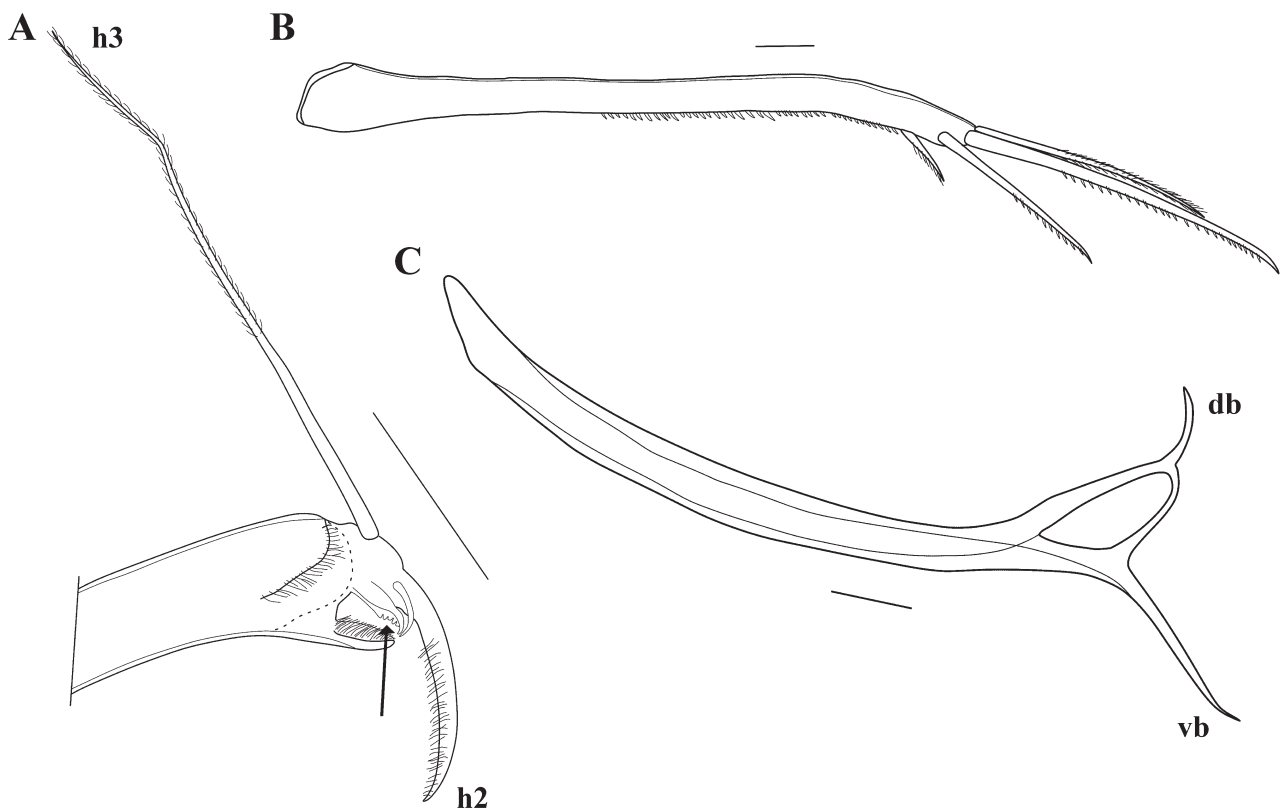




**FIGURE 39** Carapace and valves of *Strandesia colombiensis*. A, LVi (MZUSP 40456); B, RVi (MZUSP 40456); C, CpLl (MZUSP 40460); D, CpD (MZUSP 40457); E, CpV (MZUSP 40458); F, CpFr (MZUSP 40459); G, RVi detail of anterior margin (MZUSP 40456); H, RVi detail of spine (MZUSP 40456). Scale bars, A-E, 1.000  $\mu$ m; F-G, 500  $\mu$ m; H, 100  $\mu$ m.



**FIGURE 40** *Strandesia colombiensis*. A, A2 except last segment (MZUSP 40455); B, A2 last segment (MZUSP 40455); C, Md palp showing  $\alpha$ ,  $\beta$ ,  $\gamma$  setae (MZUSP 40455); D, Mx1 (MZUSP 40455); E, T1 (MZUSP 40455); F, T2 (MZUSP 40455). Scale bars, 50  $\mu\text{m}$ .



**FIGURE 41** *Strandesia colombiensis*. A, T3 pincer (MZUSP 40455); B, CR (MZUSP 40455); C, CR attachment (MZUSP 40455). Scale bars, 50 µm.

*Measurements of illustrated specimens (in mm)*

L (n=3): 1.530–1.568, H (n=2): 0.916–0.1016, W (n=3): 0.758–0.792.

*Diagnosis*

Cp subovate, with greatest height situated in front of the middle. RV with an antero-ventral pointed beak and one posteroventral spine; with calcified inner lamella wide along anterior margin, narrow along ventral and posterior margins; anterior selvage inwardly displaced and not running parallel to valve margin. LV with calcified inner lamella as in RV, and with internal groove along ventral margin. A2 with natatory setae almost reaching the tips of apical claws. CR with ventral margin strongly serrated, its attachment with a Triebel's loop oval-triangular, situated in the main branch.

*Abbreviated redescription of female*

LVi (Fig. 39A) with greatest height situated in front of the middle; dorsal margin evenly rounded; calcified inner lamella wide long anterior margin, narrow along ventral and posterior margins; internal groove along ventral margin.

RVi (Fig. 39B, G, H) greatest height situated in front of the middle; with dorsal margin evenly rounded; calcified inner lamella as in the LVi; with an antero-ventral pointed beak (Fig. 39G) and a posteroventral spine (Fig. 39H); anterior selvage inwardly displaced, not running parallel to valve margin.

CpL1 (Fig. 39C) with dorsal margin curved; greatest height situated in front of the middle; external valve surface densely set with setae; with antero-ventral beak and one postero-ventral spine. CpD (Fig. 39D) and CpV (Fig. 39E) subovate; anteriorly with a skewed rostrum and posteriorly obtusely rounded. CpFr (Fig. 39F) subtriangular and oblique with LV being the lower valve.

A1 (not illustrated) with seven segments. First segment with one short subapical seta and two long apical setae; WO not seen. Second segment wider than long, with one short dorsal seta and a small ventral RO. Third segment with two setae (the smaller with the length of the fourth segment). Fourth segment with two short and two long setae. Fifth segment with three long and one short setae. Sixth segment with four long setae. Seventh segment with one short and two long setae, and one aesthetasc ya slightly longer than the short seta.

A2 (Fig. 40A, B) with protopodite, exopodite and three-segmented endopodite. Protopodite with two ventral setae; and one long ventro-distal seta, the latter reaching beyond the tip of the first endopodal segment. Exopodite reduced to a small plate, with one long and two unequal short setae. First endopodal segment with one ventral aesthetasc Y, one long apical seta (reaching beyond the tip of the last endopodal segment), one group of five long and one short swimming setae (the five long setae almost reaching the tips of apical claws; the short one reaching the middle of second endopodal segment). Second endopodal segment undivided, with two unequal dorsal setae and a group of four unequal, long ventral t setae; apically with three claws (G1 and G3 equally long, G2 slightly shorter than G1), three setae (z1 longest, z2 and z3 slightly shorter than z1) and a short apical aesthetasc y2 (Fig. 40B). Terminal segment (Fig. 40B) with two claws (one long, GM; one short, Gm), an aesthetasc y3 with an accompanying seta (seta longer than aesthetasc), fused over a short distance only, and a fine g-seta, the latter shorter than aesthetasc y3 and its accompanying seta.

First segment of Md palp (Fig. 40C—chaetotaxy not completely shown) with short (not reaching beyond tip of  $\beta$ -seta) and smooth  $\alpha$ -seta. Second segment ventrally with long (longer than  $\alpha$ -seta) stout and hirsute  $\beta$ -seta, slightly longer than  $\alpha$ -seta. Penultimate segment laterally with stout, cone-shaped, hirsute  $\gamma$ -seta. Terminal segment rectangular, almost 1.5x as long as basal width. Md coxa (not illustrated) as typical of the family, elongated with an apical row of strong teeth of variable size, interspaced with some small setae.

Mx1 (Fig. 40D—chaetotaxy not completely shown) with three masticatory lobes, a two-segmented palp and a large respiratory plate (the latter not illustrated). Basal segment of palp with six long apical setae, and one short subapical seta. Terminal palp segment ca. 1.5x as long as basal width, slightly curved, apically with three claws and three setae. Third endite with two large, distally serrated bristles. Lateral seta on third endite reaching beyond the tip of this endite. First endite with one sideways-directed bristle only, and two long, unequal basal setae.

T1 protopodite (Fig. 40E) with two short a-setae, b and d-seta equally long; both hirsute. Apically with 10 hirsute setae, subapically with a group of four such setae. Endopodite with three unequal long hirsute apical setae (not illustrated).

T2 (Fig. 40F) protopodite with seta d1 relatively long and seta d2 shorter, ca. 3/4 of the length of d1. First endopodal segment with one subapical hirsute seta (e). Second endopodal segment medially divided into a- and b-segments; segment “a” with one long apical hirsute seta (f); segment “b” with one shorter seta (g) reaching beyond the terminal segment. Third endopodal segment with one apical claw (h2) and two setae (one ventro-apical (h1) with 1/7 the length of h2 and one dorso-apical (h3) slightly longer than h3).

T3 (Fig. 41A—chaetotaxy not completely shown) with three segments. First segment with three long setae (d1, d2, dp). Second segment, longer than wide, with one subapical seta (e). Third segment, also longer than wide, with one lateral, hirsute seta (f); distal part of the third segment fused with fourth segment into a modified pincer, with one apical comb-like seta (h2), one small recurved seta, with 1/5 of the length of the comb-like seta, and one longer and distally hirsute seta (h3). Small tooth-like structures present at the base of the comb-like seta (arrowed in Figure 41A).

CR (Fig. 41B) slender and curved, with ventral margin strongly serrated. Proximal claw 2/3 of the length of distal claw. Proximal seta hirsute, ca. 1/4 of distal seta.

CR attachment (Fig. 41C) stout, with Triebel's loop oval-triangular, situated in the main branch; vb long and straight; db short and weakly curved.

Male unknown.

### Remarks

This is the first record of *Strandesia psittacea colombiensis* in Brazil. This subspecies was described by Roessler (1990b) from temporary pools and lakes near the city of Villavicencio in Colombia. The similarity of this species with *Strandesia psittacea* (Sars, 1901) was discussed by Roessler (1990b), who then described it as a new subspecies. However, there are significant, and especially consistent, differences in the ratio of L/H of the carapace (*S. psittacea*, 1.84–1.84; *S. psittacea colombiensis*, 1.54–1.67); the more curved dorsal region on *S. psittacea colombi-*



*ensis*; and the differences in frontal view of the carapace, with *S. psittacea* with a rounded shape, whereas *S. psittacea colombiensis* has a subtriangular shape. Also, the antero-ventral beak is more rounded in *S. psittacea* and more pointed in *S. colombiensis*. These morphological differences support the decision to raise *S. psittacea colombiensis* to the rank of species, with the name of *Strandesia colombiensis*.

Roessler (1990a) described *Strandesia psittacea colombiensis*, while Roessler (1990b) described *S. obtusata colombiensis*. Following the ICZN, names of species and subspecies have the same nomenclatorial rank. Therefore, *S. obtusata colombiensis* is a junior homonym of *S. psittacea colombiensis*. Martens & Behen (1994) therefore renamed the junior name as *Strandesia obtusata roessleri*. By here raising the rank of *S. psittacea colombiensis* to species-level, the name *S. colombiensis* is thus available and can be used.

#### *Differential diagnosis*

*Strandesia colombiensis* is similar to *Strandesia psittacea*, but it can be distinguished by the higher valves, the more curved dorsal margin, and the more pointed antero-ventral beak. In frontal view, *S. colombiensis* has a subtriangular shape, whereas *S. psittacea* is rounded.

#### *Ecology and distribution*

*Strandesia colombiensis* was recorded only from lentic environments, associated with a variety of macrophytes, with different life forms, in the Amazon and Paraná floodplains. This species occurred in acidic to basic environments, with a pH range of 4.2–9.7. Electrical conductivity and dissolved oxygen ranges were 11–63  $\mu\text{S}\cdot\text{cm}^{-1}$  and 0.4–6.1  $\text{mg}\cdot\text{L}^{-1}$ , respectively (see Table 1). Distribution: Brazil and Colombia.

## **Discussion**

The present paper is a contribution towards a revision of the genus *Strandesia* in Brazil. Here, we follow the definition of the genus *Strandesia* as revised by Savatentalinton & Martens (2009a, b). This means that the suggestion by Broodbakker (1983) to retain the subgenera *Neocypris* Sars, 1901 and *Acanthocypris* Claus, 1892 within *Strandesia* is not followed here.

With the present descriptions of three new species of *Strandesia*, the number of Brazilian *Strandesia* species increases from 17 to 20 species. However, for several of the seven species not discussed here, either their generic assignment or even their status as valid species remains uncertain. This is especially true for the species described by Tressler (1950), which will be discussed elsewhere.

The *S. bicuspis*-group received two new species. Both are rare: *Strandesia thomazi* nov. sp. was found in only two lakes and *Strandesia galeati* nov. sp. in only one lake in the Araguaia floodplain. These species belong to the group of species in *Strandesia* with a dorsal protuberance or helmet-like expansion, for which Klie (1930) suggested to use the generic name *Acanthocypris*. Klie (1938) placed six species in that genus. However, as Broodbakker (1983) correctly pointed out, the presence of such a structure in a species does not automatically mean that this species belongs to the same monophyletic lineage as other species with dorsal protuberance. In fact, the profound difference in morphology of the dorsal protuberance in different *Strandesia* species is already an indication that the structure might be the result of convergent evolution in different lineages with the genus. The grouping of the three species with dorsal protuberance in the present paper is thus purely for convenience, and has no taxonomic meaning.

*Strandesia obtusata* was first described by Sars (1901) from specimens that he raised from dried mud collected from Itatiba (near São Paulo). The shape of the carapace in lateral and dorsal views (Sars 1901: plate VIII figs. 1 & 2) is almost identical to that of our specimens, but there is a difference in size: Sars's (female) specimens are said to have a length of 1200  $\mu\text{m}$ , while our female specimens are between 949 and 994  $\mu\text{m}$  long, i.e. less than 1000  $\mu\text{m}$ . Nevertheless, we are confident that we are dealing with the same species, which moreover appears to have a wide distribution: between our new localities in the Araguaia floodplain and the type locality near São Paulo, the distance is c. 1400 km.



Broodbakker (1983) already provided a partial redescription of the species based on the type material of Sars (1901) and rejected identifications of *S. obtusata* from Java by Tressler (1937) (see also Victor & Fernando 1981) and from Yucatan by Furtos (1936). In both cases, the species lacked the characteristic dorso-caudal expansion on the right valve. It would thus appear that, to date, *S. obtusata* remains endemic to the Neotropical region. Roessler (1990a) extensively described a new subspecies, *Strandesia obtusata colombiensis* Roessler, 1990 from temporary habitats near Juan de Arama in Colombia. However, Roessler (1990b) had already described the subspecies *Strandesia psittacea colombiensis* Roessler, 1990 and as species and subspecies within a genus have the same nomenclatorial rank following the ICZN, Martens & Behen (1994) gave a new name for this subspecies: *Strandesia obtusata roessleri* Martens & Behen, 1994 (see remark above). There are clear morphological differences between the carapaces of this subspecies and of *S. obtusata obtusata*, so that the delimitation of a (probably geographical) subspecies in Colombia seems justified. In fact, the Colombian populations might even belong to a separate species.

Sexual populations of *Strandesia*-species are rare. It is the first time that sexual populations of *S. obtusata obtusata* have been found and we here provide the first description of the male. The hemipenis has the same basic structure as in *S. mercatorum* (see re-description in Savatnalinton & Martens 2009a), the type species of the genus, also in the inner structure where both species display one additional loop in the postlabyrinthal spermiduct. In both species, the distal segment in the right prehensile palp is much larger than in the left prehensile palp, while the exact shapes of these segments are of course species-specific. Sexual populations of this species were recorded in four lakes, whereas asexual population occurred in three lakes from the Araguaia River floodplain. Furthermore, among 380 specimens checked, there were 58 males, i.e. ca. 15% of the overall population. We can at this stage not see any aspects of water chemistry, size or position of the lakes that might cause the population of this species to be sexual or asexual. We can thus not be sure if we are dealing here with ecological or geographical parthenogenesis (for a review of the latter, see Martens 1998; Horne & Martens 1999).

The appendage morphology of *Strandesia* species is very conservative, with only few differences detected. On the other side, the carapace shape shows a great variety among species. The fact that the soft parts are completely encompassed by the valves should limit the variation, as the contact of the limbs with the environment is reduced by this (Martens *et al.* 1998a).

The 13 *Strandesia* species (re-) described here were recorded in association with 25 macrophytes species and with sediments of the littoral from open and closed lakes, rivers, channels and backwaters. *Strandesia lansactohai*, *S. velhoi* and *S. tolimensis* were the most common species. All three species were recorded in four floodplains, associated with a variety of macrophytes of different life forms. In contrast, *S. bicuspis*, *Strandesia thomazi* nov. sp., *Strandesia galeati* nov. sp. and *Strandesia nakatanii* nov. sp. were found in only one floodplain each. No species showed significant ecological preferences regarding macrophyte life form. With the exception of *S. bicuspis*, which occurs in the Neotropics and Palaearctic (in the latter region as an introduced species in containers in a greenhouse of the Munich Botanical Garden by non-native plants (Matzke-Karasz *et al.* 2012)), all species discussed here appear to be endemic to the Neotropical region.

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