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A revision of the genus *Disparalona* (Cladocera, Chydorinae) in South America

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Abstract. The genus *Disparalona* Fryer, 1968 comprises a well-defined species complex, the *hamata*-group, which might have sibling species in South America. This *hamata*-group needs urgent revision. Besides that, a complete morphological evaluation of the endemic species *D. leptorhyncha* (Daday, 1905) is lacking. Thus, the aim of the present study is to revise populations of species of the *hamata*-group in South America and to redescribe *D. leptorhyncha*. Our findings pointed to an occurrence of species which are part of the *Disparalona (Mixopleuroxus)* linage. Currently, the Neotropics have the highest diversity to the genus, with three species of the *hamata*-complex – *D. (M.) hamata* (Birge, 1879), *D. (M.) lucianae* sp. nov., *D. (M.) tenuispina* sp. nov. – in addition to *D. (M.) leptorhyncha*. These species can be differentiated from each other by the morphology of their rostrum, labrum, and postabdomen.

Keywords. *Disparalona hamata*, hyporheic, labral keel, *Mixopleuroxus*, morphology.

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Introduction

Currently, *Disparalona* Fryer, 1968 is a well accepted genus among cladocerologists, but it has been largely debated in the past. Before Fryer (1968) introduced the name *Disparalona* to the scientific community, *D. rostrata* (Koch, 1841) had been considered a member of *Pleuroxus* Baird, 1843, *Lynceus* Müller, 1776, *Alonella* Sars, 1862, *Phrixura* (*nomina nuda*), *Rhynchotalona* Norman, 1903, and even *Alona* Baird, 1843 (Fryer 1997). This is perhaps because three important *Disparalona* aspects were long considered as 'vacant niches' in taxonomical studies. First, a complete diagnosis for the genus, based on recent findings, was lacking. Second, just four species were suitably described – *D. rostrata* (Koch, 1841) and *D. leei* (Chien, 1970), *D. ikarus* Kotov & Sinev, 2011 and *D. smirnovi* Sinev, 2015 (Michael & Frey 1984; Alonso 1996; Flössner 2000; Hudec 2010; Kotov & Sinev 2011; Klimovsky *et al.* 2015). Although good illustrations and some short diagnoses can be found in literature, complete descriptions of *D. lepthorhyncha* (Daday, 1905), *D. caudata* Smirnov, 1996, *D. acustirostris* (Birge, 1879), and *D. hamata* (Birge, 1879) are lacking (Frey 1961; Smirnov 1996a, 1996b; Sanoamuang 1998; Korosi & Smol 2012; Kotov *et al.* 2013).

Lastly, *D. leei* and *D. hamata* (Birge, 1879) seem to be cosmopolitan species. *Disparalona leei* was described for North America (Michael & Frey 1984), has since been reported in the Palearctic zone (Alonso 1996; Klimovsky *et al.* 2015). *Disparalona hamata* was also described for North America (as *Pleuroxus hamatus* Birge, 1879 and as *Pleuroxus hamulatus* Birge, 1910), but now has numerous records in Europe, Asia and South America (e.g. Rey & Vasquez 1986; Alonso 1996; Sanoamuang 1998; Soares & Elmoor-Loureiro 2011; Kotov *et al.* 2013). The African *D. chappuisi* Brehm, 1943 was indicated as synonymous of *D. hamata* by Smirnov (1996a), but Sinev & Sanoamuang (2011) suggested it might be a separate species. Clearly, *D. hamata* belongs to a complex of species, which might have strong continental endemism agreeing with Frey's concept of non-cosmopolitanism in Cladocera (Frey 1982, 1987).

Gaps related to the taxonomic history of *Disparalona* were recently resolved. Neretina *et al.* (2018) presented a diagnosis of the genus and split it into two subgenera, *Disparalona* (*Disparalona*) and *Disparalona* (*Mixopleuroxus*). Besides, *D. hamata* was redescribed based on material from the *terra typica* and the status of *D. chappuisi* and *D. striatoides* (Šrámek-Hušek, 1946) were confirmed. Herein, our objective was to make a revision of South American species of *Disparalona* with the redescription of *D. leptorhyncha,* the confirmation of *D. hamata* occurring in Brazil and Argentina, and the description of two new species.

Material and methods

Morphological analyses

Most of the samples used in this study were collected using traditional methods for littoral microcrustacean sampling, using a 60–100 µm mesh size plankton net, and posterior preservation in ethanol or formalin. Samples from the hyporheic zone were collected at 90 cm depth using a modified Bou-Rouch pump (Taglianti *et al.* 1969). These samples were elutriated in the field, filtered through a 68 µm mesh size net and preserved in 75% ethanol solution.

The selected animals were transferred to slides containing glycerin and dissected under a stereomicroscope. The morphology of appendages and other structures were studied using an Olympus BX41 phase contrast microscope. As suggested by Van Damme (2016), the description style is separated in blocks of anatomic structures (general habitus, carapace, cephalic, thoracic limbs, abdominal and postabdominal).

To enumerate the setae of limbs, we used the homology proposed by Kotov (2000a, 2000b), which presented stability when tested in different cladoceran groups (Kotov *et al.* 2010). Drawings were prepared using a camera lucida attached to an Olympus BX41 phase contrast microscope.

Abbreviations in the text and figures

as = accessory seta
en = endite
ep = epipodite
ex = exopodite
fc = filter comb
gfp = gnathobasic filter plate
gn = gnathobase
IDL = inner distal lobe
il = inner lobe
IP = interpore distance (distance between anterior and posterior major head pores)
ODL = outer distal lobe
P1 = first limb
P2 = second limb
P3 = third limb
P4 = fourth limb
PA = postabdomen
pep = pre-epipodite
PP = postpore distance (distance between the posterior major head pore and the posterior border of the head shield)
s = sensillum

Collection acronyms

EL = Personal collection of Lourdes M.A. Elmoor-Loureiro
FDRS = Personal collection of Francisco Diogo Rocha Sousa
GEEA = Research Group of Aquatic Environments, Universidade Católica de Brasília
MZUSP = Zoological Museum of Universidade de São Paulo, Brazil
UFBA = Zoological Museum of Universidade Federal da Bahia, Brazil

Results

Class Branchiopoda Latreille, 1817
Order Anomopoda Sars, 1865
Family Chydoridae Dybowsky & Grochowski, 1894 emend. Frey, 1967
Subfamily Chydorinae Dybowsky & Grochowski, 1894 emend. Frey, 1967
Genus *Disparalona* Fryer, 1968

Disparalona (Mixopleuroxus) leptorhyncha (Daday, 1905)
Figs 1–3, 13

Leptorhynchus rostratus – Daday 1905: 169–179, figs 24–25.

Diagnosis

Body elongated, length 0.36–0.58 mm, ventral margin with narrow aperture extending to posterior end. *Carapace* covered by striae, posterodorsal corner with or without notch; posterior border bears spinulae of which the proximal is as long as distal ones. *Rostrum* very long, about 3.5 times as long as antennular

body, strongly curved. *Labrum* elongated, without keel. *Antennule* about twice as long as width, not exceeding the tip of rostrum. *Antenna* with coxal setae about 1.5 times as long as first exopodite segment, first endopodite segment armed with a short spine about 0.4 of the apical spine length. *First limb* with IDL seta 1 slender and naked, about 1.6 times shorter than second seta, seta 2 about 1.3 times shorter than third seta and armed with long setulae, third seta relatively slender, hook-like, heavily chithinized and with a group of short spines inserted at mid-length of seta. *Second limb* exopodite short, armed with a seta shorter than exopodite itself, inner limb portion armed with eight slender scrapers. *Third limb* exopodite rectangular, about three times as long as the width, fourth seta setulated, about two times as long as third seta. *Fourth limb* with first seta very slender and short, about 0.4 of length of the second seta. *Fifth limb* exopodite wide, rounded, armed with four plumose setae. *Postabdomen* anal margin about 0.7 of the preanal margin length, 12–13 marginal merged denticles, distalmost denticles with width-at-base/height ratio about 0.45, lateral fascicle formed by thin spinulae not separated in groups. *Basal spines* naked, distal, about 0.28 of the postabdominal claw length, proximal about 2.5 times shorter than distal one.

Material examined

BRAZIL – **Distrito Federal**: 33 parthenogenetic ♀♀, Ecological station of Águas Emendadas, Bonita Pond, 15°35′22.1″ S, 47°41′50.1″ W, Aug. 2006 and Mar. 2009, GEEA and L.M.A. Elmoor-Loureiro leg. (FDRS 0260–0264; EL 00467; EL 01268–01269; EL 01271–01277); 2 parthenogenetic ♀♀, Joaquim Medeiros Pond, 15°38′15.9″ S, 47°41′29.5″ W, Jan. 1979 and Sep. 2008, GEEA and L.M.A. Elmoor-Loureiro leg. (FDRS 0265; EL 01270); 12 parthenogenetic ♀♀, Gansos Pond, 15°40′33.1″ S, 47°41′37.4″ W, Aug. 2006 and Mar. 2009, GEEA leg. (FDRS 0266–0268). – **Goiás**: 5 parthenogenetic ♀♀, Formosa, Instruction Field of the Brazilian Army, Grande Pond, 15°49′59.29″ S, 47°13′55.42″ W, Aug. 2009 and Dec. 2009, GEEA leg. (FDRS 0269; EL 01746); 1 parthenogenetic ♀, Mineiros, Emas National Park, Capivaras Pond, 18°16.245′ S, 52°50.529′ W, Dec. 2000, G. Miranda leg. (EL 00884); 10 parthenogenetic ♀♀, Alto Paraíso, Chapada dos Veadeiros National Park, Sete Lagoas Pond, 14°04′11.47″ S, 47°39′18.31″ W, Jun. 2012, GEEA leg. (EL 02287). – **Bahia**: 2 parthenogenetic ♀♀, Pond in Roda Velha, 12°47′18″ S, 45°57′06″ W, Jul. 1985, L.M.A. Elmoor-Loureiro leg. (EL 00466, EL 01266). – **Minas Gerais**: 4 parthenogenetic ♀♀, Januária, Peruaçu State Park, Jatobá pond, 14°56′13″ S, 44°37′35″ W, Sep. 2003, M.B.G. Souza leg. (EL 01976). – **Pará**: 1 parthenogenetic ♀, Porto Trombetas, Trombetas River, 1°30′0″ S, 56°19′30.34″ W, Jan. 1989, R.L. Bozelli leg. (EL 01825).

Redescription of adult parthenogenetic female

General habitus (Fig. 1A–E). Body elongated, length 0.36–0.58 mm, maximum height at middle of body, height/length ratio about 0.4; dorsal margin not arched, without dorsal keel or lateral projection; in dorsal and ventral view body not laterally compressed; ventral margin with narrow aperture which is extending to posterior end.

Carapace (Fig. 1A–F). Covered by striae; anteroventral margin with a widened flange; ventral margin almost straight; 72–79 plumose setae per valve (the real number of setae is not represented in the figures), of which the posterior and anterior are as long as the middle ones, anterior setae located exactly at the valve margin and clearly not articulated, posterior setae internally articulated; posterodorsal corner with or without notch; posteroventral corner rounded, posterior border bears spinulae of which the proximal is longer than the distal ones.

Cephalic structures (Fig. 1G–N). Ocellus smaller than eye. Rostrum very long, about 3.5 times as long as antennular body, strongly curved, reaching the same level of ventral line of valve, with tip sharp or bifid; in frontal view may not be straight. *Head shield* (Fig. 1I–J). Anterior and posterior region triangular-shaped, covered by striae, posterior border irregularly waved; two main pores with two closely-set tiny pores between them, tiny pores located halfway between main head pores, PP/

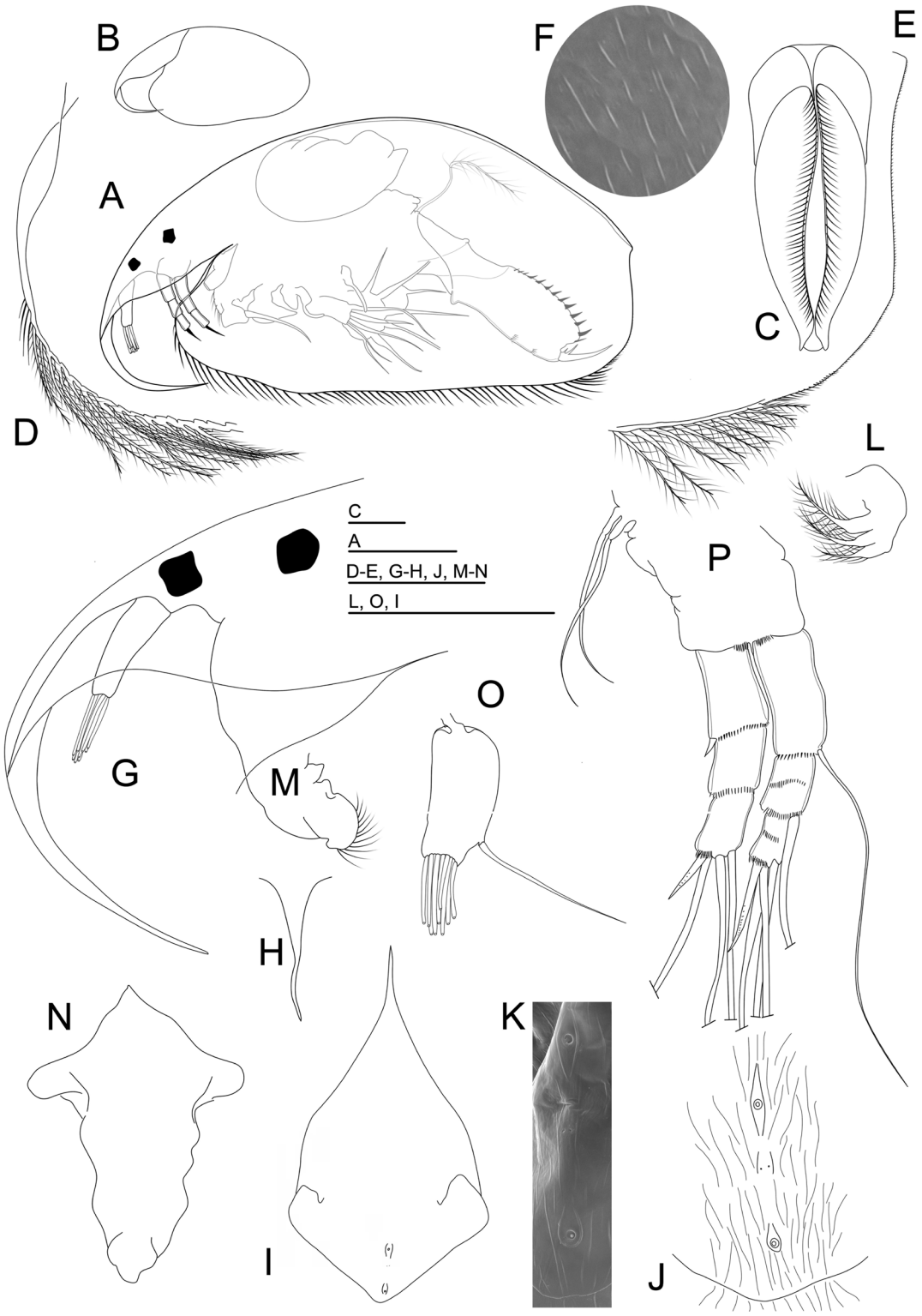

Fig. 1. *Disparalona* (*Mixopleuroxus*) *leptorhyncha* (Daday, 1905), parthenogenetic female. **A–B**. Habitus. **C**. Ventral view of carapace. **D**. Anterior portion of ventral margin of carapace. **E**. Posterior portion and posteroventral corner of carapace. **F**. Ornamentation of carapace. **G**. Rostrum. **H**. *Idem*, frontal view. **I**. Head shield. **J–K**. Main head pores. **L**. Maxilla. **M**. Labrum. **N**. *Idem*, frontal view. **O**. Antennule. **P**. Antenna. Scale bars: C–E, G–I, L–O = 50 μm; A = 80 μm. Figs B, D, F, K were not scaled.

IP about 0.35. *Labrum* (Fig. 1M–N). Elongated, without keel; lateral horns present. *Maxilla* (Fig. 1L). Well developed, with three setulate setae. *Antennule* – A1 (Fig. 1O). Length about two times the width, not exceeding the tip of rostrum; antennular sensory seta slender, about 1.3 times length of antennular body, inserted near to apex of the antennular body; nine aesthetascs which do not exceed the length of antennular body. *Antenna* – A2 (Fig. 1P). Coxal setae very long, about 1.5 times as long as first exopodite segment; basal segment thick with short and thin spine; first exopodite segment longer than first segment of endopodite; second exopodite segment with a long seta reaching or exceeding mid-length of longest apical seta; first endopodite segment armed with a short spine about 0.4 of length of the apical spine; exopodite apical spine about 1.8 times longer than the segment itself, endopodite apical spine of similar length to apical segment; apical spines armed with short denticles. Antennal formula (exo/endo): spines 001/101, setae 113/003.

Thoracic limbs (Fig. 2A–G)**.** Five pairs of thoracic limbs. *First limb* (Fig. 2A). Epipodite oval shaped without projection; ODL armed with a short seta and a thin serrated seta longer than IDL first seta; IDL (en 4) with two groups of short setulae; three setae present, third seta relatively slender, hook-like, heavily chithinized and with a group of short spines inserted at mid-length of seta; seta 1 slender and naked, about 1.6 times shorter than second seta; seta 2 about 1.3 times shorter than third seta, armed with long setulae; endite 3 with four setae, posterior setae (a–b) of similar length and shorter than anterior seta 1, seta (c) of similar length to setae (a–b); endite 2 with three posterior setae present (d–f), seta (f) about 1.2 times shorter than seta (e), both setae bear thin setulae on the lateral face, seta (d) setulated and about two times shorter than seta (e); endite 1 with three posterior setae of similar length (g–i), bisegmented and densely setulated on distal part; stiff setae long, of similar length to seta (f), seta (j) not studied; ejector hooks of similar length to corm of limb and armed with spines; ventral face of the limb with nine groups of setulae organized in clusters, increasing in length towards the distal portion. Gnathobase as a setulated setae. *Second limb* (Fig. 2B–C). Exopodite short, armed with a seta shorter than exopodite itself; inner limb portion armed with eight slender scrapers; setulation on the scrapers is inconspicuous; scraper 1 with an accessory seta at its base, scraper 2 about 0.6 of length of scraper 1; proximal portion of gnathobase flattened; distal portion armed with three elongated elements, first element with distal portion sharp, geniculated, and setulated, second element armed with strong denticles, third element longer than mid length of others elements; filter comb with seven setulated setae. *Third limb* (Fig. 2D). Epipodite oval with a long projection; exopodite rectangular, about three times as heigh as wide, with four distal and three lateral setae; seventh seta setulated and longer than sixth and fifth setae; fourth seta setulated, about twice as long as third seta; third seta similar in length to exopodite corm; second seta setulated, longer than third and first setae, about 0.68 of length of the fourth seta; first seta thin and naked; distal endite with three slender setae, seta 2 about 0.7 of length of seta 1 (third seta not studied); six long and plumose posterior setae decreasing in length towards gnathobase (a–f); basal endite with four setae of similar length (4–7); gnathobase armed with a long and cylindrical sensillum; filter comb with eight setulated setae. *Fourth limb* (Fig. 2E–F). Pre-epipodite oval and densely setulated; epipodite oval with a long projection; exopodite with seven marginal setae; setae 2–7 plumose; seventh seta shorter than sixth and fifth setae and similar in length to third seta; fourth setae relatively long, about twice as long as second seta; first seta very slender and short, about 0.4 of length of the second seta; distal endite with four setae (1–4), one scraper-like (1), three setae flaming-torch-like slightly setulated (3–4) and similar in length to seta 1; basal endite armed with three setulated setae of similar length; gnathobase thick, with three elements, armed with one curved setulated seta which is about twice as long as width of endite; filter plate with six setae. *Fifth limb* (Fig. 2G). Pre-epipodite rounded and densely setulated; epipodite oval with a long projection; exopodite wide, rounded, armed with four plumose setae and two setulated hillocks implanted near first seta; first seta about 0.75 of length of the second seta; third and fourth setae similar in length and longer than other setae of limb; internal lobe elongated, relatively rectangular and with many setulae, two setae of similar length on inner face of the lobe, seta 1 armed laterally with thick spinulae and setulae; seta 2 setulated; filter comb with four setulated setae, about 0.75 of length of internal lobe setae.

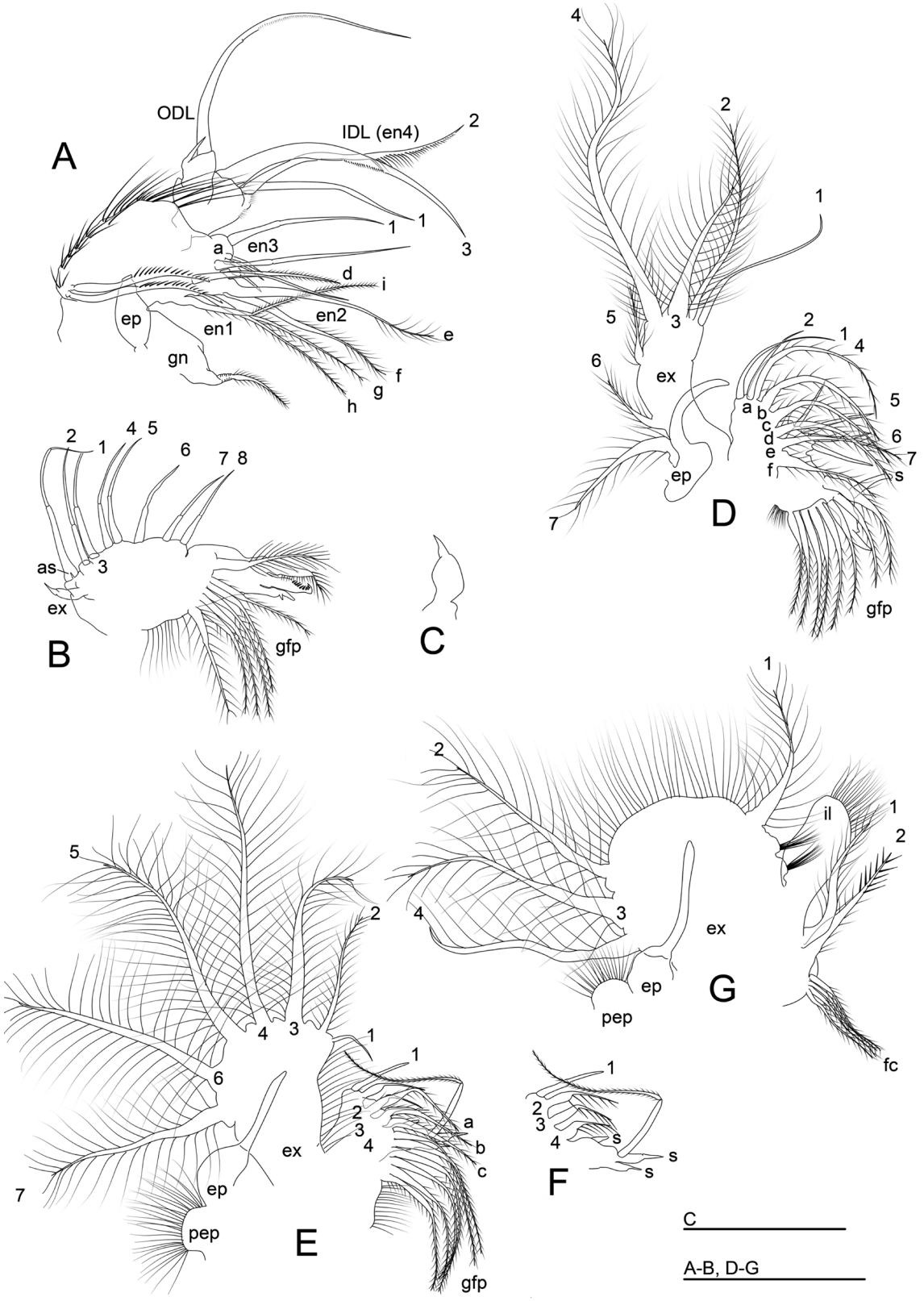

Fig. 2. *Disparalona* (*Mixopleuroxus*) *leptorhyncha* (Daday, 1905), parthenogenetic female. **A**. First limb. **B**. Second limb. **C**. *Idem*, exopodite. **D**. Third limb. **E**. Fourth limb. **F**. *Idem*, distal endite. **G**. Fifth limb. Scale bars = 50 μm.

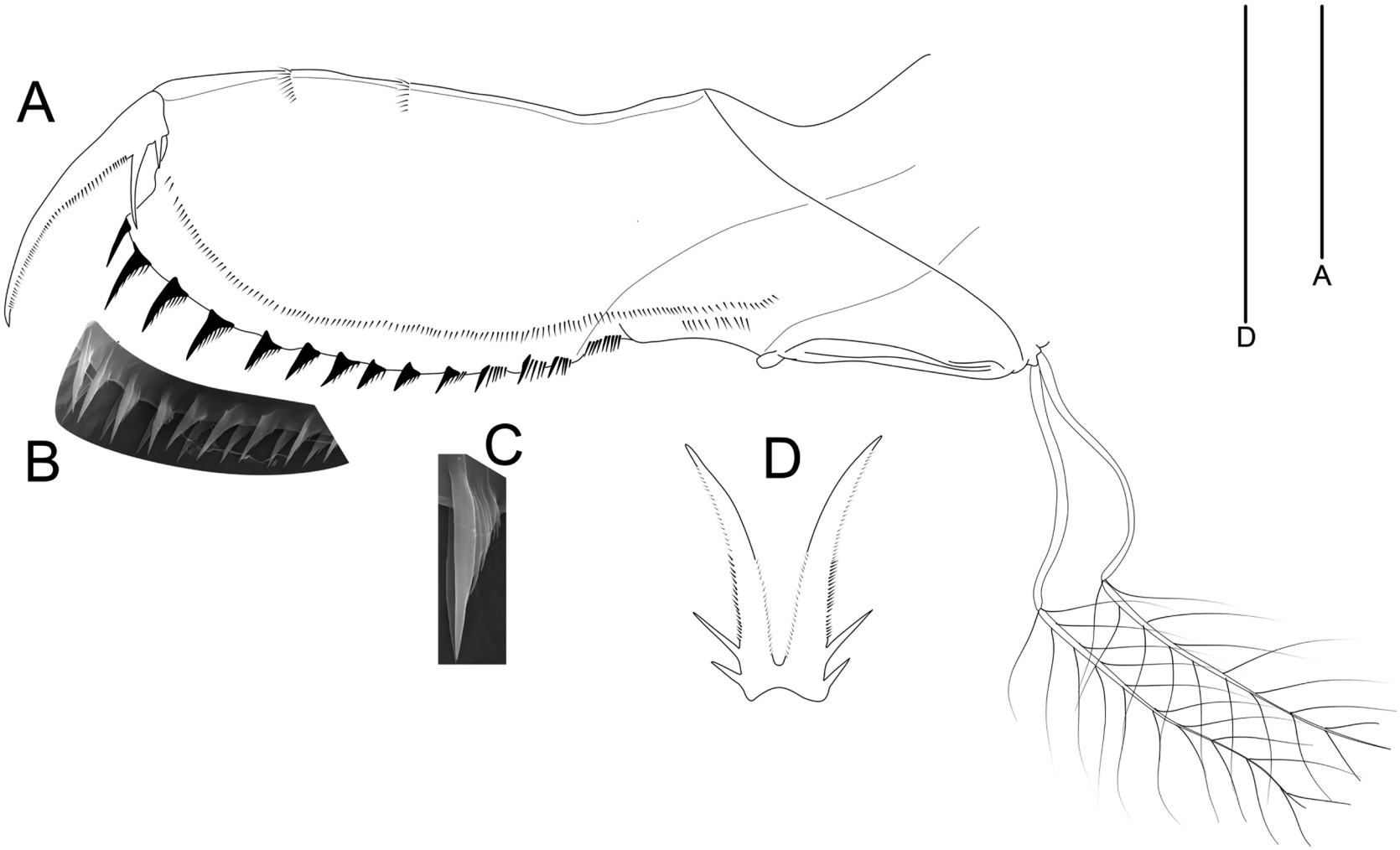

Fig. 3. *Disparalona* (*Mixopleuroxus*) *leptorhyncha* (Daday, 1905), parthenogenetic female. **A–D**. Postabdomen. **A**. Lateral view. **B–C**. Marginal denticles. **D**. Dorsal view of postabdominal claw (separation between claws not represented). Scale bars = 50 μm. Figs B–C, were not scaled.

Abdominal and postabdominal structures. *Abdomen* (Fig. 1A). About three times shorter than thorax. *Postabdomen* (Fig. 3A–D). About 3.2 times as long as wide, ventral margin relatively straight with two rows of short spinulae; anal margin about 0.7 of length of the preanal margin, armed with a group of thin spines; postanal margin uniformly rounded and very long, about 2.5 times as long as anal margin, armed with 12–13 marginal merged denticles, distalmost denticles with width-at-base/height ratio about 0.45; lateral fascicle formed by thin spinulae not separated in groups; postabdominal setae about 0.7 of length of the postabdomen, bisegmented, armed with setulae from distal segment. *Postabdominal claw* (Fig. 3A, D). With two basal spines, about 0.28 of the length of the postabdomen and 1.3 times longer than anal margin, base naked; inner group of pecten with thin proximal spinulae; outer group separated in two groups, proximal with ticker spinulae. *Basal spines* (Fig. 3A, D). Naked, distal about 0.28 of length of the postabdominal claw, proximal about 2.5 times shorter than distal one.

Ephippial female, ephippium. Unknown.

Male

See Van Damme & Dumont (2010).

Remarks

According to Smirnov (1996a, 1996b), *Disparalona* (*M.*) *leptorhyncha* was initially described as *Leptorhynchus rostratus*. As the name *rostratus* was preoccupied in the genus of *Disparalona*, Smirnov (1996a) designated the epithet *leptorhyncha*. *Disparalona* (*M.*) *leptorhyncha* differs from all species of the genus by the absence of longitudinal lines on the carapace, antenna with very long coxal setae, long and curved rostrum, closely-set tiny pores located halfway between main head pores, labrum elongated and without keel (Fig. 1M–N); third seta on the IDL relatively long and slender, ejector hook in the first limb very long, stiff setae on the endites 2–3 long, of similar length to seta (f); seta on the exopodite of second limb short, scrapers long and slender, proximal portion of gnathobase flattened and naked (Fig. 2B–C); third limb exopodite three times as heigh as wide; postabdomen with short anal margin, postanal margin rounded with 12–13 merged denticles. This set of characters makes *Disparalona* (*M.*) *leptorhyncha* the most peculiar species of the genus when compared with *hamata*-complex and Holarctic species (Alonso 1996; Flössner 2000; Kotov & Sinev 2011; Klimovsky *et al.* 2015).

Distribution and biology

Disparalona (*M.*) *leptorhyncha* is an endemic species, with distribution limited to South America. This species occurs from Paraguay to the Brazilian Amazon (Daday 1905; Smirnov 1996a, 1996b; Van Damme & Dummont 2010; Sousa *et al.* 2013; Debastiani-Júnior *et al.* 2015; Elmoor-Loureiro 2017). *Disparalona* (*M.*) *leptorhyncha* is very common in reservoirs, floodplain environments, ponds, and shallow lakes.

Disparalona (Mixopleuroxus) hamata (Birge, 1879)
Figs 4–6, 13

For synonymy, see Neretina *et al.* (2018).

Diagnosis

Body elongated, length 0.48–0.50 mm, dorsal margin uniformly arched, ventral margin with wide aperture which is located at the middle of the body. *Carapace* covered by longitudinal lines and striae between them, posterodorsal corner with a notch, posteroventral corner rounded, posterior part bears a group of long and thin spinulae exceeding the border. *Rostrum* short, about 2.8 times as long as antennular body, not curved, pointed downwards. *Antennule* length about 1.7 times the width, not exceeding the tip of

rostrum. *Antenna* with coxal setae about 0.55 the length of the first exopodite segment, first endopodite segment armed with a short spine about 0.35 of the length of the apical spine. *First limb* with IDL seta 1 slender and armed with thin spines at distal part, about 2.2 times shorter than third seta; setae 2 about 1.2 times shorter than third seta, armed with long setulae, third seta relatively thick, hook-like, heavily chithinized and with a group of short spines at distal part. *Second limb* with exopodite armed with a long seta, about three times longer than exopodite itself, inner limb portion armed with eight slender scrapers decreasing in length towards gnathobase. *Third limb* exopodite rectangular, about 2.5 times as heigh as wide, fourth seta about 1.2 times as long as third seta. *Fourth limb* first seta slender and short, about 0.4 of length of the second seta. *Fifth limb* exopodite wide, rounded, armed with four plumose setae. *Postabdomen* anal and preanal margins similar in length, 11 marginal denticles, distalmost denticles not bearing spinulae or spines, proximalmost denticles are merged; distalmost denticles with width-at-base/height ratio about 0.25. *Basal spines* naked, distalmost about 0.27 of length of the postabdominal claw, proximal about 1.7 times shorter than distal one.

Material examined

BRAZIL: 5 parthenogenetic ♀♀, Rio Grande do Sul, Santa Maria, fish pond at Universidade Federal de Santa Maria, 29°43′21.87″ S, 53°43′42.86″ W, Jul. 2014, F.D.R. Sousa and M.M. Dallosto leg. (FDR 0517).

ARGENTINA – **Provincia de Santa Fé**: 4 parthenogenetic ♀♀, Sirgadero Island, Paraná River, 31°40′51″ S, 60°40′17″ W, Oct. 1972, J.C. Paggi leg. (FDRS 0520); 6 parthenogenetic ♀♀, Clucellas Island, Laguna Los Matadores, Paraná River, 31°42′33″ S, 60°44′30″ W, Oct. 1975, J.C. Paggi leg. (FDRS 0520).

Description of adult parthenogenetic female

General habitus (Fig. 4A–E). Body elongated, length 0.48–0.50 mm, maximum height at middle of body, height/length ratio about 0.5; dorsal margin uniformly arched, without dorsal keel or lateral projection; in dorsal and ventral view, body not laterally compressed; ventral margin with wide aperture which is located at the middle of the body.

Carapace (Fig. 4A–E). Covered by longitudinal lines and striae between them; anteroventral margin with a widened flange; ventral margin with slight depression at mid length of body; 73–87 plumose setae per valve (the real number of setae is not represented in the figures) of which the posterior and anterior groups are longer than the middle group, anterior and posterior setae internally articulated, setae around median part located exactly at the valve margin and clearly not articulated; posterodorsal corner with a notch; posteroventral corner rounded, posterior part bearing a group of long and thin spinulae exceeding the border.

Cephalic structures (Fig. 4F–M). Ocellus smaller than eye. Rostrum short, about 2.8 times as long as antennular body, not curved, pointed downwards, with sharp or bifid tip; straight in frontal view. *Head shield* (Fig. 4H). Covered by striae, posterior border triangular; two main pores with two closely-set tiny pores between them, located closer to the anterior than posterior main pore, PP/IP about 0.4. *Labrum* (Fig. 4I–J). Keel not prominent, distal portion elongated and triangular, lateral horns present. *Maxilla* (Fig. 4K). Well developed, with three long setulated setae. *Antennule* – A1 (Fig. 4L). Length about 1.7 times the width, not exceeding the tip of rostrum; antennular sensory seta slender, about same length of antennular body, inserted in the second third of antennular body; nine aesthetascs not exceeding the length of antennular body. *Antenna* – A2 (Fig. 4M). Coxal setae about 0.55 the length of the first exopodite segment; basal segment thick with short and thin spine; first exopodite and endopodite segments of similar length; first endopodite segment armed with a short spine about 0.35 the length of

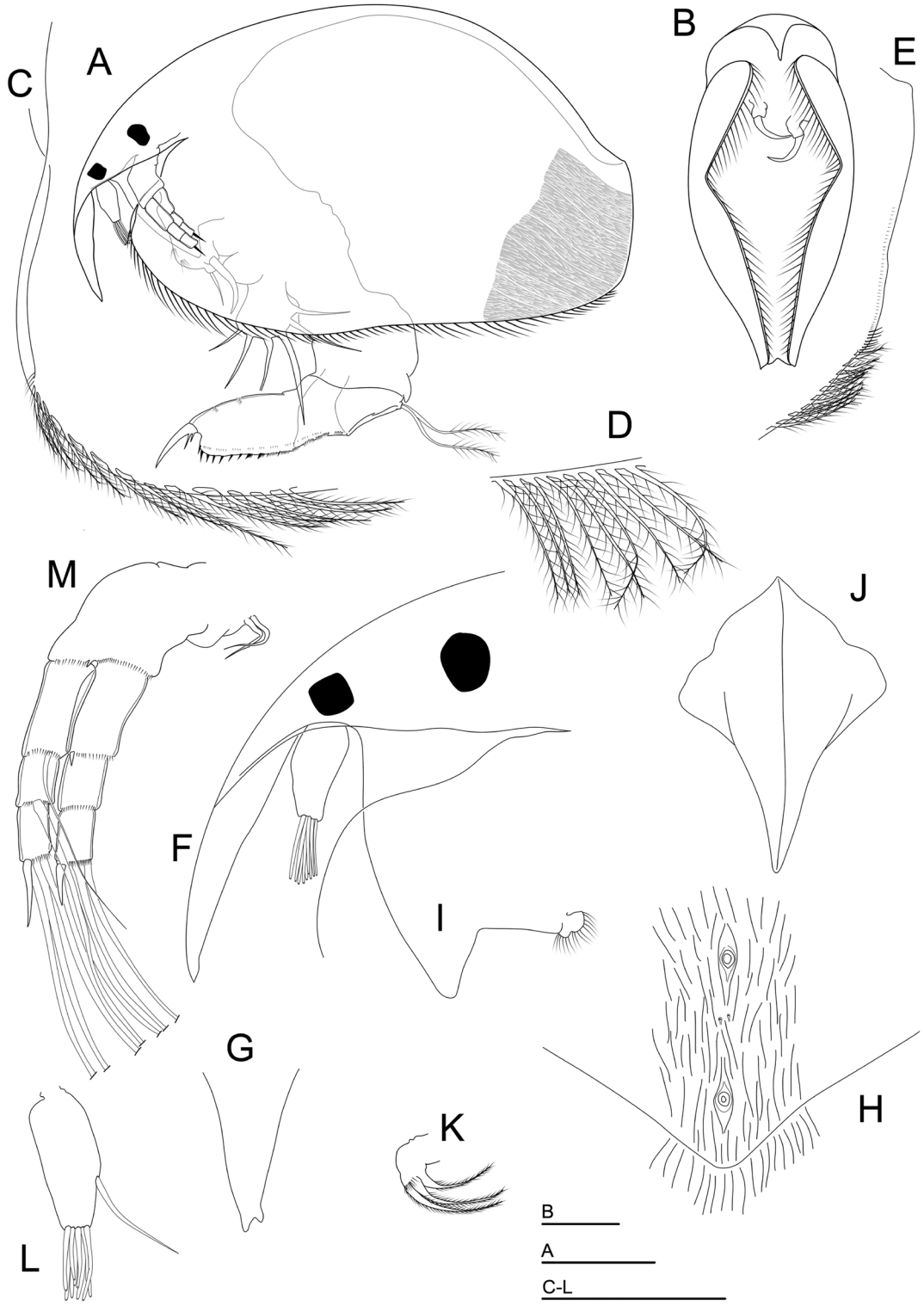

Fig. 4. *Disparalona* (*Mixopleuroxus*) *hamata* (Birge, 1879), parthenogenetic female. **A**. Habitus. **B**. Ventral view of carapace. **C**. Anterior portion of ventral margin of carapace. **D**. Middle portion of ventral margin of carapace. **E**. Posterior portion and posteroventral corner of carapace. **F**. Rostrum. **G**. *Idem*, frontal view. **H**. Main head pores. **I**. Labrum. **J**. *Idem*, frontal view. **K**. Maxilla. **L**. Antennule. **M**. Antenna. Scale bars: C–L = 50 μm; A–B = 100 μm.

the apical spine; exopodite apical spine about 1.2 times longer than apical segment and about 1.5 times longer than endopodite apical spine. Antennal formula (exo/endo): spines 001/101, setae 113/003.

Thoracic limbs (Fig. 5A–H)**.** Five pairs of thoracic limbs. *First limb* (Fig. 5A–C). Epipodite not studied; ODL armed with a short seta and a thin and serrated seta longer than IDL first seta; IDL (en 4) with a group of short setulae, three setae present, third seta relatively thick, hook-like, heavily chithinized and with a group of short spines at distal part; seta 1 slender and armed with thin spines at distal part, about 2.2 times shorter than third seta; setae 2 about 1.2 times shorter than third seta, armed with long setulae; endite 3 with four setae, posterior setae (a–b) of similar length and longer than anterior seta 1, seta (c) of similar length to setae (a–b); endite 2 with three posterior setae (d–f), seta (f) about 1.7 times shorter than seta (e) being that both setae bear thin setulae on the lateral face, seta (d) setulated and about two times shorter than seta (e), stiff setae about 1.5 times shorter than seta (d); endite 1 with three posterior setae of similar length (g–i), bisegmented and densely setulated from to distal part; stiff setae about 1.2 times shorter than seta (f), seta (j) not studied; ejector hooks about mid length of corm of limb and armed with spines; ventral face of the limb with eight groups of long setulae organized in clusters. Gnathobase not studied. *Second limb* (Fig. 5D). Exopodite with a long seta armed laterally with short spinulae, about three times longer than exopodite itself; inner limb portion armed with eight slender scrapers decreasing in length towards gnathobase, scrapers bear short and thin spinulae; proximal portion of gnathobase not elongated and armed with five long setulae; distal portion armed with four elements, first element is a sensillum, second element elongated with distal portion sharp and geniculated, third element armed with strong denticles, fourth element longer than mid-length of others elements; filter comb with eight setulated setae, first seta densely setulated and shorter than others. *Third limb* (Fig. 5E). Epipodite subrectangular without projection; exopodite rectangular about 2.5 times as heigh as wide, with four distal and three lateral setae; seventh seta setulated and longer than sixth and fifth setae; fourth seta setulate, about 1.2 times as long as third seta; third seta setulated, longer than length exopodite corm, shorter than second seta; second seta armed laterally with short spinulae, about 1.6 times as long as first setae, about 0.9 of length of the fourth seta; first seta thin and naked; setae (1–2) of distal endite slender, seta 2 about 0.7 of length of the seta 1, seta 3 not studied; six long and setulated posterior setae increasing in length towards gnathobase (a–f); basal endite with four setae (3–6), distalmost seta longer than others; gnathobase armed with a long and cylindrical sensillum; filter comb with eight setulated setae. *Fourth limb* (Fig. 5F–G). Pre-epipodite rounded and densely setulated; epipodite rectangular without projection; exopodite with seven marginal setae; setae 3–7 plumose; seventh seta shorter than sixth, fifth and fourth setae, slightly longer than third seta; fifth seta slightly longer than fourth seta; fourth seta about two times as long as second seta; first seta slender and short, about 0.4 of length of the second seta; distal endite with four setae (1–4), one scraper-like (1), three setae flaming-torch-like slightly setulated (3–4), longer than seta 1; basal endite armed with three setulated setae of similar length; gnathobase thick, with three elements, armed with one curved setulated seta about 1.3 times as long as width of endite; filter plate with six setae. *Fifth limb V* (Fig. 5H). Pre-epipodite rectangular and densely setulated; epipodite oval with a very short projection; exopodite wide, rounded, armed with four plumose setae and two setulated hillocks implanted near first seta; first seta about 0.7 of length of the second seta; third and fourth setae different in length, longer than other setae of limb; fourth seta about 0.9 of the length of the third seta; internal lobe elongated, relatively rectangular and with many setulae, two setae of different length on inner face of the lobe, seta 1 armed laterally with thick spinulae and setulae; seta 2 setulated, about 0.75 of length of the seta 1; gnathobase with an element; filter comb with four setulated setae longer than seta 2 of internal lobe.

Abdominal and postabdominal structures. *Abdomen* (Fig. 4A). About two times shorter than thorax. *Postabdomen* (Fig. 6A–C). About 3.7 times as long as wide, ventral margin slightly arched with two rows of short spinulae; anal and preanal margins similar in length; anal margin armed with four groups of thin spines; postanal margin almost straight and long, about 1.4 times as long as anal margin, armed

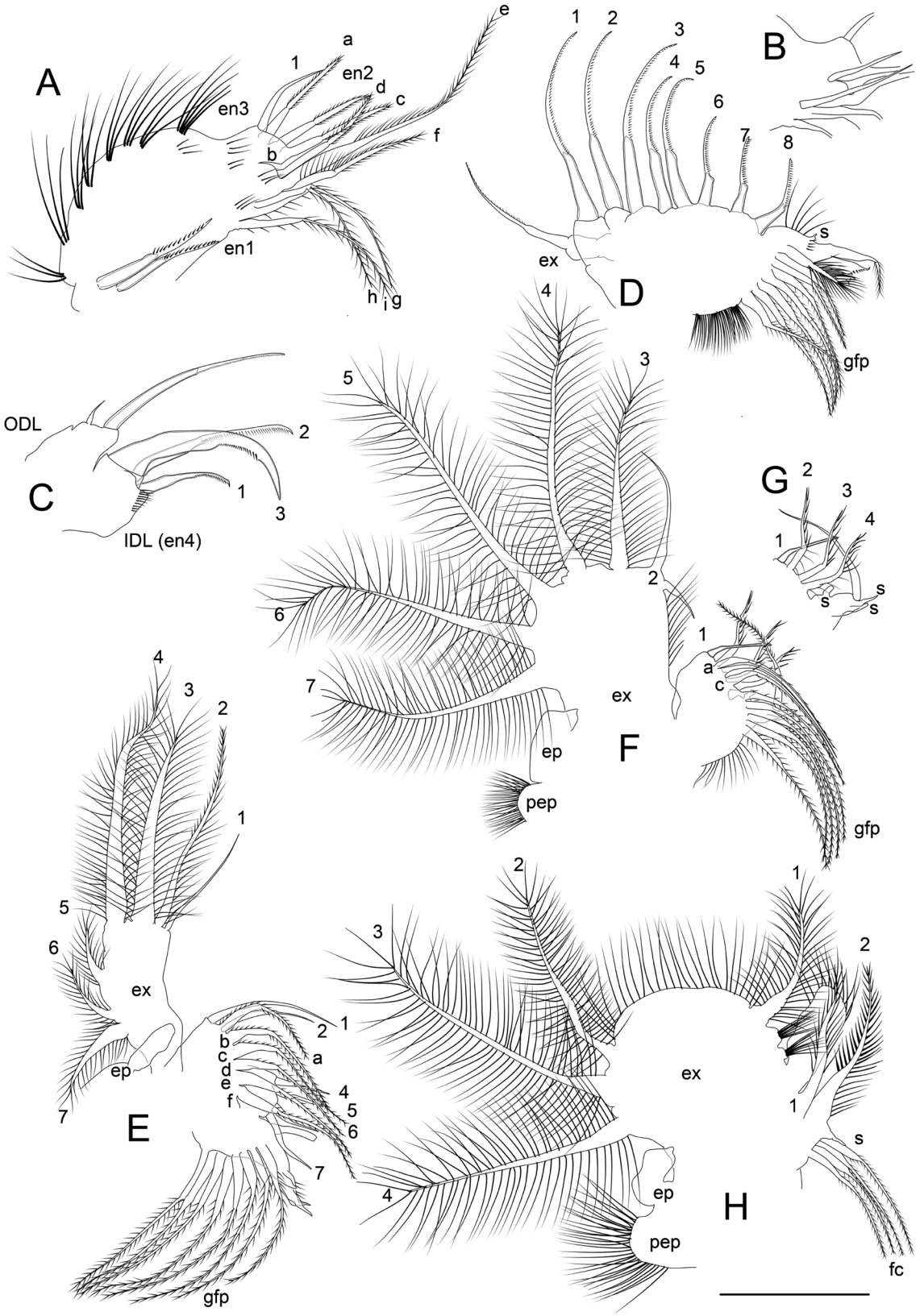

Fig. 5. *Disparalona (Mixopleuroxus) hamata* (Birge, 1879), parthenogenetic female. **A**. First limb. **B**. *Idem*, stiff setae. **C**. *Idem*, ODL and IDL. **D**. Second limb. **E**. Third limb. **F**. Fourth limb. **G**. *Idem*, distal endite. **H**. Fifth limb. Scale bar = 50 μm.

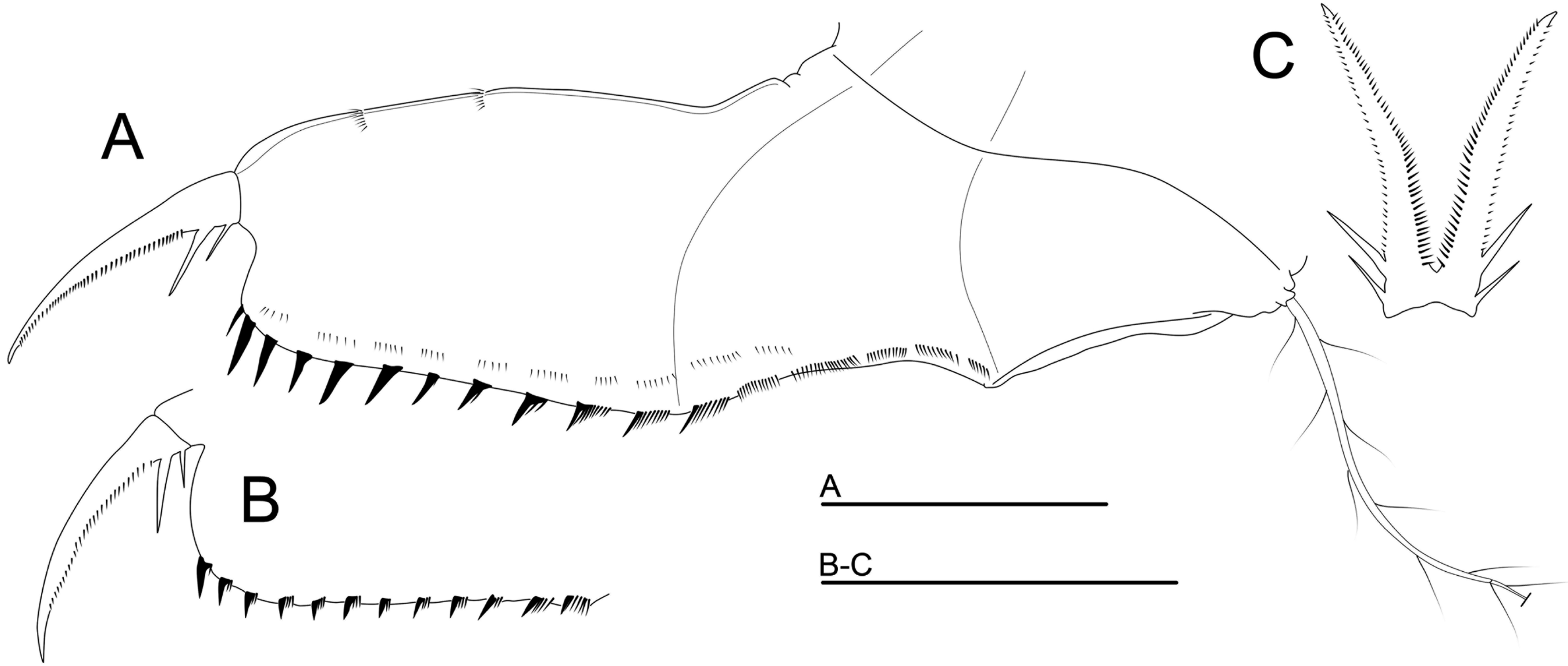

Fig. 6. *Disparalona* (*Mixopleuroxus*) *hamata* (Birge, 1879), parthenogenetic female. **A–C**. Postabdomen. **A**. Lateral view. **B**. Marginal denticles of the juvenile. **C**. Dorsal view of postabdominal claw (separation between claws not represented). Scale bars = 50 µm.

with 11 marginal denticles, distalmost denticles do not bear spinulae or spines, proximalmost denticles are merged; distalmost denticles with width-at-base/height ratio about 0.25; lateral fascicle separated in ten groups with short and thin spinulae; postabdominal setae about 0.5 of length of the postabdomen, bisegmented, armed with setulae. *Postabdominal claw* (Fig. 6A, C). With two basal spines, about 0.25 of the length of the postabdomen and slightly shorter than anal margin, base naked; inner group of pecten separated in two groups, proximal with thick spinulae, distal thin spinulae; outer pecten armed with thin spinulae. *Basal spines* (Fig. 6A–C). Naked, distalmost about 0.27 of length of the postabdominal claw, proximal about 1.7 times shorter than distal one.

Ephippial female, ephippium. Unknown.

Remarks

The morphology of South American populations of *D.* (*M.*) *hamata* is very similar to the description presented in Neretina *et al.* (2018). The most relevant aspect of variability was observed just in the distalmost marginal denticles of the postabdomen, which were smooth and unmerged; the first seta on the exopodite of the fifth limb is longer when compared to the redescription performed by Neretina *et al.* (2018). *Disparalona* (*M.*) *hamata* differs from *D.* (*D.*) *rostrata*, *D.* (*D.*) *leei*, *D.* (*D.*) *ikarus* and *D.* (*D.*) *smirnovi* in armature of seta 3 of the IDL which is thick, hook-like, and heavily chithinized. The labrum of *D.* (*M.*) *hamata* has a distal portion elongated and triangular, differently from *D.* (*M.*) *lucianae* sp. nov. and *D.* (*M.*) *tenuispina* sp. nov. which has a labrum with distal portion very short and rounded. Compared to *D.* (*M.*) *caudata*, *Disparalona* (*M.*) *hamata* is a small species it's body reaching up to 0.50 mm (height/length ratio about 0.5), while *D.* (*M.*) *caudata* reaches up to 0.6 mm (height/length ratio about 0.45); seta 1 of IDL in *D.* (*M.*) *hamata* is slender and armed with thin spines at distal part and about 1.8 times shorter than second seta, while in *D.* (*M.*) *caudata* the same seta is naked and about 2.5 times shorter than second seta; the postabdomen of *D.* (*M.*) *hamata* bears up to 11 marginal denticles while *D.* (*M.*) *caudata* has 14 marginal denticles (Smirnov 1996a, 1996b). *Disparalona* (*M.*) *hamata* differs from *D.*(*M.*) *acutirostris* in the morphology of rostrum, length of basal spines and proportion between them (Frey 1961). *Disparalona* (*M.*) *hamata* can be differentiated from *D.* (*M.*) *leptorhyncha* in the morphology of habitus, postabdomen, and limbs.

Distribution and biology

Disparalona (*M.*) *hamata* has a wide distribution in the American continent. Reports from Rey & Vasquez (1986) and Fuentes-Reines *et al.* (2018) probably belong to *Disparalona* (*M.*) *hamata*.

Disparalona (Mixopleuroxus) lucianae sp. nov.
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Figs 7–9, 13

Disparalona cf. *hamata* – Sousa & Elmoor-Loureiro 2008: 163, figs 3d–e. — Debastiani-Júnior *et al.* 2015: 24, table 2.

Diagnosis

Body elongated, oval, length 0.36–0.48 mm, dorsal margin uniformly arched, ventral margin with wide aperture which is located after middle of body, toward the anterior part. *Carapace* covered by longitudinal lines and striae between them, posterodorsal corner without evident notch; posteroventral corner rounded, posterior part bears a group of long and thin spinulae that exceed the border. *Rostrum* short, about 1.7 times longer than antennular body, slightly curved with tip sharp. *Antennule* length about two times the width, not exceeding the tip of rostrum. *Antenna* with coxal setae slightly shorter than first exopodite segment, first endopodite segment armed with a short spine about 0.3 of length of

the apical spine. *First limb* IDL seta 1 slender and armed with thin spines at distal part, about 2.2 times shorter than third seta; seta 2 about 1.2 times shorter than third seta, armed with long hard setulae, third seta relatively thick, hook-like, heavily chithinized and with a group of short spines at distal part. *Second limb* exopodite with a long seta about 2.8 times as long as exopodite itself, inner limb portion armed with one element and eight scrapers, of which 1 and 3 of similar length. *Third limb* exopodite about 2.5 times height than width, fourth seta setulated, about 1.4 times as long as third seta. *Fourth limb* first seta slender and short, about 0.4 of length of the second seta. *Fifth limb* exopodite wide, rounded, armed with four plumose setae. *Postabdomen* with anal margin about 1.2 times shorter than preanal margin, 10 merged marginal denticles; distalmost denticle with width-at-base/height ratio about 0.23. *Basal spines* naked, distal about 0.22 of length of the postabdominal claw, proximal about 1.8 times shorter than distal one.

Etymology

The epithet *'lucianae'* is given in honor to limnologist Luciana de Mendonça Galvão, an active researcher in the field of aquatic ecosystems in the Brazilian Cerrado Biome.

Material examined

Holotype

BRAZIL: parthenogenetic ♀, Minas Gerais, Diamantina, Sempre Vivas National Park, Jequitaí River, 17°54′9.90″ S, 43°46′34.93″ W, Sep. 2010, GEEA leg. (MUZUSP 38018).

Paratypes

BRAZIL – **Bahia**: 12 parthenogenetic ♀♀, Bahia, Salvador, Lagoa de Duna, 12°50′55″ S, 38°16′53″ W, Oct. 2001 and Jul. 2002, E.M. Silva leg. (EL 00460, EL 01254–01265, EL 00461). – **Goiás**: 1 parthenogenetic ♀, Mineiros, Emas National Park, Formosa River, 18°15.591′ S, 53°01.965′ W, Nov. 2006, V. Barros leg. (EL 00463); 27 parthenogenetic ♀♀, Alto Paraíso, Chapada dos Veadeiros National Park, Carioquinha waterfall, 14°08′41″ S, 47°49′17″ W, Mar. 2017, R.C. Sousa leg. (FDRS 0519). – **Minas Gerais**: 100 parthenogenetic ♀♀, Diamantina, Sempre Vivas National Park, Jequitaí River, 17°54′9.90″ S, 43°46′34.93″ W, Sep. 2010 and May. 2010, GEEA and L.M.A. Elmoor-Loureiro leg. (EL 01940–01941, FDRS 0509); 75 parthenogenetic ♀♀, Diamantina, Sempre Vivas National Park, Inhacica River, 17°50′11.40″ S, 43°45′58.61″ W, May. 2010 and Sep. 2010, GEEA leg. (EL 02417, FDRS 0510); 1 parthenogenetic ♀, Diamantina, Sempre Vivas National Park, Filipe River, 17°29′ S, 43°21′ W, Sep. 2010, GEEA leg. (EL 02418); 26 parthenogenetic ♀♀, Diamantina, Sempre Vivas National Park, Preto River, 17°55′54.01″ S, 43°48′50.33″ W, May. 2010 and Jul. 2012, GEEA and C.F.A. Barros leg. (EL 01855, FDRS 0511–0515).

Description of adult parthenogenetic female

General habitus (Figs. 7A–H). Body elongated, oval, length 0.36–0.48 mm, maximum height located after middle of body, height/length ratio about 0.55; dorsal margin uniformly arched, without dorsal keel or lateral projection; in dorsal and ventral view body not laterally compressed; ventral margin with wide aperture which is located after middle of body, toward the anterior part.

Carapace (Fig. 7D–E). Covered by longitudinal lines and striae between them; anteroventral margin with a widened flange; ventral margin with slight depression before mid length of body; 80 plumose setae per valve (the real number of setae is not represented in the figures), of which the posterior and anterior groups are longer than middle group, anterior and posterior setae internally articulated, setae around median part located exactly at the valve margin and clearly not articulated; posterodorsal corner without evident notch; posteroventral corner rounded, posterior part bearing a group of long and thin spinulae that exceed the border.

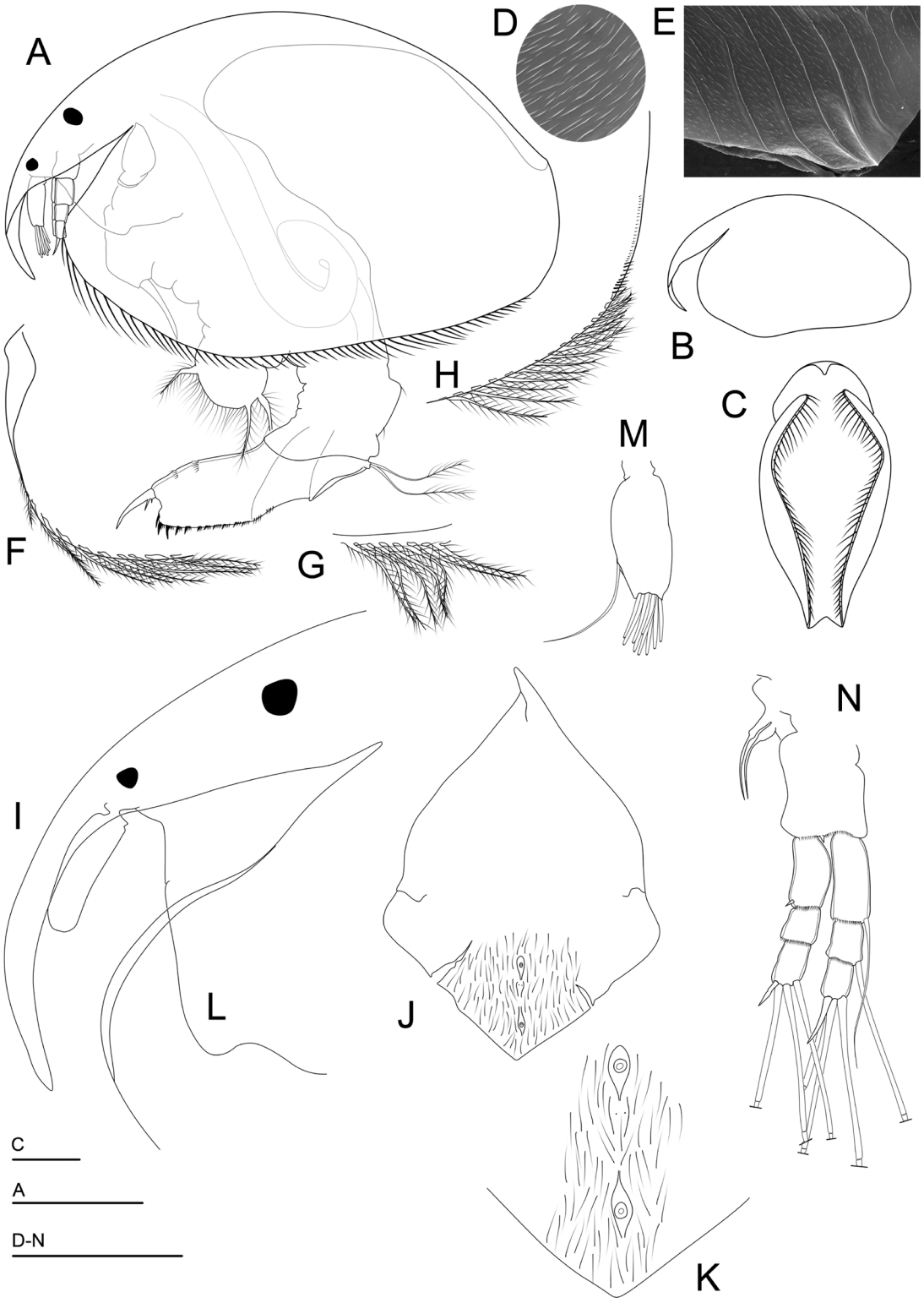

Fig. 7. *Disparalona* (*Mixopleuroxus*) *lucianae* sp. nov., parthenogenetic female. **A–B**. Habitus. **C**. Ventral view of carapace. **D–E**. Ornamentation of carapace. **F**. Anterior portion of ventral margin of carapace. **G**. Middle portion of ventral margin of carapace. **H**. Posterior portion and posteroventral corner of carapace. **I**. Rostrum. **J**. Head shield. **K**. Main head pores. **L**. Labrum. **M**. Antennule. **N**. Antenna. Scale bars = 50 μm. Figs B, D–E were not scaled.

Cephalic structures (Fig. 7I–N). Ocellus smaller than eye. Rostrum short, about 1.7 times longer than antennular body, slightly curved with sharp tip; straight in frontal view. *Head shield* (Fig. 7J–K). Anterior and posterior region triangular shaped, covered by striae; two main pores with two closely-set tiny pores between them, which are located closer to the anterior than posterior main pore, PP/IP about 0.5. *Labrum* (Fig. 7L). Keel not prominent, distal portion short and rounded, lateral horns present. *Maxilla*. Not studied. *Antennule* – A1 (Fig. 7M). Length about two times the width, not exceeding the tip of rostrum; antennular sensory seta slender, slightly shorter than antennular body, inserted in the last third of antennular body; nine aesthetascs which do not exceed the length of antennular body. *Antenna* – A2 (Fig. 7N). Coxal setae slightly shorter than first exopodite segment; basal segment thin with a short and thin spine; first exopodite and endopodite segments of different lengths; first endopodite segment armed with a short spine about 0.3 of length of the apical spine; exopodite apical spine about 1.3 times as long as apical segment and about 1.6 times as long as endopodite apical spine. Antennal formula (exo/endo): spines 001/101, setae 113/003.

Thoracic limbs (Fig. 8A–J). Five pairs of thoracic limbs. *First limb* (Fig. 8A–B). Epipodite not studied; ODL armed with a thin seta and a serrated seta similar in length to IDL third seta; IDL (en 4) with two group of short setulae, three setae present, third seta relatively thick, hook-like, heavily chithinized and with a group of short spines at distal part; seta 1 slender and armed with thin spines at distal part, about 2.2 times shorter than third seta; seta 2 about 1.2 times shorter than third seta, armed with long hard setulae; endite 3 with four setae, posterior setae (a–b) of different length and longer than anterior seta 1, seta (c) of similar length to seta (a); endite 2 with three posterior setae (d–f), seta (f) about 1.5 times shorter than seta (e) being that both setae bear thin setulae on the lateral face, seta (d) setulated and about 2.5 times shorter than seta (e), stiff setae similar in length to seta (d); endite 1 with three posterior setae of similar length (g–i), bisegmented and densely setulated from distal part; stiff setae about 1.5 times shorter than seta (f), seta (j) not studied; ejector hooks about 1.3 times shorter than corm of limb and armed with spines; ventral face of the limb with seven groups of long setulae organized in clusters. Gnathobase as a setulated seta. *Second limb* (Fig. 8C). Exopodite with a long seta armed laterally with short spinulae, about 2.8 times longer than exopodite itself; inner limb portion armed with one element and eight scrapers; scrapers 1–5 armed with thin setulae, 6–8 armed with thick spinulae; scrapers 1 and 3 of similar length; scraper 2 slightly shorter than scrapers 1 and 3; scraper 4 about 1.5 times shorter than scraper 3; scraper 5 longer than scraper 4; scraper 6 about 1.5 times as long as scrapers 7 and 8; proximal portion of gnathobase not elongated and armed with six long setulae; distal portion armed with four elements, first element is a sensillum, second element elongate with distal portion sharp, setulated and geniculated, third element armed with strong denticles, fourth element longer than mid-length of other elements; filter comb with eight setulated setae, first seta densely setulated and shorter than others. *Third limb* (Fig. 8D–E). Epipodite oval with a short projection; exopodite rectangular, about 2.5 times as heigh as wide, with four distal and three lateral setae; seventh seta long, about 2.4 times as long as sixth seta and about twice as long as fifth setae; fourth seta setulated, about 1.4 times as long as third seta; third seta setulated, longer than length of exopodite corm, about 1.6 times shorter than second seta; second seta setulated, about 1.3 times as long as first setae, longer than fourth seta; first seta thin, armed laterally with short spinulae; setae (1–2) of distal endite slender, seta 2 about 0.75 of length of the seta 1, seta 3 not studied; six long and setulated posterior setae of similar lengths (a–f); basal endite with four setae (3–6), distalmost seta longer than others; gnathobase armed with a long and cylindrical sensillum; filter comb with eight setulated setae. *Fourth limb* (Fig. 8F–I). Pre-epipodite rounded and densely setulated; epipodite oval without projection; exopodite with seven marginal setae; setae 3–7 plumose; seventh seta shorter than sixth, fifth, fourth and third setae; fifth seta slightly shorter than fourth seta; fourth seta about twice as long as second seta; first seta slender and short, about 0.4 of length of the second seta; distal endite with four setae (1–4), one scraper-like (1), three setae flaming-torch-like slightly setulated (3–4) longer than seta 1; basal endite armed with three setulated

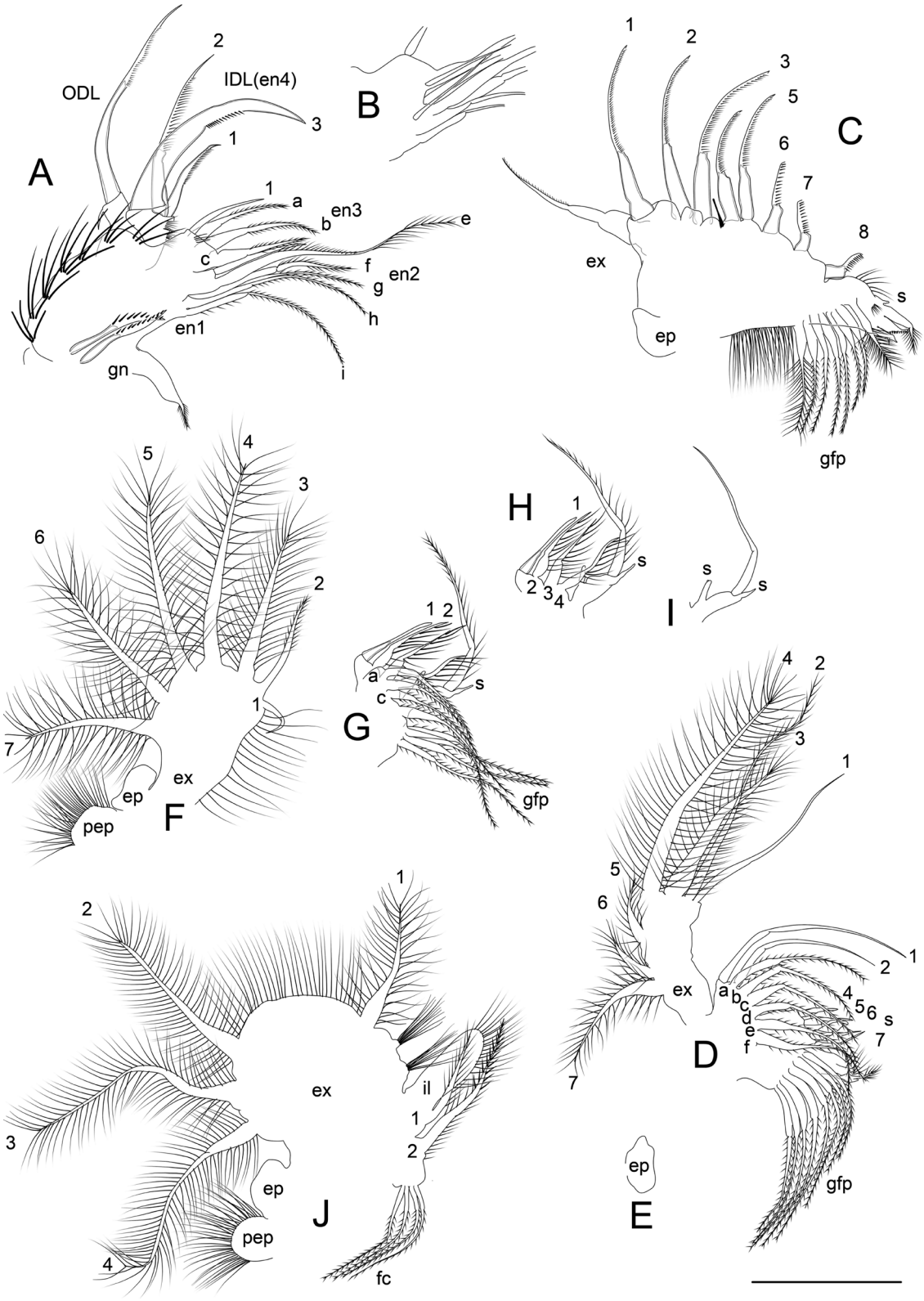

Fig. 8. *Disparalona* (*Mixopleuroxus*) *lucianae* sp. nov., parthenogenetic female. **A**. First limb. **B**. *Idem*, stiff setae. **C**. Second limb. **D**. Third limb. **E**. *Idem*, epipodite. **F–G**. Fourth limb. **H**. *Idem*, distal endite. **I**. Elements. **J**. Fifth limb. Scale bar = 50 μm.

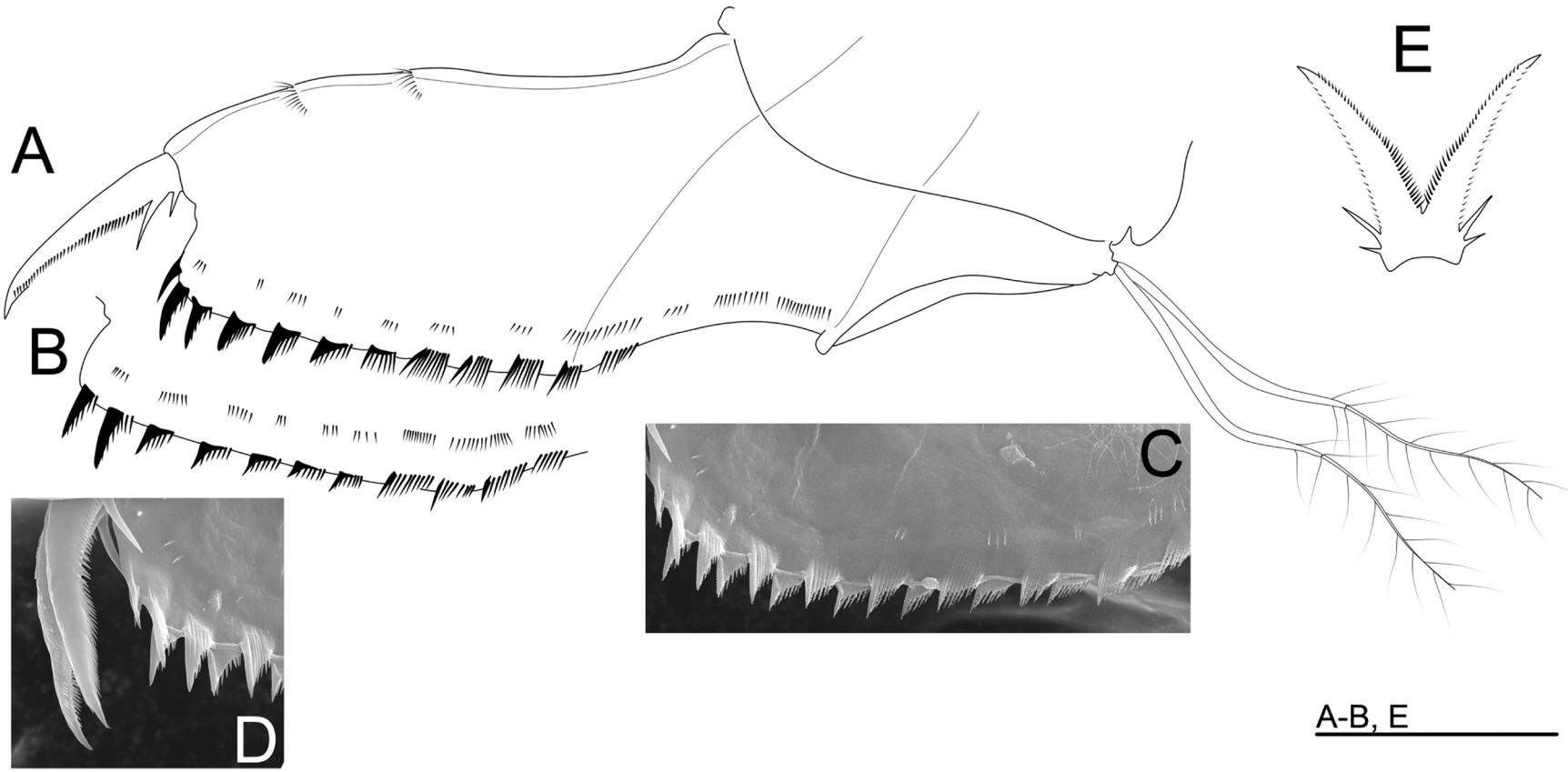

Fig. 9. *Disparalona* (*Mixopleuroxus*) *lucianae* sp. nov., parthenogenetic female. **A–E**. Postabdomen. **A**. Lateral view. **B–D**. Marginal denticles. **E**. Dorsal view of postabdominal claw (separation between claws not represented). Scale bar = 50 μm. Figs C–D were not scaled.

setae of similar length; gnathobase thick, with two elements, armed with one curved setulated seta about longer than width of endite; filter plate with six setae. *Fifth limb* (Fig. 8J). Pre-epipodite rounded and densely setulated; epipodite oval without projection; exopodite wide, rounded, armed with four plumose setae and two setulated hillocks implanted near first seta; first seta about 0.75 of length of the second seta; second seta about 0.7 of the length of the third setae; fourth seta about 0.9 of the length of the third seta; internal lobe elongated, relatively oval and with many setulae, two setae of different length on inner face of the lobe, seta 1 armed laterally with thick spinulae and setulae; seta 2 setulated, about 0.6 of length of the seta 1; gnathobase without elements; filter comb with four setulated setae longer than seta 2 of internal lobe.

Abdominal and postabdominal structures. *Abdomen* (Fig. 7A). About three times shorter than thorax. *Postabdomen* (Fig. 9A–E). About 3.4 times as long as wide, ventral margin slightly arched with two rows of short spinulae; anal margin about 1.2 times shorter than preanal margin; anal margin armed with one group of thin spines; postanal margin almost straight and long, about 1.6 times as long as anal margin, armed with 10 merged marginal denticles; distalmost denticle with width-at-base/height ratio about 0.23; lateral fascicle separated in 11 groups with short and thin spinulae, distalmost group bears 2–5 spinulae; postabdominal setae about 0.46 of length of the postabdomen, bisegmented, armed with setulae from distal part. *Postabdominal claw* (Fig. 9A–B, D–E). With two basal spines, about 0.25 of the length of the postabdomen and slightly shorter than anal margin, base naked; inner group of pecten separated in two groups, proximal with thick spinulae, distal thin spinulae; outer pecten armed with thin spinulae. *Basal spines* (Fig. 9E). Naked, distal about 0.22 of length of the postabdominal claw, proximal about 3.2 times shorter than distal one.

Ephippial female, ephippium. Unknown.

Male

Unknown.

Remarks

Disparalona (*M.*) *lucianae* sp. nov. is differentiated from *D.* (*D.*) *rostrata*, *D.* (*D.*) *leei*, *D.* (*D.*) *ikarus*, and *D.* (*D.*) *smirnovi* by the presence of seta 3 on the IDL thick, hook-like and heavily chithinized (Fig. 8A). *Disparalona* (*M.*) *lucianae* sp. nov. can be easily distinguished from *D.* (*M.*) *hamata*, *D.* (*M.*) *chappuisi* and *D.* (*M.*) *striatiodes* because it has the distal portion of labral keel short and rounded. *Disparalona (M.) lucianae* sp. nov. can be distinguished from *D. (M.) tenuispina* sp. nov. because the latter has a rostrum markedly short and curved, and about 1.3 times as long as antennular body, proximal basal spine of postabdomninal claw about 3.2 times shorter than distal one. Regarding the limbs, *D.* (*M.*) *lucianae* sp. nov. differs from *D.* (*M.*) *tenuispina* sp. nov. in the morphology of seta 2 of IDL, length of stiff setae on endites of first limb, and length of seta 1 on the exopodite of fourth limb. *Disparalona* (*M.*) *caudata* has a large body and postabdomen compared to *D.* (*M.*) *lucianae* sp. nov. (Smirnov 1996a, 1996b). *Disparalona* (*M.*) *lucianae* sp. nov. differs from the *D.* (*M.*) *acutirostris* in the morphology of rostrum (Frey 1961) and from *D.* (*M.*) *leptorhyncha* in the morphology of habitus, postabdomen and limbs.

Distribution and biology

Disparalona (*M.*) *lucianae* sp. nov. is the most common species of the *hamata*-complex occurring in Brazil. This species can be found in lentic water bodies such as, reservoirs, floodplain environments, ponds, and shallow lakes. *Disparalona* (*M.*) *lucianae* sp. nov. is somewhat common in lotic systems.

Disparalona (Mixopleuroxus) tenuispina sp. nov.
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Figs 10–13

Diagnosis

Body elongated, oval, length 0.33–0.52 mm, dorsal margin uniformly arched, ventral margin with wide aperture which is located after middle of body. *Carapace* covered by longitudinal lines and striae between them, posterodorsal corner with a notch; posteroventral corner rounded, posterior part bearing two groups of short and thick inner spinulae that do not exceed the border. *Rostrum* short, about 1.3 times longer than antennular body, curved with sharp tip. *Antennule* length about 2.6 times the width, not exceeding the tip of rostrum. *Antenna* coxal setae shorter than first exopodite segment, first endopodite segment armed with a short spine about 0.4 of length of the apical spine. *First limb* IDL seta 1 about 1.2 times shorter than second seta, armed with setulae, third seta relatively thick, hook-like, heavily chithinized, and with a group of short spines at distal part. *Second limb* exopodite with a long seta about 2.8 times longer than exopodite itself, inner limb portion armed with one element and eight scrapers. *Third limb* exopodite about two times as high as wide, fourth seta about two times as long as third seta. *Fourth limb* first seta very short, about 0.2 of length of the second seta. *Fifth limb* exopodite with characteristic shape, armed with four plumose setae. *Postabdomen* with anal margin about 1.4 times shorter than preanal margin, postanal angle evident; one unmerged marginal denticle, three merged marginal denticles, and six groups of long and thin spines; distalmost denticle with width-at-base/height ratio about 0.5. *Basal spines* naked, distal about 0.22 of length of the postabdominal claw, proximal about four times shorter than distal one.

Etymology

The epithet comes from the joining of the Latin words *tenuis* (fine) and *spina* (spine). The species' name refers to the groups of marginal setulae on the postabdomen.

Type material

Holotype

BRAZIL: parthenogenetic ♀, Bahia, Salvador, water saturated sand three meters distant from a black water coastal lagoon, Lagoa Vitória, 12°56′59″ S, 38°20′25″ W, Oct. 2016, Bou-Rouch pump collecting, R. Mugnai leg. (UFBA 2164).

Paratypes

BRAZIL: 11 parthenogenetic ♀♀, same data as for holotype (FDRS 0521).

Description of adult parthenogenetic female

General habitus (Fig. 10A–E). Body elongated, oval, length 0.33–0.52 mm, maximum height at located after middle of body, height/length ratio about 0.6; dorsal margin uniformly arched, without dorsal keel or lateral projection; in dorsal and ventral view body not laterally compressed; ventral margin with wide aperture which is located after middle of body.

Carapace (Fig. 10A–E). Covered by longitudinal lines and striae between them; anteroventral margin with a widened flange; ventral margin with slight depression before mid-length of body; 80–83 plumose setae per valve, of which the posterior group is longer than median and anterior groups, anterior and posterior setae internally articulated (the real number of setae is not represented in the figures); posterodorsal corner with a notch; posteroventral corner rounded, posterior part bears two groups of short and thick inner spinulae that do not exceed the border.

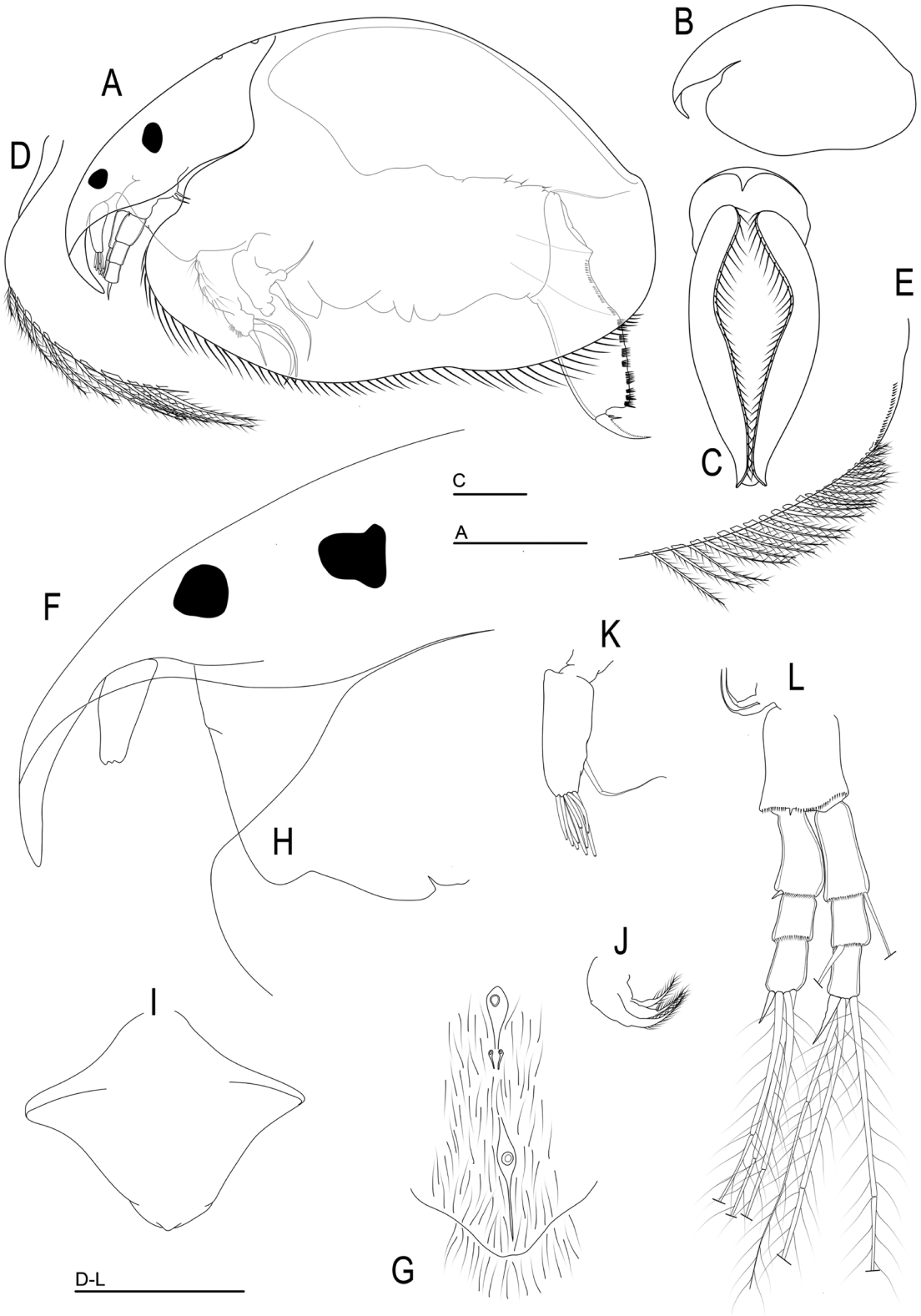

Fig. 10. *Disparalona* (*Mixopleuroxus*) *tenuispina* sp. nov., parthenogenetic female. **A–B**. Habitus. **C**. Ventral view of carapace. **D**. Anterior portion of ventral margin of carapace. **E**. Posterior portion and posteroventral corner of carapace. **F**. Rostrum. **G**. Main head pores. **H**. Labrum. **I**. *Idem*, frontal view. **J**. Maxilla. **K**. Antennule. **L**. Antenna. Scale bars: A = 80 μm; C–L = 50 μm. Fig. B was not scaled.

Cephalic structures (Fig. 10F–L). Ocellus smaller than eye. Rostrum short, about 1.3 times longer than antennular body, curved with sharp tip. *Head shield* (Fig. 10G). Covered by striae, posterior border with a projection behind main pores; two main pores with two closely-set tiny pores between them, which are located closer to the anterior than posterior main pore, PP/IP about 0.52. *Labrum* (Fig. 10H–I). Keel not prominent, distal portion short and rounded, lateral horns present. *Maxilla* (Fig. 10J). Well developed, with three setulated setae. *Antennule* – A1 (Fig. 10K). Length about 2.6 times the width, not exceeding tip of rostrum; antennular sensory seta slender, about 1.2 times shorter than antennular body, inserted in the last third of antennular body; nine aesthetascs not exceeding the length of antennular body. *Antenna* – A2 (Fig. 10L). Coxal setae shorter than first exopodite segment; basal segment thin with a short and thin spine; first exopodite and endopodite segments of different lengths; first endopodite segment armed with a short spine about 0.4 of length of the apical spine; exopodite apical spine slightly longer than apical segment and about 1.5 times longer than endopodite apical spine. Antennal formula: spines 001/101 (exo/endo), setae 113/003 (exo/endo).

Thoracic limbs (Fig. 11A–F)**.** Five pairs of thoracic limbs. *First limb* (Fig. 11A–B). Epipodite not studied; ODL armed with a short seta and a thin seta armed with short setulae, similar in length to IDL third seta; IDL (en 4) with two groups of short setulae, three setae present, third seta relatively thick, hook-like, heavily chithinized, and with a group of short spines at distal part; seta 2 slender and armed with thin setulae at distal part, about 1.8 times shorter than third seta; seta 1 about 1.2 times shorter than second seta, armed with setulae; endite 3 with four setae, posterior setae (a–b) of different length and longer than anterior seta 1, seta (c) of similar length to seta (a) and shorter than seta (b); endite 2 with three posterior setae (d–f), seta (f) about 1.5 times shorter than seta (e) being that both setae bear thick spinulae on the lateral face, seta (d) setulated and about two times shorter than seta (e), stiff setae similar in length to seta (d); endite 1 with three posterior setae of similar length (g–i), bisegmented and densely setulated from distal part; stiff setae about 1.3 times shorter than seta (f), seta (j) not studied; ejector hooks about two times shorter than corm of limb and armed with spines; ventral face of the limb with seven groups of setulae organized in clusters, the distalmost groups with setae shorter than others. Gnathobase as a setulated seta. *Second limb* (Fig. 11C). Exopodite with a long seta armed laterally with short spinulae, about 2.8 times longer than exopodite itself; inner limb portion armed with one element and eight scrapers; scrapers 1–5 armed with thin setulae, 6–8 armed with thin spines; scrapers 1–3 of similar length; scraper 4 about 1.4 times shorter than scraper 3; scraper 5 longer than scraper 4; scraper 6 about 1.6 times as long as scraper 7 and 1.2 times as long as scraper 8; proximal portion of gnathobase not elongated and armed with five long setulae; distal portion armed with four elements, first element is a sensillum, second element elongated with distal portion sharp setulated and geniculated, third element armed with strong denticles, fourth element longer than mid-length of others elements; filter comb with eight setulated setae, first seta densely setulated and shorter than others. *Third limb* (Fig. 11D). Epipodite oval with a short projection; exopodite rectangular about two times as high as wide, with four distal and three lateral setae; seventh seta setulated, about 1.7 times longer than sixth and fifth setae; fourth seta setulated, about two times longer than third seta; third seta setulated, longer than exopodite corm, about 1.4 times shorter than second seta; second seta setulated, about 1.2 times longer than first setae, shorter than fourth seta; first seta thin, naked; setae (1–2) of distal endite slender, seta 2 about 0.6 of length of seta 1, seta 3 not studied; six setulated posterior setae (a–f) decreasing in length towards gnathobase; basal endite with four setae (3–6), distalmost seta longer than others; gnathobase armed with a long and cylindrical sensillum; filter comb with eight setulated setae. *Fourth limb* (Fig. 11E). Pre-epipodite rectangular and densely setulated; epipodite oval without projection; exopodite with seven marginal setae; setae 3–7 plumose; seventh seta slightly shorter than sixth and fifth setae, longer fourth and third setae; fifth seta shorter than fourth seta; fourth seta about 1.8 times as long as second seta; first seta very short, about 0.2 of length of the second seta; distal endite with four setae (1–4), one scraper-like (1), three setae flaming-torch-like, slightly setulated (3–4), first flaming-torch longer than seta 1; basal endite armed with three setulated setae of similar

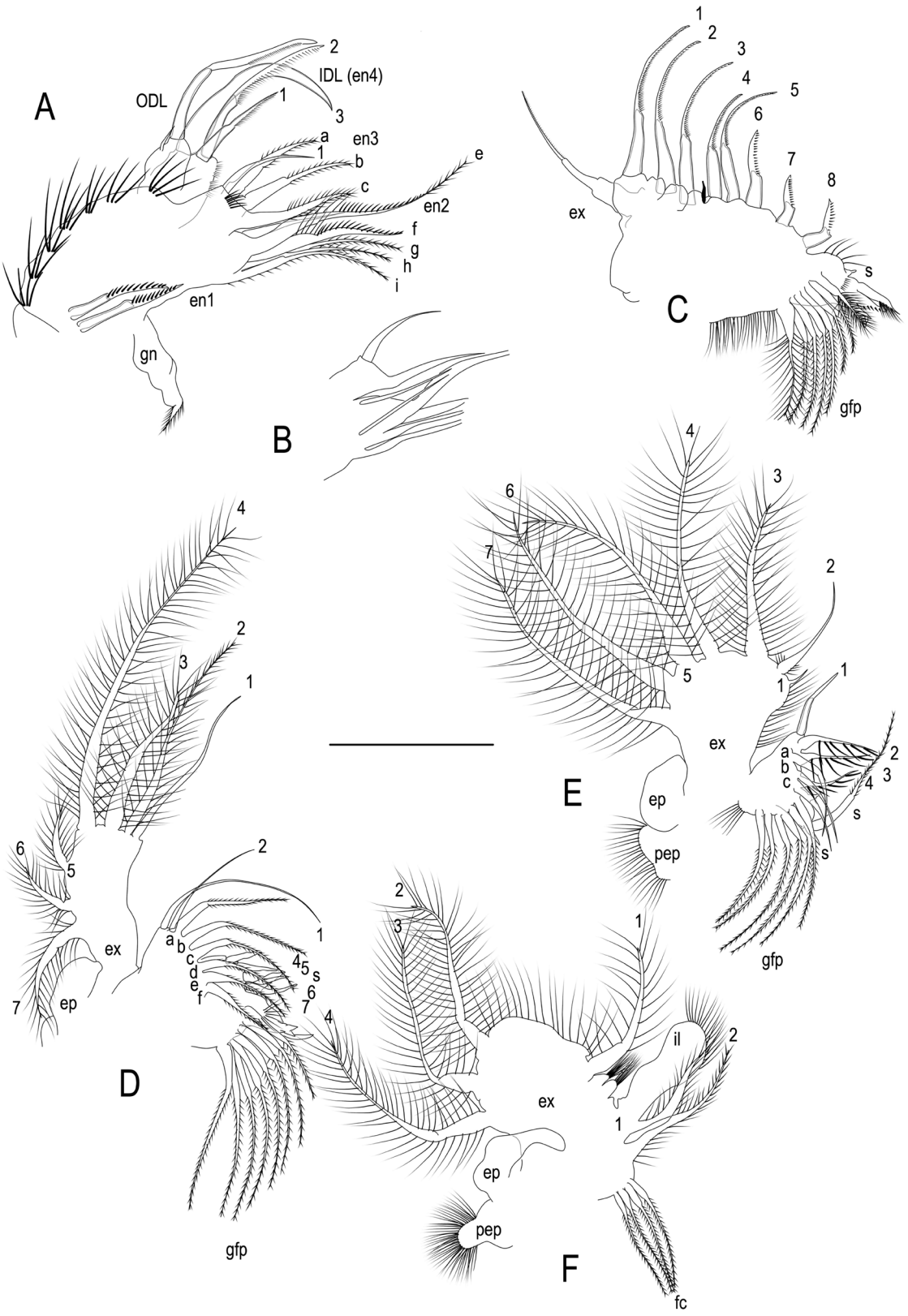

Fig. 11. *Disparalona* (*Mixopleuroxus*) *tenuispina* sp. nov., parthenogenetic female. **A**. First limb. **B**. *Idem*, stiff setae. **C**. Second limb. **D**. Third limb. **E**. Fourth limb. **F**. Fifth limb; Scale bar = 50 μm.

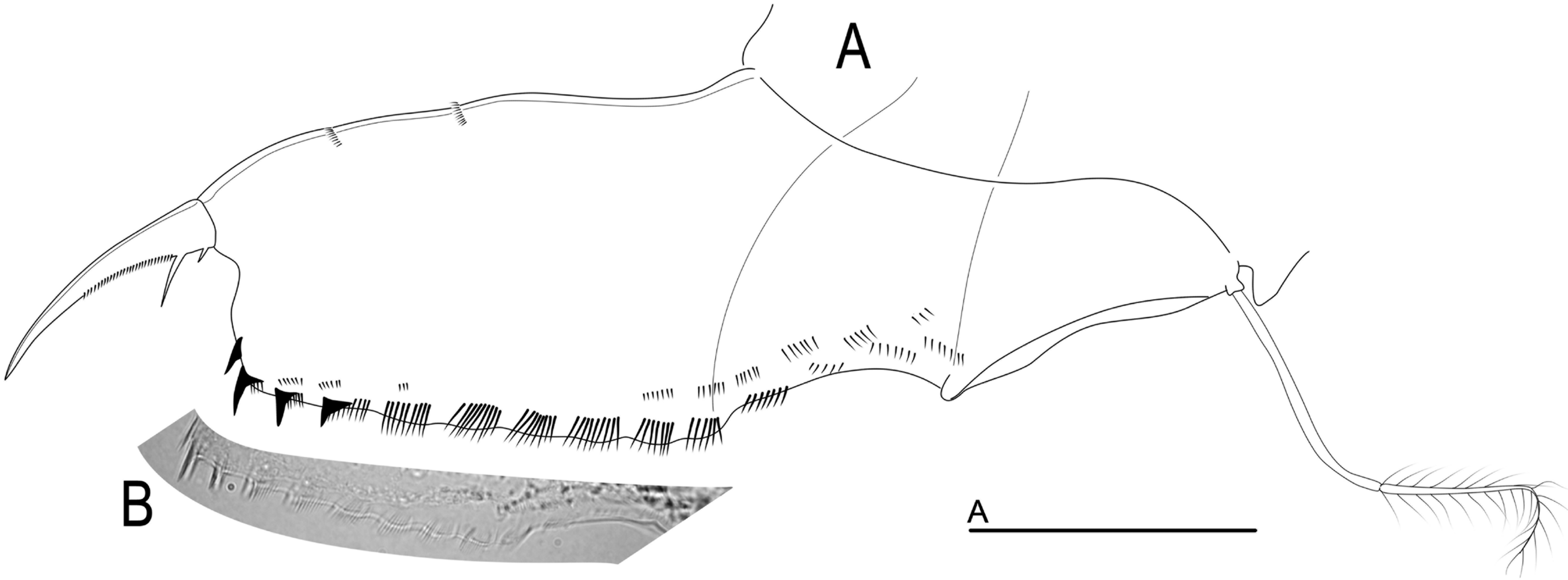

Fig. 12. *Disparalona* (*Mixopleuroxus*) *tenuispina* sp. nov., parthenogenetic female. **A–B**. Postabdomen. **A**. Lateral view. **B**. Marginal denticles. Scale bar = 50 µm. Fig. B was not scaled.

length; gnathobase thick, with two elements, armed with one curved setulated seta about 1.3 times longer than width of endite; filter plate with six setae. *Fifth limb* (Fig. 11F). Pre-epipodite rounded and densely setulated; epipodite oval with long projection; exopodite with characteristic shape, armed with four plumose setae and two setulated hillocks implanted near first seta; first seta about 0.8 of length of the second seta; second seta slightly shorter than third seta; fourth seta about 0.9 of the length of the third seta; internal lobe elongated, relatively oval and with many setulae, two setae of different length on inner face of the lobe, seta 1 armed laterally with thick spinulae and setulae; seta 2 setulated, about 0.7 of length of the seta 1; gnathobase without elements; filter comb with four setulated setae similar in length to seta 2 of internal lobe.

Abdominal and postabdominal structures. *Abdomen* (Fig. 10A). About three times shorter than thorax. *Postabdomen* (Fig. 12A–B). About three times as long as wide, ventral margin straight with two rows of short spinulae; anal margin about 1.4 times shorter than preanal margin, postanal angle evident; anal margin armed with one group of thin and long spines; postanal margin wavy , about 2.2 times as long as anal margin, armed with one unmerged marginal denticle, three merged marginal denticles and six groups of long and thin spines; distalmost denticle with width-at-base/height ratio about 0.5; lateral fascicle on the postanal face separated by a long gap, fascicules composed of short and thin spinulae; postabdominal setae about 0.42 of length of the postabdomen, bisegmented, armed with setulae from distal part. *Postabdominal claw* (Fig. 12A). With two basal spines, about 0.25 of the length of the postabdomen and slightly longer than anal margin, base naked; pecten composed of thin spinulae. *Basal spines* (Fig. 12A). Naked, distal about 0.22 of length of the postabdominal claw, proximal about four times shorter than distal one.

Ephippial female, ephippium. Unknown.

Male

Unknown.

Remarks

Disparalona (*M.*) *tenuispina* sp. nov. differs from all species of the genus by its markedly short and curved rostrum about 1.3 times as long as antennular body, the postabdomen armed with one unmerged marginal denticle, three merged marginal denticles and six groups of long and thin spines, and the lateral fascicle separated for a long gap. Furthermore, it can be differentiated from *D.* (*D.*) *rostrata*, *D.* (*D.*) *leei*, *D.* (*D.*) *ikarus,* and *D.* (*D.*) *smirnovi* by the presence of a thick, hook-like and heavily chithinized seta 3 on the IDL (Fig. 11A). The labral keel of *D.* (*M.*) *tenuispina* sp. nov. has distal portion short and rounded, differently from *D*. (*M.*) *hamata*, *D*. (*M.*) *chappuisi* and *D*. (*M.*) *striatoides*, which have labral keel with distal portion elongated (Neretina *et al.* 2018). When comparing the limbs of *D.* (*M.*) *lucianae* sp. nov. and *D.* (*M.*) *tenuispina* sp. nov., the main differences are in armature of the seta 2 of the IDL, length of stiff setae and armature of setae (e) and (f) of the first limb, length of scrapers 7–8 of the second limb, length of the seventh seta of the exopodite of the third limb, length of seta 1 on the exopodite of fourth limb, morphology of exopodite of the fifth limb, and proximal basal spine of postabdominal claw about four times shorter than distal one.

Distribution and biology

Disparalona (*M.*) *tenuispina* sp. nov. is an hyporheic species. It is rare, having been observed in the type locality only so far. *Disparalona* (*M.*) *tenuispina* sp. nov. was collected together with *Pseudosida ramosa* (Daday, 1904)*, Macrothrix* sp., *Chydorus eurtynotus* Sars, 1901, and *Ilyocryptus spinifer* Herrick, 1992.

Discussion

Fryer (1968) raised evidence to separate *Alonella rostrata* to a new genus (*Disparalona* Fryer, 1968), namely, the structure of a seta on the endite of the third limb and the way it is used for feeding. Afterwards, Fryer (1971) observed the same feeding behavior and morphology of the third limb in specimens of *Alonella acutirostris* Birge, 1879 [= *Disparalona acutirostris* (Birge, 1879)]. Although lacking in solid taxonomic basis to support *Disparalona*, Fryer's initial conclusions were correct.

Disparalona is separated from *Alonella* Sars, 1862 by many morphological traits, for example, the females of *Disparalona* have a comparatively elongated postabdomen bearing well-developed marginal denticles (in many cases, merged). Besides the habitus, *Disparalona* differ from *Pleuroxus* Baird, 1843 in the morphology of the head shield (see Frey 1993; Smirnov 1996a; Smirnov *et al.* 2006; Kotov *et al.* 2010). Recently, Sinev & Kotov (2014) evaluated the morphology of *Rhynchotalona* Norman, 1903 (Aloninae member, not Chydorinae) and showed several exclusive features for this genus. Differences related to *Disparalona* are observed in the habitus, labrum, head pores, postabdomen, and limb structures. *Alona* is a genus of another subfamily. *Phrixura* is an invalid taxon according to the International Commission of Zoological Nomenclature (ICNZ) and *Lynceus* Müller, 1776 is a genus of Laevicaudata Linder, 1845 branchiopod (Olesen *et al.* 2016).

Among all genera cited by Fryer (1968), *Alonella* presents more superficial morphological similarities to *Disparalona* (Frey 1959, 1961). Both genera share similar morphology of head shield and head pores. Smirnov (1966) noted similarities in the IDL morphology between *Alonella rostrata* [= *Disparalona* (*D.*) *rostrata* (Koch, 1841)] and *Alonella excisa* (Fisher, 1854) due to the presence of a hook-like thin seta. However, *Disparalona* has a considerable morphological variation in the setae on the IDL and there is difference in homology when comparing *Alonella* and *Disparalona*. Nevertheless, *Disparalona* and *Alonella* are considered to have a sister group relationship in phylogenetic analyses (Sacherová & Hebert 2003).

Using *Alonella dadayi* Birge, 1910 as an example (see Dr. Kotov's drawing in Hollwedel *et al.* 2003) and taking the ODL as reference, the most distal seta from IDL is slender, relatively thin and armed with setulae. The same structure is observed in *A. excisa* (Fische, 1854), *A. exigua* (Lilljeborg, 1853), *A. hampelae* Alonso & Kotov, 2017 (Alonso & Kotov 2017), and *Alonella clathratula* Sars, 1896. *Disparalona* (*D.*) *leei* (Chien, 1970), *D.* (*D.*) *ikarus* Kotov & Sinev, 2011 and *D.* (*D.*) *smirnovi* Sinev, 2015 share with *Alonella* the same morphology of seta 3 on the IDL (Smirnov 1971, 1996b; Flössner 2000; Hudec 2010). Altogether, these species of *Disparalona* represent a separate linage which received subgenus status (Neretina *et al.* 2018).

Disparalona (*Disparalona*) seems to be a linage with a mainly Holarctic distribution and with some species presenting intrusion in the Oriental zone. Species of *Disparalona* (*Disparalona*) also share a long spine of the first endopodite segment of the antenna (see Alonso 1996; Flössner 2000; Hudec 2010; Kotov & Sinev 2011; Klimovsky *et al*. 2015; Neretina *et al.* 2018). For species of this linage which have the first limb described, relatively short ejector hooks are observed when compared to length of corm limb. Another species that might belong to *Disparalona* (*Disparalona*) is *D. acutirostris* (Birge, 1879), but, limb description is lacking (for external morphology, see Frey 1961). It seems that the long seta on the filter plate of the third limb mentioned by Fryer (1968) is exclusive to (i.e. only belongs to *D. (D.)*, no other subgenus) or only observed in fresh animals.

In *D.* (*M.*) *hamata* (Birge, 1879), *D.* (*M.*) *lucianae* sp. nov., *D.* (*M.*) *tenuispina* sp. nov., *D.* (*M.*) *caudata* Smirnov, 1996, *D.* (*M.*) *striatoides* (Šrámek-Hušek, 1946), *D.* (*M.*) *chappuisi* and (Brehm, 1934) and *D.* (*M.*) *leptorhyncha* (Daday, 1905), the most robust, long hook-like and heavily chithinized seta on the IDL is homologous to seta 3 and observed in species of the Holarctic linage (Neretina *et al.* 2018).

Most species of *Disparalona* (*Mixopleuroxus*) linage are distributed in the subtropical and tropical zones with relict populations in the Holarctic zone (see Flössner 2000; Hudec 2010; Kotov *et al.* 2011; Neretina *et al.* 2018). So far, the Neotropics has higher diversity with four species: *D.* (*M.*) *hamata, D.* (*M.*) *lucianae* sp. nov.*, D.* (*M.*) *tenuispina* sp. nov., and *D.* (*M.*) *lepthorryncha*. Australia has a single species, *D.* (*M.*) *caudata*, which is also found in the Oriental Zone (Chatterjee *et al.* 2013; Sanoamuang 1998).

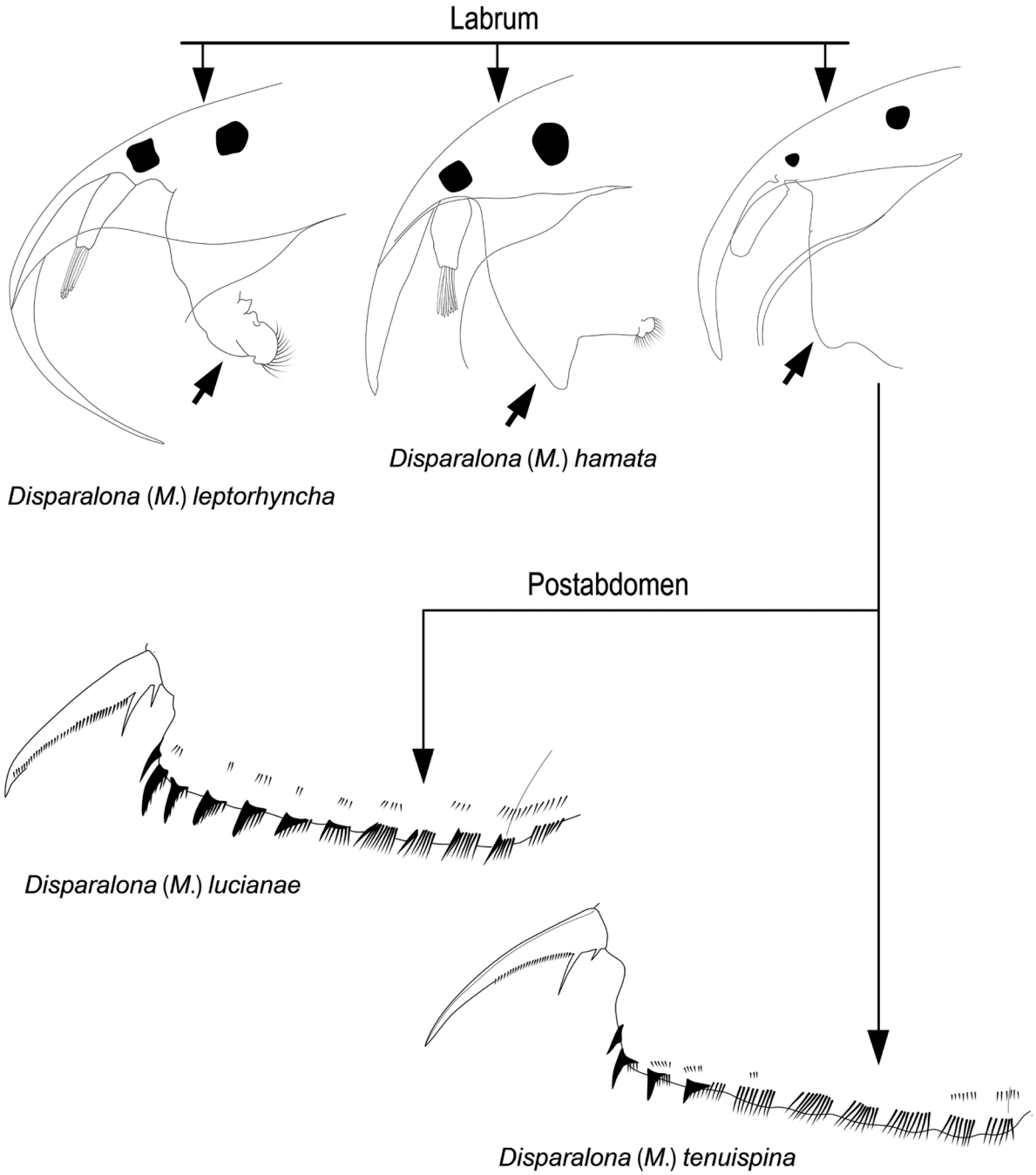

Fig. 13. Pictorial key to separation of species of *Disparalona* Fryer, 1968 occurring in South America.

Dumont (1981) found *Alonella* cf. *hamata* (= *Disparalona* (*M.*) *hamata*) in West Africa, but he questioned the validity of this population as being North American *D.* (*M.*) *hamata.* This species was also reported in other regions of Africa (Smirnov 1996b), East Asia (Idris & Fernando 1981; Sanoamuang 1998; Tanaka & Ohtaka 2010; Sinev & Korovchinsky 2013), South Korea (Kotov *et al.* 2011; Jeong *et al.* 2014), China (Sinev *et al.* 2015; Chertoprud *et al.* 2017), and Europe (Flössner 2000). It is now known that part of these populations belong to *Disparalona* (*M.*) *chappuisi*, but Neretina *et al.* (2018) indicated their cooccurrence with *D.* (*M.*) cf. *striatoides* in South Africa. *Disparalona* (*M.*) *hamata* sensu stricto occurs from North to South America (Rey & Vasquez 1986; Neretina *et al.* 2018), which was confirmed by our findings.

Disparalona (*M.*) *lucianae* sp. nov. and *D.* (*M.*) *tenuispina* sp. nov. have more affinities with *D.* (*M.*) *hamata* than with *D.* (*M.*) *leptorhyncha.* Because of its peculiar morphological traits, *D.* (*M.*) *leptorhyncha* does not belong to the *hamata*-group: a long and curved rostrum, closely-set tiny pores located halfway between main head pores, elongated labrum and nonexistent keel (Fig. 1M), relatively long and slender setae on the IDL, short seta on the exopodite of second limb and proximal portion of gnathobase flattened and naked (Fig. 2A–C). Van Damme & Dumont (2010) studied the morphology of *D.* (*M.*) *leptorhyncha* male, showing differences in the postabdomen shape and the position of gonopores when compared to *D.* (*M.*) *hamata* (Kiser 1950; Flössner 2000; Sinev & Sanoamuang 2011; Neretina *et al.* 2018), *D.* (*D.*) *leei* (Alonso 1996), and *D.* (*D.*) *rostrata* (Hudec 2010). Altogether, these difference and peculiarities lead us to argue that *D.* (*M.*) *leptorhyncha* is a specialized species within the *Disparalona* (*Mixopleuroxus)* linage.

Concluding remarks

The *Disparalona* genus can be recognized by morphology of habitus, labrum, and postabdomen. The redescription of *D.* (*M.*) *leptorhyncha* showed a peculiar morphology when compared to its congeners, leading us to argue that it is a specialized species within the *Disparalona* (*Mixopleuroxus*) linage. This linage is supported mainly by the hook-like seta 3 of the IDL morphology. Besides *D. leptorhyncha*, this clade is composed by *D.* (*M.*) *hamata*, *D.* (*M.*) *lucianae* sp. nov., *D.* (*M.*) *tenuispina* sp. nov., *D.* (*M.*) *caudata*, *D.* (*M.*) *chappuisi*, and *D.* (*M.*) *striatoides*. Those species that have a slender seta 3 of IDL armed with setulae belong to the *Disparalona* (*Disparalona*) linage, mainly distributed in the Holarctic zone (*D.* (*D.*) *rostrata*, *D.* (*D.*) *leei*, *D.* (*D.*) *ikarus* and *D.* (*D.*) *smirnovi*). Herein, we have improved knowledge about morphology and taxonomic status of *Disparalona* in South America.

Identification key of Disparalona *species in South America*

1. Labrum without keel .....***D. (M.) leptorhyncha*** (Daday, 1905)
– Labral keel poorly developed 2

2. Labrum with distal portion relatively elongated, triangular-shaped ..... ***D. (M.) hamata*** (Birge, 1879)
– Labrum with distal portion short and rounded 3

3. Postanal margin of postabdomen with three merged marginal denticles and six groups of thin spines, proximal basal spine about four times shorter than distal one .....***D. (M.) tenuispina*** sp. nov.
– Postanal margin of postabdomen with 10 merged marginal denticles, proximal basal spine about 3.2 times shorter than distal one .....***D. (M.) lucianae*** sp. nov.

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