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New records of the genus *Limnohalacarus* (Halacaridae, Trombidiformes) from southern Brazil

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Abstract: Two *Limnohalacarus* species are reported from the southern Brazilian state of Rio Grande do Sul, *Limnohalacarus cultellatus* Viets, 1940 and *L. mamillatus* Fain & Lambrechts, 1987, originally described on the basis of individuals from the Caribbean region and aquaria in Belgium, respectively. The former species is also known from Madagascar, Hungary, North America, and was referred to Brazil and El Salvador in the literature. The latter species is also known from Western Australia.

Key words: Acari, Prostigmata, Limnohalacarinae, Brazil, western South Atlantic

The fresh to slightly brackish water mites of the genus *Limnohalacarus* have a worldwide distribution. Its individuals often catch the attention during the sorting of meiobenthic samples due the usual presence of an ovoid body of excreted material and by the fact that females keep eggs attached to their hind legs until hatching.

According to Bartsch (2013a), the genus *Limnohalacarus* comprises 13 valid species: *L. africanus* Walter, 1935, *L. australis* Bartsch, 1999, *L. capernaumi* Petrova, 1966, *L. cultellatus* Viets, 1940, *L. dentatus* Bartsch, 2013, *L. fontinalis* Walter & Bader, 1952, *L. inopinatus* Fain & Lambrechts, 1987, *L. lanae* Green, 1976, *L. major* Bader, 1968, *L. mamillatus* Fain & Lambrechts, 1987, *L. novus* Bartsch, 2013, *L. portmanni* Bader, 1967, and *L. wackeri* (Walter, 1914). The genus is characterized by the sharing of the absence of the third pair of dorsal setae; the first pair of gland pores anteriorly placed; fourth and fifth pairs of gland pores on the striated cuticle lateral to posterior dorsal plate; genital acetabula arranged along lateral margins of genital plate (or region, with ventral plates merged into a ventral shield), including several acetabula anterior to the level of genital opening; anal sclerites very small; palps four-segmented, attached dorsally; apical pair of maxillary setae in dorsal position; second palpal segment with short basal spur and long distal seta, third with large ventral spine, and fourth with six setae and a spine; tarsi I to IV with pair of basal lamellae which may be fused to a ventral knob, tarsi with 1,0,0,0 ventral, 3, 3, 4, 3 dorsal setae; Paired claws of tarsi with pectines with arrangement and size of tines on claw I different from those on posterior tarsi.

Thus far, a single species was reported in the Neotropical region, *L. cultellatus*. Published records in America range from northern USA to the Caribbean region (Viets 1940; Bartsch 1984, 2011). According to Bartsch (2011) there are unpublished records from Central-West Region of Brazil (Mato Grosso State). The present article extends the range of *L. cultellatus* further south to Rio Grande do Sul and reports another species, *L. mamillatus*. Occurrences of both species are summarized in Figure 1.

The specimens were collected from floating aquatic plants on Imbé Lake (29°57′30.63″S, 50°09′14.50″W) (Imbé, Rio Grande do Sul, south Brazil). In fact, this "lake" drains to the sea and has a salinity gradient that ranges from brackish to freshwater. The companying fauna from the place where *Limnohalacarus* individuals were found, however, included only freshwater taxa, with representatives of the Hydrachnidia, genus *Arrenurus* Dugès, 1834, for example.

For the descriptions presented below, individuals were sorted under a stereoscopic microscope and were fixed in 70% alcohol. The diagnoses were based both on the specimens here described and data from literature (Bartsch, 2013a), including measurements. The mites were cleared in lactic acid and mounted in glycerin jelly. Individuals are deposited in the Acarological collection of the Universidade Federal de Minas Gerais (UFMG-AC). The illustrations were made with the aid of a drawing tube connected to a Leica DM2500 phase contrast microscope. The plates were prepared using Adobe Illustrator CS5.1.

The abbreviations used in the descriptions are as follows: AD, anterior dorsal plate; AE, anterior epimeral plate; AP, anal plate; ds, dorsal setae, from anterior to posterior: ds-1 to ds-5; GA, genitoanal plate; ε, *famulus*; gac, genital acetabula; glp, dorsal or lateral gland pores, from anterior to posterior: glp-1 to glp-5; GO, genital opening; GP, genital plate, mxs, maxillary setae; OC, ocular plate; pas, parambulacral seta; PC, *porus canaliculus*; PD, posterior dorsal plate; PE, posterior epimeral plate; pgs, perigenital setae; sgs, subgenital setae; ω, solenidion; legs numbered I to IV and the segments, from distal to proximal, are as follows: Tarsus, tibia, genu, telofemur, basifemur and trochanter; palpal segments are in the same order, numbered P4 to P1. The chaetotaxy formulas exclude the solenidia, *famuli* and parambulacral setae from the trochanter to the tarsus. The number of bipectinate spines is given in parentheses, employing roman numerals. Length of leg segments are measured along their dorsal margin.

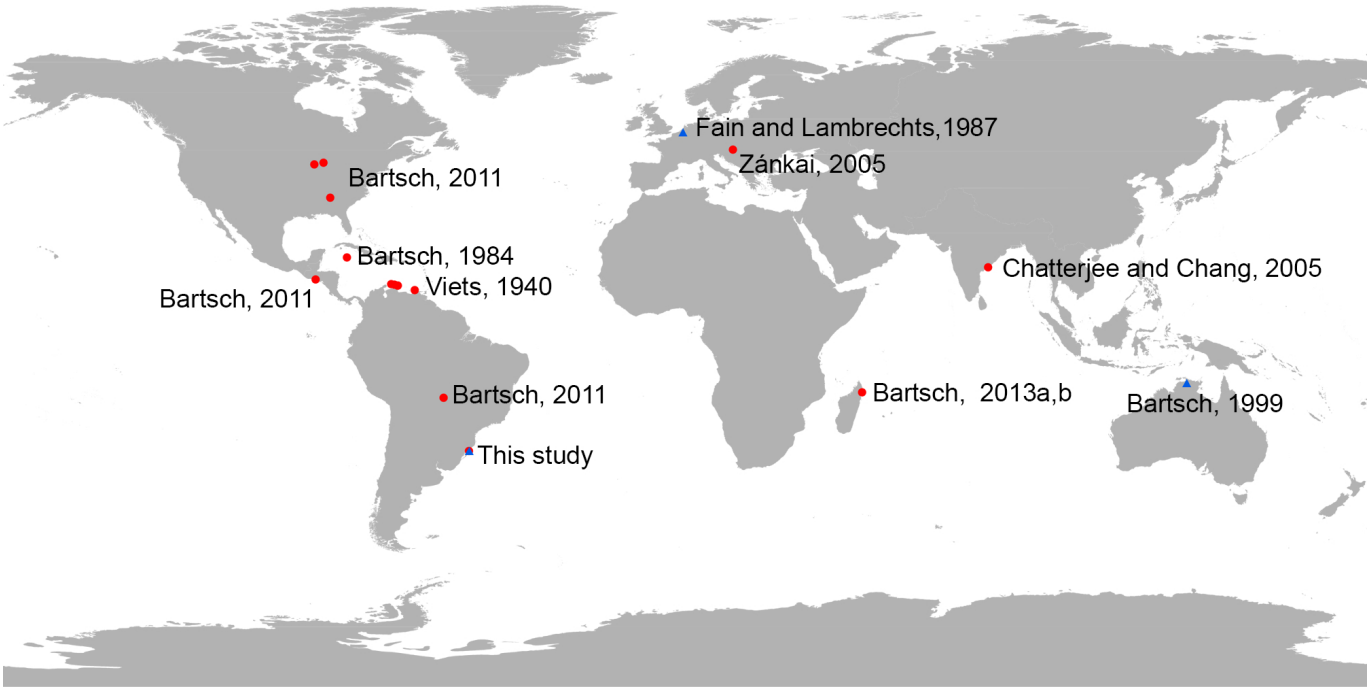

Figure 1. World map displaying records of *Limnohalacarus mamillatus* Fain & Lambrechts, 1987 (blue triangles) and *Limnohalacarus cultellatus* Viets, 1940 (red circles).

Limnohalacarus mamillatus Fain & Lambrechts, 1987
Figures 1–3

Diagnosis. Female: Length 295–347 µm. Medial and lateral eye pigment present. AD length:width ratio 0.8–0.9. OC 1.7–2.0 times longer than wide, including sclerite with gland pore. PD 1.6–1.8 times longer than wide and 2.8–3.0 times longer than AD. Second pair of dorsal setae absent. Ventral plates AE, pair of PE and GP fused to a shield. Area corresponding to GP with five to eight pairs of gac and three pairs of pgs. Genital sclerites 1–2 pairs of sgs. Gnathosoma 1.0–1.2 times longer than wide. P-2 arched, with notch between short basal and long distal seta. Trochanters I to IV with 1, 1, 1, 0 setae, basifemora with 4, 4, 2, 1 setae. Genu III with four setae. Tibiae I to IV with 9, 6–7, 7, 6 setae; none of setae on tibiae I and II barbed; tibia III with two wide, bipectinate ventromedial and two slender and smooth ventrolateral setae. Tarsus I with spiniform basal lamellae. Tarsi I and II with pairs of pas doublets tarsi III and IV with singlets. Claws on tarsus I with long, slender tines. Claws II to IV with lamellar basal process. Male: Not known.

Description. Females (UFMG-AC1200649–51, UFMG-AC1200667): Idiosoma 335–347 µm long, 226-253 µm wide. Dorsal plates uniformly reticulated. AD hexagonal, posterior border slightly concave, length 83–85µm, width 96–100 µm, length/width ratio 0.84–0.93. Medial eye pigment seen underneath a small raised area at medial anterior AD, with ds-1 at its posterior margin (Figure 2A). Second pair of dorsal setae absent. OC triangular, length 91–98µm, width 46–55 µm; with *porus canaliculus* in lateral margin and gland pore in posterior half. OC length:width ratio 1.65–2.00. Corneae not discernible, but eye pigment evident. PD elongate, 239–248 µm long, 134–152 µm wide. PD length:width ratio 1.62–1.84. PD 2.86–2.96 times longer than AD. Pair of dorsal setae on PD at 0.42–0.49 of its length. Pairs of glp-4 and glp-5 on striated cuticle lateral to PD. Adanal setae in ventromarginal position on anal plate. Ventral plates AE, pair of PE and GP fused to a shield (Figure 2B). Area corresponding to GP with three pairs of pgs and 9–13 gac (Ø approx. 4.3–5.0 µm). GO in posterior part of ventral shield. Genital sclerites large, 56–66 µm long, 72–86 µm wide, with 1–2 pairs of sgs. Length of gnathosoma 65–75 µm, width 64–68 µm, gnathosoma length:width ratio 1.0–1.1. Rostrum short, 29–37 µm long, equal to 0.45–0.52 of gnathosoma length. Dorsal pair of maxillary setae stout, basal pair slender (Figure 2C–D). Pharyngeal plate apart from posterior margin of infracapitulum by 4–7 µm. Dorsal margin of P-2 arched, with small notch between setae (Figure 2G). Legs slender, length/height of telofemora I–IV: 2.08–2.31, 1.87–2.18, 1.84–2.03, 1.85–2.14 times, respectively. Telofemur/tibia length ratio, legs I–IV: 0.95–0.98, 0.86–0.90, 0.57–0.60, 0.50–0.54. Leg chaetotaxy, from trochanter to tarsus: leg I, 1, 4, 4 (-5 asymmetrically, single individual), 6, 9, 4; leg II, 1, 4, 4, 6, 7, 3; leg III, 1, 2, 3, 4, 7 (II), 4; leg IV, 0, 1, 3, 3, 6, 3. Tibia I with two ventral and one medial spiniform setae (Figure 2F). Tibia III with two wide, bipectinate ventromedial and two slender and smooth ventrolateral setae (Figure 2H). Tarsi basally with lateral and medial spiniform lamellae, apically with lateral and medial membranes of claw fossa. Tarsi I to IV with 3/1, 3/0, 4/0, 3/0 dorsal/ventral setae (solenidia and pas excluded). Tarsi I and II with solenidion in dorsolateral position. Tarsus I with pore of *famulus* immediately lateral to solenidion (Figure 2E). Tarsi I and II with pairs of pas doublets (Figures 2F, I), tarsi III and IV with pairs of pas of singlets (Figures 2H,J). Claw I with long tines arranged along inner flank and distal outer portion of claw. Claws on tarsi II to IV with tines and a well-developed basal lamellar process.

Deutonymph (UFMG-AC1200652) (Figure 3). Idiosoma 302 µm long, 207 µm wide. OC sub-pentagonal, 36 µm long, 51 µm wide separated from triangular sclerite 36 µm long, 21 µm wide, bearing a gland pore. Eye pigment evidence the presence of medial and lateral eyes. Ventral plates separated.

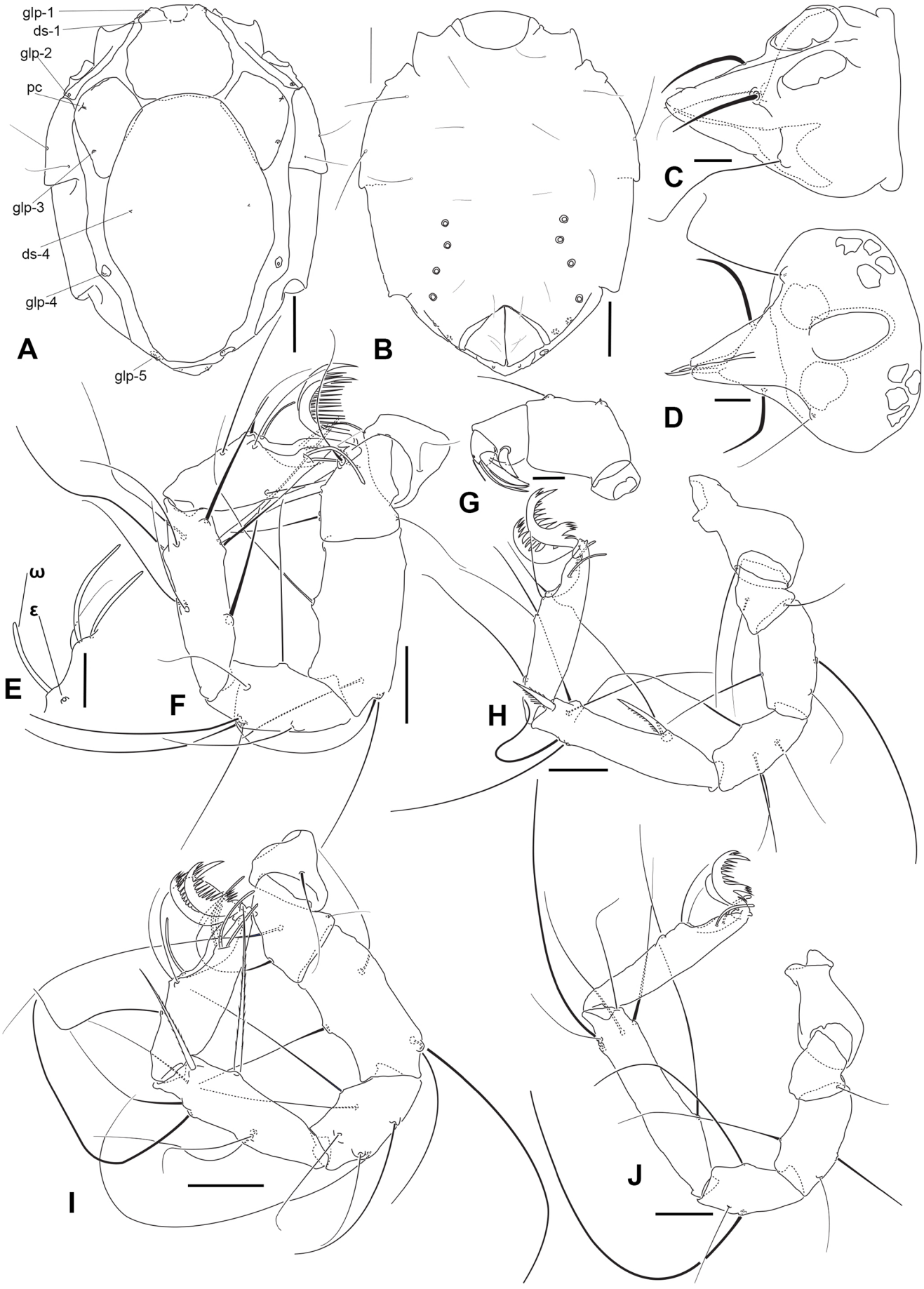

Figure 2. *Limnohalacarus mamillatus* Fain & Lambrechts, 1987, female. A: Idiosoma, dorsal. B: Idiosoma, ventral. C: Gnathosoma dorsolateral. D: Gnathosoma ventral. E: Detail from Tarsus I, dorsal. F: Leg I. G: Palp. H: Leg III. I: Leg II. J: Leg IV. Scale Bars: A–B, 100 µm; C–E, G, 10 µm; F, H-J, 25 µm.

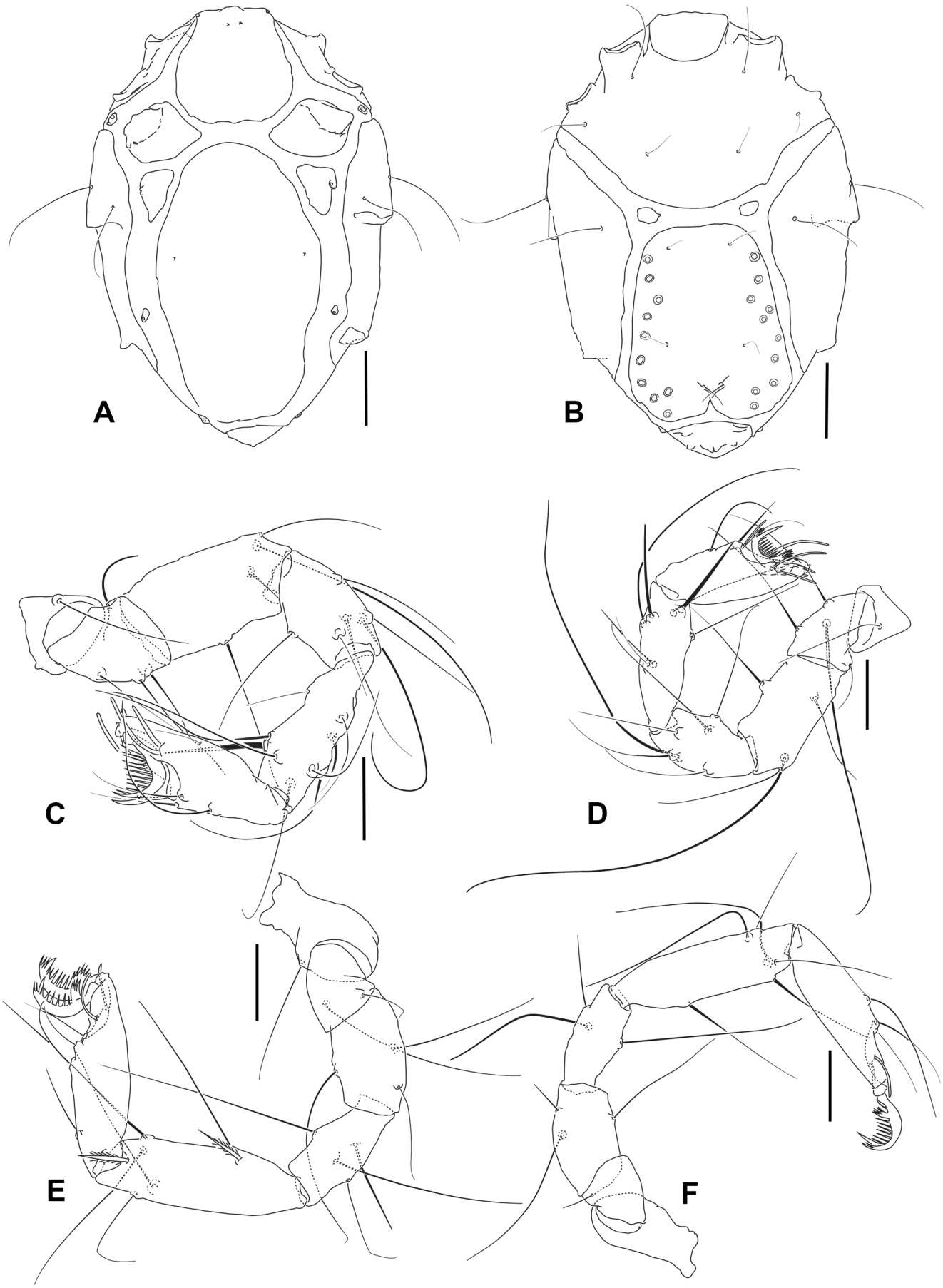

Figure 3. *Limnohalacarus mamillatus* Fain & Lambrechts, 1987, deutonymph. A: Idiosoma, dorsal. B: Idiosoma, ventral. C: Leg I. D: Leg II. E: Leg III. F: Leg IV. Scale Bars: A–B, 50 µm; C–F, 25 µm.

AE 107 µm long, 200 µm wide. GP 146 µm long, 119 µm wide, bearing two pairs of pgs, one pair of sgs flanking prospective GO, and 20 gac on marginal portions of the plate. Legs similar to adults concerning claw morphology. Chaetotaxy: leg I, 1, 4, 4, 6, 9,4; leg II, 1, 4, 4, 6, 7,3; leg III, 1, 2, 3, 4, 7(II),4; leg IV, 0, 1, 3, 3, 6,3.

Material Examined. Four females (UFMG-AC1200649–51, UFMG-AC1200667), and a deutonymph (UFMG-AC1200652), on floating aquatic plants at Imbé Lake (29°57′30.63″S, 50°09′14.50″W) (Imbé, Rio Grande do Sul, south Brazil), 04 October 2006, coll. Pepato, A. R.

Limnohalacarus mamillatus belongs to a clade supported in Bartsch (2013a) analysis by the sharing of glp-3 on OC, and not in a separate sclerite (Character 1); ds-2 absent (information lacking for some species, Character 2); and fused ventral plates (Character 4), which comprises the species *L. dentatus*, *L. fontinalis*, *L. lanae*, *L. mamillatus*, *L. novus*, and *L. portmanni*.

Limnohalacarus mamillatus may be set apart from all those species for bearing 9 setae on tibia I. Bartsch (1999) described the species *L. billabongis* as a distinct species based upon specimens from the Northern Territory, Australia due differences in exoskeleton ornamentation (only marginal areas of PE and lateral portions of PD have a reticulate ornamentation according *L. mamillatus* original description, instead the entire plate as *L. billabongis*). Further minor differences regards their length:width ratios, the position of the basal seta on P-2, and the size of the dorsal pair of maxillary setae. In her revision of the genus *Limnohalacarus*, Bartsch (2013a) regarded all these differences as negligible, and *L. billabongis* as a junior synonym of *L. mamillatus*, something we follow here.

Concerning the above mentioned minor differences, Brazilian specimens are in complete agreement with the material described by Bartsch (1999) from Australia. Only the number of pgs is variable, with one or two pairs on genital sclerites of Brazilian material instead of a single pair of such setae in Australian individuals.

Limnohalacarus cultellatus Viets, 1940

Figures 1 and 4

Diagnosis. Female: Length 272–325 µm. Dorsal plates reticulated, except for smooth anteriormost part of AD. Medial and lateral eye pigment absent. Length:width ratio of AD 1.0–1.2. OC divided, with narrow triangular sclerite bearing gland pore. PD 1.5–2.1 times longer than wide and 2.5 times longer than AD. Second pair of dorsal setae present. Ventral plates separated. GP with 4–9 pairs of gac, three, rarely four pairs of pgs and two pairs of sgs. Gnathosoma 1.3–1.5 times longer than wide; rostrum slender. Both pairs of maxillary setae slender. Pharyngeal plate removed from margin of gnathosomal base by more than half its length. P-2 basally abruptly widened, in lateral aspect rectangular and with straight dorsal margin. Telofemur I 1.6–1.8 times longer than wide. Tarsi with spiniform lamellae near their bases. Trochanters I to IV with 1, 1, 1, 1 setae, basifemora with 4, 3, 2, 1 setae, genu III with four setae, and tibiae I to IV with 7, 6, 7, 6 setae. On tibiae I to III 1, 1, 2 of setae pectinate, on tibia IV all setae slender. Tibiae III and IV with four and three ventral setae, respectively. All tarsi with pairs of pas singlets. Claws on tarsus I slender, claws with lamellar basal process and delicate apical tines. Claws of tarsi II to IV with series of tines from apical accessory process to basal process. Male: Not known.

Description. Females (UFMG-AC120066 (measurements) and UFMG-AC120068) Idiosoma 303 µm long, 205 µm wide. Dorsal plates reticulated. AD hexagonal, anterior most transverse area set off from the reticulated major part of the plate, posterior border truncate, length 82 µm, width 81 µm, length:width ratio 1.01. Medial eye pigment absent, ds-1 on an anterior slightly raised area (Figure 4A). Second pair of dorsal setae present. OC sub-pentagonal, 49 µm long, 46 µm wide separated from triangular sclerite 37 µm long, 16 µm wide, bearing a gland pore. OC length: width ratio 1.06. Neither corneas nor eye pigment discernible. PD elongate, 198 µm long, 129 µm wide, 2.53 times longer than AD. PD length:width ratio 1.53. Pair of dorsal setae on PD at 0.49 of its length. Pairs of glp-4 and glp-5 on striated cuticle lateral to PD. Adanal setae in ventromarginal position on anal plate. Ventral plates AE, pairs of PE and GP separated by stripes of membranous cuticle (Figure 4C). AE 114 µm long, 187 µm wide, with three pairs of ventral setae, PE with three setae. GP 100 µm long, 139 µm wide, with three pairs of pgs and 11–14 gac (Ø approx. 4 µm). GO in posterior part of ventral shield. Genital sclerites large, 51 µm long, 70 µm wide, with two pairs of sgs. Length of gnathosoma 95 µm, width 74 µm, gnathosoma length:width ratio 1.28. Rostrum long, 48 µm long, equal to 0.51 of gnathosoma length. Dorsal pair of maxillary setae almost as slender as basal pair (Figure 4D–E). Apical setae at tip of rostrum stouter than the dorsal one (Figure 4D). Pharyngeal plate apart from posterior margin of infracapitulum by 13 µm (Figure 4E). Dorsal margin of P-2 straight (Figure 4D). Legs slender, length/height of telofemora I–IV: 1.78, 1.79, 1.80, 1.77 times, respectively. Telofemur/Tibia length ratio, legs I–IV: 0.98, 0.81, 0.64, 0.62. Leg chaetotaxy, from trochanter to tarsus: leg I, 1, 4, 4, 6, 7(I), 4; leg II, 1, 3, 4, 6, 6 (I), 3; leg III, 1, 2, 3, 4, 7 (II), 4; leg IV, 1, 1, 3, 3, 6, 3. Tibia III with two wide, bipectinate ventromedial and two slender and smooth ventrolateral setae (Figure 4H). Tarsi basally with spiniform lamellae, apically with lateral and medial membranes of claw fossa. Tarsi I to IV with 3/1, 3/0, 4/0, 3/0 dorsal/ventral setae (solenidia and pas excluded). Tarsi I and II with solenidion in dorsolateral position. Tarsus I with porus of *famulus* immediately lateral to solenidion. All tarsi with pairs of pas singlets. Claw I with lamellar basal process and delicate apical tines. Claws on tarsi II to IV with series of tines from apical accessory process to basal process.

Material Examined. Two females (UFMG-AC120066 and UFMG-AC120068), on floating aquatic plants at Imbé Lake (29°57′30.63″S, 50°09′14.50″W) (Imbé, Rio Grande do Sul, Brazil), 04 October 2006, coll. Pepato, A. R.

According to Bartsch (2013a), *Limnohalacarus cultellatus* is member of a clade including *L. australis* and *L. inopinatus*, supported by sharing the presence of three setae on basifemur II and delicate tines on lateral claws at apotele I. Setting these species apart from each other is difficult, and Bartsch (2013a) kept them as separate due the presence of less tines on claws I of *L. australis* and presence of a rather thick, barbed seta on tibia IV of *L. inopinatus*. Chatterjee and Chang (2005), based upon individuals collected in southern India, proposed a new species, *L. kakinadus*. According to them, this species may be set apart from *L. cultellatus* due the presence of an elevated

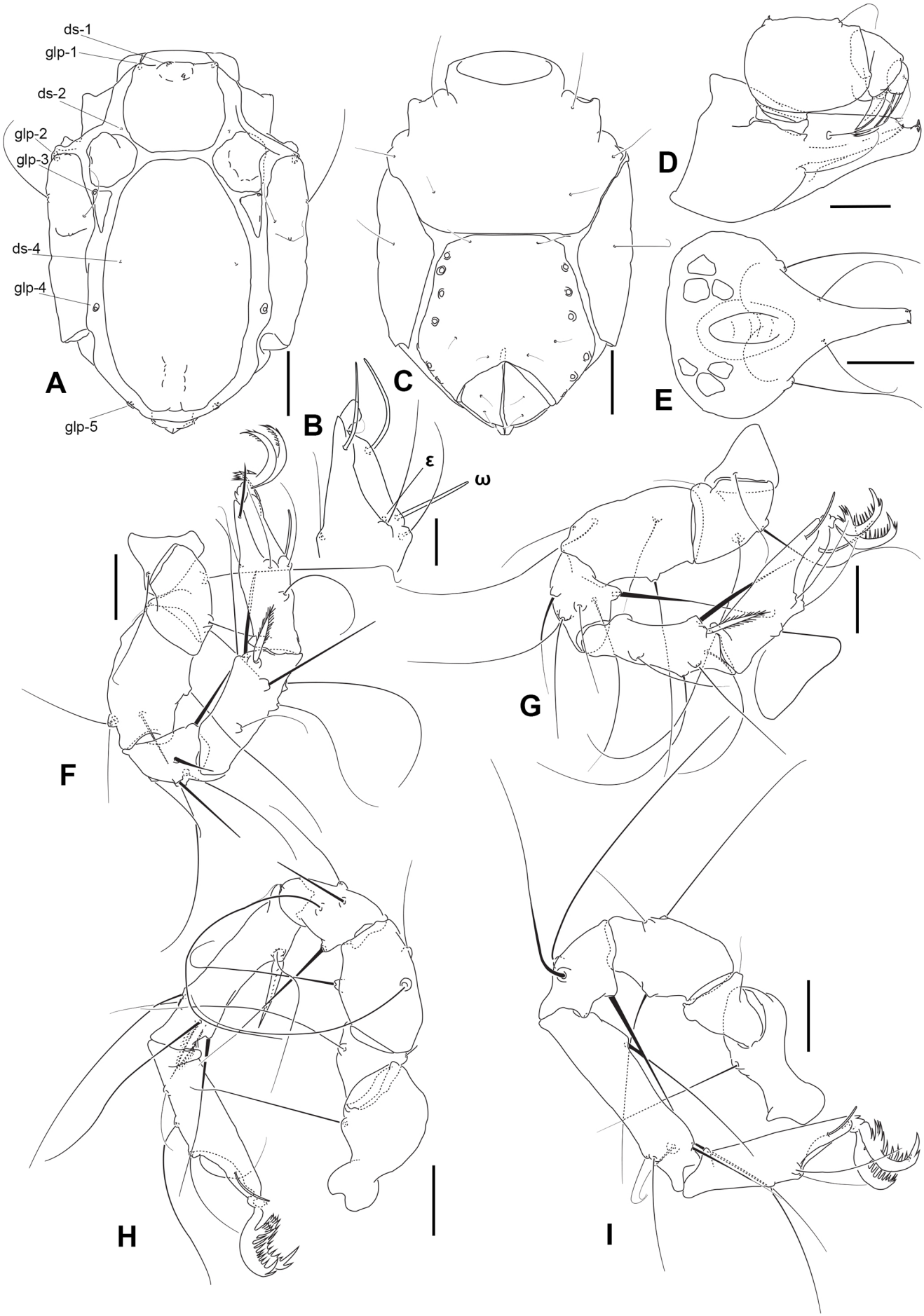

Figure 4. *Limnohalacarus cultellatus* Viets, 1940, female. A: Idiosoma, dorsal. B: Tip of tarsus I. C: Idiosoma, ventral. D: Gnathosoma lateral. E: Gnathosoma ventral. F: Leg I. G: Leg II. H:- Leg III. I: Leg IV. Scale Bars: A, C, 50 µm; B, 10 µm; D–I, 25 µm.

crest (a raised area on anterior AD) and the first pair of dorsal setae being apart from the anterior margin of anterior dorsal plate. Both features, however, could be observed in Brazilian material. In the original description, Viets (1940) depicted the anterior strip of smooth cuticle on AD in his Figure 5 and mentioned the "crest" as a domed area bearing pair of ds-1 ("...hat das Praedorsale vorn in der Mitte keine Spitze neben den beiden dort stehenden Härchen, sondern nur eine sanfte Vorwölbung seines Vorderrandes").

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Authors' contribution statement: ARP collected the mites, mounted the slides, made the drawings, took some measurements, and shared the writing with SGSC, who also took measurements, prepared the final figures and corrected the manuscript format. Both authors read and approved its final version.

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