

A new species of *Clathrosperchonella* Lundblad 1937 (Acariformes: Hydrachnidia: Hydryphantoidea: Rhynchohydracaridae) from Brazil, with descriptions of the female, male and larva

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Abstract

We describe a new species of the genus *Clathrosperchonella*, *C. olovi* **sp. nov.** from Brazil, including complete information for female, male and larva. This brings the number of named species in the Rhynchohydracaridae to thirteen. In addition, we provide a key to named species of *Clathrosperchonella*.

Key words: water mites, *C. olovi*, streams, morphology, taxonomy

Introduction

The water mite family Rhynchohydracaridae includes five genera and, up to now, twelve named species (Zhang *et al.* 2011). These mites inhabit lotic habitats such as the surface and interstitial waters of streams (Cook 1974; Smith *et al.* 2010), as well as springs. They are often found on algae, moss and root mats associated with rocks (Cook 1980). Ecological characteristics related to their larval hosts, prey during deutonymphal and adult stages, and mode of sperm transfer still remain unknown (Proctor *et al.* 2015). Regarding their distribution and taxonomy, rhynchohydracarids appear to be restricted to the New World and are currently arranged into three subfamilies (Walter *et al.* 2009): Clathrosperchontinae, distributed through North, Central and South America (Cook 1974, 1980); Rhynchohydracarinae, which is restricted to the Neotropical region (Di Sabatino *et al.*, 2008) and Santiagocarinae, known only from Central America (Valdecasas 2001) (Table 1). Here we increase knowledge of Rhynchohydracaridae from Brazil and Neotropical region by describing a third species of *Clathrosperchonella*, including complete morphological descriptions of female, male and larva, plus a discussion about its distinctive morphological features and distribution. It is the first time that a rhynchohydracarid larva is described. We also provide a key to known *Clathrosperchonella* species.

Material and methods

Water mites were collected by the first author, removing mosses with a spatula from submerged rocks in a shallow, unnamed rainforest stream that flows in “Poço das Antas” in Cardoso Island State Park, Cananéia, São Paulo, Brazil (Fig. 1A). Moss mats were transferred with water to plastic vials and taken to a laboratory at University of São Paulo, where mites were separated from the substrate

under a stereomicroscope. Males were immediately preserved in GAW solution (Proctor *et al.* 2015) whereas females were kept in small glass containers filled with water and kept in the laboratory at room temperature, between 20–25°C, for oviposition. A single female laid a small clutch of three eggs on the bottom of the plastic vial. Embryonic development in the laboratory took 20 days, in a temperature ranging between 20–25°C, from oviposition to hatching. After hatching, larvae were directly slide-mounted in PVA (BioQuip, CA, USA) and females were also preserved in GAW solution for subsequent dissection, slide-mounting in Hoyer's medium and taxonomical study, using differential interference contrast microscopy.

Adult idiosomal structures are named according to the terminology used in Lundblad (1927). Dorsal region: *dgl*—dorsoglandularia, *lgl*—lateroglandularia, *pr*—preocularia, *po*—postocularia. Ventral region: *cxgl*—coxoglandularia, *vgl*—ventroglandularia. Gnathosoma: P-1 to P-5—palp segments from proximal to distal. For larval idiosomal and leg setae, we employed the terminology used by Smith *et al.* (2010) and Proctor *et al.* (2015). Dorsal region: *vi*—internal vertical, *si*—internal scapular; *ve*—external vertical, *se*—external scapular; *c1*, *c2*, *d1*, *d2*, *e1*, *e2*—hysterosomal setae. Ventral region: *1a*, *1b*, *3a*—coxal plate setae; *ps1*, *ps2*—setae associated with the excretory pore; *fl*, *h1*, *h2*, *h3*, *h4*—hysterosomal setae. Gnathosoma: P-1 to P-5—palp segments from proximal to distal; *Hy1*, *Hy2*—hypostomal setae. Legs: I, II or III—Leg-1 to 5 free leg segments from proximal to distal (trochanter, femur, genu, tibia and tarsus); (σ) for solenidion on each genu of leg I to III; (ϕ) for solenidion on each tibia of leg I to III; (ω) for solenidion on each tarsus of legs I to II; (“2”) for eupathidium on each tarsus of leg I to II; L—length; W—width; n—number of specimens measured. All measurements are given in μm . The holotype and paratypes of the new species are deposited in the Acari collection of Department of Zoology and Botany (DZSJRP), São Paulo State University, São José do Rio Preto, Brazil.

Results

Family Rhynchohydracaridae Lundblad, 1936

Genus *Clathrosperchonella* Lundblad, 1937

Clathrosperchonella olovi sp. nov.

(Figs. 1B–F, 2–5)

Type series. Holotype female (DZSJRP-06048), dissected and slide mounted in Hoyer's fluid, Brazil, São Paulo, Cananéia, State Park of Cardoso Island, 13/I/2012, 25°05'18"S 47°55'27"W, in submerged mosses. Paratypes, same data as holotype: one female (DZSJRP-06049), two males (DZSJRP-06050–06051) and three larvae (DZSJRP-06052–06054) obtained from holotype female; collector: Luiz A. S. de Castro.

Description. Female. Dorsal. Colour in life yellowish-brown (Fig. 1B); integument bearing acutely pointed papillae on the margins of idiosoma (Fig. 1E); idiosoma partially covered by 16 dorsal and 5 ventral platelets that have radiating reticulations (Fig. 2A); *po* associated with a pair of elongated anteromedial platelets (Fig. 2A); *dgl*-2–4 and *lgl*-2 lying on irregular sclerites; opisthosoma with a horizontal sclerite, between *dgl*-5, with lateral pointed tips (Figs. 1C, 2A). **Ventral.** Coxal plates I and II fused medially; coxal plate II bearing a lateral rounded tip; coxal plate III shorter than IV; genital flaps bearing three distinct and clearly separated groups of 3, 5–6 and 6–8 genital acetabula; *cxgl*-4, *vgl*-1, *vgl*-3 and a pair of simple setae (located between three stellate sclerites and the excretory plate) lying on irregular platelets (Fig. 2B); *vgl*-2 absent; legs without

swimming hairs; claws bearing a secondary ventral tooth (Fig. 2F). Gnathosoma. Capitulum short and rounded, not protrusible, bearing two postero-medial tips, the superior one longer than the inferior (Fig. 2D); palp slender and bearing a single long ventro-distal seta on P-4 (Fig. 2C); number of setae on P-1–5: 0, 5, 4, 1, 3; chelicera with a dorso-medial hump (Fig. 2E).

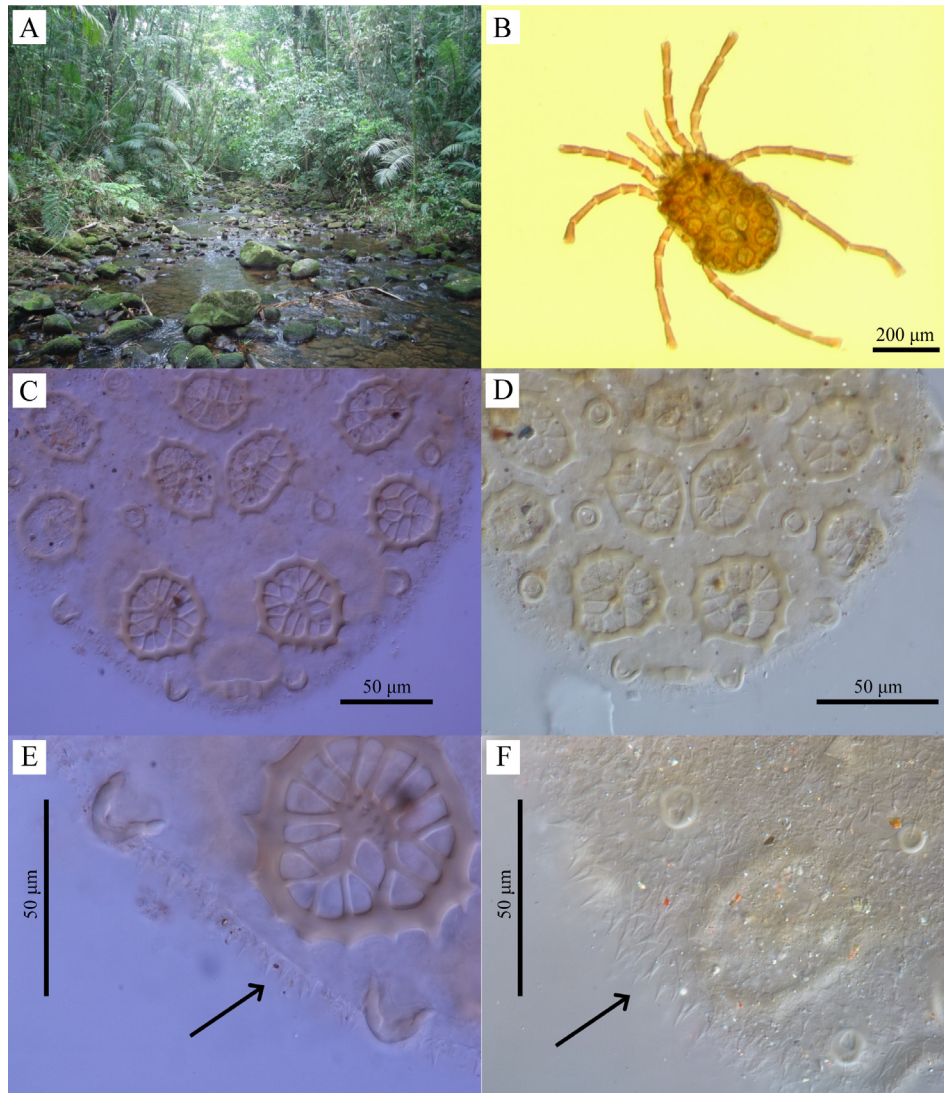


FIGURE 1. A, The new species was collected from this shallow stream in the Atlantic rainforest at Cardoso Island State Park, Cananéia, São Paulo, Brazil; B, *Clathrosperchonella olovi* **sp. nov.**, adult female, dorsal habitus; C, female, opisthosoma; D, male, opisthosoma; E, female, detail of opisthosoma, dorsal surface; F, male, detail of opisthosoma, ventral surface (arrows indicating acutely pointed papillae).

Measurements, holotype (single paratype in parentheses). Idiosoma L 360 (358), W–285 (268); genital flap L 87–89, maximum W 35 (39); capitulum L 87 (85); rostrum L 50 (48); chelicera: basal segment L 86 (82), H 23 (21), chela L 33 (31); palp segments (P-1–5) L: 22 (21), 38 (34), 41 (40), 52 (55), 18 (21); leg segments L: I-Leg-1–6: 32 (30), 51 (50), 41 (42), 63 (64), 71 (69), 76 (74); II-Leg-1–6: 28 (32), 52 (57), 45 (47), 76 (77), 85 (86), 83 (80); III-Leg-1–6: 29 (31), 52 (50), 44 (42), 86 (85), 90 (91), 82 (83); IV-Leg-1–6: 42 (45), 60 (62), 58 (60), 137 (135), 102 (100), 80 (77).

TABLE 1. Subfamilies, genera and species of Rhynchohydracaridae.

Subfamily, Genera	Species	Type locality	Distribution
Clathrosperchontinae			
<i>Clathrosperchon</i>	<i>americanus</i> Habeeb, 1953	USA ¹	USA ¹
	<i>crassipalpis</i> Lundblad, 1936	Brazil ²	Brazil ³ Colombia ⁴
	<i>minor</i> Lundblad, 1937	Brazil ⁵	Brazil ³ Colombia ⁴ Guatemala ⁶ Paraguay ³
	<i>ornatus</i> Cook, 1974	USA ⁷	USA ⁷
	<i>punctatus</i> Cook, 1980	Argentina ⁸	Argentina ^{8,9,10,11} Costa Rica ⁸ México ⁸ Panama ¹² Paraguay ¹³
	<i>transversus</i> Viets, 1977	Guatemala ¹⁴	Guatemala ^{6,14,15} Panama ¹² Venezuela ¹⁶
<i>Clathrosperchonella</i>	<i>asterifera</i> Lundblad, 1937	Brazil ¹⁷	Brazil ³ Paraguay ³
	<i>olovi</i> sp. nov.	Brazil	Brazil
	<i>rutae</i> Lundblad, 1938	Brazil ¹⁸	Brazil ³
Rhynchohydracarinae			
<i>Rhynchohydracarus</i>	<i>carmenae</i> Valdecasas, 2001	Panama ¹²	Panama ¹²
	<i>dividuus</i> Lundblad, 1941	Paraguay ³	Paraguay ³
	<i>testudo</i> Lundblad, 1936	Brazil ²	Brazil ³
Santiagocarinae			
<i>Gledhillia</i>	<i>coibensis</i> Valdecasas, 2001	Panama ¹²	Panama ¹²
<i>Santiagocarus</i>	<i>robustus</i> Valdecasas, 2001	Panama ¹²	Panama ¹²

¹Habeeb, 1953; ²Lundblad, 1936; ³Lundblad, 1941; ⁴Lundblad, 1953; ⁵Lundblad, 1937b; ⁶Böttger, 1984; ⁷Cook, 1974; ⁸Cook, 1980; ⁹Rosso de Ferradás, 1984; ¹⁰Rosso de Ferradás, 2000; ¹¹Fernández, 2003; ¹²Valdecasas, 2001; ¹³Viets & Böttger, 1986; ¹⁴Viets, 1977a; ¹⁵Viets, 1977b; ¹⁶Gruia, 1988; ¹⁷Lundblad, 1937a; ¹⁸Lundblad, 1938.

Description. Male. Dorsal. Similar to female, except that the sclerite located between *dgl-5* on the opisthosoma is shorter than that of the female and is trapezoidal in its shape (Figs. 1D, 3A). **Ventral.** Coxal plates III and IV fused and stouter than on female (Fig. 3B); genital flaps proportionally larger compared to female and also bearing three clearly separated and regular groups of 3, 4 and 8 genital acetabula. **Gnathosoma.** Capitulum and chelicera similar to female (Figs. 3D–E); palp slender, similar to female (Fig. 3C); number of setae on P-1–5: 0, 4, 4, 1, 3.

Measurements, n=2. Idiosoma L 283–360, W 236–295; genital flap L 77–80, W 33–38; chelicera: basal segment L 88–91, H 14–16; chela L 27–30; palp segments (P-1–5) L: 19–20, 38–44, 32–37, 52–54, 18–20; leg segments L: I-Leg-1–6: 31–32, 52–54, 39–44, 58–64, 67–74, 66–71; II-Leg-1–6: 30–31, 54–58, 45–48, 72–74, 78–86, 77–83; III-Leg-1–6: 22–30, 42–52, 43–46, 84–85, 82–86, 76–81; IV-Leg-1–6: 35–40, 55–62, 56–58, 138–140, 93–104, 76–85.

Description. Larva. Dorsal. Colour in life yellowish; idiosoma longer than wide, oval and slightly sclerotized; dorsum bears a great number of irregular platelets distributed along almost the whole extent of the idiosoma, from *vi* to *dl* and between eye lenses; four pairs of propodosomal setae (*vi*, *ve*, *se*, *vi*), a pair of humeral setae (*c3*) and seven pairs of hysterosomal setae (*c1*, *c2*, *dl*, *d2*, *e1*, *e2*, *fl*); propodosomal and humeral setae thin and moderately long; hysterosomal setae thin, with variable length (*c1*, *dl*, *e1*, long; *c2*, *d2*, *e2*, short); anterior eye lenses located lateral to *se*; posterior eye lenses located anterolateral to *si* (Fig. 4A); there are a pair of lateral shields full of platelets that extend along almost the whole idiosoma. **Ventral.** Coxal plates I–III enlarged, covering almost whole extent of the ventral surface of the idiosoma; coxal plate I longer than wide, with *lb* long and *la* short; coxal plate II trapezoidal, without setae and bearing a pair of urstigmata protruding forward from its antero-lateral border; coxal plate III trapezoidal, with *3a* thin and shorter than *lb* and *la*; two pairs of hysterosomal setae, thin, short and aligned; *f2* slightly longer than hysterosomal setae and located below them; *h2* absent; excretory pore oval (Fig. 4D), lying free on the integument, with *ps1* absent and *ps2* very short (Fig. 4B); legs I and II with distal famulus and euphathidium on each tarsus; number of setae on legs I–III: I-Leg-1–5: 1, 6, 5 (σ), 9 ($\phi 1$, $\phi 2$), 9 (ω , "2"); II-Leg-1–5: 1, 6, 5

(σ), 9 (ϕ 1, ϕ 2), 9 (ω , "2"); III-Leg-1-5: 1, 6, 5 (σ), 8 (ϕ 1), 8. **Gnathosoma.** Capitulum rounded posteriorly (Fig. 4B); *Hy1* very reduced, *Hy2* absent; chelicera with basal segment smooth; chela with three distal denticles (Fig. 4C); palps stocky, extending beyond the distal end of the capitulum; P-4 bearing three short setae and a thin and long solenidion; palp tarsus with a claw (Fig. 4E); number of setae from P-1-P-5: 0, 1, 2, 4(ϕ), 0.

Measurements, n=3. Idiosoma L 166–181, W 149–152; dorsal setae: *ve* L 17–18, *vi* L 16–19, *se* L 17–20, *si* L 13–16, distance between setae: *se-se* 42–45, *si-si* 44–47; ventral setae: *ps1* absent, *ps2* vestigial; excretory pore plate L 5–7, W 2–4; capitulum L 52–56; chelicera: basal segment L 40–45, chela L 8–10; palpal segments (P-1–5) L: 12–14, 22–23, 7–8, 5–6, 7–8; leg segments L: I-Leg-1–5: 24–29, 40–46, 30–33, 41–42, 47–52; II-Leg-1–5: 20–22, 35–42, 30–32, 40–42, 46–51; III-Leg-1–5: 30–31, 42–45, 32–36, 44–48, 51–56.

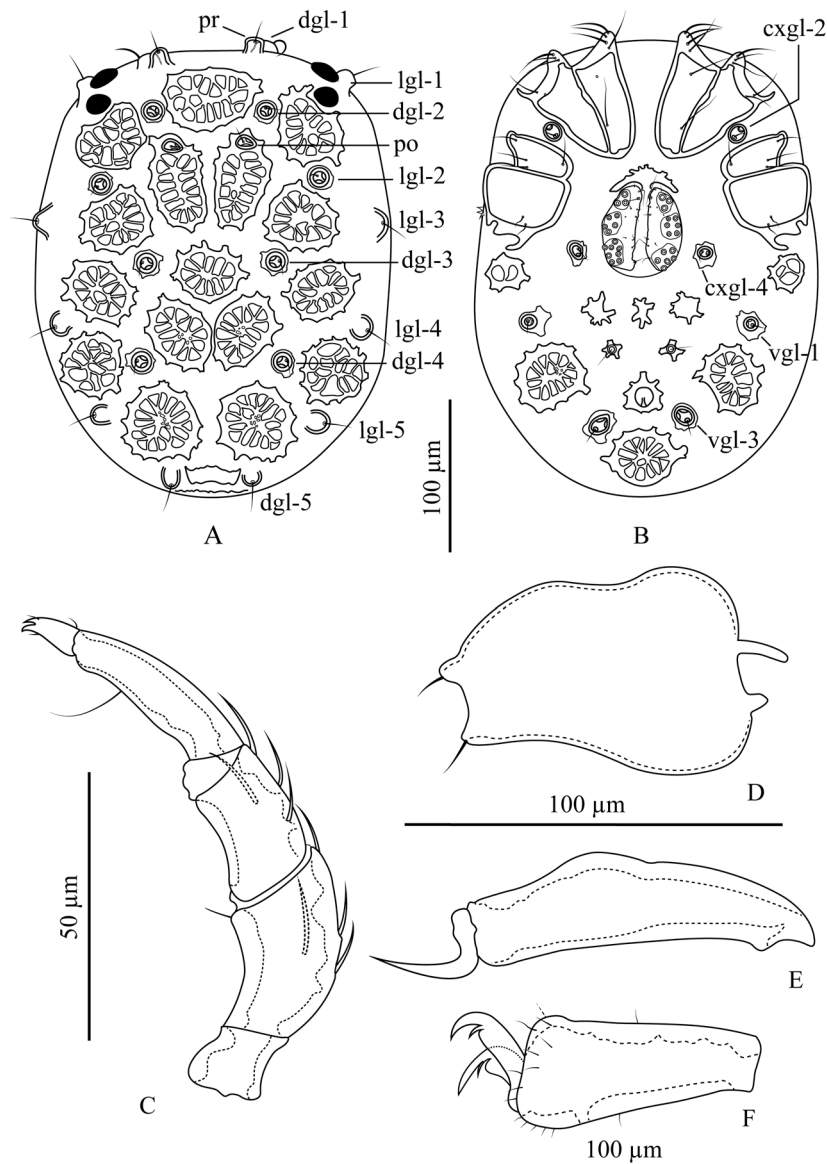


FIGURE 2. *Clathrosperchonella olovi* sp. nov., female. A, dorsal view; B, ventral view; C, palp, lateral view; D, capitulum, lateral view; E, chelicera, lateral view; F, I-Leg-6.

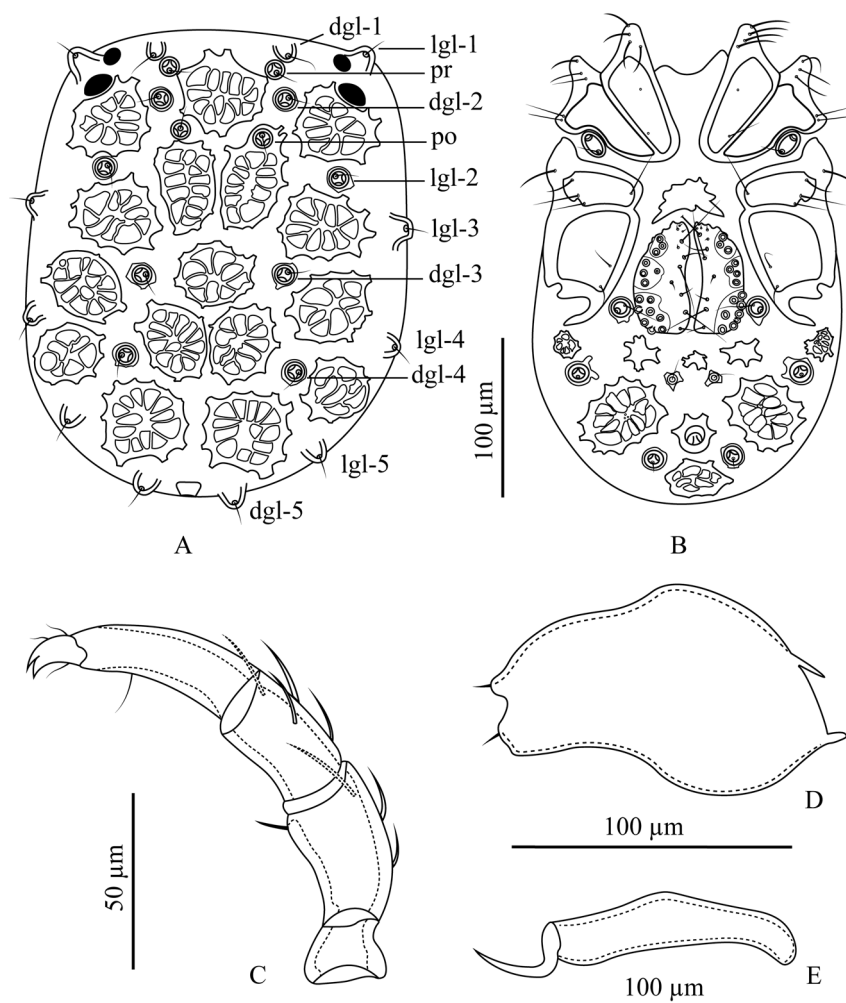


FIGURE 3. *Clathrosperchonella olovi* sp. nov., male. A, dorsal view; B, ventral view; C, palp, lateral view; D, capitulum, lateral view; E, chelicera.

Etymology. Named after Olov Lundblad (1890–1970), in honour of his studies on Brazilian water mites and also to form a pair with *Clathrosperchonella rutae* Lundblad, named by him in remembrance of his wife, Rut.

Remarks and differential diagnosis. This paper presents the first description of a *Clathrosperchonella* species based on female as holotype; Lundblad did not completely illustrate this sex in his descriptions of *C. asterifera* and *C. rutae*. *Clathrosperchonella olovi* sp. nov. is very similar to *C. asterifera*, except for the following features. Dorsally, both sexes of *C. olovi* bears both *dgl-2–4* and *lgl-2* lying on irregular sclerites, whereas in *C. asterifera* these structures are not present surrounding glandularia. Lundblad (1941) depicted the pair of *dgl-5* in *C. asterifera* as linked by a semicircular platelet, while in *C. olovi* sp. nov. this structure is shorter and horizontal, differs slightly in shape between female and male, and is located between *dgl-5* instead of linking them. Ventrally, *C. olovi* sp. nov. also bears *cxgl-4*, *vgl-1* and *vgl-3* on irregular sclerites. In this new species, differently from *C. asterifera* and *C. rutae*, a reticulated platelet is found in both sexes, below the excretory pore. However, it not can be assumed for certain that this structure is not present on the

previously described species, as on figures of Lundblad (1941) the opisthosoma was drawn as if it were folded and, possibly, the platelet may have not been visible. Furthermore, acutely pointed integumental papillae are present both on the margins of idiosoma and on ventral surface of opisthosoma of *C. olovi*, whereas these structures were neither described nor illustrated by Lundblad for *C. asterifera* and *C. rutae*, casting a doubt as to whether they are present or not. With the finding of this new species, we can extend the known distribution of the genus *Clathrosperchonella* from the Chaco region of Paraguay and west of Santa Catarina State in Brazil to the coastal Atlantic rainforest of São Paulo State on southeast Brazil. Future expeditions to the original collecting sites of *C. asterifera* and *C. rutae* may allow us to collect more males, find females, obtain their larvae and describe their characters.

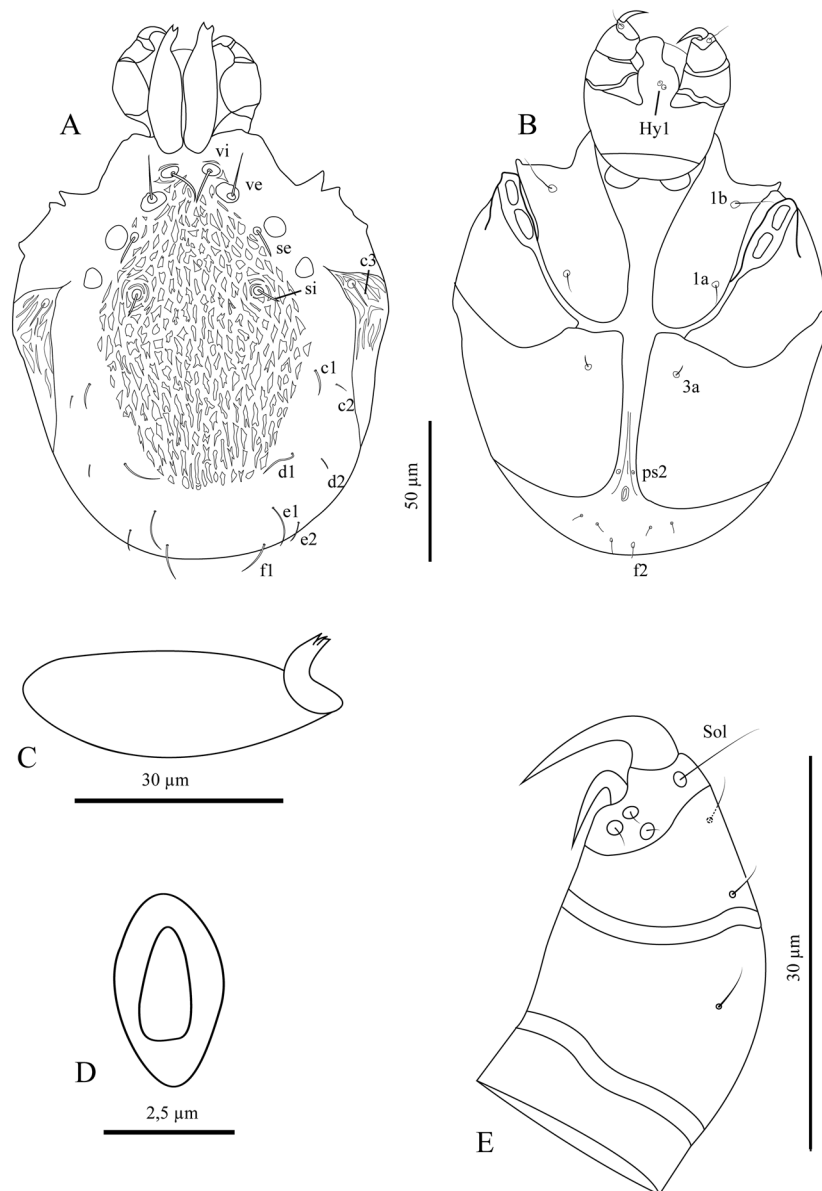


FIGURE 4. *Clathrosperchonella olovi* sp. nov., larva. A, dorsal view; B, ventral view; C, chelicera, lateral view; D, excretory pore; E, palp, ventral view. (Sol: solenidion).

Although the larva of *C. olovi* **sp. nov.** retains the plesiotypic complement of setae on the segments of the legs, as is found in all known Hydryphantoidea (Proctor *et al.* 2015), the number of movable leg segments is five, instead of six. After hatching, the larvae were observed in the laboratory swimming awkwardly below the water surface and thus can be considered aquatic rather than ‘aerial’ (active on the surface of the water), as is common among hydryphantoid larvae (Proctor *et al.* 2015). Moreover, the coxal plates are enlarged, covering almost the whole ventral surface; an unusual doubled urstigma is found between coxal plates I and II and the excretory plate is absent. These features are typical to more derived superfamilies. The occurrence of both plesiotypic and more derived characteristics in *C. olovi* **sp. nov.** likely reflects the paraphyletic nature of Hydryphantoidea (Dabert *et al.* 2016) and also suggests that the Rhynchohydracaridae may be more closely related to Neohydrachnidia than to other hydryphantoid families. Molecular phylogenetic analysis plus examination of more species of this family are needed in order to test this hypothesis.

Distribution. Brazil, São Paulo State, Cananéia. Known only from the collection site.

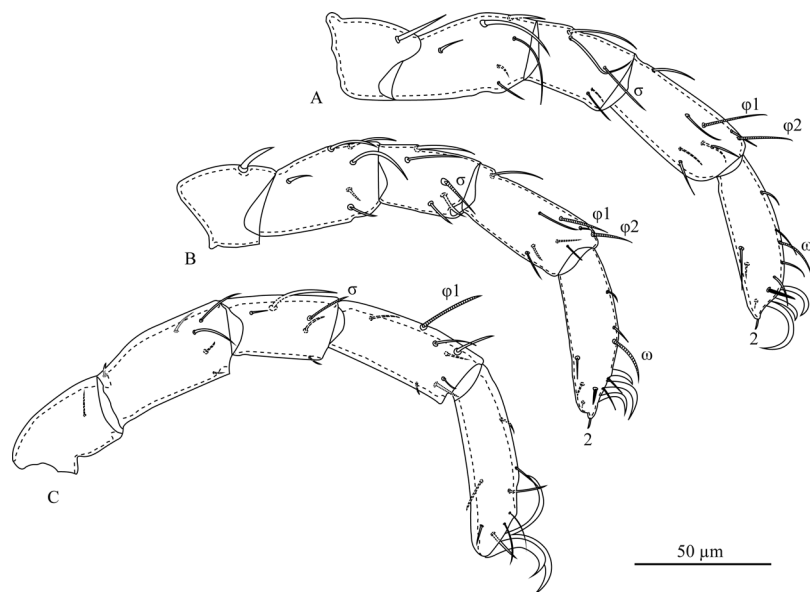


FIGURE 5. *Clathrosperchonella olovi* **sp. nov.**, larva. A, I-Leg-1 to 5; B, II-Leg-1 to 5; C, III-Leg-1 to 5.

Key to *Clathrosperchonella* species based on adults

- 1a. Dorsal and ventral plates with radiating reticulations; palp slender 2
- 1b. Dorsal and ventral plates without radiating reticulations; palp stout *C. rutae*
- 2a. Dgl-2–4, lgl-2, cxgl-4 and vgl-1,3 lying free on the integument; genital flaps bearing two distinct and clearly separated groups of genital acetabula; P-4 bearing two long ventro-distal setae *C. asterifera*
- 2b. Dgl-2–4, lgl-2, cxgl-4 and vgl-1,3 lying on irregular sclerites; genital flaps bearing three distinct and clearly separated groups of genital acetabula; P-4 bearing a single long ventro-distal seta *C. olovi* **sp. nov.**

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References

- Böttger, K. (1984) Einige ökologische Beobachtungen am Nekton und Benthon guatemalteckischer Bergbäche (Mittelamerika), unter besonderer Berücksichtigung des temporären Río Cuxjá. *Amazoniana*, 8, 475–496. <http://hdl.handle.net/21.11116/0000-0004-7022-7>
- Cook, D.R. (1974) Water Mite Genera and Subgenera. *Memoirs of the American Entomological Institute*, 21, 1–860.
- Cook, D.R. (1980) Studies on Neotropical Water Mites. *Memoirs of the American Entomological Institute*, 31, 1–645.
- Dabert, M., Proctor, H. & Dabert, J. (2016) Higher-level molecular phylogeny of the water mites (Acariformes: Prostigmata: Parasitengonina: Hydrachnidia). *Molecular Phylogenetics and Evolution*, 101, 75–95. <https://doi.org/10.1016/j.ympev.2016.05.004>
- Di Sabatino, A., Smit, H., Gerecke, R., Goldschmidt, T., Matsumoto, N. & Cicolani, B. (2008) Global diversity of water mites (Acari, Hydrachnidia; Arachnida) in freshwater. *Hydrobiologia*, 595, 303–315. <https://doi.org/10.1007/s10750-007-9025-1>
- Fernández, H.R. (2003) Structure of water mite taxocoenoses in two northwestern Argentinian subtropical sub-catchments. *Systematic & Applied Acarology*, 8(1), 55–66. <https://doi.org/10.11158/saa.8.1.6>
- Gruia, M. (1988) Hydrachnellae du Venezuela. Note 2. *Travaux de L'Institut de Speleologie "Émile Racovitza"*, 27, 21–27.
- Habeeb, H. (1953) North American Hydrachnellae, Acari. I-V. *Leaflets of Acadian Biology*, 1, 1–16.
- Lundblad, O. (1927) Die Hydracarina Schwedens. I. Beitrag zur Systematik, Embryologie, Ökologie und Verbreitungsgeschichte der schwedischen Arten. *Zoologiska Bidrag Uppsala*, 11, 185–540.
- Lundblad, O. (1936) Neue Wassermilben aus Santa Catharina in Südbrasilien. *Zoologischer Anzeiger*, 115, 29–51.
- Lundblad, O. (1937a) Vierte Mitteilung über neue Wassermilben aus Santa Catharina in Südbrasilien. *Zoologischer Anzeiger*, 118, 248–265.
- Lundblad, O. (1937b) Fünfte Mitteilung über neue Wassermilben aus Santa Catharina in Südbrasilien. *Zoologischer Anzeiger*, 120, 280–293.
- Lundblad, O. (1938) Neue Wassermilben aus Paraguay. *Zoologischer Anzeiger*, 122, 7–19.
- Lundblad, O. (1941) Die Hydracarinafauna Südbrasilien und Paraguays. Erster Teil. *Kungliga Svenska Vetenskapsakademiens Handlingar*, 19, 1–183.
- Lundblad, O. (1953) Hydracarinafauna von Colombia. *Arkiv för Zoologi*, 5, 435–585.
- Proctor, H.C., Smith, I.M., Cook, D.R. & Smith, B.P. (2015) Subphylum Chelicerata, Class Arachnida. In: Thorp, J.H. & Rogers, D.C. (Eds.), *Thorp and Covich's Freshwater Invertebrates. Vol. 1. Ecology and general biology*. Fourth Edition. Academic Press, Elsevier Incorporated, London, pp. 599–660. <https://doi.org/10.1016/B978-0-12-385026-3.00025-5>
- Rosso de Ferradás, B.E. (1984) Hidracaridos de Copina (Departamento Punilla, Cordoba, Argentina), Acari, Hydrachnellae. I. *Comunicaciones del Museo Argentino de Ciencias Naturales "Bernardino Rivadavia"*, *Hidrobiologia*, 2, 125–140.
- Rosso de Ferradás, B. (2000) Ácaros reófilos (Acari: Hydrachnidia) de las sierras de Córdoba. IV. *Revista de la Sociedad Entomológica Argentina*, 59, 25–40.
- Smith, I.M., Cook, D.R. & Smith, B.P. (2010) Water mites (Hydrachnidia) and other arachnids. In: Thorp, J.H. & Covich, A.P. (Eds.) *Ecology and Classification of North American Freshwater Invertebrates*. Third Edition. Academic Press (Elsevier), pp. 485–586. <https://doi.org/10.1016/B978-0-12-374855-3.00015-7>
- Valdecasas, A.G. (2001) A new subfamily of Rhynchohydracarinae (Acari, Hydrachnellae) from the island of Coiba (Panama) with descriptions of new taxa. *Journal of Natural History*, 35, 1565–1574. <https://doi.org/10.1080/002229301317067674>
- Viets, K.O. (1977a) Neue und seltene Wassermilben (Hydrachnellae, Acari) aus Guatemala—Teil 1. *Acarologia*, 18, 519–544. <https://www1.montpellier.inra.fr/CBGP/acarologia/article.php?id=2994>
- Viets, K.O. (1977b) Rheophile Wassermilben (Acari, Hydrachnellae) aus Guatemala. *International Journal of Acarology*, 3, 89–98. <https://doi.org/10.1080/01647957708683084>
- Viets, K.O. & Böttger, K. (1986) Wassermilben (Hydrachnellae, Acari) aus Paraguay, nebst einigen Angaben zur Begleitfauna. *Studies on Neotropical Fauna and Environment*, 20, 103–128. <https://doi.org/10.1080/01650528609360700>
- Walter, D.E., Lindquist, E.E., Smith, I.M., Cook, D.R. & Krantz, G.W. (2009) Chapter thirteen Order Trombidiformes. In: Krantz, G.W. & Walter, D.E. (Eds.) *A manual of acarology*. Third Edition. Lubbock, Texas Tech University Press, pp. 233–420.
- Zhang, Z.-Q., Fan, Q.-H., Pešić, V., Smit, H., Bochkov, A.V., Khaustov, A.A., Baker, A., Wohltmann, A., Wen, T., Amrine, J.W., Beron, P., Lin, J., Gabrys, G. & Husband, R. (2011) Order Trombidiformes Reuter, 1909. In: Zhang, Z.-Q. (Ed.), *Animal biodiversity: An outline of higher-level classification and survey of taxonomic richness*. *Zootaxa*, 3148, 129–138. <https://doi.org/10.11646/zootaxa.3148.1.24>

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