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Description of a new species of *Paralamellobates* (Acari, Oribatida) from Argentina, with a revision of the genus

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ABSTRACT

The aim of this paper is to propose a new species of *Paralamellobates, P. argentinensis* **sp. nov.**, on the basis of adult stages and to redescribe *Lamellobates quadricornis* Pérez-Iñigo & Baggio, 1985. Based on a morphological comparison between *Paralamellobates* species and *L. quadricornis, Paralamellobates quadricornis* **stat. nov.**, is proposed.

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Introduction

The genus *Paralamellobates* (Bhaduri and Raychaudhuri, 1968) was initially described as a subgenus of *Lamellobates* Hammer, 1958 considering the presence of free lamellar tips as core difference (Bhaduri and Raychaudhuri 1968). Since Hammer (1958) proposed *Paralamellobates*, it has been considered as member of the families Oribatellidae (Balogh 1972; Fujikawa 1991; Mahunka 1991) and Achipteriidae (= Austrachipteridae) (Engelbrecht 1986; Behan-Pelletier 1998; Subías 2004). Recently, with the founding of immature stages of *P. misella*, Behan-Pelletier et al. (2016) provided a detailed diagnostic of the genus and morphological characters that related this species with members of Punctoribatidae (= Mycobatidae).

Since *Paralamellobates* was erected, several species have been considered as member of that genus, but currently it is considered that only two species belong to it: *P. bengalensis* (type species) and *P. misella* (Berlese 1910). *Paralamellobates bengalensis* is a dioic and poorly known species that has been reported from Calcutta (type locality), India (Bhaduri & Raychaudhuri 1981; (Prasad 1974) and Taiwan (Tseng 1984). *Paralamellobates misella*, on the other hand, is the most known species of the genus that has been reported, under its many synonyms, from Costa Rica (Behan-Pelletier 1998), Java (Berlese 1910), Africa (Engelbrecht 1986), Japan (Aoki 1984; Aoki and Harada 1985), Italy (Bernini et al. 1995), Fiji (Hammer 1971) and Korea (Choi 1995); it is a quite variable species that probably reproduce by parthenogenesis (Behan-Pelletier et al. 2016).

Lamellobates quadricornis Pérez-Iñigo and Baggio (1985) is a dioic species that was first recorded in soils of Cardoso Island, Brazil, and posteriorly from Argentina by Martínez et al. (2009). Balogh and Balogh (2002) considered it as junior synonym of *Lamellobates molecula* (Berlese 1910), but without a clear justification. This posture has been followed by other authors (Oliveira et al. 2005; Basu and Sanyal 2016).

The aim of this paper is to propose a new species of *Paralamellobates, P. argentinensis* **sp. nov.**, on the basis of adult stages, to redescribe *Lamellobates quadricornis* Pérez-Iñigo and Baggio (1985) and to analyse the taxonomic status of this last species.

Material and methods

Soil and bark samples were collected as part of a study of oribatid mites inhabiting native forests of *Celtis erhenbergiana* (Klotzsch) in Buenos Aires province, Argentina. Soil samples were taken from June to October 2008 in Laguna de los Padres Reserve, General Pueyrredon district (37°56′1″ S, 57°44′31″ W) and from a grassland areas in "El Cardal" farm, Ayacucho district (36°49′27″ S, 58°28′11″ W) during September 2012. Microarthropods were extracted over a 12-day period using the Berlese funnel technique. Specimens of *Lamellobates quadricornis* analysed were from Misiones, Argentina, previously reported in Martínez et al. (2009), and new material provided by Dr Ramírez (Museo Argentino de Ciencias Naturales) from the same locality. A stereoscopic microscope was used for sorting specimens; they were mounted in open slides with 50% lactic acid and examined under a light microscope Olympus CX31. Sketches were drawn using drawing tube attached to the microscope and after they were processed using GIMP 2.8 software (www.gimp.org). Selected adult specimens were mounted on a stub, sputter-coated with gold (100 Å thick) during 1 min and observed with a JSM 6460LV (JEOL, Tokyo, Japan) scanning electron microscope. Measurements are given in micrometres (µm). The material identified will be kept in the Museo Argentino de Ciencias Naturales (MACN), Buenos Aires, Argentina, and in the personal collection of the author.

Punctoribatidae Thor, 1939
Paralamellobates Bhadury and Raychaudhuri, 1968
Paralamellobates argentinensis **sp. nov.**

Diagnosis. Adults with following combination of characters: lamellae broad and non-fused with medial and lateral teeth developed; infracapitulum diarthric with axillary saccule; genal tooth and tutorium present; notogaster with nine pairs of setae; immovable pteromorphs present with posterior overlapping lobes; tubiform saccules as octotaxic system; six pairs of genital setae, one pair of aggenital and two pairs of anal and adanal setae; legs monodactylous; solenidion ω_2 on tarsus II present; genua I and II with ventrolateral spur and solenidion on tibiae IV absent.

Adults measurements. Range of female length 240–270 (Holotype = 270) width 170–190 (n = 10); male length 240–250 (Holotype = 180) width 150–170 (n = 3).

Integument. Adults yellowish to pale brown. Cerotegument restricted only to interlamellar region, in form of tiny granules (Figure 3(e)).

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Prodorsum. Rostrum with medial wide incision, flanked by two free teeth (Figures 1(a) and 3(b)). Seta *ro* setiform and unilaterally barbulated, inserted laterally at end of tutorium. Seta *le* thicker and with bristles, arising on lamellar cusps. Seta *in* narrower, as long as lamella. Lamellae broad, covering almost all prodorsum, with microsculpture of fine lines; medial and lateral teeth subequal in size. Interlamellar region subtriangular and covered with granulate cerotegument (Figures 1(a) and 3(e)). Sensillus clavate with ovoid head and tiny bristles.

Gnathosoma. Infracapitulum diarthric; labiogenal articulation W-shape (Figures 1(b) and 3(c)). Hypostomatic setae setiform. Axillary saccules present. Chelicera chelate-dentated, seta *cha* barbulated, dorsally located; seta *chb* smooth and setiform, located laterally, near mobile digit articulation. Palpal formula 0–2–3–9+1.

Lateral aspect. Genal tooth long, with subtriangular carina that stretched along its length (Figure 3(d), white arrow). Tutorium developed as delicate blade ending in triangular tip, beyond it setae *ro* arise. Porose area *Al* present. Pedotecta I with it superior edge serrated and striates. Pedotecta II smaller and smooth, developed as little scale. Porose area *Ah* inconspicuous. Pteromorphs with concave edge at level of legs IV (Figure 3(a), white arrow).

Notogaster. Oval. Presence of anterior tectum covering insertion of setae *in*. Nine pairs of setiform notogastral setae arranged as shown in Figure 1(a). Immovable pteromorphs present. Sejugal furrow concave. Dorsophragmata and pleurophragmata developed. Presence of slight concavity as humeral shoulder. Octotaxic system developed as tubiform saccules; *Sa* located at level of setae *la*, S_1 and S_2 close to each other, located between setae *lp* and h_3, S_3 located near seta h_1. Lyrifissure *im* discernible. Presence of posterior overlapping lobes (Figure 3(c)).

Ventral region. Epimeric formula 3–1–2–2, all setae setiform and smooth. Coxisternal plate with tiny lines in anterior region. Circumpedal carina developed; presence of knife-like custodium extends to pedotecta II (Figure 3(c), white arrow). Six pairs of genital setae, g_1–g_3 located along anterior border of plate and g_4–g_6 located in paraxial position (Figure 1(b)). Lyrifissures *iad* in preanal position. Ventral setae smooth and setiform; one pair of aggenital setae; two pairs of anal setae. Two pairs of adanal setae; ad_1 postanal and ad_2 paranal. Postanal porose area not discernible.

Legs. Tarsi monodactylous. Femora II and IV with carina; genua I and II with ventrolateral spur (Figures 2(d) and 3(d), outline arrow); tibiae I with dorsal apophyses. Setation I (1–5–2–4–17 +1), II (1–5–2–4–16), III (2–2–1–3–14), IV (1–2–2–3–11). Solenidion on tibiae IV absent; solenidion ω_2 on tarsus II present. Setae *l″* of genua I and II tick spine like. Shape and disposition of porose areas and lyrifissures as shown in Figure 2.

Material examined. Holotype female (MACN-Ar 37214) and two paratypes (one female and one male) from Laguna de los Padres Reserve (MACN-Ar 37215), Buenos Aires and five paratypes (four females and one male) from "El Cardal", Buenos Aires (MACN-Ar 37216).

Etymology. Specific epithet *argentinensis* refers to Argentina, the country of origin.

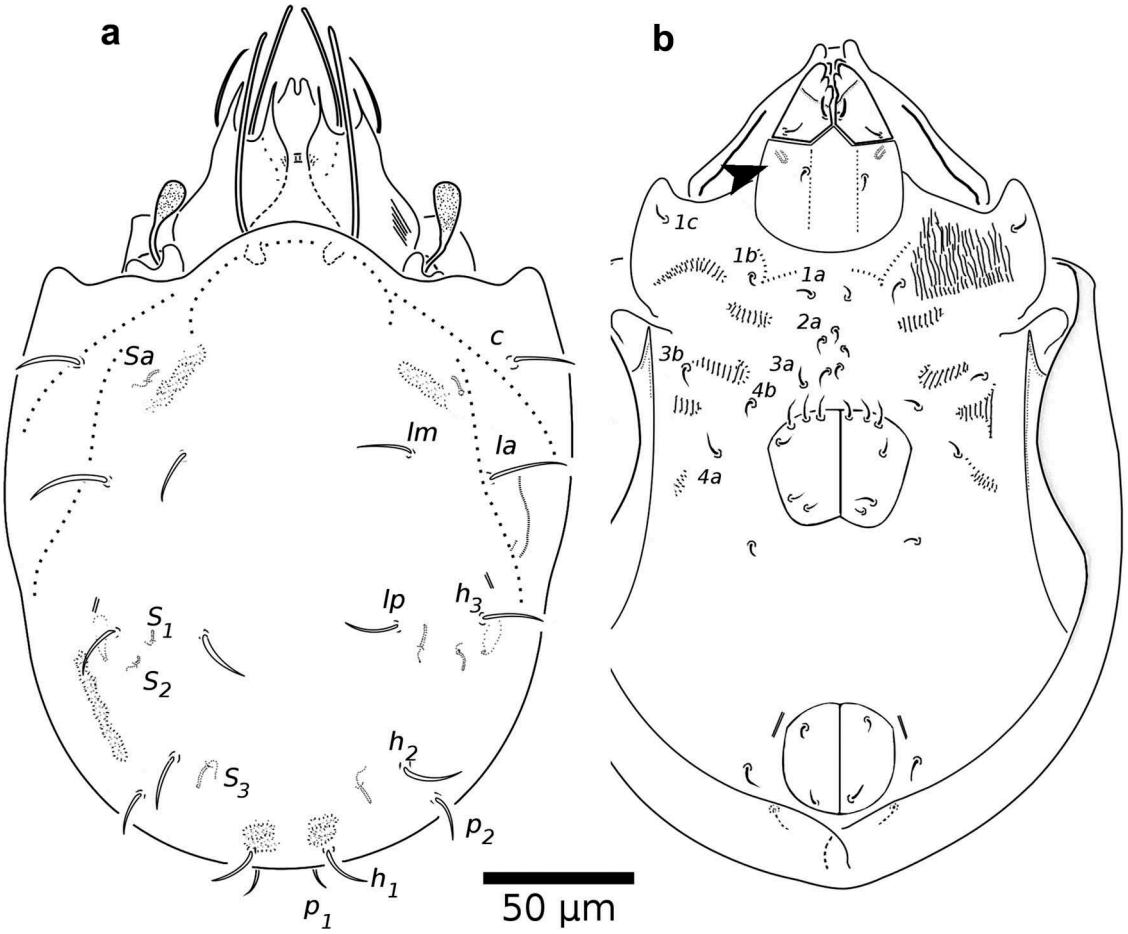

Figure 1. Adult of *Paralamellobates argentinensis* **sp. nov**. (a) Dorsal view; (b) Ventral view (black arrow = axillary saccule).

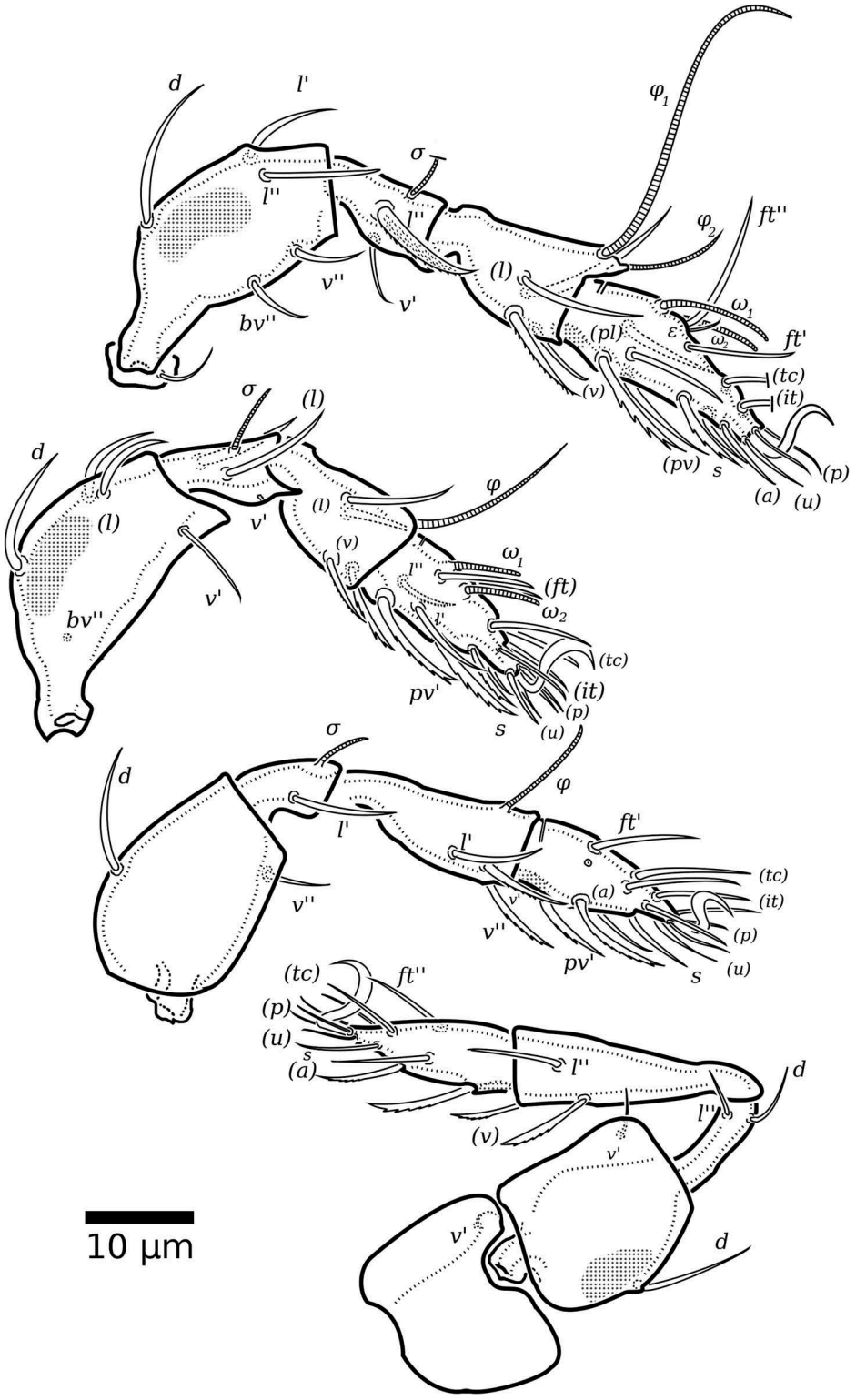

Figure 2. Legs of *Paralamellobates argentinensis* **sp. nov.** (a) Leg I right, antiaxial aspect; (b) Leg II left, paraxial aspect; (c) Leg III left, antiaxial aspect; (d) Leg IV right, antiaxial.

Paralamellobates quadricornis (Pérez-Iñigo & Baggio 1985) **stat. nov.**

Lamellobates quadricornis Pérez-Iñigo & Baggio, 1985: Pérez-Iñigo and Baggio (1985)

Lamellobates quadricornis: Martínez et al. (2009)

Additional morphological characters

Prodorsum. Rostrum with pointed "nose" and two blunt tips above (Figure 4(b–d)) arrow. Seta *ro* setiform and unilaterally barbulated, inserted at end of tutorium. Seta *le* thicker and with bristles, arising on lamellar cusps. Seta *in* narrower, projecting far from extreme of rostrum. Lamellae broader (Figure 4(a)) and sensillus club-like with tiny bristles. Lateral aspect similar to *P. argentinensis* **sp. nov.**, differing in shape and size of genal tooth and tutorium (Figure 4(d), white arrow).

Notogaster. Oval in shape (Pérez-Iñigo and Baggio 1985, fig. 18) with anterior tectum covers insertion of setae *in* Figure 4(c). Dorsophragmata and pleurophragmata developed. Octotaxic system developed as tubiform and simpler saccules; *Sa* located at level of seta *la*, S_1 and S_2 closer one of each other, located between setae *lp* and h_3, S_3 located near seta h_1.

Ventral region. Epimeric formula 3–1–2–2, seta *1c* setiform. Presence of knife-like custodium. Genitoanal formula: 6–1–3–2.

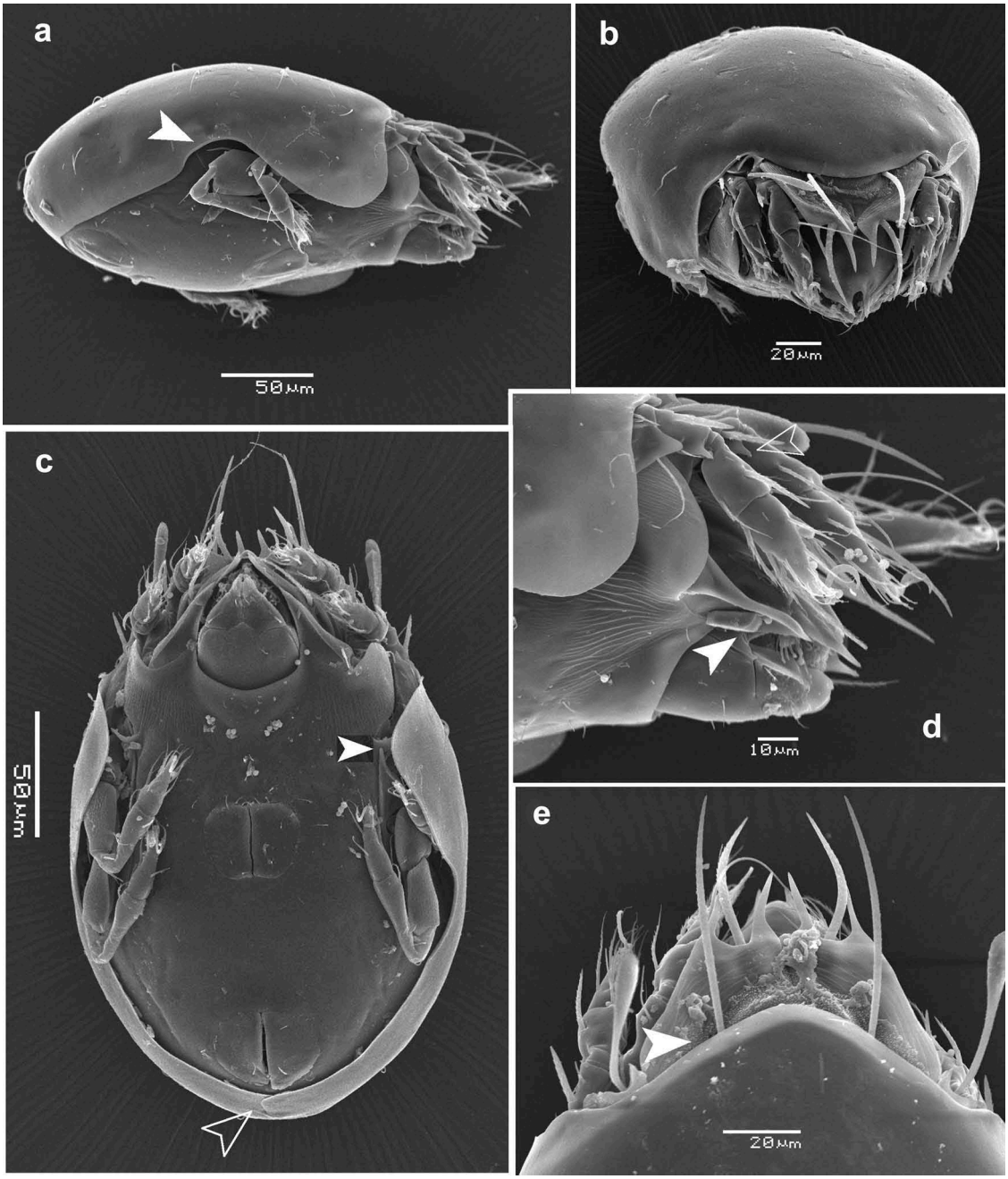

Figure 3. Adults of *Paralamellobates argentinensis* **sp. nov**. (a) Lateral aspect (white arrow = concave edge); (b) Frontal aspect; (c) Ventral aspect (white arrow = custodium; outline arrow = posterior lobes); (d) Detail of the anterior region in lateral aspect (white arrow = genal tooth, outline arrow = ventrolateral spur of genua I); (e) Detail of prodorsum in dorsal aspect (white arrow = anterior tectum).

Lyrifissure *iad* preanal (Pérez-Iñigo and Baggio 1985, fig. 19). Presence of posterior overlapping lobes. Postanal porose area not discernible.

Legs. Tarsi monodactylous. Femora II and IV with anterior carina; genua I and II with a ventrolateral spur (Figure 4(d), outline arrows). Setation: I (1–5–2–4–17+1), II (1–5–3–4–16), III (2–2–1–3–14), IV (1–2–2–3–11). Solenidion on tibiae IV absent. Setae *l''* of genua I and II ticker and spine like.

Material examined. Five females and five males (MACN-Ar 37217) from Puerto Iguazú, Misiones, Argentina.

Discussion

Paralamellobates is a Pantropical and Palaearctic genus with *P. bengalensis* as type species. It was originally erected as a subgenus of *Lamellobates* Hammer, 1958 by Bhaduri and Raychaudhuri (1968) to accommodate a species with intermediate characters between *Oribatella* and *Lamellobates*. In that first diagnosis, the authors pointed out the great resemblance with *Lamellobates pallustris*, including the octotaxic system and the arrangement of notogastral setae, differing only in the shape of lamellar system. Considering the great resemblance between *Lamellobates* and *Paralamellobates*, I reviewed species of *Lamellobates* and noted *Paralamellobates argentinensis* **sp. nov**., and *Lamellobates quadricornis* (Pérez-Iñigo and Baggio 1985) were morphologically quite similar. But, in order to discuss morphological differences between both species and with its congeneric, a redescription of *L. quadricornis* was required. The differences among *Paralamellobates* species are summarized in Table 1.

Balogh (1972), probably considering the character states of *P. schoutedeni* Balogh, 1959 (a junior synonym of *P. misella*), used as a key diagnostic character the presence of one pair of

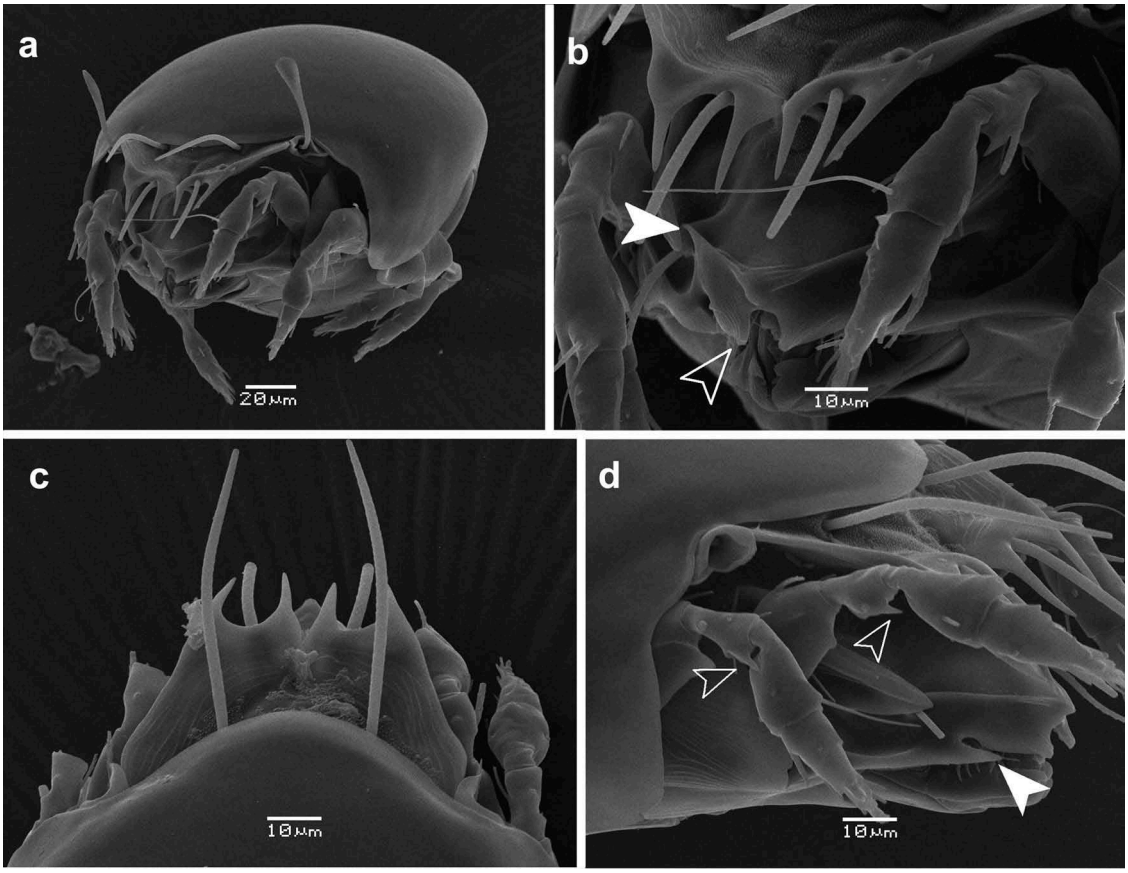

Figure 4. Adults of *Paralamellobates quadricornis* (Pérez-Iñigo and Baggio 1985) **stat. nov.** (a) Frontal aspect; (b) Detail of prodorsum in frontal aspect (white arrow = rostrum edge); (c) Detail of prodorsum in dorsal aspect; (d) Detail of anterior region in lateral aspect (white arrow = genal tooth, outline arrows = ventrolateral spur of genua I and II).

Table 1. Comparison of the main characters among *Paralamellobates* species.

	P. misella (Berlese 1910)[a,b,c]	*P. bengalensis* Bhaduri and Raychaudhuri, 1968[d]	*L. quadricornis* (Pérez-Iñigo and Baggio 1985)[e]	*P. argentinensis* **sp. nov.**
Lamellar system	Lamellae one and half longer than prodorsum	Lamellae one and half longer than prodorsum	Lamellae as long as the prodorsum	Lamellae as long as the prodorsum
Lateral teeth	Present	Without lateral teeth (?)	Present	Present
Genal teeth	With a strong and triangular carina	?	Simple and without strong carina	With a strong and triangular carina
Octotaxic system	Tubiform and filiform saccules	?	Tubiform saccules	Tubiform saccules
Number of adanal setae	1	2	2	2
Number of anal setae	1	2	2	2
Epmeral setae *1c*	Barbed and ticker	?	Setiform	Setiform
Number of solenidia on tarsus II	1	?	2	2

[a]Engelbrecht (1986); [b]Behan-Pelletier (1998); [c]Behan-Pelletier et al. (2016); [d]Bhaduri and Raychaudhuri (1968); [e]Pérez-Iñigo and Baggio (1985).
?: unknown character state.

adanal setae to separate *Paralamellobates* from *Lamellobates* (that it has two pairs). This error, keeping in the following edition (Balogh and Balogh 1992), generated a misplace of *Lamellobates quadricornis* that even though it has lamellae with lateral and medial teeth subequal in length, just as *Paralamellobates*, was described as *Lamellobates* because it has two pairs of adanal setae (Pérez-Iñigo and Baggio 1985).

Lamellobates and *Paralamellobates* are two genera closely related that share many characters and with only one fundamental difference: the absence of medial lamellar teeth in *Lamellobates*. This last difference between both genera primary placed *Lamellobates quadricornis* closer to *Paralamellobates* than *Lamellobates*. Analysing the current information of all members of *Paralamellobates* and *Lamellobates* plus the new data provided here, two more common characters between *L. quadricornis* and *Paralamellobates* supported the inclusion in this last genus. First, in all species of *Lamellobates*, along the medial side of the lamellae, there is a chitinous knob (Mahunka 1977, Fig. 46; Engelbrecht 1986, Fig. 14; Călugăr 1987, Fig. 1; Pérez-Iñigo and Baggio 1994, Fig. 34; Behan-Pelletier 1998, Figs. 18, 22), absent in all *Paralamellobates* as well as in *L. quadricornis*. Finally, in all species of *Paralamellobates*, setae *in* are inserted near the basis of the inner edge of the lamellae (Figures 3(e) and 4(c)) while in *Lamellobates* they are located far apart, closer to the bothridia (authors op. cit.). Taking into account the arguments mentioned above and the additional morphological characters provided here, I considered there are enough common characteristics to transfer *Lamellobates quadricornis* to *Paralamellobates*.

Finally, considering the morphological characters of *Paralamellobates* provided here, some topics of Behan-Pelletier et al's. (2016) generic diagnosis should be modified:

(1) Octotaxic system developed as saccules tubiform or both tubiform and filiform
(2) Epimeral setal formula 3–1–2–2; setae setiform with setae *1c* ticker or not
(3) Solenidion ω_2 on tarsi II present or absent

List of species of *paralamellobates* Hammer, 1958

Paralamellobates bengalensis Bhaduri & Raychaudhuri, 1968
Paralamellobates misella (Berlese 1910)
Paralamellobates argentinensis **sp. nov.**
Paralamellobates quadricornis (Pérez-Iñigo & Baggio 1985) **stat. nov.**

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