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Two new feather mites of the genus *Protonyssus* Trouessart, 1916 (Acariformes: Xolalgidae) from Brazilian parakeets (Psittacidae), with a key to species

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ABSTRACT

The feather mite genus *Protonyssus* Trouessart (Xolalgidae: Ingrassiinae) has included four species associated with Neotropical and Old World parrots. In this article, two new species are described from Brazilian parakeets: *Protonyssus mironovi* **sp. nov.** from *Psittacara leucophthalmus* (Statius Müller, 1776), and *P. athoracicus* **sp. nov.** from *Brotogeris chiriri* (Vieillot, 1818) (Psittaciformes: Psittacidae). A key to species of the genus *Protonyssus* is presented.

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Introduction

The family Xolalgidae (Acariformes: Analgoidea) – along with Analgidae and Psoroptoididae – is one of the three feather mite families that inhabit mostly the downy feathers of birds (Dabert and Mironov 1999). Xolalgids are generally characterized by a weak sclerotization of the idiosoma, femora and genua fused in all legs, only one ventral seta on tarsus III, seta *kT* absent from tibia IV, and epimerites I fused into a sternum. The family comprises about 130 species in three subfamilies and 25 genera (Gaud and Atyeo 1981, 1996; Mironov 2004; Dabert et al. 2007), and is one of the most diverse concerning the host range, including birds from 17 orders, being the only feather mite family recorded from the order Sphenisciformes (penguins) (Gaud and Atyeo 1981; Mironov 2004; Mironov and Proctor 2008).

The subfamily Ingrassiinae (Gaud and Atyeo 1996) is the most diverse and associated with a much wider array of hosts in comparison with the Xolalginae and Zumptiinae. In Brazil, xolalgids are still poorly studied. In a checklist of feather mites of Brazil, Valim et al. (2011) listed only four species, being three from the Ingrassiinae and one Xolalginae; subsequently, five ingrassiinae were described – one *Hartingiella*, two *Analloptes*, and two *Gymnalloptes*, from nightjars (Caprimulgidae), passerines (Conopophagidae, Tyrannidae), and hoatzins (Opisthocomidae), respectively (Hernandes 2014; Mironov and Hernandez 2014; Hernandez and Mironov 2015); *Leptosphyra centropoda* (Méglin 1877), originally described from the northern lapwing *Vanellus vanellus* (Linnaeus) (Charadriidae), was reported from the southern lapwing, *Vanellus chilensis* (Molina) (Pedroso et al. 2015), and *Ingrassia aequinoctialis* (Trouessart, 1899), described from *Phaethon aethereus* Linnaeus, 1758 and *P. rubricauda* Boddaert, 1783 was reported from *P. lepturus* Daudin, 1802 (Phaethontidae) (Hernandes et al. 2015). Undetermined species of *Dubininia*, *Analloptes*, and *Xolalgoides* were also reported from parrots (Psittacidae), jacamars (Galbulidae), and passerines (Furnariidae, Tyrannidae, Parulidae, and Vireonidae) of Brazil (Albuquerque et al. 2012; Enout et al. 2012; Silva et al. 2015).

Four xolalgid genera – all of which from the Ingrassiinae – associate with parrots (Psittaciformes): *Cacatualges* Dabert et al. 2007, *Dubininia* Vassilev, 1958, *Fainalgas* Gaud and Berla, 1964, and *Protonyssus*; Trouessart 1916.

In this article, we describe two new *Protonyssus* species from parakeets (Psittacidae) of Brazil. A key to species of this genus is presented.

Materials and methods

The material was retrieved from dead birds sent to the laboratory of Acari of São Paulo State University (UNESP), campus of Rio Claro, and kept in a freezer. Birds were washed and the liquid was filtered in paper filters; the mites were collected from the filters using a dissecting microscope, cleared in 30% lactic acid for 24 h at 50°C, and mounted in Hoyer's medium according to the standard technique for small mites (Krantz and Walter 2009). After five days at 50°C, the slides were sealed with varnish. Drawings and measuring of mites were made with a Leica DM3000 microscope equipped with differential interference contrast (DIC) optics and a *camera lucida*. Pencil sketches were scanned at 300 dpi grayscale and line drawings were created with Adobe Illustrator CS6 and a Wacom Bamboo Create tablet. Type specimens are deposited at DZUnesp-RC – Collection of Acari of Department of Zoology of the Universidade Estadual Paulista, Rio Claro, São Paulo, Brazil; ZISP – Zoological institute, Russian Academy of Sciences, Saint Petersburg, Russia; UMMZ – Museum of Zoology, the University of Michigan (Ann Arbor, USA); USNM – National Insect and Mite Collection, National Museum of Natural History, Smithsonian Institution, located at the SEL-USDA, Beltsville, Maryland, USA; DZSJR – Acari Collection of Departamento de Zoologia e Botânica of Universidade Estadual Paulista, São José do Rio Preto, São Paulo, Brazil. The chaetotaxy of the idiosoma and legs follows Griffiths et al. (1990) and Atyeo and Gaud (1990), respectively, with corrections for coxal setae proposed by Norton (1998). Measurements of particular structures are as described by Mironov et al. (2005).

Xolalgidae Dubinin, 1953 Ingrassiinae Gaud and Atyeo, 1981 *Protonyssus* Trouessart, 1916

Type species: *Protalgas larva* Trouessart, 1885, by original designation.

The type species, *Protalgas larva*, was originally described from several Neotropical hosts: “*Ara macao*, *Amazona melanocephala* [= *Pionites melanocephalus* (L.)], et autres perroquets de l'Amérique méridionale” (Trouessart 1885, p. 58). Upon erecting the genus *Protonyssus*, Trouessart (1916) elected *P. larva* from *Brotogeris jugularis* (Statius Müller, 1776) as the type species. *Protonyssus integrifolius* (Trouessart, 1885) was also described

from various Neotropical psittacids: "*Ara severus*, *Conurus cruentatus* [= *Pyrrhura cruentata*], *C. smaragdinus* [= *Enicognathus ferrugineus*], *Psittacula virescens* [= *Brotogeris versicolurus*], de l'Amérique méridionale". The two additional *Protonyssus* species were each described from a single host species: *Protonyssus brevis* (Trouessart, 1885) from *Psittacula lunulata* (= *Bolbopsittacus lunulatus*, Psittaculidae) from the Philippines, and *Protonyssus proctorae* Mironov et al. 2005, from the extinct *Conuropsis carolinensis*, from North America (Trouessart 1885, 1916; Gaud 1980; Gaud and Atyeo 1981; Mironov et al. 2005). An undetermined species was recently reported from the two species of *Enicognathus*, *E. ferrugineus* (Stadius Müller, 1776) and *E. leptorhynchus* (King, 1831) in Chile (Valdebenito et al. 2015).

The genus *Protonyssus* currently comprises six species, including the two new species described herein. Both sexes of *Protonyssus* have blade-like setae *mG* on genua II, males have well-developed interlobar membrane, and females have well-developed hysteronotal shields, and epigynum encompassing setae *4a*, *g*, and genital papillae.

Protonyssus mironovi Hernandes and Pedroso sp. nov.

(Figures 1–3)

Type material

Holotype male, 9 male and 14 female paratypes ex *Psittacara leucophthalmus* (Stadius Müller, 1776) (Psittaciformes: Psittacidae), 9 March 2010, Faz. Mt. D'Este, Campinas, SP, Brazil, 22°49'S 47°02'W, D. Vilas Boas-Filho coll. (#684).

Type deposition

Holotype and paratypes DZUnesp-RC; paratypes at ZISP, UMMZ, USNM, and DZSJRP.

Male (holotype, range for 8 paratypes in parentheses). Anterior end of idiosoma with triangular rostral projection (Figure 1(a)). Idiosoma length from anterior end of prodorsal shield to bases of setae *h3* 507 (466–516), greatest width 267 (243–268). Setae *se* separated by 116 (108–119). Prodorsal, scapular, humeral, and hysteronotal shields fused, covering almost entire idiosoma dorsally. Humeral setae *cp* blade-like, 159 long (137–155), 22 wide (14–24); setae *c3* short setiform. Opisthosomal lobes narrow, slightly divergent posteriorly, terminal cleft very wide, with narrow and long median extension reaching posterior margins of lobes, distance between setae *h3* 167 (158–174). The entire terminal cleft occupied by interlobar membrane, free margin of this membrane outlines medially a blunt-angular incision and laterally a pair of shallow convexities. Supranal concavity well-developed, closed, shaped as a teardrop or wide-based pear. Distances between hysteronotal setal rows: *c2*–*d2* 108 (102–114), *d2*–*e2* 112 (94–115), *e2*–*h3* 118 (101–120).

Coxal fields III open in anteromedian angle, anterior ends of epimerites IIIa wide. Coxal fields IV sclerotized. Genital apparatus narrow, 26 long (22–40), genital apodemes fused into narrow arch about 52 long (45–52) (Figure 1(b)). Genital shield represented by narrow longitudinal sclerite bearing setae *g* in anterior end. Adanal shield bow-shaped, bearing setae *ps3*. Setae *4b* anterior to *3a*. Distances between ventral setal rows: *4b*–*g* 47 (39–48), *g*–*ps3* 381 (71–82).

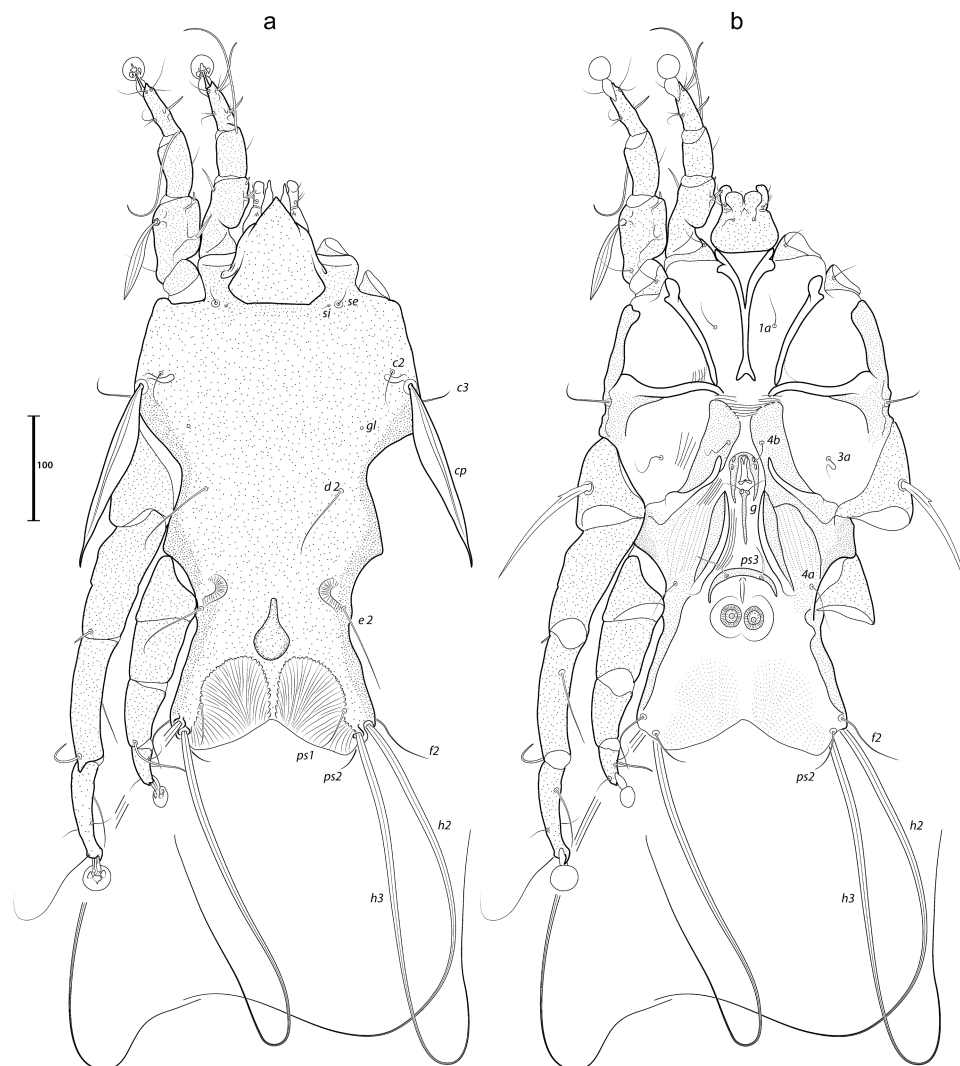


Figure 1. *Protonyssus mironovi* sp. nov., male. A – dorsal view, B – ventral view.

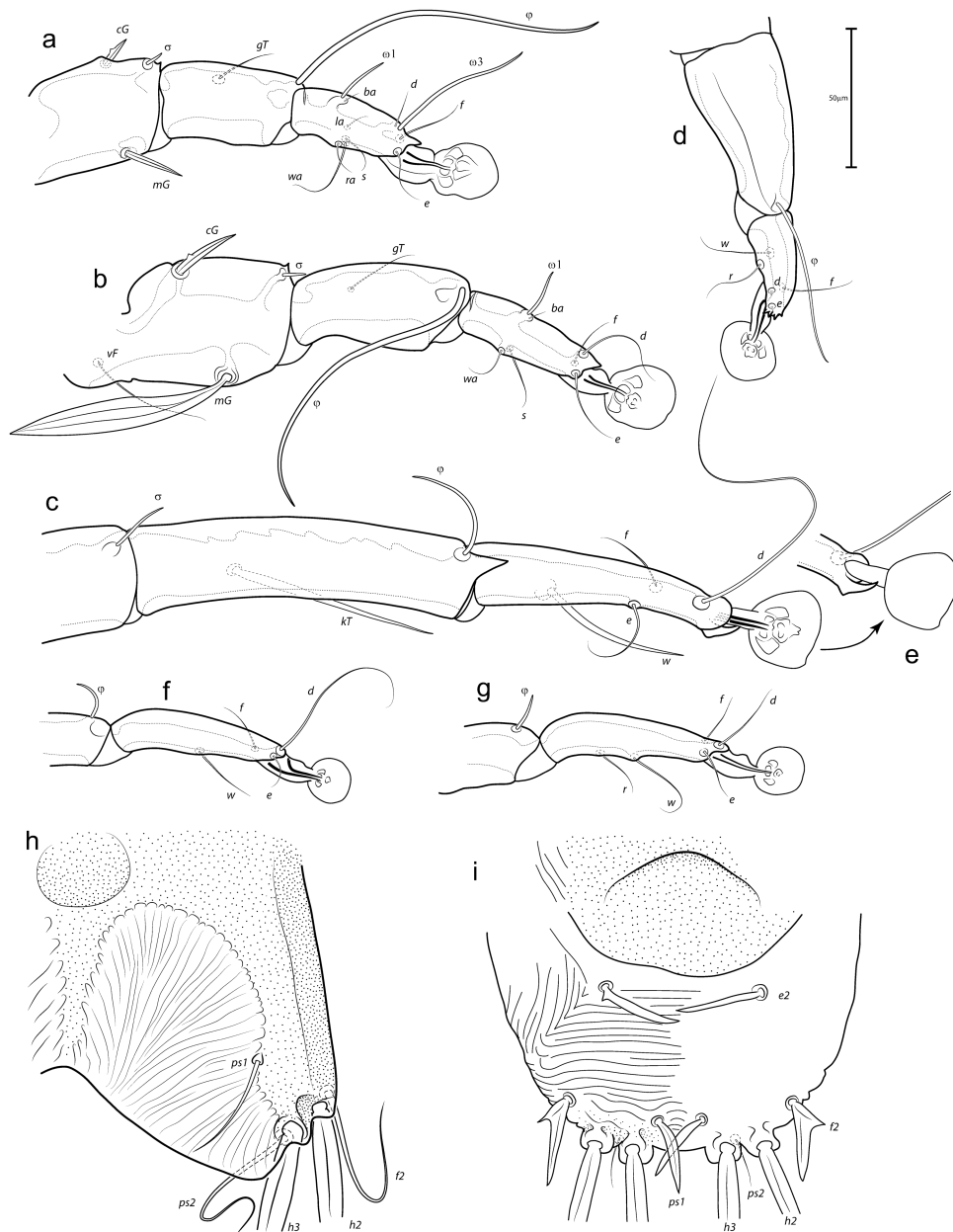


Figure 2. *Protonyssus mironovi* sp. nov. A–D, F, G – dorsal view of leg segments, E ventral. A–C – Femorogenu, tibia and tarsus of legs I–III of male; D – tibia and tarsus IV of male; E – distal part of tarsus III of male; F–G – distal part of tibia and tarsus III–IV of female. H–I – dorsal view of opisthosoma of male (H) and female (I).

Setae *mG* of femorogenua II lanceolate, 79 long (60–79), 10 (7–9) wide; setae *cG* II spine-like. Legs III and IV with tarsi extending beyond the level of lobar apices. Setae *sR* of trochanters III thickened in basal part, with small basal spine. Tarsus III with apical hook-shaped process (Figure 2(c)). Tarsus IV with apical extension bearing three to four small teeth (Figure 2(d)). Legs III (femorogenu, tibia, and tarsus excluding pretarsus): 127 (98–123), 113 (98–119), 94 (87–101), respectively. Legs IV (femorogenu, tibia, tarsus; ambulacral stalk and pretarsus not included): 70 (48–73), 58 (50–66), 37 (34–38), respectively.

Female (range for 8 paratypes). Anterior end of idiosoma with rostral projection as in the male. Idiosomal length 444–468, greatest width 175–195. Prodorsal shield 89–96 in length along median line, 55–66 in width at posterior margin; setae *se* separated by 85–93; posterior part of prodorsal (at level of scapular setae *si* and *se*) shield touching hysteronotal shield, this latter shield having a long median sclerotized ridge, length of hysteronotal shield along median line 288–305 (from the level of scapular setae to posterior margin at level anterior to setae *e2*), greatest width 133–145 (Figure 3(a)); hysteronotal area posterior to setae *e2* with striated tegument. Humeral setae *cp* large, blade-like with gradually thin

apex and smooth margins, 167–208 long, 8–14 wide; setae *d2* thick setiform, 60–71 long; setae *e2* thick setiform, 27–43 long, setae *f2* with a basal additional spine, 30–37 long; setae *ps1* thick, setiform, 26–35 long. Distances between hysteronotal setae and setal rows: *c2*–*d2* 132–150, *d2*–*e2* 91–100, *e2*–*h2* 53–61, *h2*–*h2* 57–62. Epigynum as elongated arch, 62–67 long, 79–88 wide; sclerotized apodemes of oviporus extending to mid-level of trochanters III (Figure 3(b)).

Femorogenua I, II with small lateroapical spine, setae *cG* II blade-like without additional basal spine, setae *mG* II as in the male; setae *sR* of trochanter III thickened, with small basal spine, 52–59 long. Tibiae III, IV greatly elongated.

Differential diagnosis

The new species, *Protonyssus mironovi* sp. n., is close to *P. integrifolius* (Trouessart, 1885) in having setae *cp* smooth in both sexes, the terminal cleft with a median incision posterior to the supranal concavity (lobes “M-shaped”) in males, and the median ridge of hysteronotal shield running almost the entire length in females. *Protonyssus mironovi* sp. n. is distinguished from *P. integrifolius* in having setae *e2* and *d2* relatively shorter –

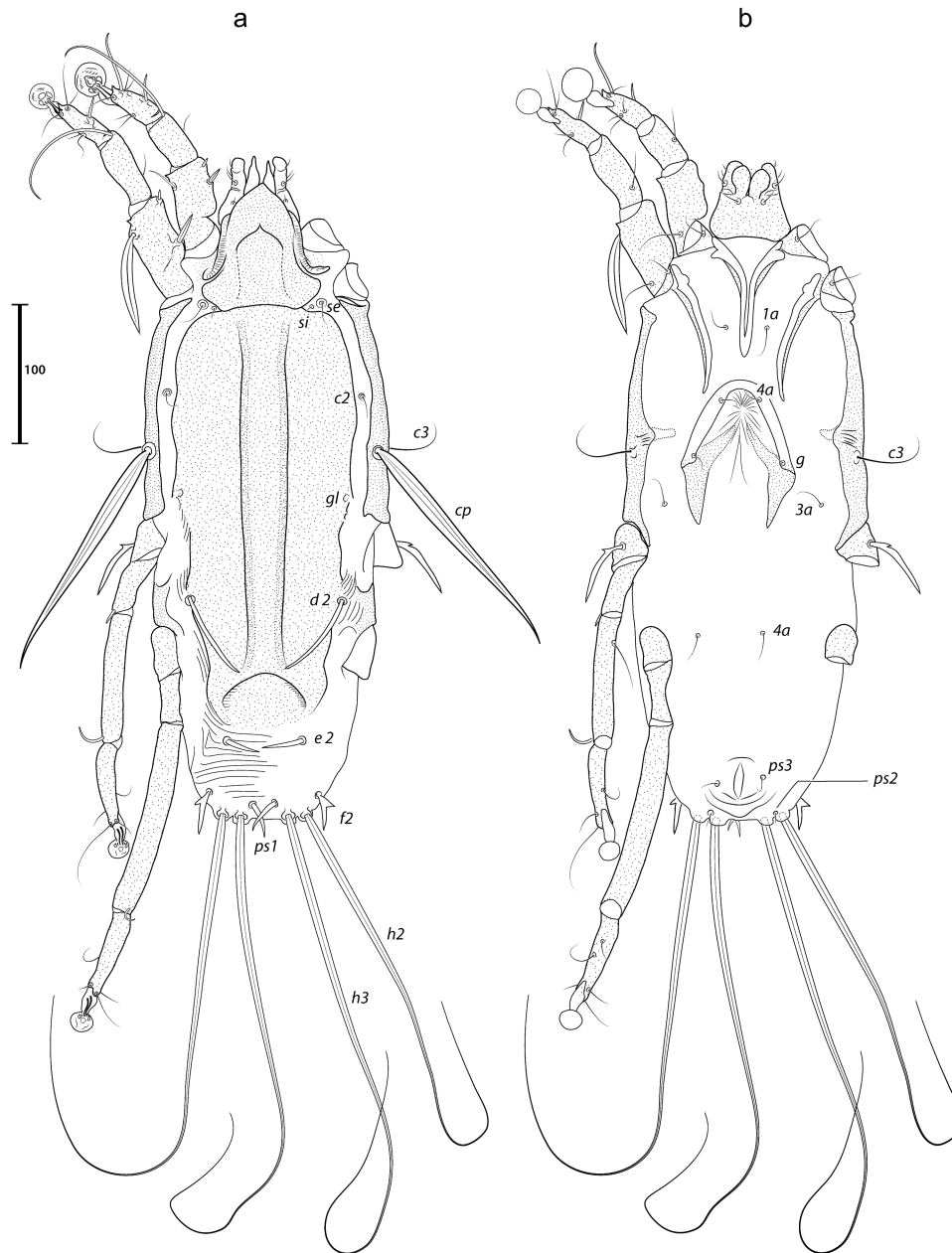


Figure 3. *Protonyssus mironovi* sp. nov., female. A – dorsal view, B – ventral view.

e2 24–30 μm , reaching about halfway to bases of *f2*; and seta *d2* not reaching the margins of the semicircular fold on the posterior part of the hysteronotal shield. In females of *P. integrifolius* setae *e2* are about 40 μm and reach the bases of *f2*; seta *d2* surpass the semicircular fold on the posterior part of the hysteronotal shield.

Etymology

The specific name is given after Dr. Sergey V. Mironov (Zoological Institute, Russian Academy of Sciences, St. Petersburg, Russia), the world expert of feather mites, in recognition to his efforts to the systematics of feather mites.

Protonyssus athoracicus Hernandez and Pedroso sp. nov.

(Figures 4–6)

Type material

Holotype male, 6 male and 5 female paratypes ex *Brotogeris chiriri* (Vieillot, 1818) (Psittaciformes: Psittacidae), October, 2013, Pedreira, SP, Brazil, 22°44'S 46°54'W, D. Vilas Boas-Filho coll. (# 1113).

Type deposition

Holotype and paratypes at DZUnesp-RC; paratypes at ZISP and UMMZ.

Male (holotype, range for 6 paratypes in parentheses). Anterior end of idiosoma with short and rounded rostral projection (Figure 4(a)). Idiosoma length from anterior end of prodorsal shield to bases of setae *h3* 368 (353–377), greatest width 185 (171–187). Setae *se* separated by 82 (76–81). Prodorsal, scapular, humeral, and hysteronotal shields fused, covering almost entire idiosoma dorsally. Humeral setae *cp* blade-like, 151 long (128–170), 22 wide (13–25); setae *c3* short setiform. Opisthosomal lobes narrow, slightly divergent posteriorly, terminal cleft semicircular, distance between setae *h3* 104 (97–103). Whole terminal cleft occupied by interlobar membrane, free margin of membrane concave, almost semicircular, with two small and acute terminal extensions near each lobar apex. Supranal concavity well-developed, closed, slightly enlarged posteriorly. Distances between hysteronotal setal rows: *c2*–*d2* 95 (93–100), *d2*–*e2* 70 (74–82), *e2*–*h3* 81 (69–75).

Coxal fields III open in anteromedian angle, anterior ends of epimerites IIIa wide (Figure 4(b)). Epimerite IIIa short, not reaching

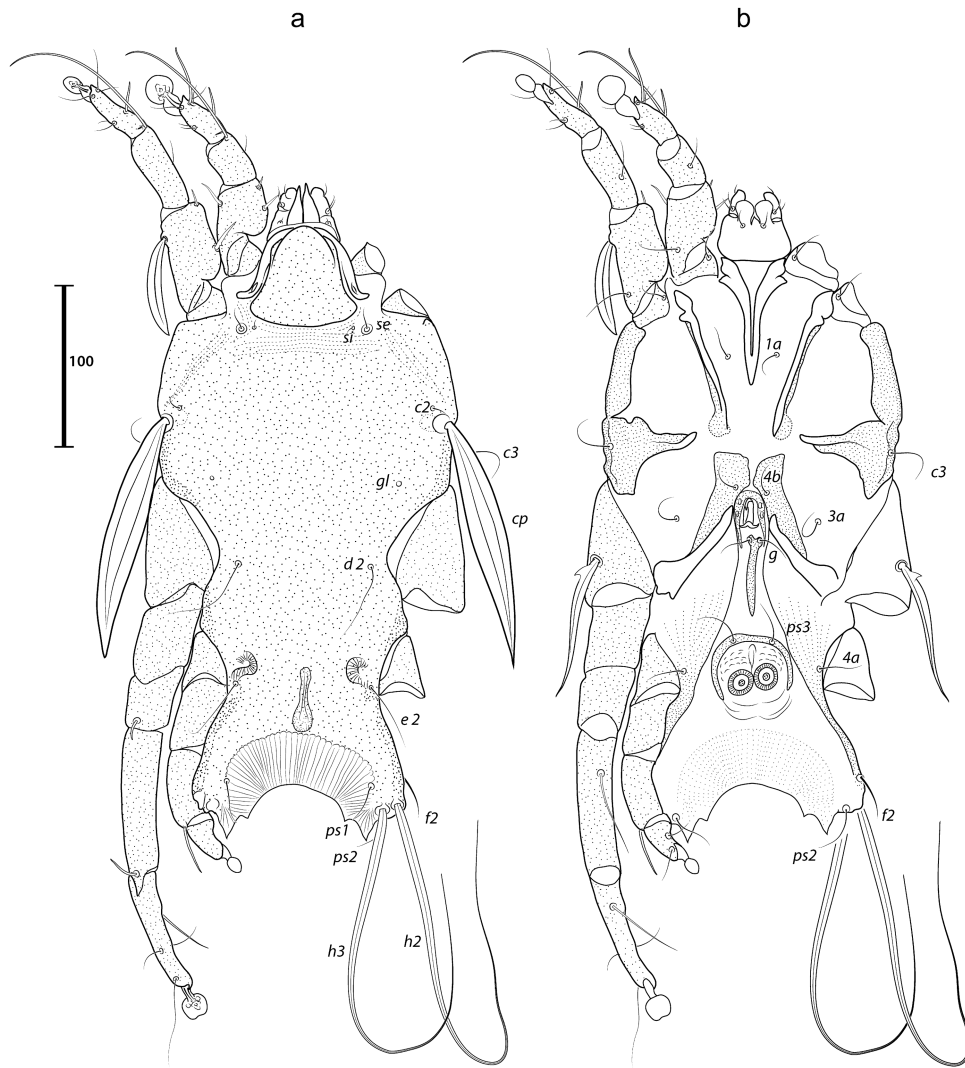


Figure 4. *Protonyssus athoracicus* sp. nov., male. A – dorsal view, B – ventral view.

posterior extremities of epimerites II. Coxal fields IV sclerotized. Genital apparatus narrow, 26 long (21–30); genital apodemes fused into narrow arch about 33 long (31–38). Genital shield represented by narrow longitudinal sclerite bearing setae *g* in anterior end. Adanal shield bow-shaped, bearing setae *ps3*. Setae *4b* anterior to *3a*. Distances between ventral setal rows: *4b–g* 31 (29–33), *g–ps3* 63 (58–63).

Setae *mG* of femorogenua II blade-like, 65 long (58–70), 10 (5–13) wide; setae *cG* II blade-like, with a small spine basally. Legs IV with tarsus extending beyond level of lobar. Setae *sR* of trochanters III thickened, with basal spine. Tarsus III with apical hook-shaped process (Figure 6(c)). Tarsus IV with apical extension bearing three to four small teeth (Figure 6(d)). Legs III (femorogenu, tibia, and tarsus excluding pretarsus): 82 (74–84), 89 (84–88), 77 (73–84), respectively. Legs IV (femorogenu, tibia, and tarsus excluding pretarsus): 41 (38–41), 43 (37–43), 27 (25–34), respectively.

Female (range for 5 paratypes). Anterior end of idiosoma with very short rounded extension. Idiosomal length 348–370, greatest width 143–155. Prodorsal shield 52–63 in length along median line, 35–43 in width at posterior margin; setae *se* separated by 64–68; posterior part of prodorsal (posterior to scapular setae *si* and *se*) shield touching hysteronotal shield, and having long median sclerotized ridge, length of hysteronotal shield along

median line 240–255, greatest width 89–98 (Figure 5(a)); area surrounding and posterior to setae *e2* with striated tegument. Humeral setae *cp* large, blade-like with gradually thin apex and smooth margins, 136–156 long, 7–11 wide; setae *d2* very thick setiform, 62–73 long; setae *e2* thick setiform, 24–30 long, setae *f2* with a basal additional spine, 21–34 long; setae *ps1* setiform, 19–32 long. Distances between hysteronotal setae and setal rows: *c2–d2* 99–107, *d2–e2* 81–88, *e2–h2* 42–47, *h2–h2* 47–52. Epigynum as elongated arch, 49–55 long, 64–74 wide; sclerotized apodemes of oviporus extending to mid-level of trochanters III (Figure 5(b)).

Femorogenua I, II without small lateroapical spine, setae *cG* II thickened blade-like, setae *mG* II slightly thinner than in the male; setae *sR* of trochanter III thickened, with small basal spine, 34–45 long.

Differential diagnosis

Protonyssus athoracicus sp. nov. is most similar to *P. larva* by the semicircular shape of the male opisthosomal lobes. It differs from the latter species most noticeably by the females, which lack the transverse rib-like extensions on the median groove of the hysteronotal shield. Females of *P. larva* have 7–8 transverse rib-like protrusions on each side of the median groove (see Gaud and Atyeo 1996, p. 25, Figure 6(f)).

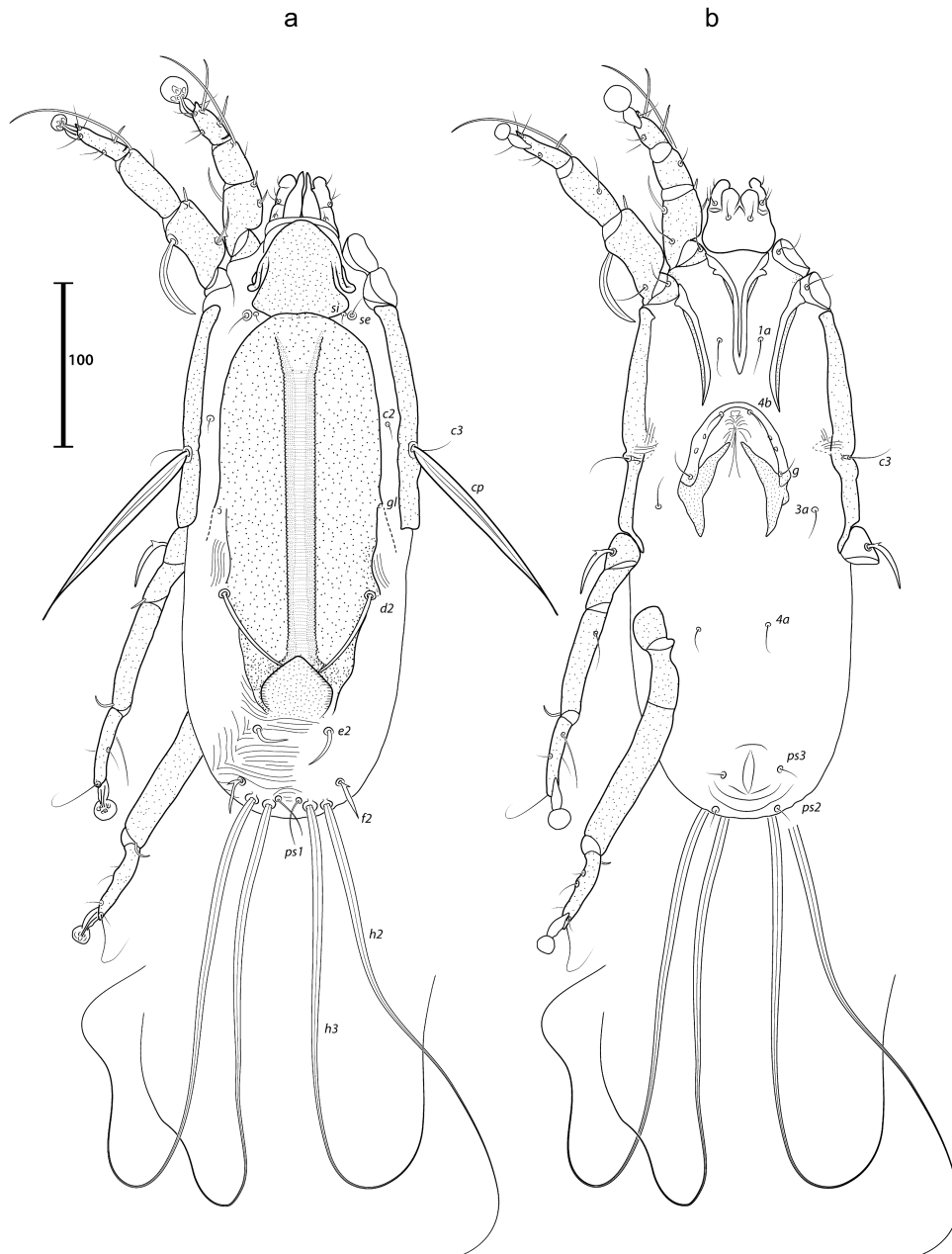


Figure 5. *Protonyssus athoracicus* sp. nov., female. A – dorsal view, B – ventral view.

Etymology

Combining of *a* (without, G.) and *thorax* (θύραξ, thorax, rib cage, G.), referring to the absence of the rib-like lateral projections of the longitudinal median ridge in females.

Key to *Protonyssus* species

1. In males, terminal cleft roughly semicircular; in females, hysteronotal shield with or without a median ridge 2
- 1'. In males, terminal cleft M-shaped because of a long and narrow median extension; in females, hysteronotal shield with a median ridge on dorsal shields 4
2. In females, median longitudinal ridge of hysteronotal shield with 7–8 transverse ribs on each side (see Gaud and Atyeo 1996, p. 25, Figure 6(f)) *P. larva* (Trouessart 1885)
- 2'. In females, median longitudinal ridge, if present, without transverse ribs 3
3. In both sexes, seta *cp* simple, setiform; in females, hysteronotal shield without median ridge *P. brevis* (Trouessart, 1885)
- 3'. In both sexes, setae *cp* expanded laterally, blade-like; in females, hysteronotal shield with a median ridge *P. athoracicus* sp. nov.
4. In both sexes, seta *cp* with inner margin indented (serrated) ...
..... *P. proctorae* Trouessart 1885 (Mironov et al. 2005)
- 4'. In both sexes, seta *cp* with both margins smooth 5
5. In females, setae *e2* about 40µm long, reaching bases of setae *f2*; setae *d2* extending to midlevel of semicircular fold on the posterior part of hysteronotal shield *P. integrifolius*)
- 5'. In females, setae *e2* 24–30µm long; setae *d2* reaching the anterior margin of the semicircular fold on the posterior part of hysteronotal shield *P. mironovi* sp. nov.

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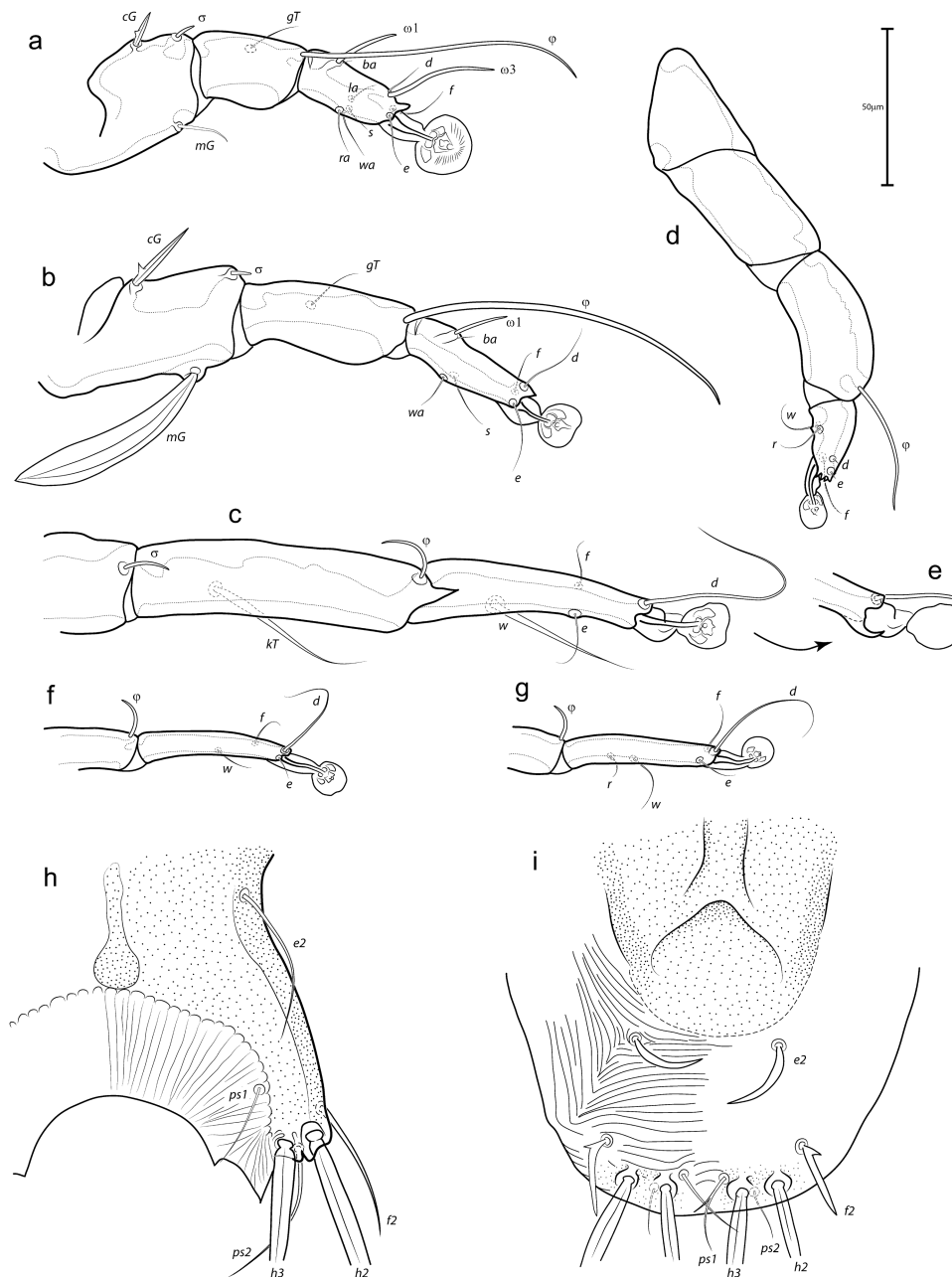


Figure 6. *Protonyssus athoracicus* sp. nov. A-D, F, G dorsal view of leg segments, E ventral. A-C – Femorogenu, tibia and tarsus of legs I–III of male; D – leg IV of male; E – distal part of tarsus III of male; F-G – distal part of tibia and tarsus III–IV of female. H–I – dorsal view of opisthosoma of male (H) and female (I).

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