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## New and little known feather mites (Acariformes: Astigmata) analysed with low-temperature scanning electron microscopy

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### ABSTRACT

Feather mites (Acari: Astigmata) were analysed with low-temperature scanning electron microscopy, including the description of three new species: *Plicatalloptes atrichogynus* **sp. nov.** (Analgoidea: AlLOPTidae) from the Neotropical cormorant *Phalacrocorax brasilianus* (Gmelin) (Pelecaniformes: Phalacrocoracidae), *Metapterodectes saturninus* **sp. nov.** (Analgoidea: Proctophyllodidae) from the chalk-browed mockingbird *Mimus saturninus* (Lichtenstein) (Passeriformes: Mimidae), and *Neumannella crypturella* **sp. nov.** (Analgoidea: Dermoglyphidae) from the small-billed tinamou *Crypturellus parvirostris* (Wagler) (Tinamiformes: Tinamidae). In addition, two previously known species are analysed, *Oustaletia pegasus* Trouessart, 1855 (Pterolichoidea: Vexillariidae) from the bushy-crested hornbill *Anorrhinus galeritus* (Temminck) (Bucerotiformes: Bucerotidae), and *Opisthocomacarus umbellifer* (Trouessart, 1899) (Pterolichoidea: Pterolichidae) from the hoatzin *Opisthocomus hoazin* (Müller) (Opisthocomiformes: Opisthocomidae). The latter two mite species display a rich variety of setal structures. *Alloptes umbrettae* Gaud, 1960 (Analgoidea: AlLOPTidae), known from *Scopus umbretta* Gmelin (Pelecaniformes: Scopidae), is transferred from the genus *Alloptes* Canestrini to *Plicatalloptes* Dubinin and given a new valid name, *Plicatalloptes umbrettae* (Gaud, 1960) **comb. nov.**

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### Introduction

As Walter and Proctor (2013, 381) noted in their monograph on the ecology, evolution and behaviour of mites, feather mites (Acariformes: Astigmata: Analgoidea and Pterolichoidea) are “perhaps the most fabulously ornamented of all Acari.” Outstanding examples of ornamentations can be seen in feather mites like *Opisthocomacarus umbellifer* (Trouessart, 1899) (Pterolichidae) and *Oustaletia pegasus* Trouessart, 1885 (Vexillariidae), having many dorsal setae variously modified into flattened, leaf-like and spiky structures which biological functions are yet a subject of speculation (Atyeo and Gaud 1971; Hernandez and Mironov 2015). Other odd feather mites can have dorsal shields adorned with longitudinal ridges (e.g. *Protonyssus* Trouessart, Xolalgidae; *Atopolichus* Gaud, Pterolichidae) (Mironov et al. 2005; Hernandez and Pedrosa 2017), bullet-like protrusions (e.g. *Aterolichus* Gaud, Pterolichidae), or perforated with numerous large lacunae (e.g. *Montesauria pardalis* [Gaud and Mouchet 1957], Proctophyllodidae; *O. umbellifer*, Pterolichidae) (Gaud and Mouchet 1957; Gaud and Atyeo 1996).

Many of such remarkable examples of rich feather mite morphology have been investigated in closer detail using scanning electron microscopy (SEM) in a number of studies (e.g. Atyeo and Gaud 1971; Atyeo et al. 1972; Kudon 1982; Atyeo 1988a, 1988b, 1992; Pérez and Atyeo 1992; Pérez 1995; Gaud and Atyeo 1996; Mestre et al. 2011; Albuquerque et al. 2012; Hernandez et al. 2015, 2016a). This technique has provided high-quality images of mites, often revealing morphological features previously unsuspected with traditional optical microscopy, e.g. the gecko-skin like texture of the pseudo-rutelar processes of *Michaelia neotropica* Hernandez & Mironov, 2016 Freyanidae (Hernandez et al. 2016a).

In the present work, various feather mites are analysed with the SEM technique, in addition to the standard optical microscopy. Three new species belonging to the genera *Plicatalloptes* Dubinin (Analgoidea: AlLOPTidae), *Metapterodectes* Mironov (Analgoidea: Proctophyllodidae), and *Neumannella* Trouessart (Analgoidea: Pyroglyphidae) are described from the Neotropical cormorant *Phalacrocorax brasilianus* (Gmelin) (Pelecaniformes: Phalacrocoracidae), the chalk-browed mockingbird, *Mimus saturninus* (Lichtenstein) (Passeriformes: Mimidae), and the small-billed tinamou, *Crypturellus parvirostris* (Wagler) (Tinamiformes: Tinamidae), respectively. In addition, *Oustaletia pegasus* (Vexillariidae) and *Opisthocomacarus umbellifer* (Pterolichidae) are also analysed with this technique.

### Materials and methods

The feather mites studied herein were obtained from two sources: (1) dead specimens of birds sent to the laboratory of Acarology of Department of Zoology of the Universidade Estadual Paulista, Rio Claro, São Paulo, Brazil; (2) museum bird skins from the collections of the Museum of Zoology of the University of Michigan (UMMZ), Ann Arbor, Michigan, USA, and the Field Museum of Natural History (FMNH), Chicago, Illinois, USA. The collection from the museum skins followed the procedures described in Gaud and Atyeo (1996). In both cases, mites were manually collected under a dissecting microscope with the aid of a fine brush, cleared in 30% lactic acid for 24 h at 50°C, and mounted in Hoyer's medium according to the standard technique for small acariform mites (Krantz and Walter 2009). After five days at 50°C, the

slides were sealed with varnish. Drawings and measurements of mites were made with a Leica DM3000 microscope equipped with differential interference contrast 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. The idiosoma and leg chaetotaxy follow Griffiths et al. (1990) and Atyeo and Gaud (1966), respectively, with corrections for coxal setae proposed by Norton (1998). Descriptions of the new species follow the scheme proposed by the most recent descriptions of the relevant or similar taxa (Mironov and Palma 2006; Dabert 2014; Hernandez et al. 2016b).

Specimens were observed by low-temperature scanning electron microscopy (LT-SEM) following the technique described in Castro et al. (2015) and Hernandez et al. (2016a). Mites collected from museum skins were directly subject to the SEM technique without cleaning or ultrasound processing. Specimens collected from frozen birds were stored in ethanol 70% prior to the SEM technique. Type specimens are deposited at DZUnesp-RC – Collection of Acari of Department of Zoology of the Universidade Estadual Paulista, Rio Claro, São Paulo, Brazil; USNM – National Insect and Mite Collection, National Museum of Natural History, Smithsonian Institution, located at the SEL-USDA, Beltsville, Maryland, USA; UMMZ – Museum of Zoology, the University of Michigan (Ann Arbor, USA); OSAL–The Acarology Laboratory, Museum of Biological Diversity, The Ohio State University, Columbus, USA; ZISP – Zoological institute, Russian Academy of Sciences, Saint Petersburg, Russia; MNHN – Muséum National d'Histoire Naturelle, Paris, France; MGAB – Acarological Collection of the “Grigore Antipa” National Museum of Natural History, Bucharest, Romania.

### Superfamily Analgoidea Trouessart & Mégnin, 1884

#### Family Alloptidae Gaud, 1957

#### Subfamily Alloptinae Gaud, 1957

#### Genus *Plicatalloptes* Dubinin, 1955

Type species: *Plicatalloptes plegadis* Dubinin, 1955, by original designation.

The genus *Plicatalloptes* was erected by Dubinin (1955) to accommodate a single species, *P. plegadis* Dubinin, 1955 from *Plegadis falcinellus* (Linnaeus, 1766) (Pelecaniformes: Threskiornithidae). Gaud and Till (1961, 240) expressed doubts about the validity of this and several other genera erected by Dubinin (1951, 1955), and Gaud (1982, 706) regarded *Plicatalloptes* as a synonym of *Alloptes* Canestrini, 1879 based on the fact that the unusual opisthosomal appearance of the male holotype of *Plicatalloptes plegadis* was caused by an incomplete moult of specimen still being inside the tritonymphal exuvia. Mironov (1996) revalidated the genus *Plicatalloptes* and, in addition to the type species, transferred to this genus five *Alloptes* species described from ibises (Threskiornithidae), cormorants (Phalacrocoracidae), and pelicans (Pelecanidae): *P. stenurus* (Gaud & Mouchet, 1957), *P. plataleae* (Gaud, 1982), *P. subcrassipes* (Dubinin & Dubinina, 1940), *P. ferrandi* (Gaud & Mouchet, 1957), and *P. pelecani* (Dubinin, 1954). Further, Mironov (2002, 41) referred *Alloptes trachelurus* Trouessart, 1885 to the genus *Plicatalloptes*, but this was an incorrect solution. Later on, it was found (Mironov 2013) that this species is the senior synonym of *Anisanchus ptilotus* Peterson & Atyeo, 1977, the type species of the genus *Anisanchus* Peterson & Atyeo, 1977. *Plicatalloptes umbrettae* (Gaud, 1960) **comb. nov.**, known from *Scopus umbretta* Gmelin, 1789 (Pelecaniformes: Scopidae) is herein transferred from *Alloptes*, based on examination of the type specimens housed at the Royal Museum for Central Africa, Tervuren, Belgium.

Thus, the genus *Plicatalloptes* presently comprises eight species, including the new one described in the following. The

most clear feature of *Plicatalloptes* distinguishing it from the genus *Alloptes* is the presence of a lateral crest or fold on tarsi III and IV of females (Mironov 1996, 1998) (Figures 3(g,h) and 4(d)).

#### *Plicatalloptes atrichogynus* Hernandez sp. nov.

(Figures 1–4)

#### Type material

Holotype male (DZUNESP-RC # 3908), paratypes 31 males and 54 females ex *Phalacrocorax brasilianus* (Gmelin, 1789) (Pelecaniformes: Phalacrocoracidae), 2009, Pedreira, São Paulo State, Brazil, 22°44'S, 46°54'W, David V. Boas-Filho col. (#390).

#### Type deposition

Holotype male at DZUnesp-RC; paratypes at DZUnesp-RC, DZSJRP, ZISP, UMMZ, USNM, OSAL, MNHN, MGAB.

Male. (Figures 1, 3(a–d) and 4(a)); holotype, range for 7 paratypes in parentheses. Idiosoma size, length × width, 330 × 150 (327–343 × 140–156). Prodorsal shield: posterior margin concave, surface without ornamentation, greatest length 84 (78–86), width of posterior part 76 (73–80), distance between setae *se* 81 (71–83). Length of hysterosoma from sejugal furrow to bases of setae *ps1* 238 (236–246). Hysteronotal shield (Figure 1(a)): greatest length from anterior end to bases of setae *ps1* 222 (222–241), width of anterior part 76 (76 – 82), anterior margin slightly concave, anterolateral corners acute, lateral margin with small incision at level of trochanters III, setae *d2* on margin of these incisions, surface without ornamentation. Distance between prodorsal and hysteronotal shields along midline 29 (25–31). Subhumeral setae *c3* lanceolate, 12 (12–15) × 2 (2–3). Opisthosoma gradually attenuate to posterior end; length of interlobar septa 92 (88–94), width of opisthosoma at level of setae *h2* 33 (33–38). Terminal lamella with three pairs of smooth-edged festoons. Setae *h2* whip-like without strong enlargement in basal half, greatest width 4. Setae *h3* absent, setae *ps2* greatly reduced. Distance between dorsal setae: *c2:d2* 48 (45–50), *d2:ps1* 145 (142–154). Bases of trochanters I, II flanked by narrow sclerotised bands connecting bases of respective epimerites. Coxal setae *4b* situated anterior to *3a*, pseudanal setae *ps3* anterior to coxal setae *4a* (Figure 1(b)). Bases of setae *4a* on small sclerites. Pregenital sclerite Y-shaped, connecting inner ends of epimerites IIIa and apex of paragenital arch. Length of genital arch 18 (17–23), width 19 (20–26). Distance between ventral setae: *4b–3a* 15 (10–15), *3a–g* 30 (25–30), *3a–4a* 60 (57–63), *g–ps3* 16 (14–17), *ps3–ps1* 120 (119–127), *4a–4a* 81 (78–88). Setae *mG* of genu I spine-like, straight, with acute apex; seta *mG* of genu II spine-like with bluntly rounded apex (Figure 3(b)). Solenidion  $\sigma$  of genu III subequal in length to tibia IV. Solenidion  $\phi$  of tibia III about  $\frac{3}{4}$  of corresponding tarsus, solenidion  $\phi$  of tibia IV about 1.5 times longer than corresponding tarsus. Legs IV 140 (134–152) in length, tarsus IV 29 (29–34) in length.

Female. (Figures 2, 3(e–h) and 4(b–e)); range for 8 paratypes). Idiosomal size, length × width, 351–371 × 130–146. Prodorsal shield as in the male, posterior margin less concave, length 75–82, width of posterior part 72–78; distance between setae *se* 78–83. Length of hysterosoma 244–269. Setae *c3* lanceolate 9–13. Hysteronotal shield: anterior margin straight, surface with faint reticulate ornamentation, greatest length (from anterior margin to setae *h3*) 235–244, width of anterior part 55–60 (Figures 2(a) and 4(b)). Setae *f2*, *ps1* absent; setae *h1* anterior to setae *e2*. Distance between prodorsal and hysteronotal shields along midline 23–41. Opisthosomal lobes moderately developed, terminal cleft as a narrow U, 31–35 long. Distance between dorsal setae: *c2:d2* 59–89, *d2:e2* 93–103, *e2:h2* 47–52, *h2:h3* 17–19, *h2:h2* 53–58, *h3:h3* 25–34. Supranal concavity ovate, separated from terminal cleft. Coxal fields I, II as in the

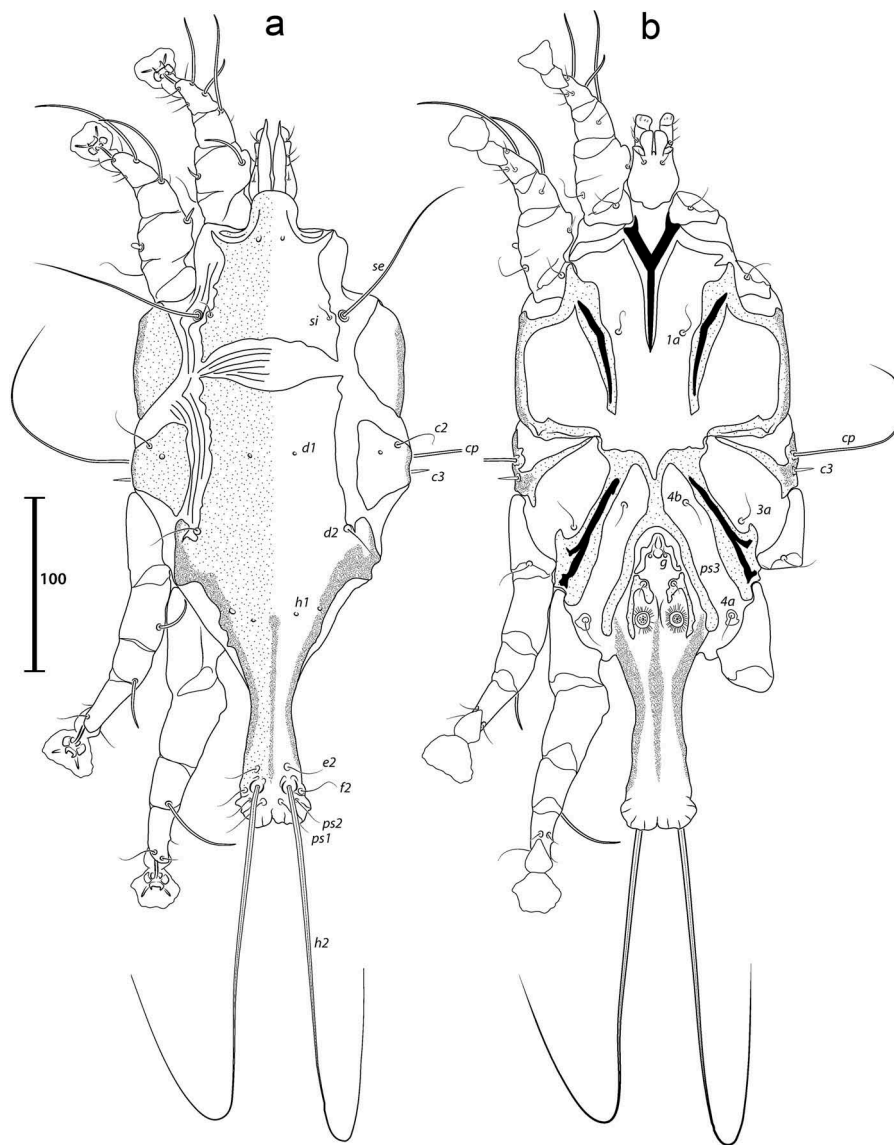


Figure 1. *Plicatalloptes atrichogynus* sp. nov. (Alloptidae), male: dorsal (a) and ventral (b) views.

male. Epigynum bow-shaped, length  $\times$  width, 24–28  $\times$  51–64 (Figure 2(b)). Legs I, II as in the male. Trochanteral seta *s*RIII very thin, barely discernible in some specimens. Solenidion  $\sigma$  vestigial on genu III (Figure 4(b), detail), solenidion  $\phi$  of tibia III about half the length of tarsus III, solenidion  $\phi$  absent from tibia IV. Tarsi III, IV with small latero-apical crest (Figure 4(d)). Legs IV with ambulacra almost extending to level of setae *h*2.

#### Etymology

The species name is a combination of *a* (without, G.), *tricho* (hair, G.), and *gynos* (female, G.), referring to the vestigial condition of the solenidion  $\sigma$  on genua III and the absence of solenidion  $\phi$  from tibiae IV of females.

#### Differential diagnosis

The new species, *Plicatalloptes atrichogynus* sp. nov., is very similar to *P. ferrandi* (Gaud & Mouchet, 1957), described from the reed cormorant, *Phalacrocorax africanus* (Gmelin, 1789). In females of both species, trochanteral seta *s*RIII is strongly reduced, solenidion  $\phi$  is vestigial on genu III and solenidion  $\phi$  is absent on tibia IV. These two species can be distinguished by the following characters: in males of *P. atrichogynus*, legs IV with distal half of tarsus surpass the opisthosomal terminus (including

terminal lamellae), and in females, the ambulacra of legs IV reach the level of setae *h*2. In males of *P. ferrandi*, tarsus IV reaches the level of body terminus by ambulacrum, and in females, the ambulacra of legs IV reach the midlevel between supranal concavity and the anterior end of terminal cleft.

**Family Proctophyllodidae** Trouessart & Mégnin, 1884

**Subfamily Pterodectinae** Park & Atyeo, 1971

**Tribe Pterodectini** Park & Atyeo, 1971

**Genus *Metapterodectes*** Mironov, 2008

Type species: *Metapterodectes furnarius* Mironov, 2008, by original designation.

The genus previously included four species: *M. furnarius* Mironov, 2008, *M. muticus* (Banks 1909), *M. leptasthernurae* Mironov & Gonzalez-Acuña, 2011, and *M. toxostomae* Mironov & OConnor, 2014, associated with passerines of the families Furnariidae, Emberizidae, and Mimidae (Mironov et al. 2008; Valim and Hernandez 2010; Mironov & Gonzalez-Acuña 2011; Mironov & OConnor 2014). A fifth species is described in the following.

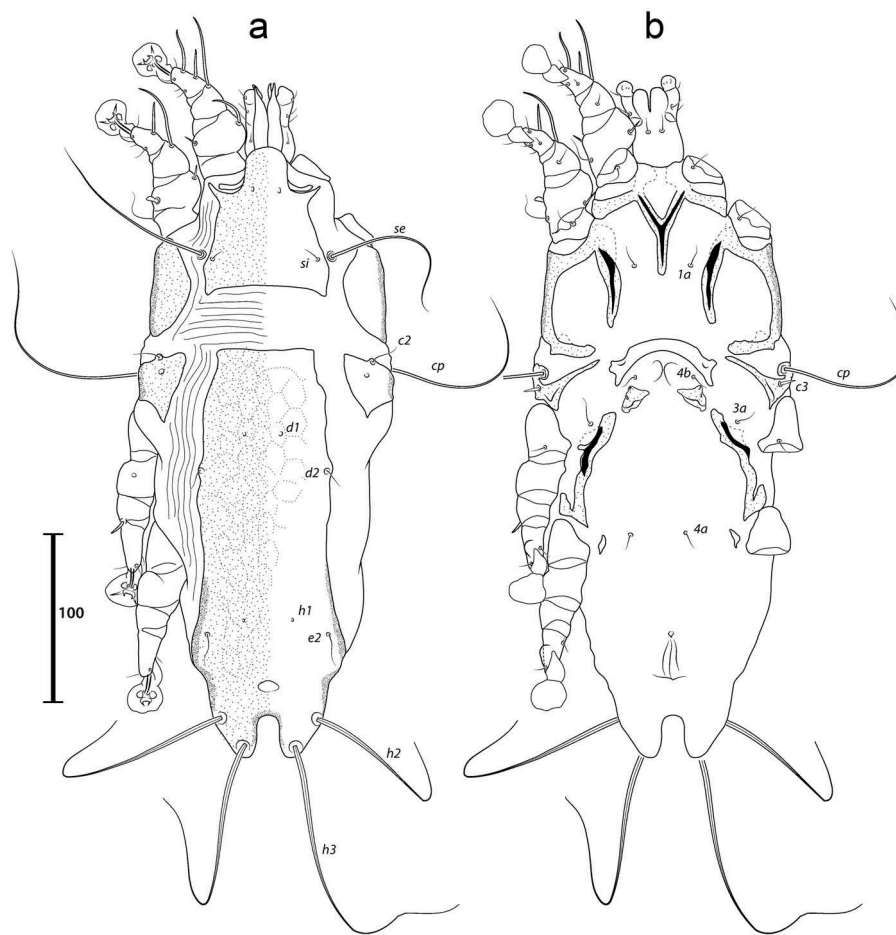


Figure 2. *Plicatalloptes atrichogynus* sp. nov. (Alloptidae), female: dorsal (a) and ventral (b) views.

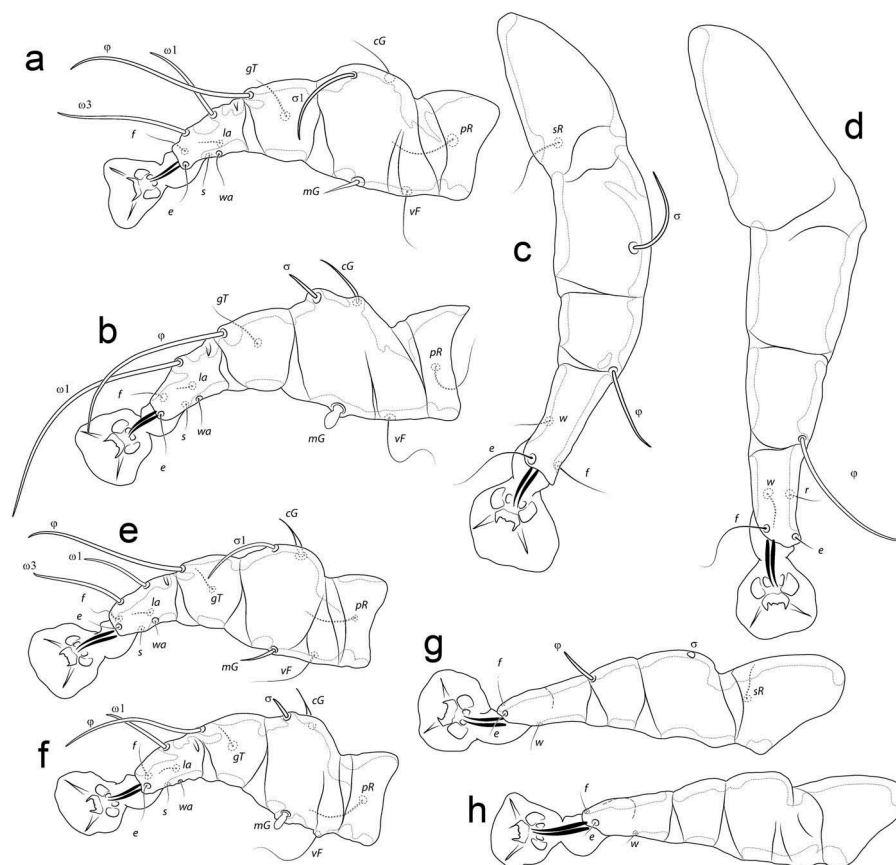
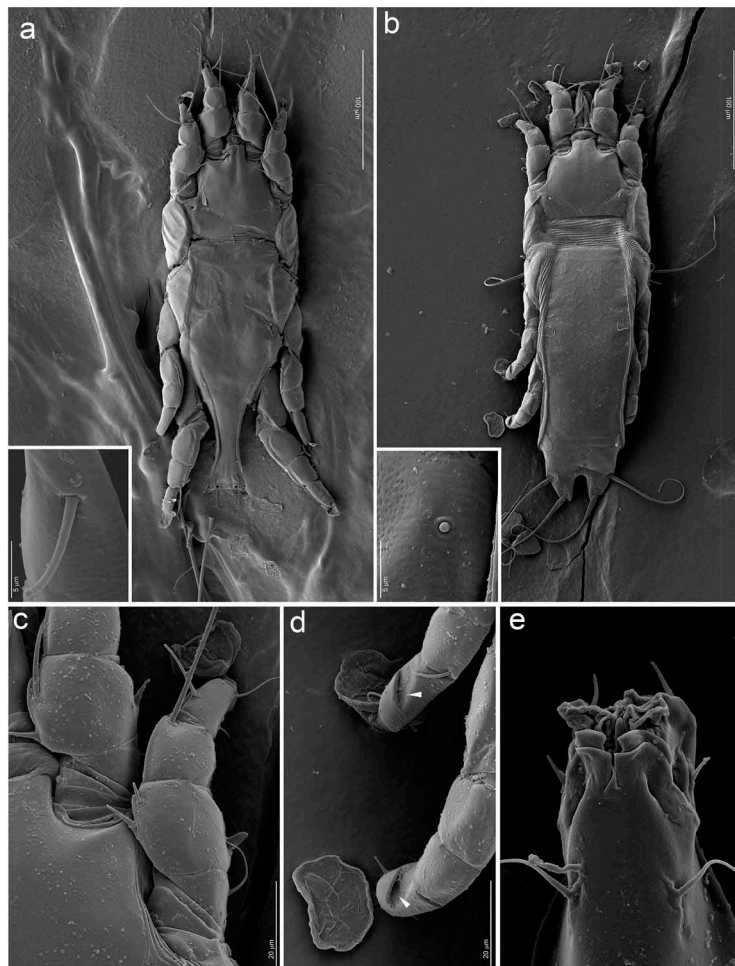


Figure 3. *Plicatalloptes atrichogynus* sp. nov. (Alloptidae), dorsal view of legs I–IV of male (a–d) and female (e–h).



**Figure 4.** *Plicatallotes atrichogynus* sp. nov. (Alloptidae). Low-temperature scanning micrographs: dorsal view of male (a) and female (b), insertions in a and b display normal and vestigial condition of solenidion  $\sigma$  of genu III in male and female, respectively; dorsal view of female legs I and II (c); female tibiae and tarsi III, IV with lateral fold on tarsi (d, arrows point to the folds); ventral view of gnathosoma of female (e).

***Metapterodectes saturninus* Hernandez sp. nov.**  
(Figures 7–10)

**Type material**

Holotype male (DZUNESP-RC # 3947), paratypes 1 male and 2 females ex *Mimus saturninus* (Lichtenstein, 1823) (Passeriformes: Mimidae), BRAZIL, São Paulo State, Rio Claro, campus of São Paulo State University (UNESP), 22°24' S 47°33' W, 13 September 2013, F. A. Hernandez col.; paratypes 18 males and 49 females, same host species, BRAZIL, São Paulo State, Campinas, 22°54' S 47°03' W, 1 April 2010, David V.Boas-Filho col.

**Type deposition**

Holotype male at DZUnesp-RC; paratypes at DZUnesp-RC, DZSJRP, ZISP, UMMZ, USNM, OSAL, MGAB.

Male. (holotype, range for 6 paratypes in parentheses). Idiosoma, length  $\times$  width, 411 (392–425)  $\times$  206 (165–209). Prodorsal shield: entire, lateral margins slightly concave at level of scapular setae, posterior margin sinuous, posterior angles acute, length 133 (120–136), width 119 (104–125), surface with numerous small circular lacunae (Figure 7(a)); bases of scapular setae *se* separated by 74 (62–78). Setae *ve* present, rudimentary. Scapular shields narrow. Humeral shields absent. Setae *cp* and *c2* situated on striated tegument. Subhumeral setae *c3* lanceolate, 29 (26–26)  $\times$  7 (7–9). Hysteronotal shield: greatest length 253 (242–267), width at anterior margin 112 (99–128), anterior margin concave, surface with numerous small, circular lacunae evenly distributed on the entire surface. Distance between prodorsal and hysteronotal shields 24 (17–31). Posterior margins of opisthosomal lobes rounded. Terminal cleft shaped as an inverted U with

divergent branches, 22 (18–23) long. Supranal concavity distinct. Setae *f2* anterior to bases of setae *ps2*. Setae *h1* situated slightly anterior to the level of supranal concavity. Setae *h3* spiculiform, 24 (24–27) long; setae *ps2* 100 (91–100) long; setae *ps1* filiform, about 6 long, situated slightly anterior to bases of setae *h3*. Distances between dorsal setae: *c1:d2* 102 (92–106), *d2:h1* 100 (99–109), *h2:h2* 67 (58–69), *h3:h3* 47 (43–51).

Epimerites I fused into a narrow U, fused part disconnected from epimerites II (Figure 7(b)). Coxal fields I, II without extensively sclerotized areas. Rudimentary sclerites *rEpIIa* absent. Coxal fields I–IV open. Epimerites IVa small. Genital arch 40 (38–42) in width; aedeagus 84 (81–86) long from anterior bend to tip, extending to anterior level of anal opening. Genital papillae connected at bases. Genital and adanal shields absent. Adanal suckers 15 (11–17) in diameter, distance between centres of discs 34 (34–42), corolla smooth, surrounding membrane with few radial striae. Opisthoventral shields occupying lateral areas of opisthosoma and distal part of opisthosomal lobes; inner margins of these shields at level of anal suckers with two extensions, anterior extension bearing setae *ps3*. Setae *4b* situated slightly posterior to level of setae *3a*. Distance between ventral setae: *1a:4b* 143 (130–151), *4b:4a* 45 (45–51), *4a:g* 44 (39–49), *g:ps3* 57 (54–62), *ps3:ps3* 83 (77–92).

Femora and other segments of legs I–IV without processes. Solenidion  $\sigma 1$  of genu I 10 (9–13) long, situated at midlevel of segment; solenidion  $\sigma$  of genu III absent. Genual setae *cGI*, II and *mGI*, II filiform. Seta *d* of tarsi II slightly shorter than corresponding seta *f*; seta *d* of tarsi III two times shorter than corresponding seta *f* (Figure 8(c)). Solenidion  $\phi$  of tibia IV extending to anterior level of ambulacral disc. Tarsus IV 38 (38–41) long, without

claw-like apical process; setae *d* and *e* button-like, seta *d* situated at basal half of segment (Figure 8(d)).

Female (range for 6 paratypes). Idiosoma, length  $\times$  width, 522–573  $\times$  178–232. Prodorsal shield: length  $\times$  width, 139–159  $\times$  128–149, surface with few small, circular lacunae, posterior margin with a pair of concavities, bases of setae *se* separated by 82–91 (Figure 9(a)). Setae *ve* present, rudimentary. Scapular shields narrow, poorly developed dorsally. Humeral shields absent. Setae *cp* and *c2* situated on striated tegument. Setae *c3* lanceolate, 26–31  $\times$  7–9. Anterior and lobar parts of hysteronotal shield separated dorsally by narrow transverse band of soft tegument (Figure 9(b)). Distance between prodorsal and anterior hysteronotal shields 22–48. Anterior hysteronotal shield roughly rectangular, anterior margin concave, greatest length 280–302, width at anterior margin 124–148, surface with numerous small, circular lacunae evenly distributed. Length of lobar region 91–100, greatest width 111–124. Terminal cleft narrow V-shaped, 49–56 long. Supranal concavity distinct; lobar shield entire, surface with few lacunae near anterior margin. Setae *h1* inserted at the anterior level of supranal concavity; setae *h1* and *f2* arranged in a trapezium. Setae *h2* lanceolate with apical filament, 71–105  $\times$  7–8. Setae *ps1* situated near inner margins of opisthosomal lobes, closer to the level of setae *h3* than to *h2*. Setae *h3* 16–23 long, about 1/8 of terminal appendages. Distances between dorsal setae: *c1:d2* 116–131, *d2:h1* 150–170, *h2:h3* 87–95, *h3:h3* 41–53.

Epimerites I fused into a narrow U (Figure 9(b)). Coxal fields I, II open. Epimerites IVa small. Translobar apodemes of opisthosomal lobes present, wide, fused to each other anterior to terminal cleft. Epigynum horseshoe-shaped, greatest width 67–92; apodemes of ovipore not connected to epimerites IIIa. Primary spermaduct slightly enlarged near the head of spermatheca; secondary spermaducts 35–41 long (Figure 9(i)). Pseudanal setae *ps2*, *ps3* button-like, situated at midlevel of anal opening; distance between pseudanal setae: *ps2:ps2* 38–48, *ps3:ps3* 36–47, *ps2:ps3* 6–9.

Femora I, II without crest. Solenidion  $\sigma 1$  of genu I short, 11–14 long, situated in distal half of segment. Solenidion  $\sigma$  of genu III absent. Genua setae *cGII* as in male, *mGII* slightly thicker than *mGI*. Seta *d* of tarsi I, II slightly shorter than corresponding seta *f*, setae *d* of tarsi III, IV three times shorter than corresponding setae *f*. Genu IV dorsally inflated.

### Differential diagnosis

*Metapterodectes saturninus* sp. nov. is most similar to *M. toxostomae* Mironov & OConnor, 2014 described from *Toxostoma rufum* (Linnaeus, 1758) (Mimidae) in having the dorsal shields covered with numerous small, circular lacunae in both sexes. The new species can be readily distinguished from the latter species by the shape of lobar region of females, having the lateral protrusions bearing setae *f2* and *h2* more pronounced and almost triangular in shape. Also, lacunae of similar size are evenly distributed on the entire hysteronotal shield in females, and the lobar shield does not have a median incision on the posterior margin. In females of *M. toxostomae*, the lobar region between those setae are rounded and less protruded, lacunae gradually increase in size in the posterior third of the hysteronotal shield, and the lobar shield has a narrow median incision extending to the level of setae *h1*. In males of both species setae *h3* sitting on lobar apices are short and subequal in length (*M. saturninus* 24–27; *M. toxostomae* 25–28), but separated by different distances: in *M. saturninus*, the bases of setae *h3* are separated by the distance about twice their length; in *M. toxostomae*, these setae are separated by a distance slightly longer distance than their length.

### Etymology

The specific epithet is taken from the specific name of the type host and is a noun in apposition.

## Family Dermoglyphidae Mégnin & Trouessart, 1884

### Genus *Neumannella* Trouessart, 1907

Type species: *Neumannia chelifer* Trouessart & Neumann, 1888, ex *Crypturellus cinnamomeus sallaei* (Bonaparte, 1856) (Tinamidae), single included species.

As for all dermoglyphids, representatives of the genus *Neumannella* are syringicoles (i.e. live inside feather quills). The six previously known species of this genus are restricted to birds of the Neotropical family Tinamidae (Tinamiformes): *N. apodemata* Gaud, Atyeo & Berla, 1973 from *Crypturellus soui* (Hermann, 1783), *N. astacus* Dabert & Skoracki, 2004 from *C. tataupa* (Temminck, 1815), *N. chelifer* (Trouessart & Neumann, 1888) from *C. cinnamomeus sallaei* (Bonaparte, 1856), *N. skorackii* Dabert, 2014 from *Rhynchotus rufescens* (Temminck, 1815), *N. tataupai* Dabert & Skoracki, 2004 from *C. tataupa*, and *N. tinamidarum* (Berla 1960) from *Tinamus solitarius* (Vieillot, 1819) (Trouessart and Neumann 1888; Berla 1960; Gaud et al 1973; Dabert & Skoracki 2004; Dabert 2014). Dabert (2014) provided a key to all previously known species of the genus. The seventh species is described below from *Crypturellus parvirostris* (Wagler, 1827).

### *Neumannella crypturella* Hernandez sp. nov.

(Figures 1–6)

#### Type material

Holotype male (DZUNESP-RC # 3984), paratypes 15 males and 21 females ex *Crypturellus parvirostris* (Wagler, 1827) (Tinamiformes: Tinamidae) (quills of wing feathers), BRAZIL, Americana, São Paulo State, 5 August 2015, Gustavo Pinto col.

#### Type deposition

Holotype male at DZUnesp-RC; paratypes at DZUnesp-RC, DZSJRP, ZISP, UMMZ, USNM, OSAL, MNHN, MGAB.

Male (Figures 1, 2 and 5) (holotype, range for 6 paratypes in parenthesis). Gnathosoma nearly rectangular, relatively small, length 59 (49–56), width 57 (47–55). Idiosoma pear-shaped, gradually attenuating posteriorly, greatest width at the level of sejugal furrow, length  $\times$  width 372 (361–393)  $\times$  277 (242–265). Propodosoma and hysterosoma lengths 103 (100–118) and 273 (251–273), respectively. Opisthosoma terminating with two minute pointed angular projections and a small triangular cleft between them. Prodorsal shield narrow, 78 (78–91) in length, width about 1/3 of distance between setae *si*; central part with two longitudinal adjoining median ridges. Supracoxal seta *scx* present. Scapular setae *se*, *si* inserted on two separate ovate platelets of prodorsal shield. Setae *si* only slightly thinner than *se*, these setae approximately at the same transverse level. Setae *si*, *se*, and *c2* as macrosetae, about 250 long. Scapular shields absent. Hysteronotal shield roughly ovate with unclear anterior margin, with anterior border crossed by intervening striae; exceed anteriorly the level of setae *d2*. Surface of prodorsal and hysteronotal shields uniformly dotted. Dorsal setae (*si*, *se*, *c2*, *d2*, *e2*, *f2*, *h2*, *h3*, *ps1*) simple, long, shaped as long macrosetae. Setae *c2* inserted slightly anterior to the level of scapular setae. Hysteronotal gland openings *gl* set closer to setae *e2* than to *d2*. Supranal concavity distinct. Distances between bases of dorsal setae and opening: *se:se* 69 (64–74), *c2:c2* 153 (137–147), *d2:d2* 150 (128–141), *c2:d2* 109 (102–114), *d2:gl* 73 (70–77), *gl:e2* 40 (38–43), *e2:e2* 128 (123–132), *e2:f2* 38 (34–39).

Coxal apodemes (epimerites I, II) with narrow sclerotizations on outer margins. Small median sclerotized plate encompasses inner tips of apodemes III and IIIa making coxal fields III closed. Coxal fields IV and lateral half of coxal fields III strongly sclerotized. Genital papillae set on small roughly triangular pregenital apodeme, much closer to setae *4b* than to *g*, setae *4b* set on striated

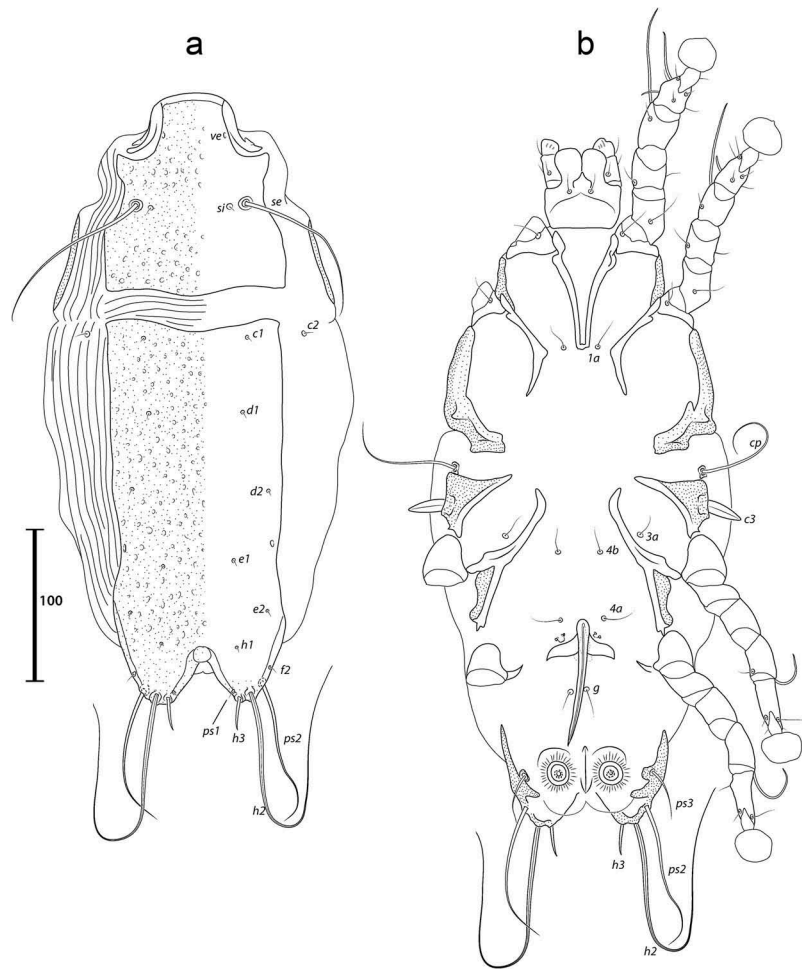


Figure 5. *Metapterodectes saturninus* sp. nov. (Proctophyllodidae), male: dorsal (a) and ventral (b) views.

tegument. Adanal suckers shaped as an inverted teardrop, 21 (16–20) in length, 13 (9–13) in width. Tibiae I, II and III with small apico-ventral spines. Legs III thinner but twice longer than two pairs of anterior legs, reaching body terminus with ambulacra, and extending to the basal end of tarsi IV. Tarsi III with apico-dorsal spine. Legs III, IV more darkly sclerotized than anterior legs, legs IV strongly hypertrophied. Complex tibia-tarsus IV modified into big pincers. Tibia IV with large rounded apico-ventral apophysis. Tarsus IV with rounded apex, ambulacra IV absent. Setae *d* and *e* of legs IV shaped as microsetae (Figure 10(d)).

Solenidion  $\sigma$  of genu III about the same length of corresponding tarsus (excluding ambulacrum and ambulacral stalk). Solenidion  $\phi$  of tibia III about as long as corresponding tarsus (including ambulacrum). Solenidion  $\phi$  of tibia IV about as long as corresponding tibia.

Female (Figures 3, 4 and 6) (range for 7 paratypes). Gnathosoma nearly rectangular, length 46–56, width 47–55. Idiosoma elongated with rounded terminus, length 373–396, width 135–210. Propodosoma and hysterosoma lengths 116–140 and 251–268, respectively. Prodorsal shield as in the male, narrow, 95–109 in length, as wide as 1/3 of distance between setae *si*. Supracoxal seta *scx* presente. Setae *si* piliform, about 10 long, inserted on small oval plates along with setae *se*. Hysteronotal shield absent, entire dorsum of hysterosoma striated. All dorsal idiosomal setae piliform. Setae *c2* about twice as long as *d2*. Hysteronotal gland openings *gl* much closer to level of setae *e2* than to *d2*. Distances between bases of dorsal setae and openings: *se:se* 61–73, *c2:c2* 126–170, *d2:d2* 89–103, *c2:d2* 111–122, *d2:gl* 85–95, *gl:gl* 117–65, *h2:h2* 69–79.

Coxal apodemes (epimerites) I, II as in the male. Epigynum absent. Setae *3a*, *g* and genital papillae approximately at the same transverse level. Setae *4a* at level of trochanters III, setae *ps3* at anterior level of anal opening. Tibiae I–IV with small apico-ventral spines. Solenidion  $\sigma$

of genu III about the same length of corresponding tibia. Solenidion  $\phi$  of tibia III about 1.5 times the length of corresponding tibia. Solenidion  $\phi$  of tibia IV only slightly longer than corresponding tibia.

#### Differential diagnosis

The new species, *Neumannella crypturella* sp. nov., is most similar to *N. astacus* Dabert & Skoracki, 2004 in having in both sexes a narrow prodorsal shield (with maximum width at midlevel about 1/3 the distance between setae *si*), in males the opisthosoma ending with two small spines, and in females in lacking the hysterosomal shield. The new species can be distinguished from *N. astacus* by the following features: in males, the corolla of anal suckers has an acute posterior extension, the pregenital apodeme does not encompass the bases of setae *4b*; and in females, setae *se* are much shorter and reach only the halfway to the gland openings *gl*. In males of *N. astacus*, the corolla of anal suckers is circular and the pregenital apodeme encompasses the bases of setae *4b*, and in females, setae *se* extend beyond the level of the gland openings *gl*.

#### Etymology

The new species name is derived from the generic name of the type host, feminine, and is a noun in apposition.

**Superfamily Pterolichoidea** Trouessart & Mégnin, 1884

**Family Vexillariidae** Gaud & Mouchet, 1959

**Subfamily Vexillariinae** Gaud & Mouchet, 1959

**Genus Oustaletia** Trouessart, 1885 (as a subgenus of *Pterolichus*)

Type species: *Pterolichus (Oustaletia) pegasus* Trouessart, 1885, by monotypy.

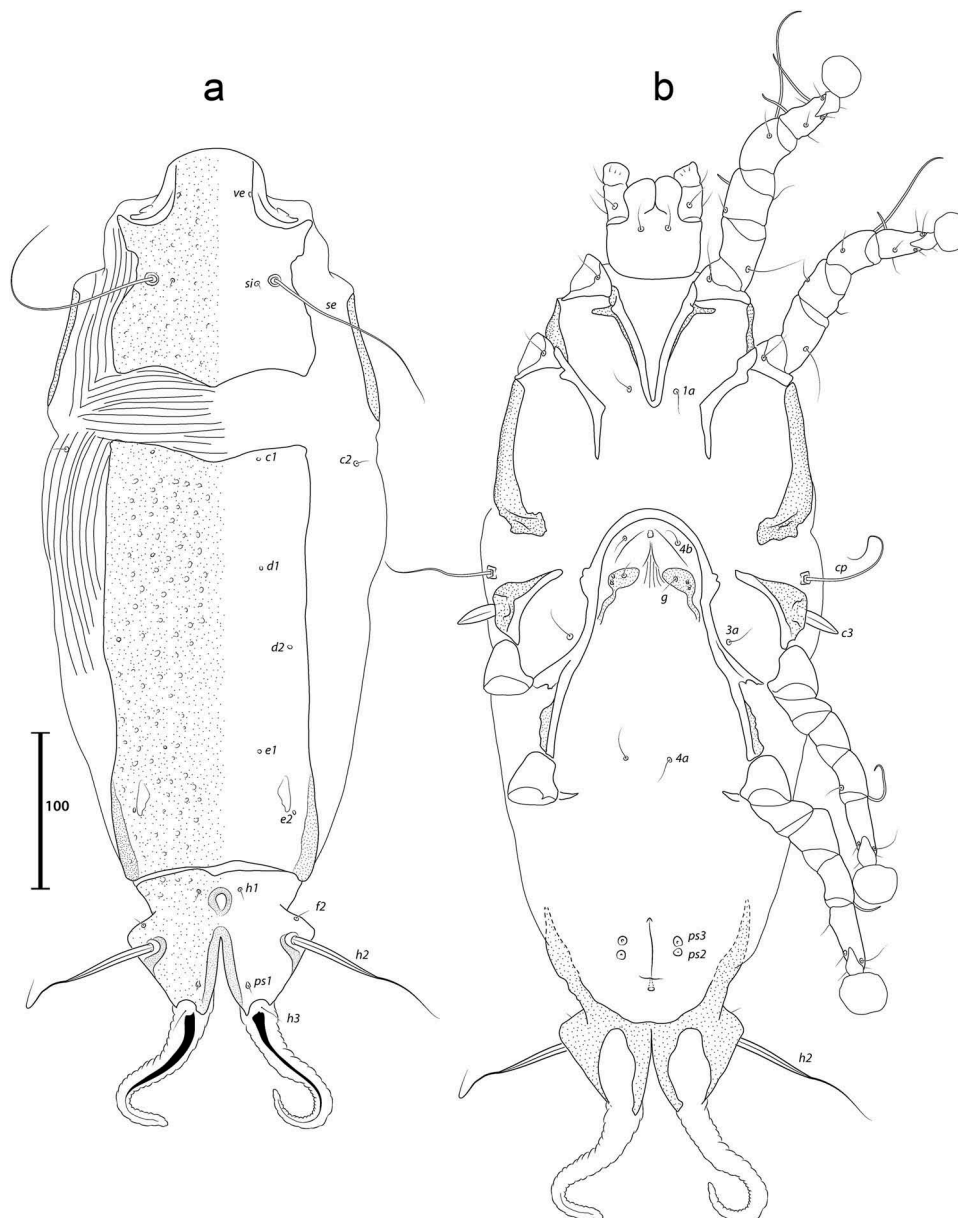


Figure 6. *Metapterodectes saturninus* sp. nov. (Proctophyllodidae), female: dorsal (a) and ventral (b) views.

***Oustaletia pegasus* Trouessart, 1885**  
(Figures 7–13)

**Type material examined**

Syntypes: 2 males ex *Anorrhinus galeritus* (Temminck, 1831) (Bucerotidae), MALAYSIA, Malacca, P. Mayer col. (MNHN # 969.678.1, 969.678.2, slides 33114, 33115).

**Additional material examined**

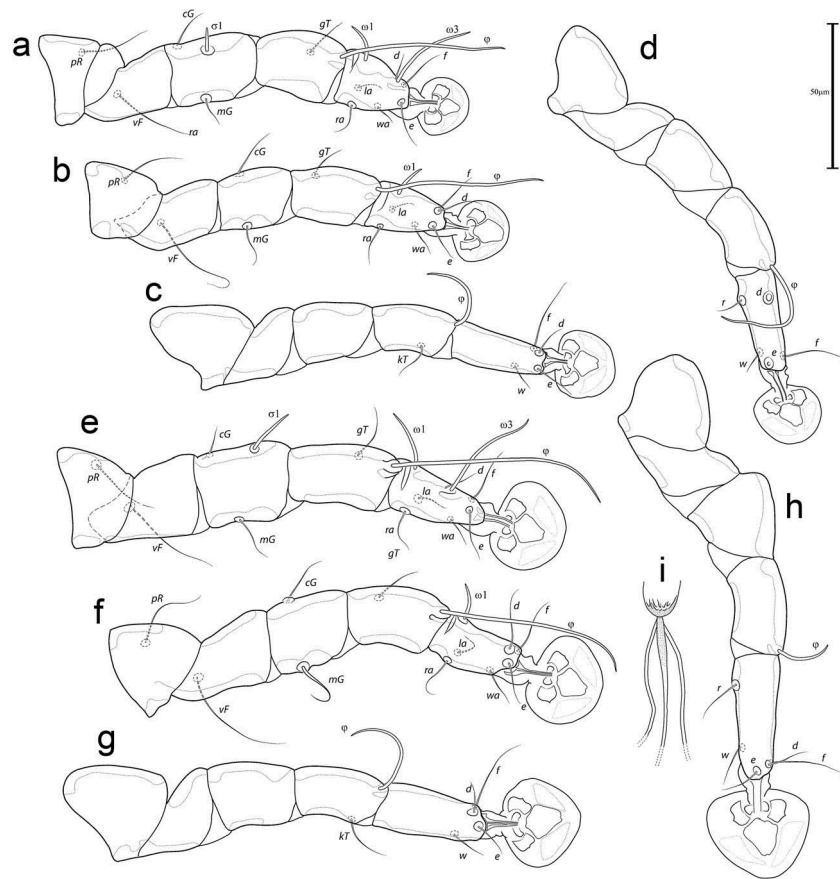
1 male and female ex *Anorrhinus galeritus galeritus* (Temminck, 1831) (Bucerotidae), BORNEO, Sabah, Little Kretam River, Kinbatangan District, 18 May 1950 (FMNH # 211792); 3 males and 3 females from the same host, Malacca, Malaysia, 10 August 1875 Beel & Steere col. (UMMZ # 23398, 23399).

This remarkable mite is the sole species of the genus *Oustaletia*, a taxon originally created by Trouessart as a subgenus of *Pterolichus* Robin, 1868, but soon after elevated to the full generic status (Trouessart 1885a, 1885b). Trouessart (1884a, 69) also described another variety (subspecies), *Pterolichus (Oustaletia) pegasus retusus* Trouessart, from *Anthracosceros albirostris* (Shaw, 1808) [= *Hydrocissa albirostris*] from North India and *Anorrhinus galeritus* from Malacca (Malaysia), distinguished from the type species by having setae c2

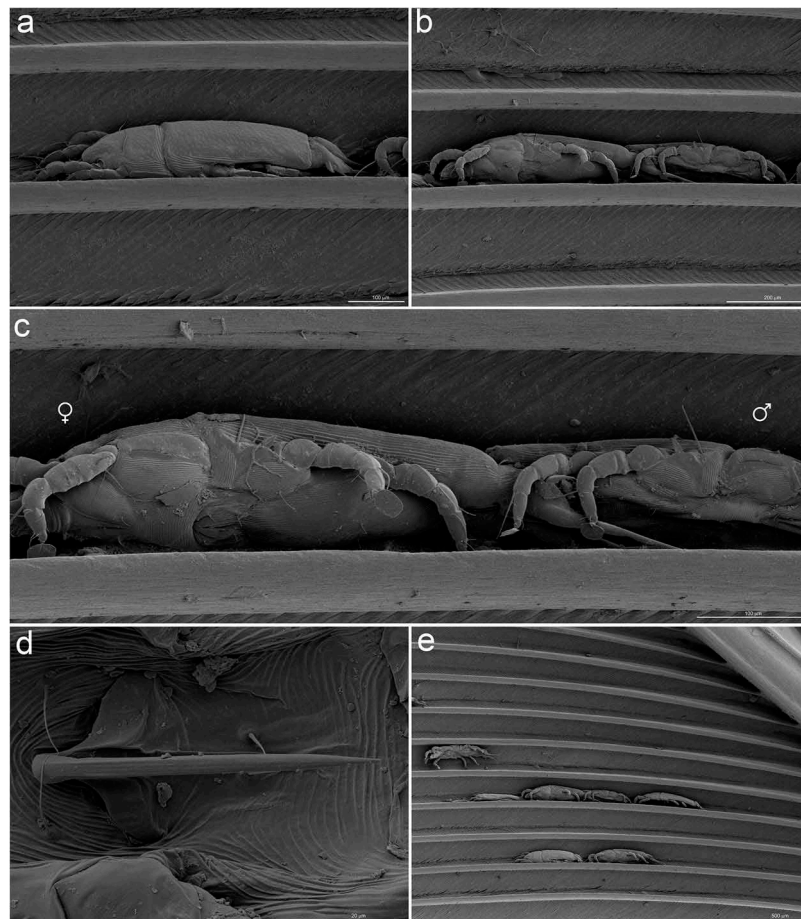
with anterior margin bluntly rounded rather than pointed anteriorly. This latter form was apparently the one figured in the monograph on feather mites of the world (Gaud and Atyeo 1996, Fig. 243).

**Hosts**

Several hornbills (Bucerotidae) were originally cited as hosts of *Oustaletia p. pegasus* by Trouessart (1884): *Anorrhinus galeritus* (Temminck), *Rhyticeros plicatus* (Foster), *Buceros hydrocorax* Linnaeus [= *Hydrocorax planicornis*] from Asia (Malaysia, Philippines, and New Guinea). By using “etc.” after the third host, Trouessart certainly meant findings of this species on more hosts. In the collections of the MNHN, slides from the following hornbills were found to contain this mite species: *Rhyticeros undulatus* (Shaw) from Java, *Anthracosceros albirostris* (Shaw, 1808) from North India, *Anthracosceros albirostris convexus* (Temminck) from Sumatra, *Bucorvus leadbeateri* (Vigors) [= *Bucorvus cafer*] from South Africa, *Penelopides manillae* (Boddaert) from Philippines. Also, one additional slide with this mite from the red-tailed black cockatoo *Calyptorhynchus banksii macrorhynchus* Gould (Psittaciformes: Cacatuidae) from Australia is present at MNHN; finding on this host is obviously result of accidental contamination.



**Figure 7.** *Metapterodectes saturninus* sp. nov. (Proctophyllodidae): dorsal view of male (a–d) and female (e–h) legs I–IV, and female spermatheca (i).



**Figure 8.** *Metapterodectes saturninus* sp. nov. (Proctophyllodidae). Low-temperature scanning micrographs: lateral view of female (a), mating couple (b, c), ventral view of male aedeagus (d), and specimens on the ventral surface of flight feather (e).

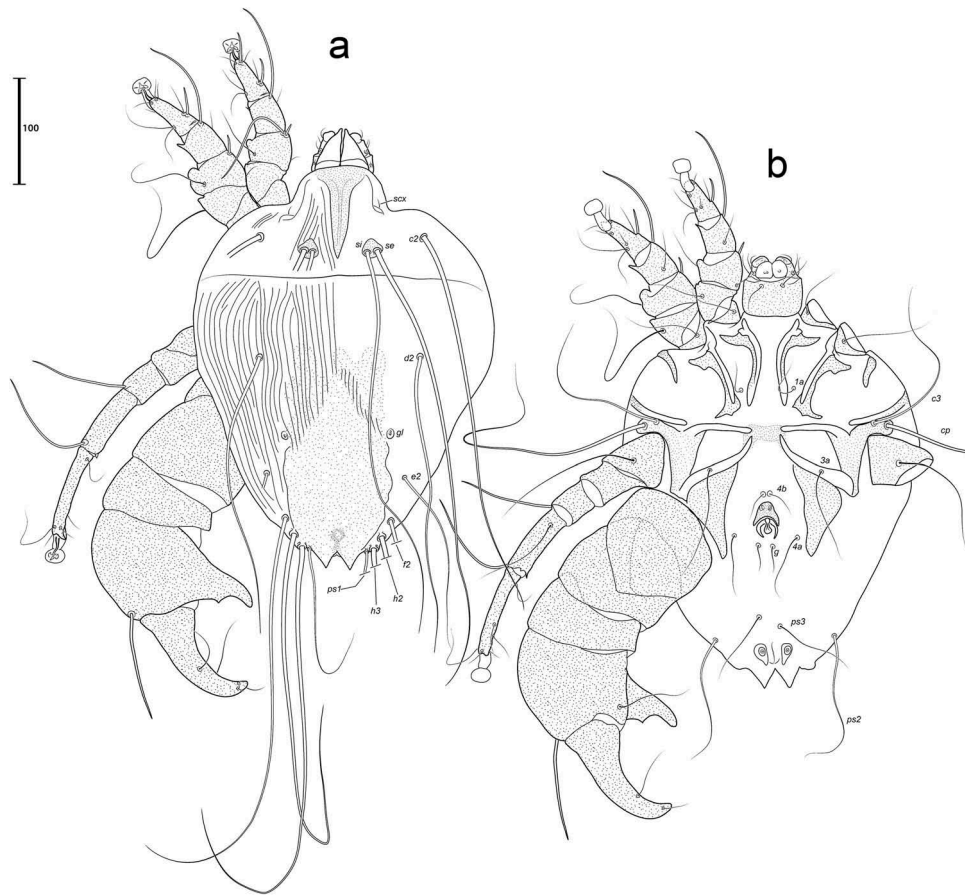


Figure 9. *Neumannella crypturella* sp. nov. (Dermoglyphidae), male: dorsal (a) and ventral (b) views.

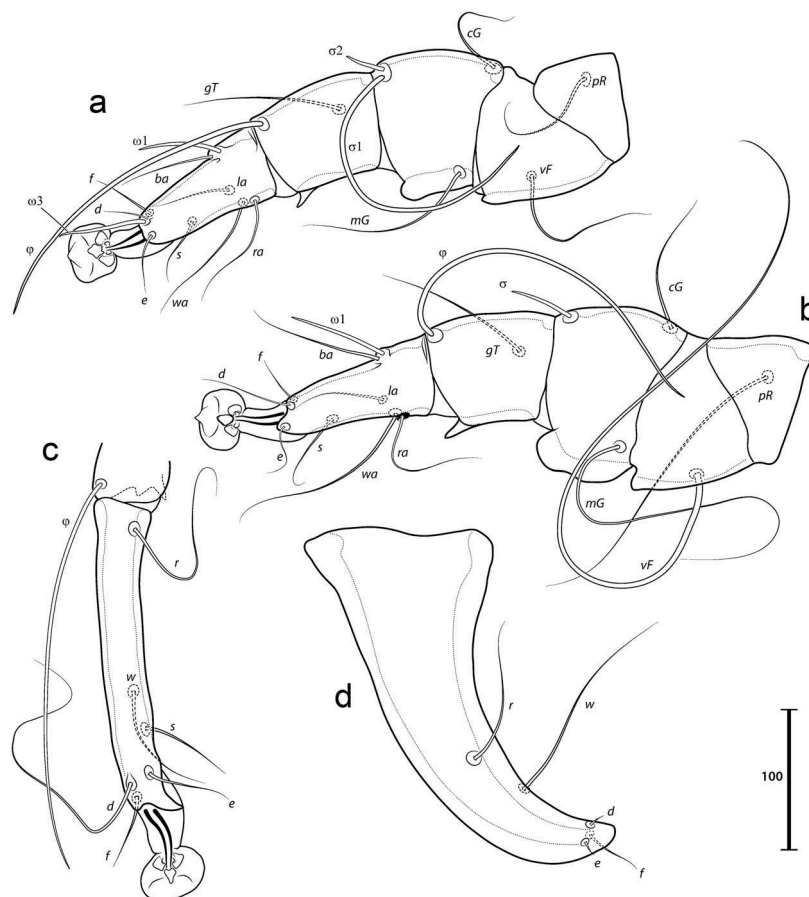


Figure 10. *Neumannella crypturella* sp. nov. (Dermoglyphidae), dorsal view of male legs I, II (a, b), tarsus III and IV (c, d).

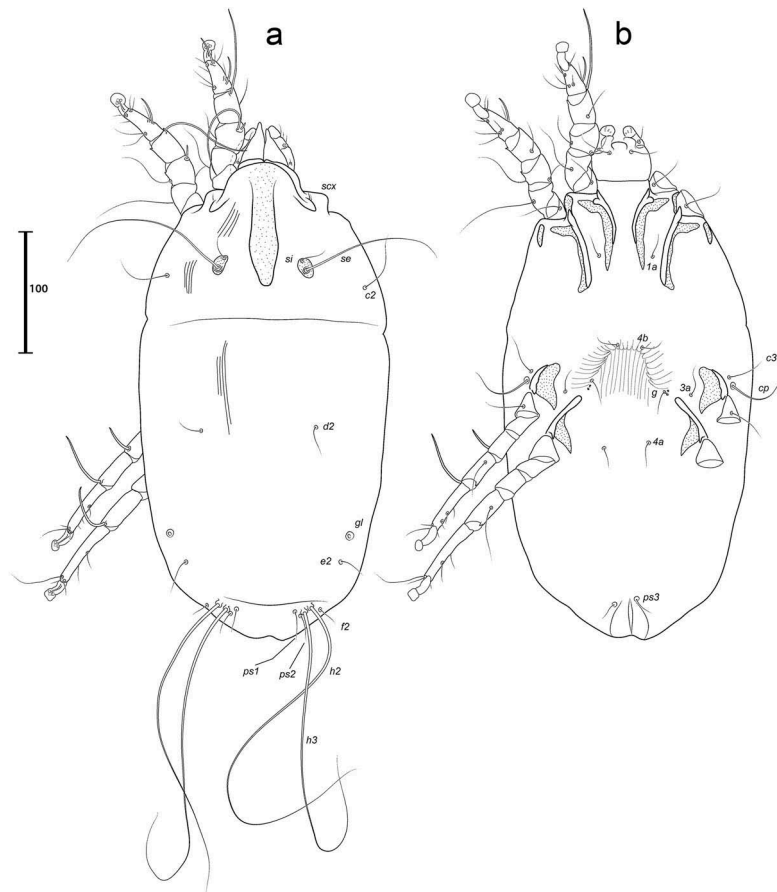


Figure 11. *Neumannella crypturella* sp. nov. (Dermoglyphidae), female: dorsal (a) and ventral (b) views.

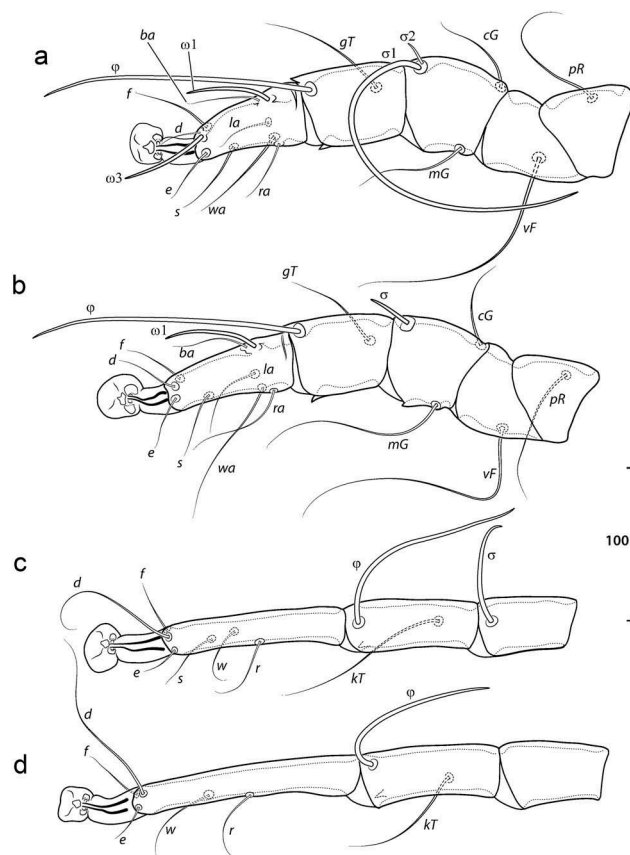
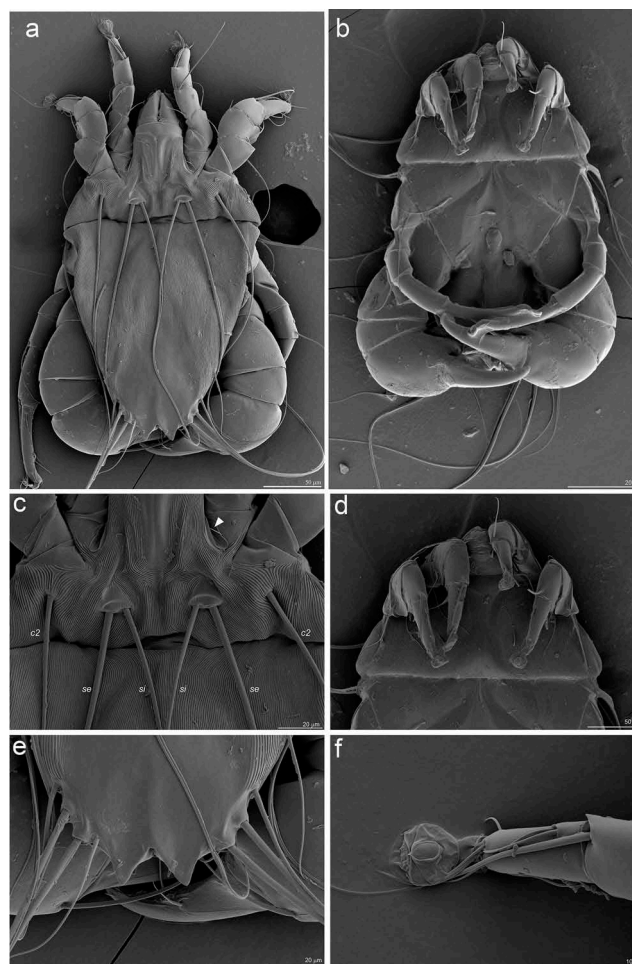


Figure 12. *Neumannella crypturella* sp. nov. (Dermoglyphidae), dorsal view of female legs I, II (a, b), genua, tibiae and tarsus III, IV (c, d).



**Figure 13.** *Neumannella crypturella* **sp. nov.** (Dermoglyphidae), male. Low-temperature scanning micrographs: dorsal (a) and ventral (b) views; sejugal region dorsal (c; arrow points to the supracoxal seta *scx*); propodosoma ventral (d); opisthosomal terminus dorsal (e); tarsus I (f).

### Remarks

Males of this species have unique morphological features. The propodosoma is anteriorly expanded towards the base of chelicerae, in a concave C-shaped structure (Figure 11(b)). Setae *h3* are greatly expanded and flattened, in a smooth-edge leaf-like structure with the largest setal area in relation to the body of all known feather mites (Figures 7(a) and 11(a)); other setae are branched (*e1*), leaf-like with expansions (*c2*), spiky (*h1*, *ps1*) or sword-like (*cp*). The females also have large sword-like setae *c2* and *cp*, and the opisthosomal terminus is adorned with numerous small, rounded, bullet-like protrusions posterior to setae *ps1*, *h3*, and *h2* (Figure 13(f)). In both sexes, ambulacra are distally bilobed (Figure 12(d)). All tarsal setae are positioned distally in the segment, and like in other members of the Vexillariidae, genual solenidia are absent from tibia III, and only one ventral setae is present on tarsus III.

**Family Pterolichidae** Trouessart & Mégnin, 1884  
**Subfamily Pterolichinae** Trouessart & Mégnin, 1884  
**Genus *Opisthocomacarus*** Dubinin, 1955

Type species: *Pterolichus* (P.) *umbellifer* Trouessart, 1899, by original designation.

***Opisthocomacarus umbellifer*** (Trouessart, 1899)  
 (Figures 13 and 14)

### Type material examined

Syntypes 5 males and 7 females, ex *Opisthocomus hoazin* (Müller, 1776) (Opisthocomiformes: Opisthocomidae), GUYANA, no further data (MNHN-Ac969.900, slide number 35G9).

### Additional material examined

13 males and 16 females from *O. hoazin*, BRAZIL, Pará State, Fazenda Fartura, 09°40'S/50°23'W, Santana do Araguaia, 08 September

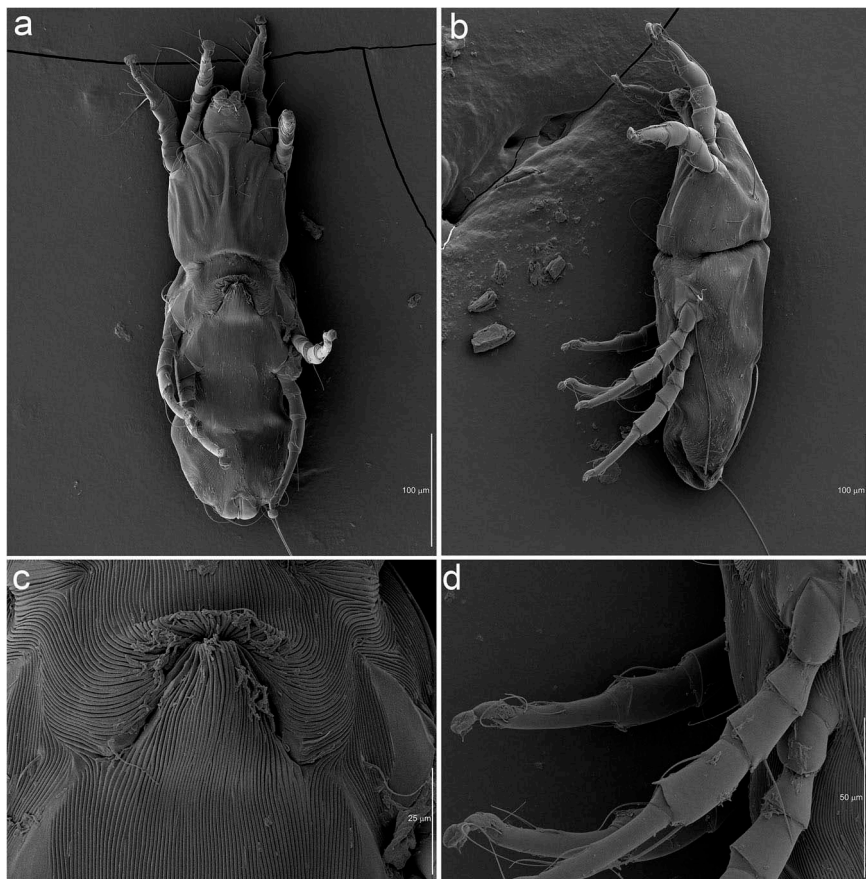
2013, D.V. Boas-Filho coll. (#1112).

### Remarks

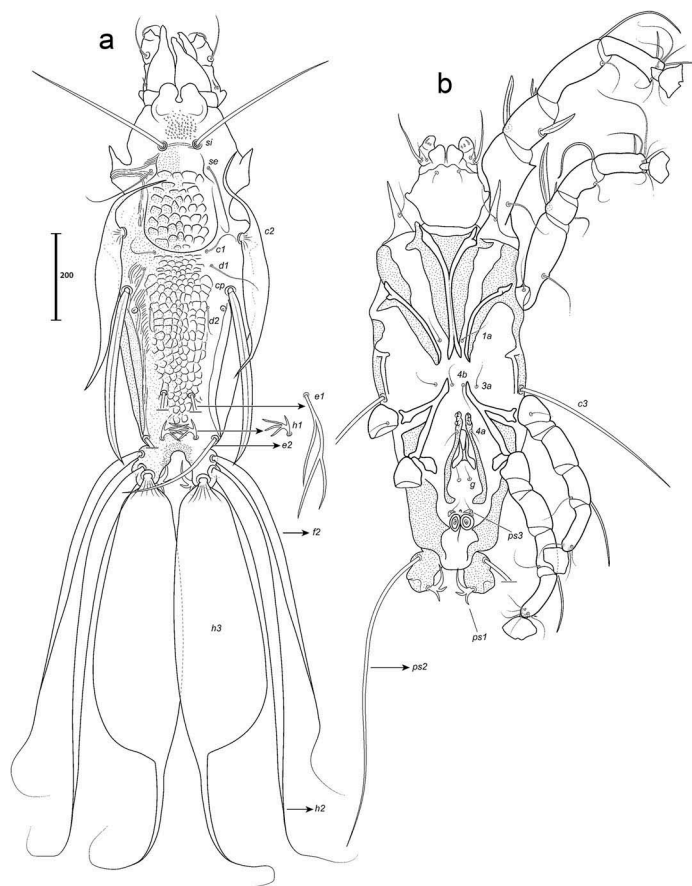
This species bearing idiosomal setae of quite amazing structure (Figures 13 and 14) was redescribed by Dubinin (1955), Atyeo and Gaud (1971), and most recently by Hernandez and Mironov (2015). The latter authors have hypothesized that the flattened and spiky setae might hold a film of water around the mite preventing it from drowning when the nestlings of hoatzins accidentally fall or throw themselves into the water in order to escape from predators.

### Discussion

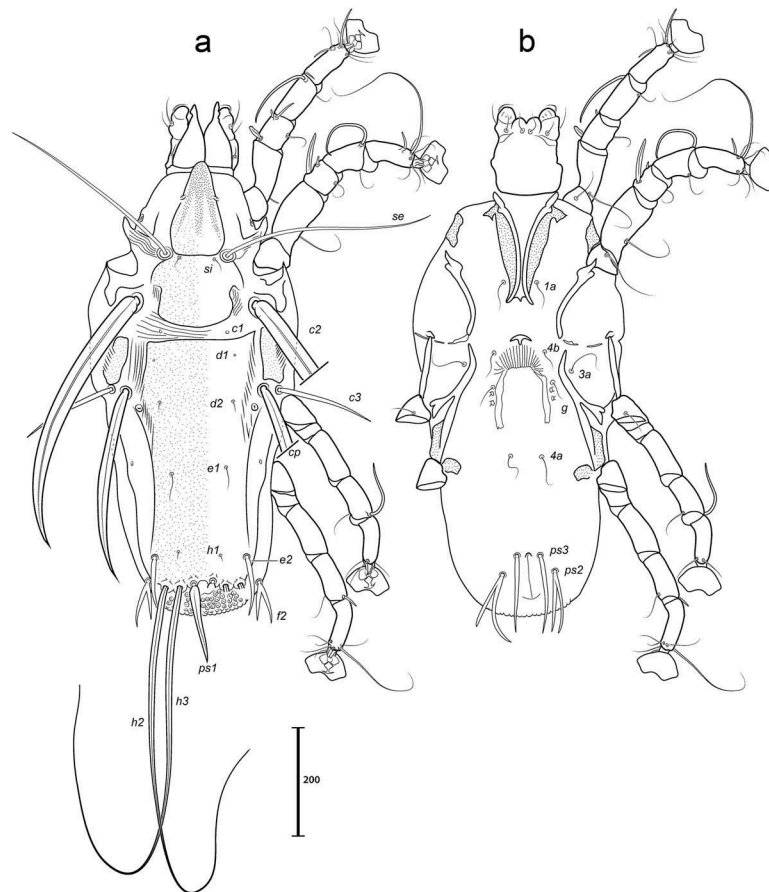
The LT-SEM technique produces mites that are frozen in pristine condition as if they were still alive without the use of chemical treatments or critical point drying. In addition, the attachment of the cryo-preparation chamber to a field emission SEM provides high-resolution images of specimens with high magnification. Therefore, a more comprehensive interpretation of the morphology can be obtained. In the feather mites studied herein, it was possible to visualize the vestigial solenidion  $\sigma$  on genu III of *Plicatallotes atrichogynus* **sp. nov.** females (Figure 4(b), detail), and the complete absence of solenidion  $\phi$  on tibia IV. Such minute structures are extremely difficult to visualize with light optical microscopy, or at least their interpretation concerning their vestigial status or absence would be highly doubtful without the use of LT-SEM. It



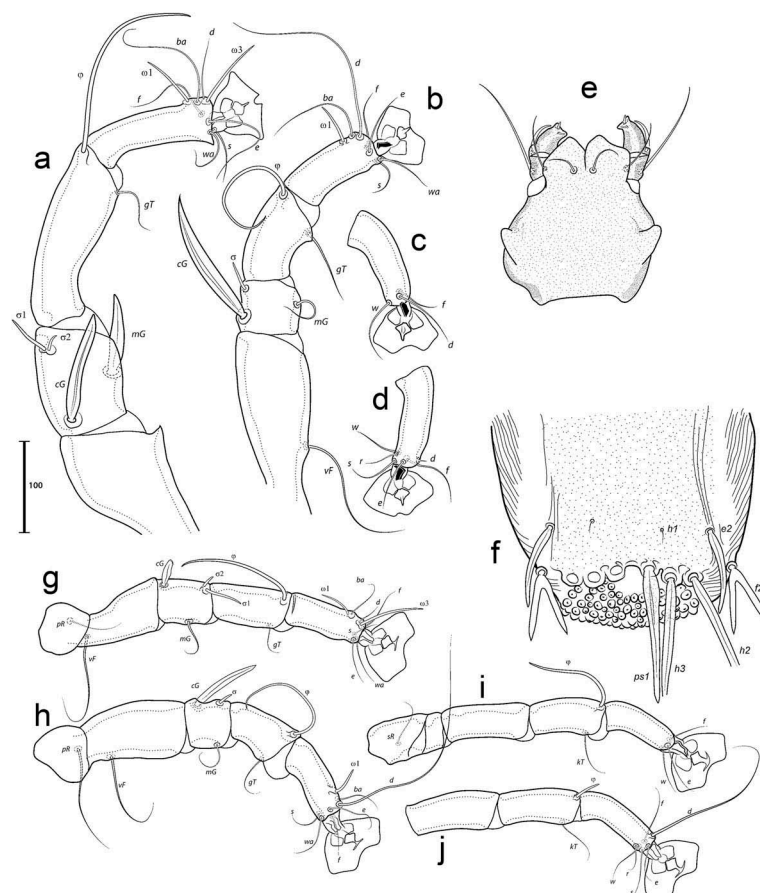
**Figure 14.** *Neumannella crypturella* **sp. nov.** (Dermoglyphidae), female. Low-temperature scanning micrographs: ventral (a) and lateral (b) views; oviporus (c); lateral view of opisthosoma and posterior legs (d).



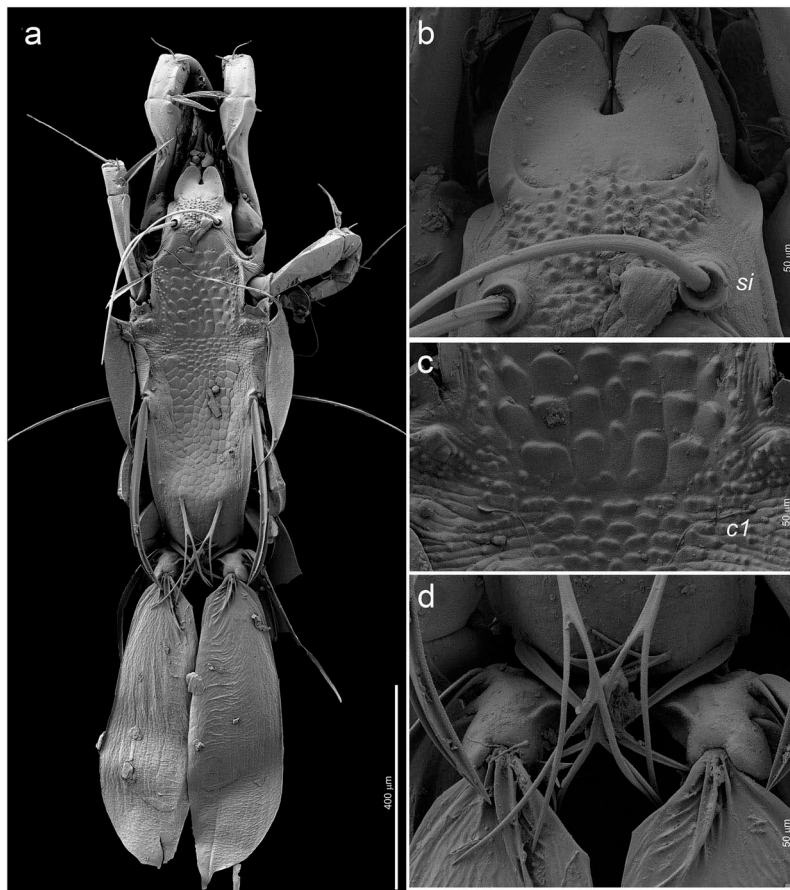
**Figure 15.** *Oustaletia pegasus* Trouessart, 1884 (Vexillariidae), male: dorsal (a) and ventral (b) views.



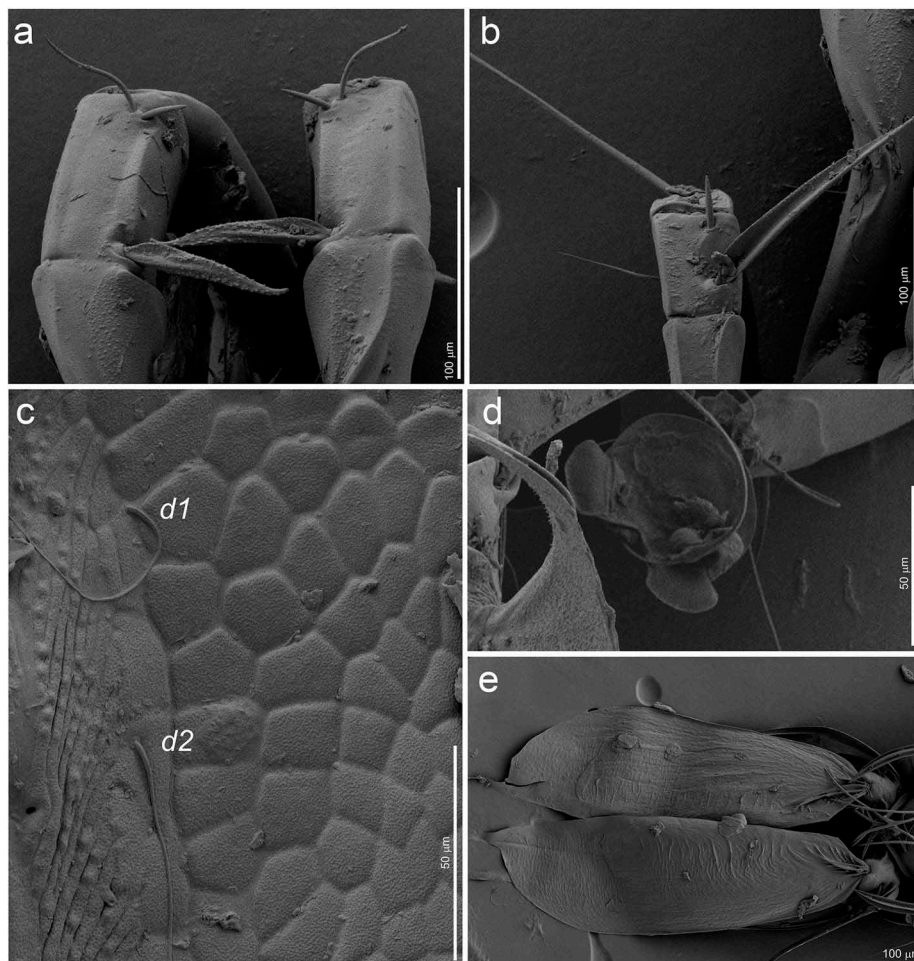
**Figure 16.** *Oustaletia pegasus* Trouessart, 1884 (Vexillariidae), female: dorsal (a) and ventral (b) views.



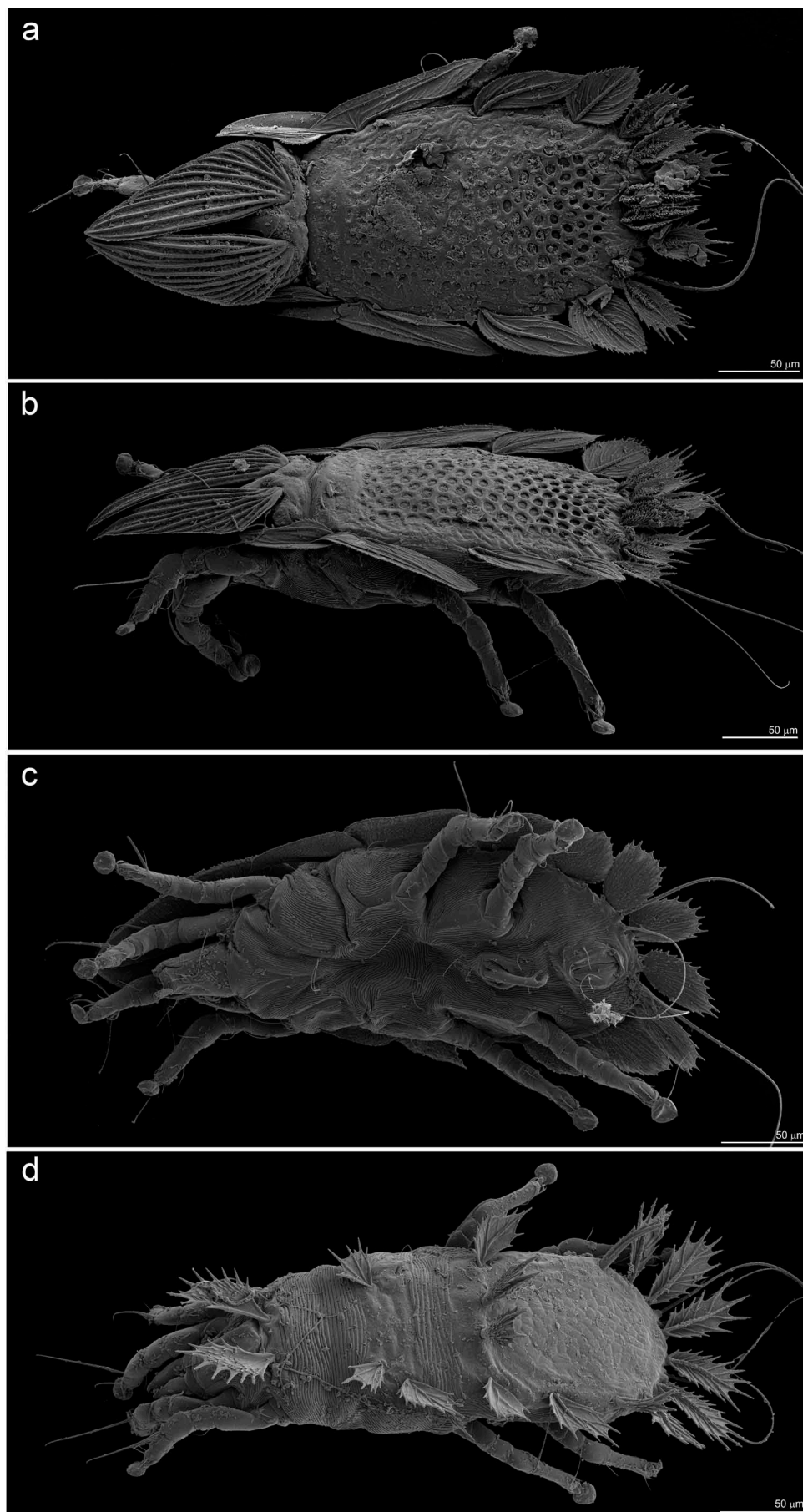
**Figure 17.** *Oustaletia pegasus* Trouessart, 1884 (Vexillariidae): dorsal view of distal part of femur, tibia and tarsus of leg I and II (a, b), tarsus III, IV (c, d), ventral view of gnathosoma of male (e), dorsal view of female opisthosoma (f), and female legs I–IV (g–j).



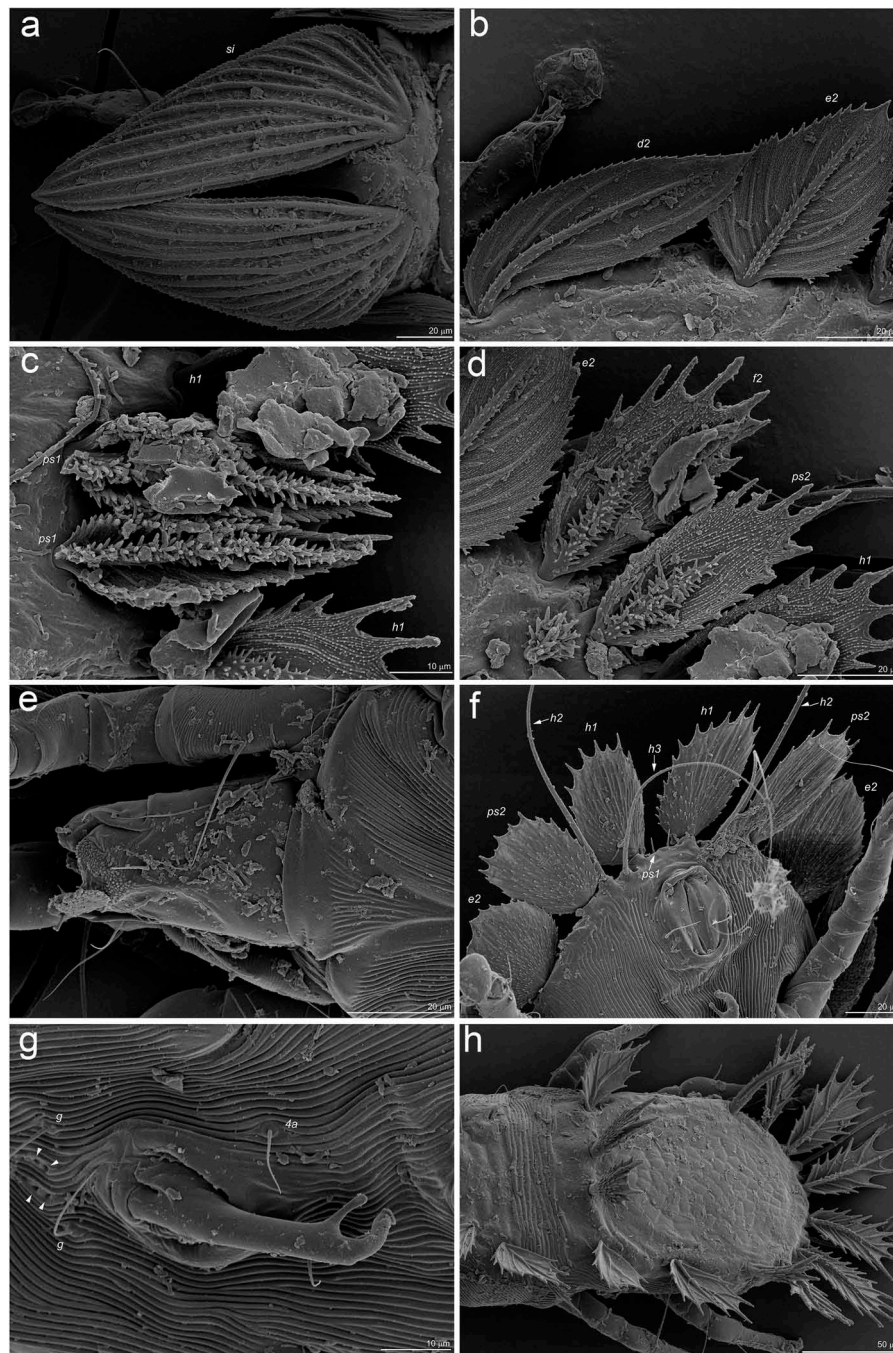
**Figure 18.** *Oustaletia pegasus* Trouessart, 1884 (Vexillariidae), male. Low-temperature scanning micrographs: dorsal habitus prodorsal extension of gnathosomal tectum (b); central region of porsal shield (c); opisthosomal lobes (d).



**Figure 19.** *Oustaletia pegasus* Trouessart, 1884 (Vexillariidae), male. Low temperature scanning micrographs: genua of legs I (a); genu II (b); dorsal hysterosoma around setae *d1* and *e1* (c); ambulacrum of leg II (d); setae *h3* (e).



**Figure 20.** *Opisthocomacarus umbellifer* (Trouessart, 1899) (Pterolichidae). Low-temperature scanning micrographs: dorsal (a) and lateral (b) views of female; ventral view of male (c); dorsal view of tritonymph (d).



**Figure 21.** *Opisthocomacarus umbellifer* (Trouessart, 1899) (Pterolichidae). Low-temperature scanning micrographs: prodorsal setae *si* (a), latero-caudal setae *d2*, *e2* (b), setae *ps1* (c), setae *e2*, *f2*, and *ps2* of female (d); ventral view of gnathosoma of male (e); ventral view of hysterosoma of male (f); male aedeagus (g) (white arrows = genital papillae); dorsal view of tritonymph (h).

was also possible to confirm the absence of several setae (e.g. *f2*, *ps1*, *g*) on females of this species. On *Neumannella crypturella* **sp. nov.**, it was possible to clearly confirm the presence of the minute seta supracoxal *scx* (Figure 13(c), arrow), also very difficult to be detected by virtue of being localized in a prodorsal area with integumental folds, which often obscure its proper visualization. *Oustaletia pegasus* is observed using the LT-SEM for the first time. The peculiarity and uniqueness of this mite's morphology makes it easy to agree with its descriptor, who regarded it the most remarkable of all known feather mites (Trouessart 1885a). Finally, although *Opisthocomacarus umbellifer* was previously observed in a SEM (Atyeo and Gaud 1971), details of its highly modified setae are revealed for the first time in high magnification (Figures 20 and 21). Maybe Walter and Proctor (2013) were not far from the truth in regarding feather mites as "perhaps the most fabulously ornamented of all Acari."

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endorsement by the USDA; USDA is an equal opportunity provider and employer.

## Disclosure statement

No potential conflict of interest was reported by the authors.

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