



<http://dx.doi.org/10.11646/zootaxa.4088.3.3>

<http://zoobank.org/urn:lsid:zoobank.org:pub:B42D411B-48FC-471E-BFE4-146C412FD9DC>

A new species of *Tenuipalpus sensu stricto* (Acari: Tenuipalpidae) from Brazil, with ontogeny and a key to the known species

ELIZEU B. CASTRO^{1,5}, REINALDO J.F. FERES², RONALD OCHOA³ & GARY R. BAUCHAN⁴

¹Programa de Pós Graduação em Biologia Animal, UNESP-Universidade Estadual Paulista, campus de São José do Rio Preto, São Paulo, Brazil

²Depto. de Zoologia e Botânica, UNESP, Rua Cristóvão Colombo, 2265, Jardim Nazareth, São José do Rio Preto, São Paulo, Brazil, 15054-000, CNPq-Brazil researcher. E-mail: reinaldo@ibilce.unesp.br

³Systematic Entomology Laboratory (SEL), Agricultural Research Service (ARS), United States Department of Agriculture (USDA), Beltsville Agricultural Research Centre (BARC), Maryland, 20705, USA. E-mail: ron.ochoa@ars.usda.gov

⁴Electron and Confocal Microscopy Unit (ECMU), ARS-USDA, BARC, Beltsville, Maryland, 20705, USA. E-mail: gary.bauchan@ars.usda.gov

⁵Corresponding author. E-mail: elizeu_unesp@yahoo.com.br

Abstract

The Cerrado is the second largest Brazilian biome, and is considered to be a “hotspot” due the great concentration of endemic species and high rate of deforestation. Surveys of the mite fauna present in this biome have revealed a great number of new species. In this paper, we describe *Tenuipalpus spinosaurus* sp. nov. (Acari: Tenuipalpidae), a new species of *Tenuipalpus sensu stricto*, from adult females, deutonymphs, protonymphs, larvae and eggs, collected on *Terminalia argentea* (Combretaceae), from the Cerrado in Brazil. Females of this new species bear a prominent longitudinal crest on the opisthosoma. The ontogenetic changes in the idiosoma and leg chaetotaxy of all stages are presented. A key to the world species of *Tenuipalpus sensu stricto* is provided.

Key words: flat mites, *Tenuipalpus spinosaurus*, crest, body projections, taxonomic, systematic, biodiversity, Cerrado, LT-SEM

Introduction

The Cerrado is the second largest Brazilian biome, surpassed only by the Amazon Rainforest (Klink & Machado 2005). It represents nearly 20% of the Brazilian territory, and is considered to be a “hotspot” due the great concentration of endemic species and high rate of deforestation (Myers *et al.* 2000). Surveys of the mite fauna present in this biome have revealed a great number of new species, including several tenuipalpid mites (Lofego & Moraes 2006; Demite *et al.* 2009; Rezende *et al.* 2014).

The definition of *Tenuipalpus sensu stricto* (Acari: Tenuipalpidae) was based on the re-description of *T. caudatus* (Dugès), 1834 (= *T. palmatus* Donnadieu, 1876), and on the study of 37 other known species of *Tenuipalpus* (Castro *et al.* 2016). These authors indicated the presence of one pair of lateral body projections associated with setae *c*₃ as a synapomorphy for this group.

In this paper, *Tenuipalpus spinosaurus* sp. nov., a new species of *Tenuipalpus sensu stricto* is described from adult females, deutonymphs, protonymphs, larvae and eggs, collected on *Terminalia argentea* (Combretaceae), from the Cerrado in Brazil. We include details of the ontogenetic changes in idiosomal and leg chaetotaxy for all stages. A key to the world species of *Tenuipalpus sensu stricto* is provided.

Material and methods

Specimens were collected on *Terminalia argentea* (Combretaceae), from Itapagipe, Minas Gerais, Brazil, and

maintained in 70% ethanol for subsequent use in low temperature scanning electron microscopy (LT-SEM) studies. Mites for LT-SEM were studied using the methodology previously described in Castro *et al.* (2015).

Measurements for the holotype are given in micrometers (μm), with the range of measurements for the paratypes shown in parentheses. The number of leg setae is written as the total number of setae followed by number of solenidia in parentheses. Leg chaetotaxy is adapted from Lindquist (1985), Xu & Fan (2010), and Seeman & Beard (2011). Photographs were obtained using a Leica DMR™ microscope with differential interference contrast (DIC) 40X Plan Fluotar objective. The key presented was based in the study of type specimens and descriptions available in the literature.

Type specimens are deposited in the Collection of Acari, Departamento de Zoologia e Botânica, UNESP, São José do Rio Preto, State of São Paulo, Brazil (DZSJRP, <http://www.splink.cria.org.br>) and in the National Insect and Mite Collection, National Museum of Natural History, Smithsonian Institution, located at the Systematic Entomology Laboratory (SEL), USDA, Beltsville, Maryland, USA (NMNH).

Family Tenuipalpidae Berlese, 1913

Genus *Tenuipalpus* Donnadieu, 1876

Type species: *Tenuipalpus palmatus* Donnadieu, 1876 (= *Tenuipalpus caudatus* (Dugès, 1834))

Diagnosis. Female: Body shape with prodorsum wider than opisthosoma or elongate-ovate; prodorsum with three pairs of setae (*v2*, *sc1*, *sc2*, except *v2* absent in *T. elegans* (Collyer)); dorsal opisthosoma with eight to ten pairs of setae (*c3*, *d3*, *e3*, *f3*, *h1*, *h2* present; *c2*, *d2*, *e2* absent; *c1*, *d1*, *e1*, *f2* present or absent (*d1*, *e1* rarely absent); setae *h2* elongate, flagellate. Palp one to three segmented. Venter with one to two pairs of setae *3a* (*3a2* present or absent) and one to four pairs of setae *4a* (*4a2*, *4a3*, *4a4* present or absent); ventral and genital plates not developed, membranous genital flap present; commonly two pairs of pseudanal setae *ps1–2* present (setae *ps3* rarely present). **Male:** Opisthosoma distinctly narrower than that of female; legs and dorsal setae usually similar to those of female; pseudanal setae *ps1* modified as accessory genital stylet.

Tenuipalpus sensu stricto group

Diagnosis. Adults female and male: Species of this group can be differentiated from other *Tenuipalpus* by presence of one pair of lateral body projections associated with setae *c3*. See Castro *et al.* (2016) for a detailed diagnosis.

Tenuipalpus spinosaurus sp. nov. Castro, Feres & Ochoa

(Figs 1–18)

Diagnosis. Female: Prodorsal setae *v2* short to minute, *sc1* obovate to oblanceolate and *sc2* falcate, elongate; dorsal opisthosoma with 10 pairs of setae (*f2* present); most of the dorsal opisthosomal setae obovate to oblanceolate, except setae *d3* and *e1* short to minute, and *h2* elongate and flagelliform; prodorsum with a pair of oblique converging ridges from *sc1* to near the sejugal furrow; opisthosoma bearing a prominent longitudinal crest between setae *e1*; dorsum with pair lateral projections anterior to setae *sc2* and pair lateral projections posterior to setae *c3*; palps one segmented; two pairs of setae *ps*; one pair of setae *3a* and *4a*. **Male:** unknown. **Immatures:** deutonymphs and protonymphs with lateral body projections anterior to setae *sc2* (lateral body projection associated with setae *c3* absent); dorsal setae similar to those of the female except narrower. Larvae with prodorsum and region of opisthosomal posterior to setae *d1–c3* with colliculate integument; setae *v2*, *sc1*, *c1*, *d1* and *e1* short to minute, with other dorsal setae similar to those of female except narrower.

Female (n = 16) (Figs 1–13). Body size measurements: distance between setae *v2–h1* 250 (240–255), *sc2–sc2* 155 (150–160); other measurements: *v2–v2* 30 (30–33), *sc1–sc1* 88 (80–88), *c1–c1* 48 (38–48), *c3–c3* 178 (165–180), *d1–d1* 28 (23–28), *d3–d3* 133 (125–133), *e1–e1* 30 (28–33), *e3–e3* 92 (87–95), *f2–f2* 80 (77–83), *f3–f3* 65 (62–68), *h1–h1* 35 (32–40), *h2–h2* 52 (50–55).

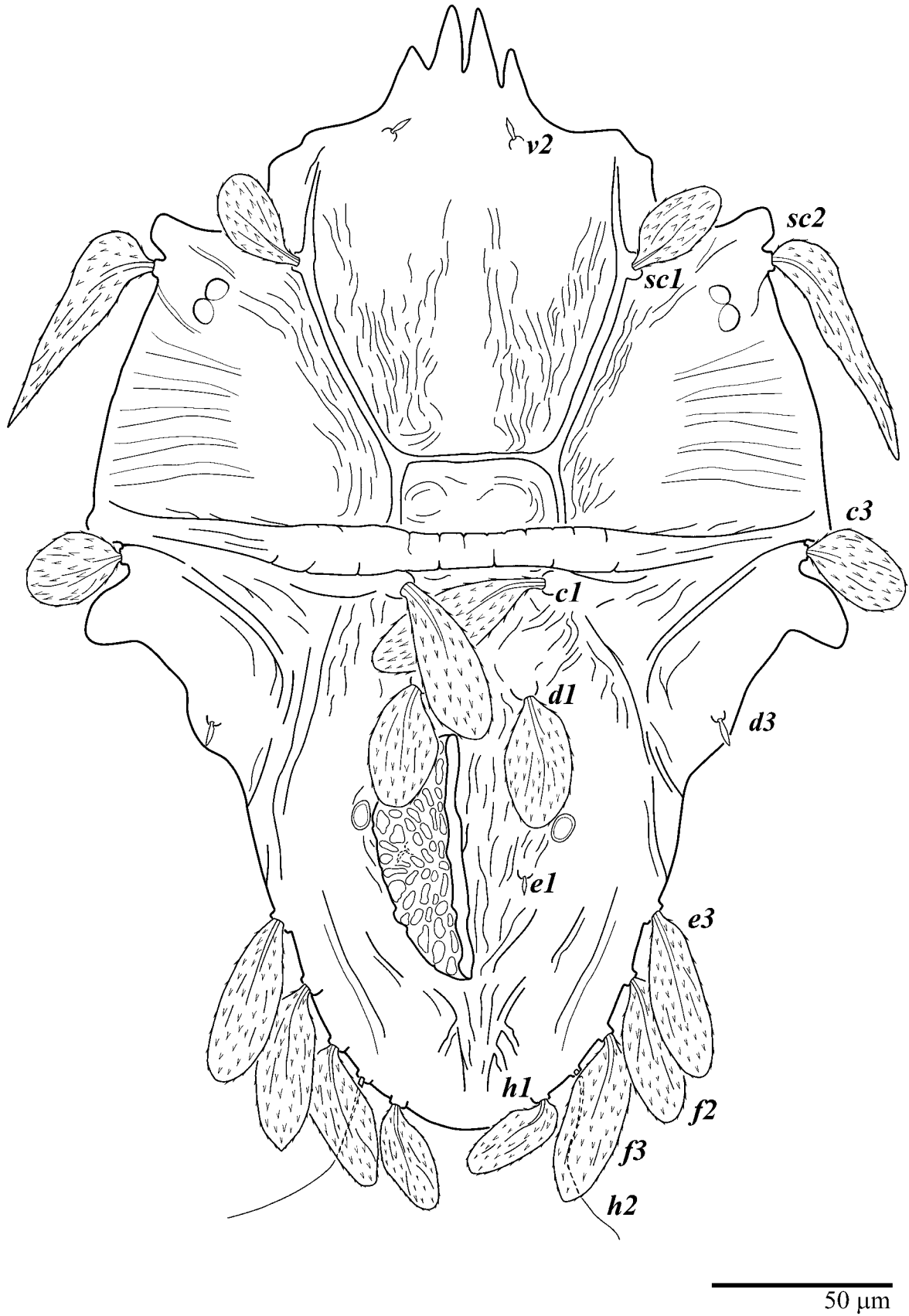


FIGURE 1. *Tenuipalpus spinosaurus* sp. nov. (Female): view of dorsum.

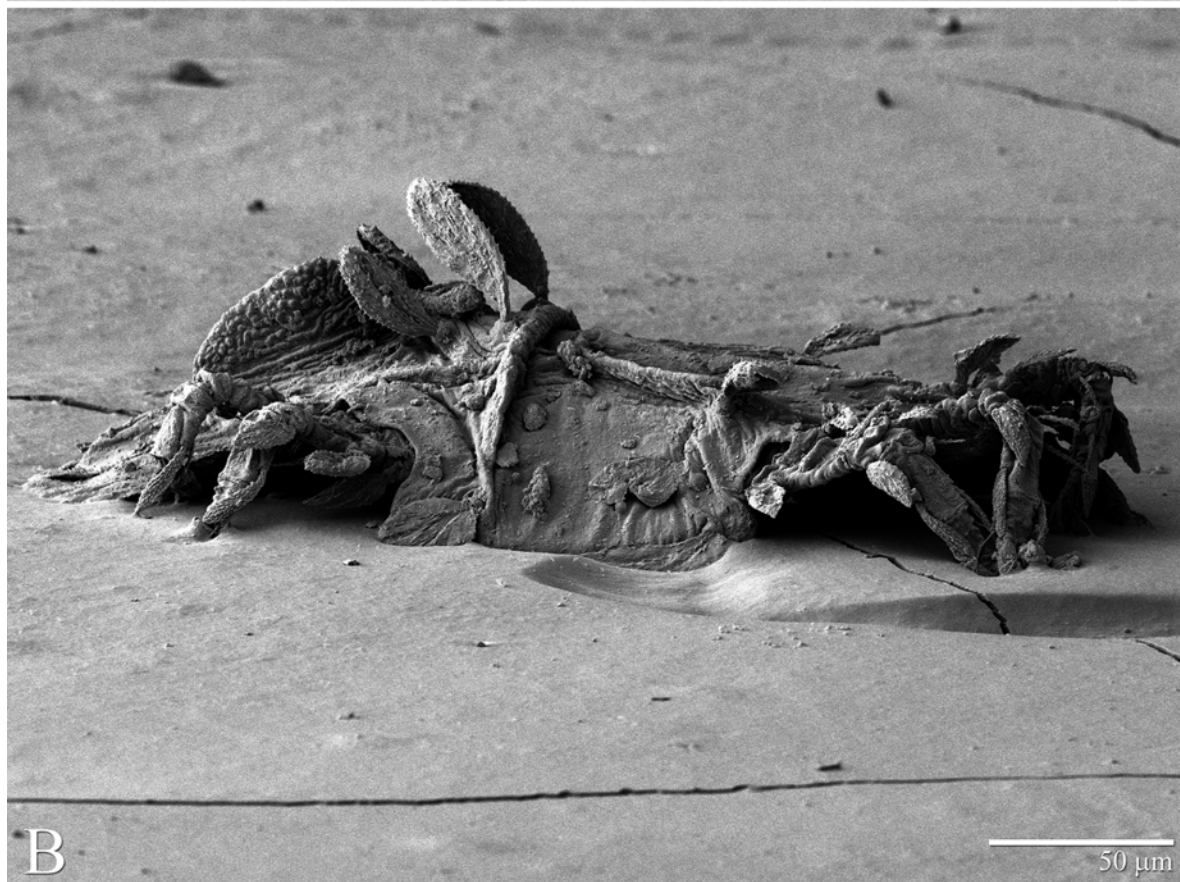
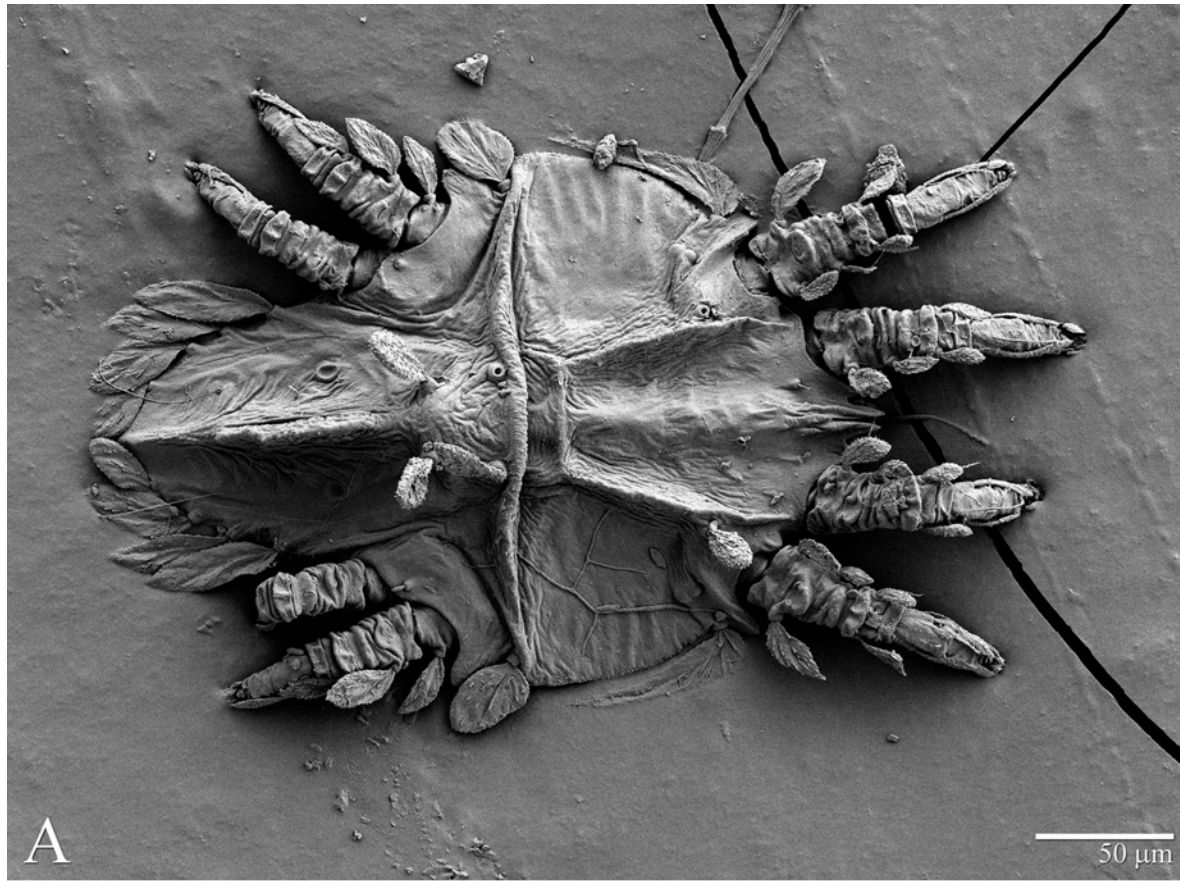


FIGURE 2. *Temuipalpus spinosaurus* sp. nov. (Female): A. dorsal view; B. lateral view.

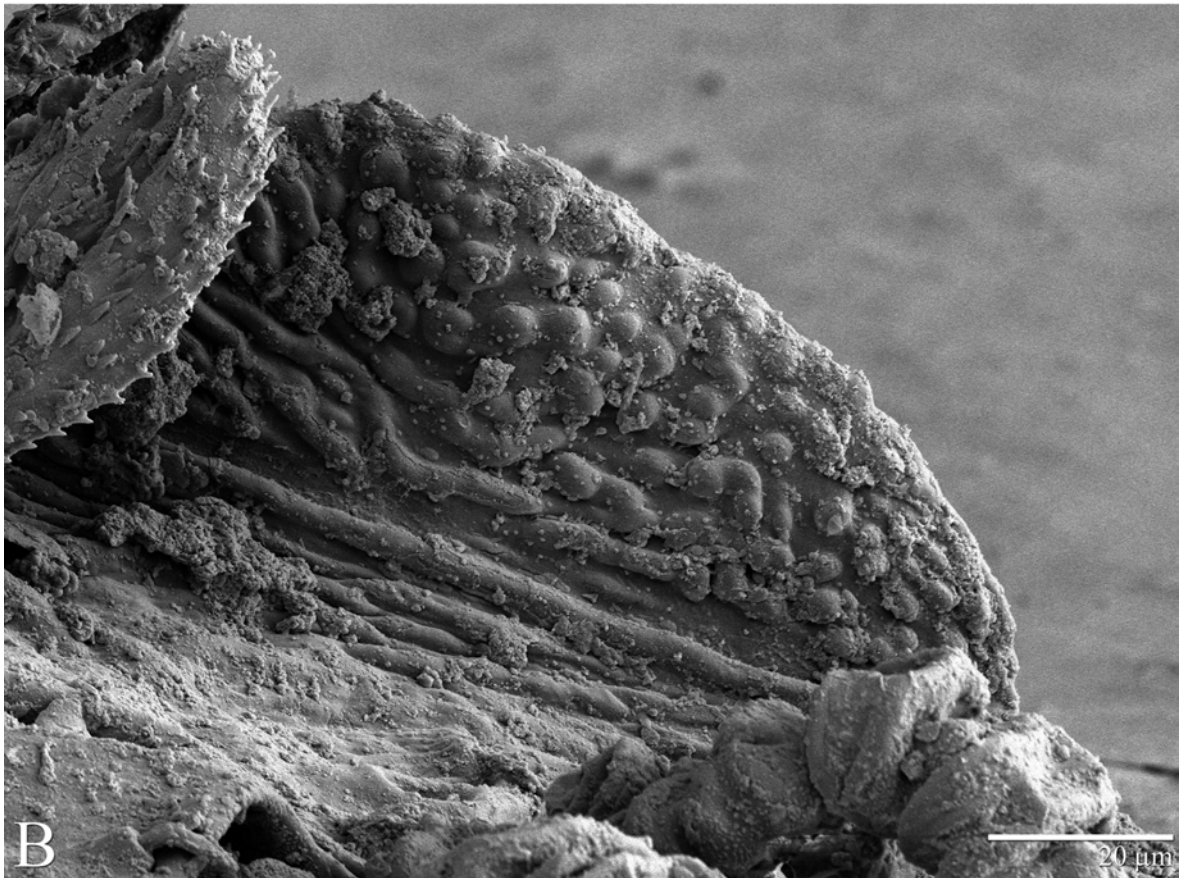


FIGURE 3. *Temuipalpus spinosaurus* sp. nov. (Female): detail of crest. A. front view; B. lateral view.

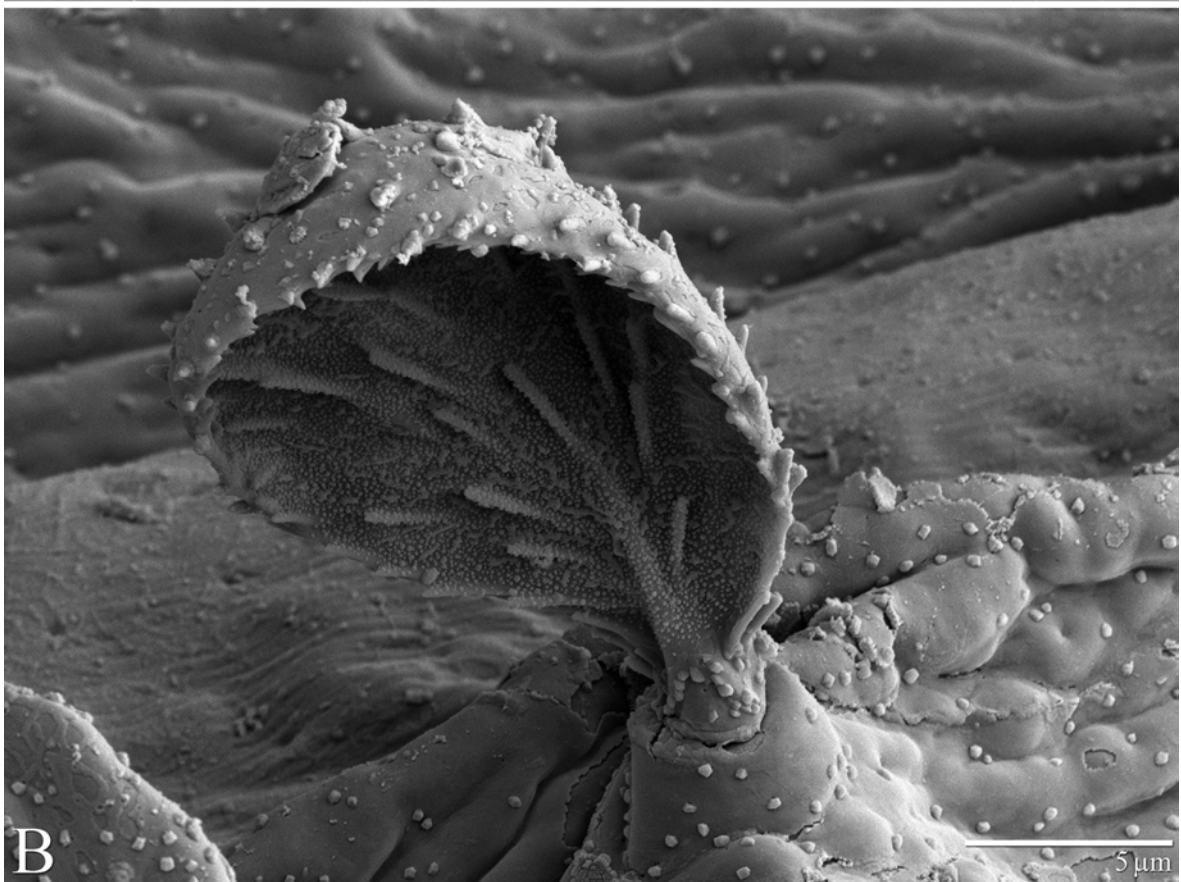
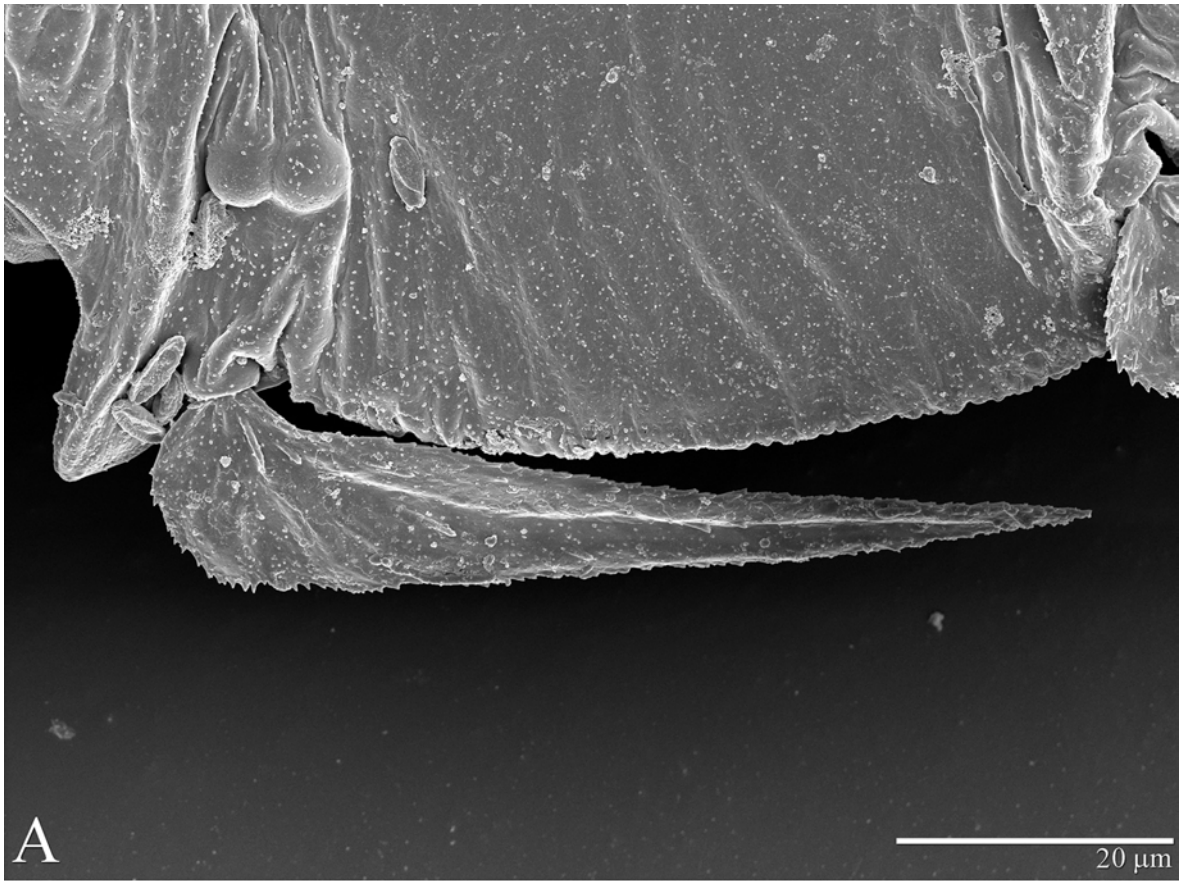


FIGURE 4. *Tenuipalpus spinosaurus* sp. nov. (Female): A. detail of the lateral region of prodorsum. Note the presence of body projection anterior to *sc2* seta; B. *sc1* seta inserted on tubercle.

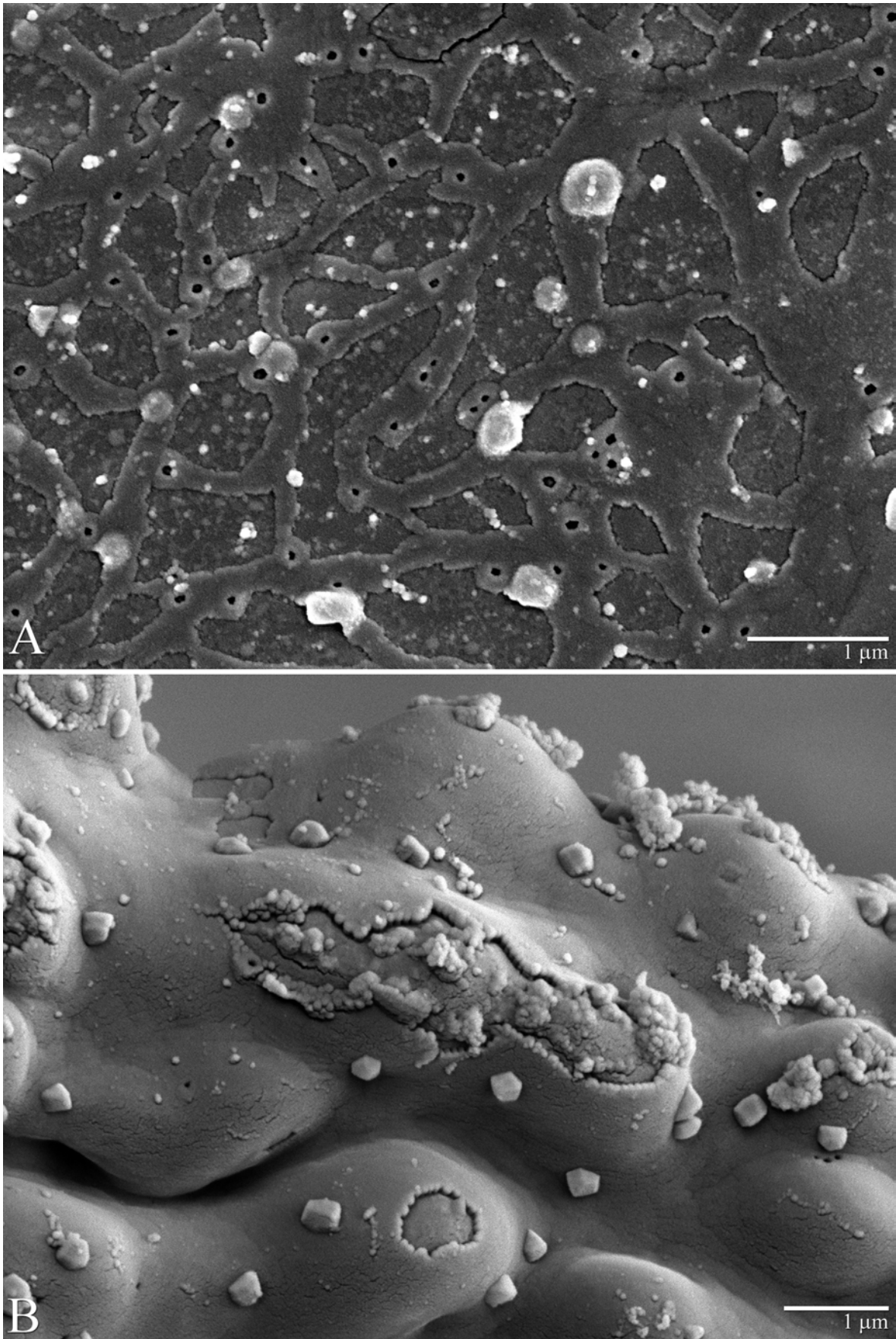


FIGURE 5. *Tenuipalpus spinosaurus* sp. nov. (Female): A. detail of microplate formation; B. view of microplate on integument of crest.



FIGURE 6. *Tenuipalpus spinosaurus* sp. nov. (Female): view of dorsum.



FIGURE 7. *Tenuipalpus spinosaurus* sp. nov. (Female): view of venter.

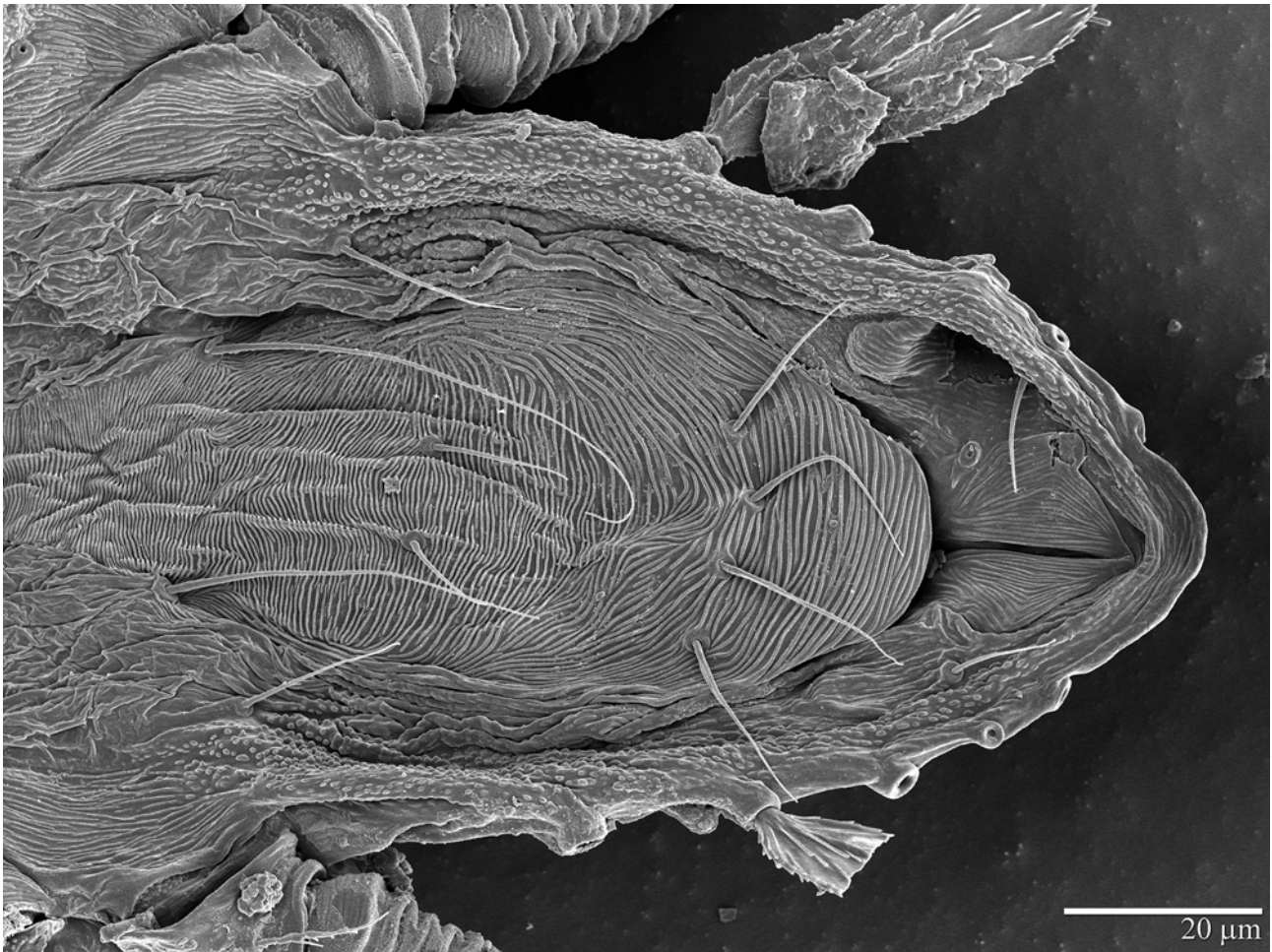


FIGURE 8. *Tenuipalpus spinosaurus* sp. nov. (Female): posterior ventral opisthosoma.

Dorsum (Figs 1–6). Anterior margin of prodorsal shield with four narrow conical projections mesally. Prodorsum with one pair of obtuse lateral projections anterior to setae *sc2*; and opisthosoma with one pair of rounded lateral projections associated with setae *c3*. Prodorsum with a pair of oblique converging ridges from *sc1* to near sejugal furrow. Opisthosoma bearing a prominent longitudinal, semi-circular crest between setae *e1*; when the mites are mounted on slides the crest is folded flat over the opisthosoma (Figs 1, 2, 3, 6); pair of large circular pores anterolaterad setae *e1*. Prodorsal setae *v2* short to minute; *sc1* obovate to oblanceolate and strongly concave like a scoop (Fig. 4B); *sc2* falcate and elongate (Fig. 4A); opisthosomal setae similar to prodorsal setae *sc1* except longer, oblanceolate, and setae *d3* and *e1* short to minute and *h2* flagelliform and elongate. Setal measurements: *v2* 5 (3–6), *sc1* 28 (25–30), *sc2* 61 (60–67), *c1* 43 (40–47), *c3* 27 (25–30), *d1* 34 (33–40), *d3* 6 (4–6), *e1* 4 (3–5), *e3* 43 (43–51), *f2* 38 (38–45), *f3* 39 (38–42), *h1* 27 (24–30), *h2* 52 (60–105).

Venter (Figs 7, 8). Ventral integument with weak transverse striae centrally along midline and finely densely colliculate on lateral region of the prodorsum and opisthosoma; genital region entirely membranous and with transverse striae; anal flaps membranous with weak longitudinal striae. Most ventral setae filiform; coxal setae *1c*, *2c* and *3b* filiform and barbed (*1b* weakly barbed); coxal setae *4b* inserted posteromesad common position, closer to *4a*. Setal measurements: *1a* 95 (70–105), *1b* 10 (10–12), *1c* 16 (16–21), *2b* 17 (16–21), *2c* 22 (25–30), *3a* 11 (11–13), *3b* 30 (26–30), *4a* 75 (65–90), *4b* 24 (24–30), *ag* 20 (17–20), *g1* 30 (25–30), *g2* 23 (21–24), *ps1* 13 (12–14), *ps2* 16 (14–16).

Gnathosoma (Figs 9, 10, 11). Palps one segmented, elongate and bearing one long, barbed seta *d* 12 (11–14) and two eupathidia, *ul'* 3 (4–5), *ul''* 1–2 (1–2) (Fig. 9). Ventral setae *m* 11 (10–11), barbed (Figs 9, 10); distance between setae *m-m* 14 (13–16). Tips of cheliceral stylets with a few bluntly rounded lateral projections (Fig. 11).

Legs (Figs 12, 13). Setation (from coxae to tarsi): I 2–1–4–3–5–8(1), II 2–1–4–2–5–8(1), III 1–2–2–1–3–5, IV 1–1–1–0–3–5. Tarsi I–II each with one solenidion ω'' 6 (5–6) (for both tarsi I and tarsi II), two eupathidia $p\zeta'$ – $p\zeta''$

(6–7, 6–7; 6, 6–7 respectively), and with seta *ft''* short, broadly lanceolate and positioned over the solenidion. Femur I with setae *d* ob lanceolate, *l'* lanceolate, and with two barbed ventral setae. Femur II with *d* and *l'* lanceolate, *bv''* broadly lanceolate to falcate, and one barbed ventral seta. Femur III with seta *d* obovate. Femora and genua with setae *d*, and trochanter III with seta *l'*, inserted in lateral position on tubercles. Detail of the development of leg chaetotaxy in Table 1.

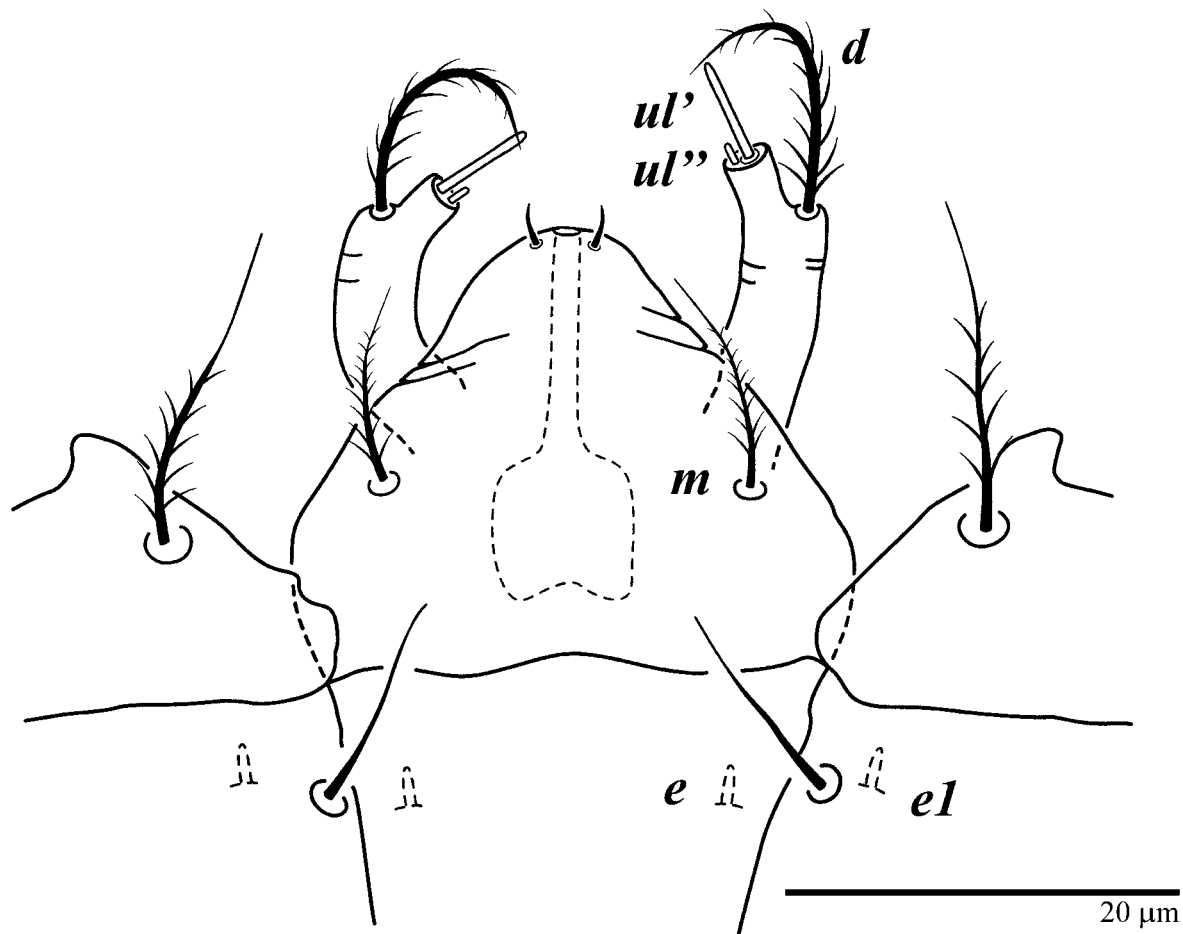


FIGURE 9. *Tenuipalpus spinosaurus* sp. nov. (Female): ventral infracapitulum.

Color. Body and legs translucent green becoming dark green in central region of idiosoma. Leg and dorsal setae white, eyes red.

Eggs. Elongate with longitudinal ridges, and yellow in colour. Most of the eggs were found near the veins of the leaves.

Male: Unknown.

Deutonymph (n = 4) (Figs 14, 15): Body size measurements: distance between setae *v2-h1* 245–265, *sc2-sc2* 122–128; other measurements: *v2-v2* 25–30, *sc1-sc1* 65–68, *c1-c1* 25–28, *c3-c3* 152–160, *d1-d1* 17–20, *d3-d3* 105–110, *e1-e1* 22–25, *e3-e3* 67–73, *f2-f2* 60–73, *f3-f3* 47–50, *h1-h1* 15–18, *h2-h2* 30–33.

Dorsum. Anterior margin of prodorsum with pair short projections mesally, forming a notch. Lateral body projections anterior to setae *sc2* present. Prodorsum mostly smooth, with pair longitudinal ridges from anterior margin past eyes to posterior margin (Fig. 15). Region between setae *sc2-c3* with widely spaced transverse striations and region posterior to setae *d1-c3* smooth; pair circular pores laterad setae *e1*; central longitudinal ridge on posterior opisthosoma from setae *d1* to posterior margin (Fig. 15). Dorsal setae similar to that of female except smaller and thinner. Setal measurements: *v2* 2–3, *sc1* 20–25, *sc2* 46–56, *c1* 24–30, *c3* 20, *d1* 30–31, *d3* 2–3, *e1* 2, *e3* 27–28, *f2* 22–27, *f3* 19–22, *h1* 13–17, *h2* 38–55.

Gnathosoma. Palps similar to those of female. Setae *d* 12–14 long; eupathidia *ul'* 4, *ul''* 1–2. Ventral infracapitular setae *m* 6–7; distance between setae *m-m* 12–14.

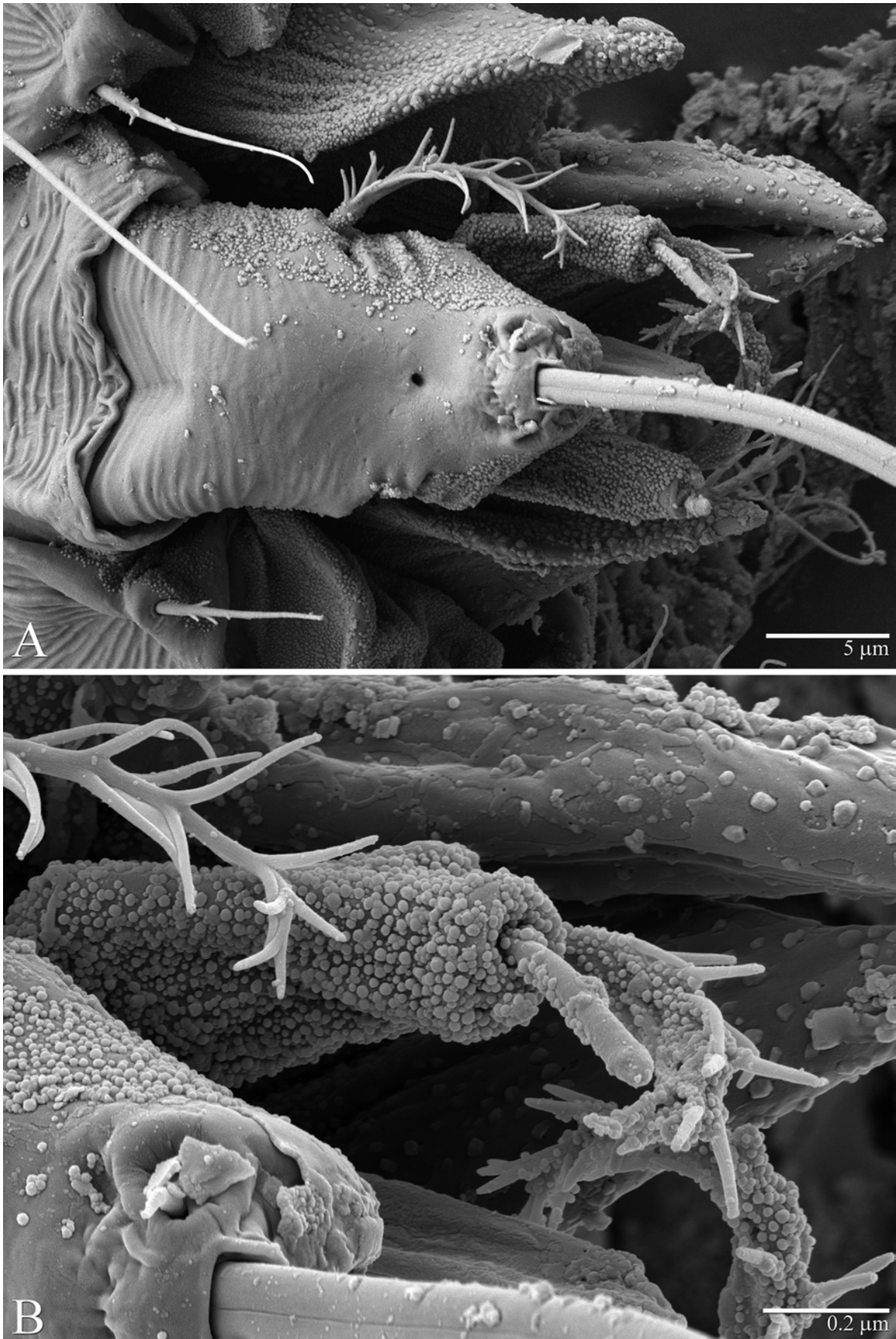


FIGURE 10. *Temuipalpus spinosaurus* sp. nov. (Female): A. view of ventral infracapitulum, detail of protracted paired cheliceral stylets. Note the inferior oral commissure below oral orifice; B. detail of palp.

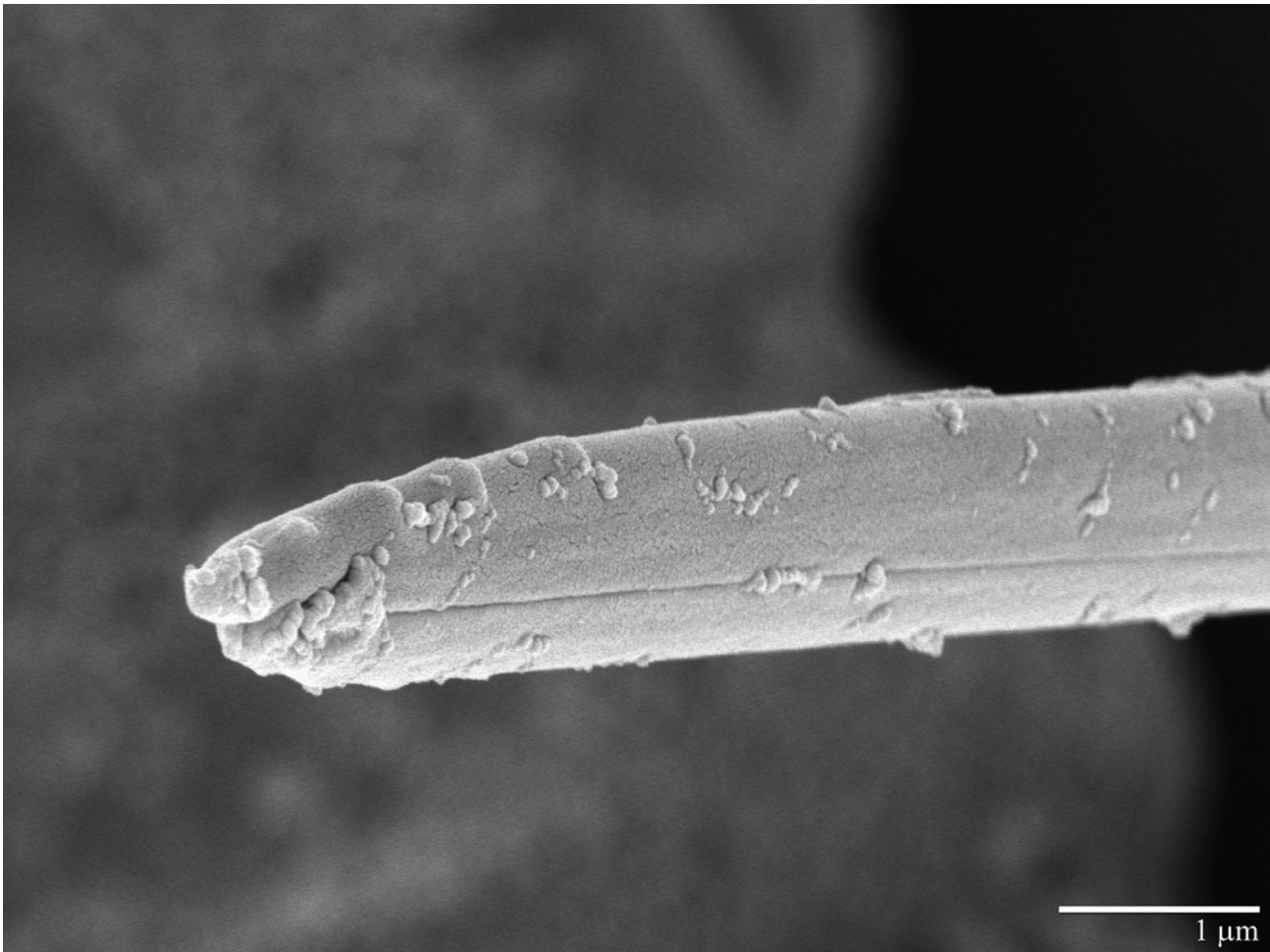


FIGURE 11. *Tenuipalpus spinosaurus* sp. nov. (Female): view of apex of chelicerae.

Venter. Cuticle covered with fine and mostly transverse striae. Coxal, genital and pseudanal setae fine. Setal lengths: *1a* 55–65, *1b* 5–6, *1c* 6–8, *2b* 10–11, *2c* 10–12, *3a* 6–7, *3b* 11–12, *4a* 45–60, *4b* 7–10, *ag* 5–8, *g1* 5–6, *ps1* 5–7, *ps2* 5–6. Setae *g2* absent.

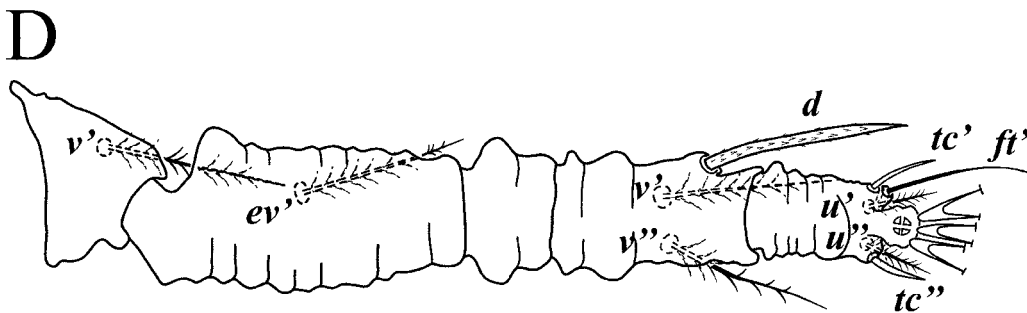
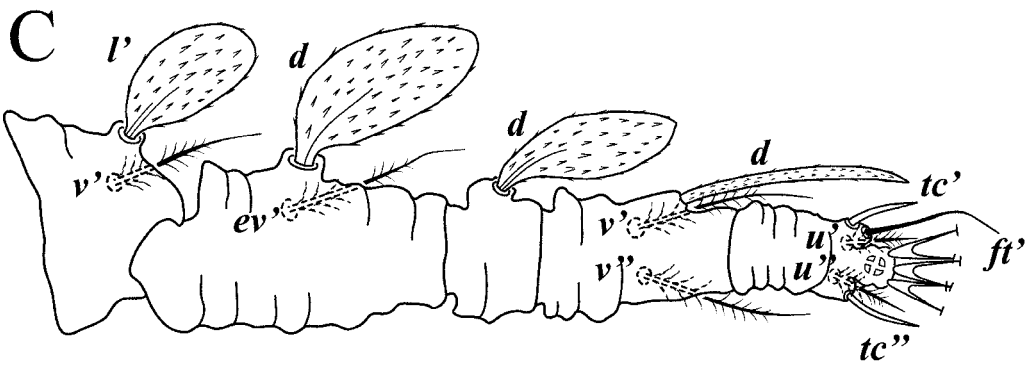
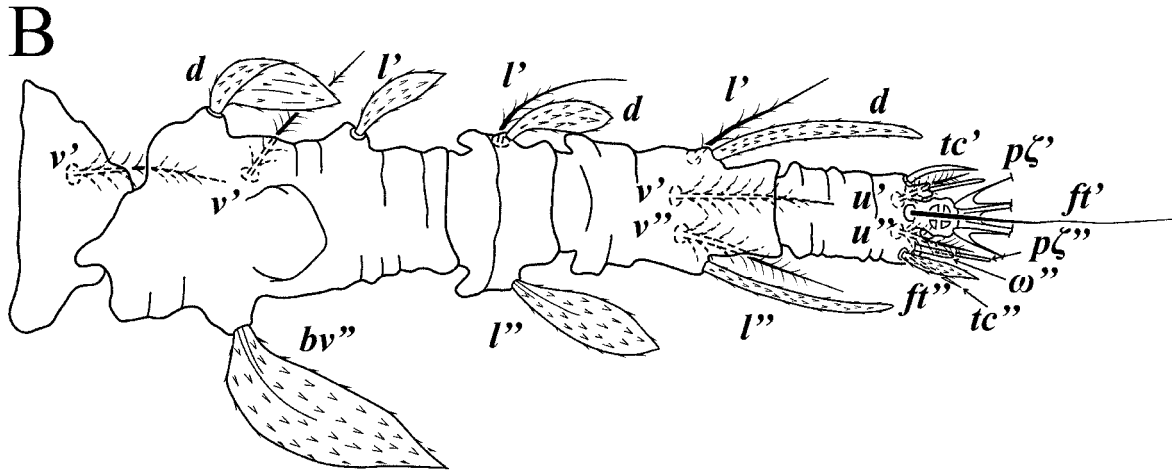
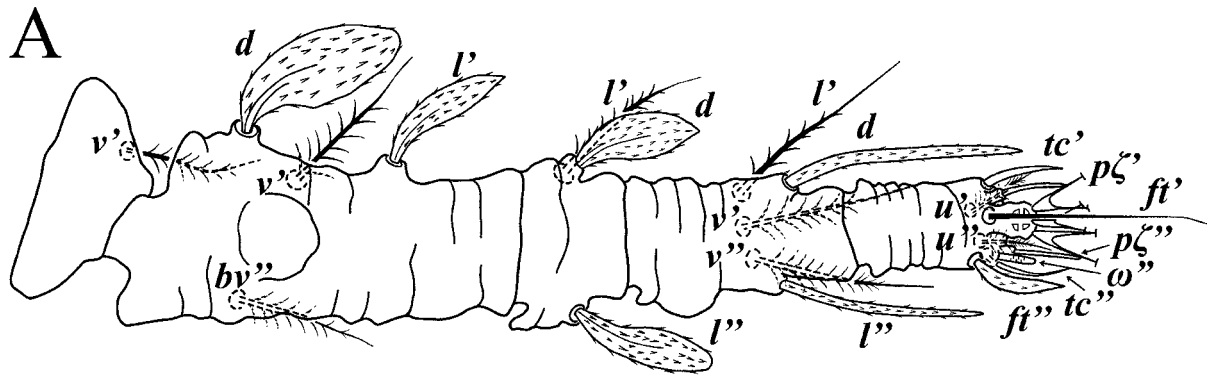
Legs. Setation (from coxae to tarsi): I 2–1–4–3–5–8(1), II 2–1–4–3–5–8(1), III 1–2–2–1–3–3, IV 1–0–1–0–3–3. Leg chaetotaxy similar to that of female, except trochanter IV nude, and *d* and *l* setae more lanceolate. Tarsi I–II each with one solenidion ω'' (tarsi I 4–5 and tarsi II 4) and two eupathidia $p\zeta'-p\zeta''$ (5–6, 6; 5–6, 6 respectively). Detail of the development of leg chaetotaxy in Table 1.

Protonymph (n = 3) (Figs 16, 17): Body size measurements: distance between setae *v2-h1* 185–210, *sc2-sc2* 110–115; other measurements: *v2-v2* 20–25, *sc1-sc1* 55–60, *c1-c1* 22–25, *c3-c3* 127–133, *d1-d1* 15–18, *d3-d3* 87–93, *e1-e1* 15–18, *e3-e3* 62–65, *f2-f2* 55–58, *f3-f3* 45, *h1-h1* 15, *h2-h2* 27–30.

Dorsum. Anterior margin of prodorsum with pair short projections mesally, forming a short notch. Lateral body projections anterior to setae *sc2* present. Prodorsum mostly smooth, with pair longitudinal ridges from anterior margin past eyes to posterior margin (Fig. 17). Prodorsal region smooth; region between setae *sc2-c3* with widely spaced transverse striations and region posterior to setae *d1-c3* smooth; pair circular pores laterad setae *e1*; short central longitudinal ridge on posterior opisthosoma from setae *d1* to posterior margin (Fig. 17). Dorsal setae similar to that of female except shorter and thinner. Setal measurements: *v2* 2–3, *sc1* 10–12, *sc2* 42–45, *c1* 9–45, *c3* 20–21, *d1* 12–20, *d3* 2–3, *e1* 2–3, *e3* 23–24, *f2* 19–22, *f3* 17–18, *h1* 14–15, *h2* 55–65.

Gnathosoma. Palps similar to those of female. Setae *d* 5–7; eupathidia *ul'* 3–4, *ul''* 1–2. Ventral infracapitular setae *m* 6–7; distance between setae *m-m* 11–12.

Venter. Cuticle covered with fine and mostly transverse striae. Coxal, genital and pseudanal setae fine. Setal measurements: *1a* 60–75, *1b* 5–6, *1c* 6–7, *2c* 11–12, *3a* 7–8, *3b* 10–11, *ag* 6–7, *ps1* 5–7, *ps2* 6–7. Setae *2b*, *4a*, *4b*, *g1* and *g2* absent.



20 μm

FIGURE 12. *Tenuipalpus spinosaurus* sp. nov. (Female): A. leg I; B. leg II; C. leg III; D. leg IV. (Right legs).

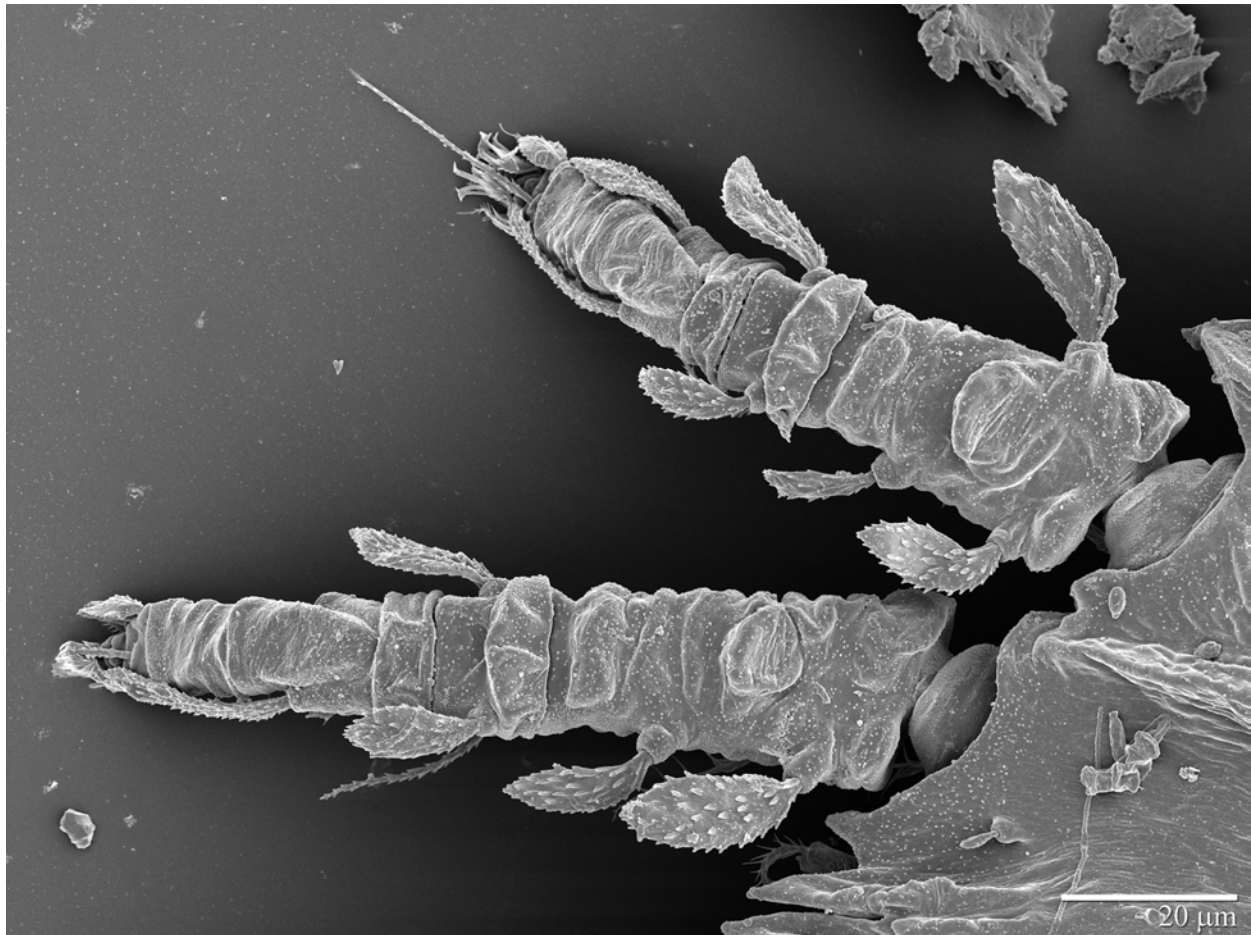


FIGURE 13. *Tenuipalpus spinosaurus* sp. nov. (Female): legs I and II (Right legs).

Legs. Setation (from coxae to tarsi): I 2–0–3–1–5–6(1), II 1–0–3–1–5–6(1), III 1–0–2–0–3–3, IV 0–0–1–0–3–3. Tarsi I–II each with one solenidium ω'' 3–4 (for both tarsi I and tarsi II) and two eupathidia $p\zeta''-p\zeta'''$ (5–6, 6; 5, 5 respectively). Detail of the development of leg chaetotaxy in Table 1.

Larva (n = 3) (Fig. 18): Body size measurements: distance between setae $v2-h1$ 150–160, $sc2-sc2$ 78–98; other measurements: $v2-v2$ 15–18, $sc1-sc1$ 50, $c1-c1$ 25, $c3-c3$ 97–105, $d1-d1$ 12–15, $d3-d3$ 67–72, $e1-e1$ 7–10, $e3-e3$ 57–63, $f2-f2$ 47–55, $f3-f3$ 35–40, $h1-h1$ 10–13, $h2-h2$ 22–25.

Dorsum. Anterior margin of prodorsum smoothly rounded, without notch. Prodorsal region with colliculate integument; region between setae $sc2-c3$ with oblique and widely spaced transverse striations and region posterior to setae $d1-c3$ with colliculate integument. Setae $v2$, $sc1$, $c1$, $d1$, $d3$ and $e1$ short to minute; other dorsal setae lanceolate except $sc2$ falcate. Setal measurements: $v2$ 2, $sc1$ 3, $sc2$ 22–26, $c1$ 3–4, $c3$ 15–18, $d1$ 5–6, $d3$ 2–3, $e1$ 2, $e3$ 15–17, $f2$ 16–18, $f3$ 13–15, $h1$ 11–13, $h2$ 35–45.

Gnathosoma. Palps similar to those of female. Seta d 5–6 long; eupathidia ul' 2, ul'' 1. Ventral infracapitular setae m absent.

Venter. Cuticle covered with fine and mostly transverse striae. Coxal, genital and anal setae fine. Setal measurements: $1a$ 35–43, $1b$ 5–6, $3a$ 5–6, $ps1$ 5–7, $ps2$ 5–6. Setae $1c$, $2b$, $2c$, $3b$, $4a$, $4b$, ag , $g1$ and $g2$ absent.

Legs. Setation (from coxae to tarsi): I 1–0–3–1–5–6(1), II 0–0–3–1–5–6(1), III 0–0–2–0–3–3. Tarsi I–II each with one solenidium ω'' 2–3 (for both tarsi I and II) and two eupathidia $p\zeta''-p\zeta'''$ (4–5, 5; 4, 5 respectively). Cuticle of all legs covered with colliculate sculpturing. Detail of the development of leg chaetotaxy in Table 1.

Type material. Holotype: female collected on *Terminalia argentea* (Combretaceae), Itapagipe, Minas Gerais, **Brazil**, (19°52'S, 49°39'W), 16 October 2008, coll. A. Mendonça (DZSJRP n. 10138). **Paratypes:** five females and three deutonymphs on same slide as holotype; two females, three protonymphs and three larvae, 19 August 2014, coll. E.B. Castro, same data as holotype (DZSJRP n. 10140 to 10144). Eight females and one deutonymph, same data as holotype (DZSJRP n. 10139, NMNH).

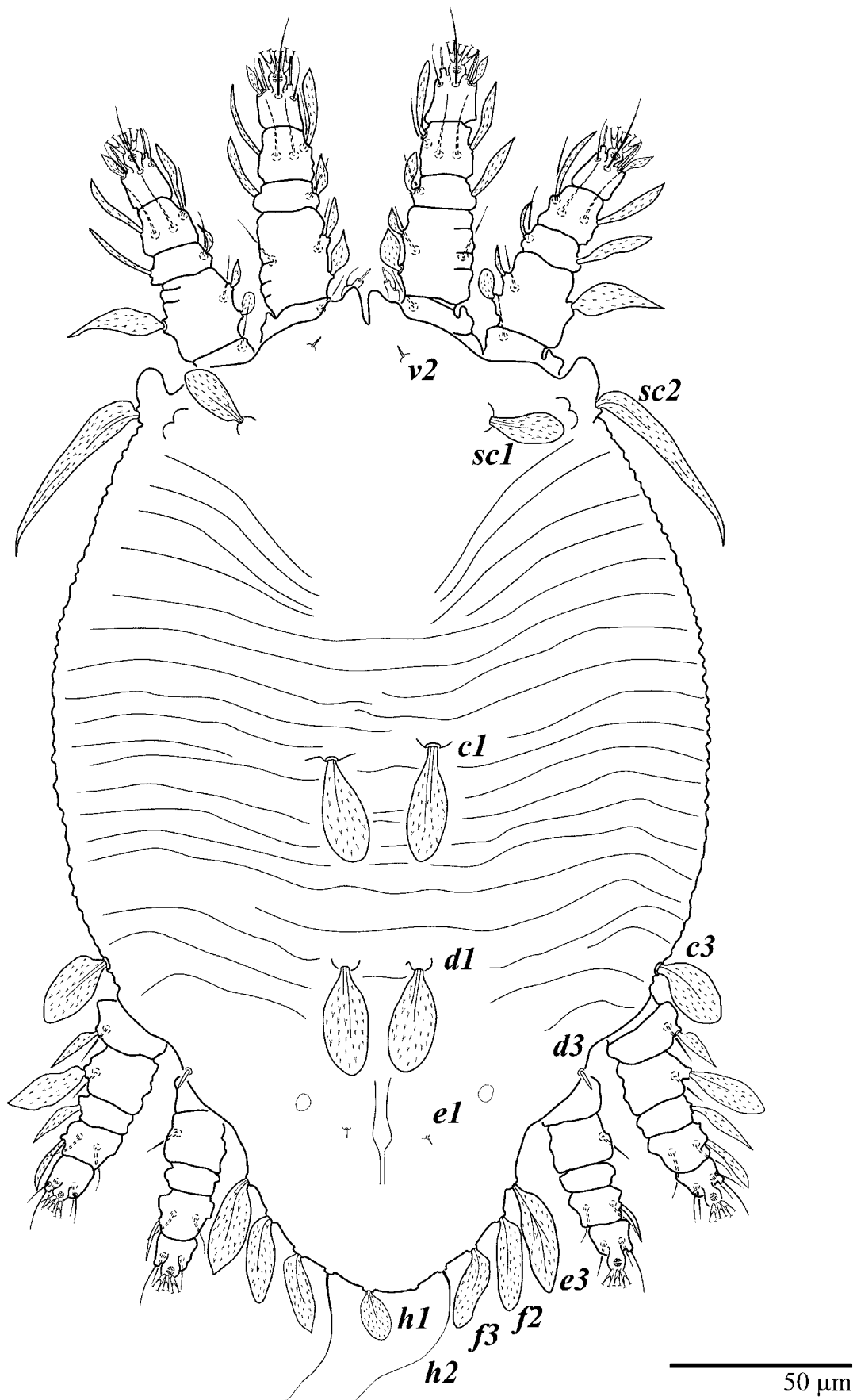


FIGURE 14. *Tenuipalpus spinosaurus* sp. nov. (Deutonymph): dorsum, with detail of legs. Unguinal setae *u'*–*u''* on tarsus I and II are not included in the drawing.

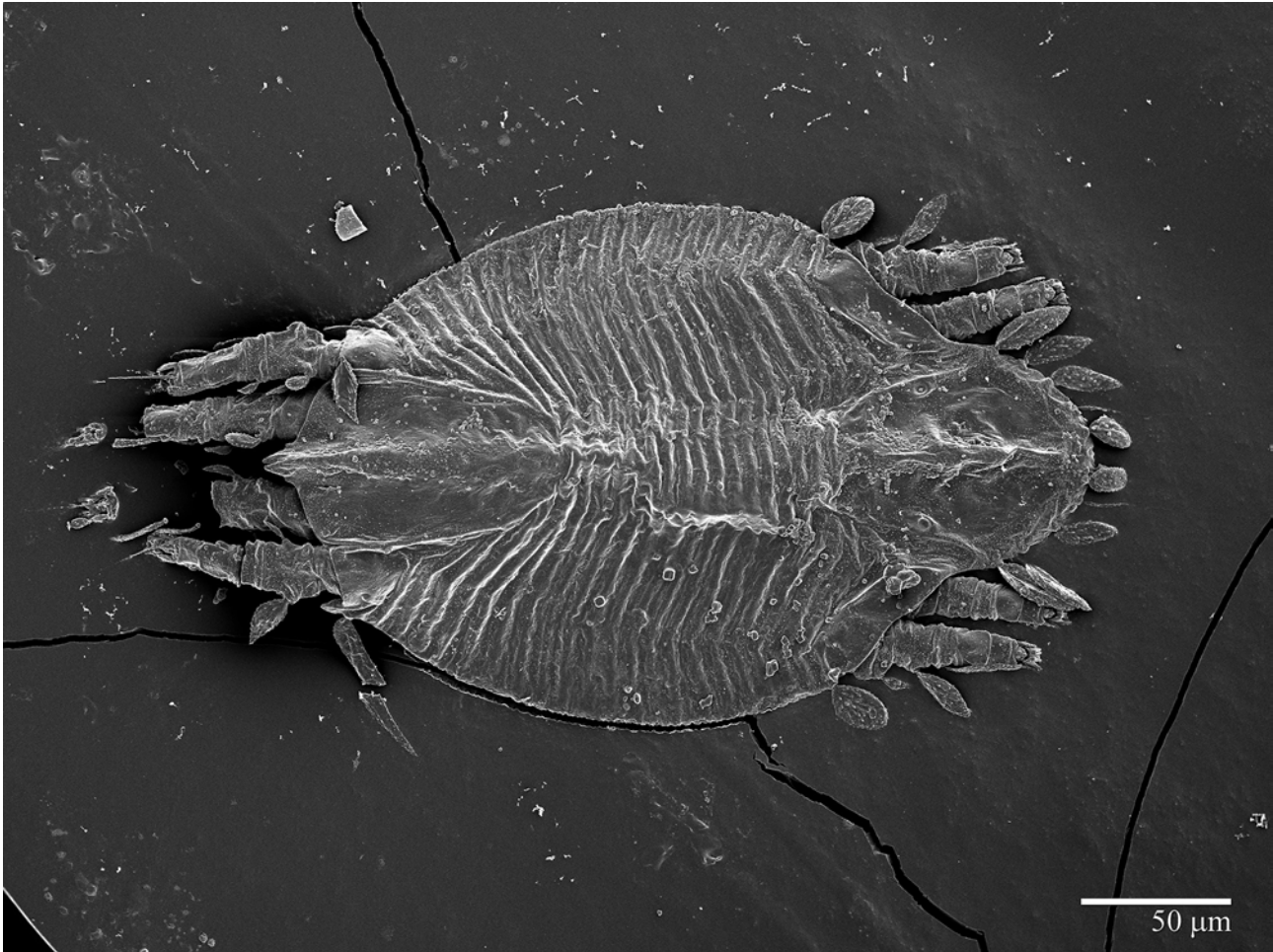


FIGURE 15. *Tenuipalpus spinosaurus* sp. nov. (Deutonymph): dorsal view.

Other material examined. *Tenuipalpus boyani* De Leon (USNM n. 2610): **Paratypes:** one female, one deutonymph and one protonymph on the slide, ex. *Pouteria* sp. (Sapotaceae), from Guyana (= British Guiana). *Tenuipalpus eugeniae* De Leon (USNM n. 2709): **Holotype:** female, ex. *Eugenia biflora* (Myrtaceae), from Jamaica. **Paratypes:** one female and one male on same slide as holotype.

Etymology. This specific name *spinosaurus* refers to presence of a prominent dorsal crest on opisthosoma which reminds us of that of the extraordinary crest of the dinosaur *Spinosaurus aegyptiacus* Stromer (Spinosauridae).

Differential diagnosis. This new species resembles *T. boyani* De Leon 1965a in sharing the presence of lateral body projections associated with setae *sc2* and *c3*, and a longitudinal crest on the opisthosoma (not illustrated in De Leon 1965a) and in having ventral seta *4b* inserted distinctly mesad of its more common position in the Tenuipalpidae. It differs by having a prodorsum with a pair of strongly developed longitudinal to converging ridges running from *sc1* to near the posterior margin of the shield (prodorsum with only weakly developed longitudinal ridges in *T. boyani*); setae *sc1* are larger in *T. spinosaurus* (25–30 long; 10 long in *T. boyani*); setae *sc1*, *c1* and *d1* are oblancoolate in the deutonymphs and protonymphs of the new species, while in the immatures of *T. boyani* these setae are minute.

Tenuipalpus spinosaurus also resembles *T. eugeniae* De Leon 1965b, but differs in the position of coxal setae *4b*, which are inserted much closer to setae *4a* in former, and in the more commonly observed position in the latter species.

Remarks. The new species was compared with the type specimens of *T. boyani* and *T. eugeniae*.

In the many samples we analysed, only eggs, immatures and females were found, and no males were located. It suggests that this species may be parthenogenetic, or that males are produced only at certain times of the year or under certain conditions.

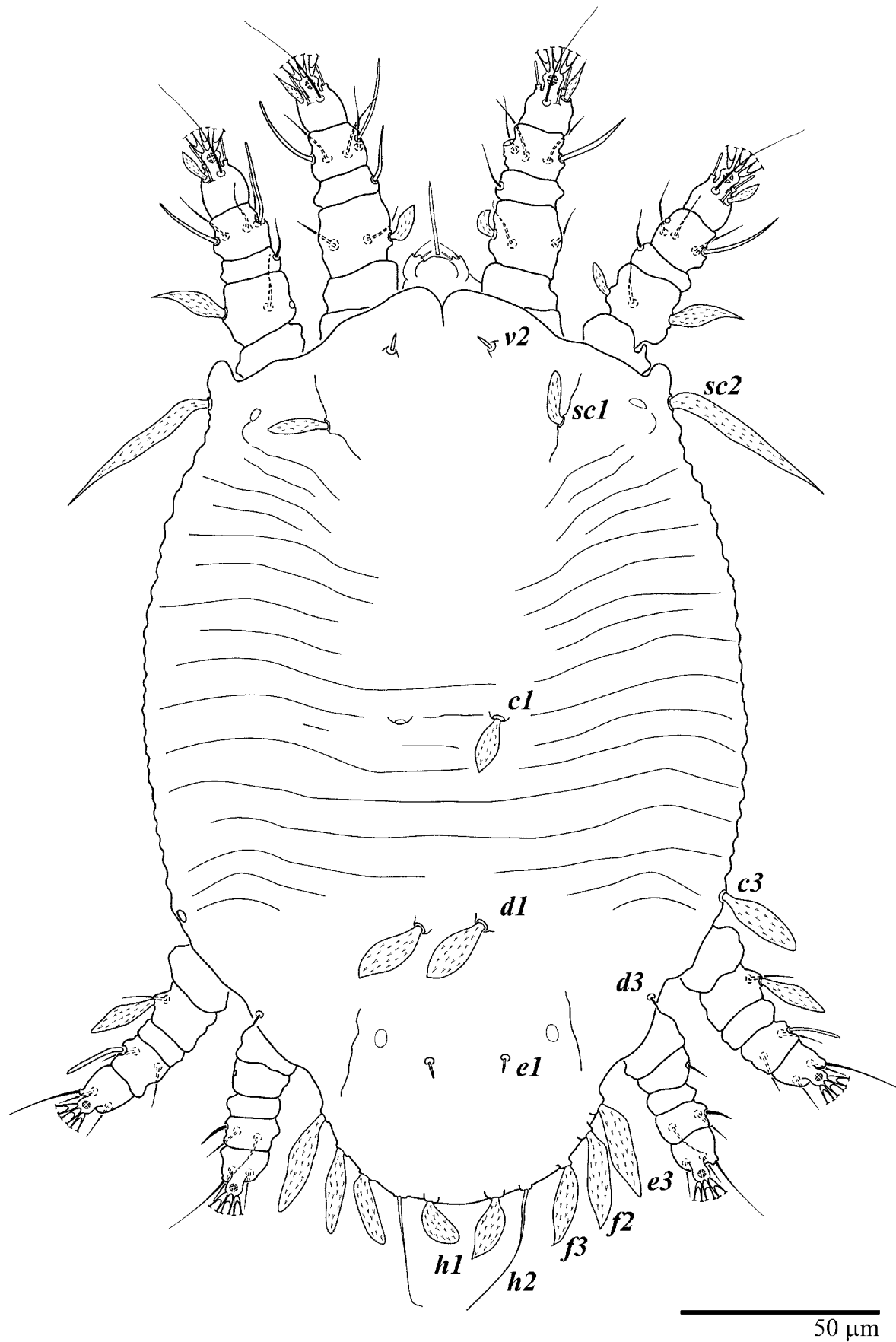


FIGURE 16. *Temipalpus spinosaurus* sp. nov. (Protonymph): dorsum, with detail of legs. Unguinal setae *u'*–*u''* on tarsus I and II are not included in the drawing.

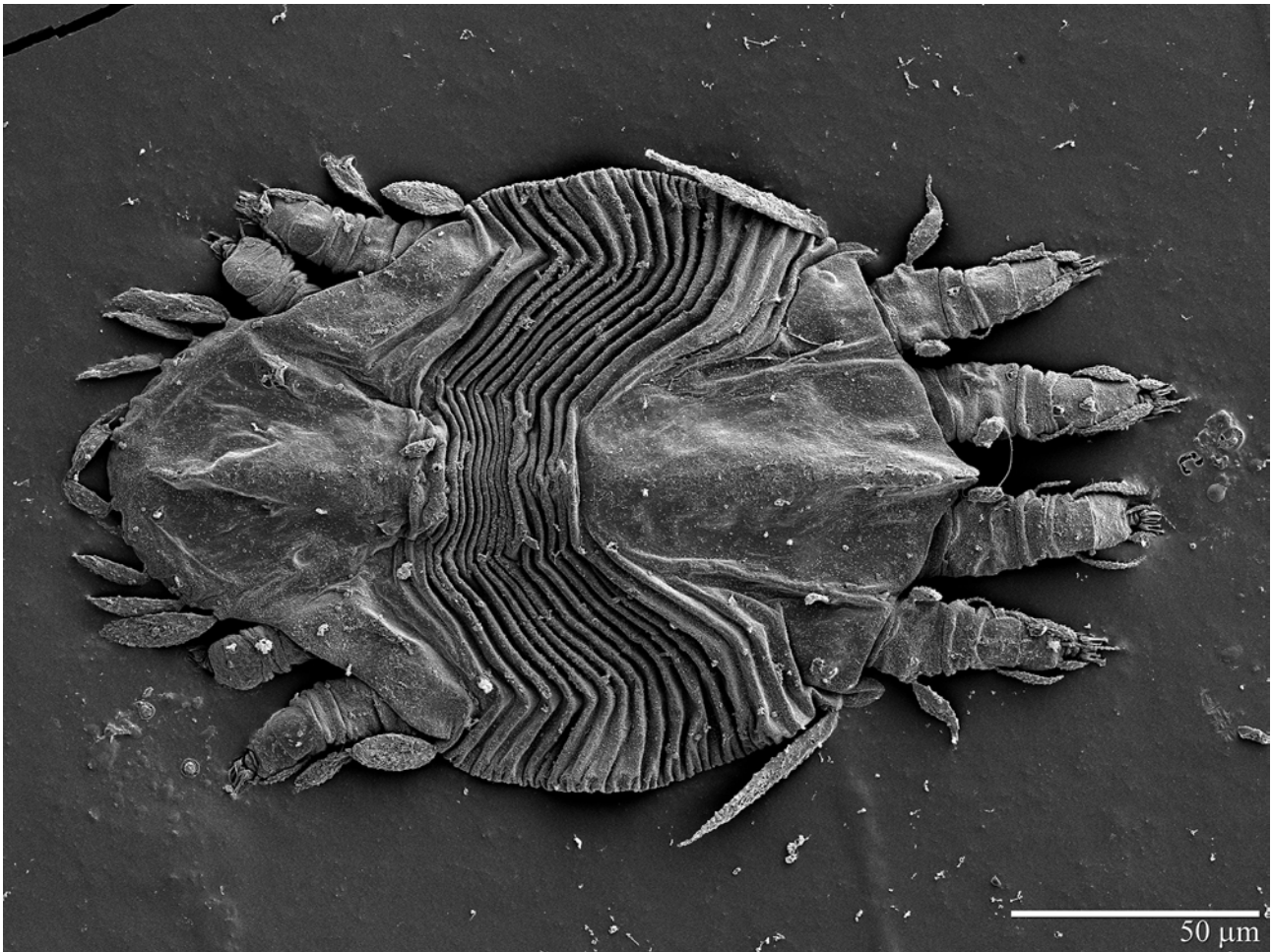


FIGURE 17. *Tenuipalpus spinosaurus* sp. nov. (Protonymph): dorsal view.

Ontogeny. *Tenuipalpus spinosaurus* sp. nov. has the pattern of additions to the coxae that is common to the family (Lindquist 1985). Coxal setae *1c*, *2c* and *3b* are added in the protonymph and *2b* and *4b* are added in the deutonymph. Here, the coxal setae *4b* are inserted in an unusual position, off of coxal region IV and closer to setae *4a*. This characteristic is also found in *Tenuipalpus boyani* De Leon.

Seta *v'* is added to trochanters I, II and III in the deutonymph and is delayed until the adult stage on leg IV. Unusually, setae *l'* is added to trochanters III in the deutonymph (more commonly appears in the protonymph (Lindquist 1985)).

Setae *l'* are added to femora I and II in deutonymph, as occurs in other Tenuipalpidae (e.g. *Aegyptobia* (Seeman & Beard 2011)). Setae *l'* are present on genua I and II of the larvae, and setae *d* (common for the family) and *l''* (delayed addition, according to Lindquist (1985)) are added to genua I and II of the deutonymph, as occurs in other Tenuipalpidae (e.g. *Aegyptobia* (Seeman & Beard (2011))). As is common in the family, seta *d* is added to genu III in the deutonymph (Lindquist 1985); while genu IV remain nude.

As in most of *Tenuipalpus* species, the pattern of tibial setae is 5-5-3-3, and represents the larval complement. The patterns of addition of the tectal setae on the tarsi are variable amongst tenuipalpid taxa. *Tenuipalpus spinosaurus* sp. nov. displays a pattern commonly expressed within the family, but one in which the tectal pairs are delayed one stage from a standard pattern (Lindquist 1985). The pairs of tectal setae are added to tarsus I, II and III in the deutonymph (instead of protonymph), and to tarsus IV in the adult (instead of deutonymph).

Setae *d* on femora I and II are inserted in a lateral position on tubercles in *Tenuipalpus* sensu stricto. In species of *Tenuipalpus* sensu lato, setae *d* on femora I and II are commonly inserted in a dorsal position and not usually on tubercles. Similarly, seta *d* on genua and tibiae of *Tenuipalpus* sensu stricto and sensu lato are also usually inserted in a lateral position.

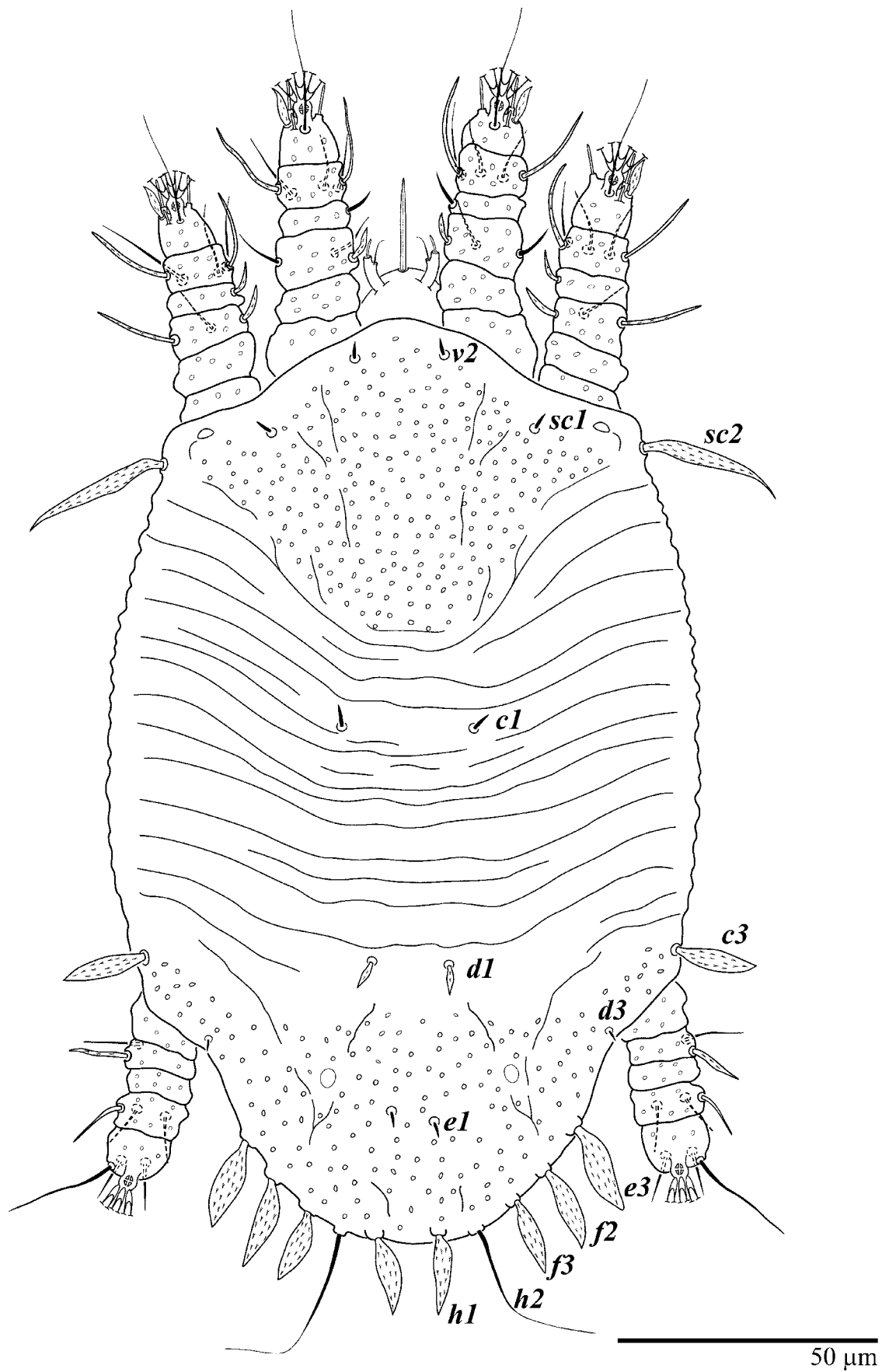


FIGURE 18. *Temuipalpus spinosaurus* sp. nov. (Larva): dorsum, with detail of legs. Unguinal setae *u'*–*u''* on tarsus I and II are not included in the drawing.

TABLE 1. Ontogenetic development of leg setae in *Tenuipalpus spinosaurus* sp. nov. Setae are indicated in the stage in which they first appear. Setae in parentheses represent pairs.

	Coxa	Trochanter	Femur	Genu	Tibia	Tarsi
Leg I						
Larva	<i>1b</i>	-	<i>d, v', bv''</i>	<i>l'</i>	<i>d, (v), (l)</i>	<i>(u), (pζ), (ft), ω''</i>
Protonymph	<i>1c</i>	-	-	-	-	-
Deutonymph	-	<i>v'</i>	<i>l'</i>	<i>d, l''</i>	-	<i>(tc)</i>
Female	-	-	-	-	-	-
Leg II						
Larva	-	-	<i>d, v', bv''</i>	<i>l'</i>	<i>d, (v), (l)</i>	<i>(u), (pζ), (ft), ω''</i>
Protonymph	<i>2c</i>	-	-	-	-	-
Deutonymph	<i>2b</i>	<i>v'</i>	<i>l'</i>	<i>d, l''</i>	-	<i>(tc)</i>
Female	-	-	-	-	-	-
Leg III						
Larva	-	-	<i>d, ev'</i>	-	<i>d, (v)</i>	<i>(u), ft'</i>
Protonymph	<i>3b</i>	-	-	-	-	-
Deutonymph	-	<i>l', v'</i>	-	<i>d</i>	-	<i>(tc)</i>
Female	-	-	-	-	-	-
Leg IV						
Protonymph	-	-	<i>ev'</i>	-	<i>d, (v)</i>	<i>(u), ft'</i>
Deutonymph	<i>4b</i>	-	-	-	-	-
Female	-	<i>v'</i>	-	-	-	<i>(tc)</i>

Discussion

The rapid replacement of the Cerrado by agricultural crops such as soybean, rice, corn, and cotton as well as pasture (Klink & Moreira 2002), increases the risk that species may become extinct before they are even known (Demite *et al.* 2009). Some tenuipalpids show host preference (Mesa *et al.* 2009) and may occur only on a single genus of plants [e.g. *T. heveae* Baker that has only ever been recorded occurring on plants of the genus *Hevea* (Euphorbiaceae)]. Due to such host specificity, we believe that if a given plant becomes extinct, then the mites associated with it may also become extinct. This information highlights the importance of the conservation of biomes with endemic species, as the Cerrado.

The 39 known species of *Tenuipalpus* sensu stricto were collected on plants of 29 different families and were described mainly from Neotropical (19 spp.) and Nearctic regions (8 spp.) (Mesa *et al.* 2009; Castro *et al.* 2016). Of these species, four are known from Brazil. Two species were described from specimens collected from Brazil: *T. spinosaurus* (described herein), and *T. latiseta* Aranda collected on an unidentified plant of the family Celastraceae from São Paulo state (Flechtmann 1976); and another two species of the sensu stricto group were recorded in Brazil: *Tenuipalpus anacardii* De Leon was collected by Flechtmann (1976) on *Anacardium occidentale* (Anacardiaceae) from Ceará State, and *T. coyacus* De Leon was recorded by Vasconcelos *et al.* (2005) on *Cocos nucifera* (Arecaceae) from Pernambuco state.

Tenuipalpus spinosaurus bears a pair of lateral projections associated with setae *c3* (synapomorphy of *Tenuipalpus* sensu stricto group), and another pair of lateral projections anterior to setae *sc2* (present also in some other *Tenuipalpus* and *Ultratenuipalpus*). It also bears a longitudinal crest on the dorsal opisthosoma that occurs in four other species of the sensu stricto group (e.g. *T. caudatus* (Dugès) and *T. erbei* Kane, Castro & Ochoa). In addition, the presence of the pair of projections anterior to setae *sc2* in the protonymphs and deutonymphs show that this character could be expressed during the ontogenetic development of *Tenuipalpus* sensu stricto.

Key to known species of *Tenuipalpus* sensu stricto (sensu Castro *et al.* 2016)

(based on adult females)

1. Dorsum with one pair of lateral projections associated with setae *c3* and another pair of lateral projections anterior to setae *sc2*; lateral setae *sc2*, *c3*, *e3*, *f2*, *f3* and *h1* variable in shape from lanceolate, obovate to ovate; femora I and II with setae *d* inserted in lateral position on tubercles *Tenuipalpus* sensu stricto (sensu Castro *et al.* 2016)...2
- Dorsum always without a pair of lateral projections associated with setae *c3* and usually without the lateral projection anterior to setae *sc2*; lateral setae not as mentioned above and usually setiform or minute; femora I and II with setae *d* usually inserted in dorsal position. *Tenuipalpus* sensu lato (sensu Castro *et al.* 2016)
2. Opisthosoma with six pairs of dorsolateral setae (*f2* absent; *c3*, *d3*, *e3*, *f3*, *h1*, *h2* present) *T. lalbaghensis* Channabasavanna & Lakkundi
- Opisthosoma with seven pairs of dorsolateral setae (*c3*, *d3*, *e3*, *f2*, *f3*, *h1*, *h2* present) 3
3. Three pairs of pseudanal setae (*ps1*–*3* present) 4
- Two pairs of pseudanal setae (*ps1*–*2* present, *ps3* absent) 6
4. Setae *c3* inserted on the associated lateral projections *T. banahawensis* Corpuz-Raros
- Setae *c3* inserted anterior to the associated lateral projections 5
5. Palps two segmented; opisthosomal setae *c3* obovate; opisthosomal setae *e3* lanceolate; opisthosomal setae *f2* and *f3* ovate with broadly acute tips *T. mahoensis* Collyer
- Palps three segmented; opisthosomal setae *c3* lanceolate; opisthosomal setae *e3*, *f2* and *f3* lanceolate with narrowly acute tips. *T. inophylli* Gutierrez & Bolland
6. Central prodorsum with honeycomb pattern 7
- Prodorsum not as above 8
7. Palps three segmented; tibiae I–IV with 5, 5, 3, 3 setae, respectively *T. rhyssus* Baker & Pritchard
- Palps one segmented; tibiae I–IV with 3, 3, 1, 1 setae, respectively *T. chichlorum* De Leon
8. Prodorsal setae *v2* distinctly longer than setae *sc1* *T. micheli* Lawrence
- Prodorsal setae *v2* smaller or of similar length to setae *sc1* 9
9. Dorsal opisthosoma with one or more crests 10
- Dorsal opisthosoma without any crests 15
10. Dorsal opisthosoma with two crests, one transverse and one longitudinal crest 11
- Dorsal opisthosoma with one crest, either one transverse or one longitudinal 12
11. Prodorsum with longitudinal striations; with transverse opisthosomal crest posterior to setae *d1* *T. caudatus* (Dugès)/*T. arbuti* Mitrofanov & Sharonov*
- Prodorsum with transverse to oblique striations; with transverse opisthosomal crest anterior to setae *d1* *T. erbei* Kane, Castro & Ochoa
12. Opisthosoma with one transverse crest *T. sandyi* De Leon
- Opisthosoma with one longitudinal crest 13
13. Ventral setae *4b* inserted in common position in coxal region IV *T. eugeniae* De Leon
- Ventral setae *4b* inserted in unusual medially displaced position off coxal region IV, closer to setae *4a* 14
14. Prodorsal setae *sc1* obovate and long (25–30 long) *T. spinosaurus* Castro, Feres & Ochoa
- Prodorsal setae *sc1* obovate and short (10 long) *T. boyani* De Leon
15. Dorsal opisthosoma with central setae *c1*, *d1*, *e1* of similar lengths and shape to lateral setae *e3*, *f2* and *f3* 16
- Dorsal opisthosoma with at least one central seta minute or with lengths distinctly smaller than lateral setae *e3*, *f2* and *f3* 25
16. Prodorsal setae *sc1* of similar length to setae *sc2* 17
- Prodorsal setae *sc1* distinctly smaller than setae *sc2* 19
17. Dorsal opisthosomal setae *e3* inserted in common position on lateral margin, and seta of similar length to setae *f2* and *f3*; genua I–IV with 2, 2, 1, 0 setae, respectively *T. coyacus* De Leon
- Dorsal opisthosomal setae *e3* inserted mesad lateral margin, and seta shorter than setae *f2* and *f3*; genua I–IV with 2, 2, 0, 0 setae, respectively 18
18. Femora I–IV with 4, 4, 1, 0 setae, respectively; trochanters I–IV with 1, 1, 2, 1 setae, respectively *T. dasples* Baker & Pritchard
- Femora I–IV with 4, 4, 2, 0 setae, respectively; trochanters I–IV with 1, 1, 1, 1 setae, respectively. *T. tuttlei* Ochoa
19. Venter with two pairs of *3a* setae (*3a₂* present) 20
- Venter with one pair of *3a* setae (*3a₂* absent) 24
20. Dorsal opisthosomal setae *e3* (12–16 long) distinctly smaller than setae *f2* and *f3* (32–36 long) *T. xylosmae* De Leon
- Dorsal opisthosomal setae *e3* with similar lengths of *f2* and *f3* setae 21
21. Prodorsal setae *sc2* broadly lanceolate and elongate *T. bakeri* McGregor
- Prodorsal setae *sc2* narrowly lanceolate and elongate 22
22. Prodorsal setae *sc1* obovate and larger than setae *v2* *T. argus* Baker & Pritchard
- Prodorsal setae *sc1* minute and of similar length to setae *v2* 23
23. Dorsal opisthosomal setae *c3* of similar length and shape to dorsocentral setae *c1*, *d1* and *e1* *T. pigrus* Pritchard & Baker
- Dorsal opisthosomal setae *c3* distinctly smaller than dorsocentral setae *c1*, *d1* and *e1* *T. rhagicus* Pritchard & Baker
24. Prodorsum with longitudinal striations; dorsal opisthosomal setae *e3* of similar length to setae *f2* and *f3* *T. raphiae* Meyer & Bolland

-	Prodorsum with irregular striations; dorsal opisthosomal setae <i>e3</i> smaller than <i>f2</i> and <i>f3</i>	<i>T. chamaedorea</i> Salas & Ochoa	
25.	Opisthosomal dorsocentral setae <i>c1</i> and <i>d1</i> obovate		26
-	Opisthosomal dorsocentral setae <i>c1</i> and <i>d1</i> minute		27
26.	Prodorsal setae <i>v2</i> of similar length to setae <i>sc1</i> ; dorsal opisthosomal setae <i>e3</i> , <i>f2</i> and <i>f3</i> obovate		
		<i>T. cupressoides</i> Meyer & Gerson	
-	Prodorsal setae <i>v2</i> minute and distinctly smaller than setae <i>sc1</i> ; dorsal opisthosomal setae <i>e3</i> , <i>f2</i> and <i>f3</i> narrowly lanceolate elongate	<i>T. victoriae</i> De Leon	
27.	Venter with two pairs of <i>3a</i> setae (<i>3a₂</i> present)		28
-	Venter one pair of <i>3a</i> setae (<i>3a₂</i> absent)		31
28.	Prodorsal setae <i>sc2</i> narrowly falcate; dorsal opisthosomal setae <i>c3</i> obovate to lanceolate, short; dorsal opisthosomal setae <i>e3</i> , <i>f2</i> and <i>f3</i> narrowly lanceolate		29
-	Prodorsal setae <i>sc2</i> broadly falcate; dorsal opisthosomal setae <i>c3</i> obovate, short; dorsal opisthosomal setae <i>e3</i> , <i>f2</i> and <i>f3</i> broadly lanceolate to obovate		30
29.	Dorsal opisthosomal setae <i>c1</i> and <i>d1</i> short and obovate (12–14 long); genua with 2, 2, 1, 1 setae, respectively	<i>T. unonopsonis</i> De Leon	
-	Dorsal opisthosomal setae <i>c1</i> and <i>d1</i> minute and acicular (4–5 long); genua with 3, 3, 1, 0 setae, respectively	<i>cocolobicolus</i> De Leon	
30.	Prodorsum with oblique striations; dorsal opisthosomal setae <i>e3</i> , <i>f2</i> and <i>f3</i> 28–32, 29, 25–27 long, respectively	<i>T. coccolobicoloides</i> De Leon	
-	Prodorsum completely smooth; dorsal opisthosomal setae <i>e3</i> , <i>f2</i> and <i>f3</i> longer than above, 49, 43, 40 long, respectively	<i>T. imias</i> Cao	
31.	Dorsum ornamented and strongly striated		32
-	Dorsum smooth or weakly striated		33
32.	Irregular striations on dorsal idiosoma; setae <i>c3</i> orbicular to obovate	<i>T. anacardii</i> De Leon	
-	Longitudinal striae on dorsal idiosoma; setae <i>c3</i> narrowly lanceolate	<i>T. cheladzeae</i> Gomelauri	
33.	Most dorsal setae narrowly lanceolate, elongate		34
-	Most dorsal setae broadly lanceolate to obovate		37
34.	Prodorsum with longitudinal striations on central region		35
-	Prodorsum without longitudinal striations on central region		36
35.	Dorsal opisthosomal setae <i>e3</i> of similar length to setae <i>f2</i> and <i>f3</i>	<i>T. vexus</i> De Leon	
-	Dorsal opisthosomal setae <i>e3</i> smaller than setae <i>f2</i> and <i>f3</i>	<i>T. mansonii</i> De Leon	
36.	Prodorsal setae <i>sc2</i> inserted posterior to the lateral projections; dorsal opisthosomal setae <i>h1</i> distinctly smaller than setae <i>e3</i> , <i>f2</i> and <i>f3</i>	<i>T. hastaligni</i> De Leon	
-	Prodorsal setae <i>sc2</i> inserted on the lateral projections; dorsal opisthosomal setae <i>h1</i> of similar length to setae <i>e3</i> , <i>f2</i> and <i>f3</i>	<i>T. podocarpi</i> Lawrence	
37.	Prodorsum and dorsal opisthosoma weakly striated; genua I–IV with 3, 3, 1, 0 setae, respectively	<i>T. lucumae</i> De Leon	
-	Prodorsum and dorsal opisthosoma completely smooth; genua I–IV with 2, 2, 1, 0 setae, respectively	<i>T. latiseta</i> Aranda	

* = likely a junior synonym of *T. caudatus*.

Remarks. *T. proctori* De Leon was described based only on a male. Information on the following species were taken using illustrations and descriptions from the literature: *T. arbuti*, *T. cheladzeae*, *T. cupressoides*, *T. imias*, *T. inophylli*, *T. lalbaghensis*, *T. mahoensis*, *T. micheli*, *T. podocarpi* and *T. raphiae*.

Acknowledgements

We offer special thanks to Nit Malikul and Debra Creel (SEL-USDA) for their technical support; to Chris Pooley (ECMU-USDA) for his help with the LT-SEM images; to Dr. Antonio C. Lofego (UNESP—São José do Rio Preto) and MSc. José M. Rezende for his help in the collecting of specimens for LT-SEM. In addition, we wish to thank to Dr. Laura Leibensperger, Department of Invertebrate Zoology, Museum of Comparative Zoology - (MCZ), Harvard University; Dr. Gilberto J. de Moraes and Dr. Carlos H.W. Flechtmann, The Acarology Collection, USP-ESALQ, for the lending of valuable specimens. We give a special thank you to Drs. Gregory Evans, Jennifer Beard and Owen Seeman for their review of the manuscript and helpful suggestions. We thank the Smithsonian Natural History Museum, National Agricultural Library (NAL-USDA), USDA National Program and APHIS for their support and assistance with references, permits and funding for this study. Mention of trade names or commercial products in this publication is solely for the purpose of providing specific information and does not imply recommendation or endorsement by the USDA; USDA is an equal opportunity provider and employer. This study was supported by the “Coordenação de Aperfeiçoamento de Pessoal de Nível Superior” (CAPES) (Proc. no. BEX

7768/13-3) and “Conselho Nacional de Desenvolvimento Científico e Tecnológico” (CNPq) (Proc. no. 303435/2013-5), with a fellowship and research grant for the first and second authors, respectively.

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