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Tarsocheylidae, a newly recorded family with description of a new species from China

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Abstract

A new species of the genus *Hoplocheylus* Atyeo and Baker (Acariformes: Heterostigmata: Tarsocheylidae), *H. lindquisti* Xu & Zhang sp. nov., is described based on larva, deutonymph, adult male and female specimens collected from the bark of dead *Pinus massoniana* Lamb. infested with *Monochamus alternatus* (Coleoptera: Cerambycidae) in Fuzhou city, China. This is the first report of the genus *Hoplocheylus* and the family Tarsocheylidae in China.

Key words: Acari, Heterostigmata, Tarsocheyloidea, *Hoplocheylus*, morphology

Introduction

Tarsocheylidae (Acariformes: Heterostigmata), the earliest-derivative lineage of Heterostigmata and the only family reported so far for the superfamily Tarsocheyloidea, was erected by Atyeo and Baker (1964) with two genera, *Tarsocheylus* Berlese, 1904 and *Hoplocheylus* Atyeo and Baker, 1964. Tarsocheylids are slender mites found in soil, sand, humus, forest, rodent nest litter, rotting wood, trunk cavities of deciduous trees or under elytra of passalid beetles (Lindquist 1976; Walter *et al.* 2009). So far, 14 species of the genus *Hoplocheylus* have been described (Cooreman 1951; Atyeo & Baker 1964; Lindquist 1976, 1987; Amin *et al.* 2014; Khaustov 2015; Fuangarworn & Butcher 2016; Arjomandi *et al.* 2018; Khaustov & Ermilov 2018): *H. atomarius* (Berlese 1913); *H. aethiopicus* (Cooreman, 1951); *H. jonnstoni* Atyeo and Baker, 1964; *H. longispinus* Atyeo & Baker, 1964; *H. pickardi* Smiley & Moser, 1968; *H. americanus* Delfinado & Baker, 1974; *H. arnoldii* Livshitz & Mitrofanov, 1973; *H. sogdianicus* Barilo & Sharipov, 1987; *H. fereshtae* Amin *et al.*, 2014; *H. magnificus* Khaustov, 2015; *H. nudus* Fuangarworn & Butcher, 2016; *H. longisetosus* Fuangarworn & Butcher, 2016; *H. evansi* Arjomandi & Hajiqaanbar, 2018; *H. zanzibariensis* Khaustov & Ermilov, 2018.

Hoplocheylus is a widespread genus, previously reported from North America, Central Africa, Southern Europe and Asia (Lindquist 1976; Walter *et al.* 2009; Khaustov 2015; Fuangarworn & Butcher 2016; Arjomandi *et al.* 2018; Khaustov & Ermilov 2018). In this paper, we describe a new species *H. lindquisti* Xu & Zhang sp. nov. collected from pine bark in Fuzhou city, China, which represents a new record of the Tarsocheylidae to China.

Material and methods

The dead trees of *Pinus massoniana* Lamb. infested by *Monochamus alternatus* were collected in Minhou county, Fuzhou city, Fujian province, China. The specimens were extracted from the bark using a Berlese funnel and separated under a stereomicroscope. All mites were removed and cleared in lactic acid, and mounted in Hoyer's medium. Specimens were examined at 400x and 1000x magnification by using differential interference contrast of a Leica DM5000B compound microscope.

In the descriptions, nomenclature for idiosomal and leg setae follows that of Lindquist (1986, 1987), and nomenclature for subcapitular, palp and cheliceral setae follows Khaustov (2015) and Khaustov & Ermilov (2018). All measurements are given in micrometers (μm). The measurements of the holotype are presented, followed by the paratype as a range in parentheses. For leg setae the number of solenidia is given in parentheses. Legs were measured from the base of trochanter to the tip of tarsus excluding claws.

Systematics

Family Tarsocheylidae Atyeo and Baker, 1964

Genus *Hoplocheylus* Atyeo and Baker, 1964

Type species: *Tarsocheylus atomarius* Berlese, 1913, by original designation

Hoplocheylus lindquisti Xu & Zhang sp. nov. (Figs 1–7)

Description

FEMALE (Figs 1, 2, 3A). Body weakly sclerotized. Length of idiosoma 425 (375–440), length of body including gnathosoma 475 (420–485), width 100 (75–100).

Gnathosoma (Fig. 3A). In dorsal view, stylophore subtrapezoidal, 50 (45–50) length, 45 (42–47) width, movable digits blade-like. Palps 3-segmented, trochanter inconspicuous, without setae; femurogenu with two setae, femoral seta longer than genual seta; tibiotarsus with large tibial claw; setae *ba* and *l'* basally fused and modified into paired dome-like spines; eupathidia *ul'* and *ul''* represented by duplex of setae. Solenidium ω weakly clavate. Postpalpal setae (*pp*) peg-like. Length of gnathosomal setae: *cha* 15 (14–16), *chb* 5 (4–6), *m* 15 (10–17), *n* 38 (30–45), *or* 5 (4–5). Subcapitular setae *m* less than half of *n*. Hypostome with a pair of short spine-like hypostomal papillae. Pharynx thin-walled, without lateral projections.

Idiosomal dorsum (Fig. 1A). Prodorsum with large, weakly sclerotized, smooth prodorsal shield, with numerous small round dimples in posterior half. Stigmata oval, not prominent, associated with long tracheal trunks. Setae v_2 blunt-ended; v_1 and sc_2 pointed; and bothridia sc_1 with capitate sensilla. Opisthosomal tergite normally developed. Setae c_1 , d , e and h_2 blunt-ended, other dorsal setae pointed. Cupules normal, *ia* inserted on membranous integument on both sides of tergite D, *im* located posteriorly to *e*, *ip* posterior to *f*, *ih* posterior to h_2 . Lengths of dorsal setae: v_1 43 (40–47), v_2 15 (11–17), sc_1 20 (18–21), sc_2 58 (50–58), c_1 18 (16–22), c_2 53 (47–55), d 18 (18–20), e 20 (17–20), f 46 (42–53), h_1 46 (42–53), h_2 18 (15–18). Anal opening terminal, flanked by a pair of plates bearing three pairs of setae, ps_1 42 (42–45), ps_2 32 (32–38), ps_3 8 (6–8). Idiosomal venter (Fig. 1B). Large rectangular midsternal plate situated in the space between coxal fields II and III. Weakly sclerotized apodemes 4 (ap4) and 5 (ap5) present between coxal fields III and IV and near the posterior margin of coxal fields IV, respectively. Setae $4a$ and ag_1 located on narrow longitudinal

smooth plates. Aggenital plate with deep incision on posterior margin, with two pairs of aggenital setae ag_2 and ag_3 . Genital opening elongated with four pairs of genital setae (g_1 , g_2 , g_3 and g_4). Coxal setation 4-3-3-3, all coxal setae blunt-ended except $1c$ and $2b$ pointed. Lengths of ventral setae: $1a$ 11 (8–11), $1b$ 9 (7–9), $1c$ 21 (15–22), $1d$ 7 (6–8), $2a$ 17 (15–17), $2b$ 45 (38–47), $2c$ 17 (15–19), $3a$ 12 (12–15), $3b$ 15 (12–15), $3c$ 12 (12–13), $4a$ 9 (9–11), $4b$ 8 (8–10), $4c$ 8 (6–10), ag_1 13 (10–13), ag_2 14 (12–14), ag_3 15 (12–15), g_1 10 (9–11), g_2 6 (4–6), g_3 6 (4–6), g_4 6 (4–6).

Legs (Fig. 2). Lengths of legs: I 105 (93–120), II 60 (60–70), III 83 (68–85), IV 110 (90–110). Leg I (Fig. 2A). Leg setation: Tr 1 (v'), Fe 5 (d, l', l'', v', bv''), Ge 5 (d, l', l'', v', v''), Ti 6 (2) ($d, l', l'', v', v'', k, \phi_1, \phi_2$), Ta 14 (2) ($p', p'', tc', tc'', ft', ft'', pl', pl'', u', u'', pv', pv'', s, bl', \omega_1, \omega_2$). Tarsus with a pair of simple hooked claws, empodium absent. Lengths of solenidia: ω_1 5 (5–7), ω_2 3 (3–5), ϕ_1 7 (7–8), ϕ_2 4 (3–5). Solenidion ω_1 finger-shaped, approximately reaching tip of tarsus. Solenidion ω_2 clavate, situated near the base of seta pl'' . Seta $ft', ft'', p', p'', tc', tc'', bl'$ and pv'' thick and slightly blunt-ended. Seta p' approximately as long as setae p'' ; setae ft' and ft'' subequal. Tibia I solenidion ϕ_1 clavate distally, ϕ_2 about half of ϕ_1 and clavate. Seta k thickened. Setae v', bv'' and l' of femur, and v' and l' of tibia blunt-ended, other leg setae pointed. Leg II (Fig. 2B). Leg setation: Tr 1 (v'), Fe 3 (d, l', v''), Ge 4 (l', l'', v', v''), Ti 5 (1) ($d, l', l'', v', v'', \phi$), Ta 8 (1) ($tc', tc'', p', u', u'', pv', pv'', pl'', \omega$). Tarsus with a pair of hooked claws. Empodium flipper-like, with weakly undulate distal margin. Lengths of solenidia: ω 4 (4–5), ϕ 3. Solenidion ω finger-shaped. Seta p' imperceptibly bifurcated at tip. Tibia II with solenidion ϕ clavate. Seta d longer than l', v', l'' and v'' . Leg III (Fig. 2C). Leg setation: Tr 2 (l', v'), Fe 2 (d, v'), Ge 4 (l', l'', v', v''), Ti 5 (1) ($d, l', l'', v', v'', \phi$), Ta 8 ($tc', tc'', p', u', u'', pv', pv'', pl''$). Solenidion ϕ 3 weakly clavate. Claws and empodium as on tarsus II. Seta p' of tarsus and l' of trochanter weakly blunt-ended, other leg setae pointed. Leg IV (Fig. 2D). Leg setation: Tr 1 (v'), Fe 2 (d, v'), Ge 5 (d, l', l'', v', v''), Ti 5 (d, l', l'', v', v''), Ta 7 ($tc', tc'', p', u', u'', pv', pv''$). Claws and empodium as on tarsus II. Seta p' of tarsus and d of genu weakly blunt-ended, other setae pointed.

MALE (Figs 3C–E, 4–5). Body weakly sclerotized. Length of idiosoma 320–360, length of body including gnathosoma 360–400, width 80–90. In dorsal view, stylophore subtrapezoidal, 40–45 length, 34–38 width, movable digit blade-like. Length of gnathosomal setae: cha 12, chb 4–5, m 12, n 26–30, or 3–4. Idiosomal dorsum and venter (Fig. 4) as in female except aggenital plate and genital area fused. Lengths of dorsal setae: v_1 30–36, v_2 10–12, sc_1 16–18, sc_2 44–47, c_1 13–18, c_2 42–48, d 15–18, e 15–17, f 37–38, h_1 34–37, h_2 12–15, ps_1 30–33, ps_2 18–26, ps_3 7. Lengths of ventral setae: $1a$ 8–10, $1b$ 6–7, $1c$ 12–13, $1d$ 4–5, $2a$ 12–15, $2b$ 22–30, $2c$ 11–15, $3a$ 10–12, $3b$ 11–13, $3c$ 10–11, $4a$ 8–10, $4b$ 6–8, $4c$ 6–8, ag_1 9–11, ag_2 11, ag_3 11–12, g_1 5–6, g_2 5–6, g_3 5–6, g_4 5–6. Legs (Fig. 5). Lengths of legs: I 92–100, II 52–55, III 62–68, IV 82–85. Leg setation as in female. Lengths of solenidia: I ω_1 6, ω_2 3, ϕ_1 7, ϕ_2 3–4, II ω 3–4, ϕ 3, III ϕ 3.

DEUTONYMPH (Figs 3B, 6). Body weakly sclerotized. Length of idiosoma 320–330, length of body including gnathosoma 360–370, width 78–80. Length of gnathosomal setae: cha 12–13, chb 3–4, m 12–13, n 26–30, or 3–4. Idiosomal dorsum as in female, except sc_1 blunt-ended. Lengths of dorsal setae: v_1 22–36, v_2 6–10, sc_1 9–12, sc_2 35–48, c_1 15–18, c_2 42–45, d 15–17, e 13–16, f 38–43, h_1 37–38, h_2 15, ps_1 29–31, ps_2 27–28, ps_3 5–6. Lengths of ventral setae: $1a$ 7–8, $1b$ 6, $1c$ 12–13, $1d$ 5, $2a$ 13–15, $2b$ 21–24, $2c$ 13, $3a$ 12–13, $3b$ 11–13, $3c$ 10, $4a$ 8–10, $4b$ 5–7, ag_1 10–11, ag_2 10–11, ag_3 8–10, g_1 5, g_2 5. Legs (Fig. 6). Lengths of legs: I 92–93, II 58–62, III 70–72, IV 85–90. Leg setation as in female except trochanter IV without seta v' . Leg setation: I 1-5-5-6+2 ϕ -14+2 ω , II 1-3-4-5+ ϕ -8+ ω , III 2-2-4-5+ ω -8, IV 0-2-5-5-7. Lengths of solenidia: I ω_1 5–6, ω_2 2–3, ϕ_1 7, ϕ_2 3–4, II ω 4, ϕ 3, III ϕ 2–3.

PROTONYMPH unknown.

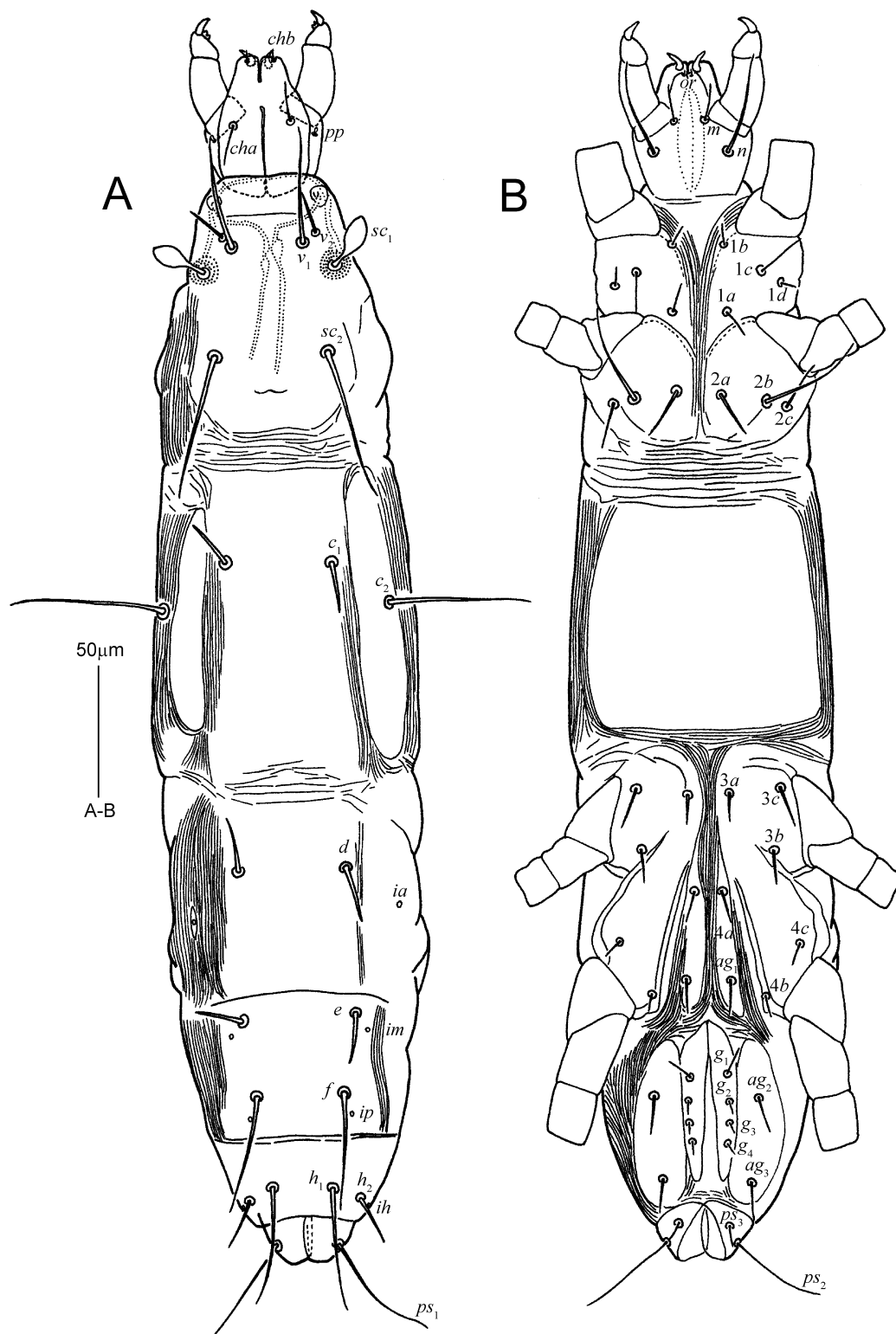


FIGURE 1. *Hoplocheylus lindquisti* Xu & Zhang sp. nov. (adult female). A. dorsal view of body; B. ventral view of body. Legs omitted.

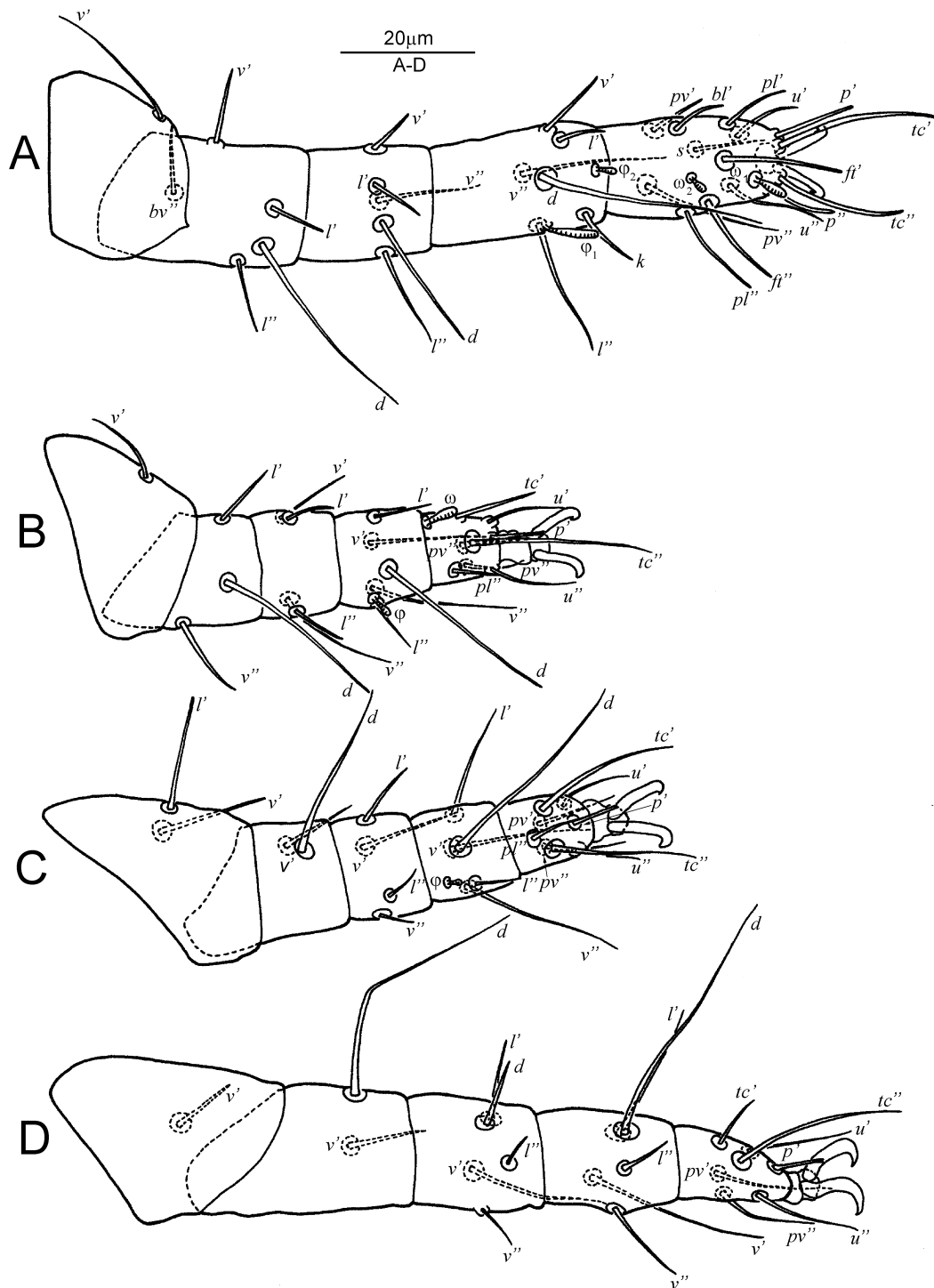


FIGURE 2. *Hoplocheylus lindquisti* Xu & Zhang sp. nov. (adult female, right side legs in dorsal view). A. leg I; B. leg II; C. leg III; D. leg IV.

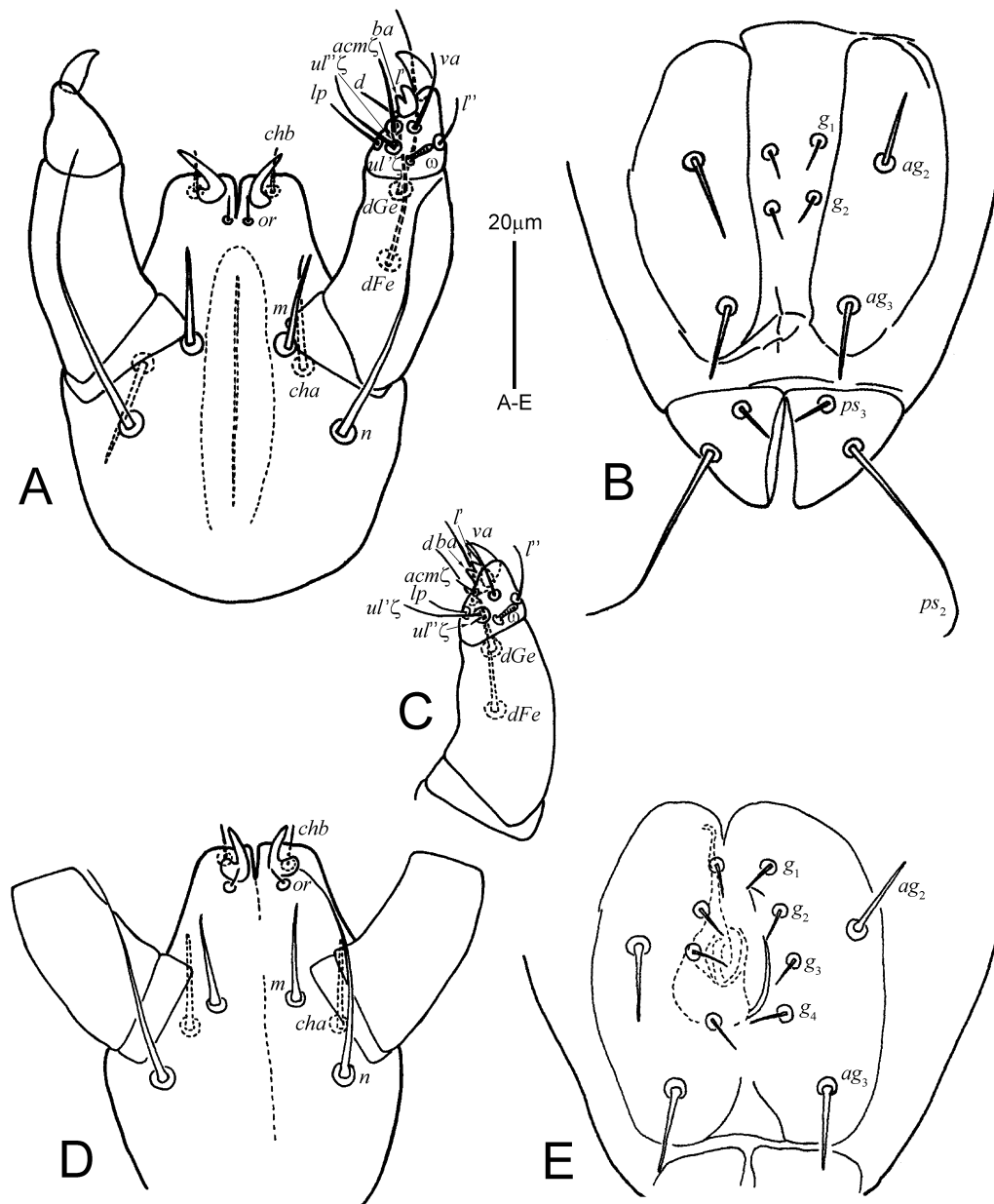


FIGURE 3. *Hoplocheylus lindquisti* Xu & Zhang sp. nov. A. ventral view of gnathosoma (adult female); B. ventral view of posterior hysterosoma (deutonymph); C–E (adult male). C. ventral view of palp; D. ventral view of gnathosoma; E. ventral view of posterior hysterosoma.

LARVA (Fig. 7). Body weakly sclerotized. Length of idiosoma 215, length of body including gnathosoma 250, width 90. Length of gnathosomal setae: *cha* 11, *chb* 3, *m* 10, *n* 27. Idiosomal dorsum as in female. Lengths of dorsal setae: v_1 29, v_2 69, sc_1 8, sc_2 40, c_1 15, c_2 44, d 16, e 15, f 36, h_1 32, h_2 31, ps_1 8, ps_2 14, ps_3 5. Lengths of ventral setae: $1a$ 12, $1b$ 6, $2a$ 13, $2b$ 14, $3a$ 14, $3b$ 10. Legs (Fig. 7). Lengths of legs: I 80, II 52, III 64. Leg setation: I 0-5-5-6+ ϕ -14+ ω , II 0-3-4-5+ ϕ -8+ ω , III 0-2-4-5+ ω -8. Lengths of solenidia: I ω_1 5–6, ω_2 2–3, ϕ_1 7, ϕ_2 3–4, II ω 4, ϕ 3, III ϕ 2–3.

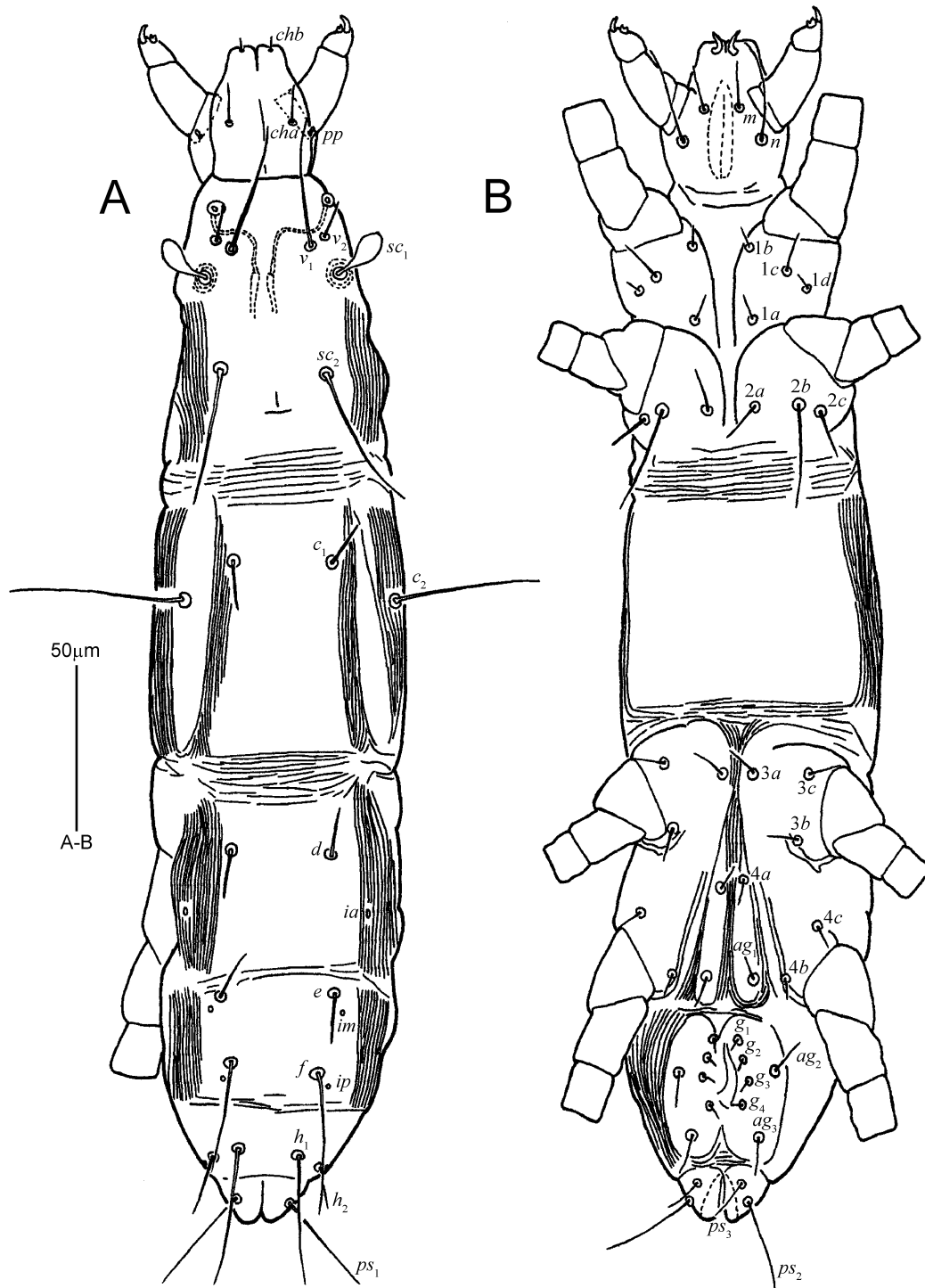


FIGURE 4. *Hoplocheylus lindquisti* Xu & Zhang sp. nov. (adult male). A. dorsal view of body; B. ventral view of body. Legs omitted.

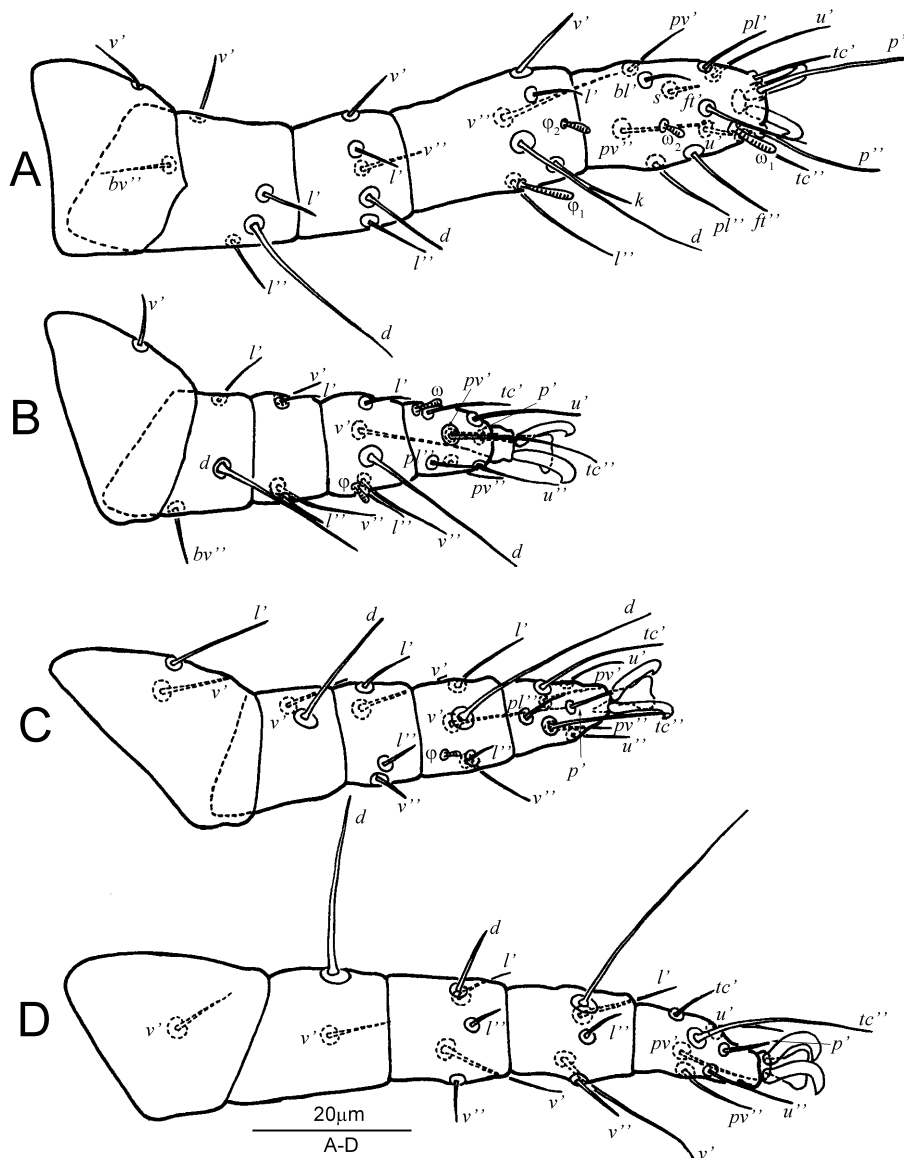


FIGURE 5. *Hoplocheylus lindquisti* Xu & Zhang sp. nov. (adult male, right side legs in dorsal view). A. leg I; B. leg II; C. leg III; D. leg IV.

Type material

Holotype female, Guangming village, Minhou county, Fuzhou city, Fujian province, China, 17 Apr., 2019, by Yu-Zhen Zhu, Jie-Qin Wu and Yun Xu, ex. the barks of *Pinus massoniana* Lamb infested by *Monochamus alternatus* (Coleoptera: Cerambycidae). Paratypes: 15 females, 7 males, 3 deutonymphs and 1 larva, same data as holotype; 6 females, Lianguang village, Minhou county, 13 Mar., 2019, by Yu-Zhen Zhu, Jie-Qin Wu and Yun Xu. The holotype and 9 paratypes (4 females, 3 males, 1 deutonymph and 1 larva) will be deposited in the National Zoological Museum of China, Institute of Zoology, Chinese Academy of Sciences, Beijing (NZMC); 23 paratypes (17 females, 4 males and 2 deutonymphs) are deposited in the Department of Plant Protection, Fujian Agriculture and Forestry University, China (FAFU).

Etymology

The new species is named in honour of the distinguished acarologist Evert E. Lindquist, who made great contributions to the systematic study of mites.

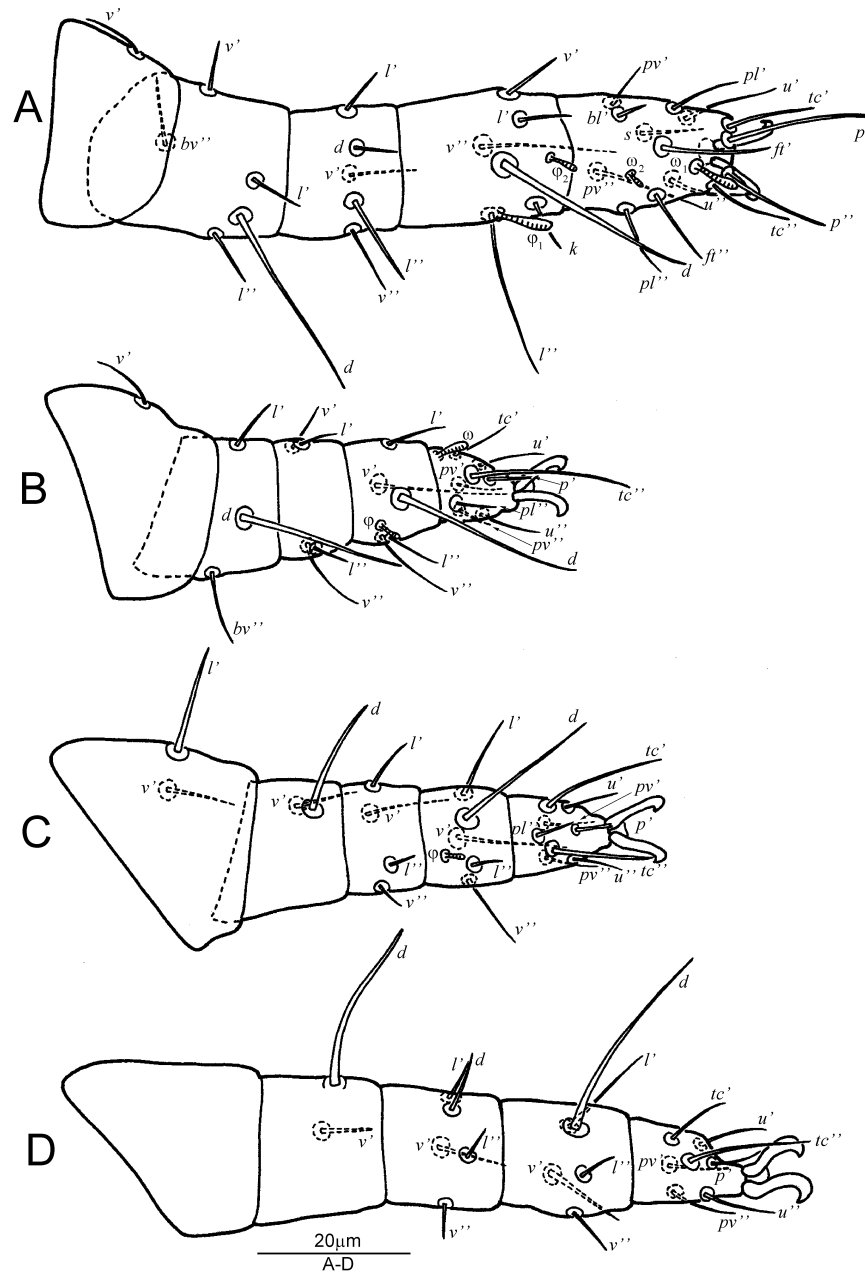


FIGURE 6. *Hoplocheylus lindquisti* Xu & Zhang sp. nov. (deutonymph, right side legs in dorsal view). A. leg I; B. leg II; C. leg III; D. leg IV.

Differential diagnosis

The new species is similar to *Hoplocheylus pickardi* Smiley and Moser 1968 and *H. magnificus* Khaustov, 2015 by the absence of solenidion on tibia IV, setae *4a* and *ag*₁ situated on the plates, solenidion ω_1 distinctly longer than ω_2 , setae *p*' on tarsi II–IV distally bifurcated; but mainly differs

in the following characters: solenidion ω_1 on tarsus I not reaching beyond tip of claws (solenidion ω_1 distinctly reaching beyond tip of claws in *H. magnificus*), tarsi I with 14 setae excluding solenidion (tarsi I with 13 setae in *H. pickardi*); *chb* minute about one-third of *cha* (*chb* and *cha* subequal in length in *H. pickardi* (according to Fig. 1 in Smiley and Moser, 1968) and *H. magnificus*); genital setae g_2 , g_3 and g_4 subequal in length, g_1 about twice as long as g_2 (4 pairs of genital setae subequal in length in *H. pickardi* (according to Fig. 2 in Smiley and Moser, 1968) and *H. magnificus*); anal setae ps_3 about one-fourth of ps_2 (pseudanal setae ps_3 about half of ps_2 in *H. pickardi* (according to Fig. 2 in Smiley and Moser, 1968) and *H. magnificus*).

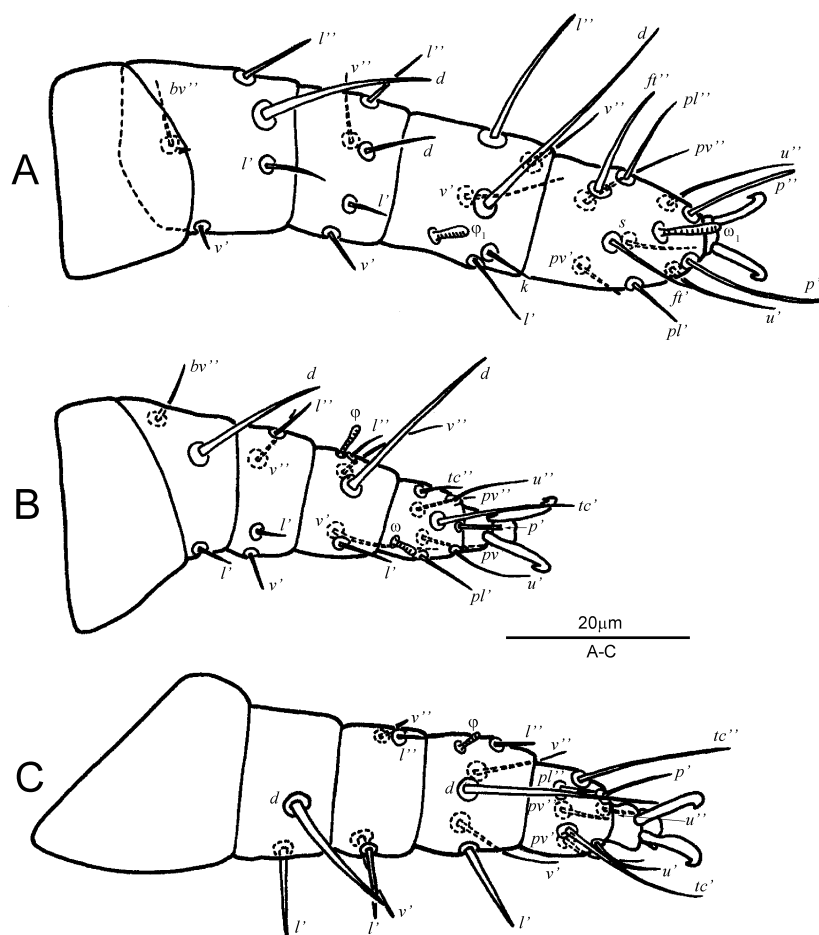


FIGURE 7. *Hoplocheylus lindquisti* Xu & Zhang sp. nov. (larva, left side legs in dorsal view). A. leg I; B. leg II; C. leg III.

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