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Two new species of *Papillacarus* (Acari, Oribatida, Lohmanniiidae) from China

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Abstract

Two new species of Lohmanniiidae, *Papillacarus* (*Papillacarus*) *internus* sp. nov. from soil in Hainan Province, South China and *Papillacarus* (*Vepracarus*) *hexagonus* sp. nov. from rotten tree and soil in Chongqing City, Southwest China are described and illustrated. *Papillacarus* (*P*.*) *internus* sp. nov. is most similar to *Papillacarus* (*P*.*) *lienhardi* (Mahunka, 1997), however, it can be distinguished from the latter by the following characters: 29–30 pairs of additional neotrichal setae, seta $c_1$ shorter than $c_2$, all genital setae setiform and smooth. *Papillacarus* (*V*.*) *hexagonus* sp. nov. is most similar to *Papillacarus* (*V*.*) *gueyeae* (Pérez-Íñigo, 1989), however, it can be distinguished from the latter by the following characters: 38 pairs of additional neotrichal setae, 7 pairs of subcapitula setae, epimeral formula 9-4-3-4.

Key words: Lohmanniiidae, new species, systematics, morphology, China

Introduction

In this paper we describe two new species of Lohmanniiidae: *Papillacarus* (*Papillacarus*) *internus* sp. nov. from soil in Hainan Province, South China and *Papillacarus* (*Vepracarus*) *hexagonus* sp. nov. from rotten tree and soil in Chongqing City, Southwest China.

Material and methods

For the material, see Material examined section of each species. The specimens were mounted in lactic acid on temporary cavity slides for measurement and illustration. The body measurements are presented in micrometers. The body length was measured in lateral view, from the tip of the rostrum to the posterior edge of the ventral plate. Notogastral width refers to the maximum width in dorsal aspect. Lengths of body setae were measured in lateral aspect. Formulae for leg setation are given according to the sequence trochanter-femur-genu-tibia-tarsus (famulus included). Formulae for leg solenidia are given in brackets according to the sequence genu-tibia-tarsus. General terminology used in this paper follows that summarized by Grandjean (1950), Norton (1977) for leg setal nomenclature, and Norton and Behan-Pelletier (2009). Morphological description of both species follows with Ermilov and Deharveng (2016), Ermilov (2017), Ermilov et al. (2017). Drawings were made with a camera lucida using an Olympus transmission light microscope “Olympus CX41”.

Descriptions

*Papillacarus (Papillacarus) internus* sp. nov.

(Figs 1–10)

**Diagnosis**


**Measurements.** Body length 472 (holotype), 467–488 (9 paratypes); body width 236 (holotype), 227–243 (9 paratypes).

**Integument.** Body yellow-brown. Surface of prodorsum, notogaster, subcapitulum, genital, adanal plates and legs densely punctate.

**Prodorsum** (Figs 1–3). Rostrum widely rounded. Rostral seta (ro, 52) setiform. All prodorsal setae setiform, with short cilia, and thin, smooth apex. Lamellar seta (le, 62), interlamellar seta (in, 70) longer than others, posterior exobothridial seta (exp, 65) setiform, smooth. Anterior exobothridial seta (exa, 59) barbed bilaterally. Bothridial seta (bs, 82) pectinate, with 12 to 13 branches on one side, and four bars on the opposite side. Postbothridial transverse band (Sb) between bothridia.

**Notogaster** (Figs 1–3). Five transverse bands (S1–S5) present on notogaster. S1 and S4 complete, while S2, S3 and S5 interrupted medially. Sixteen pairs of primary notogastral setae present, 29–30 pairs of additional neotrichal setae present, all setiform, with short cilia bilaterally or unilaterally and smooth apex. Setae c1, d1, e1 and f1 never reaching the margin of notogaster, seta c1 shorter than distance c1–d1, setae d1, d2 lie on (d1) resp. inside of a duplication (d1) of the transverse band S5. Neotrichal setae of two types: 3 pairs long (m, 45–48; n, 50–53; r, 58–60) and 26–27 pairs short (21–33). Lyrifissures ia, im, ip, ih distinct, ia laterally to seta c1, ip anterior laterally to f1, ih laterally to h1, ip not distinct. Notogastral setal lengths: c1 ≈ h1 = 41 (39–42), c2 = d1 ≈ e1 = f1 = 52 (51–54), c3 ≈ d2 ≈ e2 = 57 (56–58), f2 ≈ h2 = 63 (62–64), d3 = h3 = p1 = p2 = 69 (68–71).
FIGURE 1. Papillacarus (Papillacarus) internus sp. nov., adult: dorsal view. Scale bar 50 µm.

Gnathosoma (Figs 2, 4–6). Subcapitulum longer than wide (116–122×92–97). Setae h, m₁ and m₂ (11–20) thickened in medio-basal part, barbed bilaterally, represented by four pairs: a (26), h (17), m₁ (11), m₂ (18). Adoral setae smooth: or₁ (23) more or less triangular, wide in proximal part, blunt-ended; or₂ (30) long, setiform, blunt-ended; or₃ (25) long, setiform, pointed-ended. Palp (49) with setal formula 0-1-0-1-10(+1ω). Chelicera (139) with two setae, seta cha (17) short, thorn-like, seta chb (27) long, setiform and barbed. Trägårdh’s organs (Tg) triangular, tip slightly pointed.

Epimeral region (Fig. 2). Epimeral plates distinct, partly distinct ridges, epimeral setae setiform, setae 1a, 2a, 3a, 4a, 4b and one pair of lateral setae of epimere I smooth (6–9); other setae barbed bilaterally. Epimeral formula 7-4-3-4.

Anogenital region (Figs 2–3). Ten pairs of genital setae, setiform and smooth, four setae in outer row and six setae in inner row, setae g₂, g₅, g₆, g₈ longer (17–22), others setae shorter (8–10). Two pairs of anal setae, setiform, barbed unilaterally. Four pairs of adanal setae (ad, 56–72), setiform, barbed unilaterally. Lyrifissure iad distinct.

Legs (Figs 7–10). All legs with one simple claw each of which with small basoventral tooth. Famulus ε conical and short, posterior to solenidion ω₁. Solenidion ω₁ on tarsus I, ω₁ and ω₂ on tarsus II, φ on tibia III thickened and blunt distally. Other solenidia setiform, with thinner tips. Formulae
of leg setation and solenidia: I 0-5-3(2)-4(1)-18(2), II 0-6-3(1)-4(1)-13(2), III 2-4-2(1)-3(1)-12(0), IV 2-3-2(1)-3(0)-12(0) (see Table 1).

FIGURE 2. Papillacarus (Papillacarus) internus sp. nov., adult: ventral view. Scale bar 50 µm.

TABLE 1. Leg setation and solenidia of adult Papillacarus (Papillacarus) internus sp. nov.

<table>
<thead>
<tr>
<th>Leg</th>
<th>Trochanter</th>
<th>Femur</th>
<th>Genu</th>
<th>Tibia</th>
<th>Tarsus</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>–</td>
<td>d, (l), bv, v</td>
<td>(l), d' x2, xt1, I, v', φ</td>
<td>(l), (c), (p), (a), s, m, n, (pv), x, o, o'</td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>–</td>
<td>d, (l), l', bv, v</td>
<td>(l), d' x2, xt1, I, v', φ</td>
<td>(l), (c), (p), (a), s, (pv), o, o'</td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>l', v'</td>
<td>d, l', l' ev</td>
<td>d, l', v, φ</td>
<td>(l), (c), (p), (a), s, (pv)</td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td>l', v'</td>
<td>d, l', ev</td>
<td>d, l', v, φ</td>
<td>(l), (c), (p), (a), a', s, (pv)</td>
<td></td>
</tr>
</tbody>
</table>

Note: Roman letters for normal setae, Greek letter for solenidia, except ϵ for famulus, d – seta and solenidion coupled. Single prime (') marks setae on anterior and double prime (") setae on posterior side of the given leg segment. Parentheses refer to a pair of setae.
Material examined
Holotype, Chengmai County (19°63′N, 110°3′E), Haikou City, Hainan Province, 9 Jan. 2016, Guoru Ren, in soil. Nine paratypes, same data as holotype. The holotype and nine paratypes are deposited in the Institute of Entomology, Guizhou University, Guiyang of China (GUGC).

Etymology
The new specific name “internus” is derived from the Latin “internus”, and refers to the notogastral setae $d_1$ and $d_2$ which are situated on and inside of the duplication of the transverse band S4.
Remarks

The new species Papillacarus (P.) internus sp. nov. is most similar to Papillacarus (P.) lienhardi (Mahunka, 1997) from Brunei in having setiform prodorsal and notogastral setae.
However, the new species differs from the latter by the following characters: (1) 29–30 pairs of additional neotrichal setae (versus approximately 25 pairs *P. lienhardi*); (2) seta \( c_1 \) shorter than \( c_2 \) (versus seta \( c_1 \) longer than \( c_2 \)); (3) five transverse bands, \( S_4 \) complete (versus four transverse bands, \( S_4 \) interrupted medially); (4) all genital setae setiform and smooth (versus all genital setae ciliate).

The new species *Papillacarus* (*P.*) *internus* sp. nov. is also similar to *Papillacarus* (*P.*) *gramenicus* (Bayartogtokh, 2010) from Mongolia in having setiform prodorsal and notogastral setae. However, the new species differs from the latter by the following characters: (1) 29–30 pairs of additional neotrichal setae (versus 13 pairs); (2) epimeral formula 7-4-3-4 (versus 8-4-4-4); (3) four pairs of subcapitular setae (versus five pairs).

**FIGURES 9–10.** *Papillacarus* (*Papillacarus*) *internus* sp. nov., adult: legs, femur to tarsus, antiaxial view. 9. leg III, left; 10. leg IV, left. Scale bar 50 µm.
Papillacarus (Vepracarus) hexagonus sp. nov.
(Figs 11–20)

Diagnosis


FIGURE 11. Papillacarus (Vepracarus) hexagonus sp. nov., adult: dorsal view. Scale bar 50 µm.

Measurements. Body length 462 (holotype), 455–472 (15 paratypes); body width 213 (holotype), 210–228 (15 paratypes).

**FIGURE 12.** *Papillacarus* (Vepracarus) *hexagonus* sp. nov., adult: ventral view. Scale bar 50 µm.


**Notogaster** (Figs 11–13). Four transverse bands (*S2–S5*) present on notogaster, all interrupted medially. Sixteen pairs of primary notogastral setae and 38 pairs of additional neotrichal setae present, all with 5–7 branches, tree-shaped. Setae *c1*, *c2*, *d1*, *e1*, *h1* and *f1* never reaching margin of notogaster, setae *d2*, *e2*, looking like hexagram in dorsal view. Lyrifissures *ia*, *im*, *ip*, *ih* distinct, *ia* laterally to seta *c1*, *ip* laterally to *f2*, *ih* anterior laterally to *h1*, *ips* not distinct. Lengths of notogastral setae: *c1*, *c2*, *d1*, *d2*, *e1*, *f1*, *h1*, *p1*, *p2* (13–25); *c3*, *d3*, *e2*, *f2*, *h2*, *h3*, *p3* (31–48).

**Gnathosoma** (Figs 12, 14–16). Subcapitulum longer than wide (98–105×80–84). Surface of subcapitulum papilliform. Seven pairs of subcapitula setae, *a* (22–24) setiform, smooth, pointed-ended; *m1* and *m2* (18–23) setiform, barbed unilaterally; *h1*, *h2*, *m3*, *m4* (12–17) setiform, barbed
bilaterally. Three pairs of smooth adoral setae: or₁ (14) wide in proximal part, tapering up, blunt-ended; or₂ (22) long, setiform, blunt-ended; or₃ (17) long, setiform, pointed-ended. Palp (38) with setal formula 0-1-0-3-10(+1ω). Chelicera (134) with two setae, seta cha (4) short, thorn-like, seta chb (36) long, setiform and smooth. Trägårdh’s organs (Tg) triangular, rounded distally.


Epimeral region (Fig. 12). Epimeral plates distinct, partly distinct ridges, epimeral I and II neotrichous, setae setiform or tree-shaped, epimeral formula 9-4-3-4, setae 1a, 2a, 3a, 4a, and one pair of lateral setae of epimere I setiform and smooth (6–10); other setae tree-shaped (11–26).
Anogenital region (Figs 12–13). Ten pairs of genital setae, setiform or tree-shaped, four setae in outer row and six setae in inner row, $g_7, g_8, g_9$ setiform and smooth (17–19), other setae tree-shaped (11–14). Two pairs of anal setae bearing several long branches unilaterally (an, 31–34). Four pairs of adanal setae with several long branches (ad, 33–42). Lyrifissure iad distinct.

Legs (Figs 17–20). Surface of leg femur papilliform. All legs with one simple claw each of which with small basoventral tooth. Famulus ε conical short, posterior to solenidion ω₁. Solenidion ω₁ on tarsus I, ω₁ and ω₂ on tarsus II, ϕ on tibia III thickened and blunt distally. Other solenidia setiform, with thinner tips. Formulae of leg setation and solenidia: I 0-5-3(2)-4(1)-17(2), II 0-6-3(1)-4(1)-11(2), III 2-4-2(1)-3(1)-11(0), IV 2-3-2(1)-3(0)-12(0) (see Table 2).
TABLE 2. Leg setation and solenidia of adult Papillacarus (Vepracarus) hexagonus sp. nov.

<table>
<thead>
<tr>
<th>Leg</th>
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<th>Femur</th>
<th>Genu</th>
<th>Tibia</th>
<th>Tarsus</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td></td>
<td>d, l, b, v‴</td>
<td>(l), α, σ, i, v‴</td>
<td>xt2, xt1, l, v‴, φ</td>
<td>(φ), (tc), (p), (u), (a), (s, m, n, pv), r, m, α, ω</td>
</tr>
<tr>
<td>II</td>
<td></td>
<td>d, l, b, v‴</td>
<td>(l), α, σ, i, v‴</td>
<td>xt2, xt1, l, v‴, φ</td>
<td>(φ), (tc), (p), (u), (a), (s, pv), α, ω</td>
</tr>
<tr>
<td>III</td>
<td>l‴, v‴</td>
<td>d, l, l‴, l‴, v‴</td>
<td>(l), α, σ, i, v‴</td>
<td>d, l‴, v‴, φ</td>
<td>(φ), (tc), (p), (u), a‴, s, pv‴</td>
</tr>
<tr>
<td>IV</td>
<td>l‴, v‴</td>
<td>d, l‴, l‴, v‴</td>
<td>(l), α, σ, i, v‴</td>
<td>d, l‴, v‴</td>
<td>(φ), (tc), (p), (u), a‴, s, (pv)</td>
</tr>
</tbody>
</table>

Note: Roman letters for normal setae, Greek letter for solenidia, except r for famulus. α, σ - seta and solenidion coupled. Single prime (′) marks setae on anterior and double prime (″) setae on posterior side of the given leg segment. Parentheses refer to a pair of setae.

Material examined

Holotype, Simian Mountain (28°34'N, 106°20'E), Chongqing City, 23 Sept. 2017, Guoru Ren, in rotten tree and soil. Fifteen paratypes, same data as holotype. The holotype and fifteen paratypes are deposited in the Institute of Entomology, Guizhou University, Guiyang of China (GUGC).

Etymology

The new specific name “hexagonus” is derived from the Latin “hexagonus”, and refers to the notogastral setae d‴ and e‴, which look like a hexagram in dorsal view.

Remarks

The new species Papillacarus (V.) hexagonus sp. nov. is most similar to Papillacarus (V.) gueyeae (Pérez-Íñigo, 1989) described from Senegal, in having tree-shaped prodorsum and notogastral setae. However, the new species differs from the latter by the following characters: (1) 38 pairs of additional neotrichal setae (versus 46–50 pairs in Papillacarus (V.) gueyeae); (2) bothridial seta with 9 to 10 branches (versus 13 to 15 branches); (3) epimeral formula 9-4-3-4 (versus 8-5-3-3); (4) seven pairs of subcapitular setae (versus six pairs); (5) genital setae g‴-g‴, tree-shaped; g‴ setiform and smooth (versus g‴-g‴, setiform, smooth; g‴ tree-shaped).

The new species Papillacarus (V.) hexagonus sp. nov. is also similar to Papillacarus (V.) cornutus (Sarkar & Subías, 1984) described from India in having tree-shaped prodorsal and notogastral setae. However, the new species differs from the latter by the following characters: (1) body size 455–472×210–228 (versus 342–349×134–141 in Papillacarus (V.) cornutus); (2) body surface covered with polygonal network sculpture (versus without); (3) 38 pairs of additional neotrichal setae (versus 18 pairs); (4) genital setae g‴-g‴, tree-shaped; g‴ setiform and smooth (versus all genital setae bilaterally barbed).

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