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REDESCRIPTION OF *PAPILLACARUS HIRSUTUS* WITH REMARKS ON TAXONOMIC STATUS OF *PAPILLACARUS ARBORISETA* (ACARI: ORIBATIDA: LOHMANNIIDAE)

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ABSTRACT — The adult instar of an oribatid mite, *Papillacarus hirsutus* (Aoki, 1961) is redescribed, including the first detailed descriptions of the gnathosoma and legs. Some morphological characters of *P. hirsutus* from different regions (Japan, Vietnam, China, Tahiti, Philippines) are analyzed, and *P. arboriseta* Jeleva and Vu, 1987 is recognized as a junior synonym of the former species.

KEYWORDS — oribatid mites; Lohmanniidae; *Papillacarus hirsutus*; *Papillacarus arboriseta*; redescription; morphology; taxonomic status

INTRODUCTION

The oribatid mite family Lohmanniidae comprises 21 genera and 192 species that are collectively distributed in the pantropical and subtropical regions of the world (Subías 2004, online version 2010). *Papillacarus* is a lohmanniid genus that was proposed by Kunst (1959) with *Lohmannia murcioides aciculata* Berlese, 1904 as type species. It is one of the largest genera in the family, comprising more than 25 species, the majority of which have restricted geographical distribution.

Papillacarus hirsutus (Aoki, 1961) was described as *Cryptacarus hirsutus* from Japan. Subsequent collections showed it to be distributed more widely in tropical regions and the oriental part of Palearctics (Subías 2004, online version 2010). The original

description (Aoki 1961) of this species was incomplete (lacking, for example, important information about the gnathosoma and legs), even after some subsequent redescription (Hammer 1972; Corpuz-Raros 1979; Wen *et al.* 1984). Our main objective is to provide a more complete redescription of this species. We also discuss the taxonomic status of *P. arboriseta*, which was briefly described by Jeleva and Vu (1987), based on specimens from northern Vietnam. These authors compared *P. arboriseta* only with *P. ramosus* Balogh, 1961, but they did not notice the great similarity of their species with *P. hirsutus*. As the differences between these two species were unclear, Balogh and Balogh (2002) considered *P. arboriseta* as a *species inquirenda*. Below, we compare topotypes of these two species and conclude that they are conspecific.

MATERIALS AND METHODS

Four adults (topotype materials) of *P. hirsutus* were obtained from Japan, 33°28' N, 139°35' E, Yokohama city, Kanagawa prefecture, 42 m above sea level, collected in dark loamy soil and litter in a *Castanopsis* forest (*Castanopsis sieboldii*): 08 August, by S. Shimo. Specimens are mounted whole on two slides, with Hoyer's medium.

Also, 20 adults of *P. hirsutus* were obtained from southern Vietnam, 11°25' N, 107°25' E, Cat Tien National Park, 149 m above sea level, from dark loamy soil of a *Lagerstroemia* forest, February-March 2009, collected by A.E. Anichkin. Specimens are stored in 70% alcohol in tubes.

Four adults (topotype materials) of *P. arboriseta* were obtained from two places in Central Vietnam: 1) 17°22' N, 105°45' E, Phong Nha-Ke Bang National Park, a World Heritage site, 800 – 900 m above sea level, soil, 14 March 2010, collected by H.T. Nguyen; 2) 17°50' N, 106°24' E, Phong Nha-Ke Bang National Park, a World Heritage site, 500 – 600 m above sea level, soil, 14 March 2010, collected by H.T. Nguyen. Specimens are stored in 70% alcohol in tubes.

Vietnamese specimens were mounted in lactic acid on temporary cavity slides for measurement and illustration. All body measurements are presented in micrometers. Body length was measured in lateral view, from the tip of the rostrum to the posterior edge of the ventral plate, to avoid discrepancies caused by different degrees of notogastral distortion. Notogastral width refers to the maximum width in dorsal aspect. Lengths of body setae were measured in lateral aspect. Some specimens were dissected for detailed study.

Formulae for leg setation are given in parentheses according to the sequence trochanter-femur-genu-tibia-tarsus (famulus included). Formulae for leg solenidia are given in square brackets according to the sequence genu-tibia-tarsus.

Terminology used in this paper follows that of Grandjean (1950).

FAMILY LOHMANNIIDAE

Redescription of *Papillacarus hirsutus*

(Figures 1–4)

Diagnosis

Body size 336 – 360 by 143 – 155; surface of body and legs with dense papillae; rostrum slightly rounded or truncate in dorsal view; rostral (*ro*), lamellar (*le*), interlamellar (*in*) and both pairs of exobothridial (*exa*, *exp*) setae branched; sensilli pectinate, with 13 or 14 branches in one side; two pairs of transverse bands well developed (S_3 and S_4), both interrupted medially; notogastral setae multiply branched; two pairs of anal (an_1 , an_2) and four pairs of adanal (ad_1 – ad_4) setae setiform, with long cilia; genital plates with branched or heterogeneous (branched and setiform) setae; epimeral setal formula: 8(9)-4-3-4; four or five pairs of hypostomal setae; palps with setation 0-1-0-1-9(+1 ω); leg claws with strong thorn ventrally.

Measurements — Ten specimens from southern Vietnam: body length 336 – 348 (mean 344), body width 143 – 151 (mean 146). Three specimens from central Vietnam: body length 356 – 360 (mean 359), body width 147 – 155 (mean 151).

Integument — Body yellowish to light brown. Surface of body and legs with dense papillae; dorsal papillae rounded (diameter up to 2 μ m), lateral papillae conical (length up to 6 μ m) (Figures 8, 10).

Prodorsum — (Figure 1A, C–E). Roughly triangular in dorsal view, occupying about 1/3 of total body length. Rostrum slightly rounded or truncate in dorsal view, colorless (Figure 1C). Rostral (24 – 28), lamellar (20 – 24), interlamellar (20 – 24), anterior (20 – 24) and posterior (20 – 28) exobothridial setae similar in morphology, branched (central core of setae setiform, with long branches) (Figure 1C–D). Sensilli (49 – 57) pectinate, with 13 or 14 branches on one side and two or four short cilia on other side (Figure 1E).

Notogaster — (Figure 1A; Figure 2A–C). Dorsosejugal suture straight. Two pairs of transverse bands well-developed (S_3 and S_4), both interrupted medially. Band S_2 always absent, but indistinct line rarely present. Only eight pairs of notogastral setae (c_1 , c_2 , c_3 , d_1 , d_2 , d_3 , e_1 , e_2) well visible, other notogastral setae are difficult for differentiating between numerous neutrichial setae.

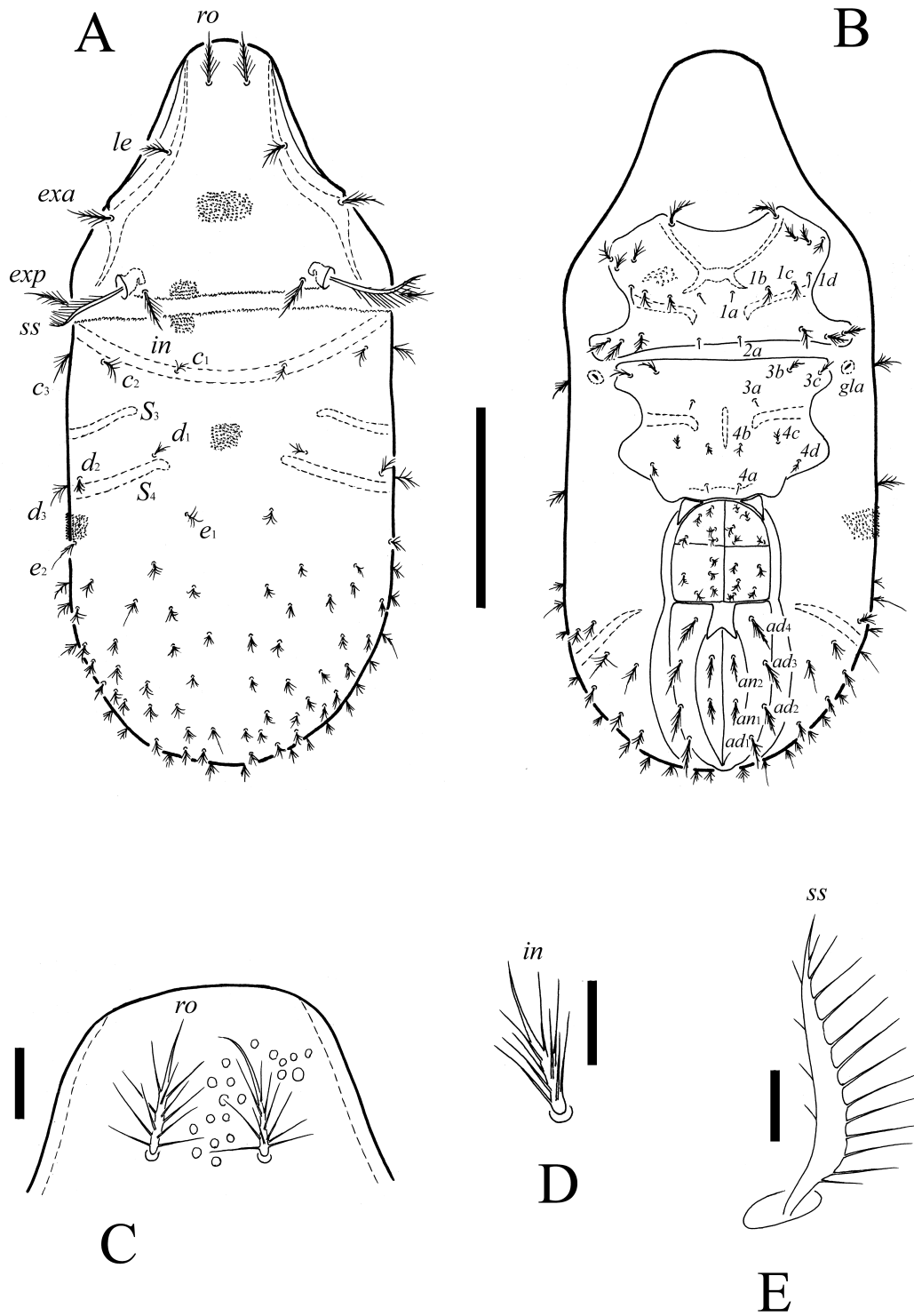


FIGURE 1: *Papillacarus hirsutus*, adult. A – dorsal view; B – ventral view, gnathosoma and legs removed; C – rostrum and rostral setae; D – interlamellar seta; E – sensillus. Scale bar (A + B) 100 μ m, scale bar (C, D, E) 10 μ m.

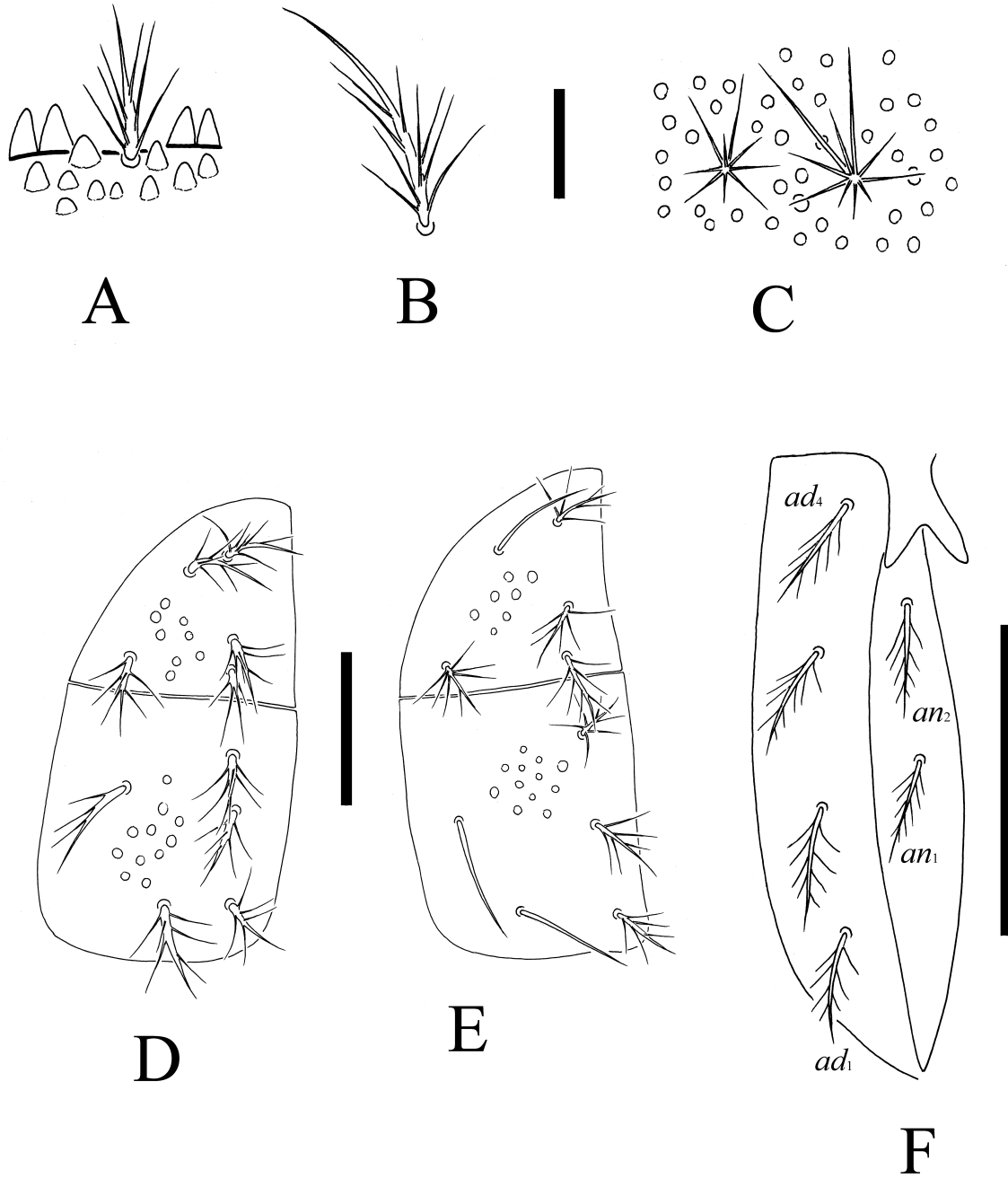


FIGURE 2: *Papillacarus hirsutus*, adult. A – neotrichial seta with short thinner tip and papillae of notogaster, lateral view; B – neotrichial seta with long thinner tip; C – neotrichial setae and papillae of notogaster, dorsal view; D – genital plate with branched setae, right; E – genital plate with heterogeneous (branched and setiform) setae, right; F – ano-adanal plates, right. Scale bar (A + B + C) 10 μm , scale bar (D + E) 20 μm , scale bar (F) 50 μm .

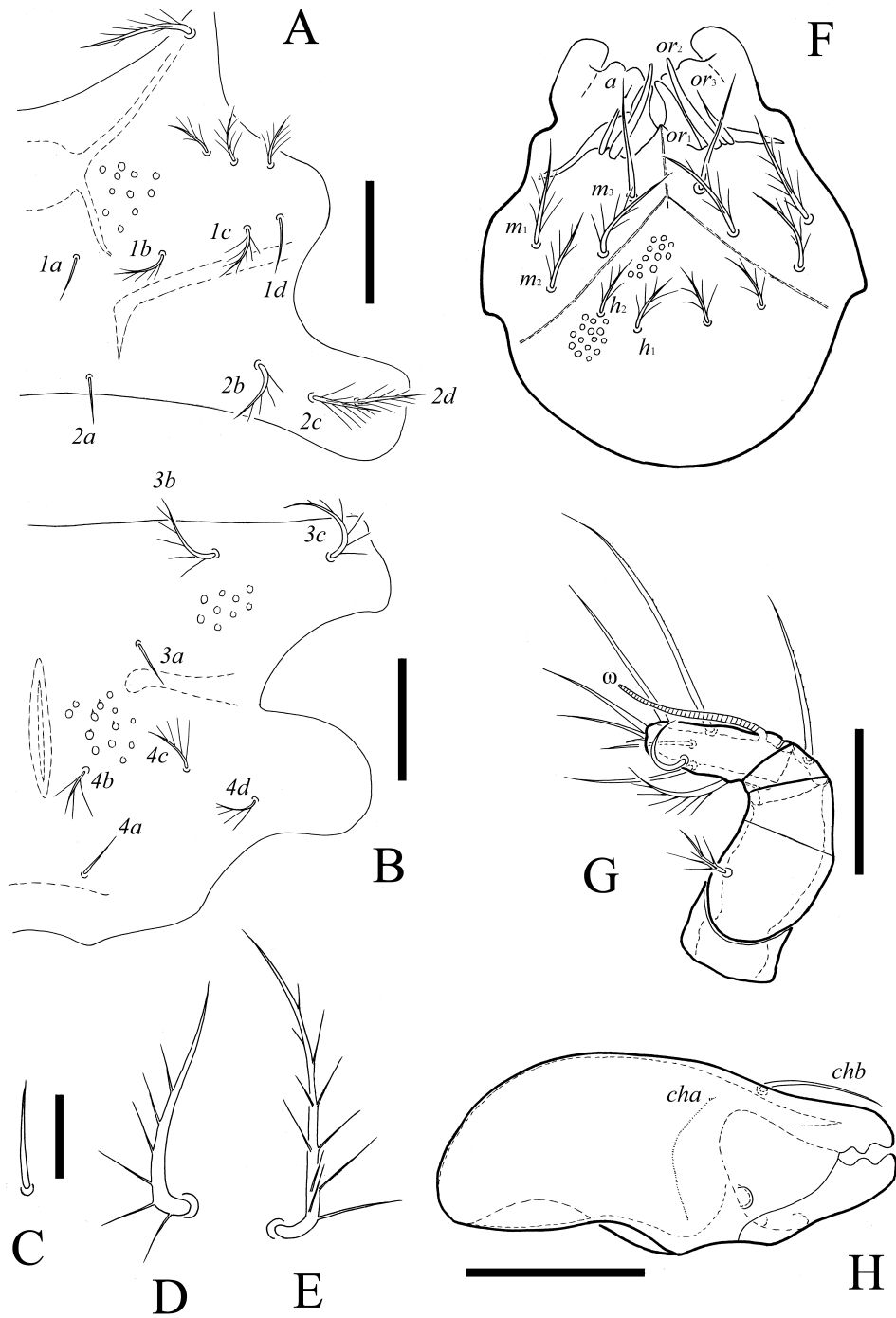


FIGURE 3: *Papillacarus hirsutus*, adult. A – epimera 1 and 2, left; B – epimera 3 and 4, left; C – epimeral seta 3a; D – epimeral seta 3b; E – seta of epimera 1, near subcapitulum; F – subcapitulum; G – palp; H – chelicera. Scale bar (A, B, J) 20 μ m, scale bar (C + D + E) 10 μ m, scale bar (F, H) 50 μ m.

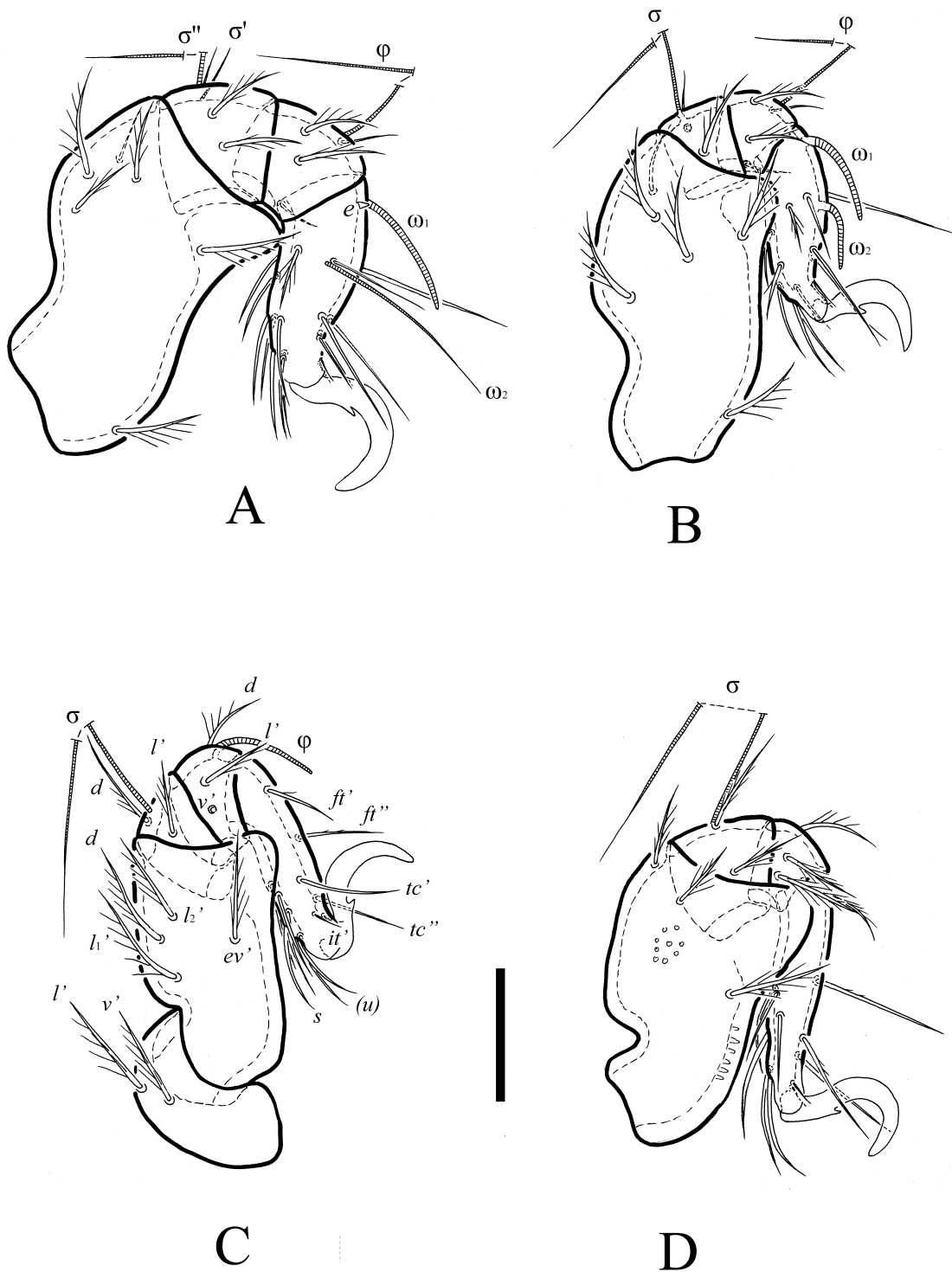


FIGURE 4: *Papillacarus hirsutus*, adult. A – leg I, without trochanter, right, antiaxial view; B – leg II, without trochanter, right, antiaxial view; C – leg III, left, antiaxial view; D – leg IV, without trochanter, left, antiaxial view. Scale bar (A + B + C + D) 20 μ m.

All setae similar in morphology, multiply branched, with short or sometimes very longer thinner tips (in lateral view) and stellate (in dorsal view) (Figure 2A–C). Lateral, caudal and ventrolateral setae (24 – 32) longer than dorsal setae (12 – 20).

Anogenital region — (Figure 1B; Figure 2D–F). One pair of ventrolateral bands present. Two pairs of anal (20 – 24) and four pairs of adanal (24 – 28) setae setiform, with long cilia (Figure 2F). Genital setae (16 – 20) branched, but four specimens (two from central Vietnam and two from southern Vietnam) with heterogeneous genital setae (seven pairs branched, three pairs setiform, longer, 20 – 24) (Figures 9–11).

Epimeral region — (Figure 1B; Figure 3A–E). Typical for genus. Epimeres I and II neutrichous, setal formula: 8(seldom 9)-4-3-4. Medial setae *1a*, *2a*, *3a*, *4a* and often setae *1d* setiform, smooth, other setae branched or setiform, ciliate.

Gnathosoma — (Figure 3F–H). Subcapitulum longer than wide, 98 – 106 x 82 – 86. Hypostomal setae *a* 24 – 26, setiform, thickened, smooth; setae *m*₁, *m*₂ and *m*₃ slightly shorter, 20 – 24, setiform, with cilia; setae *h*₁ and *h*₂ (sometimes *h*₂ absent) shorter than *m*, 16 – 20, setiform, thickened, with cilia. Three pairs of adoral setae present: *or*₂ longest, 32 – 36, setiform, thickened, smooth, blunt-ended; *or*₃ shorter, 22 – 26, setiform, thickened in proximal part and thin tip, smooth; *or*₁ shortest, 16 – 20, wide, lobe-form. Palps 45 – 49, with setation 0-1-0-1-9(+1 ω). Distal three setae fused basally. Solenidion long, thick. Chelicerae 123 – 135, chelate-dentate. Cheliceral setae *chb* long, 32 – 36, setiform, smooth; setae *cha* minute, thorn-like, thin.

Legs — (Figure 4A–D). All claws with strong thorn ventrally. Formulae of leg setation and solenidia: leg I (0-6-3-4-18) [2-1-2], leg II (0-6-3-4-13) [1-1-2], leg III (2-4-2-3-12) [1-1-0], leg IV (2-3-2-3-12) [1-0-0]; homology of setae and solenidia indicated in Table 1. Most setae with long cilia. Setae *it* on tarsi II–IV short, thin. Famulus conical, small, thickened. Solenidia ω ₁ on tarsi I, ω ₁ and ω ₂ on tarsi II, σ on tibiae III rod-like, thickened, blunt-ended. Other solenidia long, setiform, with thinner tips.

Morphological variability of *Papillacarus hirsutus*

Some morphological characters of *P. hirsutus* are variable (body size; shape of rostrum, sensilli and genital setae; epimeral setation) in specimens from different regions (Japan, Vietnam, China, Tahiti, Philippines) (our data; Aoki 1961; Hammer 1972; Corpuz-Raros 1979; Wen *et al.* 1984; Jeleva and Vu 1987). A compilation of these differences is presented in Table 2.

Taxonomic status of *P. arboriseta*

According to the literature, *P. arboriseta* differs from *P. hirsutus* in only two characters (compare Jeleva and Vu 1987 with Aoki 1961; Hammer 1972; Corpuz-Raros 1979; Wen *et al.* 1984): 1) sensilli with 7-8 cilia (13-14 in *P. hirsutus*), 2) neutrichial setae absent (present in *P. hirsutus*). However these differences are probably illusory, because:

1. apparent differences in numbers of cilia on sensilli (7 – 8 to 13 – 14) can be considered as morphological variability. All compared four topotype materials of *P. arboriseta* from central Vietnam carrying sensilli with 13-14 cilia.
2. absence of neutrichial setae is obviously a misinterpretation. Some such setae are well visible in Figures 1a, 1b of Jeleva and Vu (1987, p. 11). Unfortunately, the figures of *P. arboriseta* provided by above authors are small-sized, so it is difficult to determine the exact number of neutrichial setae. All compared four topotype materials of *P. arboriseta* from central Vietnam show strongly developed neutrichial setae.

We compared topotypes of *P. hirsutus* from Japan, topotypes of *P. arboriseta* from central Vietnam and additional specimens from southern Vietnam. All were nearly identical morphologically. Thus, there are no clear distinctions between *P. arboriseta* and *P. hirsutus*, therefore we consider them as conspecific. In accordance with the principle of priority, *P. arboriseta* is deemed a junior subjective synonym of *P. hirsutus*.

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TABLE 1: Leg setation and solenidia of adult *Papillacarus hirsutus*

Leg	Trochanter	Femur	Genu	Tibia	Tarsus
I	-	<i>d</i> , (<i>l</i> ₁), <i>l</i> ₂ '', <i>bv</i> '', <i>v</i> ''	<i>d</i> , <i>l</i> ', <i>v</i> ', σ' , σ''	(<i>l</i> ₁), <i>l</i> ₂ ', <i>v</i> ', ϕ	(<i>ft</i>), (<i>tc</i>), (<i>it</i>), (<i>p</i>), (<i>u</i>), (<i>a</i>), <i>s</i> , (<i>pv</i>), <i>n</i> , <i>m</i> , <i>e</i> , ω_1 , ω_2
II	-	<i>d</i> , (<i>l</i> ₁), <i>l</i> ₂ '', <i>bv</i> '', <i>v</i> ''	<i>d</i> , (<i>l</i>), σ	(<i>l</i> ₁), <i>l</i> ₂ ', <i>v</i> ', ϕ	(<i>ft</i>), (<i>tc</i>), (<i>it</i>), (<i>u</i>), (<i>a</i>), <i>s</i> , (<i>pv</i>), ω_1 , ω_2
III	<i>l</i> ', <i>v</i> '	<i>d</i> , <i>l</i> ₁ ', <i>l</i> ₂ ', <i>ev</i> '	<i>d</i> , <i>l</i> ', σ	<i>d</i> , <i>l</i> ', <i>v</i> ', ϕ	(<i>ft</i>), (<i>tc</i>), (<i>it</i>), (<i>u</i>), (<i>a</i>), <i>s</i> , <i>pv</i> '
IV	<i>l</i> ', <i>v</i> '	<i>d</i> , <i>l</i> ', <i>ev</i> '	<i>d</i> , <i>l</i> ', σ	<i>d</i> , <i>l</i> ', <i>v</i> '	(<i>ft</i>), (<i>tc</i>), (<i>it</i>), (<i>u</i>), (<i>a</i>), <i>s</i> , <i>pv</i> '

Roman letters refer to normal setae (*e* to famulus), Greek letters to solenidia. 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.

TABLE 2: Variability of some morphological characters in adult *Papillacarus hirsutus*

Character	Our data	Literature data from:				
		Aoki (1961)	Hammer (1972)	Corpuz-Raros (1979)	Wen <i>et al.</i> (1984)	Jeleva and Vu (1987)*
Body length	336–360	381–423	370	363–394	365–390	378–385
Body width	143–155	141–169	Data absent	173–185	145–160	158–164
Rostrum	Slightly rounded or truncate	Slightly rounded or truncate	With concavity in the middle	Slightly rounded or truncate	Truncate	Slightly rounded or truncate
Number of sensillar cilia	13–14	13–14	13	13	Data absent	7–8
Genital setae	Branched or branched + setiform	Branched	Setiform	Data absent	Branched	Setiform
Epimeral formula	8(9)–4–3–4	7–4–3–4	8–4–3–4	Data absent	6–4–3–4	Data absent

*In paper this species referred to as *Papillacarus arboriseta*.


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