

Three new species of the genus *Aporcelaimoides* Heyns, 1965 from Vietnam (Nematoda, Dorylaimida, Aporcelaimidae), with an updated taxonomy of the genus

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Abstract

Three new species of *Aporcelaimoides* from natural habitats in Vietnam are studied, described and illustrated, including line drawings, LM and/or SEM pictures. *Aporcelaimoides brevistylum* **sp. n.** is characterized by its body 1.95–2.90 mm long, lip region offset by deep constriction and 17–18 µm broad, ventral side of mural odontostyle 11–14 µm long with aperture occupying 62–71% of its length, neck 663–767 µm long, pharyngeal expansion occupying 58–66% of total neck length, uterus a simple tube 85–182 µm long, *pars refringens vaginae* absent, $V = 55–63$, tail short and rounded (34–46 µm, $c = 49–76$, $c' = 0.6–0.8$), spicules 67–86 µm long, and one ventromedian supplement out the range of spicules. *Aporcelaimoides minor* **sp. n.** is distinguished in having body 2.09–2.61 mm long, lip region offset by deep constriction and 19–20 µm broad, mural odontostyle 14–16 µm long at its ventral side with aperture occupying 73–84% of its length, neck 579–649 µm long, pharyngeal expansion occupying 57–66% of total neck length, uterus a simple tube 44–69 µm long, *pars refringens vaginae* well developed, $V = 48–56$, female tail very short, rounded conoid or truncate (14–26 µm, $c = 90–146$, $c' = 0.3–0.6$), and male unknown. *Aporcelaimoides silvaticum* **sp. n.** is characterized by its body 2.09–2.60 mm long, lip region offset by depression and 17–18 µm broad, mural odontostyle 11–12 µm long at its ventral side with aperture occupying 60–66% of its length, neck 597–720 µm long, pharyngeal expansion occupying 58–64% of total neck length, uterus a simple tube 128–243 µm long, *pars refringens vaginae* well developed, $V = 58–60$, tail

short and rounded (27–37 μm , $c = 67\text{--}94$, $c' = 0.6\text{--}0.7$), spicules 64–75 μm long, and two or three widely spaced ventromedian supplements bearing hiatus. The genus *Aporcelaimoides* is restored, its diagnosis emended, and three species of *Sectonema*, namely *S. amazonicum*, *S. haguei* and *S. moderatum*, transferred to it. An updated list of its species, a key to their identification and a tabular compendium with the most important morphometric features are also presented.

Keywords

Description, morphology, morphometrics, new combinations, new species, taxonomy, *Sectonema*, SEM

Introduction

The genus *Aporcelaimoides* is an interesting aporcelaimoid taxon, created by Heyns (1965) to accommodate two new species, namely *A. probulbum* (type species) and *A. californicum*. It was originally characterized among other features by its “Spear dorylaimoid, with a large dorsal aperture, but the basal part of the spear much narrower than the lumen of the pharynx, and situated ventrally in the pharynx”. Later, Siddiqi (1995) regarded it as a junior synonym of *Sectonema* Thorne, 1930, an action that, several years later, was followed by Andr  ssy (2009). However, this taxonomical decision deserves further analyses since important morphological differences exist between both genera, being especially important those affecting the nature of the stomatal protrusible structure.

The study of dorylaimid fauna from Vietnam has received poor attention. Several authors (Vu et al. 2010; Nguyen et al. 2011; Gagarin and Gusakov 2012 and 2013a,b; Nguyen et al. 2014) discovered some new species and reported for the first time information about other known species. It is suggested that Vietnamese dorylaimid fauna might be highly diverse. This is the first contribution in a series devoted to study the aporcelaimid fauna of this Asian country.

During a general nematological survey conducted during the last five years to study the diversity of the Vietnamese nematode fauna, several specimens of the genus *Aporcelaimoides* were collected from natural areas in Vietnam. Their detailed examination revealed they belonged to three unknown forms, which are herein described. Besides, the study of this nematode material has confirmed relevant data to reconsider the identity of the genus *Aporcelaimoides*.

Material and methods

Nematodes

Nematodes were collected from several natural areas in Vietnam, extracted from soil samples using the methods of Baermann (1917) and Flegg (1967) somewhat modified, relaxed and killed by heat, fixed in 4% formaldehyde, and processed to anhydrous

glycerine following Siddiqi's (1964) technique. Finally, the specimens were mounted on permanent glass slides to allow handling and observation under LM.

Light microscopy

Nematodes were measured using a light microscope. Morphometrics included de Man's indices and most of the usual measurements. The location of the pharyngeal gland nuclei is expressed according to Loof and Coomans (1970) and spicule terminology follows Peña-Santiago et al. (2014). Some of the best preserved specimens were photographed with a Nikon Eclipse 80i microscope and a Nikon DS digital camera. Raw photographs were edited using Adobe® Photoshop® CS. Drawings were made using a *camera lucida*.

Scanning electron microscopy

After their examination and identification, a few specimens preserved in glycerin were recycled to their observation under SEM following the protocol by Abolafia and Peña-Santiago (2005). The nematodes were hydrated in distilled water, dehydrated in a graded ethanol and acetone series, critical point dried, coated with gold, and observed with a Zeiss Merlin microscope.

Taxonomy

Aporcelaimoides brevistylum sp. n.

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Figs 1–3, 4A–E

Material examined. Twelve females and fourteen males from two localities, in variable state of preservation.

Measurements. See Table 1.

Description. *Adult.* Moderately slender to slender nematodes of medium size, 1.95–2.90 mm long. Body cylindrical, distinctly tapering towards the anterior end, less so towards the posterior one because the caudal region is rounded. Habitus regularly (often strongly) curved ventrad after fixation, usually spiral-shaped. Cuticle three-layered, especially distinguishable at caudal region, where it consists of thinner outer layer bearing very fine transverse striation through the entire body, thicker intermediate layer with radial striation and thin inner layer; thickness 3–5 µm at anterior region, 4–7 µm in mid-body and 9.0–12.5 µm on tail. Lateral chord 8–20 µm wide at mid-body, occupying one-eighth to less than one-fifth (12–18%) of mid-body diameter. Three ventral and three dorsal body pores are usually present at level of mural

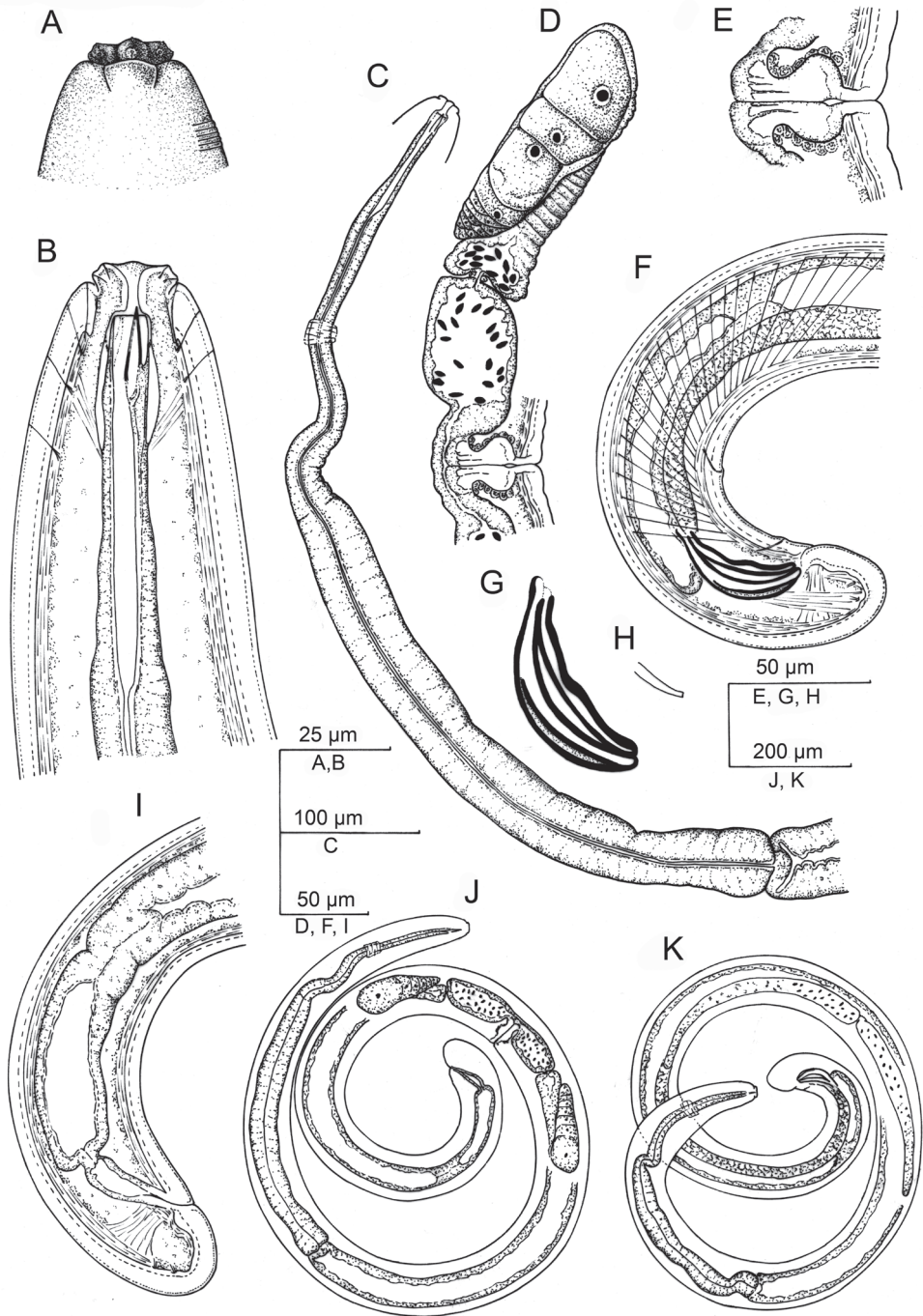


Figure 1. *Aporcelaimoides brevistylum* sp. n. (Line drawing). **A** Lip region in surface, lateral view **B** Anterior region in median lateral view **C** Neck **D** Female, anterior genital branch and vagina **E** Vagina **F** Male, posterior body region **G** Spicule **H** Lateral guiding piece **I** Female, posterior body region **J** Female, entire **K** Male, entire.

odontostyle-odontophore, their corresponding ducts appearing especially thickened beneath intermediate cuticle layer. Lip region offset by deep constriction, 2.7–3.3 times as wide as high and one-fifth to two-sevenths (18–30%) of body diameter at neck base; lips (under SEM) amalgamated; labial papillae button-like, very perceptible and protruding under LM, surrounded by a ring-like annulus (occasionally two annuli), the inner ones at the margin of oral field; cephalic papillae larger than the labial ones, with an oval transverse slit; oral aperture a dorso-ventral, slightly hexagonal orifice, the lip region hence showing a biradial symmetry. Amphid fovea cup-shaped, its opening occupying 9–11 μm or one-half to two-thirds (52–64%) of lip region diameter. Cheilostom nearly cylindrical, lacking any differentiation. Mural odontostyle attached subventrally and comparatively short, 4.1–5.4 times as long as wide, 0.6–0.8 times as long as lip region diameter, and 0.43–0.61% of body length; aperture 8–9 μm long or up to five-sevenths (62–71%) its length. Guiding ring simple, somewhat plicate, at 0.6–0.8 lip region diameters from anterior end. Odontophore linear, rod-like, 3.4–4.2 times the mural odontostyle length. Anterior region of pharynx enlarging very gradually; basal expansion 9.5–12.6 times as long as wide, 4.6–7.2 times as long as body diameter, and occupying 58–66% of total neck length; gland nuclei obscure in most specimens examined, DN = 50 (n=1) and S₂N = 84 (n=1). Nerve ring located at 154–185 μm from anterior end or 21–26% of total neck length. Cardia rounded conoid, 10–14 \times 14–18 μm ; a ring-like structure is present surrounding its junction to pharyngeal base. Tail short and rounded; inner core with irregular shape at tail end. Caudal pores two pairs, one lateral, another sub-lateral.

Female. Genital system didelphic-amphidelphic, with both branches almost equally and well developed, the anterior 207–254 μm long or 9–10% of body length and the posterior 233–300 μm long or 9–13% of body length. Ovaries moderately sized, usually not surpassing the sphincter level, the anterior 95–365 μm , the posterior 106–316 μm long; oocytes arranged first in two or more rows, then in a single row. Oviduct 96–124 μm long or 1.0–1.4 times the corresponding body diameter, and consisting of a slender part with prismatic cells and a well developed *pars dilatata* bearing wide lumen that often containing sperm cells inside. Oviduct-uterus junction marked by a sphincter. Uterus a short, simple, tube-like structure 85–182 μm long or 1.0–2.1 times the corresponding body diameter, most specimens with abundant sperm cells inside. Uterine eggs ovoid, 153 (n=1) \times 79, 85 (n=2) μm , 1.8 (n=1) times as long as wide. Vagina extending inwards 43–57 μm or four-ninths to two-thirds (45–65%) of body diameter: *pars proximalis* 32–44 \times 28–34 μm , with somewhat sigmoid walls and surrounded by weak musculature; *pars refringens* absent; and *pars distalis* well developed, 11–14 μm long. Vulva a post-equatorial transverse slit. Prerectum 1.8–2.6, rectum 1.0–1.2 anal body diameters long.

Male. Genital system diorchic, with opposite testes. In addition to the ad-cloacal pair, situated at 15–20 μm from cloacal aperture, there is only one ventromedian supplement located out the range of spicules, at 48, 58 (n=2) μm from ad-cloacal pair. Spicules distinctly robust and massive, especially in its posterior half, 3.4–4.6 times its maximum width, 1.2–1.7 times the body diameter at level of the cloacal aperture:

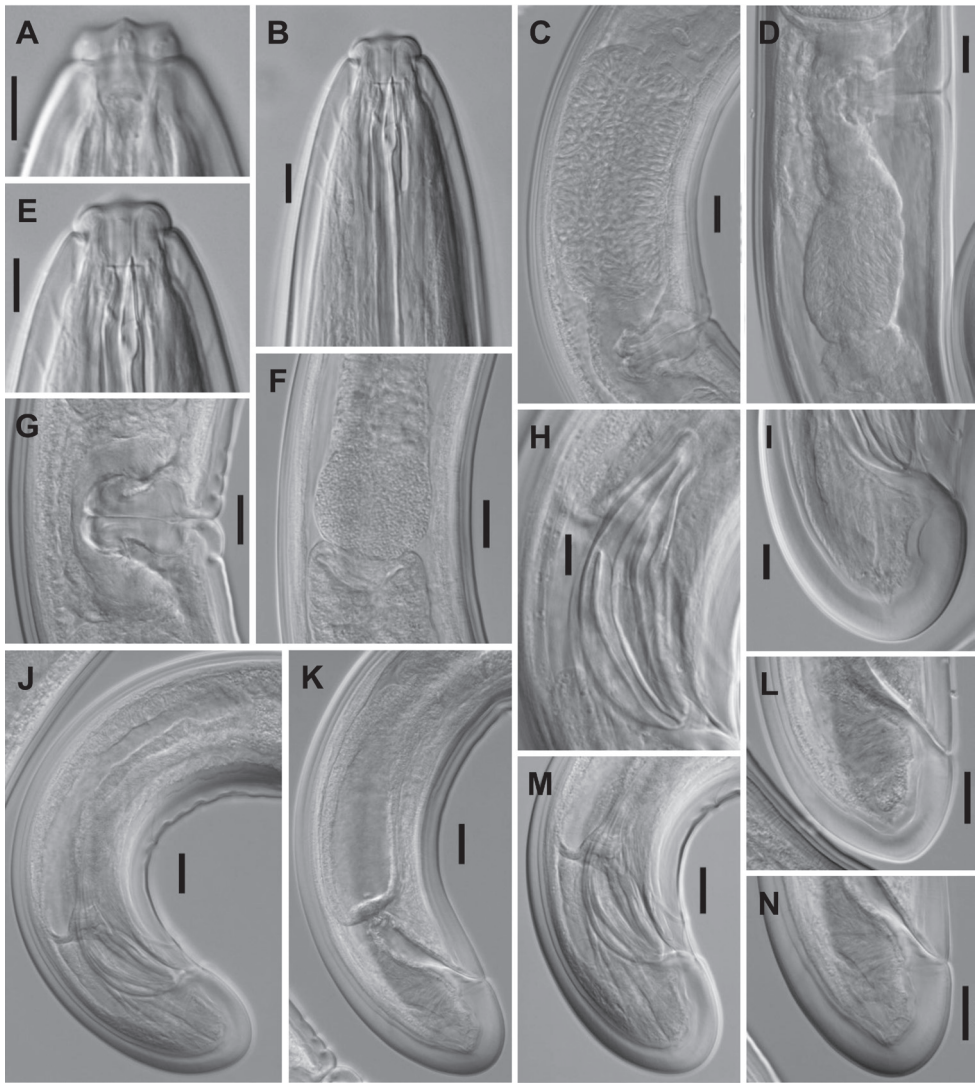


Figure 2. *Aporcelaimoides brevistylum* sp. n. (LM, type population). **A** Anterior region in surface, lateral view **B, E** Anterior region in median, lateral view **C, D** Uterus, containing sperm cells inside **F** Pharyngo-intestinal junction **G** Vagina **H** Spicule **I, M** Male, caudal region **J** Male, posterior body region **K** Female, posterior body region **L, N** Female, caudal region. Scale bars: 10 μm (**A, B, E, H, I**); 20 μm (**C, D, F, G, J–N**).

dorsal contour regularly convex, ventral contour very weakly concave, with shallow or weak hump and hollow; curvature $126\text{--}142^\circ$; head occupying 7–21% of spicule total length, its dorsal contour conspicuously curved at its anterior end and longer than the ventral one, which is short and straight; median piece 7.2–10.9 times as long as wide, occupying 35–50% of spicule maximum width, reaching the posterior tip; posterior end 5–9 μm wide. Lateral guiding pieces 13–17 μm long, 3.5–5.1 times as long as wide. Prerectum 2.9–4.4, cloaca 1.1–1.3 the corresponding body widths long.

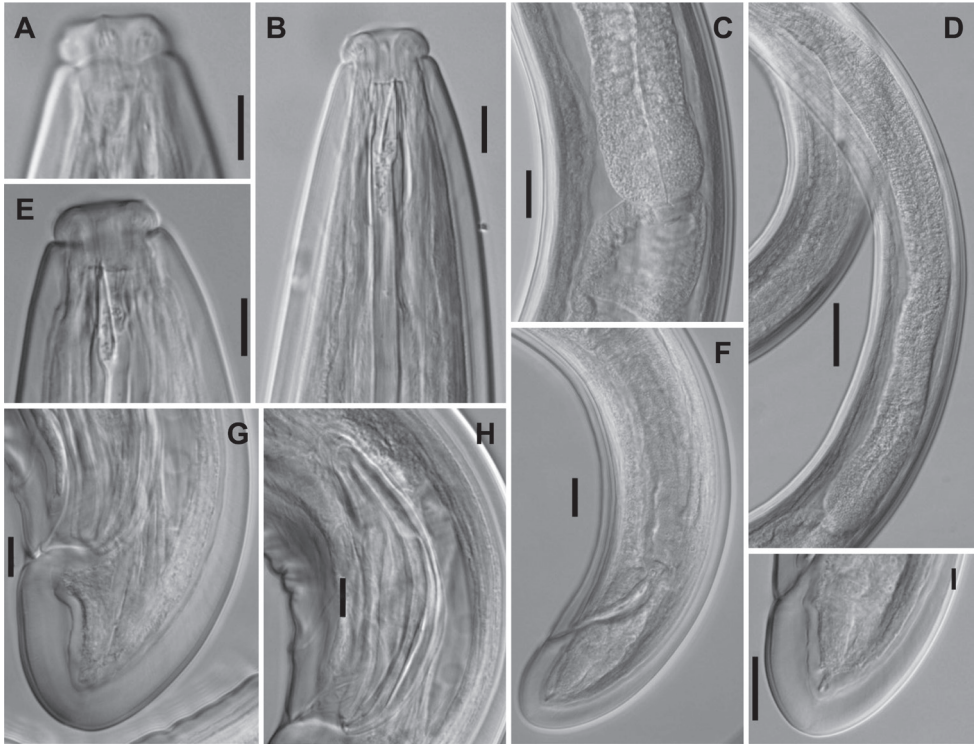


Figure 3. *Aporcelaimoides brevistylum* sp. n. (LM, other population). **A** Anterior region in surface, lateral view **B, E** Anterior region in median, lateral view **C** Pharyngo-intestinal junction **D** Pharyngeal expansion **F** Female, posterior body region **G** Male, caudal region **H** Spicules **I** Female, caudal region. (Scale bars: 10 μ m (**A, B, E, G, H**); 20 μ m (**C, F, I**); 50 μ m (**D**).

Diagnosis. The new species is characterized by its body 1.95–2.90 mm long, lip region offset by deep constriction and 17–18 μ m broad, ventral side of mural odontostyle 11–14 μ m with aperture occupying 62–71% of its length, neck 663–767 μ m long, pharyngeal expansion 387–508 μ m long or occupying 58–66% of total neck length, uterus a simple tube and 85–182 μ m long or 1.0–2.1 times the corresponding body diameter, *pars refringens vaginae* absent, $V = 55\text{--}63$, female tail short and rounded (35–46 μ m, $c = 58\text{--}76$, $c' = 0.6\text{--}0.8$), male tail similar to that of female (34–42 μ m, $c = 49\text{--}69$, $c' = 0.6\text{--}0.8$), spicules 67–86 μ m long, and one ventromedian supplement bearing hiatus.

Relationships. In having short mural odontostyle (11–14 μ m at its ventral side) and *pars refringens vaginae* absent, the new species is morphologically close to *A. californicum* Heyns, 1965 and *A. probulbum* Heyns, 1965, but it can be distinguished from both species in its smaller ($L = 1.95\text{--}2.90$ vs $L = \text{more than } 3$) and less slender ($a = 25\text{--}35$ vs $a \geq 41$) body. Besides, *A. brevistylum* sp. n. differs from *A. californicum* in its comparatively longer neck ($b = 3.3\text{--}3.7$ vs $b = 7.6$), larger mural odontostyle aperture (occupying 62–71% vs one-half of its length), more posterior vulva ($V = 55\text{--}63$ vs $V = 51$), shorter uterus (85–182 μ m or 1.0–2.1 times the corresponding body diameter vs

Table 1. Morphometrics of *Aporcelaimoides brevistylus* sp. n. Measurements in μm (except L, in mm), and in the form: mean \pm standard deviation (range).

Population	Chu Yang Sin National Park			Bidoup-Nui Ba National Park			Total range
	Holotype	Paratypes					
Character	n	8♀♀	10♂♂	3♀♀	4♂♂	12♀♀	14♂♂
L		2.55	2.59 \pm 0.16 (2.33–2.77)	2.24 \pm 0.18 (1.95–2.60)	2.77 \pm 0.15 (2.60–2.90)	2.44 \pm 0.03 (2.41–2.49)	2.33–2.90
a		30	29.2 \pm 3.2 (25–33)	29.0 \pm 1.7 (27–32)	28.4 \pm 3.4 (26–32)	31.8 \pm 2.9 (29–35)	25–33
b		3.3	3.4 (n=1)	3.3 (n=1)	3.5 (n=1)	3.6 \pm 0.1 (3.6–3.7)	3.3–3.7
c		69	67.8 \pm 7.2 (58–76)	59.2 \pm 5.7 (49–67)	70.6 \pm 4.0 (67–75)	64.8 \pm 4.0 (61–69)	58–76
c'		0.6	0.7 \pm 0.1 (0.6–0.8)	0.7 \pm 0.1 (0.6–0.8)	0.7 \pm 0.1 (0.7–0.8)	0.7 \pm 0.0 (0.7–0.8)	0.6–0.8
V		61	59.0 \pm 2.3 (55–63)	-	60.0 \pm 1.0 (59–61)	-	55–63
Lip region diam.		18	17.4 \pm 0.5 (17–18)	16.8 \pm 0.2 (17–17)	17.0 \pm 0.5 (17–18)	17.5 \pm 0.0 (18–18)	17–18
Mural odontostyle length at ventral side		13	12.0 \pm 0.6 (11–13)	11.8 \pm 0.3 (11–12)	12.9 \pm 0.7 (13–14)	11.4 \pm 0.3 (11–12)	11–14
Mural odontostyle length at dorsal side		15	13.9 \pm 0.5 (13–14)	13.5 \pm 0.4 (13–14)	15.2 \pm 1.2 (14–17)	13.4 \pm 0.2 (13–13)	13–17
Odontophore length		49	47.8 \pm 2.1 (44–50)	45.7 \pm 2.0 (43–49)	48.4 \pm 1.8 (46–50)	45.9 \pm 1.1 (45–48)	44–50
Guiding ring from ant. end		11	12.1 \pm 0.3 (12–13)	11.0 \pm 0.7 (10–12)	12.5 \pm 0.3 (12–13)	11.3 \pm 0.2 (11–12)	11–13
Neck length		767	695 (n=1)	663 (n=1)	740 (n=1)	677 \pm 11 (664–685)	695–767
Pharyngeal expansion length		508	405 (n=1)	389 (n=1)	458 (n=1)	402 \pm 13 (387–412)	405–508
Diam. at neck base		71	81.5 \pm 9.5 (70–96)	72.6 \pm 9.9 (56–85)	81, 88 (n=2)	74.7 \pm 2.5 (73–77)	70–96
at midbody		85	89.2 \pm 10.8 (72–106)	77.4 \pm 7.1 (66–88)	99.0 \pm 16.0 (81–109)	77.4 \pm 6.9 (69–84)	72–109
at anus		57	58.0 \pm 3.0 (54–63)	53.7 \pm 2.7 (49–58)	53.3 \pm 2.0 (52–56)	51.7 \pm 2.0 (49–53)	52–63
Preectrum length		134	128.1 \pm 15.7 (111–149)	177 \pm 27 (149–218)	131 (n=1)	199 \pm 33 (166–232)	111–149
Rectum/cloaca length		63	61.1 \pm 3.9 (55–65)	62.7 \pm 5.3 (56–70)	62.1 \pm 1.0 (61–63)	62.7 \pm 1.9 (61–65)	55–65
Tail length		37	38.9 \pm 3.5 (35–46)	38.0 \pm 2.7 (34–42)	39.3 \pm 2.1 (38–42)	37.9 \pm 1.9 (36–40)	35–46
Spicule length		-	-	79.6 \pm 5.3 (67–86)	-	82.0 \pm 2.9 (80–85)	-
Ventromedian supplements		-	-	1.0 \pm 0.0 (1–1)	-	1.0 \pm 0.0 (1–1)	-

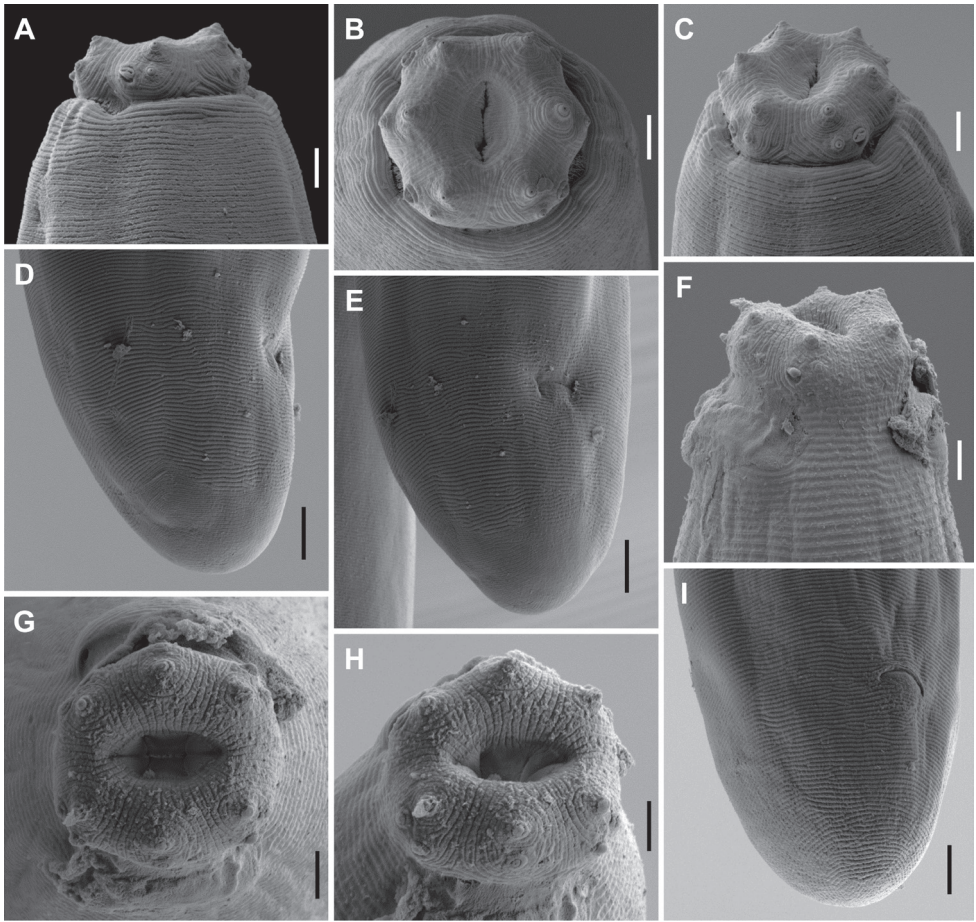


Figure 4. *Aporcelaimoides brevistylum* sp. n. **A–E** and *A. silvaticum* sp. n. **F–I** (SEM, juvenile). **A, C, F** Lip region in ventral view **B, G, H** Lip region in face view **D, E, I** Caudal region in lateral (**D**) or subventral (**E, F**) view. Scale bars: 2 μm (**A–C, F–H**); 5 μm (**D, E, I**).

about 430 μm long or about 5.3 times the corresponding body diameter), comparatively shorter female tail ($c = 58\text{--}76$, $c' = 0.6\text{--}0.8$ *vs* $c = 126$, $c' = 1.0$), and male present (*vs* absent). And from *A. probulbum* in its shorter neck (663–767 μm , $b = 3.3\text{--}3.7$ *vs* 883–1011 μm , $b = 3.9\text{--}5.2$), narrower lip region (17–18 *vs* about 21 μm), and comparatively longer tail ($c = 49\text{--}76$ *vs* $c = 75\text{--}127$).

Moreover, in having short mural odontostyle (11–14 μm at its ventral side) the new species resembles *A. haguei* (Hunt, 1978), comb. n., but it differs in its smaller general size ($L = 1.95\text{--}2.90$ and neck 663–767 μm long *vs* $L = 4.67\text{--}5.42$ and neck 1172–1178 μm long), less slender body ($a = 25\text{--}35$ *vs* $a = 52\text{--}62$), absence (*vs* presence of rows of minute denticles on stomatal wall, indeed a very relevant feature), *pars refringens vaginae* absent (*vs* present), comparatively longer female tail ($c = 49\text{--}76$ *vs* $c = 99\text{--}118$), and male present (*vs* absent).

Type locality and habitat. Vietnam, Dak Lak province, Chu Yang Sin National Park, where it was collected from soil of a pristine forest in October 2012.

Other locality and habitat. Vietnam, Lam Dong Province, Bidoup-Nui Ba National Park, from soil of a pristine forest, collected in June 2013.

Type material. Female holotype and seven female and nine male paratypes deposited in the nematode collection of the University of Jaén, Spain. One female and one male paratypes deposited in the nematode collection of the Institute of Ecology and Biological Resources, Vietnam.

Etymology. The specific epithet is a compound Latin term referring to the short mural odontostyle that characterizes this species.

Remarks. The two populations examined are very similar in their morphological features and morphometrics, but some minor differences have been also noted, which are herein regarded as intraspecific variation. Thus, the population from Dak Lak province shows a shorter mural odontostyle (ventral side 11–13 *vs* 13–14 μm , dorsal side 13–14 *vs* 14–17 μm , in females) and comparatively longer neck ($b = 3.3\text{--}3.4$ *vs* $b = 3.5\text{--}3.7$).

***Aporcelaimoides minor* sp. n.**

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Figs 5–7

Material examined. Ten females from three localities, in good state of preservation.

Measurements. See Table 2.

Description. *Female.* Moderately slender to slender nematodes of medium size, 2.09–2.61 mm long. Body cylindrical, distinctly tapering towards the anterior end, less so towards the posterior one as the caudal region is very short and rounded to truncate. Habitus regularly curved ventrad after fixation, often spiral-shaped. Cuticle three-layered, especially distinguishable at caudal region: thin outer layer bearing fine transverse striation through the entire body, a much thicker intermediate layer with radial striation, and a thin inner layer; thickness 3.0–4.5 μm at anterior region, 4.5–6.5 μm in mid-body and 6.5–9.5 μm on tail. Lateral chord 7–13 μm wide at mid-body, occupying one-tenth to less than one-sixth (9–15%) of mid-body diameter. Two ventral and two dorsal body pores are usually present at level of mural odontostyle-odontophore, their corresponding ducts appearing especially thickened beneath intermediate cuticle layer. Lip region offset by deep constriction, 2.8–3.3 times as wide as high and one-fifth to less than one-third (21–30%) of body diameter at neck base; lips mostly amalgamated, somewhat angular; papillae perceptible, somewhat protruding. Amphid fovea cup-shaped, its opening occupying 8–10 μm or up to one-half (44–50%) of lip region diameter. Cheilostom nearly cylindrical, lacking any differentiation. Mural odontostyle attached subventrally, 6.7–7.7 times as long as wide, 0.7–0.9 times as long as lip region diameter, and 0.54–0.72% of body length; aperture 11–13 μm long or up to six-sevenths (73–84%) its length. Guiding ring simple, somewhat plicate, at 0.6–0.8

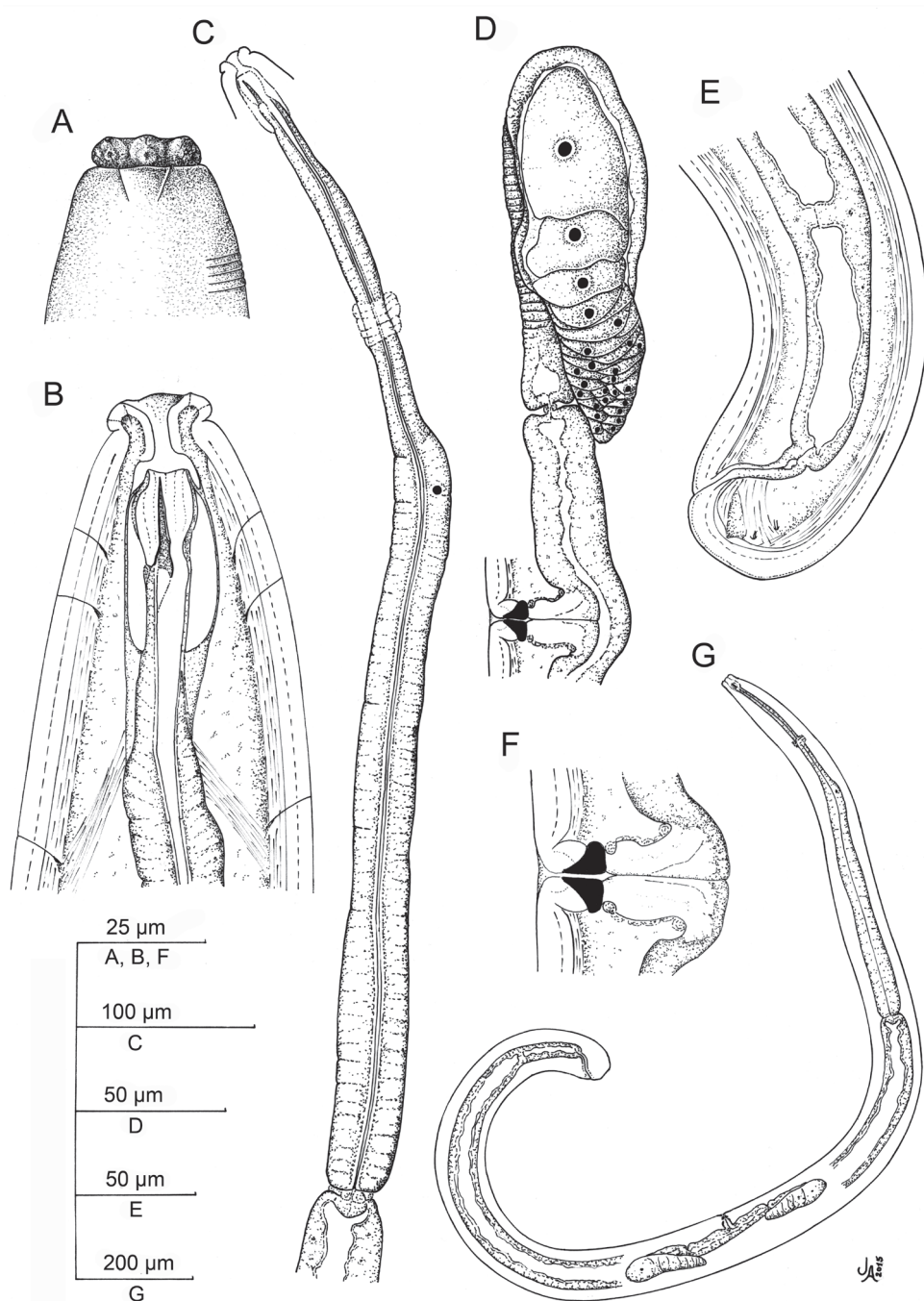


Figure 5. *Aporcelaimoides minor* sp. n. (Female, line drawing). **A** Lip region in surface, lateral view **B** Anterior region in median, lateral view **C** Neck **D** Anterior genital branch and vagina **E** Posterior body region **F** Vagina **G** Entire.

lip region diameters from anterior end. Odontophore linear, rod-like, irregular at its base, in lateral view with the ventral side longer than the dorsal one (figure 7A, C), and 2.0–2.4 times the mural odontostyle length. Anterior region of pharynx enlarging very gradually; basal expansion 8–12 times as long as wide, 4.1–5.3 times as long as body diameter and occupying 57–66% of total neck length; gland nuclei obscure in most specimens examined, DN = 54 (n=1) and S₂N = 92 (n=1). Nerve ring located at 158–177 µm from anterior end or 24–31% of total neck length. Cardia rounded conoid, 11–19 × 14–18 µm; a ring-like structure is present surrounding its junction to pharyngeal base. Genital system didelphic-amphidelphic, with both branches almost equally and well developed, the anterior 174–207 µm long or 7–9% of body length and the posterior 168–220 µm long or 7–9% of body length. Ovaries variably sized, the anterior 93–191 µm, the posterior 84–175 µm long; oocytes arranged first in two or more rows, then in a single row. Oviduct 73–103 µm long or 0.9–1.1 times the corresponding body diameter, and consisting of a slender part with prismatic cells and a weakly developed *pars dilatata*. Oviduct-uterus junction marked by a sphincter. Uterus a short, simple, tube-like structure 44–69 µm long or 0.5–0.9 times the corresponding body diameter, lacking sperm cells inside. Vagina extending inwards 38–51 µm or two-fifths to one-half (43–53%) of body diameter: *pars proximalis* 25–35 × 15–20 µm, with somewhat sigmoid walls and surrounded by weak musculature; *pars refringens* with two small, triangular to drop-shaped pieces measuring 8–10 × 6–8 µm and with a combined width of 14–19 µm; and *pars distalis* short, 3.0–5.5 µm long. Vulva a transverse slit. Prerectum 1.4–2.1, rectum 0.8–1.1 anal body diameters long. Tail very short and rounded to truncate. Caudal pores two pairs, one sublateral, another sub-dorsal.

Male. Unknown.

Diagnosis. The new species is characterized by its body 2.09–2.61 mm long, lip region offset by deep constriction and 19–20 µm broad, mural odontostyle 14–16 µm long at its ventral side with aperture occupying 73–84% of its length, neck 579–649 µm long, pharyngeal expansion 331–423 µm long or occupying 57–66% of total neck length, uterus a simple tube and 44–69 µm long or less than (0.5–0.9 times) the corresponding body diameter, *pars refringens vaginae* well developed, *V* = 48–56, female tail very short and rounded to truncate (14–26 µm, *c* = 90–146, *c'* = 0.3–0.6), and male unknown.

Relationships. This species resembles *A. haguei* comb. n. in having relatively small mural odontostyle (up to 17 µm long) and *pars refringens vaginae* present. It can be, however, easily distinguished from this in its smaller general size (*L* = 2.09–2.61, neck 579–649 µm long *vs* *L* = 4.67–5.42, neck 1112–1178 µm long), less slender body (*a* = 23–33 *vs* *a* = 52–62), the absence (*vs* presence) of rows of minute denticles on stomatal wall), and its much shorter female tail (14–26 µm, *c'* = 0.3–0.6 *vs* 46–47 µm, *c'* = 0.7).

Besides, in having short mural odontostyle (11–14 µm at its ventral side) the new species resembles *A. brevistylum* sp. n. and *A. californicum*, but it differs from these in its well developed *pars refringens vaginae* (*vs* absent). Moreover, it differs from *A. brevistylum* sp. n. in its shorter neck (579–649 *vs* 663–767 µm), wider lip region (19–20

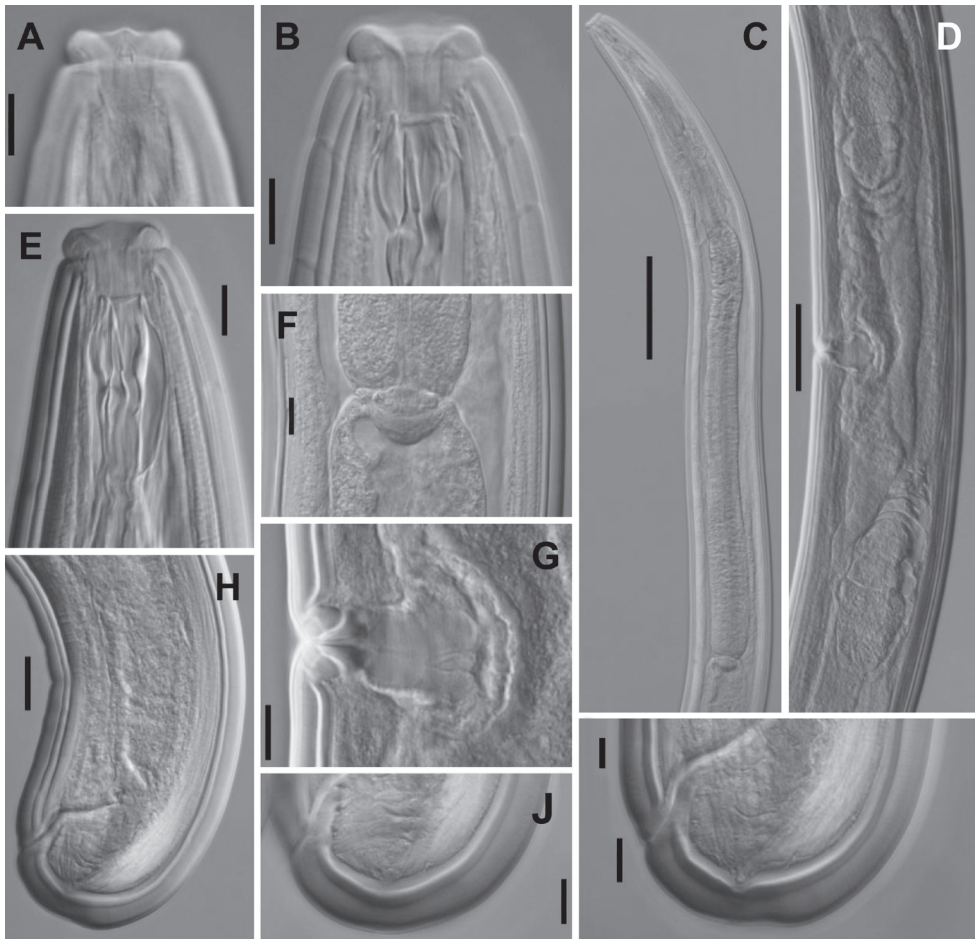


Figure 6. *Aporcelaimoides minor* sp. n. (LM, female, type population). **A** Anterior region in surface, lateral view **B, E** Anterior region in median, lateral view **C** Neck region **D** Genital system **F** Pharyngo-intestinal junction **G** Vagina **H** Posterior body region **I, J** Caudal region. Scale bars: 10 μ m (**A, B, E–G, I, J**); 100 μ m (**C**); 50 μ m (**D**); 20 μ m (**H**).

vs 17–18 μ m), smaller mural odontostyle aperture (occupying 73–84% *vs* 62–71% its length), shorter female tail (14–26 μ m, $c = 90$ –146, $c' = 0.3$ –0.6 *vs* 35–46 μ m, $c = 58$ –76, $c' = 0.6$ –0.8), and male absent (*vs* present). And from *A. californicum* in its shorter ($L = 2.09$ –2.61 *vs* $L = 5.53$) and less slender ($a = 23$ –33 *vs* $a = 75$) body, larger mural odontostyle aperture (occupying 73–84% *vs* one-half of its length), shorter uterus (44–69 μ m long or less than one body diameter *vs* about 430 μ m long or about 5.3 times the corresponding body diameter), and shorter female tail (14–26 μ m, $c' = 0.3$ –0.6 *vs* 44 μ m, $c' = 1.0$).

Type locality and habitat. Vietnam, Bac Giang Province, Tay Yen Tu Natural Reserve, collected from soil in a pristine tropical forest, in July 2008.

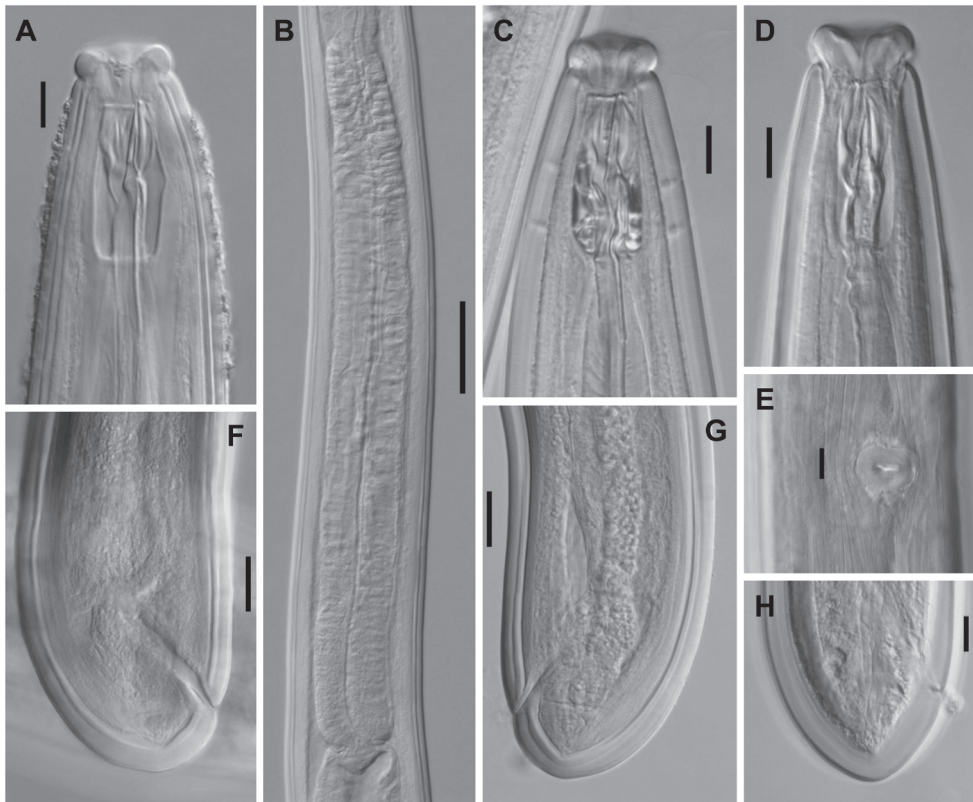


Figure 7. *Aporcelaimoides minor* sp. n. (LM, female, other populations). **A, B, F** (Population from Cao Bang Natural Reserve) **C-E, G, H** (Population from Chu Yang Sin National Park) **A, C** Anterior region in median, lateral view **B** Pharyngeal expansion **D** Anterior region in median, ventral view **E** Vulva in ventral view **F-H** Caudal region. Scale bars: 10 μ m (**A, C, D, E, H**); 50 μ m (**B**); 20 μ m (**F, G**).

Other localities and habitats. Vietnam, Cao Bang Province, Cao Bang Natural Reserve (GPS coordinates: 22°34'07"N and 105°52'34"), in a tropical evergreen forest soil in association with *Dipterocarpus* sp. and *Cinnamomum* sp., collected in 2013. Dak Lak province, Chu Yang Sin National Park, in October 2012.

Type material. Female holotype and one female paratype deposited in the nematode collection of the University of Jaen, Spain. One female paratype deposited in the nematode collection of the Institute of Ecology and Biological Resources, Vietnam.

Etymology. The specific epithet means 'small' and refers to the comparatively small general size of the new species.

Remarks. In spite of it was collected from three localities, the material examined is very similar in its main morphological features and morphometrics. Nevertheless, some differences have been also observed, especially affecting the female tail shape as some specimens show a short and rounded-conoid caudal region whereas it becomes extremely short and truncate in other individuals.

***Aporcelaimoides silvaticum* sp. n.**

<http://zoobank.org/C8EAC3A3-EB59-485C-86DC-1471D682731A>

Figs 4F–I, 8, 9

Material examined. Two females and four males, in variable state of preservation.

Measurements. See Table 2.

Description. *Adult.* Moderately slender to slender nematodes of medium size, 2.09–2.60 mm long. Body cylindrical, distinctly tapering towards the anterior end, less so towards the posterior one because the caudal region is rounded conoid. Habitus regularly curved ventrad after fixation, to a more or less open C, occasionally more curved at posterior body region, spiral-shaped in only one male specimen. Cuticle three-layered, especially visible distinct at caudal region, consisting of thin outer layer bearing fine transverse striation through the entire body, a much thicker intermediate layer with radial striation, and a thin inner layer; thickness 2.5–4.0 μm at anterior region, 5–6 μm in mid-body and 8–10 μm on tail. Lateral chord 7–12 μm wide at mid-body, occupying one-tenth to one-eighth (10–12%) of mid-body diameter. Three ventral and three dorsal body pores are usually present at level of odontostyle-odontophore, their corresponding ducts appearing especially thickened beneath inner cuticle layer. Lip region visibly narrower than adjacent body, offset by depression, 2.2–2.6 times as wide as high and one-fifth to one-fourth (19–27%) of body diameter at neck base; lips (under SEM) amalgamated; papillae button-like, the inner labial ones rather close the margin of oral field and surrounded by one or two ring-like annuli, whereas the outer labial ones are surrounded by only one annulus and the cephalic ones lack a such differentiation; oral aperture a dorsoventral, nearly hexagonal orifice, the lip region hence showing a biradial symmetry. Amphid fovea cup-shaped, its opening at level of cephalic depression and occupying 12–13 μm or up to three-fourths (72–75%) of lip region diameter. Cheilostom nearly cylindrical, lacking any differentiation. Mural odontostyle attached subventrally and comparatively short, 4.5–4.9 times as long as wide, 0.6–0.7 times as long as lip region diameter, and 0.44–0.54% of body length; aperture 7–8 μm long or up to two-thirds (60–66%) its length. Guiding ring simple, somewhat plicate, at 0.5–0.7 lip region diameters from anterior end. Odontophore linear, rod-like, 3.8, 4.1 (3.5, 3.7 in males, $n=2$) times the odontostyle length. Anterior region of pharynx enlarging very gradually; basal expansion 8.3–11.0 times as long as wide, 5.0–5.8 times as long as body diameter, and occupying 58–64% of total neck length; gland nuclei obscure in all the specimens examined. Nerve ring located at 139–169 μm from anterior end or 23–26% of total neck length. Cardia rounded conoid, 10–16 \times 12–18 μm ; a ring-like structure is present surrounding its junction to pharyngeal base. Tail short, rounded to rounded conoid, its inner core bearing a finger-like projection at tail end. Caudal pores two pairs, one lateral, another sub-lateral.

Female. Genital system didelphic-amphidelphic, with both branches almost equally and well developed, the anterior 246, 387 μm long or 10, 15% of body length and the posterior 301 μm long or 12% ($n=1$) of body length. Ovaries moderately sized, usually not surpassing the sphincter level, the anterior 82, 119 μm , the posterior 66,

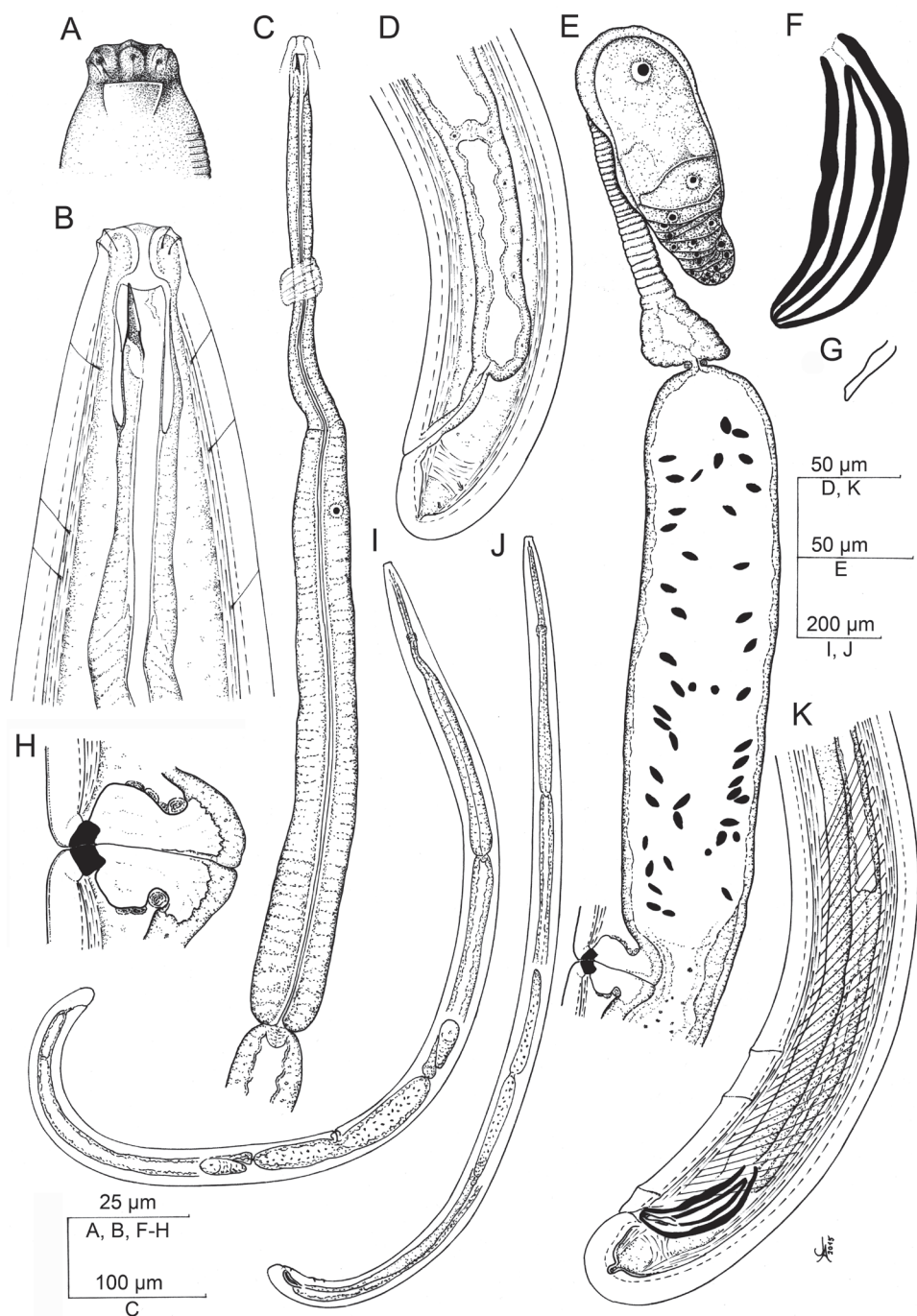


Figure 8. *Aporcelaimoides silvaticum* sp. n. (Line drawing). **A** Lip region in surface, lateral view **B** Anterior region in lateral, median view **C** Neck **D** Female, posterior body region **E** Female, anterior genital branch and vagina **F** Spicule **G** Lateral guiding piece **H** Vagina **I** Female, entire **J** Male, entire **K** Male, posterior body region.

103 μm long; oocytes arranged first in two or more rows, then in a single row. Oviduct 99–107 μm long or 1.2, 1.3 times the corresponding body diameter, and consisting of a slender part with prismatic cells and a moderately developed *pars dilatata* with visible lumen but no sperm cell. Oviduct-uterus junction marked by a sphincter. Uterus a short, simple, tube-like structure 128–243 μm long or 2.1, 2.8 times the corresponding body diameter, one female containing abundant sperm cells inside. Vagina extending inwards 31, 32 μm or about three-eighths (36%, $n=1$) of body diameter: *pars proximalis* 23, 24 \times 25, 26 μm , with somewhat sigmoid walls and surrounded by weak musculature; *pars refringens* with two small, triangular to drop-shaped pieces measuring 5 \times 4, 5 μm and with a combined width of 9, 10 μm ; and *pars distalis* 1.0, 1.5 μm long. Vulva a post-equatorial transverse slit. Prerectum 2.3, 2.5, rectum 0.8, 1.2 anal body diameters long.

Male. Genital system diorchic, with opposite testes. In addition to the ad-cloacal pair, situated at 16–19 μm from cloacal aperture, there is a series of two or three widely spaced (22–42 μm apart) ventromedian supplements, the posteriormost of which lying out the range of spicules, but very close to the spicules end, being situated at 42–63 μm from ad-cloacal pair. Spicules relatively robust, 3.5–4.6 times its maximum width, 1.3–1.6 times the body diameter at level of the cloacal aperture: dorsal contour regularly convex, ventral contour bearing weak hump and hollow; curvature 140–143°; head occupying 8–10% of spicule total length, with both contours nearly straight, and its dorsal side longer than the ventral one; median piece 6.5–8.3 times as long as wide, occupying 45–54% of spicule maximum width, reaching the posterior tip; posterior end 5–6 μm wide. Lateral guiding pieces 19–23 μm long, 6.4–7.8 times as long as wide. Prerectum 3.0–3.3, cloaca 1.2–1.4 times the corresponding body width long.

Diagnosis. The new species is characterized by its body 2.09–2.60 mm long, lip region offset by depression and 17–18 μm broad, mural odontostyle 11–12 μm long at its ventral side with aperture occupying 60–66% of its length, neck 597–720 μm long, pharyngeal expansion 353–452 μm long or occupying 58–64% of total neck length, uterus a simple tube and 128–243 μm long or 2.1–2.8 times the corresponding body diameter, *pars refringens vaginae* well developed, $V = 58\text{--}60$, female tail short and rounded to rounded conoid (31–37 μm , $c = 69\text{--}83$, $c' = 0.7$), male tail similar to that of female (27–31 μm , $c = 67\text{--}94$, $c' = 0.6\text{--}0.7$), spicules 64–75 μm long, and two or three widely spaced ventromedian supplements bearing hiatus.

Relationships. The new species differs from its relatives by its lip region offset by depression (*vs* constriction). Besides, in having *pars refringens vaginae* and short mural odontostyle (11–12 μm long at its ventral side), *A. silvaticum* sp. n. is morphologically similar to *A. haguei* comb. n. and *A. minor* sp. n., but it can be distinguished from them in its narrower lip region (17–18 *vs* equal or 19 μm or more) and more posterior vulva ($V = 58\text{--}60$ *vs* V up to 57). It also differs from *A. haguei* comb. n. in its smaller general size ($L = 2.09\text{--}2.60$, neck 597–720 μm long *vs* $L = 4.67\text{--}5.42$, neck 1112–1178 μm long), less slender body ($a = 28\text{--}33$ *vs* $a = 52\text{--}62$), absence (*vs* presence) of rows of minute denticles on stomatal wall, shorter female tail (31–37 *vs* 46–47 μm), and male present (*vs* absent). And from *A. minor* sp. n. in its shorter mural odontostyle

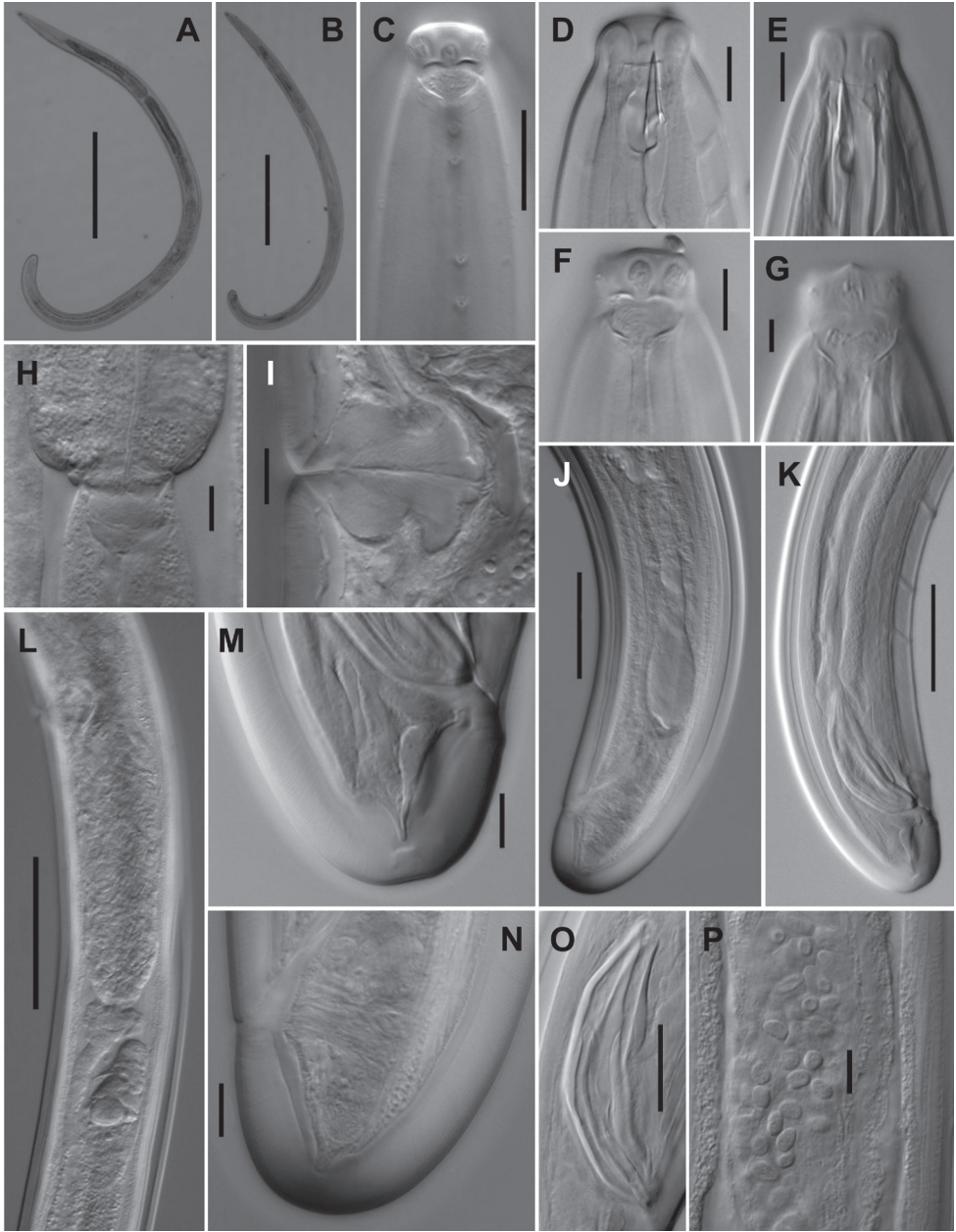


Figure 9. *Aporcelaimoides silvaticum* sp. n. (LM). **A** Female, entire **B** Male, entire **C** Anterior region in surface, lateral view showing four lateral pores **D, E** Anterior region in median, lateral view **F, G** Anterior region in surface, lateral view showing the amphid fovea **H** Pharyngo-intestinal junction **I** Vagina **J** Female, posterior body region **K** Male, posterior body region **L** Female, posterior genital branch **M** Male, caudal region **N** Female, caudal region **O** Spicules **P** Sperm cells. Scale bars: 500 μ m (**A, B**); 20 μ m (**C**); 10 μ m (**D-F, H, I, M-P**); 5 μ m (**G**); = 50 μ m (**J-L**).

(11–12 *vs* 14–16 μm at its ventral side) with smaller aperture (occupying 60–66% *vs* 73–84% of its length), longer female tail (27–31 μm , $c = 67\text{--}94$, $c' = 0.6\text{--}0.7$ *vs* 14–26 μm , $c = 90\text{--}146$, $c' = 0.3\text{--}0.6$), and male present (*vs* absent). Finally, the new species also resembles *A. brevistylum* sp. n. in having short mural odontostyle, but it differs from this in its well developed (*vs* absent) *pars refringens vaginae* and higher number of ventromedian supplements (two or three *vs* one).

Type locality and habitat. Northern Vietnam, Cuc Phuong National Park, where the new species was collected from soil of a pristine tropical forest in 2009.

Type material. Female holotype and one female and three male paratypes, deposited in the nematode collection of the University of Jaen, Spain. One male paratype deposited in the nematode collection of the Institute of Ecology and Biological Resources, Vietnam.

Etymology. The specific epithet is a Latin term meaning ‘from the jungle’, and refers to the habitat where the species dwells.

On the taxonomy of *Aporcelaimoides*

As mentioned in the introductory section, the identity of *Aporcelaimoides* has been matter of some controversy. In his original description of this genus, Heyns (1965) highlighted the differences between it and *Sectonema*, mainly based on the nature of the stomatal protrusible structure, “a dorylaimid spear which is set ventrally ... similar in position to the mural tooth of *Sectonema*”, putting hence emphasis on the existence of a large dorsal aperture in the protrusible structure of *Aporcelaimoides* and the absence of a such aperture in the mural tooth of *Sectonema*. Heyns (*op. cit.*) also noted that “the basal part of the spear (is) much narrower than the lumen of the pharynx (stoma)” [text between brackets incorporated by the authors]. Subsequent contributions by Andrásy (1976) and Jairajpuri and Ahmad (1992) assumed Heyns’ point of view. Siddiqi (1995), however, stated (p. 99) that “...Since there is a great variation in the mural tooth of *Sectonema* (see Siddiqi 1984), there is no justification for holding *Aporcelaimoides* as a valid genus”. And, later, Andrásy (2009) followed Siddiqi’s opinion.

Very recently, Peña-Santiago and Álvarez-Ortega (2014a) redescribed *S. ventrale* Thorne, 1930, the type species of *Sectonema*, and conclude that (p. 1103) “the protrusible structure of *Sectonema*, as observed in its type species, is not a typical mural tooth as seen in nygolaims, but a reduced odontostyle with its base occupying most (if not whole) the stomatal lumen”. It means that mural odontostyle of *Aporcelaimoides* significantly differs from the reduced odontostyle of *Sectonema*. Thus, Siddiqi’s (1995) action might be not well supported as there are morphological arguments to separate both genera and to restore *Aporcelaimoides* as valid genus. Unfortunately, there is no molecular information of the latter, which would be especially useful to confirm the morphological data.

A revised diagnosis of *Aporcelaimoides* as well an updated list of its species, three of them transferred from *Sectonema*, and a key to their identification are given in the following. Besides, a compendium of their main morphometrics is presented in Table 3.

Table 3. Main morphometrics and distribution data of species belonging to the genus *Aporcelaimoides* Heyns, 1965 (Measurements in μm , except L, in mm).

	Character**	n	L	a	b	c	c'	V	Lrd	Mural Odont. Vent.	Mural Odont. Dors.	Neck	Ph. exp.	Tail	Spicul.	Ve. Sup.	Geog. Dis.	Reference
1	<i>amazonicum</i> comb. n.	♀	3.34	43	3.4	88	0.8	53	27	25	30	991*	62%	38*	-	-	Brazil	Siddiqi 1995
		♂	3.30	53	4.5	81	1.0	-	21*	?	23	733*	?	41*	78	3		
2	<i>brevistylum</i> sp. n.	12♀♀	2.33–2.90	25–33	3.3–3.5	58–76	0.6–0.8	55–63	17–18	11–14	13–17	695–767	58–66%	35–46	-	-	Vietnam	Present paper
		14♂♂	1.95–2.60	27–35	3.3–3.7	49–69	0.6–0.8	-	17–18	11–12	13–14	663–685	58–60%	34–42	67–86	1		
3	<i>californicum</i>	♀	5.53	75	7.6	126	1.0	51	19*	16*	17	728*	?	44*	-	-	California-USA	Heyns 1965
4	<i>haguei</i> comb. n.	2♀♀	4.67–5.42	52–62	4.2–4.6	99–118	0.7	56–57	24*	?	16	1112–1178*	71%*	46–47*	-	-	St. Lucia	Hunt 1978
5	<i>minor</i> sp. n.	10♀♀	2.09–2.61	23–33	3.3–4.4	90–146	0.3–0.6	48–56	19–20	14–16	15–17	579–649	57–66%	14–26	-	-	Vietnam	Present paper
6	<i>moderatum</i> comb. n.	2♀♀	4.34–5.66	37–38	3.9–4.2	82–105	0.7	55–59	25*	?	25–26.5	1113–1348*	?	53–54*	-	-	Cameroon	Siddiqi 1995
7	<i>probulbum</i>	11♀♀	3.35–4.75	41–55	3.9–5.2	75–127	0.6*	50–60	21*	15.5*	17–20	883*	64–67%	33*	-	-	South Africa	Heyns 1965
		11♂♂	3.62–4.66	49–63	4.0–4.9	78–118	0.8*	-	?	?	?	991*	?	44*	75–90	0–4		
		2♀♀	4.35–4.70	51–55	5.3–5.4	117–150	0.5–0.7	53–54	?	?	18	813–882	?	29–40	-	-	India	Khan et al. 1989
8	<i>silvaticum</i> sp. n.	2♀♀	2.60, 2.56	29, ?	3.6, 3.8	83, 69	0.7	60, 58	17	12	13	720, 668	63, 60%	31, 37	-	-	Vietnam	Present paper
		4♂♂	2.09–2.58	28–33	3.4–4.2	67–94	0.6–0.7	-	17–18	11–12	12–13	597–684	58–64%	27–31	64–75	2–3		

* Calculated from original description. ** Abbreviations for columns: Lrd: Lip region diameter. Mural Odont. Vent: Mural odontostyle length at ventral side. Mural Odont. Dors.: Mural odontostyle length at dorsal side. Ph.exp.: Pharyngeal expansion length. Spicul.: Spicule length. Ve.sup.: Number of ventromedian supplements. Geog.dis.: Geographical distribution. ? This information is not available in the corresponding description.

Diagnosis (emended)

Aporcelaimidae. Slender to very slender nematodes ($a = 23\text{--}75$) of medium to large size, 1.95–5.66 mm long. Cuticle three-layered, especially obvious at caudal region, with the intermediate layer more refringent and thicker than the outer and the inner ones. Oral aperture a dorso-ventral, nearly hexagonal slit. Lip region offset by a more or less distinct constriction, but by depression in *A. silvaticum* sp. n. Mural odontostyle attached subventrally, comparatively short and with wide aperture, often occupying more than one-half its length. Guiding ring simple and plicate. Odontophore rod-like. Pharynx enlarging gradually, with basal expansion occupying three-fifths to two-thirds of total neck length. Female genital system didelphic-amphidelphic; *pars refringens vaginae* present or absent; and vulva a transverse slit. Tail similar in both sexes, short, rounded conoid, rounded or truncate. Spicules dorylaimoid, well developed. Ventromedian supplements in low number (0–4), widely separated, always with pre-cloacal space (hiatus).

Relationships

As mentioned, *Aporcelaimoides* is morphologically very similar to *Sectonema*, from which it differs in the nature of the stomatal protrusible structure. It can be easily distinguished from the typical species of *Sectonema*, for instance *S. ventrale* — the type species of the genus, recently re-described by Peña-Santiago and Álvarez-Ortega (2014a) — in having a mural odontostyle attached to the ventral side of stoma (*vs* a reduced axial odontostyle), much narrower than (*vs* occupying the whole) stomatal lumen, with (in lateral view) its dorsal and ventral sides parallel and distinctly perceptible (*vs* dorsal side nearly lost) and a perceptible dorsal aperture often occupying more than half of its total length (*vs* nearly the total odontostyle length). Besides, *Aporcelaimoides* compares to other atypical species of *Sectonema*, for instance *S. demani* Altherr, 1965 (see recent description by Peña-Santiago and Álvarez-Ortega 2014b) and *S. septentrionale* Peña-Santiago & Álvarez-Ortega, 2015, which are characterized by having a mural tooth (a protrusible structure lacking a distinct aperture, resembling that found in nygolaims) with asymmetrical sides as (in lateral view) the dorsal side is visibly sigmoid and distinctly longer than the ventral one.

List of species

Type species

Aporcelaimoides probulbum Heyns, 1965

= *Sectonema probulbum* (Heyns, 1965) Siddiqi, 1995

Other valid species

Aporcelaimoides amazonicum (Siddiqi, 1995), comb. n.

= *Sectonema amazonicum* Siddiqi, 1995

Aporcelaimoides brevistylum sp. n.

Aporcelaimoides californicum Heyns, 1965

= *Sectonema californicum* (Heyns, 1965) Siddiqi, 1995

Aporcelaimoides haguei (Hunt, 1978), comb. n.

= *Sectonema haguei* (Hunt, 1978) Andr ssy, 2009

Nygolaimium haguei Hunt, 1978

Aporcelaimoides minor sp. n.

Aporcelaimoides moderatum (Siddiqi, 1995), comb. n.

= *Sectonema moderatum* Siddiqi, 1995

Aporcelaimoides silvaticum sp. n.

Remarks on some species

A. amazonicum: The nature of the stomatal protrusible structure, a mural odontostyle, supports its inclusion in *Aporcelaimoides* rather than in *Sectonema*.

A. haguei: Andr ssy (2009) transferred this species to *Sectonema* from *Nygolaimium*, but the mural odontostyle that characterized this species justifies its transference to *Aporcelaimoides*.

A. moderatum: The general morphology of this species, very especially that of the stomatal protrusible structure, fits the updated concept of *Aporcelaimoides* and justifies its transference to this genus.

Key to identification of *Aporcelaimoides* species

- | | | |
|---|---|----------------------------------|
| 1 | Lip region nearly continuous with the adjacent body..... | <i>silvaticum</i> sp. n. |
| – | Lip region offset by constriction | 2 |
| 2 | <i>Pars refringens vaginae</i> absent | 3 |
| – | <i>Pars refringens vaginae</i> present..... | 5 |
| 3 | Larger (body 5.53 mm long) and more slender ($a = 75$) nematodes; neck comparatively shorter ($b = 7.6$); mural odontostyle aperture occupying one-half its length; male absent..... | <i>californicum</i> |
| – | Smaller (body up to 4.75 mm long) and less slender (a up to 63) nematodes; neck comparatively longer (b up to 5.4); mural odontostyle aperture occupying 62–71% its length; male present..... | 4 |
| 4 | Body 1.95–2.90 mm long and less slender ($a = 25$ –35); shorter neck (663–767 μ m long, $b = 3.3$ –3.7); lip region 17–18 μ m wide; comparatively longer tail ($c = 49$ –76) | <i>brevistylum</i> sp. n. |

- Body 3.35–4.75 mm long and more slender ($a = 41$ –63); longer neck (883–1011 μm long, $b = 3.9$ –5.2); lip region about 21 μm wide; comparatively shorter tail ($c = 75$ –127) ***probulbum***
- 5 Mural odontostyle 23 μm long or more **6**
- Mural odontostyle up to 17 μm long **7**
- 6 Smaller general size (body 3.30–3.34 mm, neck 733–991 μm long); more slender body ($a = 43$ –53); mural odontostyle aperture occupying 80–85% its length; vulva more anterior ($V = 53$); female tail 38 μm long; male present
..... ***amazonicum* comb. n.**
- Larger general size (body 4.34–5.66 mm, neck 1113–1348 μm long); less slender body ($a = 37$ –38); mural odontostyle aperture occupying 66–75% its length; vulva more posterior ($V = 55$ –59); female tail 53–54 μm long; male absent ***moderatum* comb. n.**
- 7 Smaller general size (body 2.09–2.61 mm, neck 579–649 μm long); more obese body ($a = 23$ –33); stomatal walls lacking rows of minute denticles; mural odontostyle occupying 73–84% its length; shorter tail (14–26 μm long, $c' = 0.3$ –0.6) ***minor* sp. n.**
- Larger general size (body 4.67–5.42 mm, neck 1112–1178 μm long); more slender body ($a = 52$ –62); stomatal walls bearing rows of minute denticles; mural odontostyle aperture occupying 69% its length; longer tail (46–47 μm long, $c' = 0.7$) ***haguei* comb. n.**

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References

- Abolafia J, Peña-Santiago R (2005) Nematodes of the order Rhabditida from Andalucía Oriental: *Pseudacrobeles elongatus* (de Man, 1880) comb. n. *Nematology* 7: 917–926. doi: 10.1163/156854105776186415

- Altherr E (1965) La faune des sables submergés des rives du Rhin près de Krefeld. Nématodes. Gewässer und Abwässer, Düsseldorf 39/40: 80–101.
- Andrássy I (1976) Evolution as a basis for the systematization of nematodes. Pitman Publishing, London, 288 pp.
- Andrássy I (2009) Free-living nematodes of Hungary. III. Pedozoologica Hungarica n°5. Hungarian Natural History Museum, Budapest, Hungary, 608 pp.
- Baermann G (1917) Eine einfache Methode zur Auffindung von *Ankylostomum* (Nematoden) Larven in Erdproben. Geneeskunding Tijdschrift voor Nederlandsch-Indië 57: 131–137.
- Flegg JJM (1967) Extraction of *Xiphinema* and *Longidorus* species from soil by a modification of Cobb's decanting and sieving technique. Annals of Applied Biology 60: 429–437. doi: 10.1111/j.1744-7348.1967.tb04497.x
- Gagarin VG, Gusakov VA (2012) *Mesodorylaimus dolichurus* sp. nov. (Nematoda, Dorylaimida) from freshwater body of Vietnam. Zoosystematica Rossica 21: 189–192.
- Gagarin VG, Gusakov VA (2013a) Two species of dorylaimids (Nematoda) from waterbodies of Vietnam. Inland Water Biology 6: 176–183. doi: 10.1134/S199508291303005X
- Gagarin VG, Gusakov VA (2013b) *Neotripyla vulgaris* gen. n., sp. n. and *Semitobrilus andrassyi* sp. n. (Nematoda, Triplonchida) from freshwater bodies of Vietnam. Zootaxa 3716: 565–576. doi: 10.11646/zootaxa.3716.4.4
- Heyns J (1965) On the morphology and taxonomy of the Aporcelaimidae, a new family of dorylaimoid nematodes. Entomology Memoirs, Department of Agricultural Technical Services, Republic of South Africa 10: 1–51.
- Hunt DJ (1978) Bionomics of *Paractinolaimus vigor* Thorne, 1967 (Dorylaimida: Paractinolaimidae) with a description of *P. dominicus* n. sp. and *Nygolaimium haguei* n. sp. (Dorylaimida: Aporcelaimidae). Nematologica 23: 452–462. doi: 10.1163/187529277X00381
- Jairajpuri MS, Ahmad W (1992) Dorylaimida. Free-living, predaceous and plant-parasitic nematodes. E.J. Brill, Leiden, 458 pp.
- Khan TH, Jairajpuri MS, Ahmad W (1989) Description of some new and known species of dorylaim nematodes. Nematologica 35: 419–437. doi: 10.1163/002825989X00179
- Loof PAA, Coomans A (1970) On the development and location of the oesophageal gland nuclei in Dorylaimina. Proceedings of the IX International Nematology Symposium (Warsaw, Poland, 1967), 79–161.
- Nguyen TAD, Vu TT, Ahmad W, Peña-Santiago R (2011) New observations on *Thornedia opisthodelphis* (Jairajpuri, 1968) Siddiqi, 1982 (Dorylaimida, Leptonchidae) from Vietnam, with discussion on the identity of the genus. Journal of Nematode Morphology and Systematics 14: 63–69.
- Nguyen TAD, Vu TT, Bonkowski M, Peña-Santiago R (2014) New data of three rare belondirid species (Nematoda, Dorylaimida, Belondiridae) from Vietnam, with the first record and description of the male of *Oxybelondira paraperplexa* Ahmad & Jairajpuri, 1979. Biodiversity Data Journal. doi: 10.3897/BDJ.2.e1156
- Peña-Santiago R, Abolafia J, Álvarez-Ortega S (2014) New proposal for a detailed description of the dorylaim spicule (Nematoda: Dorylaimida). Nematology 16: 1091–1095. doi: 10.1163/15685411-00002834

- Peña-Santiago R, Álvarez-Ortega S (2014a) Studies on the genus *Sectonema* Thorne, 1930 (Dorylaimida: Aporcelaimidae). Re-description of *S. ventrale*, the type species of the genus. *Nematology* 16: 1097–1104. doi: 10.1163/15685411-00002837
- Peña-Santiago R, Álvarez-Ortega S (2014b) Re-description of three species of the genus *Sectonema* Thorne, 1930 (Nematoda: Dorylaimida: Aporcelaimidae) originally studied by E. Altherr. *Zootaxa* 3881: 63–74. doi: 10.11646/zootaxa.3881.1.5
- Peña-Santiago R, Álvarez-Ortega S (2015) Description of *Sectonema septentrionale* sp. n. (Nematoda: Dorylaimida: Aporcelaimidae) from Northern Iberian Peninsula. *Zootaxa* 3947: 573–580. doi: 10.11646/zootaxa.3947.4.8
- Siddiqi MR (1964) Studies on *Discolaimus* spp. (Nematoda: Dorylaimidae) from India. *Zeitschrift für Zoologische Systematik und Evolutionsforschung* 2: 174–184. doi: 10.1111/j.1439-0469.1964.tb00720.x
- Siddiqi MR (1984) *Sectonema anisonchum* sp. n., *S. mucrodens* sp. n. and *S. truxum* sp. n. (Nematoda: Dorylaimida) from Colombian rain forest. *Indian Journal of Nematology* 14: 84–88.
- Siddiqi MR (1995) Nematodes of Tropical Rainforests. 5. Seven new genera and forty two new species of dorylaims. *Afro-Asian Journal of Nematology* 5: 72–109.
- Thorne G (1930) Predaceous nemas of the genus *Nygolaimus* and a new genus *Sectonema*. *Journal of Agricultural Research USDA* 41: 445–466.
- Vu TT, Ciobanu M, Abolafia J, Peña-Santiago R (2010) Two remarkable new species of the genus *Crassolabium* Yeates, 1967 from Vietnam (Nematoda: Dorylaimida: Qudsianematidae). *Journal of Natural History* 44: 2049–2064. doi: 10.1080/00222933.2010.481055

A new genus of water mites (Acari, Hydrachnidia, Wettinidae) from bromeliad phytotelmata in the Brazilian Atlantic rainforest

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Abstract

Adults of *Bromeliacarus cardoso* **gen. n., sp. n.** are described from phytotelmata of *Quesnelia arvensis* (Vellozo) Mez. (Bromeliaceae) in the subtropical area of the Atlantic rainforest, São Paulo State, Brazil. The new genus *Bromeliacarus* is proposed and diagnosed, based primarily on the autapomorphic presence of 7–9 pairs of acetabula flanking the gonopore. A possible relationship between *Bromeliacarus* and other Wettinidae are discussed.

Keywords

Water mite, new genus, taxonomy, Brazil

Introduction

Bromeliads phytotelmata (i.e. tank bromeliads) are considered biodiversity amplifiers in the environments where they occur due to the specificity of a high number of species in this habitat (Rocha et al. 2000, Gonçalves-Souza et al. 2010). Despite the taxonomy and biology of several bromeliad-dwellers, organisms are poorly understood (Frank and Lounibos 2008) and there are continuous studies increasing descriptions of new species

and genera in different invertebrates groups such as dipterans (Epler 2010, Pinho et al. 2013), beetles (Clarkson et al. 2014, Albertoni and Fikáček 2014) and water mites (Pešić et al. 2015, present study). The water mite fauna of bromeliad phytotelmata is insufficiently known (Kitching 2000). Although the first paper appeared in the early part of the 20th century (K. Viets 1939), only a few more studies on water mites from this unusual habitat have been published (see review in Kitching 2000 and references in Pešić et al. 2015). Recently, an extensive sampling effort in bromeliad aquatic fauna for ecological studies in Brazilian subtropical area of the Atlantic rainforest provides material to improve taxonomic knowledge of bromelicolous water mites. The first paper resulting from that expedition dealt with the new species of the genus *Xystonotus* (Pešić et al. 2015). In this paper one new genus of the family Wettinidae is described.

After the revision by Cook et al. (2000), Wettinidae is recognized as separate family, which in addition to the Holarctic nominate genus, includes *Stormaxonella* K.O. Viets, 1962 (South Africa), *Tasmanaxona* Cook, 1986, *Wheeneyella* Cook, 1986, and *Wheeneyoides* Harvey, 1990 (all from Australia). The new genus described here is the first member of Wettinidae to exhibit a polyacetabulate condition, bearing 7-9 acetabula on each side flanking the gonopore. In other characters, notably in the presence of a large central shield surrounded by a ring of small platelets, the new species is similar to *Stormaxonella* K.O. Viets, 1962, a monotypic genus known only from streams in South Africa (K. O Viets 1962). This character state is apparently apomorphic, and may represent synapomorphy indicating a close relationship between *Bromeliacarus* gen. n. and *Stormaxonella* and members of the family Lethaxonidae which have a dorsal shield similar in structure. Cook et al. (2000) wrote about Lethaxonidae: “We interpret modifications of the first and fourth pair of legs found in members of *Lethaxona* and *Lethaxonella* as synapomorphies indicating common ancestry with Wettinidae.” (p. 435). The same authors mentioned that a more detailed analysis of the relationship between the genera of Lethaxonidae and Wettinidae based upon on comparative larval morphology (only known for *Wettina*) is warranted (Cook et al. 2000, p. 441).

Material and methods

The sampling site is located in State Park of Ilha do Cardoso, São Paulo State, Brazil. This area is included in Atlantic Rainforest domain and shows most of coastal phytophysiognomies of rocky shores, mangroves and restingas (Bernardi et al. 2005). Mites were collected from phytotelmata of *Quesnelia arvensis* (Vellozo) Mez., a bromeliad species with terrestrial and epiphytic habits densely distributed in the understory of restinga. Each leaf of the bromeliad was carefully dissected and washed, and all detritus and water were collected in white trays. Mites and other fauna were extracted and fixed in 80% alcohol. The holotype will be deposited at the Acari Collection of the Departamento de Zoologia e Botânica (DZSJRP), São Paulo State University, São José do Rio Preto, São Paulo, Brazil; paratypes are deposited in the Zoological Collection of the Department of Biology, University of Montenegro, Podgorica.

All measurements are given in μm . The following abbreviations are used: Cx-I = first coxae, dL = dorsal length, H = height, L = length, I-L-6 = Leg 1, sixth segment (tarsus), P-1 = palp, first segment, vL = ventral length, W = width.

Systematics

Family Wettinidae Cook, 1956

Genus *Bromeliacarus* Pešić, gen. n.

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Diagnosis. Characters of the family Wettinidae (see Cook et al. 2000): dorsum with a large central shield bearing two pairs of glandularia and a pair of postocularia (Fig. 2D), flanked by ring composed of 6 pairs of platelets (Figs 1A, 2A), with 1th, 2nd, 3rd, 4th, and 6th pairs bearing glandularia; 6th pair of platelet fused to each other, occasionally on one side 5th platelet fused with 4th platelet. Venter with coxal plates and genital field fused into a ventral shield (Figs 1B, 2C, 2E); suture lines indicating posterior edges of anterior three coxal plates weakly indicated but directed posteriorly; IV-L insertion laterally, well separated from each other and without projections; coxoglandularia 1 in posterior edges of Cx-II; Cx-IV without glandularia; coxoglandularia 2 between Cx-IV and genital field. Legs: I-L stocky, I-L-6 with a long and deep claw socket extending over more than half the dorsal segment surface (Fig. 1E), claw large, ventral clawlet apically rounded, slightly longer than main claw (Fig. 1C); legs I-IV without swimming setae. Genital field with 7-9 pairs of acetabula; acetabular plates fused with ventral shield in both sexes (Figs 1B, 2C); suture lines between genital field and ventral shield obliterated; excretory pore incorporated into ventral shield. Gnathosoma with relatively long apodemes (Fig. 1K); palp slender, P-4 bearing two short ventral setae inserting in the centre and a peg-like mediobasal seta (Fig. 1F-G).

Type species. *Bromeliacarus cardoso* sp. n.

Etymology. Named for its occurrence in bromeliad phytotelmata, and the Latin *acarus* meaning "mite".

Remarks. Adults of *Bromeliacarus* gen. n. share with those of all Wettinidae the apomorphic characteristic modifications of first leg (short and stocky with tarsal claw sockets exceptionally large and claws large with ventral clawlet slightly longer than main claw) and fourth leg (trochanter being long and massive, tarsal claw sockets reduced) and the posterior orientation of the suture lines between coxal plates. This new species is autapomorphic in having 7-9 pairs of genital acetabula flanking the gonopore. Other members of Wettinidae differ in exhibiting the plesiotypic character state of small number of genital acetabula (i.e., *Stormaxonella* K.O. Viets, 1962 with four pairs of acetabula, all other genera with three pairs of acetabula but one species of *Wettina* (*W. octopora* Cook) with four pairs. Due to the similar structure of dorsal shield, the new genus appears to be related to *Stormaxonella* K.O. Viets, 1962. This character state

is apomorphic and may indicate that both genera belong to a monophyletic group within Wettinidae. However in light of striking difference in genital field and palp (*Stomoxanella scutulata* is autapomorphic in P-4 bearing one thick, spatulate seta medially in proximal third of segment) it would appear that divergence from a common ancestor have occurred early during wettinid evolution. Cook et al. (2000; 437) claim that “the occurrence of different clades on widely separated land masses in both the Northern and Southern Hemispheres suggests that members of this family were distributed throughout Pangea before it broke apart during the Jurassic”.

***Bromeliacarus cardoso* Pešić, sp. n.**

<http://zoobank.org/8A11B848-9412-4A5A-9C0A-53A970719CE1>

Figs 1–2

Type series. Holotype female, dissected and slide mounted in Hoyer's fluid, Brazil, São Paulo, Cananéia, 25°04'16"S, 47°55'23"W, in *Quesnelia arvensis* (Vellozo) Mez. (Bromeliaceae), v.2013 col. Gustavo Cauê de Oliveira Piccoli. Paratype: three females (two of them damaged, palps and legs lacking), one male (damaged, palps and legs lacking), same data as holotype, two females (both damaged) and one male dissected and slide mounted in Hoyer's fluid.

Diagnosis. As given for genus.

Description. Character states as given in generic diagnosis.

Measurements. Female (holotype, in parentheses some measurements of paratype): Idiosoma (ventral view: Fig. 1B) L/W 434/375 (441–456/367–400). Dorsal shield (Figs 1A, 2D) L/W 363/308 (398–409/309–322), ratio 1.18 (1.27–1.29); gnathosomal bay L 69 (78); distance between IV-leg insertions 172 (173); gonopore L/W 69/39 (63/40), distance between most lateral pairs of Ac 146 (151). Palp (Figs 1F–G): total L 177; L/H, L/H ratio: P-1, 25/14, 1.8; P-2, 44/28, 1.6; P-3, 32/20, 1.6; P-4, 48/15, 3.1; P-5, 28/8, 3.4; gnathosoma vL 72, with apodemes 105; chelicera total L 86. Legs: dL of I-L (Fig. 1D): 41, 51, 40, 52, 51, 74; I-L-6 H 26, I-L-6 dL/H ratio 2.8; dL of II-L-2-6: 59, 44, 55, 64, 72; dL of III-L-2-6: 56, 45, 59, 72, 72; dL of IV-L (Fig. 1I): 75, 56, 66, 69, 71, 74.

Male: Idiosoma (ventral view: Fig. 1C) L/W 434/375. Dorsal shield L/W 384/306, ratio 1.26; gnathosomal bay L 77; distance between IV-leg insertions 167; gonopore L/W 54/6, distance between most lateral pairs of Ac 148.

Etymology. Named after the locality (State Park of Ilha do Cardoso, São Paulo, Brazil) where the new species was detected.

Variability. The number of acetabula flanking the gonopore varies from 7 to 9 on each side. We found three different combinations Ac numbers flanking (right+left) the gonopore: 7+9 (one male), 8+8 (one female) and 8+9 (two females).

Distribution. Brazil; only known from the type locality.

Habitat and biology. Members of *Bromeliacarus cardoso* sp. n., are unusual about their habitats, because they appear to live only in the water-filled leaf axils of the bromeliads,

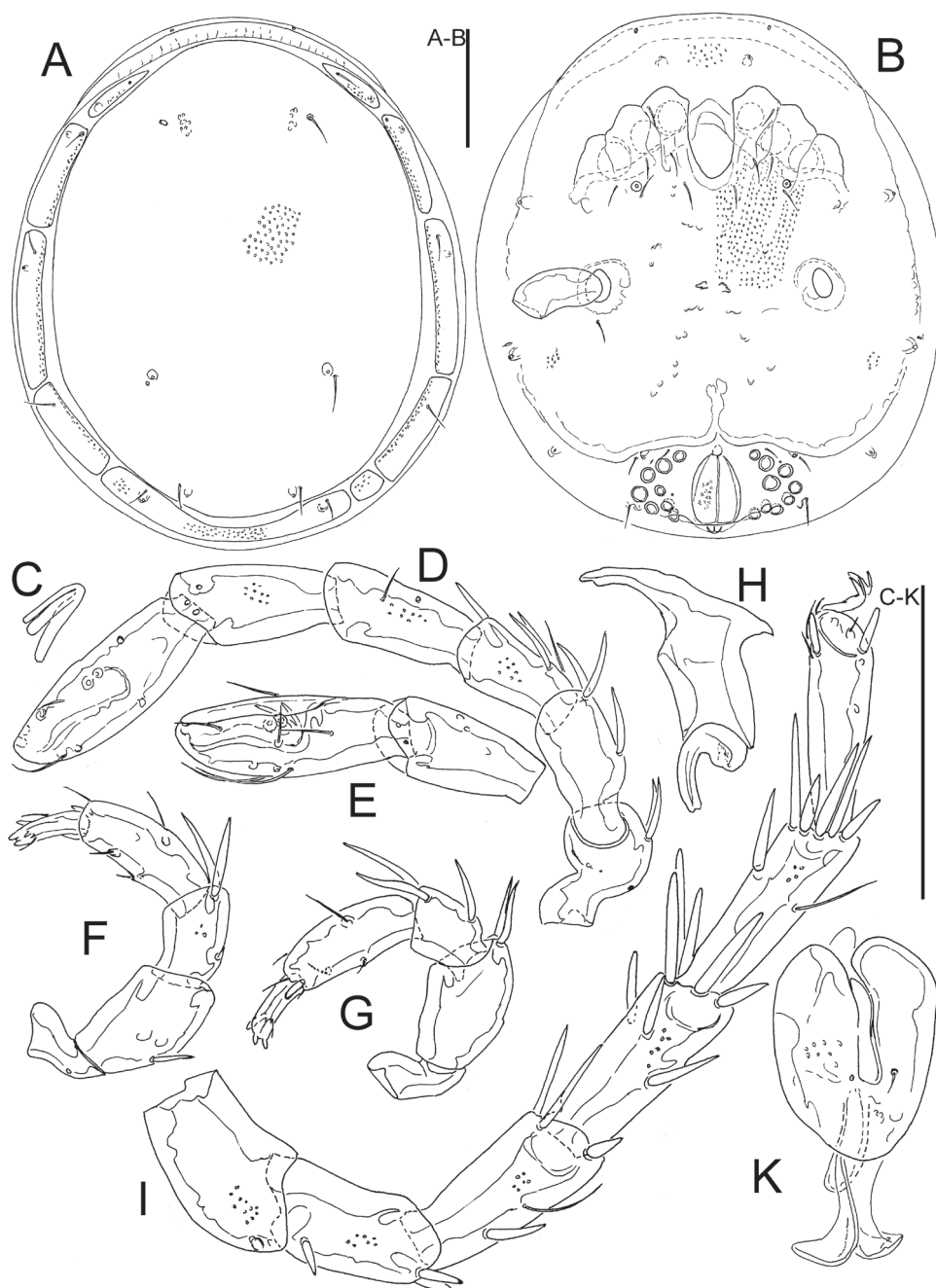


Figure 1. **A–H** *Bromeliacarus cardoso* sp. n., female: **A** idiosoma, dorsal view **B** idiosoma, ventral view **C** claw of first leg **D** I–L **E** I–L-5 and -6 **F** palp, lateral view **G** palp, medial view **H** chelicera **I** IV–L **K** gnathosoma. Scale bars: 100 µm.

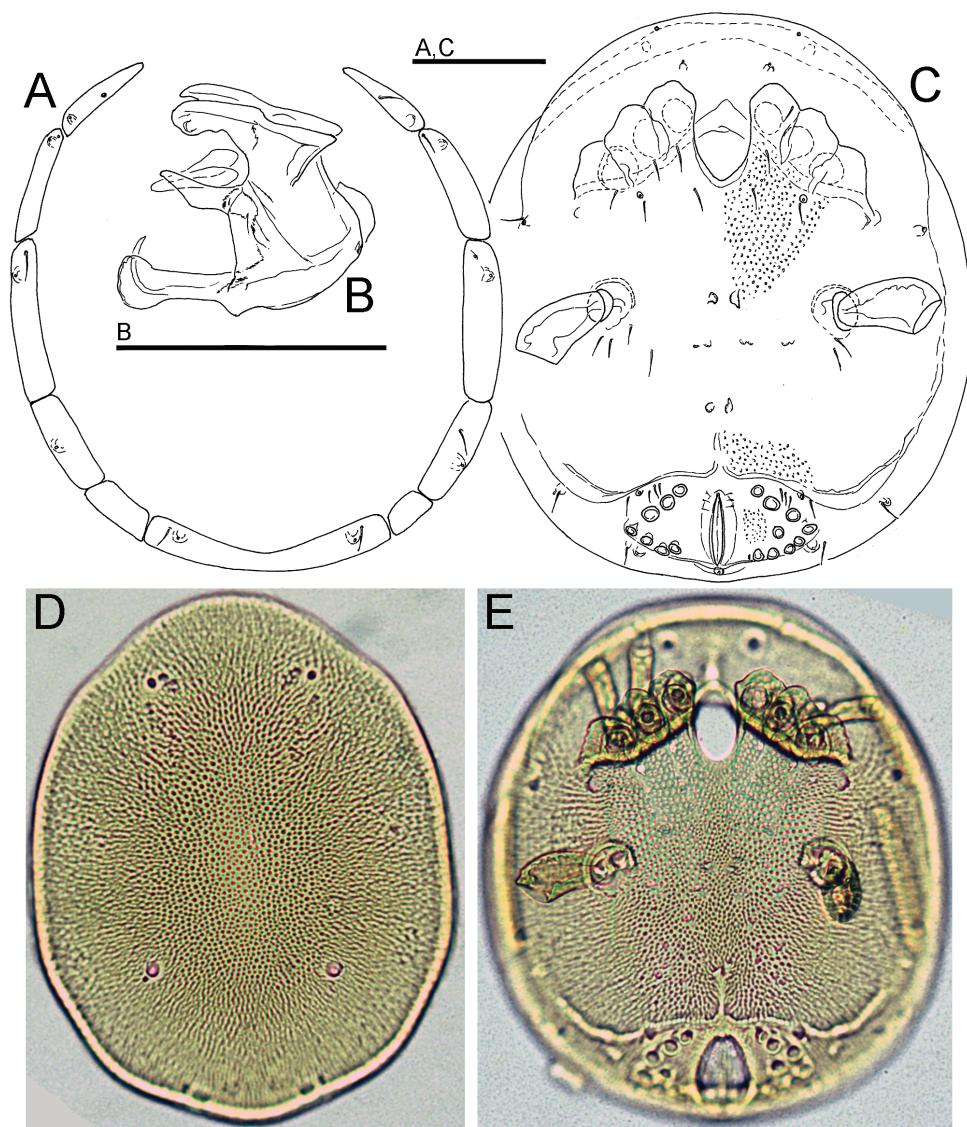


Figure 2. A–E *Bromeliacarus cardoso* sp. n. (A, D–E female B–C male) A–C line drawing D–E photographs: A ring of platelets surrounding dorsal plate B gnathosoma C, E idiosoma, ventral view D dorsal plate. Scale bars: 100 μ m.

where they walk attached to submerged detritus in bromeliads tank or free swimming in water column. Additional collecting effort is clearly needed in order to understand life history as well as habitat preferences of this species. However, as already mentioned by Albertoni and Fikáček (2014), the usual method used for searching for fauna inside bromeliads, i.e. dismantling the leaves one by one and washing the content in a tray, may not to be effective enough for very small species.

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References

- Albertoni FF, Fikáček M (2014) A new bromeliad-inhabiting species of *Omicrus* Sharp from South Brazil (Coleoptera, Hydrophilidae, Sphaeridiinae). *Spixiana* 37: 111–122.
- Cook DR, Smith IM, Harvey MS (2000) Assessment of lateral compression of the idiosoma in adult water mites as a taxonomic character and reclassification of *Frontipodopsis* Walter, *Wettina* Piersig and some other basal Hygrobatoida (Acari: Hydrachnidia). *Invertebrate Taxonomy* 14: 433–448. doi: 10.1071/IT99014
- Clarkson B, Albertoni FF, Fikáček M (2014) Taxonomy and biology of the bromeliad-inhabiting genus *Lachnodacnum* (Coleoptera: Hydrophilidae: Sphaeridiinae). *Acta Entomologica Musei Nationalis Pragae* 54: 157–194.
- Bernardi JVE, Landim PBM, Barreto CL, Monteiro RC (2005) Spatial study of the vegetation gradient from Cardoso Island State Park, SP, Brazil. *Holos Environment* 5: 1–22.
- Epler JH (2010) *Phytotelmatocladius*, a new genus from bromeliads in Florida and Brazil (Diptera: Chironomidae: Orthoclaadiinae). *Proceedings of the XV International Symposium on Chironomidae*, 285–293.
- Frank JH, Lounibos LP (2008) Insects and allies associated with bromeliads: a review. *Terrestrial Arthropod Reviews* 1: 125–153. doi: 10.1163/187498308X414742
- Gonçalves-Souza T, Brescovit AD, Rossa-Feres DC, Romero GQ (2010) Bromeliads as biodiversity amplifiers and habitat segregation of spider communities in a Neotropical rainforest. *Journal of Arachnology* 38: 270–279. doi: 10.1636/P09-58.1
- Kitching RL (2000) Food webs and container habitats: the natural history and ecology of phytotelmata. Cambridge University Press, Cambridge. doi: 10.1017/CBO9780511542107
- Pinho LC, Mendes HF, Andersen T, Marcondes CB (2013) Bromelicolous *Polypedilum* Kieffer from South Brazil (Diptera: Chironomidae). *Zootaxa* 3652: 569–581. doi: 10.11646/zootaxa.3652.5.6
- Rocha CFD, Cogliatti-Carvalho L, Almeida DR, Freitas AFN (2000) Bromeliads: biodiversity amplifiers. *Journal of Bromeliads Society* 50: 81–83.
- Viets KO (1962) Neue Gattungen und Arten von Wassermilben aus Südafrika. *Zoologischer Anzeiger* 168(7–10): 356–388.
- Viets K (1939) Eine neue, die erste Süßwassermilbe (Hydrachnellae, Acari) aus tropischen Pflanzgewässern. *Zoologischer Anzeiger* 128(3–4): 69–77.
- Pešić V, Piccoli GCO, Araújo MS, Rezende JM, Gonçalves AZ (2015) A new species of *Xystonotus* Wolcott, 1900 (Acari, Hydrachnidia, Mideopsidae) from bromeliad phytotelmata in Brazilian Atlantic rainforest. *Zootaxa* 3981(1): 147–150. doi: 10.11646/zootaxa.3981.1.10

A contribution to Asian *Afidentula* Kapur (Coleoptera, Coccinellidae, Epilachnini)

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Abstract

Two new species of *Afidentula*, *A. dentata* **sp. n.** and *A. jinpingensis* **sp. n.** are described from China. *Afissa siamensis* Dieke is moved to *Afidentula* **comb. n.**. All three species are described and illustrated, and a distribution map is given. A key to Asian species of *Afidentula* is updated. Diagnostic similarities and differences between *Afidentula* and *Afidenta* are discussed and illustrated.

Keywords

Entomology, taxonomy, Cucujoidea, *Afidentula*, *Afidenta*, new species

Introduction

The genera *Afidentula* Kapur, 1958 and *Afidenta* Dieke, 1947 belong to the tribe Epilachnini Mulsant, 1846, the group of phytophagous Coccinellidae. The taxonomy and nomenclatural history of species of both genera have been confused for decades.

The genus *Afidenta* was established by Dieke (1947) for species having bifid claws with a sharp basal tooth and sixth abdominal ventrite of female not longitudinally divided. *Afidenta mimetica* Dieke (= *A. misera* (Weise)) was designated as the type species. Other two species, *A. minima* (Gorham, 1894) and *A. bisquadrupunctata* (Gyllenhal in

Schönherr, 1808) were placed in this genus at the same time, although Dieke noted that the mandibles and male genitalia of *A. bisquadrupunctata* were different from the type species of *Afidenta*.

Kapur (1958) established the genus *Afidentula* with *Epilachna manderstjernae* Mulsant as the type species and distinguished it from *Afidenta* by the antennae subequal to the width of the head with a relatively thick and compact club and subtriangular mandibles with three teeth and without any additional denticulations or serrations. Kapur (1958) also pointed that both *A. minima* and *A. bisquadrupunctata* should not belong to *Afidenta* but transferred only *A. minima* to *Afidentula*. Subsequently, *Afidentula himalayana* Kapur, 1963 from India and *A. thanhsonensis* Hoang, 1977 from Vietnam have been described, and several other mainland Asian species were added to that genus, e.g. *Epilachna stephensi* was transferred to *Afidentula* by Booth and Pope (1989). Bielawski (1963) transferred the Papuan *Epilachna aruensis* Crotch to *Afidentula* and Bielawski (1963, 1965) and Jadwiszczak (1986) added further new species from New Guinea.

Li in Li and Cook (1961) described *Afidenta arisana* from Taiwan, which was moved to *Afissula* Kapur by Zeng (1995). Pang and Mao (1979) transferred *Afissa siamensis* Dieke into *Afidenta* and moved *A. bisquadrupunctata* into *Afidentula*.

Chazeau (1975, 1976) studied African Epilachninae, and described 29 new species, which included nine species of *Afidenta*. Fürsch (1986) revised species of *Afidenta* describing five new species and included 25 species but not Chazeau's (1975, 1976) species.

Jadwiszczak and Węgrzynowicz (2003) listed 39 species belonging to *Afidenta* (of which 37 have been distributed in Africa and two in Asia) and 18 species of *Afidentula* (11 species distributed in mainland Asia and seven in New Guinea and Aru Island).

Tomaszewska and Szawaryn (2013), and Szawaryn and Tomaszewska (2013) revised Asian and Papuan species of *Afidentula*. They concluded that the mainland species of the *Afidentula* form uniform group which can be characterized by: comparatively small body, brown colour with black markings on elytra, compact and short mandibles provided with three apical teeth of which only middle one is sometimes weakly serrated, maxilla with basistipes and mediastipes separated entirely or almost so, terminal labial palpomere shorter than subterminal one, tibial spurs absent, tarsal claw with basal tooth present, and sternite VIII in females undivided. Species from New Guinea and Aru Island are considerably different having among others the body much larger and entirely black or black with orange spots on elytra, mandibles large and thin laterally with apical and subapical teeth, often additionally serrated, elytral epipleura complete (incomplete in *Afidentula*), the distance between antennal sockets about three or four times greater than a distance between antennal socket and inner margin of eye (in *Afidentula* this distance is about twice as great), coxites with styli and the tegmen with stout parameres. For New Guinean species Szawaryn and Tomaszewska (2013) proposed a new genus *Papuaepilachna* and for *A. aruensis* from Aru Island a new genus *Lalokia*.

Szawaryn et al. (2015) conducted phylogenetic research on Epilachnini based on molecular and morphological data. According to this study, both *Afidenta* and *Afi-*

dentula have not been recovered as monophyletic groups and each of them has been redefined. Studied species of *Afidentula* from Africa formed monophyletic clade with Asian mainland species of *Afidentula* and exclusion of the Papuan species from *Afidentula* has been confirmed by the study. From among two species of *Afidentula* from Asia, the type species (*A. misera*) was studied and it formed a separate clade by itself, based on the following combination of characters: ventral surface of the mandible densely tuberculate, galea transversely oval, terminal palpomere of labium distinctly narrower than penultimate one, metaventral postcoxal lines joined or almost so on metaventral process, forming somewhat w-shaped line along discrimen, male tergite VIII rounded apically and styli absent. The definition of *Afidentula* has been extended after inclusion of African species of *Afidentula* and some Malagasy *Epilachna* and *Henosepilachna*, and it has been characterized by the following combination of characters: gular sutures shorter than half-length of gula, mandibular incisor edge without teeth, terminal maxillary palpomere weakly elongate, expanded apically, labial apical palpomere distinctly narrower than penultimate palpomere and styli absent.

Based on the results of the phylogenetic analyses of Szawaryn et al. (2015), the present paper describes two new species of *Afidentula* from China, *A. dentata* sp. n. and *A. jinpingensis* sp. n. The study of *Afidentula siamensis* permits the move of this species from *Afidentula* to *Afidentula* as *Afidentula siamensis* comb. n., confirming with this that *Afidentula* now includes only one species.

Material and methods

The external morphology was observed with a dissecting stereoscope (SteREO Discovery V20, Zeiss and Leica Mz Apo). The following measurements were made with an ocular micrometer: total length, length from apical margin of clypeus to apex of elytra (TL); total width, width across both elytra at widest part (TW=EW); height, from the highest part of the beetle to elytral outer margins (TH); head width in front view, widest part (HW); pronotal length, from the middle of anterior margin to margin of basal foramen (PL); pronotal width at widest part (PW); elytral length, along suture, from the apex to the base including scutellum (EL). Male and female genitalia were dissected, cleared in 10% solution of NaOH by boiling for several minutes, and examined with an Olympus BX51 and Leica compound microscope.

Morphological characters were photographed with digital cameras (AxioCam HRc and Coolsnap-Procf & CRI Micro*Color), connected to the dissecting microscope. The software AxioVision Rel. 4.8 and Image-Pro Plus 5.1 were used to capture images from both cameras, and photos were cleaned up and laid out in plates with Adobe Photoshop CS 8.0.

Coccinellidae morphological terms follow Ślipiński (2007) and Ślipiński and Tomaszewska (2010). Type specimens designated in the present paper are deposited at SCAU-the Department of Entomology, South China Agriculture University, Guangzhou, China.

Taxonomy

Genus *Afidentula* Kapur

Afidentula Kapur, 1958: 324. Type species: *Epilachna manderstjernae* Mulsant, 1853 (by original designation). – Jadwiszczak and Węgrzynowicz 2003; Kovár 2007; Ren et al. 2009; Tomaszewska and Szawaryn 2013; Szawaryn et al. 2015.
part of *Afidentia* Dieke, 1947; Szawaryn et al. 2015.
part of *Epilachna* Chevrolat in Dejean, 1837; Szawaryn et al. 2015.
part of *Henosepilachna* Li in Li & Cook, 1961; Szawaryn et al. 2015.

Diagnosis and comments. Species of *Afidentula* are most similar to *Afidentia* by the general body shape and colouration (Figs 1a–d, 2a–c, 3a–d, 4a–c), bifid tarsal claws with a large basal tooth (Figs 1k, 2k), abdominal sternite VIII in female not divided longitudinally and female genitalia with oval coxites lacking styli (Figs 1h, o, 2d, o, 3e, j, 4d). *Afidentula* in the present sense (Szawaryn et al. 2015) constitutes morphological pretty diverse group, especially after inclusion of some species of former *Epilachna* and *Henosepilachna* from Madagascar. The Asian species of *Afidentula*, however, can be easily distinguished from *Afidentia* (and other Epilachnini genera) by the following combination of characters: mandibular incisor edge smooth (incisor edge microdenticulate in *Afidentia*, Fig. 1e), ventral surface of incisor edge without tubercles, terminal labial palpomere narrower and shorter than penultimate one (narrower but as long as penultimate one in *Afidentia*), metaventral postcoxal lines joined on metaventral process in form of straight line (forming somewhat w-shaped line along discrimen in *Afidentia*), tibial spurs absent (present in *Afidentia*, Figs 1i–j), abdominal postcoxal lines complete or almost so (distinctly incomplete in *Afidentia*, Fig. 1h), tegminal strut triangularly expanded apically (simple in *Afidentia*, Fig. 1m–n), parameres shorter than penis guide and very narrow (in *Afidentia*, parameres as long as penis guide and much broader than in *Afidentula*, Fig. 1m–n).

Afidentula is also similar to *Afissa* Dieke (= *Afissula* Kapur) in general appearance, but it can be separated by having antennae distinctly shorter than width of the head and with at least antennomeres 7 and 8 subquadrate (in *Afissa* antennae are longer than width of head and have antennomeres 3–8 elongate) and tibiae without apical spurs (tibial spurs present in *Afissa*).

Monographic revision of all Epilachnini genera based on the results of phylogenetic analysis is in preparation (Tomaszewska and Szawaryn, in prep.) and richly illustrated; detailed descriptions of all genera will be provided there.

Distribution. Asia and Africa.

Key to the Asian species of *Afidentula*

(based on Tomaszewska and Szawaryn 2013)

- 1 Background of elytra black, covered with yellowish orange, round spots (Fig. 4a–c)..... *A. jinpingensis* sp. n.

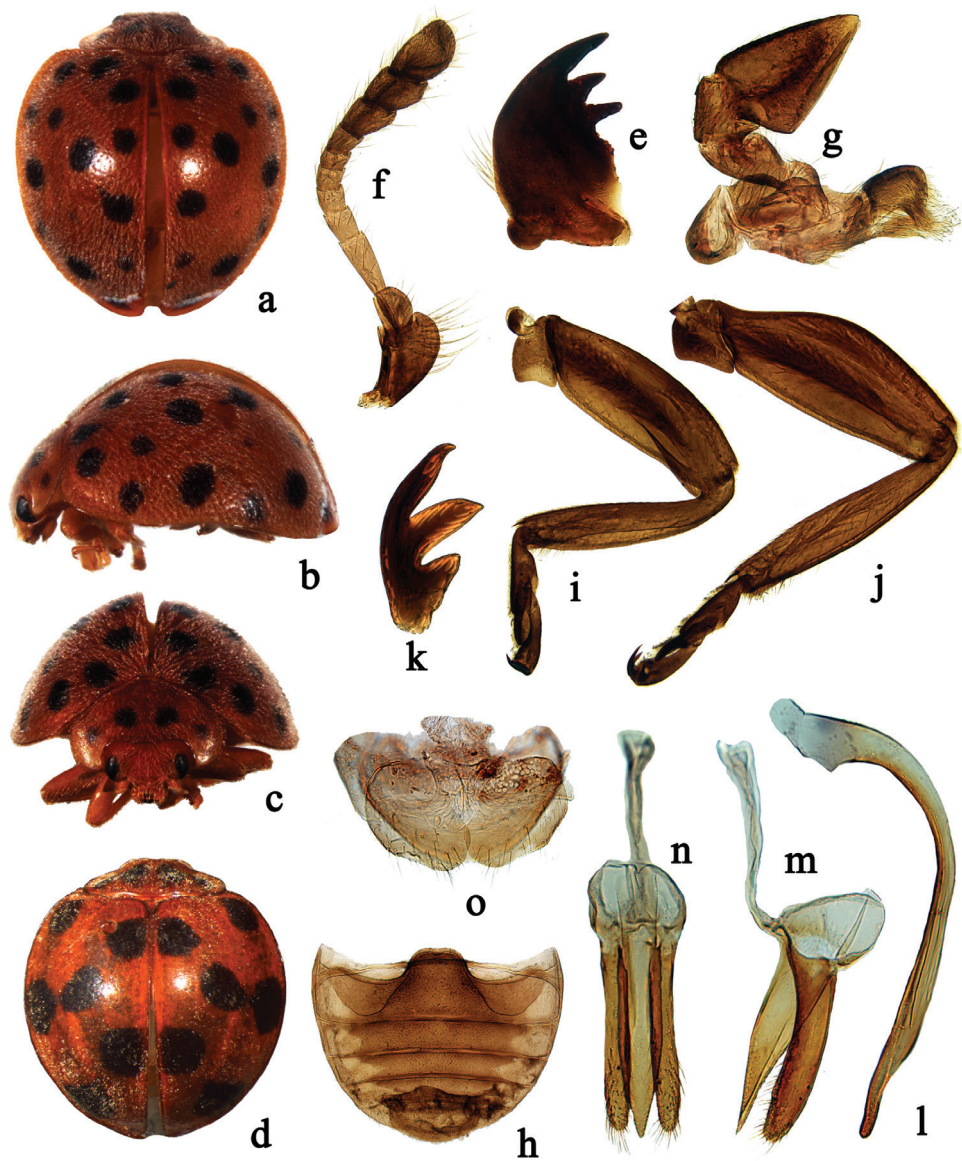


Figure 1. *Afidentula misera* (Weise, 1909). (a, d) dorsal habitus b lateral habitus c frontal habitus e mandible f antenna g maxilla h abdomen i front leg j hind leg k tarsal claw l-n male genitalia: l penis m tegmen, lateral view n tegmen, ventral view o ovipositor.

- Background of elytra brown, covered with black spots or bands2
- 2 Lateral and basal margins of elytra black; disk of each elytron with three round-oval, black spots *A. minima* (Gorham)
- Lateral and basal margins of elytra brown like elytral background; each elytron with more than three spots, rarely some of them may be fused and arranged in transverse bands3

- 3 Each elytron with four black spots 4
- Each elytron with more than four spots or with transverse bands 6
- 4 Body 1.13 times as long as wide, heart-shaped; elytra chestnut brown; epipleura about 3.5 times wider than metepisternum
..... ***A. semisqualens* Tomaszewska & Szawaryn**
- Body 1.24–1.43 times as long as wide, oval; elytra reddish brown or orange; epipleura at most 2.65 times wider than metepisternum 5
- 5 Labial palpomere 2 at most 1.15–1.20 times longer than terminal palpomere; prosternal process about 0.28–0.30 times as wide as longest procoxal diameter, truncate apically; penis guide with sharp tooth in apical fourth and short incision at apex ***A. bisquadrupunctata* (Gyllenhal)**
- Labial palpomere 2 1.35–1.50 times longer than terminal palpomere; prosternal process about 0.34–0.36 times as wide as longest procoxal diameter, weakly rounded apically; penis guide with blunt tooth in apical fourth and without incision at apex ***A. thanhsonensis* Hoàng**
- 6 Body larger, 4.90–5.33 mm long; long-oval, 1.38–1.43 times as long as wide; elytra 1.17–1.20, almost parallel-sided 7
- Body smaller, 2.83–4.80 mm long; short-oval, 1.16–1.33 times as long as wide; elytra 0.97–1.13 times as long as wide, oval 8
- 7 Head black; mesoventral process about 0.55 times as wide as mesocoxal diameter; meso- and metaventrite without distinct grooves behind anterior raised borders ***A. quindecimguttata* (Dieke)**
- Head red or reddish brown; mesoventral process about 0.65 times as wide as mesocoxal diameter; with distinct groove behind anterior raised border of mesoventrite and behind raised border of metaventral process
..... ***A. himalayana* Kapur**
- 8 Elytron with medio-anterior spot distant from scutellum and suture; body 2.83–3.68 mm long ***A. manderstjernae* (Mulsant)**
- Elytron with medio-anterior spot touching at least suture; body 3.85–4.80 mm long 9
- 9 Medio-anterior spot on each elytron touching one another along suture but constitute distinct separate spots; antennomere 4 slightly longer than 5; penis guide in anterior view gradually narrowing from mid length to apex
..... ***A. stephensi* (Mulsant)**
- Medio-anterior spot on each elytron fused together forming one macula; antennomere 4 not longer than 5 (Figs 2a–b, 3a–d); penis guide in ventral view subparallel or even widening before apex (Figs 2n, 3i) 10
- 10 Antennomere 4 and 5 subequal in length; pronotum with large black spot which almost cover whole surface of pronotum (Fig. 3c); apex of penis with two tooth-shaped processes directed inwardly (Fig. 3f–g) .. ***A. dentata* sp. n.**
- Antennomere 4 shorter than 5; pronotum with two, separate large black spots (Fig. 2c); apex of penis with small, sharp process directed outwardly (Fig. 2l) ***A. siamensis* (Dieke)**

***Afidentula siamensis* (Dieke, 1947), comb. n.**

Figures 2, 5

Afissa siamensis Dieke, 1947: 127.*Afidenta siamensis*: Pang and Mao 1979: 119; Cao 1992: 221; Ren et al. 2009: 250.

Diagnosis. This species is most similar to *A. dentata* and *A. stephensi* (known from India and Pakistan) but can be distinguished from both by having pronotum with two large black oval spots, apex of penis with small sharp process directed outwardly (Fig. 2a–c, 2l) and apex of penis guide curved outwardly (Fig. 2m–n).

Description. TL: 4.0–4.3 mm, TW: 3.0–3.7 mm, TH: 1.8–2.1 mm, TL/TW: 1.16–1.33; PL/PW: 0.35–0.36; EL/EW: 0.97–1.13; HW/TW: 0.30; PW/TW: 0.77.

Body short oval, dorsum strongly convex, densely pubescent (Fig. 2a–c). Head yellowish brown. Pronotum yellowish brown except anterior corners yellowish white, with two large black, triangularly-oval spots. Scutellum yellowish brown. Elytra yellowish brown, with 14 rounded black spots, arranged as in Fig. 2a–c. Underside yellowish brown, except metaventricle and middle area of abdomen black. Epipleura and legs yellow.

Head with frontal punctures moderately large and densely distributed, 0.8–1.0 diameters apart, associated with scattered long setae; interocular distance 0.64 times head width (Fig. 2c). Pronotal disk with fine and densely distributed punctures, distinctly smaller than those on head, 2.0–4.0 diameters apart. Elytra dually punctate; large punctures 1.0–6.0 diameters apart and small ones 1.0–4.0 diameters apart. Surfaces of prosternum and mesoventrite shagreened, with scattered short setae. Metaventricle broad with fine and densely distributed punctures, 2.0–4.0 diameters apart.

Male genitalia. Penis short and stout, strongly curved at base, apex with small and sharp process directed inwardly, capsule inconspicuous (Figs 2l). Tegmen stout (Fig. 2m–n); penis guide in lateral view widest at base and narrowing to apex, strongly curved outwardly at apical 1/4, apex pointed (Fig. 2m); parameres slender, distinctly shorter than penis guide (Fig. 2m); penis guide in ventral view flattened and asymmetrical at apex, lateral margins almost parallel, apex blunt (Fig. 2n).

Female terminalia and genitalia. Proctiger (TX) triangularly pointed at apex. Coxites oval, without styli, apical margin with several setae. (Fig. 2o). Spermatheca not studied.

Specimens examined. Holotype. Nan, Siam, Jan. 27/28, Cockerell/ Type No. 57138 USNM/ *Afissa siamensis* Dieke, holotype.

CHINA, Yunnan Prov.: 1 male, Jiluoshan, Xishuangbanna National Natural Reserve, Mengla County, 6.v.2009, Wang XM et al. leg; 1 female, Lafu, Menglian County, 1130m, 7.v.2008, Wang XM et al. leg; Guizhou Prov.: 3 males, Dadugang, Badu Town, Ceheng County, 15.x.2006, Wang XM leg.

Distribution. China: Guizhou, Yunnan; Thailand.

Remark. Pang and Mao (1979) transferred *Afissa siamensis* Dieke into *Afidenta* without any explanation. However, a detailed examination of *A. siamensis* and *Afidenta misera* left no doubt that they do not belong to a same genus, and that diagnostic characters of *A. siamensis* match *Afidentula*. Thus this species is formally transferred to the genus *Afidentula*.

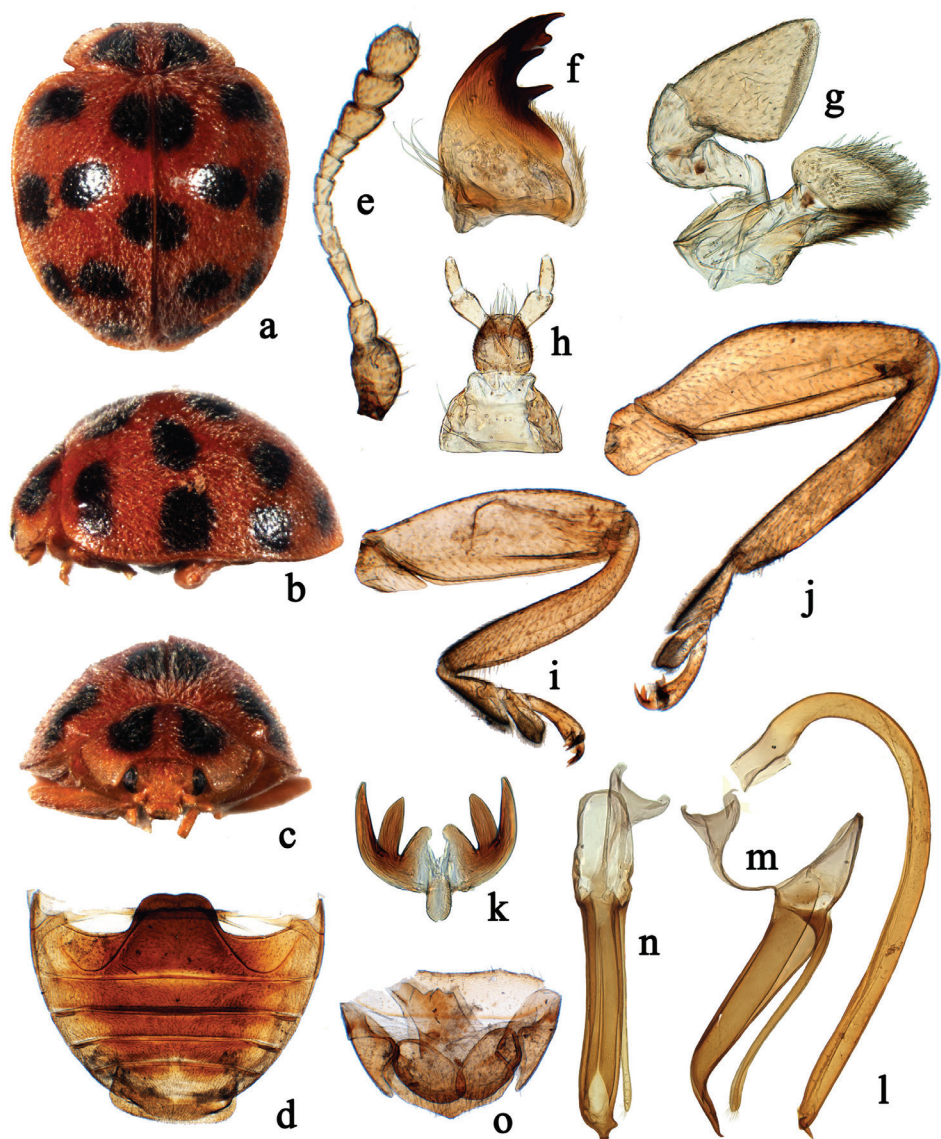


Figure 2. *Afidentula siamensis* (Dieke, 1947), comb. n. **a** dorsal habitus **b** lateral habitus **c** frontal habitus **d** abdomen **e** antenna **f** mandible **g** maxilla **h** labium **i** front leg **j** hind leg **k** tarsal claw **l–n** male genitalia: **l** penis **m** tegmen, lateral view **n** tegmen, ventral view **o** ovipositor.

***Afidentula dentata* sp. n.**

<http://zoobank.org/A8E6482A-BBA3-432C-BC20-F072867D7C5F>

Figures 3, 5

Diagnosis. This species is most similar to *A. siamensis* in general appearance and coloration, e.g. having two mutual maculae on elytra along suture (anteriorly and medi-

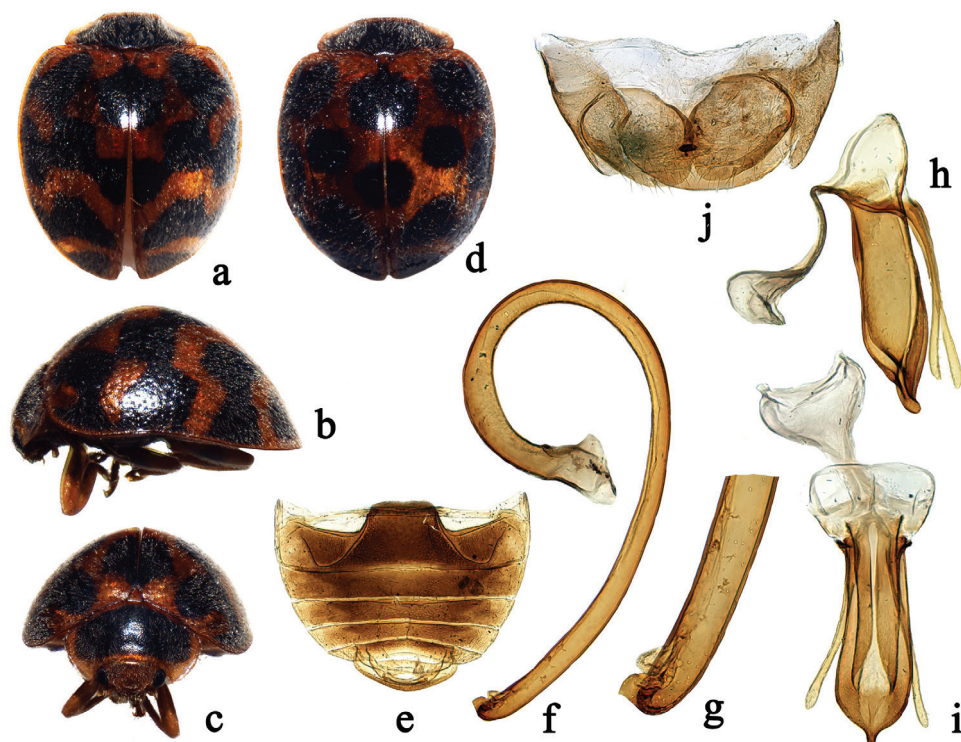


Figure 3. *Afidentula dentata* sp. n. (a, d) dorsal habitus b lateral habitus c frontal habitus e abdomen f-h male genitalia: f penis g apex of penis h tegmen, lateral view i tegmen, ventral view j ovipositor.

ally) but can be distinguished from the latter by having pronotum with a large black spot which almost covers entire surface of the pronotum leaving only lateral and anterior margins brown (Fig. 3a-d), and apex of penis with two tooth-shaped appendices inwardly (Fig. 3f-g). In *A. siamensis*, pronotum has two large black spots, and apex of penis has a small and sharp process directed outwardly (Fig. 2a-c, l).

Description. TL: 4.20–4.80 mm, TW: 3.40–3.90 mm, TH: 1.90–2.40 mm, TL/TW: 1.23–1.24; PL/PW: 0.42–0.43; EL/EW: 0.97–1.03; HW/TW: 0.31; PW/TW: 0.62.

Body short oval, dorsum strongly convex, densely pubescent (Figs 3a-d). Head yellowish brown. Pronotum mostly black with only lateral and anterior margins yellowish brown (Fig. 3c). Scutellum yellowish brown. Elytra yellowish brown, with 14 rounded black spots arranged as in Figures 3d; spots may connect to each other forming transverse bands (Fig. 3a, b). Underside yellowish brown, except meso-, metaventricle and middle area of abdomen dark brown. Epipleura yellowish brown, except areas close to meso- and metaventricle dark brown. Legs yellow.

Head with frontal punctures fine and densely distributed, 1.0–1.5 diameters apart, associated with scattered long setae; interocular distance 0.67 times head width (Fig. 3c). Pronotal disk with fine and densely distributed punctures, slightly smaller than those on head, 1.0–2.0 diameters apart. Elytral disk dually punctate, large punctures

1.0–6.0 diameters apart and small ones 2.0–4.0 diameters apart. Surfaces of prosternum and mesoventrite shagreened, with scattered short setae. Metaventricle broad with fine and densely distributed punctures, 1.0–2.0 diameters apart.

Male genitalia. Penis stout, strongly curved, apex with two tooth-shaped appendixes directed inwardly, capsule inconspicuous (Fig. 3f–g). Tegmen stout (Fig. 3h–i); penis guide in lateral view short and stout, widest at base, lateral margins almost parallel along basal 4/5, and then suddenly narrowed to apex, apex slightly curved outwardly (Fig. 3h). Parameres slender and almost straight, distinctly shorter than penis guide (Fig. 3h). Penis guide in ventral view flattened and symmetrical, widest at apical 1/10, gradually weakly narrowing to base but strongly narrowing to apex, apex finger-shaped protruded (Fig. 3i).

Female terminalia and genitalia. Proctiger (TX) rounded apically. Coxites oval, without styli, apical margin with small protuberance and several setae (Fig. 3j). Spermatheca not studied.

Types. **Holotype:** male, CHINA, Yunnan Prov.: Menglun, Xishuangbanna National Natural Reserve, Mengla County, 21.viii.2005, Wang XM leg; **Paratypes (110):** CHINA, Yunnan Prov.: 3 males, same data as holotype; 1 male, Longmen Village, Shangyong Town, Mengla County, 1.v.2008, Wang XM leg; 2 males, Menglun, Xishuangbanna National Natural Reserve, Mengla County, 29.iv.2008, Wang XM leg; 1 female, Yaoqu Village, Mengla County, 700m, 7–8.v.2009, Ren SX leg; 30 females and males, Jiluoshan, Xishuangbanna National Natural Reserve, Mengla County, 28.iv.2008, Wang XM et al. leg; 11 females and males, Mengla Town, Mengla County, 1170m, 12.v.2009, Ren SX et al. leg; 5 females and males, Jiluoshan, Xishuangbanna National Natural Reserve, Mengla County, 6.v.2009, Wang XM et al. leg; 6 females and males, Caiyanghe Natural Reserve, Puer County, 4.v.2009, Wang XM et al. leg.; 7 females and males, Longtan, Ximeng County, 900m, 9–10.v.2008, Wang XM et al. Leg.; 11 females and males, Banhong, Nangunhe National Natural Reserve, 1790m, 14–15.v.2008, Wang XM et al. leg.; 33 females and males, Banlao, Nangunhe National Natural Reserve, 1100m, 16.v.2008, Wang XM et al. leg.

Distribution. China (Yunnan).

Etymology. The specific epithet is formed from the Latin adjective *dentatus*, referring to the apex of penis with two tooth-shaped processes.

Afidentula jinpingensis sp. n.

<http://zoobank.org/86095FE9-6635-4AB4-8903-1E926E8A0D88>

Figures 4–5

Diagnosis. This species can be easily distinguished from all other Asian species of *Afidentula* by having elytra black covered with 12 yellow spots (Fig. 4a).

Description. TL: 4.6–4.8 mm, TW: 3.7–4.0 mm, TH: 2.0–2.2 mm, TL/TW: 1.20–1.24; PL/PW: 0.43–0.46; EL/EW: 1.05–1.08; HW/TW: 0.28; PW/TW: 0.62.

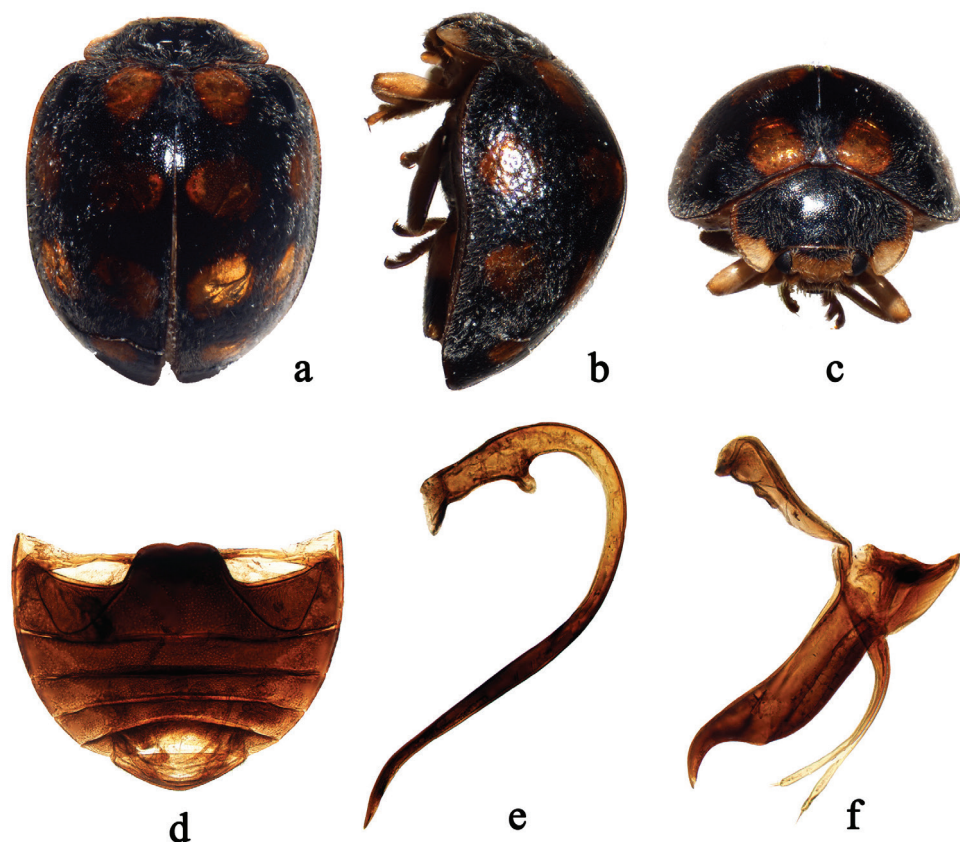


Figure 4. *Afidentula jinpingensis* sp. n. **a** dorsal habitus **b** lateral habitus **c** frontal habitus **d** abdomen **e–f** male genitalia: **e** penis **f** tegmen, lateral view.

Body short oval, dorsum strongly convex, densely pubescent (Figs 4a–c). Head with frons yellowish brown and occiput black. Pronotum black with anterior corners pale yellow. Scutellum black. Elytra black, each elytron with six yellow spots, arranged as 1-2-2-1. Underside yellowish brown, except metaventrite black. Epipleura yellowish brown at basal 1/3 and dark brown at apical 2/3. Legs yellowish brown.

Head with frontal punctures fine, 1.0–2.0 diameters apart, associated with scattered long setae; interocular distance 0.64 times head width (Fig. 4c). Pronotal disk with fine and densely distributed punctures, slightly larger than those on head, 0.5–1.0 diameters apart. Elytral disk dually punctate; large punctures 1.0–6.0 diameters apart and small ones 1.0–4.0 diameters apart. Surfaces of prosternum and mesoventrite shagreened, with scattered setae. Metaventrite broad with fine and inconspicuous punctures.

Male genitalia. Penis stout, strongly curved, apex simple and pointed, capsule with an expanded outer arm and a small inner one (Fig. 4e). Tegmen stout (Fig. 4f); penis guide in lateral view subparallel along 4/5 of its length and hook-like at apex; apex curved outwardly; parameres extremely slender, distinctly shorter than penis guide.

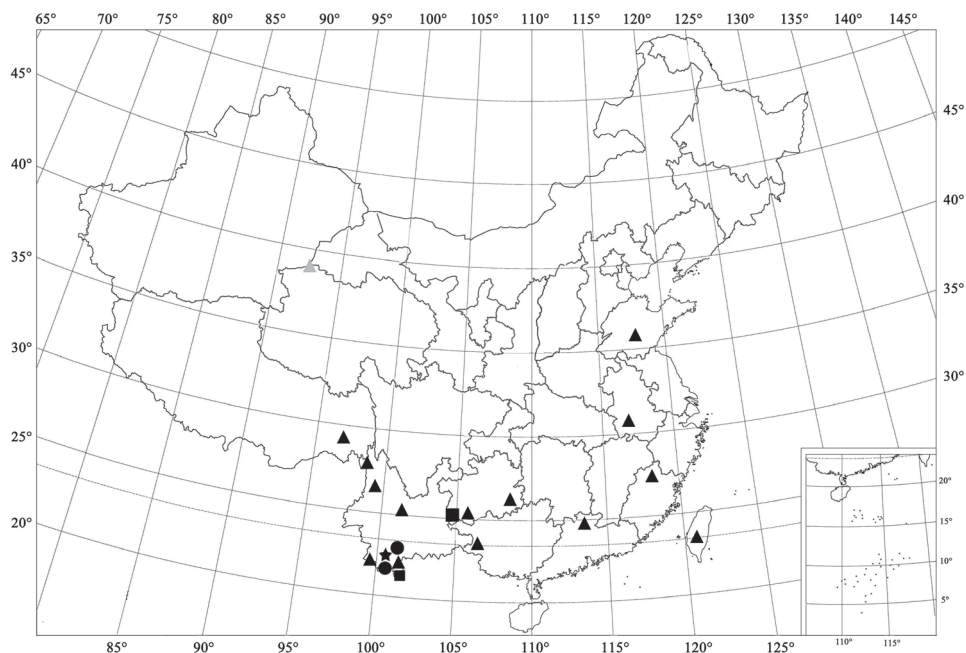


Figure 5. Distribution map. *Afidentula misera* (Weise, 1909) (▲); *Afidentula siamensis* (Dieke, 1947), comb. n. (■); *Afidentula dentata* sp. n. (●); *Afidentula jingpingensis* sp. n. (★).

Female genitalia not known.

Types. Holotype: male, CHINA, Yunnan Prov.: Fenshuiling National Natural Reserve, Jingpin County, 1800–2200m, 18.v.2009, Ren SX leg.

Distribution. China (Yunnan).

Etymology. The specific epithet is named after Jingpin County, China, the type locality of this ladybird.

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References

- Bielawski R (1961) Materialien zur Kenntnis der *Coccinellidae* (Coleoptera). II. Annales Zoologici (Warszawa) 19(10): 383–415. [1960–1961]

- Bielawski R (1963) Monographie der Epilachninae (Coleoptera: Coccinellidae) der Australischen Region. Annales Zoologici 21(17): 295–461.
- Bielawski R (1965) Four new species of the genus *Afidentula* Kapur (Coleoptera, Coccinellidae) from New Guinea. Annales Zoologici 23(4): 45–55. [1965–1966]
- Booth RG, Pope RD (1989) A review of the type material of Coccinellidae (Coleoptera) described by F.W. Hope, and by E. Mulsant in the Hope Entomological Collections, Oxford. Entomologia scandinavica 20: 343–370. doi: 10.1163/187631289X00366
- Cao C, Pan Y, Wang H (1992) Coccinellidae of Yunnan. Yunnan Science & Technology Publishing House, Kunming, 242 pp. [In Chinese]
- Chazeau J (1975) Nouvelles especes d'Epilachninae de Madagascar (Coleopteres, Coccinellidae). Cahiers ORSTOM (Serie Biologie) 10(1): 41–59.
- Chazeau J (1976) Nouvelles especes d'Epilachninae de Madagascar (Coleopteres, Coccinellidae). Cahiers ORSTOM (Serie Biologie) 11(2): 69–84.
- Dieke GH (1947) Ladybeetles of the genus *Epilachna* (sens. lat.) in Asia, Europe, and Australia, Smithsonian Miscellaneous Collections, 106(15): 1–183.
- Dejean PFMA (1837) Catalogue des Coleopteres de la Collection de M. le Comte Dejean. Troisieme edition, revue, corrigee et augmentee. Mequignon-Marvis Peres & Fils, Paris, 503 pp.
- Fürsch H (1986) Die afrikanischen Vertreter der Gattung *Afidentula* (Coccinellidae, Col.). Koeopterologische Rundschau, Wien 58: 83–104.
- Gorham HS (1894) On the *Coccinellidae* from India in the Collection of MT H. E. Andrewes of the Indian Forest Service. Annales de la Societe Entomologique de Belgique 38: 200–208.
- Hoàng DN (1977) Epilachninae (Coleoptera, Coccinellidae) of the Northern Viet Nam. I. Revue d'Entomologie de l'URSS 56(1): 132–145.
- Jadwiszczak A, Węgrzynowicz P (2003) World Catalogue of Coccinellidae. Part I-Epilachninae. Mantis, Olsztyn, 264 pp.
- Jadwiszczak A (1986) Materials to the knowledge of the Epilachninae (Coleoptera, Coccinellidae) of New Guinea and Solomon Islands with the description of two new species. Polish Journal of Entomology 56: 249–261.
- Kapur AP (1958) *Coccinellidae* of Nepal. Records of the Indian Museum 53: 309–338.
- Kapur AP (1963) The Coccinellidae of the third Mount Everest expedition, 1924 (Coleoptera). Bulletin of the British Museum (Natural History), Entomology 14(1): 1–48.
- Kovář I (2007) New nomenclatorial and taxonomic acts and comments Coccinellidae. In: Löbl I, Smetana A (Eds) Catalogue of Palaearctic Coleoptera. Apollo books, Stenstrup, 568–631
- Li CS, Cook EF (1961) The Epilachninae of Taiwan (Col.: Coccinellidae). Pacific Insects, Honolulu 3(1): 31–91.
- Mulsant E (1853) Supplément a la Monographie des Coléoptères Trimères Sécuripalpes. Annales de la Société Linneenne de Lyon, Nouvelle Série, 1[1852–1853]: 129–333. doi: 10.5962/bhl.title.60609
- Pang XF, Mao JL (1979) Coleoptera: Coccinellidae II. Economic Entomology China, 14. Science Press, China, Beijing, 170 pp. [In Chinese]

- Ren SX, Wang XM, Pang H, Peng ZQ, Zeng T (2009) Colored Pictorial Handbook of Ladybird Beetles in China. Science Press, China, Beijing, 336 pp. [In Chinese]
- Ślipiński A (2007) Australian ladybird beetles (Coleoptera: Coccinellidae) their biology and classification. ABRS, Canberra, 286 pp.
- Ślipiński SA, Tomaszewska W (2010) Coccinellidae Latreille, 1802. In: Leschen RAB, Beutel RG, Lawrence JF (Eds) Handbook of Zoology, Vol. 2, Coleoptera. Walter de Gruyter, Berlin and New York, 454–472.
- Szawaryn K, Tomaszewska W (2013) Two new genera of Epilachnini Mulsant from New Guinea and Aru Islands (Coleoptera: Coccinellidae). Journal of Natural History 47(37–38): 2427–2457. doi: 10.1080/00222933.2012.763067
- Szawaryn K, Bocak L, Ślipiński A, Escalona HE, Tomaszewska W (2015) Phylogeny and evolution of phytophagous ladybird beetles (Coleoptera: Coccinellidae: Epilachnini), with recognition of new genera. Systematic Entomology 40: 547–569. doi: 10.1111/syen.12121
- Tomaszewska W, Szawaryn K (2013) Revision of the Asian species of *Afidentula* Kapur, 1958 (Coleoptera: Coccinellidae: Epilachnini). Zootaxa 3608(1): 26–50. doi: 10.11646/zootaxa.3608.1.2
- Weise J (1901) Coccinelliden aus Ceylon gesammelt von Dr. Hörn. Deutsche Entomologische Zeitschrift 1900(2): 417–445.
- Zeng T (1995) Appendix and corrections of Epilachninae from Guangxi, China. Guangxi Plant Protection 4: 4–5.

Three new species and distributional records for *Paramaronius* Wittmer (Coleoptera, Cantharidae, Chauliognathinae)

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Abstract

Three new species of *Paramaronius* Wittmer from southeastern Brazil are described and illustrated: *P. ser-ranus* **sp. n.**, *P. brancuccii* **sp. n.** and *P. cavipennis* **sp. n.** *Paramaronius impressipennis* (Pic) is redescribed, with supplementary description of the female. This species is recorded from Northeastern Brazil for the first time and its distribution pattern is discussed. A distribution map of *Paramaronius* in South America is provided. An identification key to all known species of the genus as well as photographs are given.

Keywords

Chauliognathini, description, distribution, key, taxonomy

Introduction

The genus *Paramaronius* Wittmer, 1963 is included in the group of short-elytra Chauliognathini and recognized by a remarkable sexual dimorphism (Wittmer 1963, Magis and Wittmer 1974, Brancucci 1981). It was established to include three species whose males present strong sculptural modifications and dense pubescence on the elytral surface: *Paramaronius kraatzii* (Pic, 1938), *P. freyi* Wittmer, 1963 and *P. murianus* Wittmer, 1963. Brancucci (1982) revised the genus, with description of *P. menieri* and proposed synonyms and new combinations: *Paramaronius impressipennis* (Pic, 1906)

and *P. gounellei* (Pic, 1906) were transferred from *Maronius* Gorham, 1881, and *Paramaronius murianus* and *Maronius minasensis* Pic, 1934 considered junior synonyms of *P. gounellei*. Brancucci also presented an identification key and a phylogenetic hypothesis for the five species. Later, Brancucci (1983) described *P. campbelli*.

In addition to the elytral modifications, Brancucci (1982) proposed the reduced right paramere divided apically, and the enlarged and dorsally projected right prolongation of the tegmen with an apophysis on its dorsal face as synapomorphies of *Paramaronius*.

In this study, three new species of *Paramaronius* from southeastern Brazil are described. The genus now includes nine species totally, which are distributed from French Guiana to northern Argentina and from the southeastern Brazilian coast to Bolivia and western Brazil, most frequently on highlands.

Material and methods

Acronyms of the institutions where the types and other examined specimens are deposited as following:

CEIOC	Coleção Entomológica do Instituto Oswaldo Cruz, Rio de Janeiro, Brazil;
CZMA	Coleção Zoológica do Maranhão, Caxias, Brazil;
DZUP	Coleção de Entomologia Pe. Jesus Santiago Moure, Universidade Federal do Paraná, Curitiba, Brazil;
MNHN	Muséum national d'Histoire naturelle, Paris, France;
MNRJ	Museu Nacional do Rio de Janeiro, Rio de Janeiro, Brazil;
MZSP	Museu de Zoologia da Universidade de São Paulo, São Paulo, Brazil;
NHM	Natural History Museum, London, England;
NHMB	Naturhistorisches Museum Basel, Basel, Switzerland.

The morphological terminology and methods of dissection follow Brancucci (1980, 1982) and Constantin (2008). Illustrations were produced via camera lucida attached to a Carl Zeiss Discovery V8 stereomicroscope. Photographs were taken with a Canon EOS Rebel T3i camera with Canon MP-E 65mm macro-lens, StackShot macro-rail and Griffi Equipamentos portable camera stand. Focus stacking was performed with software Zerene Stacker, version 1.04. Illustrations and photographs were edited in Adobe Photoshop CS6 and Adobe Illustrator CS6.

Localities for the distribution map were obtained from label data and compiled from literature (Wittmer 1963, Brancucci 1982, 1983). Those were plotted on software Google Earth v. 7.1.2.2041 and exported to Quantum GIS version 1.7.3-Wroclaw for edition of the final map, made with Natural Earth (2015).

Abbreviations of the genital structures: rpt: right prolongation of tegmen, ap: apophysis, lsp: left setiferous prolongation, rp: right paramere, lp: left paramere, ml: median lobe.

Results

Descriptions

Paramaronius serranus sp. n.

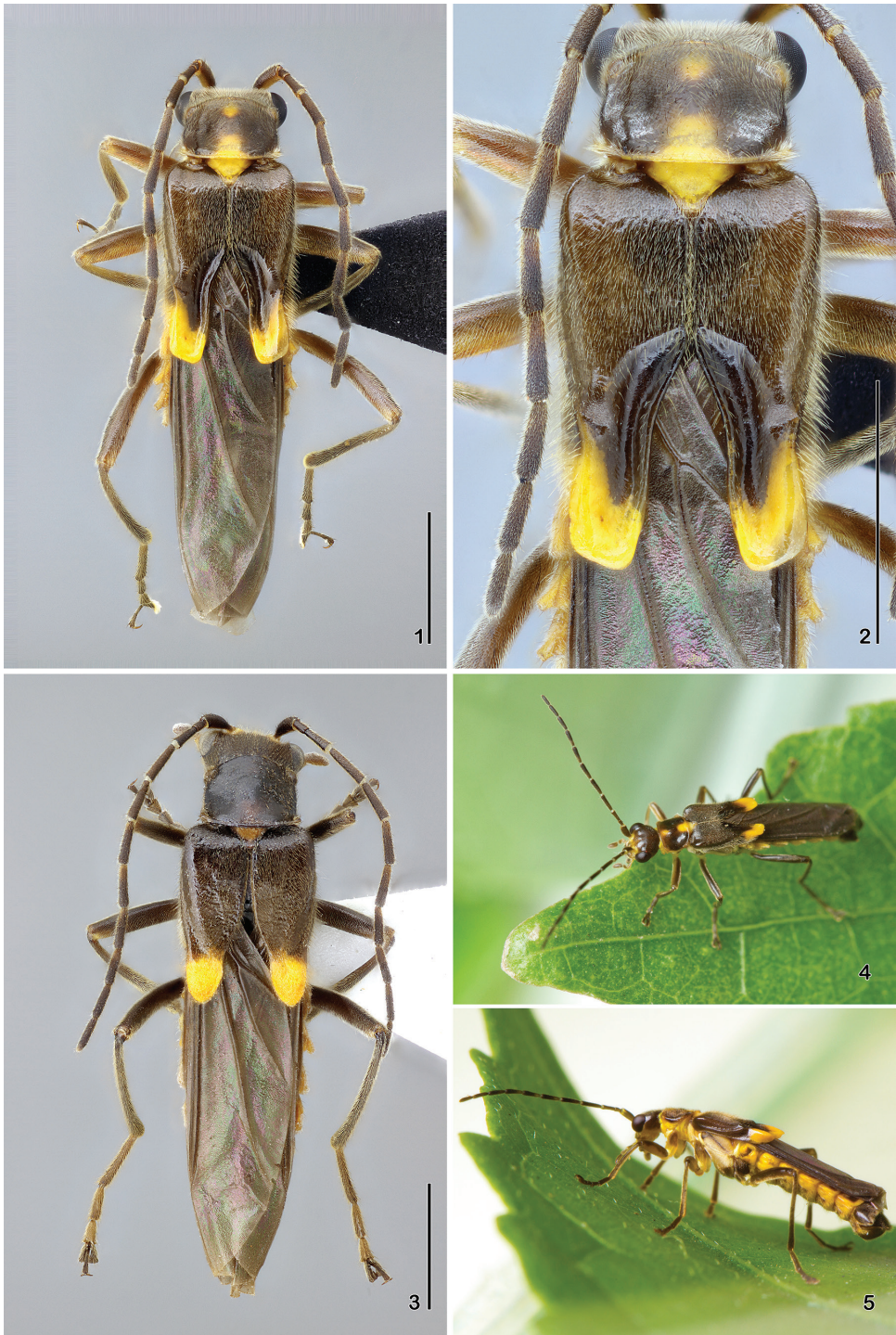
<http://zoobank.org/042F416D-FD46-446B-8AD4-15ABF5738BB6>

Figs 1–5, 14, 18, 19, 22, 26, 30

Type material. HOLOTYPE ♂: BRAZIL: São Paulo, Jundiaí (Reserva Biológica Serra do Japi), 23°14'20"S; 46°57'27"W, 8.xi.2011, Biffi, G. & Nascimento E.A. cols. (MZSP). PARATYPES: BRAZIL: São Paulo, Jundiaí (Reserva Biológica Serra do Japi), 23°14'20"S; 46°57'27"W, 8.xi.2011, Biffi, G. & Nascimento E.A. cols. (2♂, 3♀) (MZSP); same locality, 23–25.i.2012, Nascimento, E.A., Biffi, G. & Fernandes, F.R. (1♀ pinned; 1♂, 1♀ in alcohol) (MZSP); São Paulo, Bocaina [Serra da Bocaina], 27.x.1963, H.S. Lopes col. (1♂) (CEIOC); same locality, 27.x.1963, P. Ildo col. (1♀) (CEIOC); Minas Gerais (Serra do Caraça), 1380 m, xi.1961, Kloss, Lenko, Martins & Silva col. (1♂, 1♀) (MZSP).

Description. Holotype (Figs 4, 5): Head with the occipital region, vertex and apex of mandibles dark brown; frons, clypeus, genae and base of mandibles pale yellow. Frons presents a small and barely defined brown spot between the antennae. Antennomeres 1–3 dark brown dorsally and pale yellow ventrally; antennomeres 4–11 dark brown on the apex and lighter on the base. Labial and maxillary palpi pale yellow, and last palpomeres, light brown dorsally. Pronotum dark brown, with two medial yellow spots: one round anteriorly and another sub-rectangular posteriorly, reaching the posterior margins; posterior margin, anterior angles and hypomera pale yellow. Scutellum yellow with translucent apex. Elytra dark brown with yellow apices. Hind wings dark brown. Thorax pale yellow ventrally, with anterior margins of meso- and metanepisterna brown. Legs pale yellow, with the base of coxae, dorsal face of femora, apical and dorsal faces of tibiae and tarsi, brown. Abdominal tergites dark brown, with yellow borders; posterior borders of tergites VI and VII yellow; ventrites yellow with brown spots laterally; two last ventrites brown.

Male (Fig. 1): Head covered with fine and dense pubescence; vertex and occipital region flat; lateral margin of head arcuated behind the eyes. Eyes prominent. Antennae long, last two antennomeres exceeding the apex of elytra; antennomere 1 slender, 3.6 times longer than wide; antennomere 2 short, third antennomere 2 times shorter than antennomere 1, fourth to sixth subequal in length, as long as the antennomere 1, seventh antennomere is the longest, slightly longer than the antennomere 1, eighth to eleventh antennomeres progressively shorter than the seventh. Pronotum 1.15 times wider than long, longer at middle; anterior and posterior margins arcuated; lateral margins slightly sinuate; posterior angles directed upwards. Scutellum wide, triangular, with truncate apex. Elytra short, 1.5 times longer than wide; pubescence short, fine and dense; sutures dehiscent from apical half; apical half modified into a shallow impression forming glabrous slopes; truncate apex. Epipleura with a row of thin and longer setae born on a shallow groove directed backwards to meet a slight fold on dorsal face (Fig. 2). Legs



Figures 1–5. *Paramaronius serranus* sp. n. **1** male habitus, dorsal view **2** male elytra, dorsal view **3** female habitus, dorsal view **4** live male habitus, dorsal view **5** live male habitus, lateral view. Scale bars: 2.0 mm.

slender, hind tibia longer than hind femur; tarsomeres gradually increasing in size from fore to hind legs; first metatarsomere 1.9 times longer than second and 2.6 times longer than third. Abdominal glandular pores slightly prominent. Seventh abdominal ventrite (Fig. 14) wider than long, deeply emarginated forming two sharpened lobes with membranous apices. Aedeagus (Fig. 22) with right prolongation of tegmen large and slightly sinuous on the posterior margin, covered by long setae. Dorsal surface with a short apophysis. Left setiferous prolongation very long and curved, not clubbed, with few setae at apex. Right paramere (Fig. 26) short, narrow at base and very wide at apex, directed backwards, meeting dorsal apophysis of tegmen. Left paramere flat, short and wide, divided apically and partially covering the dorsal surface of median lobe. Median lobe (Fig. 30) long and curved to the right. Ventral and lateral surfaces of tegmen smooth.

Female (Fig. 3) slightly bigger than male; eyes smaller and less prominent; pronotum longer than of male with anterior margin more arched and lateral margins almost straight; dorsal surface of elytra without sculptural modifications; sutures gradually dehiscent from apical half. Seventh abdominal ventrite (Fig. 18) trapezoidal, with distal margin sinuate and emarginated at middle. Coxites elongated, narrow basally and more sclerotised at distal margins. Styles (Fig. 20) long and straight.

Color variations. Other specimens from the type locality are much more pigmented. In these cases the frons, clypeus, palpi, thorax and legs vary from dark brown to black; the yellow pronotal spots may be indistinct. On less pigmented specimens, the head is pale with a posterior V-shaped mark; pronotum broadly pale, the sides light brown; elytra light brown, with the apex yellow.

Etymology. The specific epithet is a derivative of the Portuguese word “serra” (mountain ranges), referring to the regions where the specimens were collected.

Distribution. Brazil (Minas Gerais and São Paulo) (Figs 44, 45).

Biological data. The specimens from Serra do Japi were collected on shrub vegetation across the most humid part of the trail near the Paraíso stream. The local vegetation is composed of a highland mesophyllous semideciduous forest (Leitão-Filho 1992).

***Paramaronius brancuccii* sp. n.**

<http://zoobank.org/8418A273-638E-46D8-A947-4C676ABBDA6B>

Figs 6, 7, 15, 23, 27, 31

Type material. HOLOTYPE ♂: BRAZIL: São Paulo, Pindamonhangaba (Eugênio Lefèvre), 26.x.1962, Exp. Dep. Zool. col. (MZSP). PARATYPES: BRAZIL: São Paulo, Pindamonhangaba (Eugênio Lefèvre), 26.x.1962, Exp. Dep. Zool. col. (1♂) (MZSP); Minas Gerais, Monte Verde, 10.xii.1969, F. Halik. (9266) (1♂) (MZSP)

Description. Head, clypeus and apex of mandibles dark brown; antennal sockets surrounded by a thin yellow ring; base of mandibles and labial and maxillary palpi light brown; last palpomeres darker. Antennae dark brown, with the ventral face of antennomere 1 lighter. Pronotum dark brown laterally and light brown medially; a barely defined yellow spot near anterior medial margin and a broader, yellow, medial,



Figures 6–9. 6–7 *Paramaronius brancuccii* sp. n. 6 male habitus, dorsal view 7 male elytra, dorsal view 8–9 *P. cavipennis* sp. n. 8 male habitus, dorsal view 9 male elytra, dorsal view. Scale bars: 2.0 mm.

basal spot reaching the posterior margin; posterior angles and hypomera pale yellow. Scutellum pale yellow. Elytra dark brown, with yellow apex. Hind wings brown. Thorax pale ventrally; metathorax gradually darker posteriorly. Legs dark brown, with apex of coxae and ventral surface of femora, pale. Abdominal tergites dark brown, with lateral borders yellow; posterior borders of tergites VI and VII yellow; ventrites dark brown with yellow spots basally and laterally; two last ventrites light brown.

Male (Fig. 6): Head covered with fine and dense pubescence; vertex and occipital region flat; lateral margin of head arcuate behind eyes. Eyes prominent. Antennae slender and long, last two antennomeres exceeding the apex of elytra; antennomere 1 slender, 3.6 times longer than wide; antennomere 2 short, third antennomere slightly shorter than antennomere 1, fourth to ninth antennomeres as long as the antennomere 1, tenth and eleventh slightly shorter than antennomere 1. Pronotum 1.1 times wider than long; anterior and posterior margins slightly arcuate; lateral margins slightly sinuate; posterior angles directed upwards. Scutellum wide, triangular, apex slightly rounded. Elytra (Fig. 7) short, 1.4 times longer than wide; pubescence long and dense; sutures slightly dehiscent apically; dorsal surface modified into a deep longitudinal incision which widens apically and are covered by a dense, long and thick pubescence. External margin of each elytron constricted laterally and with a large tubercle; apices broadly rounded. Legs slender; hind tibia longer than hind femur; tarsomeres gradually increasing in size from fore to hind legs; first metatarsomere twice longer than second and 3 times longer than third. Abdominal glandular pores slightly prominent. Seventh abdominal ventrite (Fig. 15) wider than long and deeply emarginated, forming two apical, narrow lobes with margins truncate. Aedeagus (Fig. 23) with right prolongation of tegmen very large and sinuous on posterior margin, with angles rounded and prominent laterally, and covered by large setae. Dorsal surface with a short apophysis. Left setiferous prolongation (Fig. 23) long and curved, slightly clubbed, with few setae at apex. Right paramere (Fig. 27) long, narrow at the base and divided in two asymmetrical processes: one lateral, short and one longitudinal, long, which reaches the apophysis of tegmen. Left paramere flat, short and wide, divided apically and partially covering dorsal surface of median lobe. Median lobe short and slightly curved to the right. Ventral and lateral surfaces of tegmen smooth (Fig. 31).

Female: Unknown.

Etymology. The specific epithet is patronymic, in honor of Dr Michel Brancucci (NHMB), eminent Cantharidae taxonomist, especially devoted to the Chauliognathinae, deceased in 2012 (Klausnitzer 2012).

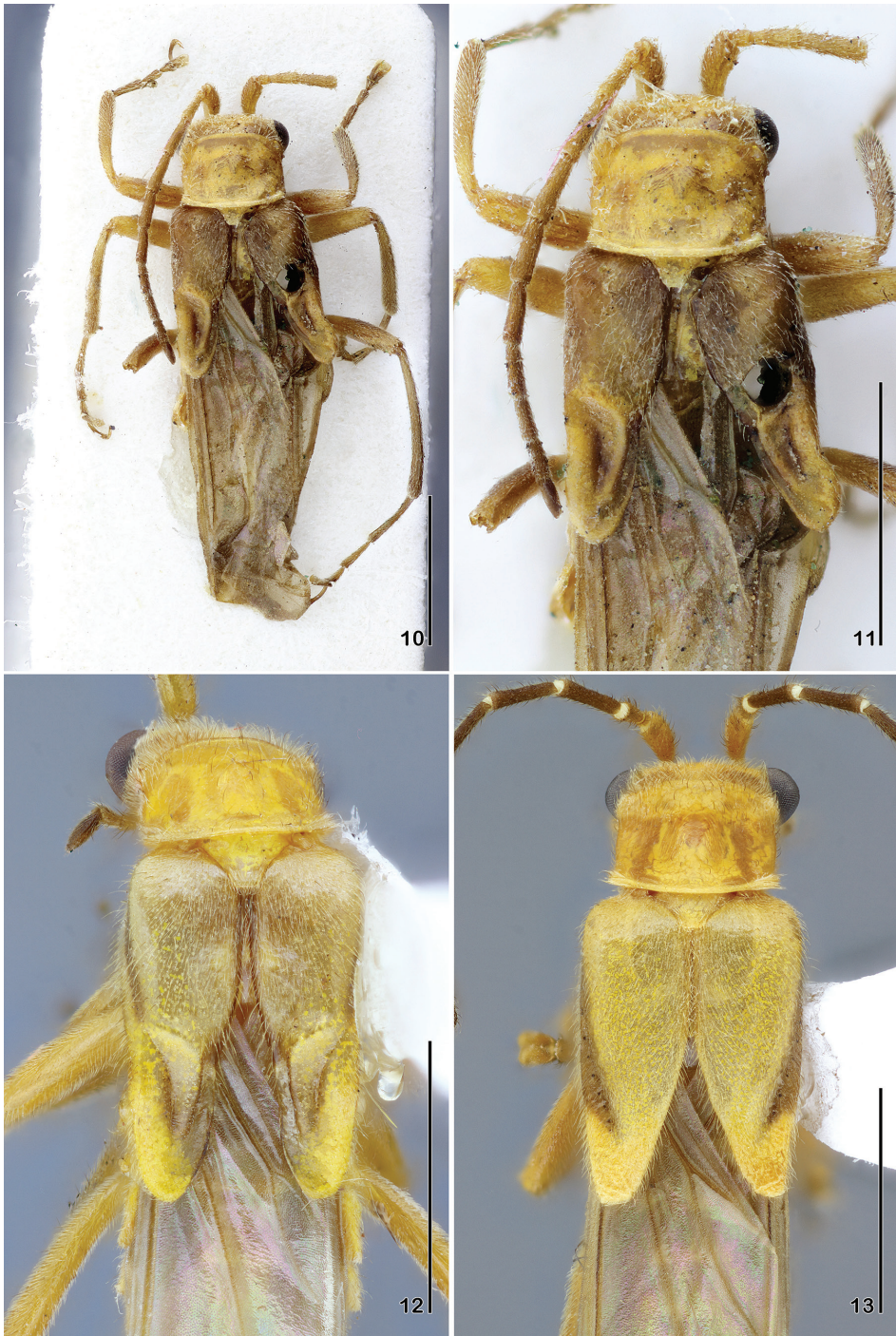
Distribution. Brazil (Minas Gerais and São Paulo) (Figs 44, 45).

***Paramaronius cavipennis* sp. n.**

<http://zoobank.org/7E1948A7-66DB-4CB1-9DC0-A96BBB150975>

Figs 8, 9, 16, 24, 28, 32

Type material. HOLOTYPE ♂: BRAZIL: Minas Gerais, Serra do Caraça, Santa Bárbara, 23–25.xi.1960, Araujo & Martins col. (MZSP).



Figures 10–13. 10–11 *Paramaronius impressipennis* (Pic), holotype 10 habitus, dorsal view 11 elytra, dorsal view 12–13 *P. impressipennis* (Pic) from Brazil 12 male elytra, dorsal view 13 female elytra, dorsal view. Scale bars: 2.0 mm.

Description. Head with the occipital region and vertex dark brown; frons, clypeus and mandibles light brown; base of antennae, genae, labium and ventral base of mandibles yellow. Antennae with antennomere 1 dark brown dorsally and light brown ventrally; last antennomeres lost. Labial and maxillary palpi light brown. Pronotum dark brown, with a median anterior small round yellow spot and a basal, median, bigger, yellow spot reaching posterior margin; hypomera yellow. Scutellum pale yellow with the apex translucent. Elytra light brown with yellow apices. Hind wings brown. Ventrally, thorax light brown, with anterior margins of meso- and metanepisterna dark brown. Legs totally dark brown. Abdominal tergites light brown with lateral margins yellow; ventrites light brown, with lateral margins yellow covered with dark brown spots; two last tergites and ventrites dark brown.

Male (Fig. 8): Head with short and dense pubescence; vertex and occipital region flat; lateral margins of head arcuate behind eyes. Antennae with antennomere 1 slender, 2.7 times longer than wide. Pronotum 1.1 times wider than long; anterior and posterior margins slightly rounded; lateral margins slightly sinuate; posterior angles slightly directed upwards. Scutellum wide, triangular, apex truncate. Elytra (Fig. 9) short, 1.5 times longer than wide; dorsal surface modified in a deep hollow surrounded by a scarce, long and thin pubescence, followed by a sloped surface covered by very short pubescence; external margins of elytra constricted laterally; sutures abruptly dehiscent from apical half; apex truncate, with rounded angles. Legs slender; hind tibia slightly longer than hind femur; tarsomeres gradually increasing in size from fore to hind legs; first metatarsomere 1.15 times longer than second and 2.5 times longer than third. Abdominal glandular pores slightly prominent. Seventh abdominal ventrite (Fig. 16) wider than long, densely pubescent, deeply emarginated forming two apical wide lobes with truncate apices. Aedeagus (Fig. 24) with a large right prolongation of tegmen, slightly sinuous on posterior margin, with one angle well developed and other truncate, and rather straight on lateral margin, covered with large setae. Dorsal surface with projecting apophysis. Left setiferous prolongation (Figs 24, 32) long and curved, slightly clubbed, with few setae at apex and on the dorsal surface. Right paramere (Fig. 28) long, curved, narrowing upwards and divided in two opposite processes reaching apophysis of tegmen. Left paramere flat, short and wide, divided apically and covering the base of dorsal surface of median lobe. Median lobe (Fig. 32) long and slightly curved to the right. Ventral and lateral surfaces of tegmen smooth.

Female: Unknown.

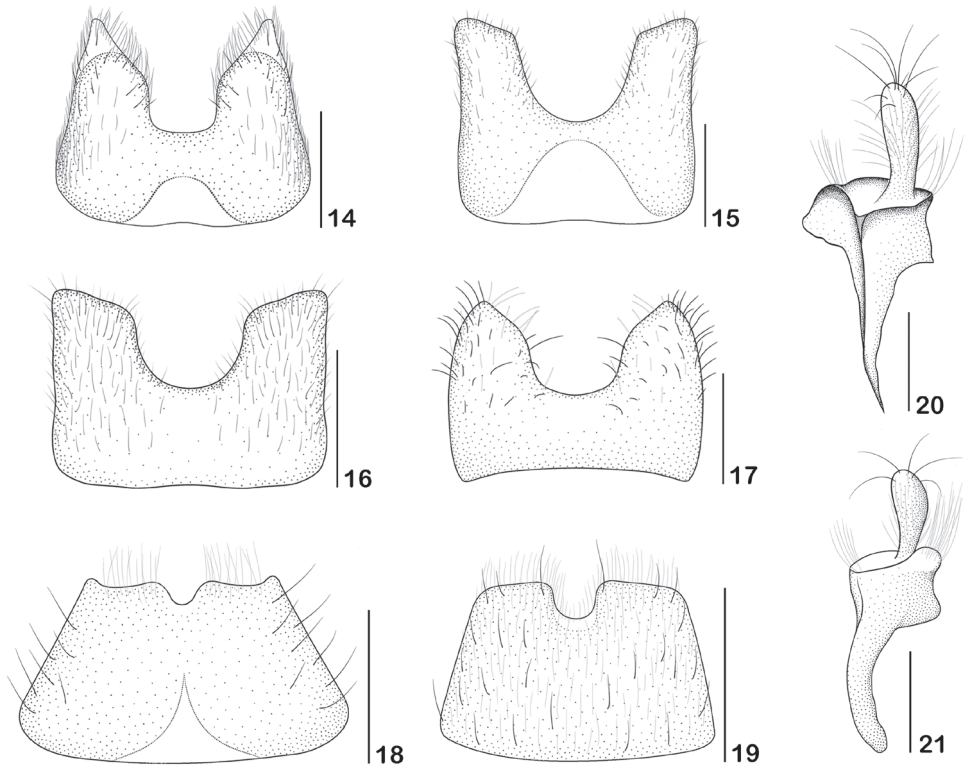
Etymology. The specific epithet is derivative of the Latin words *cavum* (cavity) + *pennis* (wings), referring to its deep hollows on dorsal surface of elytra.

Distribution. Brazil (Minas Gerais) (Fig. 44, 45).

Paramaronius impressipennis (Pic, 1906)

Figs 10–13, 17, 19, 21, 25, 29, 33

Remarks. This species was briefly described by Pic (1906) based on a male from Tucumán, northern Argentina. However, some specimens have been collected in the



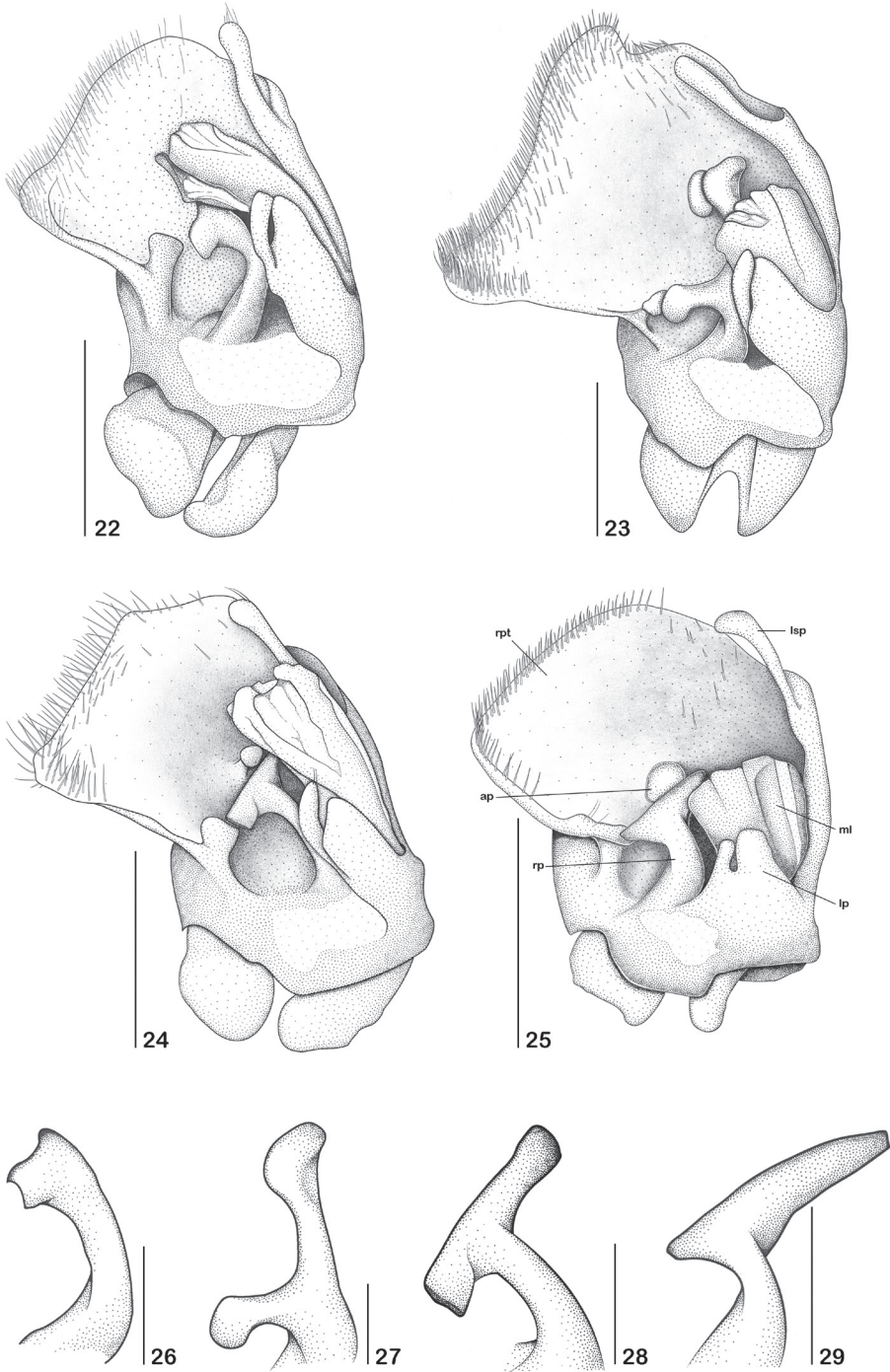
Figures 14–21. 14–17 Seventh abdominal ventrite of male, ventral view 18–19 seventh abdominal ventrite of female, ventral view 20–21 female right coxite, ventral view 14, 18, 20 *Paramaronius serranus* sp. n. 15 *P. brancuccii* sp. n. 16 *P. cavipennis* sp. n. 17, 19, 21 *P. impressipennis* (Pic). Scale bars: 0.5 mm (14–19); 0.2 mm (20–21).

northeastern region of Brazil (states of Bahia and Maranhão), far away from the type locality. The comparison of the Brazilian specimens with the holotype (MNHN) shows there are no observable differences within them and they are, indeed, the same species.

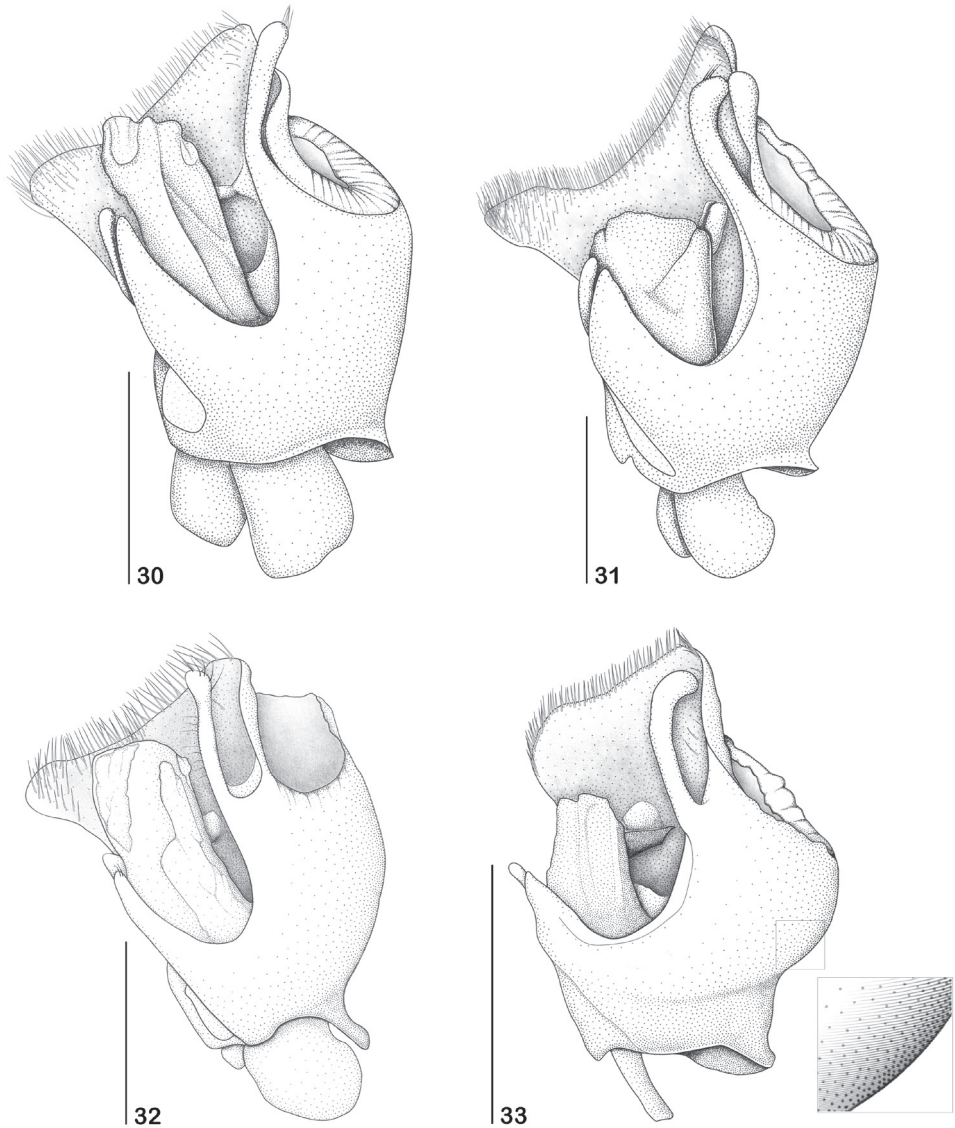
Even though these localities are so distant, they belong to Cerrado and Chaco provinces, adjacent areas of the same biogeographic subregion (Chaco dominion) (Morrone 2000, 2006) (Fig. 44).

A redescription of *P. impressipennis* is presented as well as a supplementary description of the female for the first time to complete its morphological information after specimens from Brazil.

Material examined. HOLOTYPE ♂ (MNHN): ARGENTINA: Tucumán, 4.i.1900. BRAZIL: Maranhão, Mirador (Parque Estadual do Mirador, Base da Geral-dina) 6°46'37"S; 45°06'34"W, 22.ii–01.iii.2009, armadilha luminosa [light trap], F. Limeira-de-Oliveira col. (4♂, 14♀ MZSP, 4♂, 15♀ CZMA); same locality, (Parque Estadual do Mirador, Base do Mosquito), 04–08.ii.2011, armadilha luminosa, F. Limeira-de-Oliveira col. (1♀) (CZMA); Bahia, Barreiras (Estrada Mata de Cachoei-



Figures 22–29. 22–25 Aedeagus, dorsal view 26–30 right paramere, dorsal view 22, 26 *Paramaronius serranus* sp. n. 23, 27 *P. brancuccii* sp. n. 24, 28 *P. cavipennis* sp. n. 25, 30 *P. impressipennis* (Pic). Scale bars: 0.5 mm (22–25); 0.2 mm (26–29).



Figures 30–33. Aedeagus, left view **30** *Paramaronius serranus* sp. n. **31** *P. brancuccii* sp. n. **32** *P. cavi-pennis* sp. n. **33** *P. impressipennis* (Pic). Scale bars: 0.5 mm.

ras, Acaba Vida, km 7), 11°52'20"S; 45°32'55"W, 23.i.2009, luz [light trap], Nihei, Figueiredo, Almeida & Cezar col. (1♀) (MZSP).

Redescription. Head with vertex, frons, clypeus and bases of mandibles pale yellow, slightly translucent; apex of mandibles dark brown; occipital region with a V-shaped testaceous mark; labial and maxillary palpi pale yellow, last palpomere brown. Antennae light brown, three first antennomeres pale yellow. Pronotum pale yellow to light brown,

sometimes translucent. Scutellum pale yellow with apex translucent. Elytra testaceous to light brown with a lateral longitudinal darker brown band from the epipleura to the posterior third quarter of dorsal surface; apex of elytra with an oblique yellow band on outer margin; on less pigmented specimens, pronotum pale yellow and lateral and apical patches indistinct. Hind wings light brown. Legs testaceous to light brown; tarsi and dorsal surface of tibiae darker. Ventrally, thorax and abdomen pale yellow.

Male (Fig. 10): body covered by dense and fine pubescence. Lateral margins of head arcuate behind eyes; vertex slightly convex, frons flat. Eyes prominent. Antennae short, with one antennomere exceeding the apex of elytra. Antennomere 1 long and swollen, 2.7 times longer than wide; antennomere 2 short, third antennomere 1.7 times shorter than antennomere 1, fourth to seventh subequal in length, slightly shorter than antennomere 1, the latter progressively shorter than seventh. Pronotum subrectangular, shiny, slightly narrower near fore angles; anterior margin slightly rounded. Scutellum triangular, apex truncate. Elytra short, 1.5 times longer than wide, covered by fine hairs and some sparse black hairs. Apical half modified, forming a longitudinal ridge and two sloped surfaces covered by very short hairs (Figs 11, 12). Legs slender; hind tibia as long as hind femur; tarsomeres gradually increasing in size from fore to hind legs; first metatarsomere 1.7 times longer than second and 2.7 times longer than third. Abdominal glandular pores slightly prominent. Seventh abdominal ventrite (Fig. 17) wider than long, deeply emarginate, forming two distal lobes, narrowed apicad. Aedeagus (Fig. 25) with right prolongation of tegmen large and arcuate on posterior margin, and covered with large setae; dorsal surface with a short and rounded apophysis; left setiferous prolongation very long and curved, clubbed apically, with few setae on its apex. Right paramere (Fig. 29) short, narrowing apicad, then divided at apex, forming an inclined prolongation, reaching apophysis of tegmen; left paramere flat, very short and wide, divided apically and partially covering dorsal surface of median lobe; median lobe long and curved to right, sometimes retracted. Ventral and lateral surfaces of tegmen (Fig. 33) with fine scratches.

Female (Fig. 13) slightly bigger than male; antennomere 1 slender, not swollen; dorsal surface of elytra without sculptural modification, brown lateral and yellow apical bands more distinct. Seventh abdominal ventrite (Fig. 19) trapezoidal, distal margin straight with a short, rounded notch. Coxites (Fig. 21) small and membranous; styles short, wider apically.

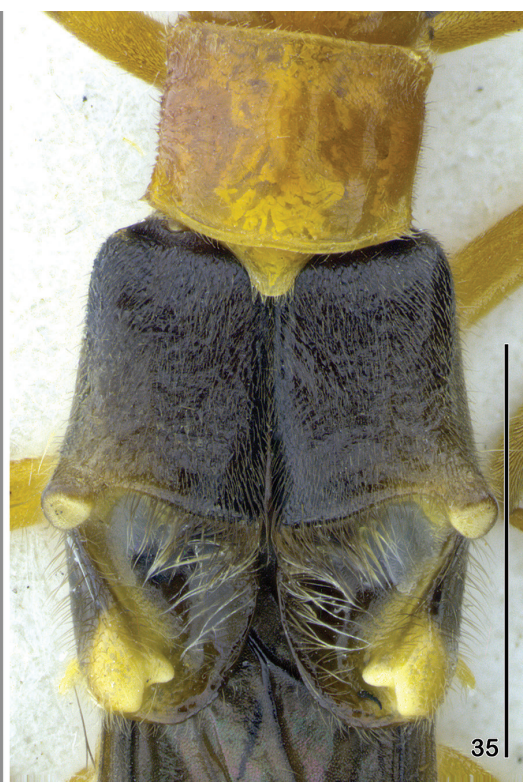
Distribution. Argentina (Tucumán) and Brazil (Maranhão and Bahia) (Fig. 44).

Biological data. The specimens from Maranhão and Bahia were collected on Brazilian savannah (cerrado) and were attracted by light traps.

Paramaronius kraatzii (Pic, 1938)

Figs 34, 35

Material examined. BOLIVIA: Cochabamba, Chaparé, Locotal, 1200m, 8.xi.1953, Martínez leg. (4♂); Cochabamba, Chaparé, Yungas de Palmar, 1250m 17.x.1953, W.



Figures 34–37. 34–35 *Paramaronius kraatzii* (Pic) **34** male habitus, dorsal view **35** male elytra, dorsal view **36–37** *P. freyi* Wittmer **36** male habitus, dorsal view **37** male elytra, dorsal view. Scale bars: 2.0 mm.

Foster (1♀) (NHMB); Santa Cruz, Florida, 1050-1150m, (Refugio Los Volcanes), 18°06,3'S; 63°26'W, 10-14.xii.2011, beating of vegetation, L. Sekerka lgt. (2♀) (NHM).

Distribution. Bolivia (Cochabamba and Santa Cruz) (Fig. 44).

Paramaronius freyi Wittmer, 1963

Figs 36, 37

Remarks. This species was described based on a single male holotype from northwestern Brazil, labelled “Brasilien, Acre, Rio Branco, 29.x.1954” and preserved at NHMB. Several specimens were collected with interception traps disposed for faunistic inventory purpose at Saül, French Guiana, by the SEAG (Société entomologique Antilles-Guyane). The specimens from French Guiana were compared and found to be identical to the holotype.

Material examined. FRENCH GUIANA, Saül, Belvédère de la Montagne Pelée, 320m, 3°37'22"N; 53°12'58"W, 20.xii.2010, P.H. Dalens & S. Brûlé (1♀) (MZSP), same locality, 320m, 3°37'22"N; 53°12'58"W, 24.i.2011, P.H. Dalens & S. Brûlé, SEAG (1♂) (MZSP).

Distribution. French Guiana and Brazil (Acre) (Fig. 44).

Paramaronius gounellei (Pic, 1906)

Figs 38, 39

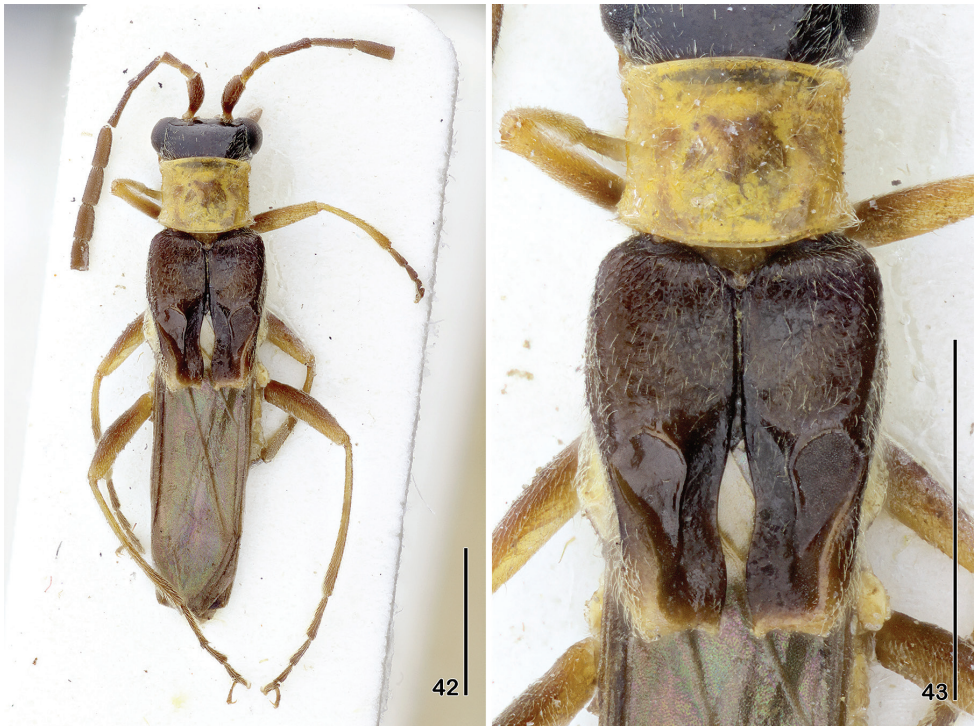
Material examined. BRAZIL: Minas Gerais, Serra do Caraça, 1380m, xi.1961, Kloss, Lenko, Martins & Silva col. (2♂, 6♀) (MZSP); Serra do Caraça (Engenho), 800m, xi.1961, Kloss, Lenko, Martins & Silva col. (1♂) (MZSP); Serra do Caraça, Santa Bárbara, 23–25.xi.1960, Araujo e Martins col. (2♀) (MZSP); Minas Gerais, Poços de Caldas (morro de São Domingos), 12.ii.1969, J. Becker, O. Roppo & O. Leoncini cols. (1♀) (MNRJ); Rio de Janeiro, Serra de Macaé, xi.1909, E. Garbe (1♂) (MZSP 15235); Parque Nacional de Itatiaia, 10.xii.1950, L. & H. Travassos (1♂) (MNRJ); Rio de Janeiro, Itatiaia, xi.1950, Travassos & Dalcy, (1♂) (MNRJ); Rio de Janeiro, Itatiaia (L. 41, 1300m), 10–12.x.1950, Trav., Albuquerque & Pearson col. (1♂) (CEIOC); same locality, 6–10.x.1950, H. Trav. col. (1♀) (CEIOC); Rio de Janeiro, Teresópolis, i.1940, Trav. & Freitas col. (2♀) (CEIOC); São Paulo, Serra da Bocaina, São José do Barreiro, 1650m, i.1969, M. Alvarenga col. (2♂) (DZUP 273518; DZUP 273519); São Paulo, Serra da Bocaina, 1300m, Parq. Criaç. Trutas, iii.1954, Dalcy, R. Barros (1♀) (MNRJ); São Paulo, Salesópolis, Estação Biológica de Boracéia, 23°39'15"S; 45°53'22"W, light trap, 14-18.ix.2012, F.F. Albertoni col. (1♂) (MZSP).

Distribution. Brazil (Minas Gerais, Rio de Janeiro and São Paulo) (Fig. 44, 45).

Note. One female referred by Brancucci (1982) as “BRAZIL: Mato Grosso do Sul, Corumbá, Serra do Urucum” (MZSP) in unlikely a *Paramaronius gounellei*. This damaged specimen cannot be precisely identified and is referred to the distribution map as *Paramaronius* sp. (Fig. 44).



Figures 38–41. 38–39 *Paramaronius gounellei* (Pic) 38 male habitus, dorsal view 39 male elytra, dorsal view 40–41 *P. campbelli* Brancucci, holotype 40 male habitus, dorsal view 41 male elytra, dorsal view. Scale bars: 2.0 mm.



Figures 42–43. *Paramaronius menieri* Brancucci, holotype **42** male habitus, dorsal view **43** male elytra, dorsal view. Scale bars: 2.0 mm.

***Paramaronius campbelli* Brancucci, 1983**

Figs 40, 41

Material examined. HOLOTYPE ♂ (MZSP) and 1 PARATYPE ♂ (NHMB): BRAZIL: Distrito Federal, Parque Nacional, 1000 m, 9.iii.1970, JM & BA Campbell; 1 PARATYPE ♀ (NHMB): Distrito Federal, 15 km N. Brasília, 1250 m, 5.iii.1970, JM & BA Campbell. Other material: BRAZIL: Goiás, Ribeirão Vãozinho, 12.ii.1962, J. Bechyné col. (1♂, 2♀) (MZSP).

Distribution. Brazil (Goiás and Distrito Federal) (Figs 44, 45).

***Paramaronius menieri* Brancucci, 1982**

Figs 42, 43

Material examined. HOLOTYPE ♂ (MNHN): BRAZIL, Goiás, Jataí, coll. L. Fairmaire, 1906.

Distribution. Brazil (Goiás) (Figs 44, 45).



Figure 44–45. Distribution records for *Paramaronius* Wittmer.

Distribution of *Paramaronius*

Paramaronius is widely distributed throughout South America. The new records extend the distribution of the genus from French Guiana to northern Argentina (Tucumán province) and from the southeastern Brazilian coast (Rio de Janeiro and São Paulo states) to western Brazil (Acre state) and Bolivia (Cochabamba department) (Figs 44, 45). The species are distributed through a wide variety of biomes and vegetation, most frequently present on mountains at mid altitude (1000 m to 1700 m): *Paramaronius gounellei*, *P. serranus* sp. n., *P. brancuccii* sp. n. and *P. cavipennis* sp. n. occur on the southeastern South American Atlantic Forest (Fig. 45); *Paramaronius campbelli*, *P. menieri* and *P. impressipennis* are present in the Brazilian savannah (cerrado) of the great plateau of central Brazil. *Paramaronius freyi* occurs in dense rainforests in northern and western Amazon, while *P. kraatzi* occurs in the Bolivian Yungas, a transition area between the Amazon and the highlands (Fig. 44). However, the discussion of distribution patterns of the species is still unfeasible due to the scarce records for species of *Paramaronius*.

Identification Key

- 1 Antennae short, with one antennomere exceeding or barely reaching the apex of elytra; males: elytra with one or two longitudinal ridges on posterior half of dorsal surface; sides of tegmen finely scratched **2**
- Antennae long, with two or more antennomeres exceeding the apex of elytra; males: elytra with strong tubercles, deep grooves or shallow impressions on internal margins; sides of tegmen tuberculated or smooth, never scratched. **3**
- 2 Head black; males: antennomeres 6–11 expanded; elytra with two ridges on the posterior half and truncate to slightly emarginate apex (Figs 42, 43) ***P. menieri* Brancucci**
- Head yellow; males: antennomeres not expanded; elytra with one ridge on the posterior half and apex rounded (Figs 10–13) ***P. impressipennis* (Pic)**
- 3 Legs completely or mostly testaceous, sometimes light brown; males: elytra widely rounded on posterior margins and provided with strong tubercles; sides of tegmen tuberculated **4**
- Legs completely or mostly dark brown to black; males: elytra truncate or slightly rounded on posterior margins and without strong tubercles; sides of tegmen smooth **5**
- 4 Head, pronotum and legs completely testaceous; antennae testaceous, darker from antennomere 7 to apex; males: each elytron with one median and two apical tubercles (Figs 34, 35) ***P. kraatzi* (Pic)**
- Head black; pronotum completely yellow or with two brown spots on lateral margins; legs yellow with brown spots on apex of femora and tibiae, tarsi brown; antennae brown, slightly lighter on two first and three last antennomeres; males: each elytron with one median and three apical tubercles (Figs 36, 37) ... ***P. freyi***

- 5 Pronotum mostly or completely pale yellow; males: dorsal surface of elytra with shallow impressions covered by strong setae on their anterior margins..... **6**
- Pronotum mostly or completely dark brown to black; males: dorsal surface of elytra with shallow impressions not covered by strong setae or with deep longitudinal grooves..... **7**
- 6 Head yellow, sometimes with two brown spots between the eyes and a V-shaped brown spot on occipital region; pronotum yellow with brown spots on sides; elytral suture yellow at apical third; males: dorsal surface of elytra with a straight shallow impression (Figs 38, 39) ***P. gounellei* (Pic)**
- Head dark brown on vertex and yellow on clypeus and frons; pronotum completely testaceous to almost completely brown; elytral suture entirely black; males: dorsal surface of elytra with a circular impression (Figs 40, 41) ***P. campbelli* Brancucci**
- 7 Males: elytra with shallow impressions on internal margins not covered by dense pubescence (Figs 1–5) ***P. serranus* sp. n.**
- Males: elytra with deep hollows or grooves surrounded by pubescence **8**
- 8 Males: dorsal surface of each elytron modified in a deep longitudinal incision covered by a dense, short and thick pubescence; apical half of internal margin of each elytron slightly arcuate (Figs 6, 7) ***P. brancuccii* sp. n.**
- Males: dorsal surface of each elytron modified in a deep hollow surrounded by a scarce, long and thin pubescence, followed by a sloped surface covered by very short pubescence; apical half of internal margin of each elytron deeply sinuate (Figs 8, 9) ***P. cavipennis* sp. n.**

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References

- Brancucci M (1980) Morphologie comparée, évolution et systématique des Cantharidae (Insecta: Coleoptera). *Entomologica Basiliensia* 5: 215–388.
- Brancucci M (1981) Révision du genre *Maronius* Gorham et notes sur les genres voisins (Coleoptera: Cantharidae). *Entomologica Basiliensia* 6: 328–367.
- Brancucci M (1982) Révision du genre *Paramaronius* Wittmer (Coleoptera: Cantharidae). *Bulletin de la Société Neuchâteloise des Sciences Naturelles* 105: 123–136. doi: 10.5169/seals-89183
- Brancucci M (1983) A new *Paramaronius* from Brazil (Coleoptera: Cantharidae). *The Coleopterists Bulletin* 37(4): 362–364. <http://www.jstor.org/stable/4008260>
- Constantin R (2008) A contribution to the genus *Plectonotum* Gorham, 1891, in Ecuador (Coleoptera, Cantharidae). *Entomologica Basiliensia et Collectionis Frey* 30: 49–74.
- Klausnitzer B (2012) Dr. Michel Brancucci (9. September 1950 bis 18. Oktober 2012) zum Gedenken. *Entomologische Blätter und Coleoptera* 108: 1–14.
- Leitão-Filho HF (1992) A flora arbórea da Serra do Japi. In: Morellato LPC (Ed.) *História Natural da Serra do Japi: ecologia e preservação de uma área florestal no sudeste do Brasil*. Editora da Unicamp, FAPESP, Campinas, 40–62.
- Morrone JJ (2000) What is the Chacoan subregion? *Neotropica* 46: 51–68.
- Morrone JJ (2014) Biogeographical regionalisation of the Neotropical region. *Zootaxa* 3782(1): 1–110. doi: 10.11646/zootaxa.3782.1.1
- Magis N, Wittmer W (1974) Nouvelle répartition des genres de la sous-famille des Chaulognathinae (Coleoptera, Cantharoidea: Cantharidae). *Bulletin de la Société Royale des Sciences de Liège* 43(1–2): 78–95.
- Natural Earth (2015) Free vector and raster map data. <http://naturalearthdata.com>
- Pic M (1906) Sur divers *Maronius* Gorh. et genres voisins de l'Amérique Méridionale. *L'Echange, Revue Linnéenne* 22: 51–52.
- Wittmer W (1963) Neue neotropische Malacodermata aus dem Museum G. Frey. *Entomologische Arbeiten aus dem Museum Georg Frey* 14: 128–135.

A new species of *Noblella* (Amphibia, Anura, Craugastoridae) from the humid montane forests of Cusco, Peru

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Abstract

A new species of *Noblella* is described from the humid montane forest of the Región Cusco in Peru. Specimens were collected at 2330–2370 m elevation in Madre Selva, near Santa Ana, in the province of La Convención. The new species is readily distinguished from all other species of *Noblella* by having a broad, irregularly shaped, white mark on black background on chest and belly. The new species further differs from known Peruvian species of *Noblella* by the combination of the following characters: tympanic membrane absent, small tubercles on the upper eyelid and on dorsum, tarsal tubercles or folds absent, tips of digits not expanded, no circumferential grooves on digits, dark brown facial mask and lateral band extending from the tip of the snout to the inguinal region. The new species has a snout-to-vent length of 15.6 mm in one adult male and 17.6 mm in one adult female. Like other recently described species in the genus, this new *Noblella* inhabits high-elevation forests in the Andes and likely has a restricted geographic distribution.

Resumen

Describimos una nueva especie de *Noblella* de bosques nublados de la Región Cusco en Perú. Los especímenes fueron colectados a una elevación de 2330–2370 m en Madre Selva, cerca de Santa Ana, en la provincia de La Convención. La nueva especie se diferencia fácilmente de todas las demás especies de *Noblella* por su coloración de fondo negra con una mancha irregular blanca en el pecho y vientre. Además la nueva especie se diferencia de las demás especies de *Noblella* conocidas de Perú por la combinación de las siguientes características: membrana timpánica ausente, pequeños tubérculos en los párpados y en la

espalda, tubérculos o pliegues tarsales ausentes, puntas de los dedos no expandidas, surcos circunferenciales ausentes, y máscara facial y banda lateral marrón oscuras que se extienden desde la punta del rostro hasta la ingle. La nueva especie tiene una longitud hocico–cloaca (LHC) de 15.6 mm en un macho adulto y de 17.6 mm en una hembra adulta. Al igual que otras especies recientemente descritas en el género, esta nueva *Noblella* habita bosques altoandinos y es probable que tenga una distribución geográfica restringida.

Keywords

Frog, La Convención, leaf litter amphibian, *Noblella madrevelva*, new species

Palabras clave

Rana, La Convención, anfibio de hojarasca, especie nueva, *Noblella madrevelva*

Introduction

The frog genus *Noblella* currently includes 11 species distributed across the humid forests of the western Amazon basin and the Andes from Ecuador to Bolivia (Harvey et al. 2013). Except for *N. myrmecoides* (Lynch, 1976) which occurs in the western Amazon lowlands of Ecuador, Peru, Bolivia, Brazil and Colombia, all other ten species of *Noblella* inhabit montane humid forests and high-elevation grasslands up to 3450 m. Of these ten species, only two, *N. lochites* (Lynch, 1976) and *N. heyeri* (Lynch, 1986), occur in both Peru and Ecuador, whereas the other eight species are country endemics. *Noblella coloma* Guayasamin & Terán-Valdez, 2009, and *N. personina* Harvey, Almendáriz, Brito-M., and Batallas-R., 2013 are endemic to Ecuador, whereas *N. duellmani* (Lehr et al., 2004), *N. lynchi* (Duellman, 1991), *N. peruviana* (Noble, 1921) and *N. pygmaea* Lehr and Catenazzi, 2009 are endemic to Peru. Finally, *Noblella carascoicola* (De la Riva & Köhler, 1998) and *N. ritarasquinae* (Köhler, 2000) are only found in Bolivia.

The species currently assigned to *Noblella* were part of *Phyllonastes* (Heyer, 1977) until De la Riva et al. (2008b) revalidated *Noblella* Barbour, 1930 and considered *Phyllonastes* a junior synonym. The genus was placed within the Holoadeninae in the family Strabomantidae by Hedges et al. (2008), but Pyron and Wiens (2011) synonymized Strabomantidae with Craugastoridae. Phylogenetic relationships among the Holoadeninae are not fully resolved. For example, on the basis of similarity in external morphology, *Psychrophrynella bagrecito* (Lynch, 1986) from the montane forests of Cusco seems to be related to *Noblella* rather than to *Psychrophrynella* (Lehr 2006; De La Riva et al. 2008a). Therefore, for the purpose of this description we considered *P. bagrecito* for comparisons with other species of *Noblella*.

Species of *Noblella* are among the smallest Neotropical vertebrates: *N. pygmaea* is the smallest frog in the Andes (Lehr and Catenazzi 2009a). Although they can locally be abundant, these frogs are often overlooked in amphibian inventories due to their patchy distribution, small size and predominantly terrestrial life style. An efficient way of detecting *Noblella* is by sampling leaf litter plots, which requires substantial time and effort. Therefore, several species are poorly represented in collections, and it is very

likely that more *Noblella* species remain to be discovered, even in regions that have previously been surveyed. Surveys in the humid montane forests of La Convención, Cusco, Peru recently revealed the existence of a species of *Noblella* with a striking ventral coloration consisting of a black background with a large, irregularly shaped white mark, unlike known congeneric species. Here we describe this new species.

Methods

The format of the diagnosis and description follows Duellman and Lehr (2009) and Lynch and Duellman (1997), except that the term dentigerous processes of vomers is used instead of vomerine odontophores (Duellman et al. 2006). Taxonomy follows Hedges et al. (2008) except for family placement (Pyron and Wiens 2011).

Specimens were preserved in 70% ethanol. Sex and maturity of specimens were determined by observing sexual characters and gonads through dissections. The following variables were measured (Table 1) to the nearest 0.1 mm with digital calipers under a stereomicroscope: snout-vent length (SVL), tibia length (TL), foot length (FL, distance from proximal margin of inner metatarsal tubercle to tip of Toe IV), head length (HL, from angle of jaw to tip of snout), head width (HW, at level of angle of jaw), eye diameter (ED), tympanum diameter (TY), interorbital distance (IOD), upper eyelid width (EW), internarial distance (IND), eye–nostril distance (E–N, straight line distance between anterior corner of orbit and posterior margin of external nares). Fingers and toes are numbered preaxially to postaxially from I–IV and I–V respectively. We determined comparative lengths of toes III and V by adpressing both toes against Toe IV; lengths of fingers I and II were determined by adpressing the fingers against each other. Photographs taken by V. Uscapi in the field were used for descriptions of coloration in life. Photographs of preserved types taken by A. Catenazzi have been deposited at the Calphoto online database (<http://calphotos.berkeley.edu>).

Specimens examined are listed in Appendix I; codes of collections are: CORBIDI = Herpetology Collection, Centro de Ornitología y Biodiversidad, Lima, Peru; KU = Natural History Museum, University of Kansas, Lawrence, Kansas, USA; MUSM = Museo de Historia Natural Universidad Nacional Mayor de San Marcos, Lima, Peru; MHNG = Muséum d'Histoire Naturelle, Genève, Switzerland; MTD = Museum für Naturkunde Dresden, Dresden, Germany.

Taxonomy

Noblella madreSelva sp. n.

<http://zoobank.org/8B7C4133-4482-4D24-8F5A-6E389AE52BA8>

Holotype (Figs 1–3). CORBIDI 15769, an adult male (Figs 2, 3) from 12°49'59.6"S; 72°48'07.7"W (WGS84), Madre Selva, 2330–2370 m, Distrito Santa Ana, Provincia

La Convención, Región Cusco, Peru, collected by V. Uscapi, L. Salas Montesinos and V. Mamani Ccoyllolle on 10 January 2011.

Paratopotype (Fig. 2). CORBIDI 15770, an adult female (Figs 2, 3) collected by V. Uscapi, L. Salas Montesinos and V. Mamani Ccoyllolle on 10 January 2011.

Generic placement. A new species of *Noblella* as defined by Heyer (1977), De la Riva et al. (2008b), Hedges et al. (2008), and Duellman and Lehr (2009). Frogs of the genus *Noblella* are morphologically similar and closely related to *Barycholos* (Heinicke et al. 2007; Hedges et al. 2008). The new species is assigned to *Noblella* rather than *Barycholos* (characters in parentheses), because it lacks dentigerous processes of the vomers (present), has Finger I shorter than Finger II (Finger I > Finger II), and has low, rounded subarticular tubercles (subarticular tubercles elevated).

Diagnosis. A new species of *Noblella* characterized by (1) skin on dorsum bearing small tubercles, skin on belly smooth to finely areolate, discoidal fold absent, dorso-lateral folds on anterior half part of body; (2) tympanic membrane not differentiated, tympanic annulus barely visible below skin; (3) snout short, rounded in dorsal view and bluntly rounded in profile; (4) upper eyelid with minute tubercles, narrower than IOD; cranial crests absent; (5) dentigerous process of vomers absent; (6) vocal slits present; nuptial pads absent; (7) Finger I shorter than Finger II; tips of digits rounded; Finger IV having three phalanges; (8) fingers with narrow lateral fringes; (9) ulnar tubercles small, round; (10) heel and tarsus lacking tubercles (11) inner metatarsal tubercle oval, of higher relief and about one and a half times the size of conical, rounded outer metatarsal tubercle; supernumerary plantar tubercles absent; (12) toes bearing narrow lateral fringes; webbing absent; Toe V shorter than Toe III; tips of digits not expanded, weakly acuminate distally; circumferential grooves absent; (13) dorsum tan to dull brown with or without dark brown markings; diffuse brown suprainguinal stripes, when present, do not reach the inguinal region; a yellow-orange middorsal line, when present, extends from mid of body to cloaca and continues on the posterior surface of thighs; interorbital bar present; venter black with large, irregularly shaped white mark; proximal areas of legs red ventrally; (14) SVL 15.6 mm in a male, 17.6 mm in a female.

Comparisons. The new species differs from known species in the genus (Harvey et al. 2013) by having a unique pattern of chest and belly coloration consisting of a broad, irregularly shaped white mark on black background (Figs 2, 4). *Noblella madreSelva* has three phalanges on Finger IV and differs from *N. carrascoicola*, *N. lochites*, *N. myrmecoides*, and *N. ritarasquinae* which have two phalanges on Finger IV (De La Riva and Köhler 1998; Köhler 2000; Duellman and Lehr 2009; Guayasamin and Terán-Valdez 2009; Harvey et al. 2013). Among the other six species with three phalanges on Finger IV, it differs from *N. coloma*, *N. heyeri*, *N. lynchi* and *N. peruviana* (De La Riva and Köhler 1998; Duellman and Lehr 2009; Guayasamin and Terán-Valdez 2009) by lacking inguinal spots (*N. madreSelva* has diffuse suprainguinal stripes that do not reach the inguinal region). The three remaining species, *N. duellmani*, *N. personina* and *N. pygmaea*, either lack a facial mask and lateral dark band (*N. duellmani* and *N. pygmaea*), or have a facial mask but lack a lateral dark band extending to the inguinal region (*N. personina*; Harvey et al. 2013).

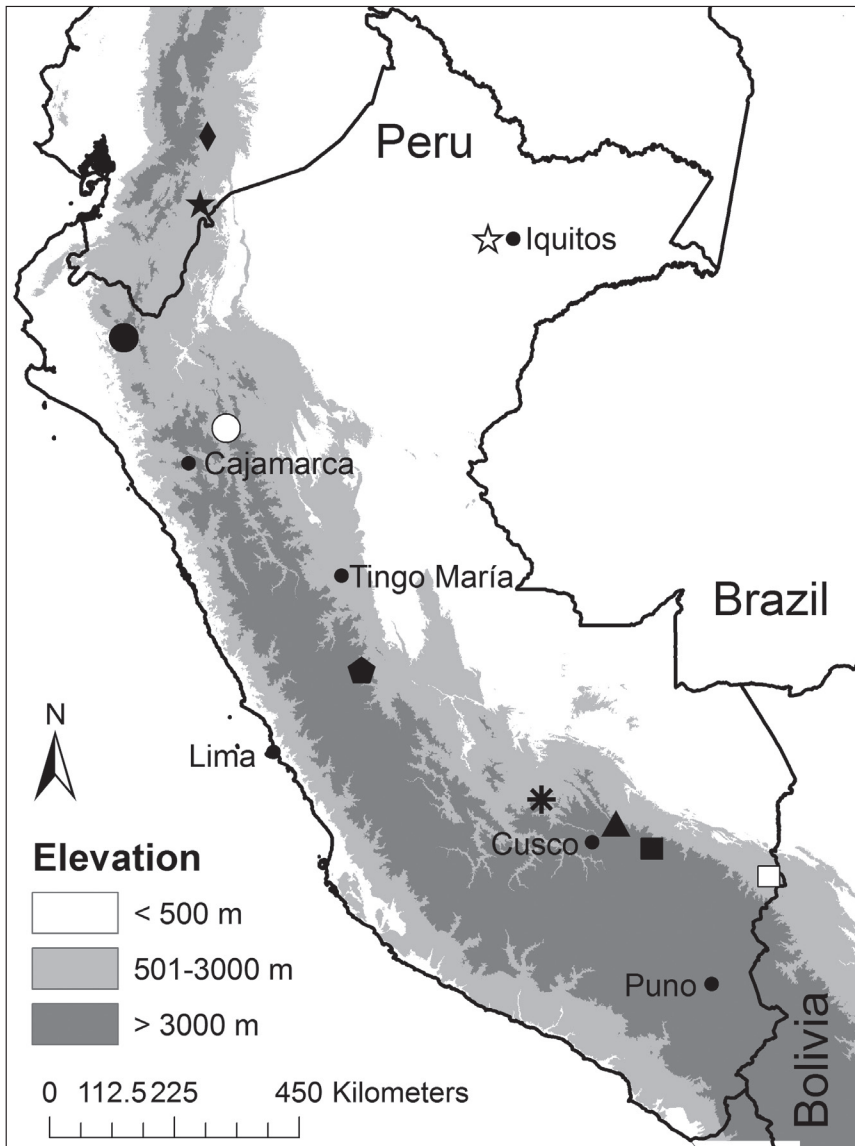


Figure 1. Map of Peru indicating the type localities of Peruvian and southern Ecuadorian species of *Noblella*: *Noblella madreSelva* sp. n. (asterisk), *N. personina* (diamond), *N. lochites* (black star), *N. duellmani* (pentagon), *N. heyeri* (black circle), *N. lynchi* (white circle), *N. myrmecoides* (white star), *N. peruviana* (white square), and *N. pygmaea* (triangle). Also shown is the type locality of *Psychrophrynella bagrecito* (black square; see text for explanation).

The facial mask and dark lateral band in *N. madreSelva* are dark brown and extend from the tip of the snout to the inguinal region.

The new species further differs from known Peruvian species of *Noblella* by lacking a tympanic membrane (present in *N. heyeri*, *N. lynchi*, *N. myrmecoides* and *N. pygmaea*), by

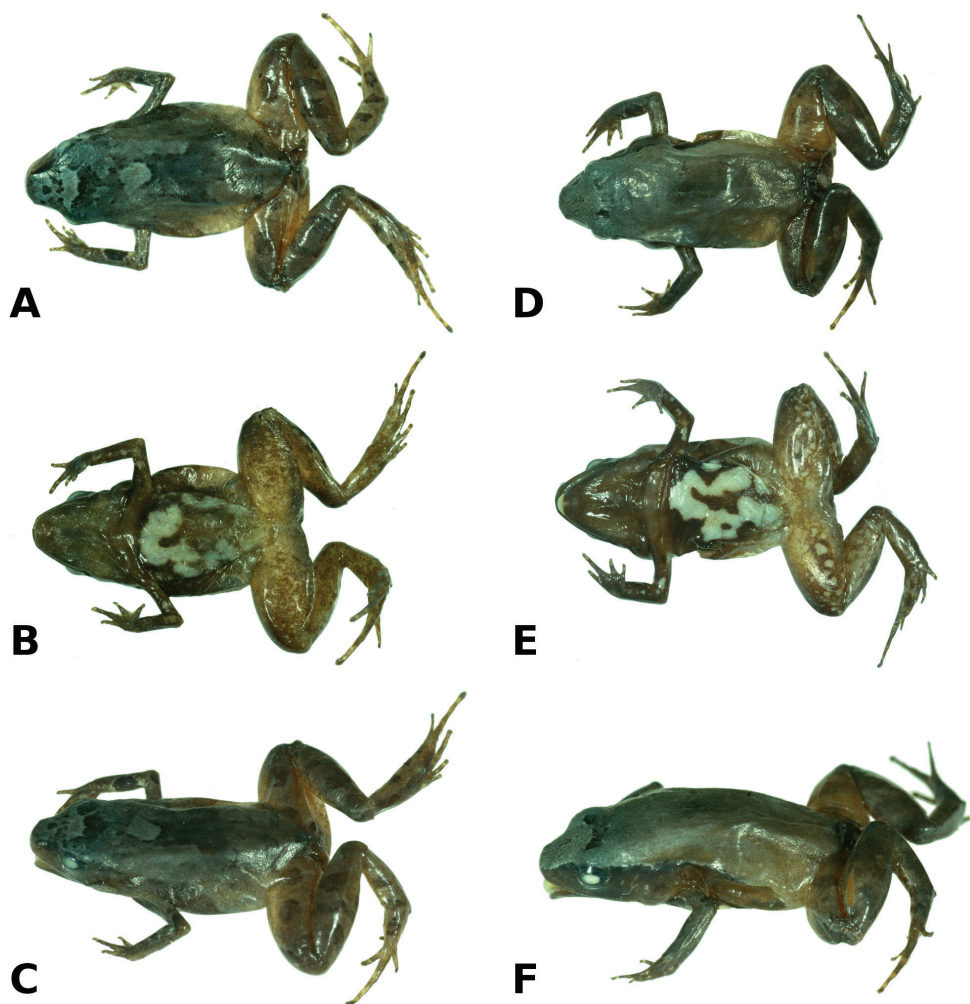


Figure 2. Holotype of *Noblella madrevelva* sp. n., male CORBIDI 15769 (SVL 15.6 mm) in dorsal (A), ventral (B) and dorsolateral (C) views. Paratopotype, female CORBIDI 15770 (SVL 17.6 mm) in dorsal (D), ventral (E) and dorsolateral (F) views. Photographs by A. Catenazzi.

bearing small tubercles on the upper eyelid (absent in *N. heyeri*, *N. lynchi*, *N. myrmecoides* and *N. peruviana*) and small tubercles on dorsum (dorsum finely shagreen in *N. myrmecoides* and *N. peruviana*), by lacking tarsal tubercles or folds (inner surface of tarsus bearing one prominent tubercle in *N. heyeri*, *N. lynchi*, and *N. peruviana*), and by having the tips of digits not expanded (slightly expanded in *N. duellmani*, *N. heyeri*, and *N. lynchi*). The species is much larger in SVL (female 17.6 mm) than *N. myrmecoides* (largest known female 13.6 mm) and *N. pygmaea* (largest known female 12.4 mm). *Noblella madrevelva* differs from *N. myrmecoides* from the Amazonian lowlands in having tips of toes not expanded (tips of toes slightly expanded, teardrop-shaped in *N. myrmecoides*) and in lacking circumferential grooves (present in *N. myrmecoides*).

The new species was also compared with *Psychrophrynella bagrecito*. Unlike other species of *Psychrophrynella*, *P. bagrecito* has a fold-like tarsal tubercle, weakly pointed toes and fingers, a prominent conical outer metatarsal tubercle, dark brown flanks, a dark brown facial mask and lateral band extending from the tip of snout to the flanks, no nuptial pads and no vomerine teeth, small size and slender body with relatively long arms and legs, all characteristics that *P. bagrecito* shares with many species of *Noblella* (Lehr 2006; De La Riva et al. 2008a). *Noblella madreselva* differs from *P. bagrecito* (traits in parentheses) in having small tubercles on dorsum (skin shagreen), no discoidal fold (present), no tarsal tubercle (prominent sickle-shaped tubercle present), in having a broad dark brown mark on dorsum (longitudinal stripes) and an irregularly shaped, large white mark on venter (venter orange brown with light gray flecks).

Thirteen other small species of craugastorid frogs lacking circumferential grooves are known to occur in montane forests and high Andean grasslands south of the Apurímac canyon in Peru: *Psychrophrynella bagrecito*, *P. boettgeri*, *P. usurpator*, *Bryophryne abramalagae*, *Bryophryne bustamantei*, *B. cophites*, *B. flammiventris*, *B. gymnotis*, *B. hanssaueri*, *B. nubilosus*, *B. zonalis*, *N. peruviana* and *N. pygmaea*. None of these species has the unique ventral coloration of *N. madreselva*, and all but *N. pygmaea* are larger in size. Furthermore, the new species differs from *P. usurpator* in lacking a tarsal fold, and from species of *Bryophryne* (characters in parentheses) in having a tympanum (absent except for *B. flammiventris* and *B. gymnotis*), T-shaped terminal phalanges (knob-shaped), toe V shorter than toe III (about equal in length), no nuptial pads (present or absent), small size and slender body with longer limbs (larger size with stubby body and short limbs).

Description of holotype. Adult male (15.6 mm SVL); head narrower than body, its length 32.5% of SVL; head slightly longer than wide; head width 29.9% of SVL; snout short, rounded in dorsal view, subtruncate in lateral view (Fig. 2), eye large, 37% of head length, its diameter 1.6 times as large as its distance from the nostril; nostrils not protuberant, situated close to snout; canthus rostralis slightly curved in dorsal view, rounded in profile; lores flat; lips rounded; dorsal surface of head and upper eyelids with small tubercles; upper eyelid width 70.0% of inter-orbital distance; supratympanic fold short; tympanic membrane absent, tympanic annulus not visible; one long, enlarged postrostral ridge on each side of head. Choanae round, very small, positioned far anterior and laterally, widely separated from each other, slightly concealed by palatal shelf of maxilla; dentigerous processes of vomer and vomerine teeth absent; tongue long and narrow, about 3 three times as long as wide.

Skin on dorsum with small tubercles, denser posteriorly; narrow dorsolateral folds extend from posterior margin of eye to about mid of body; skin on flanks smooth; skin on ventral surfaces and gular regions smooth to finely areolate; pectoral fold present, discoidal fold not evident; cloaca protuberant; cloacal region bearing several small tubercles. Outer surface of forearm brachium with a row of small tubercles; palmar tubercle flat and oval, approximately twice the size of elongate, thenar tubercle; low supernumerary palmar tubercles present; subarticular tubercles prominent, ovoid in ventral view, rounded in lateral view, largest at base of fingers; fingers with narrow lateral



Figure 3. Ventral views of hand (**A**) and foot (**B**) of holotype, CORBIDI 15769 (hand length 3.0 mm, foot length 6.7 mm), and ventral views of hand (**C**) and foot (**D**) of paratopotype, CORBIDI 15770 (hand length 3.7 mm, foot length 7.7 mm) of *Noblella madrevela* sp. n. Photographs by A. Catenazzi.

Table 1. Measurements (in mm) of type series of *Noblella madreselva* sp. n.

Characters	Holotype, male CORBIDI 15769	Paratopotype, female CORBIDI 15770
SVL	15.6	17.6
Tibia length	7.4	7.8
Foot length	6.7	7.7
Head length	5.1	6.0
Head width	4.7	5.5
Interorbital distance	1.4	1.8
Upper eyelid width	1.2	1.3
Internarial distance	1.9	2.0
Eye to nostril distance	1.2	1.5
Snout to eye distance	2.2	2.3
Eye diameter	1.9	2.0
Tympanum diameter	0.8	1.0
Eye to tympanum distance	0.3	0.4
Forearm length	3.5	4.0
Hand length	3.0	3.7
Finger I length	1.2	1.8
Finger II length	1.4	2.2

fringes; Finger IV has three phalanges; when adpressed, Finger $3 > 4 > 2 > 1$ (Fig. 3); tips of digits rounded, circumferential grooves absent (Fig. 3); forearm lacks tubercles.

Hindlimb lengths moderate, tibia length 47.1% of SVL; foot length 42.7% of SVL; upper and posterior surfaces of hindlimbs tubercular; heel with one small, round tubercle; outer surface of tarsus without tubercles; inner metatarsal tubercle, oval, of higher relief and about one and a half times the size of conical, rounded outer metatarsal tubercle; low plantar supernumerary tubercles present; subarticular tubercles rounded, ovoid in dorsal view; toes with narrow lateral fringes, basal webbing absent; toe tips slightly acuminate, circumferential grooves absent; digital tip of Toe V smaller than tips of Toes III—IV; when adpressed, relative lengths of toes: $4 > 3 > 5 > 2 > 1$ (Fig. 3).

Measurements of holotype and paratopotype are provided in Table 1.

Coloration of holotype in alcohol. Dorsal surfaces of head, body, and limbs grayish tan, with a broad, dark brown and irregularly shaped middorsal mark. The interorbital bar is a narrow dark stripe that separates the light gray coloration on top of the head from the generally darker gray tan coloration posterior to the eyelids. Suprainguinal marks are diffuse and narrow and do not reach the inguinal region. The dorsal surfaces of hind limbs have transverse dark bars. The facial mask and dark lateral band are dark brown and extend from the tip of the snout along the flanks almost reaching the point of insertion of thighs. The iris is dark gray. The throat is pale brown with minute cream spots. The chest and belly is dark brown with a broad, irregularly shaped white mark. The ventral surfaces of thighs are beige with small cream spots; posterior surfaces with narrow, pale gray stripe from cloaca diagonally to inside of knee; plantar and palmar surfaces and tips of digits are brown, completely lacking cream spots.

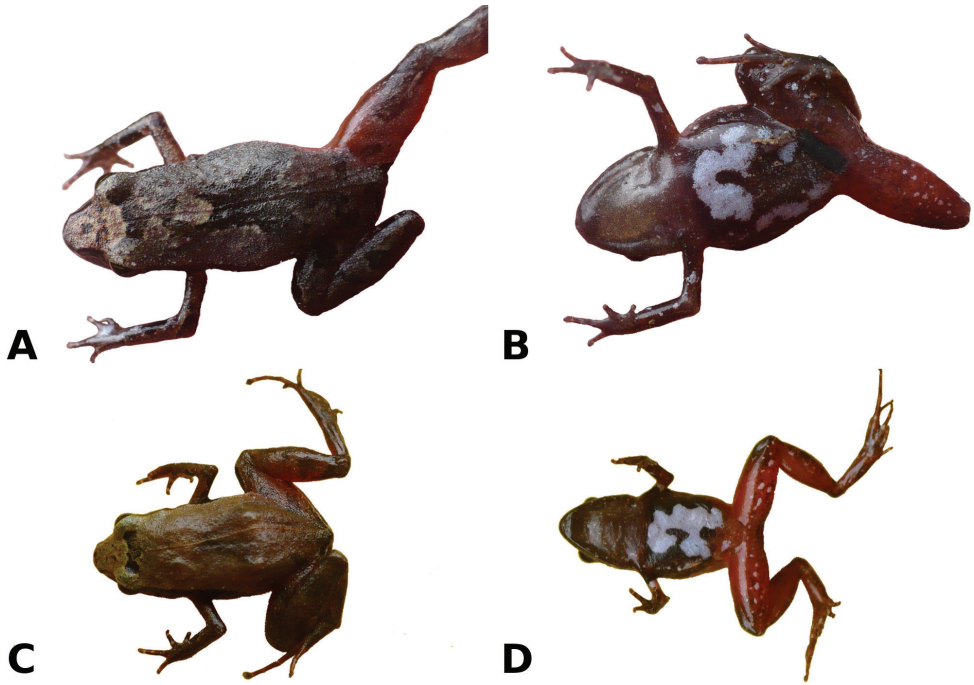


Figure 4. Dorsal (A, C) and ventral (B, D) views of two uncollected specimens of *Noblella madreSelva* sp. n. taken at the type locality. Scale not available, but specimens likely measure ~15–18 mm in SVL. Photographs by V. Uscapi.

Coloration of holotype in life. Unknown.

Variation. Coloration in life is based on field notes and photographs taken by V. Uscapi (Fig. 4) of four uncollected specimens found at the type locality. The dorsum is dull grayish tan with or without a broad and irregularly shaped middorsal dark brown mark. Three individuals have narrow and diffuse brown suprainguinal marks that do not reach the inguinal region. A dark brown interorbital bar separates the dorsal coloration from the lighter coloration on dorsal surface of head. There is a narrow, orange to reddish middorsal line extending from the tip of the snout to the cloaca, and from the cloaca along the posterior side of thighs to the knee. There are dark brown transverse bars on the dorsal surface of limbs. The sides of the head and flanks are dark brown, bordered above by a narrow tan stripe. The iris is bronze with black flecks. The throat is brown with minute white spots, whereas the belly is black reddish with one or two broad, irregularly shaped white marks surrounded by small white spots. The ventral surfaces of limbs are red with small white spots.

Etymology. The name of the new species is a toponym and is used in apposition to refer to the type locality and to the name of the lodge Madre Selva created near the type locality. Ecotourism can contribute to biodiversity conservation by promoting a sustainable use of fragile ecosystems such as humid montane forests.

Distribution, natural history, and threats. The new species was found during surveys in the humid montane forest conducted in January 2011. Three observers made intensive visual searches under rocks, logs, in the leaf litter and the understory during mornings (9h00–12h00) and evenings (18h30–24h00). Specimens of the new species were observed active in the leaf litter during the day. Field notes indicate that the species was only found at one of six sampling sites in the area. At this site, *Noblella madreselva* was the most common amphibian. Sympatric species include *Pristimantis pharangobates*, *Pristimantis* sp., and *Psychrophrynella* sp. Other species found around the type locality are *Nymphargus pluvialis* and *Gastrotheca* cf. *excubitor*. The conservation status of *N. madreselva* is unknown, but according to the IUCN Red List criteria and categories (IUCN 2013), and given the limited information on its geographic range, this species could provisionally be considered to be in the “Data Deficient” category. The main threats faced by *N. madreselva* are habitat loss and modification associated with agricultural activities in the region, which are primarily dominated by cultivation of coffee, tea and other crops. These land use changes are particularly detrimental for montane forest species with limited geographic or elevational distribution (Catenazzi et al. 2014).

Discussion

A large number of new species of small craugastorid frogs have recently been described from Andean montane forests (De La Riva 2007; Guayasamin and Terán-Valdez 2009; Lehr and Catenazzi 2010; Lehr et al. 2012; Lehr and Oroz 2012; Harvey et al. 2013; De la Riva and Burrowes 2014), including the eastern slopes of the Andes in southern Peru (De La Riva et al. 2008a; Lehr and Catenazzi 2008; Lehr and Catenazzi 2009a; Lehr and Catenazzi 2009d; Lehr and Catenazzi 2010). The phylogenetic relationships of several of these species and groups remain unclear, and the description of new taxa will improve our understanding of biodiversity in this clade. The new species has been assigned to the genus *Noblella*, which contains some of the smallest anurans, on the basis of shared meristic traits, general body shape and appearance.

Five of the twelve species currently assigned to *Noblella* have been described in the past ten years, all from Andean montane forests around or above 1900 m (Lehr et al. 2004; Lehr and Catenazzi 2009a; Guayasamin and Terán-Valdez 2009; Harvey et al. 2013). Similarly to other recently described, high-elevation craugastorid frogs (De La Riva 2007; Lehr and Catenazzi 2009d), these species of *Noblella* are likely to have geographic distributions restricted to the upper watersheds of their type localities and adjacent valleys. Because most of these regions remain largely unexplored, especially with regard to surveying small leaf litter amphibians, there likely are many new species awaiting discovery and formal description.

Guayasamin and Terán-Valdez (2009) hypothesized that the genus *Noblella* originated in the Andes and later dispersed to the Amazon, where a putative single species,

N. myrmecoides, is widely distributed in the western Amazon basin. In light of recent descriptions highlighting the diversity of the genus at high elevations, the hypothesis that *N. myrmecoides* forms a panmictic Amazonian population should be revisited. It is likely that the taxon is instead comprised of several cryptic species, particularly in the foothill and submontane forests where the distribution of predominantly lowland and montane species may overlap.

Although the conservation status of *N. madreselva* is presently unknown, Andean montane forest amphibian faunas face many threats, including deforestation and disease (von May et al. 2008; Catenazzi et al. 2014; Cole et al. 2014). Species with restricted geographic distributions are intrinsically threatened, and they are less likely to be protected by national parks and other national reserves, as previously shown for Peru (von May et al. 2008; Catenazzi and von May 2014). It is therefore imperative to document the highly endemic amphibian faunas of wet montane Andean forests as a first step towards designing a network of natural reserves that maximizes protection of amphibian biodiversity.

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References

- Catenazzi A, Lehr E, Vredenburg VT (2014) Thermal physiology, disease and amphibian declines in the eastern slopes of the Andes. *Conservation Biology* 28: 509–517. doi: 10.1111/cobi.12194
- Catenazzi A, von May R (2014) Conservation status of amphibians in Peru. *Herpetological Monographs* 28: 1–23. doi: 10.1655/HERPMONOGRAPHS-D-13-00003
- Cole EM, Bustamante MR, Almeida-Reinoso D, Funk WC (2014) Spatial and temporal variation in population dynamics of Andean frogs: Effects of forest disturbance and evidence for declines. *Global Ecology and Conservation* 1: 60–70. doi: 10.1016/j.gecco.2014.06.002
- De La Riva I (2007) Bolivian frogs of the genus *Phrynopus*, with the description of twelve new species (Anura: Brachycephalidae). *Herpetological Monographs* 21: 241–277. doi: 10.1655/07-011.1
- De la Riva I, Burrowes PA (2014) A new species of *Psychrophrynella* (Anura: Craugastoridae) from the Cordillera Real, Department La Paz, Bolivia. *Zootaxa* 3887: 459–470. doi: 10.11646/zootaxa.3887.4.4
- De La Riva I, Chaparro JC, Padial JM (2008a) A new, long-standing misidentified species of *Psychrophrynella* Hedges, Duellman & Heinicke from Departamento Cusco, Peru (Anura : Strabomantidae). *Zootaxa*: 42–50.

- De la Riva I, Chaparro JC, Padial JM (2008b) The taxonomic status of *Phyllonastes* Heyer and *Phrynopus peruvianus* (Noble) (Lissamphibia, Anura): resurrection of *Noblella* Barbour. *Zootaxa* 1685: 67–68.
- De La Riva I, Köhler J (1998) A new minute leptodactylid frog, genus *Phyllonastes*, from humid montane forests of Bolivia. *Journal of Herpetology* 32: 325–329. doi: 10.2307/1565445
- Duellman WE, Lehr E (2009) Terrestrial-breeding frogs (Strabomantidae) in Peru. *Natur und Tier Verlag, Münster*, 382 pp.
- Duellman WE, Lehr E, Venegas PJ (2006) Two new species of *Eleutherodactylus* (Anura: Leptodactylidae) from the Andes of northern Peru. *Zootaxa* 1285: 51–64.
- Guayasamin JM, Terán-Valdez A (2009) A new species of *Noblella* (Amphibia: Strabomantidae) from the western slopes of the Andes of Ecuador. *Zootaxa*: 47–59.
- Harvey MB, Almendariz A, Brito MJ, Batallas RD (2013) A new species of *Noblella* (Anura: Craugastoridae) from the Amazonian slopes of the Ecuadorian Andes with comments on *Noblella lochites* (Lynch). *Zootaxa* 3635: 1–14. doi: 10.11646/zootaxa.3635.1.1
- Hedges SB, Duellman WE, Heinicke MP (2008) New World direct-developing frogs (Anura: Terrarana): molecular phylogeny, classification, biogeography, and conservation. *Zootaxa* 1737: 1–182.
- Heinicke MP, Duellman WE, Hedges SB (2007) Major Caribbean and Central American frog faunas originated by ancient oceanic dispersal. *Proceedings of the National Academy of Sciences of the United States of America* 104: 10092–10097. doi: 10.1073/pnas.0611051104
- Heyer WR (1977) Taxonomic notes on frogs from the Madeira and Purus rivers, Brazil. *Papéis Avulsos de Zoologia* 8: 141–162.
- IUCN (2013) Guidelines for using the IUCN Red List categories and criteria. – Version 10.1. Prepared by the Standards and Petitions Subcommittee. Downloadable from <http://www.iucnredlist.org/documents/RedListGuidelines.pdf> [accessed 5 April 2015]
- Köhler J (2000) A new species of *Phyllonastes* Heyer from the Chapare region of Bolivia, with notes on *Phyllonastes carrascoicola*. *Spixiana* 23: 47–53.
- Lehr E (2006) Taxonomic status of some species of Peruvian *Phrynopus* (Anura : Leptodactylidae), with the description of a new species from the Andes of Southern Peru. *Herpetologica* 62: 331–347. doi: 10.1655/0018-0831(2006)62[331:tsosso]2.0.co;2
- Lehr E, Aguilar C, Lundberg M (2004) A new species of *Phyllonastes* from Peru (Amphibia, Anura, Leptodactylidae). *Journal of Herpetology* 38: 214–218. doi: 10.1670/135-03a
- Lehr E, Catenazzi A (2008) A new species of *Bryophryne* (Anura: Strabomantidae) from southern Peru. *Zootaxa* 1784: 1–10.
- Lehr E, Catenazzi A (2009a) A new species of minute *Noblella* (Anura: Strabomantidae) from southern Peru: The smallest frog of the Andes. *Copeia*: 148–156. doi: 10.1643/ch-07-270
- Lehr E, Catenazzi A (2009d) Three new species of *Bryophryne* (Anura: Strabomantidae) from the Region of Cusco, Peru. *South American Journal of Herpetology* 4: 125–138.
- Lehr E, Catenazzi A (2010) Two new species of *Bryophryne* (Anura: Strabomantidae) from high elevations in southern Peru (Region of Cusco). *Herpetologica* 66: 308–319.
- Lehr E, Moravec J, Cusi JC (2012) Two new species of *Phrynopus* (Anura, Strabomantidae) from high elevations in the Yanachaga-Chemillen National park in Peru (Departamento de Pasco). *Zookeys*: 51–71. doi: 10.3897/zookeys.235.3885

- Lehr E, Oroz A (2012) Two new species of *Phrynopis* (Anura: Strabomantidae) from the Cordillera de Carpish in central Peru (Departamento de Huanuco). *Zootaxa*: 53–63.
- Lynch JD, Duellman WE (1997) Frogs of the genus *Eleutherodactylus* in western Ecuador. Systematics, ecology, and biogeography. The University of Kansas Special Publication 23: 1–236.
- Pyron RA, Wiens JJ (2011) A large-scale phylogeny of Amphibia including over 2800 species, and a revised classification of extant frogs, salamanders, and caecilians. *Molecular Phylogenetics and Evolution* 61: 543–583. doi: 10.1016/j.ympev.2011.06.012
- von May R, Catenazzi A, Angulo A, Brown JL, Carrillo J, Chávez G, Córdova JH, Curo A, Delgado A, Enciso MA, Gutiérrez R, Lehr E, Martínez JL, Medina-Müller M, Miranda A, Neira DR, Ochoa JA, Quiroz AJ, Rodríguez DA, Rodríguez LO, Salas AW, Seimon T, Seimon A, Siu-Ting K, Suárez J, Torres C, Twomey E (2008) Current state of conservation knowledge on threatened amphibian species in Peru. *Tropical Conservation Science* 1: 376–396.

Appendix

Specimens examined

- Noblella duellmani* (2 specimens): PERU: PASCO: Santa Barbara, KU 315004–05.
- Noblella heyeri* (3 specimens): PERU: PIURA: 33 km SW Huancabamba, KU 196529 (holotype), 196530–31 (paratypes).
- Noblella lochites* (2 specimens): ECUADOR: MORONA-SANTIAGO: Río Piuntza, KU 147070 (holotype); ECUADOR: PASTAZA: Mera, KU 177356.
- Noblella myrmecoides* (5 specimens): PERU: LORETO: lower Rio Napo region, E bank Rio Yanayacu, ca 90 km N Iquitos, KU 206120; Quebrada Oran, ca 5 km N Rio Amazonas, 85 km NE Iquitos, KU 206121; Quebrada Vasquez, N side of lower Rio Tahuayo, KU 220577, 220578, 220579.
- Noblella* cf. *myrmecoides* (23 specimens): PERU: CUSCO: Provincia Paucartambo, Kosñipata, MHNG 2606.82–84, MUSM 21072–80, 30426–29, 30458–60; MADRE DE DIOS: Provincia Manu, Los Amigos Conservation Concession, MUSM 27261, 24219, 24251, 24266, 27274–75.
- Noblella pygmaea* (15 specimens): PERU: CUSCO: Provincia Paucartambo, Kosñipata, MHNG 2725.29–30, MUSM 24535–36, 26306–7, 26318–20, 30423–24, 30453–54, MTD 47286–87.
- Psychrophrynella bagrecito* (14 specimens): PERU: CUSCO: Quispicanchis: Marcapata, Río Marcapata, below Marcapata, ca. 2740 m, KU 196512 (holotype), KU 196513–18, 196520–21, 196523–25 (all paratypes); La Convención: Hacienda Huyro between Huayopata and Quillabamba, 1830 m, KU 196527–28.
- Psychrophrynella usurpator* (78 specimens): PERU: CUSCO: Provincia Paucartambo, Kosñipata, MUSM 20011, 20873–81, 20896–20913, 20925–33, 20946–47, 20955–57, 21012–18, 26272–73, 26278–79, 26308, 27592, 27906, 27950, 28033–28047, 30303, 30305, 30396–30400, 30405–30409, 30471–30474.

A snail in the long tail: a new *Plekocheilus* species collected by the ‘Comisión Científica del Pacífico’ (Mollusca, Gastropoda, Amphibulimidae)

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Abstract

Among the historical collection gathered by the ‘Comisión Científica del Pacífico’ during 1862–1865, type material was found of one of the species described on the basis of the material collected shortly afterwards. Inspection of the types revealed that only one specimen may be considered as type material of *Bulimus aristaceus* Crosse, 1869; this specimen is now designated as the lectotype. The other specimens are described as a new species, *Plekocheilus* (*P.*) *cecepeus*.

Keywords

Ecuador, Orthalicoidea, historical collection

Introduction

Natural museum collections act as reservoirs of potential new species (Green 1998), but historical collections with the results of large expeditions during e.g. the 19th century, have usually been worked upon and new species have already been described. The expeditions of the ‘Comisión Científica del Pacífico’ (CCP) in South America during 1862–1865 (López-Ocón and Ponsati 2015), resulted in a large amount of specimens which are now in the collection of the Museo Nacional de Ciencias Naturales (MNCN) in Madrid. Hidalgo (1870, 1872) investigated the CCP-material and distributed part of

it to colleagues, i.e. Crosse, Pfeiffer and Philippi. In total they described 20 new species of land shells.

One of these new species was *Bulimus aristaceus* Crosse, 1869 described from “Quito, reipublicae Aequatoris”, now placed in the genus *Plekocheilus* Guilding, 1828. Crosse (1869) first gave a brief diagnosis of this species, and later (Crosse 1870) published a description and a figure; both papers appeared in the *Journal de Conchyliologie*. Since Crosse had the habit of asking for types which had been described in that journal, the location of the type material of this taxon might have been expected in that journal’s collection (now part of the Paris museum). However, this material was not listed by Fischer-Piette (1950), and the types had not been traced when Breure (1979) listed all taxa in the genus *Plekocheilus*. While working on a new compilation the type material was found in the Madrid museum, but proved to consist of two different species, one of which is undescribed.

Recently Fontaine et al. (2012) studied the ‘shelf life’ between discovery and description of new species, based on a random selection of species described in 2007 from all kingdoms of life. They concluded that the average ‘shelf life’ was 20.7 years, ranging between zero and 206 years. While no specific data on molluscs were presented, the group ‘other invertebrates’ had an average ‘shelf life’ of ca. 15 years. Anderson (2004) coined the term ‘long tail’ for obscure products that form a niche market provided that they are available online. By analogy, one might call the undescribed species that remain on the museum shelves, well beyond the average time needed for a formal description, as being ‘in the long tail’.

We will re-describe the material of Crosse’s taxon found in the Madrid collection, and provide a description for the hitherto unrecognized species that was part of the material collected by the ‘Comisión Científica del Pacífico’.

Methods

The following abbreviations are used in the text to refer to shell dimensions (in mm with an accuracy of 0.1 mm): D—diameter, H—shell height, HA—height of aperture, LW—height of last whorl, W—number of whorls, WA—width of aperture.

Systematics

Superfamily Orthalicoidea Albers, 1860

Family Amphibulimidae P. Fischer, 1873

Genus *Plekocheilus* Guilding, 1828

Plekocheilus Guilding 1828: 532.

Type species. *Caprella undulata* Guilding, 1824, by monotypy.

Distribution. West Indies, Panama, Colombia, Ecuador, Peru, Bolivia, Brazil, French Guyane, Suriname, Guyana, Venezuela.

Subgenus *Plekocheilus* (*Eurytus*) Albers, 1850

Eurytus Albers 1850: 169.

Type species. *Helix pentadina* d'Orbigny, 1835, by subsequent designation (Albers 1860: 195).

Distribution. West Indies (St. Lucia, St. Vincent), Panama, Venezuela, Brazil, Bolivia, Peru, Ecuador, Colombia.

***Plekocheilus* (*Eurytus*) *aristaceus* (Crosse, 1869)**

Fig. 1

Bulimus aristaceus Crosse 1869: 185; Hidalgo 1870: 54, pl. 6 fig. 5; Crosse 1870: 105, pl. 6 fig. 5; Crosse 1871: 318; Pfeiffer 1877: 44; Miller 1878: 182; Paetel 1889: 208.

Eurytus aristaceus; Pfeiffer and Clessin 1879 [1879–1881]: 227; Cousin 1887: 204.

Bulimulus aristaceus; Paetel 1889: 221.

Plekocheilus aristaceus; Pilsbry 1895 [1895–1896]: 88, pl. 4 fig. 4; Pilsbry 1902: xix; Richardson 1995: 302.

Plekocheilus (*Eurytus*) *aristaceus*; Breure 1979: 29; Breure and Borrero 2008: 5.

Type locality. “Quito, republica Aequatoris”.

Type material. MNCN 15.05/7180, lectotype.

Re-description. Shell 2.12 times as high as wide, with nearly covered, rimate perforation, ventricose-ovate, sides of the short spire slightly convex, moderately solid. Colour light chestnut-brown, with irregular blotches of reddish-brown, especially on last whorl which also shows a faint pattern of spiral bands, the interstices about as wide, which is due to the surface sculpture. Upper whorls slightly paler. Surface somewhat shining, finely granulate, entire teleoconch with a faint pattern of spiral lines of dot-like granulation, crossed by irregular longitudinal growth striae, especially on last whorl. Protoconch smooth and polished (eroded). Whorls 4.3, slightly convex, penultimate more convex and last whorl inflated, its height 0.93 total shell height. Suture well impressed, deeply descending in front. Aperture elongate-ovate, whitish inside, 1.80 times as long as wide, height 0.60 times shell height. Peristome hardly expanded, and slightly reflexed, whitish. Columellar margin slightly curved, above narrowly dilated at insertion to parietal wall, which has a thin, whitish callus.

Dimensions in mm: H 48.3, D 22.7, HA 29.1, WA 16.1, LW 44.8, 4.3 whorls.

Remarks. In the MNCN three lots are labelled ‘*Bulimus aristaceus* Crosse’ which are considered as syntypes. These lots appear not to be conspecific, and only lot MNCN

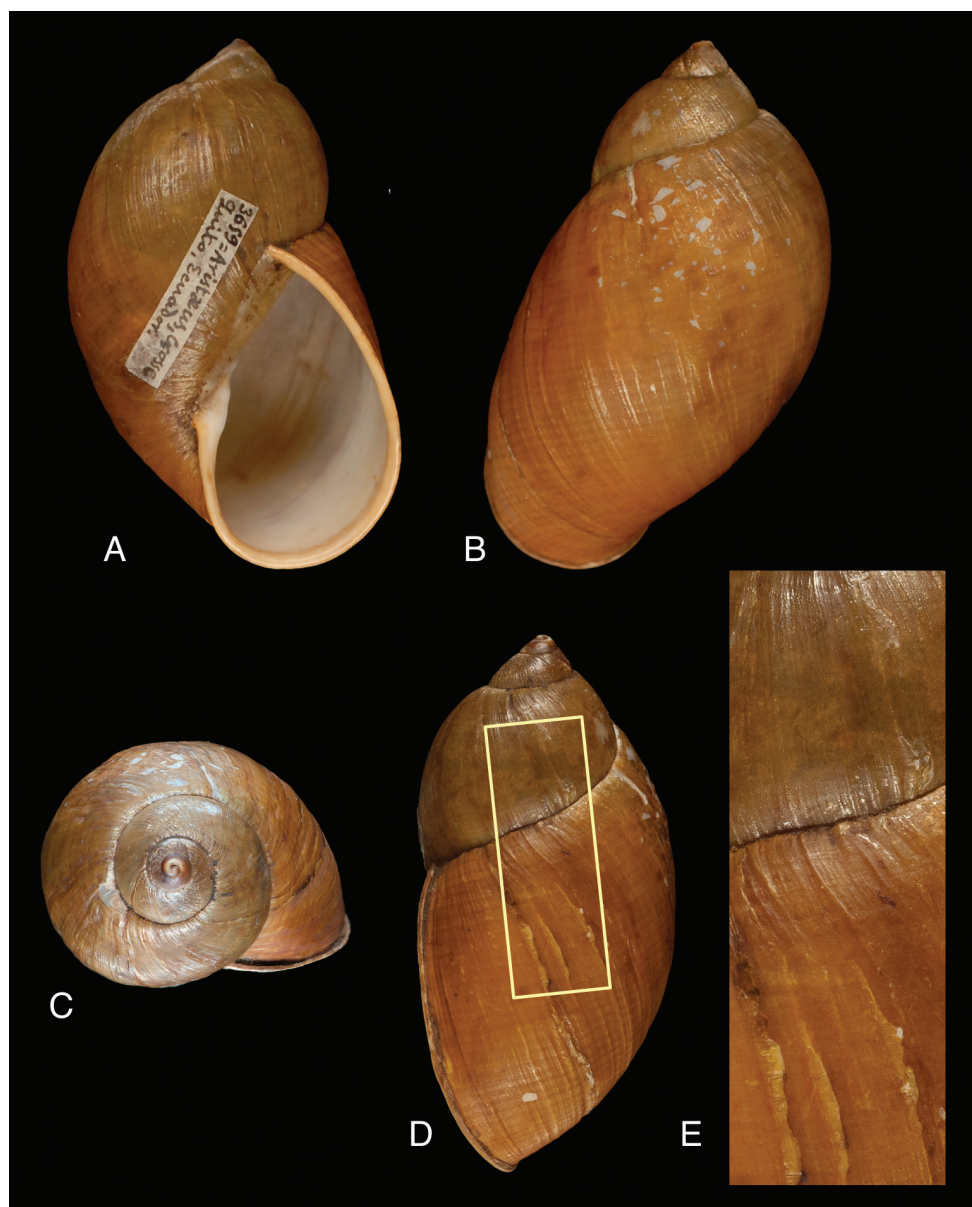


Figure 1. *Plekocheilus (Eurytus) aristaceus* (Crosse, 1869), lectotype MNCN 15.05/7180 (H = 48.3).

15.05/7180 is considered as type material of this taxon. As Crosse did not state on how many specimens his description was based, but no material of this species is present in the Paris collection, the sole specimen is now designated lectotype (**design. n.**) to fixate the taxon. The figure of Crosse (1870) does not entirely adequately represent the current state of the shell as the colour marks may largely have faded away. Crosse

(1871) mentioned a variety, collected “Route de Quito à Napo (prof. Orton)”; this would indicate that this species might occur on the eastern slopes of the Cordillera, but we have not seen this material.

Subgenus *Plekocheilus* (*Plekocheilus*) Guilding, 1828

Distribution. West Indies (St. Vincent, Barbados), Venezuela, Ecuador, Colombia.

***Plekocheilus* (*Plekocheilus*) *cecepeus* sp. n.**

<http://zoobank.org/5546825B-CF3D-4056-8778-AB58D5824937>

Fig. 2

Diagnosis. A moderately small species of *Plekocheilus* (*Plekocheilus*), characterized by the irregularly shaped, widely spaced, narrowly reddish-brown axial colour streaks, and the spiral series of oblong granules between the axial riblets, becoming a malleate pattern on the dorsal side of the last whorl.

Description. Shell up to 45.0 mm, 1.76 times as high as wide, imperforate, ovate, sides of spire hardly convex, moderately solid. Colour light chestnut-brown, with irregular, axial streaks of reddish-brown, partly as oblique lines or as zig-zag lightning streaks and partly broken up. Upper whorls paler or denuded of epidermis. Surface somewhat glossy, with moderately strong axial riblets, partly broken up into smaller ones, especially on lower ventral part of last whorl; penultimate whorl with spirally arranged oblong granules in between axial riblets, becoming gradually stronger and forming, on dorsal side of last whorl, a malleated pattern of spirally arranged, broken axial riblets partly irregularly shaped. Protoconch smooth (eroded). Whorls up to 4.9, hardly convex, last whorl 0.94 times shell height, somewhat swollen. Suture well impressed, descending in front and abruptly ascending behind lip. Aperture elongate-ovate, 2.28 times as long as wide, height 0.72 times shell height. Peristome expanded and reflexed, whitish or pinkish, slightly curved at insertion to parietal wall. Columellar margin curved, above a more or less weak fold entering the aperture; broadly dilated above at the insertion to the parietal wall, which has a thin whitish or translucent, broadly spreading callus.

Dimensions in mm: H 37.8–45.0, D 22.3–25.4, HA 23.5–32.2, WA 11.6–14.8, LW 34.0–42.2, 3.8–4.9 whorls. Holotype H 44.8, D 25.4, HA 32.2, WA 14.1, LW 42.2, 4.8 whorls.

Type locality. Ecuador, “Quito” (teste Hidalgo 1893: 102). See remarks.

Type material. MNCN 15.05/60013H, holotype; MNCN 15.05/60013P, five paratypes; MNCN 15.05/7477P, three paratypes.

Comparison with other species. This new species bears resemblance with *Plekocheilus* (*P.*) *blainvillanus* (Pfeiffer, 1848) from northern Venezuela, but differs in being smaller, the last whorl less malleated, and having the suture abruptly ascending behind

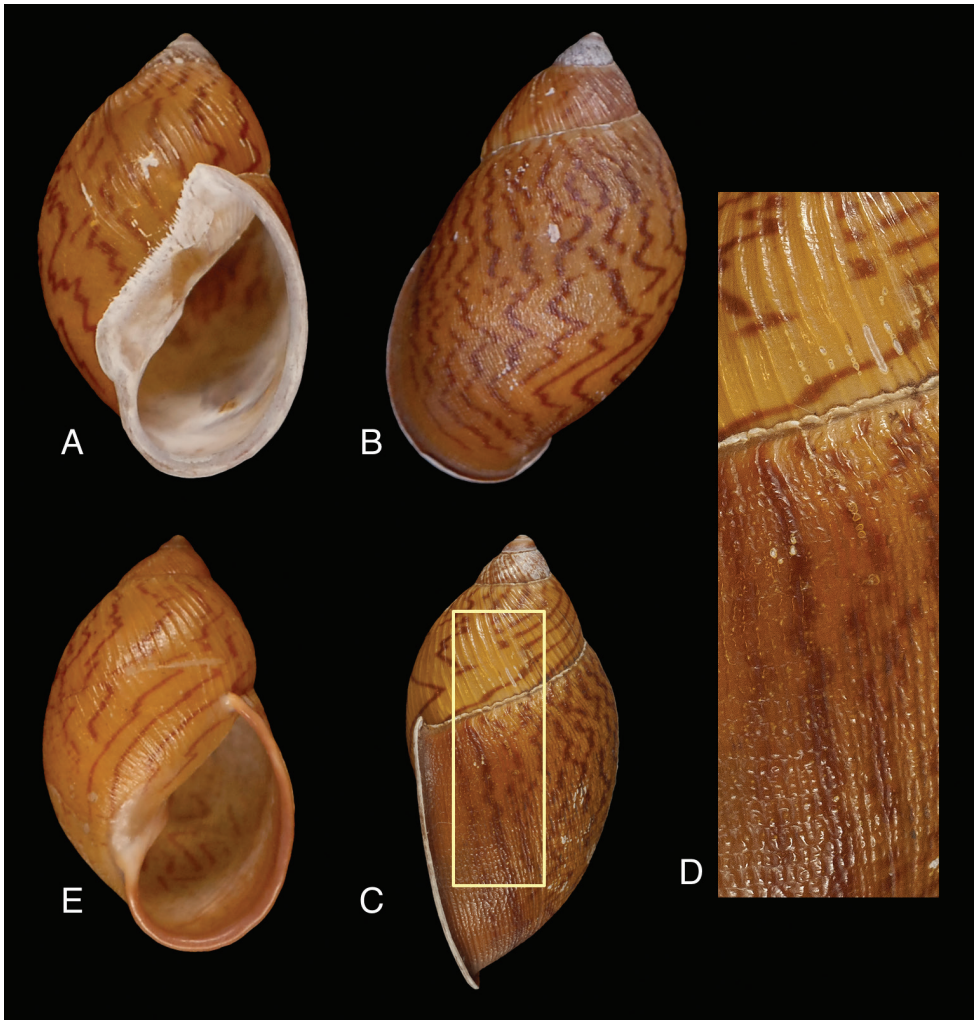


Figure 2. *Plekocheilus (Plekocheilus) cecepeus* sp. n., **A–D** holotype MNCN 15.05/60013H (H = 44.8) **E** paratype MNCN 15.05/60013P (H = 38.8).

the lip. It may also be compared to the Venezuelan *P. (P.) fulminans* (Nyst, 1843), from which it differs by having a larger aperture, the lip less thick, and a less pronounced fold in the columella. Finally, it resembles *P. (P.) alticola* Haas, 1955 from Venezuelan Guayana, but differs by being slightly larger, and having a less malleated sculpture.

Remarks. The type locality is unfortunately very imprecise, which was not uncommon with material collected during the 19th century (Breure and Borrero 2008). Almagro (1866: 81) briefly described the two months the expedition stayed in Quito from the beginning of December 1864 to the beginning of 1865. During that period they made excursions in the province of Imbabura and to the volcanoes of Antisana, and Pichincha. A detailed list of localities of Ecuadorian material, with collectors and

number of specimens can be found in Almagro 1866: 163–164. However, it cannot be excluded that the material was actually collected at a considerable distance from the capital, and it remains to be seen if future collecting may provide more precise localities for this species.

Etymology. The specific epithet is formed after the abbreviation for the ‘Comisión Científica del Pacífico’ (CCP). Named in honour of the expedition members of this commission, i.e. Patricio María Paz y Membiela (1808–1874), Manuel Almagro (1834–1895), Fernando Amor (1820–1863), Francisco de Paula Martínez y Sáez (1835–1898), Marcos Jiménez de la Espada (1831–1898), Rafael Castro y Ordóñez (1834–1865), and Juan Isern (1825–1866). 150 years ago they returned with many undescribed species and this novelty remained all those years on the shelves. The epithet is used as a noun.

Discussion

López-Ocón and Badía (2003) have discussed the political-historical context of this expedition and have described the up’s and down’s in the study of the collected material. Although description of new species that have remained unnoticed for more than a century remains a rare event (but see e.g., Breure 2011: 44–45), it highlights the need for revisions of museum collections by specialists, and especially the historical parts of these. This rare find also stresses the need for additional field work in the area, trying to locate the true home of this novelty.

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References

- Albers JC (1850) Die Heliceen, nach natürlicher Verwandtschaft systematisch geordnet von Joh. Christ. Albers. Enslin, Berlin, 262 pp. doi: 10.5962/bhl.title.11507
- Almagro M de (1866) Breve descripción de los viajes hechos en América por la Comisión científica enviada por el Gobierno de S. M. C. durante los años de 1862 á 1866, acompañada de dos mapas y de la enumeracion de las colecciones que forman la exposición pública. Imprenta Rivadeneyra, Madrid, 174 pp.
- Anderson C (2004) The long tail. <http://archive.wired.com/wired/archive/12.10/tail.html> [accessed 29 June 2015]
- Breure ASH (1979) Systematics, phylogeny and zoogeography of Bulimulinae (Mollusca). Zoologische Verhandelingen Leiden 168: 1–215.

- Breure ASH (2011) Annotated type catalogue of the Orthalicoidea (Mollusca, Gastropoda) in the Royal Belgian Institute of Sciences, Brussels, with descriptions of two new species. *ZooKeys* 101: 1–50. doi: 10.3897/zookeys.101.1133
- Breure ASH, Borrero JF (2008) An annotated checklist of the land snail family Orthalicidae (Gastropoda: Pulmonata: Orthalicoidea) in Ecuador, with notes on the distribution of the mainland species. *Zootaxa* 1768: 1–40.
- Cousin A (1887) Faune malacologique de la république de l'Équateur. *Bulletin de la Société Zoologique de France* 12: 187–287.
- Crosse H (1869) Diagnoses molluscorum novorum. *Journal de Conchyliologie* 17: 183–188.
- Crosse H (1870) Descriptions d'espèces nouvelles. *Journal de Conchyliologie* 18: 97–109.
- Crosse H (1871) Note sur les coquilles terrestres recueillies par M. le professeur Orton dans la région supérieure de l'Amazonie et descriptions d'espèces nouvelles. *Journal de Conchyliologie*, 19: 312–318.
- Fischer-Piette E (1950) Liste des types décrits dans le *Journal de Conchyliologie* et conservés dans la collection de ce *Journal*. *Journal de Conchyliologie* 90: 8–23, 65–82, 149–180.
- Fonatine B, Perrard A, Bouchet P (2012) 21 years of shelf life between discovery and description of new species. *Current Biology* 22: R943–R944. doi: 10.1016/j.cub.2012.10.029
- Green SV (1998) The taxonomic impediment in orthopteran research and conservation. *Journal of Insect Conservation* 2: 151–159. doi: 10.1023/A:1009633811789
- Guilting L (1828) Observations on the zoology of the Caribbean Islands. *Zoological Journal* 3: 527–544.
- Hidalgo JG (1870) Catalogue des coquilles terrestres recueillies par les naturalistes de la commission scientifique espagnole sur divers points de l'Amérique méridionale. *Journal de Conchyliologie* 18: 27–70.
- Hidalgo JG (1872) Moluscos del viaje al Pacífico verificado de 1862 á 1865 por una comisión de naturalistas enviada por el gobierno Español. Parte Primera. Univalves terrestres. Bailly-Bailliere, Madrid, 152 pp.
- Hidalgo JG (1893) Catálogo de las conchas terrestres recogidas por los naturalistas de la comisión científica española en diversos puntos de la América meridional. In: Hidalgo JG (1893–1900) *Obras Malacológicas*. Parte III, Descripción de los moluscos recogidos por la Comisión Científica enviada por el Gobierno Español á la América Meridional. Imprenta de Don Luis Aguado, Madrid, 75–134.
- López-Ocón L, Badía S (2003) Overcoming obstacles: the triple mobilization of the Comisión Científica del Pacífico. *Science in Context* 16: 505–534. doi: 10.1017/S0269889703000942
- López-Ocón L, Ponsati A (2015) Servidor de información world wide web de la Comisión Científica del Pacífico (II): Sistemas de difusión digital del patrimonio cultural. <http://www.pacifico.csic.es> [accessed 29 June 2015]
- Miller K (1878) Die Binnenmollusken von Ecuador. *Malakozoologische Blätter* 25: 153–199.
- Pfeiffer L (1877) *Monographia heliceorum viventium sistens descriptiones systematicas et criticas omnium huius familiae generum et specierum hodie cognitarum*, 8. Brockhaus, Lipsiae, 729 pp.
- Pfeiffer L, Clessin S (1879–1881) *Nomenclator heliceorum viventium quo continetur nomina omnium huius familiae generum et specierum hodie cognitarum disposita ex affinitate naturali*. Fischeri, Cassellis, [ii +] 617 pp.

Pilsbry HA (1895–1896) American bulimi and bulimuli. *Strophocheilus*, *Plekocheilus*, *Auris*, *Bulimulus*. Manual of Conchology (2) 10: i–iv, 1–213.

Pilsbry HA (1902) Classification of Bulimulidae and index to volumes 10–14. Manual of Conchology (2) 10: i–xcix.

Description of a new species of *Petrolisthes* in the Indo-West Pacific with a redefinition of *P. hastatus* Stimpson, 1858 and resurrection of *P. inermis* (Heller, 1862) (Crustacea, Anomura, Porcellanidae)

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Abstract

The porcellanid crab *Petrolisthes hastatus* Stimpson, 1858, has been traditionally viewed as a highly variable species with a wide distribution in the West Pacific. For more than a century there has been taxonomic confusion of this species with morphologically similar taxa, some of which were synonymized with Stimpson's taxon. We redefine *P. hastatus*, resurrect *P. inermis* as a valid species, discuss the status of *P. tenkatei* De Man, 1893, and describe a new species as *P. elegantissimus* from Indonesia.

Keywords

Crustacea, Decapoda, Porcellanidae, new species, Indo-West Pacific

Introduction

Porcellanidae is a morphologically and ecologically diverse family of decapod Crustacea containing approximately 280 species in 23 genera with littoral or sublittoral distributions throughout the tropical and temperate regions of all oceans (e.g. Haig 1956, 1960; Werding 1977; Werding et al. 2003; Osawa and Chan 2010; Osawa and McLaughlin 2010). This family comprises one of the most abundant groups of crustaceans in rocky and coral habitats. The genus *Petrolisthes* Stimpson, 1858, is the most species-rich in the family (> 100 species), contains several complexes of species that are morphologically highly variable and widely distributed, and has a long and complicated taxonomic history (e.g. Haig 1960; Stillman 2001; Hiller et al. 2006).

For more than a century, *Petrolisthes hastatus* Stimpson, 1858 has been object of taxonomic confusion. This species has been known to have large intraspecific variation. In his original description Stimpson briefly characterized the species, and in a later paper (Stimpson 1907) this description was essentially repeated with the addition of a figure (Pl. XXII, fig. 4) that exhibits the main characteristics of the species including a flattened, spineless carapace with a triangular rostrum, large, flattened chelipeds, each with the carpus armed with three evenly distributed teeth at the anterior margin, and with a single, prominent curved distal spine at the posterior end. The presence of pubescence in the gape of the cheliped fingers was not mentioned by Stimpson (1858, 1907), and the walking legs were characterized as “hairy, sparsely spinulose above”.

Subsequent to Stimpson’s original description, Heller (1862) described *Petrolisthes inermis*, a species Heller characterized as close to *P. rufescens* (Heller, 1861), but with three instead of four teeth at the anterior margin of the cheliped carpus (the two species were originally referred to the genus *Porcellana*). De Man (1888) compared six specimens from the Nicobar Islands with a type of *P. inermis*, and considered the species to be potentially synonymous with *P. hastatus*. De Man (1893) described *Petrolisthes tenkatei* from the Malay Archipelago and discussed the possibility of his new species being a synonym of *P. hastatus*.

Succeeding studies (Haig 1964, 1979; Miyake 1943) considered *P. inermis* a synonym of *P. hastatus*. Nakasone and Miyake (1971) formally synonymised *P. tenkatei* with *P. hastatus*. This concept of synonymies has been retained in the recent list of porcellanid species of the world provided by Osawa and McLaughlin (2010).

Most figures of *P. hastatus*, e.g. Miyake (1943, fig. 5), Haig (1979, fig. 5), Hsieh et al. (1998, fig. 18), and Osawa and Chan (2010, figs 98–102), exhibit a phenotype that largely agrees with Stimpson’s (1907) figure (Pl. XXII, fig. 4), while the specimens photographed by Nakasone and Miyake (1971, pl. 1 C, D and also probably B) seem to represent another phenotype, with each cheliped having a slender carpus (more than three times longer than broad) armed with two low teeth on the anterior margin, and an elongated chelae, each with a large tuft of setae in the gape of the fingers, visible from dorsal side.

While examining collections of Porcellanidae from the Naturalis Biodiversity Center (Leiden) and the Muséum National d’Histoire Naturelle (Paris), we found

three morphotypes from Indonesia and Papua New Guinea that fit the general characters of *P. hastatus* as described in the literature. However, a detailed examination of these morphotypes revealed that they correspond to three distinct species: *P. hastatus* Stimpson, *P. inermis* (Heller) and a third new species described herein as *P. elegantissimus*. These three species share the following characters: carapace without spines; carpus of cheliped with widely-set, low teeth on the anterior margin, the number of teeth varying, the posterior margin slightly curved outside, and with a single, prominent distal tooth; merus of walking legs unarmed or with a varying number of spines on dorsal margin, and with a distal spine on the ventral margin, at least in first legs.

Type material of *P. hastatus* was searched for in the collections of the Smithsonian National Museum of Natural History, but it seems to be inexistent (R. Lemaitre, pers. comm.). In the collections of the Naturalis Biodiversity Center (Leiden) there are series of types corresponding to the original series collected by H. ten Kate in 1891, on which the description of *P. tenkatei* by De Man (1893) was based, and which is clearly distinct from *P. hastatus* as defined here. Regarding *P. inermis* (Heller, 1862), there are three specimens from the Novara Expedition from the Nicobars (Naturhistorisches Museum, Vienna, Austria), which were examined.

Material and methods

Most material examined is deposited in the Naturalis Biodiversity Center (NBC) in Leiden, the Netherlands, and the Muséum National d'Histoire Naturelle (MNHN) in Paris, France. This material was compared to old samples from the Naturhistorisches Museum (NHM) in Vienna, Austria, which corresponds to the original material collected by the Novara Expedition, and labelled as syntypes of *Porcellana inermis* Heller, 1862 by later curators. Additionally, other NBC specimens collected by H. ten Kate, and presently designated as lectotype and paralectotypes of *Petrolisthes tenkatei* De Man, 1893, were also examined. Two paratypes of the new species, were deposited in the collections of the Senckenberg Naturmuseum (SNM), Frankfurt, Germany. In the synonymy are included only those citations in which we could confirm that the respective species were treated in former reports.

Measurements are given as carapace length (CL) × carapace width (CW) for representative and/or largest specimens of each species. Oviparous females are denoted as “ov”, and the three pairs of walking legs as L1-L3.

Data resources

The data underpinning the analysis reported in this paper are deposited in the Dryad Data Repository at <http://dx.doi.org/10.5061/dryad.k71m0>

Results

Systematic account

Petrolisthes hastatus Stimpson, 1858

Fig. 1

Petrolisthes hastatus Stimpson, 1858: 228, 241; 1907: 184, pl. 22 fig. 4. – Miyake 1943: 54, 62, figs 5, 6. – Haig 1964: 360 (partim); 1979: 124, fig. 5. – Johnson 1970: 13. – Nakasone and Miyake 1971: 5 (partim), pl. 1, fig. A. – Hsieh, Chan and Yu 1998: 307, figs 14D, 18A–H. – Osawa and Chan 2010: 131, figs 98–102.

Material examined. Indonesia: Snellius Expedition 1929–1930. RMNH. CRUS.D.56378, ca. 260 specimens, Sissie by Misool, beach, 06. Oct. 1929; RMNH. CRUS.D.56379, ca. 140 specimens; RMNH.CRUS.D.56380, ca. 60 specimens, Ambon, 11.–17.09.1930; RMNH.CRUS.D.56381, ca. 145 specimens; RMNH. CRUS.D.56382, ca. 90 specimens. Aloonf, beach and reef, 08.02.1930; RMNH. CRUS.D.56383, ca. 90 specimens, Tidore, strand, 24.–29.09.1929; RMNH. CRUS.D.56384, 9 males, 9 females (3ov), Pelee (by Misool), beach, 04.10.1929; RMNH.CRUS.D.56386, 1 male, Menado, 10.10.1930; RMNH.CRUS.D.56390, 1 male, Morotai, 03.–10.06.1930 RMNH.CRUS.D.56396, 2 spec. Bopyridae, Alsang, beach and reef, 08.02.1930; RMNH.CRUS.D.56397, 1 male, 1 female (ov), Los (by Misool), beach and reef, 03.–06.10.1929; RMNH.CRUS.D.56398, 4 males with Bopyridae, Tidore, beach, 24.–29.09.1929; RMNH.CRUS.D.56399, 1 male with Bopyridae, Paleleh, Celebes, beach, 21.0.1929; RMNH.CRUS.D.56400, 1 male, Maenado, 01. Oct. 1930; RMNH.CRUS.D.56401, 1 male, Ambon, 11.–17.09.1930; RMNH.CRUS.D.56402, 2 males with Bopyridae, Pelokan, Postiljon Island, beach and reef, 20.12.1929; RMNH.CRUS.D.56403, 1 male, near Koepang, strand, 25.11.1929; RMNH.CRUS.D.56404, 1 male, Tidore near Koepang, Tjabo, beach, 24.–29.09.1929; RMNH.CRUS.D.56405, 1 male, Paleleh Celebes, beach, 21.08.1929; MNH.CRUS.D.56406, 1 male, Ake Salaka, Raoebaai Halmakeira, beach and reef, 28.05.1930; RMNH.CRUS.D.56407, 1 male, Taliaboe, Pasik Lpah, Solea Island), beach, 19.03.1930. **Papua New Guinea.** MNHN-IU-2013-9128, 1 male, Stn. PM08, 05°15'17.82" - 145°46'38.91E", Yabob Village, Gum River, 0–1m, 12.11.2012; MNHN-IU-2013-960, 1 male; MNHN-IU-2013-9539, 1 female (ov), Stn. PM41, 05°08.1'S - 145°49.3'E, Wonad Island, sandy beach and intertidal rocks, 0–1m, 27.11.–09.12.2012; MNHN-IU-2013-295, 1 male, Stn. PM12 05°00.2'S - 145°47.6'E, Rempi Area, S Dumduman Island, limestone rocky intertidal, 0–1m, 09.11.2012; MNHN-IU-2013-9615, 1 male, Stn. PM22, 05°04.7'S - 145°48.9'E Sek I, Night Tide, 14.11.2012. MNHN-IU-2013-9615, 1 male, Stn. PM22, 05°04.7'S - 145°48.9'E Sek I, Night Tide, 14.11.2012; MNHN-IU-11212, 1 male; Stn. VM46, 15°34'S- 167°12'E, Vanuatu, Aoré Island, 03.10.2006.



Figure 1. *Petrolisthes hastatus* Stimpson, 1858. Dorsal view of male RMNH.CRUS.D.56380, Ambon, Indonesia. Scale bar – 5 mm.

Measurements. Largest male: CL 10.7 mm \times CW 10.9 mm; largest female: CL 10.3 mm \times CW 10.7 mm.

Description. Carapace as broad as long or slightly broader than long, evenly rounded on branchial regions, broadest at posterior branchial level; surface covered with flattened, fine granules and faint plications. Front strongly produced, sinuously triangular, rostrum with a median sulcus, supraocular angle scarcely produced, depressed by a shallow groove. Orbits shallow; outer orbital angle rounded, scarcely produced, forming a low lobe with continuing hepatic margin; epibranchial angle accentuated but without notch or spine, continuing in a ridge along mesobranchial margin; branchial margin unarmed. Protogastric ridge forming a distinct crest, cervical grooves and regions slightly defined. Lateral walls with short, feathered setae.

Basal segment of antennular peduncle with faint transverse rugae; anterior margin rounded, with a distinct tooth at mesial corner and a rounded protuberance at lateral corner.

First movable segment of antenna with foliate, subquadrate projection without prominent tooth; second segment with a longitudinal granular crest ending proximally in a rounded tooth; third rounded, unarmed.

Chelipeds sub-equal. Merus with transverse, low granules on dorsal surface, anterior margin armed distally with a prominent, finger-shaped, rounded lobe; dorso-distal margin fringed with short setae. Carpus about 2.5 to 3 times longer than broad; dorsal surface covered with shallow, transverse rows of granules; anterior margin with 3 (rarely 4) wide-set, serrate-edged, hooked teeth, the proximal one normally the largest; posterior margin slightly curved outwards, granules along posterior margin enlarged, forming a crest terminating in a prominent, curved tooth; dorso-distal margin with short pubescence posteriorly.

Chelae large, broad and flattened; outer margin evenly arcuate and unarmed; dorsal surface covered with shallow, rounded granules; fingers broad, spineless, meeting at their entire length or slightly gaping in the larger chela, entire gape covered with a short pubescence.

Ischium of walking legs covered with feathered setae; merus spineless or with 1–3 irregularly-set spines and a fringe of feathered setae along the anterior margin; merus of L1 and L2 with a posterodistal spine. Carpus with a fringe of feathered setae on the anterior margin. Propodus and dactylus with scattered, feathered and long, simple setae; propodus ventrally with a distal triplet of movable spinules, and one additional spine at mid-distance; dactylus with 3 movable spines on posterior margin.

Variation. The number of teeth on the anterior margin of the cheliped carpus may be reduced, the position of the lacking tooth is then marked by a small knob; in other cases a vestigial additional tooth is present.

Habitat. *Petrolisthes hastatus* is a shallow water species. The specimens of the Snelius and Papua New Guinea expeditions were collected from intertidal or shallow subtidal (0.5 m depth) rocks and reefs. Haig (1979) and Osawa and Chan (2010) described the habitat of the species as intertidal, under rocks.

Distribution. The species, as defined here, is restricted to the western Pacific, from Singapore, eastwards through Indonesia and Papua New Guinea to Vanuatu. Northwards it occurs in Taiwan, and Ryukyu and Kikajima, Japan.

Petrolisthes inermis (Heller, 1862)

Fig. 2

Porcellana inermis Heller, 1862: 424 (partim); 1865: 76, pl. 6, fig. 5.

Petrolisthes inermis? De Man, 1893: 288, pl. 7, fig. 1.

Petrolisthes tenkatei De Man, 1893: 289, pl. 7, figs 2, 2a, 2b.

Petrolisthes sp. n.? De Man, 1902: 69, pl. 23, fig. 37.

Petrolisthes hastatus Nakasone & Miyake, 1971: 5 (partim), pl. 1, B-D.

Type material. **Nicobar Islands: Novara Expedition 1857–59.** NHM24237, lectotype, female (ov), CL 6.4 mm × CW 7.0 mm, 23.02.–20.03.1858; NHM24238, paralectotype, 1 male, CL 6.7 mm × CW 6.6 mm, 23.02.–20.03.1858.

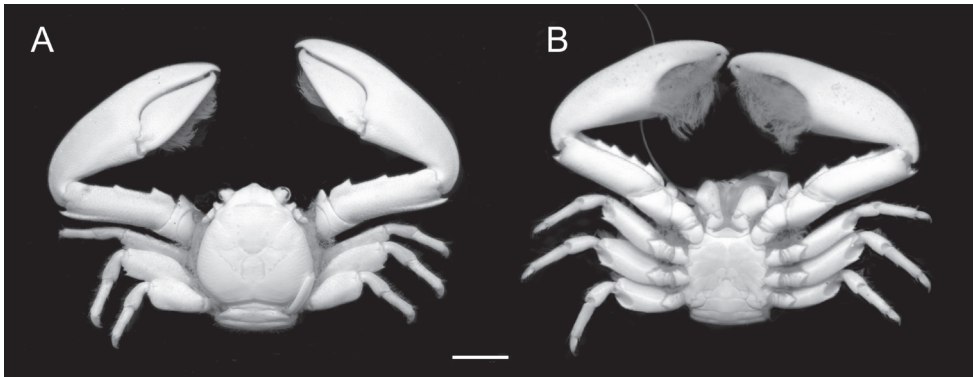


Figure 2. *Petrolisthes inermis* (Heller, 1862). Dorsal (A) and ventral (B) views of female RMNH. CRUS.D.56417, Ambon, Indonesia. Scale bar – 5 mm.

Other material examined. Indonesia. RMNH.CRUS.D.2604, 1 male, Indonesia, Endeh, Flores Island, leg. H. ten Kate, 1891; Measurements: CL 8,5 mm × CW 9,0 mm; RMNH.CRUS.D.1643, 5 males, 2 females (1ov), Indonesia, Endeh, Flores Island, leg. H. ten Kate, 1891; RMNH.CRUS.D.56410, 4 males, Indonesia, Sangihe Island, leg. D.J. Hoedt 1867. Indonesia: Snellius Expedition. RMNH. CRUS.D.56411, 12 males, 3 females (ov), Ternate, beach, 24.09.1929; RMNH. CRUS.D.56412, 1 male, Rambay by Timor, beach and reef, 26-28.11.1929; RMNH.CRUS.D.56413, 1 male, 2 females (ov), Paleleh, Celebes (Sulawesi), beach, 22.08.1929; RMNH.CRUS.D.56414, 1 male, 1 female, (with Bopyridae), Ende, (Flores), 06.-08.11.1930; RMNH.CRUS.D.56415, ca. 430 specimens, Ende, (Flores), 06.-08.11.1930; RMNH.CRUS.D.56416, 2 males, Ambon, beach and reef 0-2m, 06.05.1930; RMNH.CRUS.D.56417, ca. 80 specimens, Ambon, 11.-17. 09. 1930. **Indonesia: Indonesien-Dutch Snellius-II Expedition.** RMNH.CRUS.D.56418, 3 males, Sta.4.001, Ambon Bay, near Tawiri, cobble beach to disturbed reef, dead corals, 0-5m, snorkeling, scuba diving, 22. and 30.08.1984. RMNH.CRUS.D.56419, 1 male, Sta.18, Ambon, Hitu, E side of Laha, up to and including Tawiri, littoral, 08.11.1990; RMNH.CRUS.D.56420, 12 males, 6 females (5ov), Ambon, Hitu, W side of Laha, 06.12.1990; RMNH.CRUS.D.56421, 2 males (1 without chelae), 1 female (ov), Ambon, Sta. 36, Paso,(Bugala), littoral collection, 05.12.1990; RMNH. CRUS.D.56422, 1 male, Ambon, Station 1, in front of the house, littoral collection, leg. CHJM Franssen, 06.11.1990. **Papua New Guinea.** MNHN-IU-2013-9125, 3 males, 1 female (ov), Stn. PM08, 05°15'17.82" – 145°46'38.91", Yabob Village, Gum River, 0-1m, 12.11.2012.

Measurements. Largest male: CL 11.0 mm × CW 11.0 mm; largest female: CL 8.6 mm × CW 9.0 mm.

Description. Carapace as broad as long, or somewhat broader than long, evenly rounded at branchial regions, broadest at posterior branchial level; surface covered with faint plications, more accentuated laterally. Front produced, sinuously triangular,

rostrum with a moderately deep median sulcus, supraocular angle scarcely produced, depressed by a shallow groove. Orbits shallow, outer orbital edge bluntly produced, forming a shallow lobe with hepatic margin. Epibranchial angle unarmed, marked by a ridge continuing along the mesobranchial margin. Protogastric ridge forming a distinct crest, cervical grooves and regions poorly defined. Lateral walls thickly matted with long, feathered setae, largely concealing the basal parts of the walking legs.

Basal segment of antennular peduncles with faint transverse rugae, anterior margin rounded, with distinct tooth at mesial corner and rounded protuberance at lateral corner.

First movable segment of antenna anteriorly with foliate, square-cut projection with a shallow, forwardly directed tooth; second with a longitudinal granular crest, extending proximally in a rounded tooth, third rounded, unarmed.

Chelipeds sub-equal. Merus with transverse, shallow plications on dorsal surface, anterior margin armed distally with a finger-shaped, granular lobe, fringed with short setae. Carpus slender, highly variable, from about 3 to 4 times longer than broad, dorsal surface covered with low, scale-like granules; anterior margin with 2 shallow teeth, a third one faintly marked or lacking; the proximal tooth normally the largest and acute, the second one smaller and blunt. Posterior margin slightly curved outwards, granules along posterior margin enlarged, forming a crest along the postero-distal margin, extending into a spine-tipped, distal tooth. Chelae large, slender, transversely swollen; outer margin curved on entire length, unarmed; fingers spineless, frequently gaping in larger chela. Gape of fingers with large, dense pubescence, visible from above, sometimes only in one chela, seldom lacking. Ischium of walking legs covered with a pubescence of feathered setae; merus with a single dorsal spine close to the distal edge in L1 and L2, and a fringe of feathered setae on anterior margin; merus of L1 and L2 with a posterodistal spine, sometimes lacking in L2 or in both. Carpus and propodus with a fringe of feathered setae on anterior margin, with scattered feathered and simple setae. Propodus ventrally with distal triplet of movable spinules and one additional spine at mid-distance; dactylus with 3 movable spines on posterior margin.

Variation. Large specimens normally present more elongate and narrower chelipeds, more variation in the form of the chelipeds than smaller ones, and often exhibit a remarkable heterochely.

Habitat. *P. inermis* seems to be a shallow water species. According to the material of the Papua New Guinea Expedition and the two Snellius Expeditions in Indonesia the species was collected in the littoral in rocky beaches and on dead corals, in depths of 0–5 m.

Distribution. Eastern Indian Ocean, Nicobar Islands, Indonesia, Papua New Guinea, New Caledonia.

Remarks. Some of the original material from the Novara Expedition is deposited in the collections of the Naturhistorisches Museum (NHM) in Vienna. We found two lots labelled as “Syntypus” of *Porcellana inermis* Heller, 1862. One lot (NHM24237) contained a moderate-sized female, which was selected as lectotype. The other (NHM24238) contained a small male lacking the right chela and two walking legs, and a larger female lacking one cheliped. The small male was selected as paralecto-

type. The second specimen represents a different species. De Man's (1893) original specimens of *Petrolisthes tenkatei* (RMNH.CRUS.D.2604, RMNH.CRUS.D.1643) are deposited in the collections of the Naturalis Biodiversity Center (Leiden). They are labelled as lectotype and paralectotypes of *P. tenkatei*, which is a synonym of *P. inermis*. Judging from the figure of *Petrolisthes* sp. n. from De Man (1902, fig. 37) this species also corresponds to *P. inermis*, and is therefore included in the synonymy of that species.

***Petrolisthes elegantissimus* sp. n.**

<http://zoobank.org/3EAE708F-6E86-4545-9CE7-43939FBEB380>

Figs 3 and 4

Type material. Indonesia. RMNH.CRUS.D.56374, holotype, male, CL 8.9 mm × CW 8.7 mm, NW Guinea, Pulau Japen, coast near Sarawandori, leg. W. van Seroei, 24.2.1955. Paratypes: RMNH.CRUS.D.56408, 4 males, 5 females (3 ov), same data as holotype. RMNH.CRUS.D.56375, 2 males, CL 8.8 mm × CW 8.8 mm, and CL 6.3 mm × CW 6.0 mm, same data as holotype. **Indonesia: Snellius Expedition.** RMNH.CRUS.D.56376, 5 males, 3 females (ov), Los (near Misool), 3–6.10.1929; RMNH.CRUS.D.56377, 2 males, Wotap, (Pulau Wotap), Tanimbar Island, beach and reef, 20.–23.10.1929; RMNH.CRUS.D.56409, 3 males, 1 female (ov), Pelee near Misool, beach, 04.10.1929. SMF 48329, 1 male, 1 female (ov), CL 8.1 mm × CW 8.6 mm, Sissie near Misool, beach, 06.10.1929.

Measurements. Largest male: CL 8.9 mm × CW 8.7 mm; largest female (ov): CL 8.1 mm × CW 8.6 mm.

Description. Carapace as long as broad or slightly broader than long, invertedly heart-shaped, broadest at metabranchial level; dorsal surface granular, branchial regions with low striae on outer margin. Front strongly produced, sinuously trilobate; lateral lobes formed by the supra-ocular edge; rostrum dorsally with deep median sulcus extending beyond protogastric ridge; orbits shallow, nearly straight, outer orbital

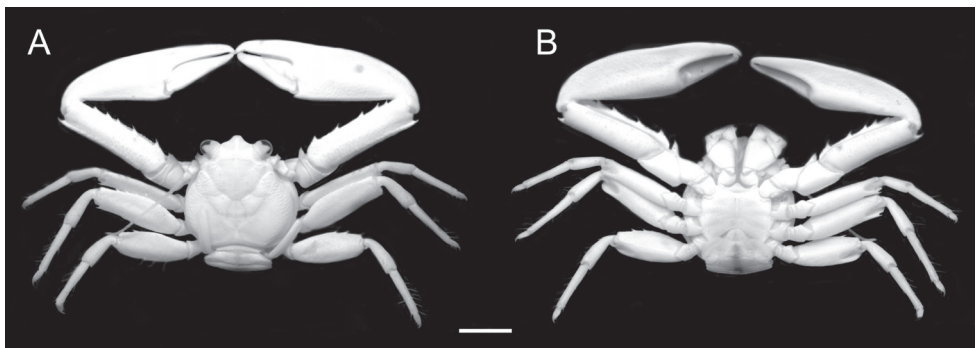


Figure 3. *Petrolisthes elegantissimus* sp. n. Dorsal (A) and ventral (B) views of paratype male RMNH. CRUS.D.56375, NW Guinea, Indonesia. Scale bar – 4 mm.

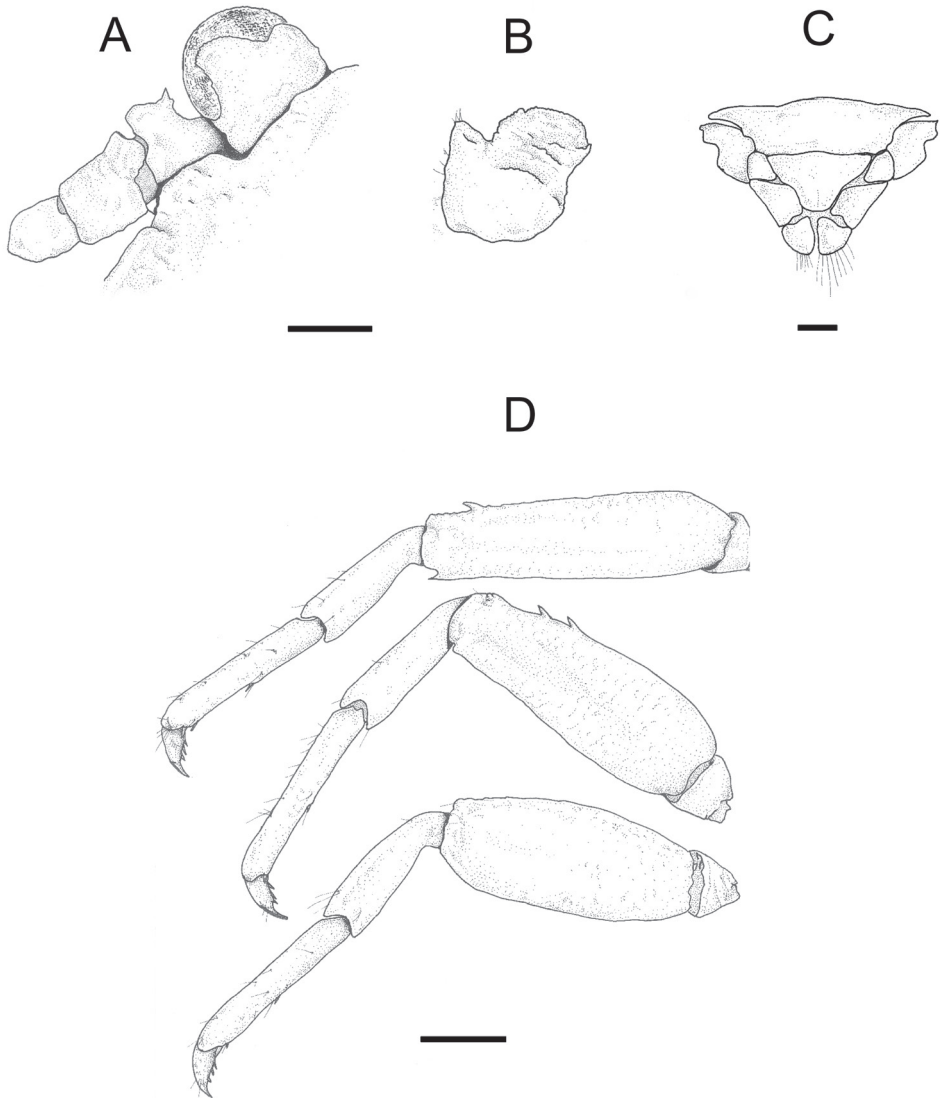


Figure 4. *Petrolisthes elegantissimus* sp. n., paratype male RMNH.CRUS.D.56408, NW Guinea, Indonesia. **A** Dorsal view of left ocular peduncle and basal segments of left antennal peduncle **B** Dorsal view of basal segment of left antennular peduncle **C** External view of sixth abdominal segment with telson **D** Lateral view of first to third left walking legs. Scale bar – 1 mm (**A–C**), 2 mm (**D**).

angle rounded, forming a shallow lobe extending to hepatic margin. Epibranchial angle distinct but without a notch or spine, continuing in a ridge along the branchial margin. Protogastric ridge, cervical grooves and regions well marked. Lateral walls with scattered, simple setae.

Telson (Fig. 4C) composed of 7 plates; lateral plates narrow; lateral margins of central plate emarginate.

Basal segment of antennular peduncle (Fig. 4B) with faint transverse rugae; anterior margin rounded, granular, with minute teeth at mesial and lateral corners.

First movable segment of antenna with a lamellar, spine-tipped lobe, second with a longitudinal granular crest extending proximally into a rounded tooth, third rounded, unarmed.

Chelipeds sub-equal, merus with transverse, low granules on dorsal surface; anterior margin armed distally with a prominent, spine-tipped lobe. Carpus straight, margins subparallel, about 4–5 times as long as broad; dorsal surface covered with small, verruciform granules; anterior margin armed with 3–5 irregularly-set, acute small teeth of similar size; posterior margin slightly curved outwards with larger granules forming a crest along the distal half of length extending in a prominent, curved, distal tooth. Chela large, slender, posterior margin weakly curved, unarmed; dorsal surface covered with low, spherical granules, with a low, median crest extending to the base of the dactylus; fingers unarmed, gape without or with very short pubescence.

Walking legs extremely long and slender. Ischium devoid of setae or with few scattered, plumose setae. Merus devoid of setae or with few simple setae, unarmed or with a varying number (1–4) of irregularly-set, sharp spines along anterior margin with a prominent postero-distal spine in L1, weakly developed or lacking in L2, and postero-distally rounded in L3. Carpus, propodus and dactylus with scattered, simple setae. Propodus with distal triplet of movable spinules, and one additional spine on median part of posterior margin. Dactylus with 3 movable spines on posterior margin.

Variation. Large specimens normally present more elongate and narrower chelipeds than smaller ones. The teeth of the anterior margin of the cheliped carpus often varies in the same specimen in number and position.

Habitat. *Petrolisthes elegantissimus* sp. n., like the other two species, seems to be a shallow water species.

Distribution. Only known from a restricted region in eastern Indonesia.

Etymology. The specific name is derived from the Latin *elegans* (tasteful, refined), referring to a more elegant and gracile general habitus compared with that of the related species, *P. hastatus* and *P. inermis*. The species name is an adjective in the nominative singular.

Remarks

The status of *Petrolisthes hastatus*, *P. inermis* and *P. tenkatei* has been unclear for more than a century. The comparison of old and new specimens with part of the original material from Heller in the NHM, Vienna, and from De Man from NBC, Leiden, revealed that *P. inermis* is a valid species, and that *P. tenkatei* falls into synonymy with the latter. The main characters that allow distinguishing *Petrolisthes hastatus*, *P. inermis* and *P. elegantissimus* sp. n. are: 1) anterodistal lobe of the merus of the cheliped: in *P. hastatus* and *P. inermis* it is finger-shaped and rounded; in *P. elegantissimus* sp. n. it is subtriangular and spine-tipped. 2) Cheliped carpus: in *P. hastatus* it is approximately

2.5–3 times longer than broad, the anterior margin bearing three, wide-set, serrate-edged, hooked teeth with the proximal one normally being the largest; in *P. inermis* the carpus is slender, nearly 3–4 times longer than broad, armed on anterior margin with two shallow teeth, the proximal one being the largest and forming an acute tooth, the second one being smaller and blunt; in *P. elegantissimus* sp. n. it is slender, 4–5 times longer than broad, armed on the anterior margin with 3–5, irregularly-set, acute small teeth of similar size. 3) Chela: in *P. hastatus* it is broad, flattened, the gape of the fingers being covered with a short pubescence; in *P. inermis* it is slender, transversely swollen, with the gape of fingers with large, dense pubescence, normally visible from above; in *P. elegantissimus* sp. n. it is large, slender, with the gape without or with short pubescence. 4) Merus of walking legs: in *P. hastatus* it is spineless or with 1–3 irregularly-set, small spines, merus of L1 and L2 bearing a posterodistal spine; in *P. inermis* it bears a single dorsal spine close to the distal edge in L1 and L2, and merus of L1 and L2 bears a posterodistal spine; in *P. elegantissimus* sp. n. it is long, slender, with anterior margin spineless or with a varying number (1–4) of irregularly-set, prominent spines; in L1 it bears a prominent posterodistal spine, in L2 it is weakly developed or lacking, and in L3 it is posterodistally rounded.

Discussion

The geographic range of the three species here treated suggests that they are sympatric in Indonesian waters. *Petrolisthes hastatus* has the widest range in the West Pacific while *P. inermis* and *P. elegantissimus* sp. n. seem to have a more limited distribution. *Petrolisthes inermis* is the only one of the three species extending its range to the eastern Indian Ocean. Ecologically, the three species seem to prefer shallow-water habitats characterized by reefs, and rocks on sand. New sampling efforts that document coloration and compile more precise ecological information, combined with molecular analyses that corroborate species monophyly, will further aid in clarifying the taxonomic status, ecological preferences and geographic boundaries of the three species, and in proposing possible speciation scenarios.

Acknowledgements

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References

- Haig J (1956) The Galatheidea (Crustacea Anomura) of the Allan Hancock Atlantic Expedition with a review of the Porcellanidae of the western North Atlantic. Allan Hancock Atlantic Expedition Report 8: 1–44.
- Haig J (1960) The Porcellanidae (Crustacea Anomura) of the eastern Pacific. Allan Hancock Pacific Expeditions 24: 1–440.
- Haig J (1964) Papers from Dr. Th. Mortensen Pacific expedition 1914–1916. 81. Porcellanid crabs from the Indo-West Pacific, Part 1. Videnskabelige Meddelelser fra Dansk Naturhistorik Forening i Kjobenhavn 126: 355–386.
- Haig J (1979) Expédition Rumphius II (1975) Crustacés parasites, commensaux, etc. In: Monod Th, Sèrene R (Eds) V. Porcellanidae (Crustacea, Decapoda, Anomura). Bulletin du Muséum national d'Histoire naturelle, Section A, Zoologie, Biologie et Ecologie Animales, Paris, 4e série 1: 119–136.
- Heller C (1861) Synopsis der im rothen Meere vorkommenden Crustaceen. Verhandlungen der Zoologisch-Botanischen Gesellschaft in Wien 11: 3–32.
- Heller C (1862) Neue Crustaceen gesammelt während der Weltumsegelung der K.K. Fregatte „Novara“. Zweiter vorläufiger Bericht. Abhandlungen des Kaiserlich- und Königlischen Zoologisch-Botanischen Gesellschaft in Wien 28: 519–528.
- Heller C (1865) Crustaceen. Reise der österreichischen Fregatte Novara um die Erde in den Jahren 1857, 1858, 1859 unter den Befehlen des Commodore B. von Wüllerstorff-Urbair. Zoologischer Theil. Zweiter Band. III. Abtheilung. Vol. 2: 1–280.
- Hiller A, Kraus H, Almon M, Werding B (2006) The *Petrolisthes galathinus* complex: Species boundaries based on color pattern, morphology and molecules, and evolutionary interrelationships between this complex and other Porcellanidae (Crustacea: Decapoda: Anomura). Molecular Phylogenetics and Evolution 40: 547–569. doi: 10.1016/j.ympev.2006.03.030
- Hsieh BF, Chan TY, Yu HP (1998) On the Porcellanid Crabs (Crustacea: Decapoda: Porcellanidae) of Taiwan. Annual of Taiwan Museum 40: 276–360.
- Johnson DS (1970) The Galatheidae (Crustacea: Decapoda) of Singapore and adjacent waters. Bulletin of the National Museum Singapore 35: 1–44.
- De Man JG (1888) Report on the podophthalmous Crustacea of the Mergui Archipelago, collected for the Trustees of the Indian Museum, Calcutta, by Dr. John Anderson, FRS, Superintendent of the Museum, Part V. Journal of the Linnean Society of London, Zoology 22: 241–305. doi: 10.1111/j.1096-3642.1888.tb00032.x
- De Man JG (1893) Report on the podophthalmous Crustacea, collected in the year 1891 by Dr. H. Ten Kate in some Islands of the Malay Archipelago. Notes Leyden Museum 15: 284–311.
- De Man JG (1902) Die von Herrn Professor Kükenthal im Indischen Archipel gesammelten Dekapoden und Stomatopoden. Abhandlungen der Senckenbergischen Naturforschenden Gesellschaft 25: 467–929.
- Miyake S (1943) Studies on the crab-shaped Anomura of Nippon and adjacent waters. Journal of the Department of Agriculture, Kyusyu Imperial University 7: 49–158.

- Nakasone Y, Miyake S (1971) Porcellanid crabs (Anomura: Porcellanidae) from New Caledonia and the Fiji Islands. *Biological Magazine of Okinawa* 8: 1–13.
- Osawa M, Chan TY (2010) Porcellanidae (Porcellanid Crabs). In: Chan TY (Ed.) *Crustacean Fauna of Taiwan: Crab-Like Anomurans (Hippoidea, Lithodoidea and Porcellanidae) Part III*. National Taiwan Ocean University, 76–195.
- Osawa M, McLaughlin PA (2010) Annotated checklist of anomuran decapod crustaceans of the world (exclusive of the Kiwaoidea and families Chirostylidae and Galatheidae of the Galatheoidea), Part II-Porcellanidae. *The Raffles Bulletin of Zoology Supplement* 23: 109–129.
- Stillman JH, Reeb CA (2001) Molecular Phylogeny of Eastern Pacific Porcelain Crabs, Genera *Petrolisthes* and *Pachycheles*, Based on the mtDNA 16S rDNA sequence: Phylogeographic and Systematic Implications. *Molecular Phylogenetics and Evolution* 19: 236–245. doi: 10.1006/mpev.2001.0924
- Stimpson W (1858) *Prodromus descriptionis animalium evertibratorum, quae in Expeditione ad Oceanum Pacificum Septentrionalem, a Republica Federata missa, Cadwaladaro Ringgold et Johanne Rodgers Ducibus, observavit et descripsit. Pars VII. Crustacea Anomura*. *Proceedings of the Academy of Natural Sciences of Philadelphia* 10: 225–252.
- Stimpson W (1907) Report on the Crustacea (Brachyura and Anomura) collected by the North Pacific Exploring Expedition, 1853–1856. *Smithsonian Miscellaneous Collections* 49: 1–240. doi: 10.5962/bhl.title.51448
- Werding B (1977) Los porcelanidos (Crustacea: Anomura: Porcellanidae) de la región de Santa Marta, Colombia. *Anales del Instituto de Investigaciones Marinas de Punta de Betín* 9: 173–214.
- Werding B, Hiller A, Lemaitre R (2003) Geographic and depth distributional patterns of western Atlantic Porcellanidae (Crustacea: Decapoda: Anomura), with an updated list of species. *Memoirs of Museum Victoria* 60: 79–85.

Descriptions of two new species of *Aelurillus* Simon, 1884 (Araneae, Salticidae) from the Mediterranean, with the synonymization of *A. steliosi* Dobroruka, 2002

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Abstract

Two *Aelurillus* species are described as new, *A. alboclypeus* **sp. n.** (♂♀, from Turkey) and *A. deltshevi* **sp. n.** (♂, from Macedonia, Bulgaria and Azerbaijan). *Aelurillus steliosi* Dobroruka, 2002 is synonymized with *A. leipoldae* (Metzner, 1999). Additional distributions of the closely related species *A. v-insignitus* are provided for the region of study. Distributional maps are provided for the five species reported in this paper.

Keywords

Aranei, jumping spiders, Mediterranean, synonymy

Introduction

To date, 69 species and two subspecies of *Aelurillus* have been described in the world fauna (World Spider Catalog 2015). The genus *Aelurillus* is distributed predominantly in the Palearctic Region, with only ten species being recorded from outside its limits. The fauna of the Balkans, Turkey and Azerbaijan consists of 14 species of *Aelurillus*. The best studied region is Greece containing ten species (Deltshev and Paraschi 1990;

Metzner 1999; Azarkina 2002; Dobroruka 2002; Logunov and Chatzaki 2003; Bosmans and Chatzaki 2005; Azarkina and Logunov 2006; Bosmans et al. 2009; Russell-Smith et al. 2011). Four species have been recorded from Macedonia (Komnenov 2002; 2003; 2006; Fišer and Azarkina 2005), four species from Turkey (Topçu et al. 2005; Danişman et al. 2012; Azarkina and Mirshamsi 2014, Coşar et al. 2014, Logunov 2015), two from Azerbaijan (Logunov and Guseinov 2002) and one from Bulgaria (Deltshev et al. 2001, Lazarov 2005). Four of the 14 species recorded from the region at hand are regional endemics: two species from Crete (*A. cretensis* Azarkina, 2002 and *A. leipoldae* (Metzner, 1999)) and two species from Paros Island, Greece (*A. guecki* Metzner, 1999 and *A. steinmetzi* Metzner, 1999).

Logunov and Chatzaki (2003: 96) proposed *A. steliosi* as a synonym of *A. cretensis* “It is safe to assume that this species is a synonym of *A. cretensis*”. Bosmans and Chatzaki 2005 mentioned *A. steliosi* in reference to *A. cretensis*, but synonymization was confirmed only in Bosmans et al. 2013 followed by Logunov and Chatzaki 2003. However this synonymization was provided without examination of any type material. In this paper the correct synonymization of *A. steliosi* with *A. leipoldae* is established, based on type material. Two new species are also described, *Aelurillus deltshevi* sp. n. (♂, from Macedonia, Bulgaria and Azerbaijan) and *A. alboclypeus* sp. n. (♂♀, from Turkey), and a new synonymy of *A. steliosi* Dobroruka, 2002 with *A. leipoldae* (Metzner, 1999) is proposed to replace an erroneous one (Bosmans et al. 2013).

Material and methods

This paper is based on both museum collections and newly collected material from Macedonia, Bulgaria, Greece and Turkey. Specimens were studied in ethanol and their colours refer to those of the preserved specimens. All drawings were made with the aid of a reticular eyepiece attached to an MBS-10 stereomicroscope. The male pedipalps and epigynes were detached for study. Epigynes were macerated in 20% KOH solution for one night. After being drawn, the copulatory organs were placed in microvials or small pieces of paper with ethanol together with the specimens from which they had been removed. Digital images were taken with a Zeiss Stemi 2000 and an attached Canon EOS 550D camera. Stack images were combined using Helicon Focus software. All drawings were edited and assembled in Adobe Photoshop. Distribution maps were produced using the online mapping software SimpleMappr (Shorthouse 2010) with minor modification.

Specimens for this study were borrowed from or placed in the following museums and personal collections:

ISEA	Institute for Systematics and Ecology of Animals, Novosibirsk, Russia (G. N. Azarkina);
IZSB	Institute of Zoology, Sofia, Bulgaria (C. Deltshev);
LM	World Museums Liverpool, Liverpool, UK (G. Night);

MMUM	Manchester Museum, University of Manchester, Manchester, UK (D.V. Logunov);
MNHN	Muséum national d'Histoire naturelle, Paris, France (E.-A. Leguin);
NHM	Natural History Museum, Vienna, Austria (J. Gruber);
NHMC	Natural History Museum, University of Crete, Crete, Greece (A. Trichas);
PCHM	Personal collection of H. Metzner (Burghaslach, Germany);
PCMK	Personal collection of M. Komnenov (Scopje, Macedonia);
SMNK	State Museum of Natural History, Karlsruhe (H. Höfer);
SNHM	Senckenberg Natural History Museum, Frankfurt am Main, Germany (P. Jäger).

Abbreviations used in the text: **AME** – anterior median eyes, **ALE** – anterior lateral eyes, **PLE** – posterior lateral eyes, **Fm** – femur, **Pt** – patella, **TA** – terminal apophysis; **Tb** – tibia, **Mt** – metatarsus. The sequence of leg segments in measurement data is as follows: femur+patella+tibia+metatarsus+tarsus. All measurements are in mm. For the leg spination the system adopted is that used by Ono (1988).

Taxonomy

Aelurillus alboclypeus sp. n.

<http://zoobank.org/F680F462-FC96-4652-AE0E-265C11C1B249>

Figs 1–15

A. gershomi: Danişman et al. 2012: 215 (misidentification); Coşar et al. 2014: 84 (misidentification).

Type material. Holotype: ♂ (ISEA 000.287) TURKEY, Antalya Province, 18 km SSE of Elmalı, Bey Mt. Range, 6 km WSW of Kızılarsivrisi Mt., 1800–2000 m a.s.l., 36°35'N, 30°03'E, 25 April 2009, coll. R.Yu. Dudko, I.I. Lyubechanskij, A.A. Stekolnikov. **Paratypes:** TURKEY: 1 ♂ (ISEA 000.286) Ankara Province, Bala District, Revnam Forests, 1392 m a.s.l., 39°40'N, 32°54'E, 29 May 2009, coll. Yu.M. Marusik; 1 ♂ 1 ♀ (ISEA 000.515) Çankırı Province, Ankara-Çankırı Highway, 689 m a.s.l., 40°23'N, 33°34'E, semidesert, 15 September 2010, coll. Yu.M. Marusik; 4 ♂ (ISEA 000.875) Adıyaman Province, Nemrut Mt., 37°58'N, 38°44'E, 14.05.1997 (V. Bryja); 1 ♂ (LM) Kayseri Province, Nigde, Demirkazık, 37°51'N, 35°05'E, 13 June 1993, coll. C. Felton; 1 ♂ (MNHN 12.840) Amasia [=Amasya], 40°39'N, 35°49'E, date unknown, coll. S.L.; 2 ♂ (NHM) Pass vor Alahan, Karaman ü. Mut [=Mersin Province, Alahan Monastery, nr Mut, 36°47'N, 33°21'E], 8 April 1977, coll. H. Nemenz.

Diagnosis. This species is closely related to *A. v-insignitus* and other species of *Aelurillus v-insignitus*-group (sensu Azarkina 2006), but differs in the male body coloration, viz. *A. alboclypeus* sp. n. has a black eye field (Fig. 2) and the abdomen with a few white spots. *Aelurillus v-insignitus* has a V-shaped figure on the eye field and a broad light

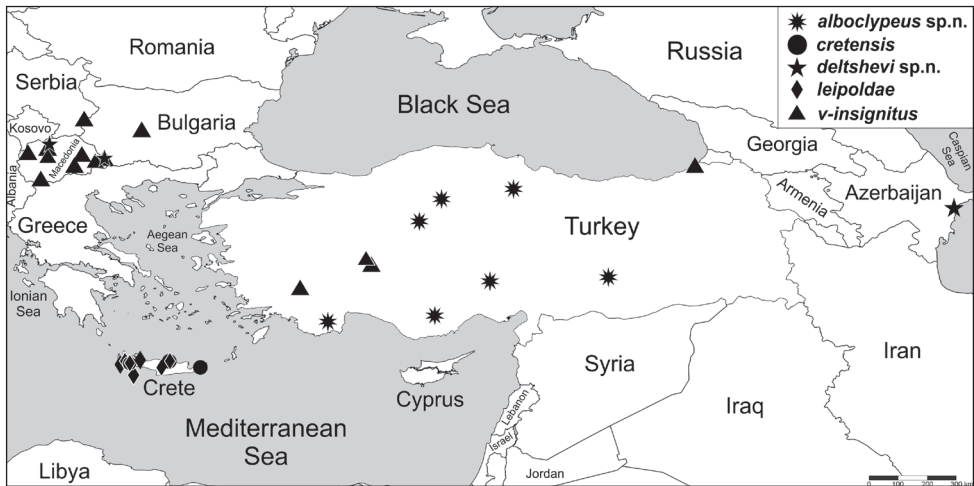
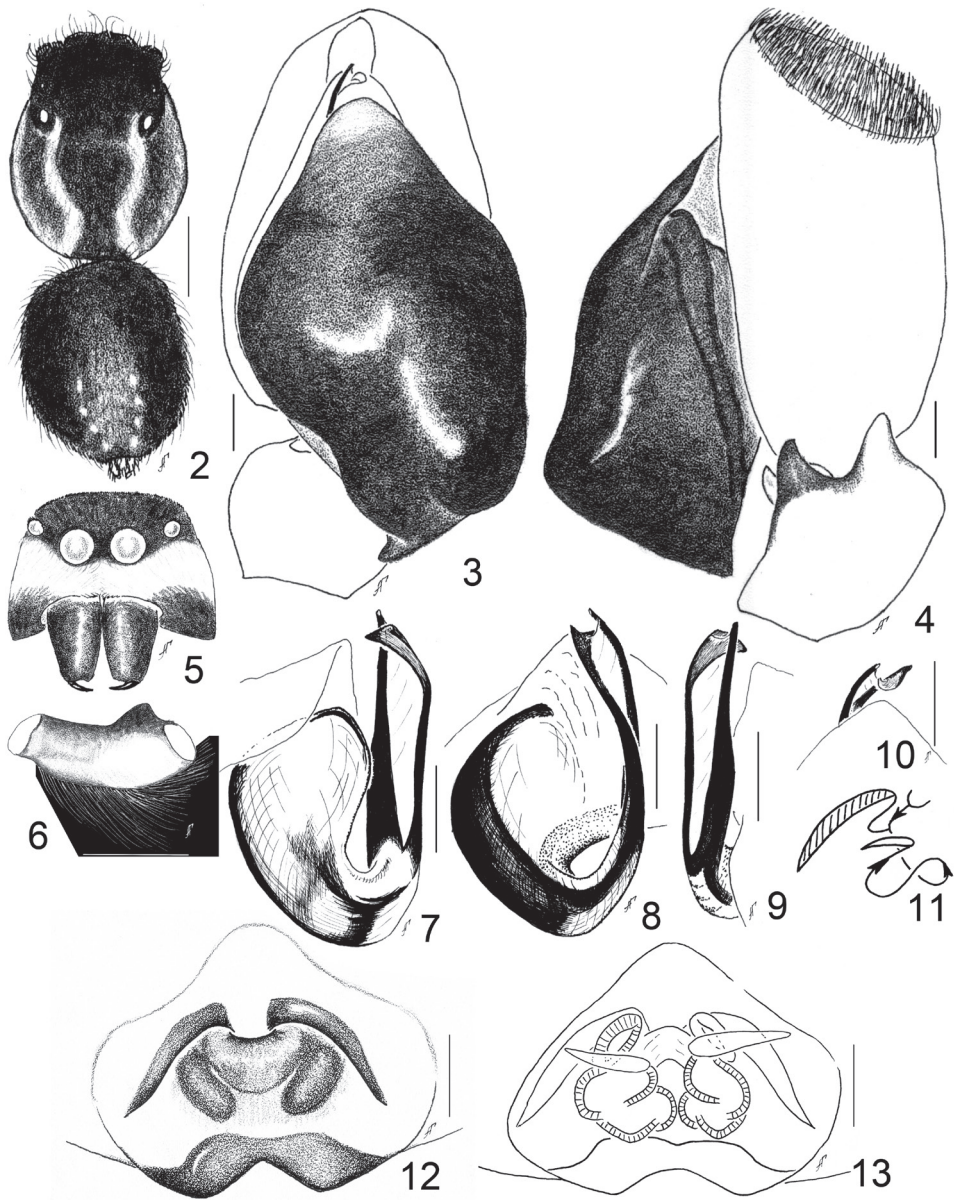


Figure 1. Distributional map of five *Aelurillus* species.

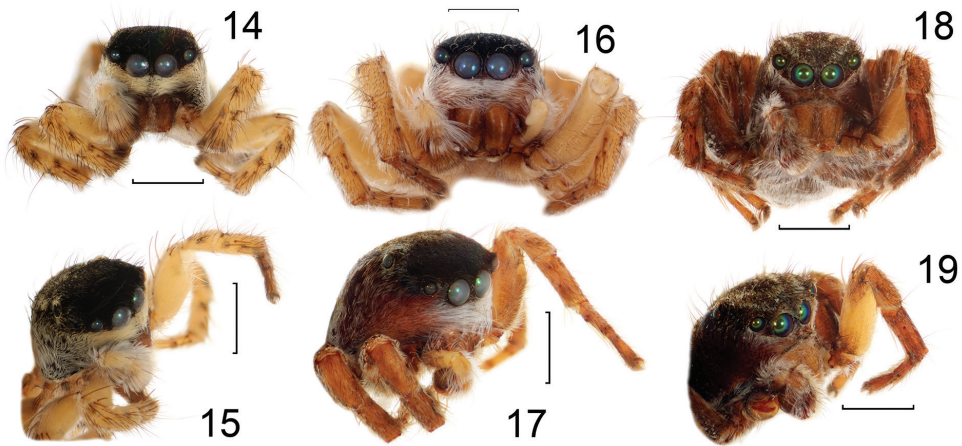
stripe on dorsum on the abdomen in both the black and grey forms (see Žabka 1997: figs 25, 38), *A. laniger* Logunov & Marusik, 2000 and *A. steinmetzi* Metzner, 1999 has a modified V-shaped figure pattern on eye field (see Metzner 1999: fig. 41 a). The clypeus of *A. alboclypeus* sp. n. is covered with short dense adpressed white hairs (Figs 5, 14) while *A. v-insignitus* has sparse white hairs (Fig. 18). *Aelurillus guecki* Metzner, 1999 and *A. laniger* has long shaggy and short yellow-white hairs on clypeus respective and *A. steinmetzi* has light red hairs. *Aelurillus alboclypeus* sp. n. has dark brown metatarsi and tarsi of leg I and yellow femora, patellae and tibiae (Fig. 15) while *A. v-insignitus* has yellow femora and brown to dark brown patellae, tibiae, metatarsi and tarsi (Fig. 19). *Aelurillus guecki* has red-brown metatarsi and tarsi of leg I, all legs covered with dark brown hairs. *Aelurillus laniger* has grey femora of leg I ventrally, femora of other legs are brown-grey ventrally. The TA of the embolic division has a small tooth-like process (Figs 7–10) which absent from both forms of *A. v-insignitus* (Žabka 1997: figs 31, 42) and other *Aelurillus v-insignitus*-group species (see Logunov and Marusik 2000: figs 5–6; Metzner 1999: figs 43 f, h–i). Palpal tibial apophysis both straight and slightly curved dorsally, almost adequate in size (Fig. 4) while palpal tibial apophysis of *A. laniger* both straight, ventral apophysis slightly longer (Logunov and Marusik 2000: fig. 4), ventral palpal tibial apophysis curved ventrally, small and dorsal palpal tibial apophysis long and straight in *A. guecki* (Metzner 1999: fig. 40 c), palpal tibial apophysis adequate in size, ventral tibial apophysis slightly curved ventrally and dorsal tibial apophysis straight in *A. steinmetzi* (Metzner 1999: fig. 41 c), palpal tibial apophysis adequate in size, ventral palpal tibial apophysis bended ventrally and dorsal tibial apophysis slightly curved dorsally in *A. v-insignitus* (Metzner 1999: fig. 42 c). Females differ from those of *A. v-insignitus*-group by the poorly visible copulatory openings (Fig. 12).

Etymology. The species is named for its “face coloration”: *A. alboclypeus* sp. n. has white dense hairs on the clypeus.



Figures 2–13. *Aelurillus alboclypeus* sp. n.: **2** male, body pattern **3** left palp, ventral view **4** ditto, retrolateral view **5** male face **6** palpal femur, retrolateral view **7** embolic division, retrolateral view **8** ditto, dorsal view **9** ditto, prolateral view **10** ditto, ventral view **11** diagrammatic course of the insemination ducts **12** epigyne, ventral view **13** spermathecae; dorsal view. Scale bars – 0.1 mm (**3–8, 11–12**), 0.5 mm (**10**), 1 mm (**2**).

Description. Male (holotype (small) and paratype (large) from Demirkazık): Carapace 2.00–3.10 long, 1.60–2.10 wide, 1.00–1.80 high at PLE. Ocular area 0.95–1.10 long, 1.25–1.60 wide anteriorly and 1.20–1.55 wide posteriorly. Diameter of AME



Figures 14–19. Faces of *A. alboclypeus* sp. n. (14–15), *A. deltshevi* sp. n. (16–17) and *A. v-insignitus* (Clerck, 1757) (18–19). Scale bars – 1 mm.

0.30–0.40. Abdomen 1.90–2.50 long, 1.70–2.10 wide. Cheliceral length 0.65–1.00. Clypeal height 0.25–0.30. Length of leg segments: I 1.3+0.9+0.8+0.5+0.6; II 1.4+0.9+0.8+0.6+0.5; III 2.0+0.9+1.0+1.0+0.8; IV 1.9+0.9+1.2+1.5+0.8. Leg spination: I: Fm d 1–1–5; Pt pr 1; Tb pr 1–1–1, v 1–1–2 ap; Mt pr and rt 1–1, v 2–2 ap. II: Fm d 1–2–5; Pt pr and rt 1; Tb d 1–0–0, pr 1–1–1, v 1–1–2 ap; Mt pr and rt 1–1, v 2–2 ap. III: Fm d 1–3–5; Pt pr and rt 1; Tb d 1–0–0, pr and rt 1–1–1–1, v 1–0–2 ap; Mt d 1–1–0, pr and rt 1–0–2, v 1–1–2 ap. IV: Fm d 1–2–5; Pt pr and rt 1; Tb d 1–0–0, pr and rt 1–1–1–1, v 2–0–2 ap; Mt d 1–1–0, pr 1–1–2, rt 1–0–2, v 1–1–2 ap. Coloration. Carapace dark brown, with black eye field, covered with dark brown to black adpressed scales. Carapace with two thick white stripes dorsally (Fig. 2) and covered with white hairs laterally. Clypeus with short dense white adpressed hairs (Figs 5, 14). Chelicerae dark brown. Abdomen yellow-gray, dorsum black, with an indistinct white longitudinal stripe (Fig. 2) and 5–6 pairs of white indistinct spots in the posterior part of abdomen. Legs yellow-brown. Femur I and II with two yellowish dorsal stripes. Femur I covered prolaterally with dense yellow hairs. Legs III and IV brown. Patella and tibia I and II yellow, covered with short and thin long hairs. Metatarsi and tarsi I and II dark brown (Fig. 15). Palpal femur brown, with a ventral knob, covered dorsally with long white dense hairs. Palpal patella and tibia yellow, with white hairs. Cymbium brown, covered with dark brown hairs. Palpal structure as in Figs 3–4, 7–10.

Female (from Çankırı Prov.): Carapace 2.30 long, 1.30 wide, 1.20 high at PLE. Ocular area 1.00 long, 1.35 wide anteriorly and 1.30 wide posteriorly. Diameter of AME 0.40. Abdomen 2.20 long, 1.40 wide. Cheliceral length 0.70. Clypeal height 0.30. Length of leg segments: I 1.0+0.7+0.7+0.5+0.5; II 1.0+0.7+0.7+0.5+0.45; III 1.7+0.9+0.9+1.0+0.65; IV 1.55+0.7+0.85+1.2+0.7. Leg spination: I: Fm d 1–1–4; Tb pr 1–1, v 1–1–2 ap; Mt pr and rt 1–1, v 2–2 ap. II: Fm d 1–2–4; Tb pr 1–1, v 1–1–2

ap; Mt pr and rt 1–1, v 2–2 ap. III: Fm d 1–2–4; Pt pr and rt 1; Tb d 1–0–0, pr and rt 1–1–1, v 1–0–2 ap; Mt d 1–1–0, pr 1–0–2, rt 1–1–2, v 1–1–2 ap. IV: Fm d 1–1–2; Pt pr and rt 1; Tb d 1–0–0, pr and rt 1–1–1, v 2–0–2 ap; Mt d 1–1–0, pr 1–1–2, rt 1–0–2, v 1–1–2 ap. Coloration. Carapace dark brown with black ocular area, covered with white scales. Sternum dark brown covered with white hairs. Clypeus dark brown covered with white hairs, cheeks dark brown with two strips formatted by dense white hairs. Abdomen grayish-yellow, dorsum dark brown with mixed yellowish-white hair pattern. Book-lungs are grayish-yellow, spinnerets are yellowish-grey. All legs and palps are yellow. Legs with dark brown patches and semi-rings. Structure of spigyne and spermathecae as in Figs 11–13.

Distribution. Turkey (Fig. 1).

Comments. First author re-examined *Aelurillus* material from Danişman et al. 2012 and Coşar et al. 2014 (except *A. luctuosus*) kindly provided by Tarık Danişman in 2013 (*Aelurillus* material is the same in both papers). All *A. gershomi* belongs to the new species, *A. alboclypeus* sp. n.

***Aelurillus cretensis* Azarkina, 2002**

Figs 1, 32–34

A. cretensis Azarkina 2002: 251, figs 8–18 (♂♀, re-examined).

A. steliosi Dobroruka 2002: 8, figs 5–13 (allotype ♀, re-examined).

A. cretensis: Bosmans and Chatzaki 2005: 100 (in part).

Type material. Allotype of *Aelurillus steliosi*: 1 ♀ (MNHN #AR 13335) “GREECE, Crete, Psiloreitis, Kouroutes (Prefectura Irakleio), near Agios Titos church, 1180 m a.s.l., 35°20'N, 25°08'E, 12 June 2001, coll. S. Simaiakis”. Holotype of *Aelurillus cretensis*: ♂ (NHMC) GREECE, Crete, Lefka Ori Mts., 1650 m a.s.l., 35°17'N, 23°54'E, 8 June 1991, coll. P. Lymperakis. Paratypes: GREECE: 1 ♂ (NHMC), 1 ♂ (MMUM) Crete, Lefka Ori Mts., 1650–2100 m a.s.l., 35°17'N, 23°54'E, 16–17 October 1990, coll. P. Lymperakis; 7 ♂ 2 ♀ (ISEA 000.516), 1 ♀ (ISEA 000.517), 2 ♂ 2 ♀ (NHMC), 1 ♀ (MMUM) Crete, Lefka Ori Mts., 1650 m a.s.l., 35°17'N, 23°54'E, 8 June–6 October 1991, coll. P. Lymperakis; 1 ♀ (ISEA 000.711) Crete, Lefka Ori Mts., 2000 m a.s.l., 35°17'N, 23°54'E, 6 August 1992, coll. P. Lymperakis.

Other material. 1 ♀ (SNHM) Greece, Crete, Lasithi, mountains S of Sitia, stony, moist beds of stream, under stones and on ground, 35°10'N, 26°06'E, 22 March 1958, coll. H. Kahmann.

Distribution. Only known from Crete, Greece (Fig. 1; Azarkina 2002: fig. 8).

Comments. The male holotype and the female allotype of *A. steliosi* belong to two different species, *A. cretensis* (female) and *A. leipoldae* (male).

Bosmans et al. 2013 erroneously (R. Bosmans, pers. comm.) mentioned *A. blandus* in reference to *A. cretensis* (WSC 2015) therefore we excluded this reference from the list.

***Aelurillus deltshevi* sp. n.**

<http://zoobank.org/32281E16-6FEA-4D40-84B9-562CD08673D5>

Figs 1, 16–17, 20–28

Aelurillus sp. 1: Komnenov 2006: 302

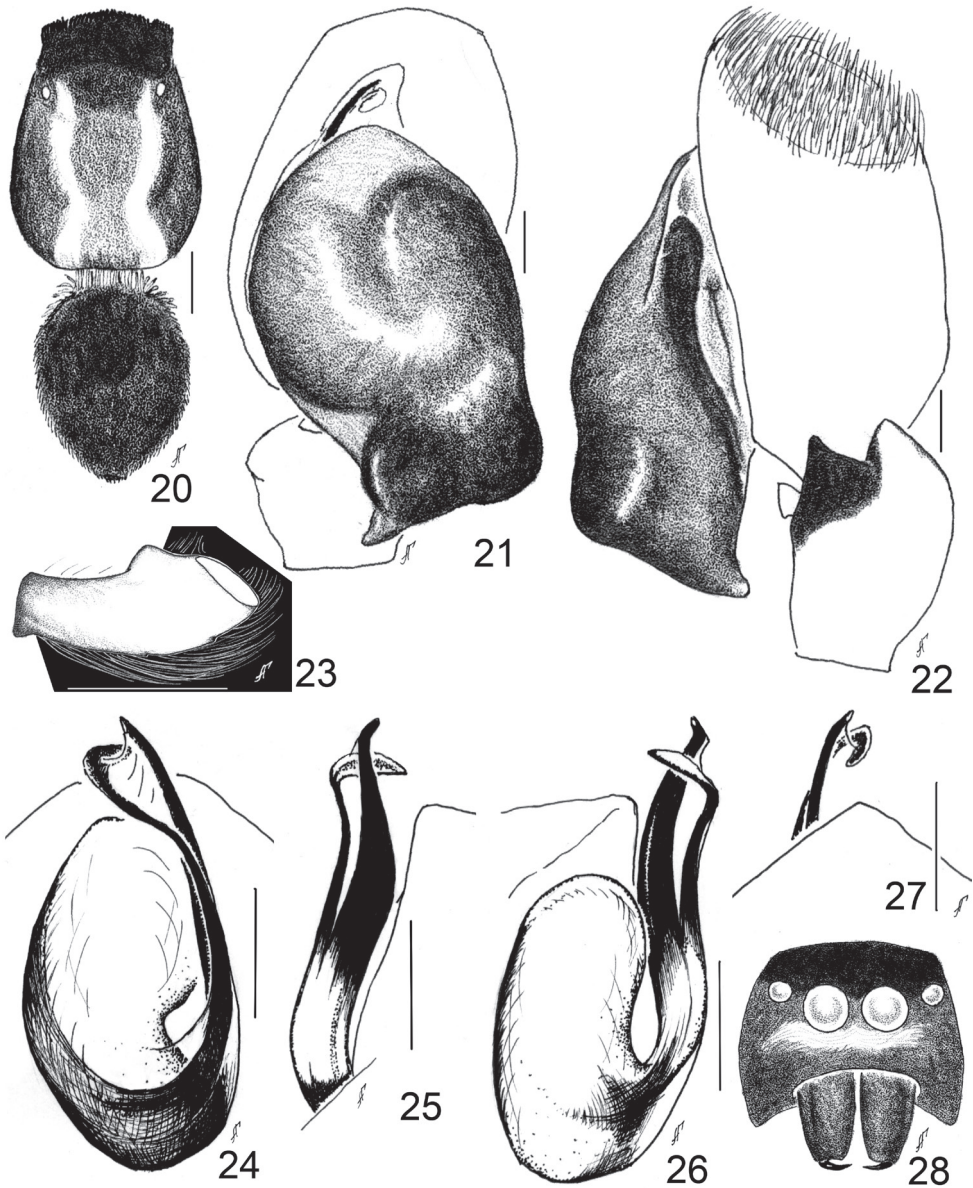
A. v-insignitus: Lazarov 2005: 151, Tab. 1 (in part).

Type material. Holotype: ♂ (IZSB) BULGARIA, Blagoevgrad Province, Strouma Valley, 2 km S of Kamenitsa, 170–240 m a.s.l., 41°38'N, 23°09'E, soil traps, 28 September – 2 February 2002, coll. M. Langourov & S. P. Lazarov. **Paratypes:** MACEDONIA: 1 ♂ (ISEA 000.472) Skopje, Radišani [=Radishani], 42°04'N, 21°27'E, 3 September 1995, coll. M. Komnenov. BULGARIA: 4 ♂ (IZSB) Blagoevgrad Province, Strouma Valley, FM 71, 2 km S of Kamenitsa, 170–240 m a.s.l., 41°37'N, 23°09'E, soil traps, 28 September – 2 February 2002, coll. M. Langourov & S. Lazarov. AZERBAIJAN: 1 ♂ (MMUM) 60 km SW of Baku [=Bakı], Gobustan [=Qobustan], Gobustan Rock Art Cultural Landscape, 40°05'N, 49°24'E, 7.05.1989, coll. P. M. Dunin.

Diagnosis. *Aelurillus deltshevi* sp. n. belongs to *A. v-insignitus*-group and is closely related to *A. alboclypeus* sp. n., *A. guecki*, *A. steinmetzi* and *A. v-insignitus*; it also shares the same colour pattern on the eye field (Fig. 20) with *A. alboclypeus* sp. n. (Fig. 2) and *A. guecki* (Metzner 1999: fig. 40 a), but differs from other species of this group which have “V” shape (or its modification) on eye field; the clypeal pattern (a narrow stripe of white hairs under anterior median eyes, Fig. 28), differences in size and shape of the lateral tibial apophysis (Fig. 22, cf. Prószyński 1971: see fig. 18 for *A. v-insignitus*), and in the structure of the embolic division where the embolus and TA are more curved pro- and retro-laterally, and the apical part of TA is simple, without lateral expansions (Figs 24–27), whereas the apical part of TA of *A. v-insignitus* is more complicated and laterally expanded, (Metzner 1999: see fig. 43 f), apical part of TA of *A. alboclypeus* sp. n. with small tooth (Fig. 8), apical part of TA of *A. guecki* and *A. steinmetzi* are pointed apically (Metzner 1999: figs. 43 h-i) while apical part of TA of *A. deltshevi* sp. n. pointed perpendicular to embolus (Fig. 25).

Etymology. This species is named after Prof. Christo Deltshev, the well-known Bulgarian arachnologist.

Description. Male (Paratype, from Bulgaria): Carapace 2.8 long, 2.0 wide, 1.6 high at PLE. Ocular area 1.1 long, 1.55 wide anteriorly and 1.55 wide posteriorly. Diameter of AME 0.45. Abdomen 1.3 long, 1.2 wide. Cheliceral length 1.0. Clypeal height 0.3. Length of leg segments: I 1.4+0.7+0.9+0.65+0.55; II 1.5+0.9+0.9+0.6+0.6; III 1.9+0.9+1.4+1.3+0.65; IV 1.9+0.8+1.3+1.5+0.8. Leg spination: I: Fm d 1–1–5; Pt pr and rt 1; Tb pr 1–2, v 1–1–2 ap; Mt pr and rt 1–1, v 2–2 ap. II: Fm d 1–2–5; Pt pr and rt 1; Tb pr 1–1–1, v 1–1–2 ap; Mt pr and rt 1–1, v 2–2 ap. III: Fm d 1–3–5; Pt pr and rt 1; Tb d 1–0–0, pr and rt 1–1–1–1, v 1–0–2 ap; Mt d 1–1–0, pr and rt 1–0–2, v 1–1–2 ap. IV: Fm d 1–2–5; Pt pr and rt 1; Tb d 1–0–0, pr and rt 1–1–1–1, v 1–0–2 ap; Mt d 1–1–0, pr 1–1–2, rt 1–0–2, v 1–1–2 ap. Coloration: Carapace dark brown, with black eye field, covered with adpressed white scales, more densely on its



Figures 20–28. *Aelurillus deltshevi* sp. n.: **20** male, body pattern **21** left palp, ventral view **22** ditto, retrolateral view **23** palpal femur, prolateral view **24** embolic division, ventral view **25** ditto, prolateral view **26** ditto, retrolateral view **27** embolic division, ventral view **28** male face;. Scale bars – 0.1 mm (**21–22**, **24–27**), 0.5 mm (**23**); 1 mm (**20**).

sides. Carapace with two dorsal longitudinal white stripes. Eye field covered with black shining scales, with no colour pattern (Fig. 20). Clypeus, cheeks and chelicerae brown to dark brown (Fig. 16). Clypeus and cheeks densely covered with white hairs (espe-

cially beneath anterior median eyes) (Fig. 28). Hairs around eyes laterally and ventrally white, dorsally black. Abdomen yellow-gray, dorsum dark brown, with thin white hairs. Legs brownish yellow. Metatarsus and tarsus I yellow-brown (Fig. 17). Palps yellow, covered with white hairs, cymbium brown-yellow, covered with brown hairs. Palpal femur with a ventral knob (Fig. 23). Palpal structure as in Figs 21–22, 24–27.

Remarks. *Aelurillus deltshevi* sp. n. was hitherto identified as *A. v-insignitus*. There are two subspecies of *A. v-insignitus*, *A. v. morulus* (Simon, 1937) from France, and *A. v. obsoletus* (Kulczyński in Chyzer and Kulczyński 1891) from Hungary. Simon (1937: p. 1267) commented that in southern France *A. v. morulus* would occur together with *A. v-insignitus*. This species is a local form and can be distinguished from *A. v-insignitus* by the abdomen and femur coloration (see p. 1227). Kulczyński (1891: p. 30) stated that *A. v-insignitus* and *A. v. obsoletus* were similar in the body colouration, but that of the eye field in *A. v. obsoletus* was not adequately visible (“*areae huius pictura parum definita*”). One of us (GA) tried to find the holotypes of both Simon’s and Kulczyński’s species but failed. It is most likely that they were lost. *Aelurillus deltshevi* sp. n., described here, has the black eye field, without a “V” pattern. According to Kulczyński’s picture (1891: plate 1, figs 4 a–b), the tibial apophysis is typical of *A. v-insignitus*. The TA in *A. deltshevi* sp. n. is different as the dorso-lateral branch of the TA in these species is not higher than in *A. v-insignitus*, and the ventro-lateral branch of the TA is less curved (Figs 24–27). Prószyński (1971) described two forms of *A. v-insignitus*, “black” and “grey”. Both these forms have visible “V” pattern on the eye field (Prószyński 1971: figs 8–10) and a high dorso-lateral tibial apophysis (Prószyński 1971: figs 13, 16, 18–21). The terminal apophyses of the “black” and “grey” forms are also different from those of *A. deltshevi* sp. n. (Žabka 1997: figs 30–31, 41–42). However, all of them can easily be separated from *A. deltshevi* sp. n. by the carapace and clypeal colouration, also by the structure of the embolic division and the shape of the tibial apophysis.

Distribution. Macedonia, Bulgaria and Azerbaijan (Fig. 1).

Comments. *Aelurillus deltshevi* sp. n. occurs in Macedonia and Bulgaria at the elevations below 500 m a.s.l., while *A. v-insignitus* has been recorded from the elevations above 500 m a.s.l..

Aelurillus leipoldae (Metzner, 1999)

Figs 1, 29–31

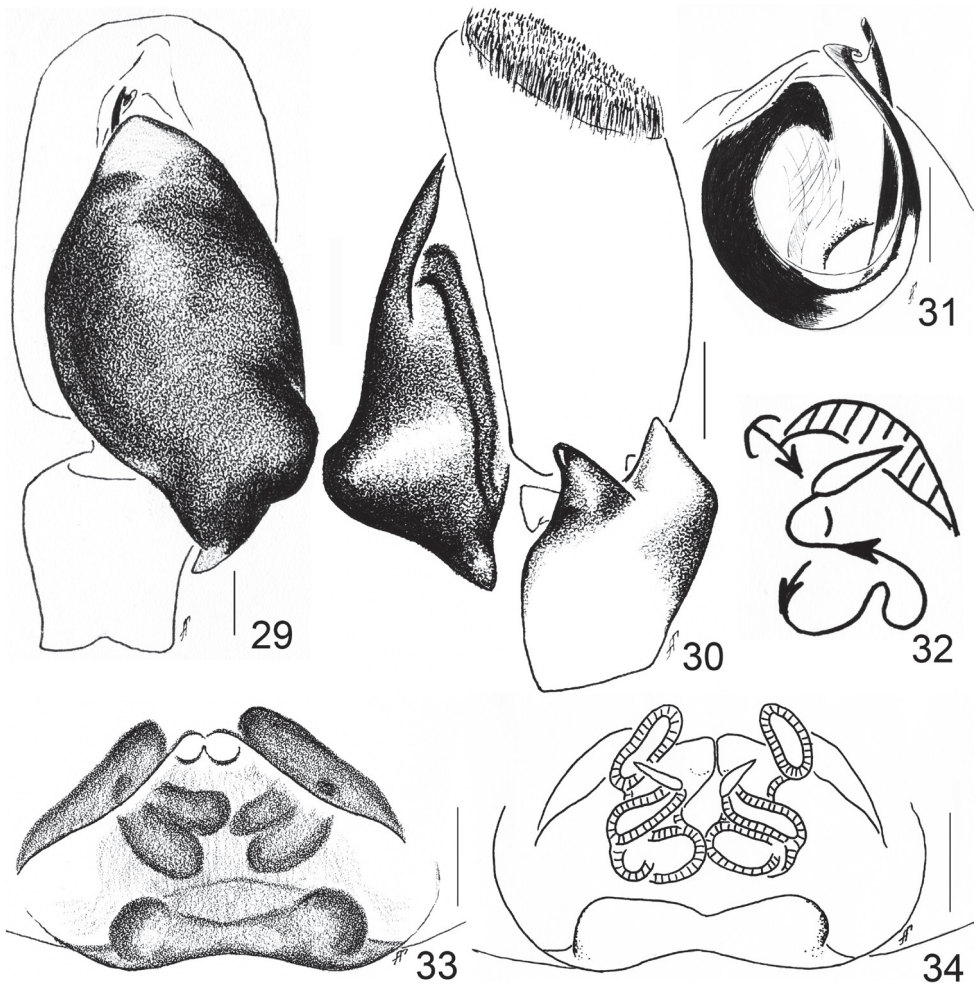
Asianellus leipoldae Metzner 1999: 72, figs 37 a–i (♂, SMNK, re-examined).

Aelurillus leipoldae: Azarkina 2002: 253, figs 31–42; Logunov and Chatzaki 2003: 96.

Aelurillus steliosi Dobroruka 2002: 8, figs 5–13 (♂, re-examined) **syn. n.**

Aelurillus cretensis: Bosmans and Chatzaki 2005: 100 (in part); Bosmans et al. 2013: 110 (in part).

Type material. Holotype of *Aelurillus steliosi*: ♂ (MNH #AR 13334) “GREECE, Crete, Skalani (Pref. Irakleio), 230 m a.s.l., 35°17'N, 25°11'E, 21 May 2001, coll.



Figures 29–34. Male of *Aelurillus leipoldae* (holotype of *Aelurillus steliosi*) and female of *A. cretensis* (allotype of *A. steliosi*): **29** left palp, ventral view **30** ditto, retrolateral view **31** embolic division, dorsal view **32** diagrammatic course of the insemination ducts **33** epigyne, ventral view **34** spermathecae, dorsal view. Scale bars: 0.1 mm (**29–31**, **33–34**).

S. Simaiakis. Holotype of *Asianellus leipoldae* ♂ (SMNK, 2177) “GREECE, Kreta, Paleohóra, Küstengebirge” [=Crete, Palaiochora, Coastal Ranges, 35°13'N, 23°40'E], 9.01.1993 (D. Leipold). Paratype of *Asianellus leipoldae* 1 ♂ (PCHM) “Kreta [=Crete], Chania, 35°18'N, 23°48'E, 4.09.1974 (A. Senglet).

Other material. GREECE: 10 ♂ 2 ♀ (ISEA 001.4045, 001.4047, 001.4058) Crete, Chania, Lefka Ori Mts., 800 and 1650 m a.s.l., 35°17'N, 23°54'E, 23 November 1990, 6 July–6 November 1991, coll. P. Lymperakis; 2 ♀ (ISEA 001.4057) Gavdos Island, Chania, Lavrakas sand-dunes, *Juniperus* forest, 34°52'N, 24°04'E, 24 July–8 November 1997, coll. K. Paragamian; 1 ♂ (LM) Crete, September 2002, coll.

S.L. Felton; 1 ♀ (SNHM) Crete, Chania, N of Lake Curna [=Kournas], N slope, 100 m from the coast, *Luminacea*, *Salvia*, 0–15 m a.s.l., 35°20'N, 24°16'E, 16 April 1958, coll. H. Kahmann; 1 ♀ (SNHM) Crete, Heraklion, 2 km SE of Zaros, NE slope, flat hill, sandy, *Phrygana*, *Cirsium*, *Cystus*, under stones, 35°07'N, 24°55'E, 7 April 1958, coll. H. Kahmann.

Remarks. The holotype of *Aelurillus steliosi* is conspecific with that of *A. leipoldae*. Both specimens examined (the male holotypes of *A. leipoldae* and *A. steliosi*) have the same body coloration and structure of the palpus and the embolic division (Figs 29–31 and see Azarkina 2002: figs 31–38, 41; Dobroruka 2002: figs 6–10). Therefore, it is safe to conclude that the name *A. steliosi* Dobroruka, 2002 is a junior synonym of *A. leipoldae* (Metzner, 1999), contrary to Bosmans et al. (2013) (see also comment under *A. cretensis*) who synonymized *A. steliosi* with *A. cretensis* Azarkina, 2002.

Distribution. Only known from Crete, Greece (Fig. 1; Metzner 1999: map 29; Azarkina 2002: fig. 43).

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References

- Azarkina GN (2002) New and poorly known species of the genus *Aelurillus* Simon, 1884 from central Asia, Asia Minor and the eastern Mediterranean (Araneae: Salticidae). *Bulletin of the British Arachnological Society* 12: 249–263.
- Azarkina GN (2006) Revision of *Aelurillus* Simon, 1884 (Salticidae) of the world. Autoreferate of the Thesis of Candidate (Ph.D.) of Biological Sci. Degree, Novosibirsk, 1–26. [In Russian]
- Azarkina GN, Logunov DV (2006) Taxonomic notes on nine *Aelurillus* species of the western Mediterranean (Araneae: Salticidae). *Bulletin of the British Arachnological Society* 13(7): 233–248.
- Azarkina GN, Mirshamsi O (2014) Description of a new *Aelurillus* species from Khorasan province of Iran, with comments on *A. concolor* Kulczyński, 1901 (Araneae: Salticidae). *Zoology in the Middle East* 60(1): 82–91. doi: 10.1080/09397140.2014.892353

- Bosmans R, Baert L, Bosselaers J, de Koninck H, Maelfait J-P, van Keer J (2009) Spiders of Lesbos (Greece). A catalogue with all currently known spider reports from the Eastern Aegean Island of Lesbos. Newsletter of the Belgian Arachnological Society, volume 24 (suppl.): 1–70.
- Bosmans R, Chatzaki M (2005) A catalogue of the spiders of Greece. Critical review of all spider species cited from Greece with their localities. Newsletter of the Belgian Arachnological Society, volume 20 (2 suppl.): 1–124.
- Bosmans R, van Keer J, Russell-Smith A, Kronestedt T, Alderweireldt M, Bosselaers J, de Koninck H (2013) Spiders of Crete (araneae). A catalogue of all currently known species from the Greek island of Crete. Nieuwsbrief van de Belgische Arachnologische Vereniging 28 (supplement 1): 1–147.
- Coşar İ, Danişman T, Budak Yıldırım FA (2014) The jumping spiders' fauna of Kırıkkale Province (Araneae, Salticidae). Sekret 14(2): 83–94.
- Danişman T, Coşar İ, Erdek M, Sancak Z (2012) A contribution to the knowledge of Turkish jumping spider fauna (Araneae: Salticidae). Acta Zoologica Bulgarica 64(2): 215–216.
- Deltshev C, Paraschi L (1990) A contribution to the study of spiders (Araneae: Dysderidae, Salticidae, Agelenidae) in Greece, with a description of a new species (*Malthonica spinipalpis* Deltshev, sp. n. Agelenidae). Biologia Gallo-Hellenica 17: 3–12.
- Deltshev C, Lazarov S, Blagoev G (2001) The spiders (Araneae) of Sashnitska Sredna Gora Mountain (Bulgaria). Faunistic and zoogeographical analysis. Acta Zoologica Bulgarica, 53(1): 3–28.
- Dobroruka LJ (2002) Notes on a collection of jumping spiders from Greece, mainly from Crete (Araneae: Salticidae). Biologia Gallo-hellenica 28: 5–26.
- Fişer C, Azarkina GN (2005) A contribution to the knowledge of the jumping spiders (Salticidae: Araneae) of the Republic of Macedonia. Acta Zoologica Bulgarica 57(3): 299–304.
- Komnenov M (2002) Contribution to the study of spiders (Araneae) on Šar Planina Mountain, North-Western Macedonia. Bulletin of Biology Students' Research Society 2: 103–110.
- Komnenov M (2003) Contribution to the study of spiders (Araneae) on Jakupica Mountain, Macedonia. Bulletin of Biology Students' Research Society 3: 45–49.
- Komnenov M (2006) New data on jumping spiders in the Republic of Macedonia with a complete checklist (Araneae: Salticidae). Acta Zoologica Bulgarica Suppl. 1: 301–314.
- Lazarov S (2005) Spiders (Araneae) from Maquises in south-west Bulgaria - Part I. Acta Zoologica Bulgarica 57: 145–152.
- Logunov DV (2015) Taxonomic-faunistic notes of the jumping spiders of the Mediterranean (Aranei: Salticidae). Arthropoda Selecta 24(1): 33–85.
- Logunov DV, Chatzaki M (2003) An annotated check-list of the Salticidae (Araneae) of Crete, Greece. Revista Iberica de Arachnologia 7: 95–100.
- Logunov DV, Guseinov EF (2002) Faunistic review of the jumping spiders of Azerbaijan (Aranei: Salticidae), with additional faunistic records from neighbouring Caucasian countries. Arthropoda Selecta 10(3): 243–260.
- Metzner H (1999) Die Springspinnen (Araneae, Salticidae) Griechenlands. Andrias 14: 1–279.
- Ono H (1988) A revisional study of the spider family Thomisidae (Arachnida, Araneae) of Japan. National Science Museum, Tokyo, ii + 252 pp.

- Prószyński J (1971) Notes on systematics of Salticidae (Arachnida, Aranei). I–VI. Annales zoologici Warszawa 28: 227–255.
- Russell-Smith A, Allison M, Blumstom W, Snazell R, Spilling C (2011) A provisional checklist and gazetteer of the spiders of Chios, Greece (Arachnida, Araneae). Bulletin of the British Arachnological Society 15(5): 133–167. doi: 10.13156/arac.2010.15.5.133
- Shorthouse DP (2010) SimpleMapper, an online tool to produce publication-quality point maps. <http://www.simplemapper.net> [accessed on 2nd June 2015]
- Topçu A, Demir H, Seyyar O (2005) A check-list of the spiders of Turkey. Sekret 9(4): 109–140.
- World Spider Catalog (2015) World Spider Catalog. Natural History Museum Bern. <http://wsc.nmbe.ch>, version 16 [accessed on 2nd June 2015]
- Żabka M (1997) Salticidae: Pajaki skaczące (Arachnida: Araneae). Fauna Polski 19: 1–188.

Appendix

Aelurillus v-insignitus (Clerck, 1757)

Material (the studied material was partly published by Komnenov 2002, 2003, 2006 and Logunov 2015). MACEDONIA: 1 ♂ (PCMK) Šar Planina [=Shar] Mt., 1320 m a.s.l., 41°48.455'N, 20°47.862'E, pitfall traps, 19 July 1998 (M. Komnenov); 3 ♀ (PCMK) Pelister [=Baba] Mt., 1200–1500 m a.s.l., 41°01.760'N, 21°13.369'E, July 2001 (M. Komnenov); 2 ♂ 1 ♀ (PCMK) Demir Kapija, 550 m a.s.l., 41°20.843'N, 22°18.334'E, 21 May 2005 (M. Komnenov); 1 ♂ (PCMK) Jakupica Mt., 2000 m a.s.l., 41°40.670'N, 21°24.245'E, 11 July 1999 (M. Komnenov); 1 ♂ (PCMK) Plačkovica [=Plachkovica] Mt., 1700 m a.s.l., 41°45'N, 22°28'E, 8–20 July 2002 (M. Komnenov); 1 ♂ (PCMK) Vodno Mt., Skopje, 41°57'N, 21°23'E, 26 April 2003 (M. Komnenov); 1 ♂ (PCMK) Vodno Mt., Skopje, 41°57.972'N, 21°23.890'E, 5 May 2002 (M. Komnenov); 1 ♂ (PCMK) Ogražden [=Ograzhden] Mt., 41°33.719'N, 22°49.440'E, 14 July 2000 (M. Komnenov). BULGARIA: 1 ♂ (IZWP) Zelenigrad near Tran, 42°50'N, 22°33'E, 2 May 1966 (V. Beškov, W. Starega); 1 ♂ 2 ♀ (IZSB) FM 71, Soil traps, Pirin N.P., Struma [=Strouma] River valley (South), 2 km S of Kamenuca [=Kamenitsa], 1700–2400 m a.s.l., 41°37'N, 23°09'E, 5 April – 9 May 2002 (M. Langourov & S. P. Lazarov); 1 ♂ (IZSB) Šaštinska Sredna Gora [=Sredna Gora] Mt. Range, Strelča [=Strelcha], 700 m a.s.l., 42°30'N, 24°19'E, 9 May 1998 (S. P. Lazarov). TURKEY: 1 ♂ (ISEA) Artvin Province, Hopa, 41°23'N, 41°25'E, 17 May 1997 (V. Bryja).

The spider family Filistatidae (Araneae) in Iran

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Abstract

All species of Filistatidae occurring in Iran are surveyed. *Zaitunia akhanii* sp. n. is described on the basis of female specimens collected in Tehran province, and the previously unknown male of *Sahastata sinuspersica* Marusik, Zamani & Mirshamsi, 2014 is described for the first time. Also, the endogynes of the holotypes of *Z. alexandri* Brignoli, 1982, *Z. medica* Brignoli, 1982 and *Z. persica* Brignoli, 1982 are illustrated. Including these results, the number of Iranian species of Filistatidae is increased to seven, which indicates the highest species-richness of this family in the Western Palaearctic.

Keywords

Fauna, Aranei, Near East, new species, *Filistata*, *Sahastata*, *Zaitunia*

Introduction

Filistatidae is a relatively small, globally-distributed family currently comprised of 119 extant species within 18 genera (World Spider Catalog 2015). The family has never been revised at the global scale. Filistatids are relatively well-studied in the West Palaearctic due to Brignoli (1982), who surveyed all species known from the Iberian Peninsula to Iran. In that paper, Brignoli described three new species of *Zaitunia* Lehtinen, 1967 and reported *Filistata insidiatrix* (Forsk., 1775) from Iran for the first time. The taxonomy

of Filistatidae of Iran has been dealt with in three publications only (Zamani et al. 2015). The second paper dealing with Iranian Filistatidae was published by Marusik and Zonstein (2014), where they surveyed the Middle East *Filistata* Latreille, 1810, described a new species from Azerbaijan, and provided taxonomic and faunistic data regarding *F. insidiatrix* in Iran. The third paper was published by Marusik et al. (2014), in which the genus *Sabastata* Benoit, 1968 was recorded from Iran for the first time, and a new species, *S. sinuspersica* Marusik, Zamani & Mirshamsi, 2014, was described on the basis of female specimens collected in southern Iran. In addition, four faunistic papers have been published that provided additional information regarding the distribution of *F. insidiatrix* in Iran (Ghahari and Marusik 2009, Ghahari and Tabari 2012, Tabrizi et al. 2014, Zamani 2015) and one recent publication provided the first Iranian record of *F. lehtineni* Marusik & Zonstein, 2014 (Moradi et al. in press). In this study, one new species and the male of *S. sinuspersica* are described and all taxonomic and faunistic data published regarding this family in Iran are provided.

Materials and methods

Specimens were photographed using an Olympus Camedia E-520 camera attached to an Olympus SZX16 stereomicroscope or to the eye-piece of an Olympus BH-2 transmission microscope. Digital images were prepared using “CombineZP” image stacking software (<http://www.hadleyweb.pwp.blueyonder.co.uk/>). Illustrations of internal genitalia were made after clearing in 10% KOH aqueous solution and exposure for a few minutes in an alcohol/water solution of Chlorazol Black. Lengths of leg segments were measured on the dorsal side. Measurements of palp and legs are listed as: total length [femur, patella, tibia, metatarsus, tarsus]. Description of the palp refers to the left one. All measurements are given in millimeters.

Depositories

MCSN	Museo Civico di Storia Naturale di Verona.
SMF	Senckenberg Museum, Frankfurt am Main.
ZMMU	Zoological Museum of the Moscow State University.
ZMUT	Zoological Museum of University of Tehran.

Taxonomy

Genus *Filistata* Latreille, 1810

Type species. *Filistata testacea* Latreille, 1810 (considered a junior synonym of *F. insidiatrix*).

Filistata is a genus of medium to large-sized Filistatinae spiders with 19 valid species mainly distributed from Mediterranean to Turkmenistan. Members of this genus

can be diagnosed by the long and cylindrical palpal tibia of males, well-developed thoracic fovea, long and subhorizontal clypeus, oval sternum and longer than wide labium (Zonstein et al. 2013).

***Filistata insidiatrix* (Forskål, 1775)**

Figs 1c–d, 7

Filistata insidiatrix: Brignoli 1982: 68, f. 1–5 (♂♀); Ghahari and Marusik 2009: 4 (distribution record); Ghahari and Tabari 2012: 139 (distribution record); Marusik and Zonstein 2014: 200, f. 1–3, 7–8, 11–12, 15–16, 19–22, 25–27 (♂♀); Tabrizi et al. 2014: 30 (distribution record); Zamani 2015: 12 (distribution record).

For the complete list of taxonomic references see World Spider Catalog (2015).

Diagnosis. This species differs from *F. lehtineni* by larger size, longer male palp, and larger receptacles (cf. Fig. 1a–d).

Description. Well-described by Brignoli (1982).

Records in Iran. Chahar Mahal & Bakhtiary, Fars, Golestan, Isfahan, Kordestan, Mazandaran, Razavi Khorasan, Tehran.

Global distribution. This species has the widest range within the entire family. It is known from the Iberian Peninsula to Turkmenistan and northeastern Iran (Marusik and Zonstein 2014). The record of this species from Razavi Khorasan is the easternmost in its range.

***Filistata lehtineni* Marusik & Zonstein, 2014**

Figs 1a–b, 7

Filistata lehtineni Marusik and Zonstein 2014: 202, f. 4–6, 9–10, 13–14, 17–18, 23–24, 28–30 (♂♀); *F. l.*: Moradi et al. in press (♂).

Diagnosis. This species differs from *F. insidiatrix* by smaller size, shorter and thicker male palp with screw-shaped embolus, and smaller receptacles (cf. Fig. 1c–d).

Description. Both sexes of this species are described in detail in Marusik and Zonstein (2014).

Record in Iran. Zanjan.

Global distribution. Known only from southern Azerbaijan and northwestern Iran.

Genus *Sahastata* Benoit, 1968

Type species. *Filistata nigra* Simon, 1897.

Sahastata is a small genus of large-sized Filistatinae spiders with four described species distributed from the Mediterranean to India. Members of *Sahastata* differ distinctly from

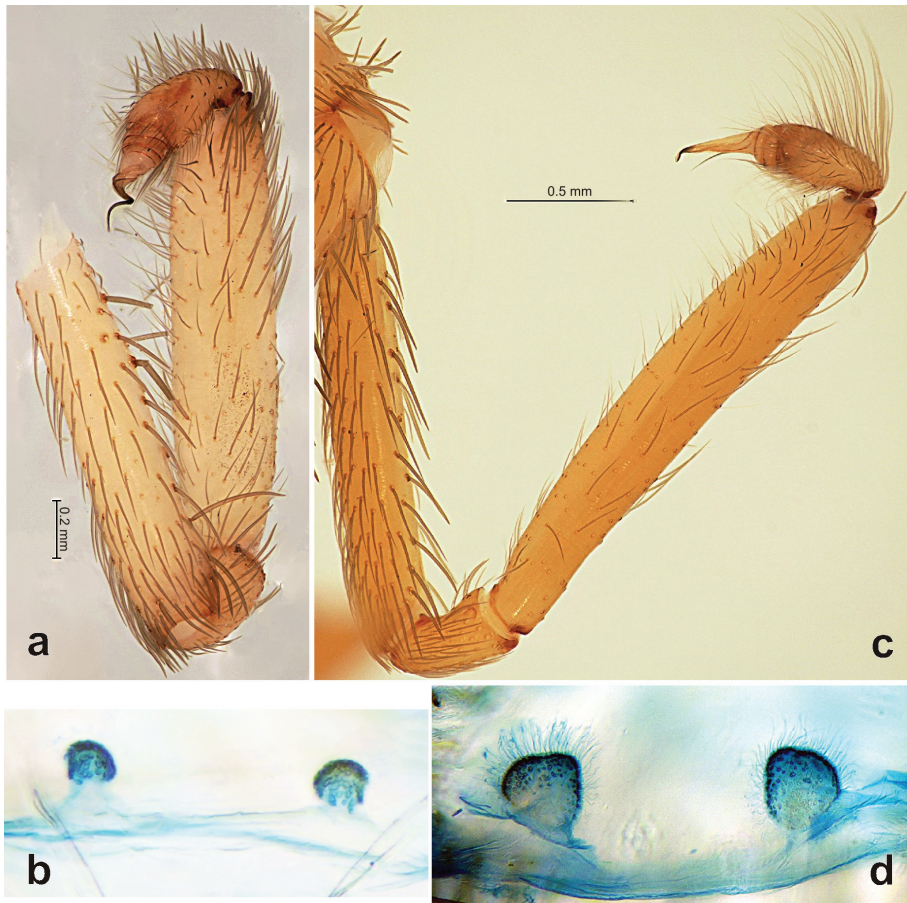


Figure 1. Copulatory organs of *Filistata lehtineni* (a–b) and *F. insidiatrix* (c–d). **a, c** male palp, retro-lateral **b, d** endogyne, dorsal. After Marusik and Zonstein (2014).

other genera of Filistatinae by the shape of the calamistrum (two-three rows, not placed in a crest), presence of a dense ventral scopula on the femora I and II of females (Benoit 1968), dense hairs on female sternum and labium and several small spines on the femora I and II of males. So far, *Sabastata* males are known only by one species from India, *S. ashapuriae* Patel, 1978. Unfortunately, the description of this species lacks several important characters, such as female internal genitalia and cribellum and male legs spination (*cf.* Patel 1978), which are critical for the genus recognition and the separation of species.

***Sabastata sinuspersica* Marusik, Zamani & Mirshamsi, 2014**

Figs 2, 3, 6b–c, 7

Sabastata sinuspersica Marusik et al. 2014: 9, f. 22–29, 34–40 (♀).

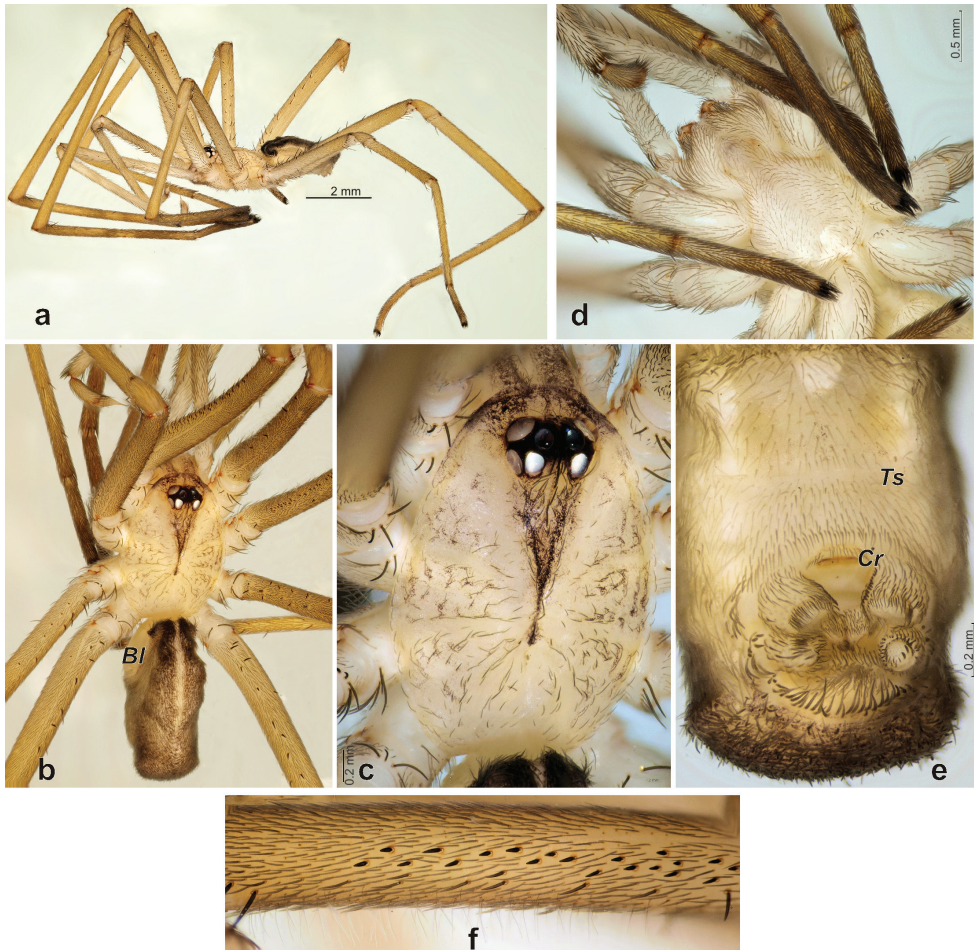


Figure 2. Somatic characters of *Sabastata sinuspersica*, male. **a, b** habitus, lateral and dorsal **c** carapace, dorsal **d** prosoma, ventral **e** abdomen, ventral **f** part of femur I showing spination, prolateral. Abbreviations: *Bl* book lung, *Cr* cribellum, *Ts* tracheal spiracle.

Material examined. IRAN: 1♂ 1♀ (SMF), *Hormozgan Province*: Hormuz Island, 27°04'N, 56°28'E, January 2015 (A. Zamani).

Diagnosis. Females of *S. sinuspersica* can be distinguished from the other female congeners by having one pair of receptacle heads connected to the epigastric furrow by a pair of ducts, while *S. nigra* Simon, 1897 present two pairs of spermathecae heads (Benoit 1968: fig. 4) and *S. sabaia* Brignoli, 1982 has the duct connected to the bursa copulatrix (Brignoli 1982: fig. 18) (Fig. 3e–f). The male differs from all known filistatids except for *Filistata puta* O.Pickard-Cambridge, 1876 (*sensu* Wunderlich 1995) by having numerous small spines on femora I and II. Males of *S. sinuspersica* and *F. puta* both have relatively long palps but differ by the shape of the bulb: conical and tapering in *S. sinuspersica* and with round tegular part in *F. puta* (Wunderlich 1995: figs 2–4). The

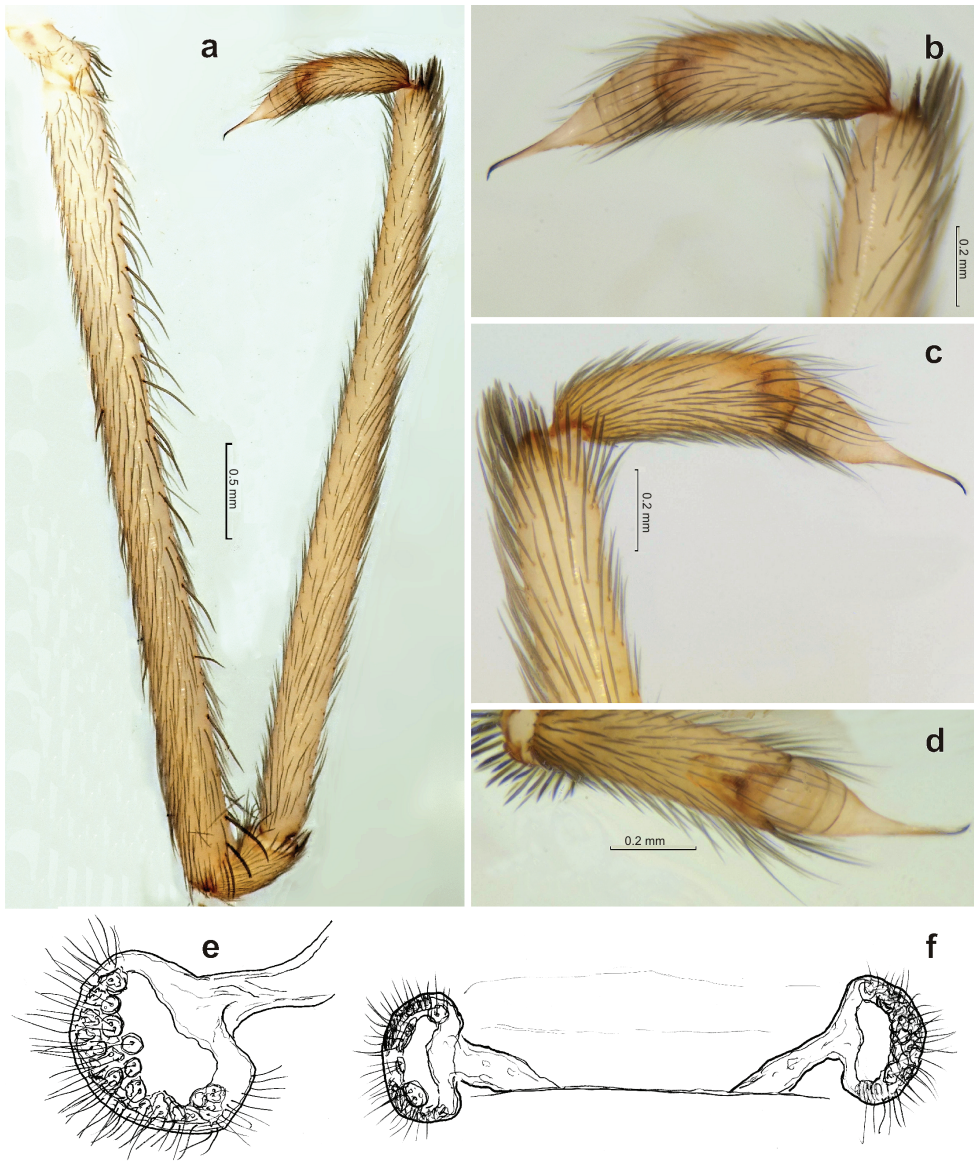


Figure 3. Copulatory organs of *Sahastata sinuspersica*. **a** whole male palp, retrolateral **b–d** terminal part of the male palp, retrolateral, prolateral and from above **e** receptacle, dorsal **f** endogyne, dorsal.

bulb of *S. sinuspersica* is very similar to that in *S. ashapuriae*. Although the latter species is poorly-described and illustrated, it can be easily distinguished from *S. sinuspersica* by having palps longer than leg I (palp twice shorter than leg I in Iranian species).

Description. Male. Total length 4.85. Carapace 2.32 long, 1.75 wide, 0.5 high, flat, light-colored, with V-shaped brown median spot reaching clypeus and poorly distinct radial stripes, covered with short adpressed dark hairs, postocular area with few strong erected hairs (Fig. 2b–c). Eye tubercle moderately elevated, brownish-black.

Chelicerae with median brown bands (Fig. 2b–c). Sternum uniformly light-colored (Fig. 2d), hairs covering sternum not as dense as in female (Marusik et al. 2014: fig. 24). Legs light brownish-yellow, darker than carapace, metatarsi and tarsi darker than other segments due to dense brownish hairs (Fig. 2a, d). Legs very long, first leg four times longer than body (Fig. 2a). All legs with distinct spines, femora I with numerous pro- and retrolateral small spines (Fig. 2b, f), femora II with less dense spination prolaterally. All leg tarsi with pseudosegmentation (cuticular cracks) (Fig. 2a, d). Calamistrum absent. Measurements of palp and legs: Palp 9.66 [4.5, 0.5, 4.03, 0.63], I 19.65 [5.25, 1.05, 5.85, 5.5, 2.0], II 13.75 [3.85, 1.0, 3.65, 3.75, 1.5], III 11.9 [3.25, 0.95, 2.8, 3.5, 1.4], IV 16.65 [4.5, 1.05, 4.3, 4.8, 2.0]. Abdomen brownish, with dark brown anterior part of dorsum and distinct light median stripe. Book lungs (*Bl*) very large (length about 1/3 of abdomen length) (Fig. 2b), tracheal spiracle (*Ts*) wide, located almost on half way from epigastric furrow to cribellum (Fig. 2e). Cribellum (*Cr*) present (Fig. 2e), large, transverse and divided.

Palp as in Fig. 3a–d, very long, two times longer than body, femur as long as femur of leg IV, covered with spines; patella very short, shorter than cymbium; tibia slightly thinner than femur, without spines; cymbium cylindrical, longer than free part of bulb; bulb conical gradually tapering, embolic part not well-separated from tegular part, shorter than tegular part; tip of embolus slightly bent retrolaterally; Sperophor with three coils in retrolateral and two coils in prolateral.

Female. Described by Marusik et al. (2014).

Habitat. Specimens were mostly found under stones and in natural crevices on a sandy substrate near the sea.

Records in Iran. Hormozgan.

Distribution. Endemic to southern Iran.

Genus *Zaitunia* Lehtinen, 1967

Type species. *Filistata schmitzi* Kulczyński, 1911.

Zaitunia is a small genus of small to medium-sized Filistatinae spiders with 11 described species distributed from East Mediterranean to Central Asia. They are diagnosable from the similarly-looking *Filistata* by the lack of a thoracic fovea, short and subvertical clypeus, subcircular sternum, as broad as long labium, and by a short and swollen palpal tibia of males (Zonstein 2009, Zonstein et al. 2013).

Zaitunia akhanii sp. n.

<http://zoobank.org/61D6F60B-59E9-4E87-973A-F46DB5BE979B>

Figs 4, 6a, 7

Material examined. IRAN: Holotype ♀ (SMF) and paratypes 7♀ (ZMMU, ZMUT), *Tehran Province*: Southern macroslopes of Alborz mountains, 35°48'29"N, 51°23'E, July 2014 (A. Zamani).

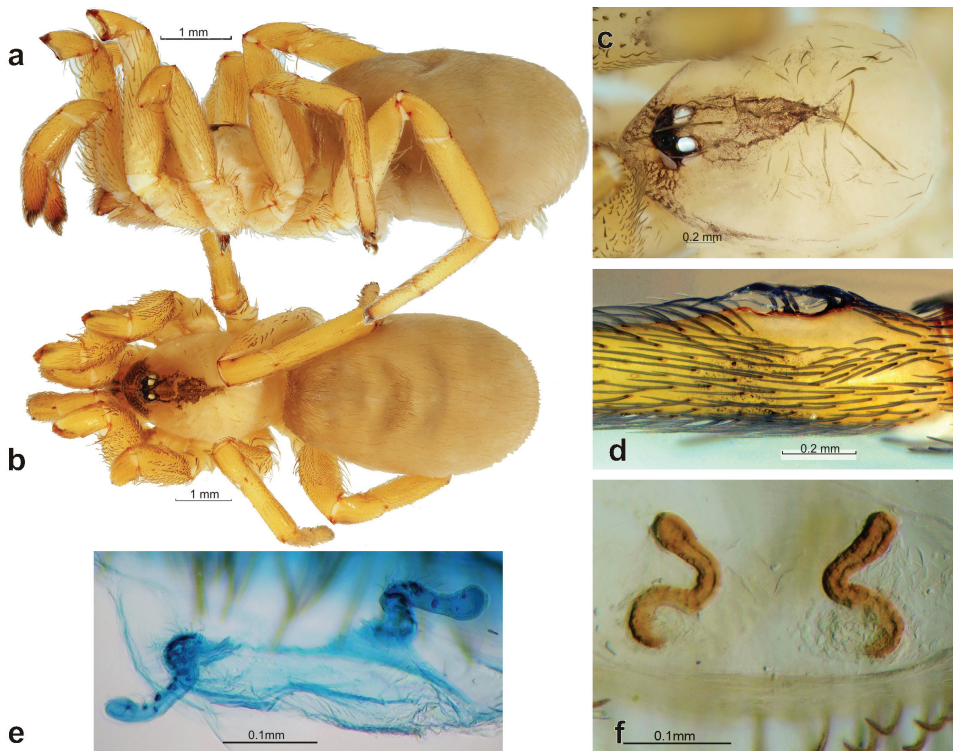


Figure 4. Holotype of *Zaitunia akhanii* sp. n. **a–b** habitus, lateral and dorsal **c** carapace, dorsal **d** calamistrum **e–f** endogyne, anterior and ventral.

Etymology. This species is named after Iranian botanist Hossein Akhane (University of Tehran), in recognition of his contributions to the botanical studies of Iran and his numerous environmental activities.

Diagnosis. Females of *Z. akhanii* sp. n. resemble those of *Z. persica* Brignoli, 1982 by having one pair of sinuous tube-like receptacles, but *Z. akhanii* sp. n. has two loops (or curves) while *Z. persica* has four (Brignoli 1982: fig. 14).

Description. Female (paratype). Total length 5.2. Carapace 2.16 long, 1.6 wide. Eye sizes and interdistances: AME 0.09, ALE 0.16, PLE 0.11, PME 0.12, AME-AME 0.03. Light yellowish-colored with distinct pattern on carapace and legs: clypeus whole dark, wide dark median band terminated near fovea. Abdomen uniformly yellowish-gray without darker pattern. Legs with few spines; calamistrum located on low ridge, uniseriate (Fig. 4d). Measurements of palp and legs: Palp 3.28 [1.2, 0.6, 0.68, 0.8], I 9.4 [3.12, 0.8, 2.28, 2.0, 1.2], II 6.28 [1.76, 0.72, 1.48, 1.44, 0.88], III 5.28 [1.52, 0.6, 1.2, 1.2, 0.76], IV 7.12 [2.08, 0.8, 1.68, 1.68, 0.88].

Vulva as in Fig. 4e–f, with one pair of sinuous tube-like receptacles. Receptacles wavy, bent two times, glands not distinct in low magnification but well visible after contrasting coloring (Fig. 4e); glands distributed along whole receptacle and denser in the basal half.

Male. Unknown.

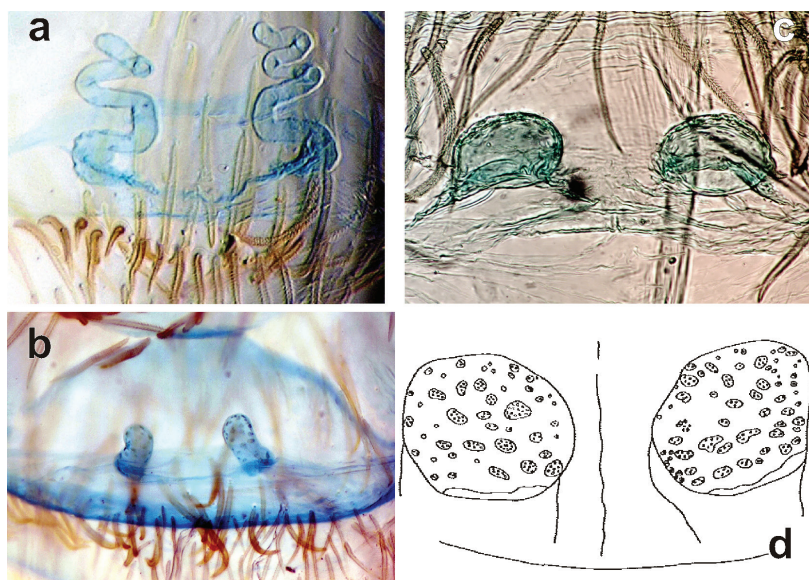


Figure 5. Dorsal view of endogynes of the holotypes of *Zaitunia persica* (a), *Z. alexandri* (b) and *Z. medica* (c–d). 6d after Brignoli (1982).

Variations. Total length 4.8–7.2. Pale specimens may have light clypeus.

Habitat. Specimens were found in large, dusty cribellate webs made around human dwellings.

Distribution. Known only from the type locality in Tehran.

Zaitunia alexandri Brignoli, 1982

Figs 5b, 7

Zaitunia alexandri Brignoli 1982: 74, f. 15 (♀).

Type. IRAN: holotype ♀ (MCSN), *Fars Province*: Kuhenjan, 27 May 1976 (S. Zerunian).

Diagnosis. This species differs from other Iranian congeners by the shape of the sac-like receptacles, slightly longer than wide.

Description. Well-described by Brignoli (1982).

Record in Iran. Fars.

Distribution. Endemic to southern Iran.

Zaitunia medica Brignoli, 1982

Figs 5c–d, 7

Zaitunia medica Brignoli 1982: 72, f. 16 (♀).

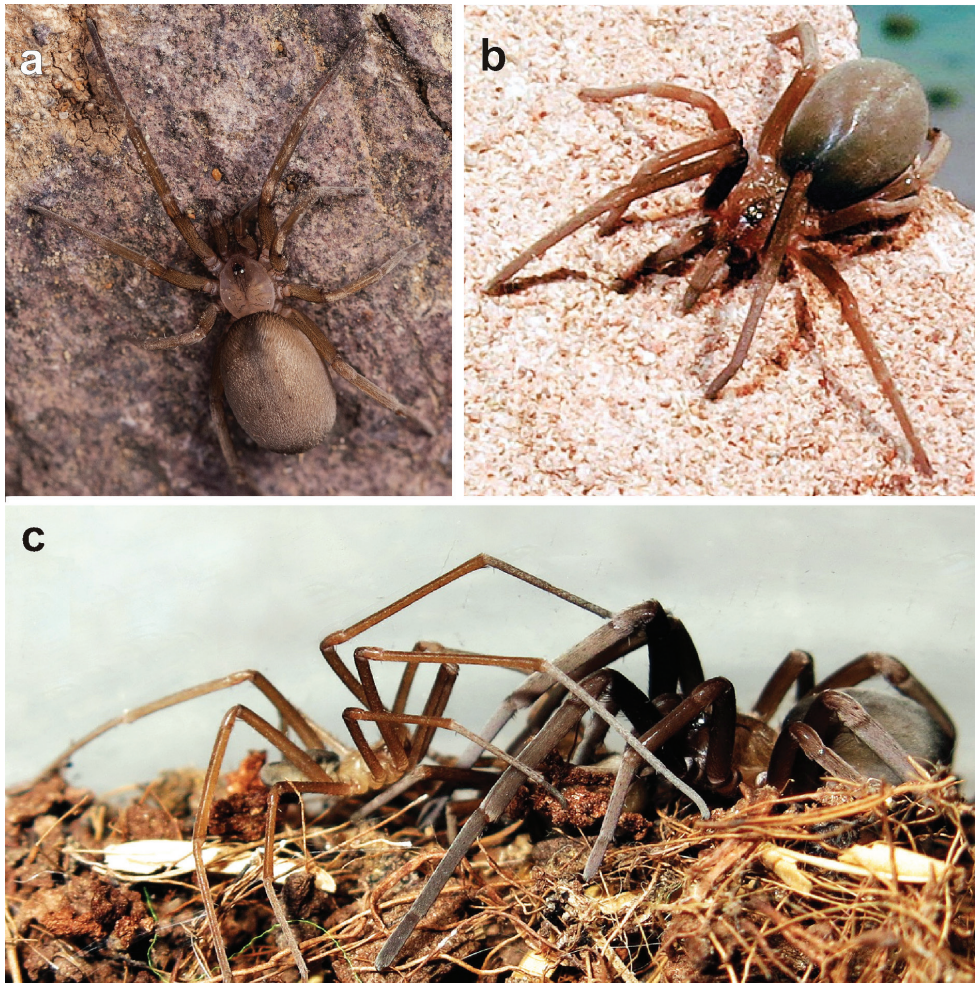


Figure 6. Live specimens of *Zaitunia akhanii* sp. n. (a), and *Sahastata sinuspersica* (b–c). a–b female, dorsal c male (left) and female (right) prior to copulation, on artificial surface. Photographs by A. Mohajeran (a) and A. Zamani (b–c).

Types. IRAN: holotype ♀ and paratype ♀ (MCSN), *Isfahan Province*: Laybid, 2100 m, 7 July 1975 (P. Brignoli & M. Di Rao).

Diagnosis. This species differs from other Iranian congeners by the shape of sac-like receptacles, which are wider than long.

Description. Well-described by Brignoli (1982).

Record in Iran. Isfahan.

Distribution. Endemic to central Iran.



Figure 7. Distribution records of filistatids in Iran: *Filistata insidiatrix* (circle), *F. lehtineni* (square), *Sahastata sinuspersica* (triangle), *Zaitunia akhanii* sp. n. (star), *Z. alexandri* (pentagon), *Z. medica* (cross) and *Z. persica* (diamond).

Zaitunia persica Brignoli, 1982

Figs 5a, 7

Zaitunia persica Brignoli 1982: 70, f. 13–14 (♀).

Types. IRAN: holotype ♀ and paratype ♀ (MCSN), *Fars Province*: Dehbid, 2100m, 24 May 1976 (P. Brignoli).

Diagnosis. This species differs from other Iranian congeners by very long, tube-like receptacles curved four times.

Description. Well-described by Brignoli (1982).

Record in Iran. Fars.

Distribution. Endemic to southern Iran.

Conclusions

Although some other species of *Zaitunia* described from nearby countries have not been properly described and their genitalia have never been illustrated, and female filistatids are known to be morphologically variable to some degrees, an ongoing revision of this genus (Zonstein and Marusik, unpublished) and the examination of more than 20 species, including types of all central Asian species (which all have very limited distributions) confirm that *Z. akhanii* sp. n. is a separate, undescribed species. The results of this study show that there are seven species in three genera of Filistatidae known from Iran, of which five are endemic and one is sub-endemic. This is the highest species-richness of the family in the Western Palaearctic, and is considerably higher than the whole Caucasus (three species in two genera), adjacent Turkey (two species in two genera) and all of Europe (six species in two genera). Although this indicates a high diversity of this group in Iran, an even higher diversity should be expected, considering that most regions of Iran, especially the large Zagros Mountain range in the western parts, have never been thoroughly studied in regards to the filistatid fauna. We expect the occurrence of at least three additional genera in Iran: *Microfilistata* Zonstein, 1990, *Pritha* Lehtinen, 1967 and *Tricalamus* Wang, 1987. All these genera are known in adjacent Afghanistan, Azerbaijan and Turkmenistan (Zonstein et al. 2013, Mikhailov 2013).

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References

- Benoit PLG (1968) Synopsis des Filistatidae africains (Araneae). Annali del Museo Civico di Storia Naturale Giacomo Doria 77: 92–102.
- Brignoli PM (1982) Contribution à la connaissance des Filistatidae paléarctiques (Araneae). Revue Arachnologique 4: 65–75.
- Ghahari H, Marusik YM (2009) New data on spider fauna of Iran (Araneae). Turkish Journal of Arachnology 2: 1–8.
- Ghahari H, Tabari M (2012) Fauna and population fluctuations of spiders (Arthropoda: Araneae) in rice fields of Mazandaran Province. Journal of Plant Protection 26: 136–144.

- Marusik YM, Zamani A, Mirshamsi O (2014) Three new species of mygalomorph and filistatid spiders from Iran (Araneae, Cyrtaucheniidae, Nemesiidae and Filistatidae). *ZooKeys* 463: 1–10. doi: 10.3897/zookeys.463.8692
- Marusik YM, Zonstein SL (2014) A synopsis of Middle East *Filistata* (Aranei: Filistatidae), with description of new species from Azerbaijan. *Arthropoda Selecta* 23: 199–205.
- Mikhailov KG (2013) The spiders (Arachnida: Aranei) of Russia and adjacent countries: a non-annotated checklist. *Arthropoda Selecta Supplement* 3: 1–260.
- Moradi M, Yağmur EA, Moradi-Gharakhloo P, Zamani A (in press) First record of *Filistata lehtineni* Marusik & Zonstein, 2014 for the fauna of Iran (Araneae: Filistatidae). *Biharean Biologist*.
- Patel BH (1978) Studies on Indian filistatid spiders (Araneae: Arachnida). *Journal of the Bombay Natural History Society* 75: 183–189.
- Tabrizi SS, Rad SP, Hedayati Z (2014) A faunistic study on the spiders of several metropolis parks in Tehran, Iran. *Indian Journal of Arachnology* 3: 28–39.
- World Spider Catalog (2015) World Spider Catalog. Natural History Museum Bern. <http://wsc.nmbe.ch>, version 16. [accessed on 8th April 2015]
- Wunderlich J (1995) Beschreibung des fraglichen Männchens von *Filistata puta* O. Pickard-Cambridge 1876 aus Algerien (Arachnida: Araneae: Filistatidae). *Beiträge zur Araneologie* 4: 617–619.
- Zamani A (2015) The spider collection (Arachnida: Araneae) of the Zoological Museum of the Iranian Research Institute of Plant Protection, with new species records for Iran. *Arachnologische Mitteilungen* 50: 10–17. doi: 10.5431/aramit5002
- Zamani A, Mirshamsi O, Marusik YM, Moradmand M (2015) The Checklist of the Spiders of Iran. Version 2015. <http://www.spiders.ir> [accessed on 8th April 2015]
- Zonstein SL (2009) The spider genus *Zaitunia* Lehtinen, 1967 (Araneae: Filistatidae) in Israel and Sinai (Egypt). *Israel Journal of Entomology* 38: 125–131.
- Zonstein SL, Marusik YM, Koponen S (2013) Redescription of three species of Filistatidae (Araneae) described by C.F. Roewer from Afghanistan. *Zootaxa* 3745: 64–72. doi: 10.11646/zootaxa.3745.1.5

***Aenictus hoelldobleri* sp. n., a new species of the *Aenictus ceylonicus* group (Hymenoptera, Formicidae) from China, with a key to the Chinese members of the group**

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Abstract

Aenictus is the most species-rich genus of army ants in the subfamily Dorylinae and one of the most species rich ant genera in China and the world. In this paper, a new species of the *Aenictus ceylonicus* group, *Aenictus hoelldobleri* sp. n., is described and illustrated based on the worker caste. The new species occurs in the subtropical forests of south-east China and is morphologically most similar to *A. henanensis* Li & Wang, 2005 and *A. wudangshanensis* Wang, 2006. *Aenictus hoelldobleri* sp. n. can be distinguished from both species by the shape of the subpetiolar process. The new species also resembles *Aenictus lifuiae* Terayama 1984 and *A. thailandianus* Terayama & Kubota, 1993 but clearly differs in various features of the cuticular sculpture. A key to the Chinese species of the *A. ceylonicus* group based on the worker caste is provided, which may help to reassess and clarify the taxonomic status of the abundant Chinese records of the true *A. ceylonicus* (Mayr, 1866), a species which almost certainly does not occur in China. Several new locality records are given, among them the first record of *A. watanasiti* Jaitrong & Yamane, 2013 from China.

Keywords

Army ants, Dorylinae, Gutianshan National Nature Reserve, species descriptions, subtropical forest, taxonomy

Introduction

Army ants form a monophyletic group in the subfamily Dorylinae (Brady et al. 2014). As a taxonomic group, all army ants can be characterized by a set of ecological and behavioral traits, most notably the specialized queen morphology, frequent nest relocations, and mass foraging raids for arthropod prey (Gotwald 1995, Kronauer 2009). Recently, Brady et al. (2014) clarified the in-depth phylogeny of army ants and their related taxa. Nevertheless, the species level taxonomy of most army ants is still far from being resolved and new species continue to be described (e.g. Bharti et al. 2012, Jaitrong and Yamane 2013, Staab 2014a, Liu et al. 2015b).

Of all army ant genera the genus *Aenictus* is the most species rich and widely distributed. Currently, 181 valid species (AntCat 2015) are known from the Mediterranean and the tropical and subtropical regions of Asia, Africa, and Australia (Gotwald 1995). As far as it is known, almost all *Aenictus* species are specialized predators of other ants, which are captured by raiding nests (e.g. Hirose et al. 2000, Hashimoto and Yamane 2014), but a few species are more generalized predators of arthropods (Schneirla and Reyes 1966) or can even occasionally be trophobiotic (Staab 2014b).

Over the last years, in a series of significant papers Weeyawat Jaitrong, Seiki Yamane, and co-workers divided the south-east Asian *Aenictus* fauna in 12 species groups based on the worker caste (Jaitrong and Yamane 2011, the key to species groups is freely available online at http://www.antwiki.org/wiki/Key_to_Aenictus_species_groups), which the authors comprehensively revised (Jaitrong and Yamane 2010, Jaitrong et al. 2010, Jaitrong and Yamane 2011, Wiwatwitaya and Jaitrong 2011, Jaitrong and Hashimoto 2012, Jaitrong and Yamane 2012, Jaitrong and Wiwatwitaya 2013, Jaitrong and Yamane 2013). Workers of the *A. ceylonicus* species group can be distinguished from all other species groups by the linear mandibles, the presence of a gap between the closed mandibles and the anterior clypeal margin, and an anterior clypeal margin without denticles (Jaitrong and Yamane 2011, 2013). Out of all *Aenictus* species groups the *A. ceylonicus* group is most diverse. In their comprehensive revision Jaitrong and Yamane (2013) treat 23 worker-based species from south-east Asia, of which 19 were newly described. Recently, Liu et al. (2015b) added a further new species from tropical China and gave new species records for the south-west Chinese fauna (Liu et al. 2015a). Despite this, it is likely that several species still await discovery and description in this region.

In the present paper *Aenictus hoelldobleri* Staab sp. n. is described, a new species of the *A. ceylonicus* group from the subtropical forests of south-east China. Furthermore, the first Chinese record of *A. watanasiti* Jaitrong & Yamane, 2013 is reported, and new Chinese locality records for *A. formosensis* Forel, 1913, *A. fuchuanensis* Zhou, 2001, *A. thailandianus* Terayama & Kubota, 1993, and *A. wudangshanensis* Wang, 2006 are added. As the key from Jaitrong and Yamane (2013) did not include a few *A. ceylonicus* group species that have been described from non-tropical China, an updated key to the ten *A. ceylonicus* group species known from China is provided, based on the worker caste.

Methods

All morphological observations were made with a Leica SD6 stereomicroscope, which was equipped with an ocular micrometer to take measurements. Automontage images of specimens were provided by <http://www.antweb.org/> (photographer: Michele Esposito) or extracted from Jaitrong and Yamane (2013) and Liu et al. (2015b).

The general worker terminology as well as abbreviations used for measurements and indices follow Jaitrong and Yamane (2011, 2013). All measurements are expressed in millimeters and are:

- CI** Cephalic index, $HW / HL \times 100$.
HL Maximum head length in full-face view, measured from the midpoint of the anterior clypeal margin to the midpoint of the posterior margin of the head.
HW Maximum head width in full-face view.
ML Mesosomal length measured from the point at which the pronotum meets the cervical shield to the posterior base of the metapleuron in profile.
PL Petiole length measured from the anterior margin of the peduncle to the posteriormost point of the petiolar tergite in profile.
SI Scape index: $SL / HW \times 100$.
SL Scape length excluding the basal constriction and condylar bulb.
TL Total length, measured roughly from the anterior margin of head to the tip of gaster in fully stretched specimens in profile.

Depositories of type material

- CASC** California Academy of Science Collection, San Francisco, California, USA.
HLMD Hessisches Landesmuseum Darmstadt, Darmstadt, Germany.
IZAS Insect Collection of the Institute of Zoology, Chinese Academy of Sciences, Beijing, China.
ZMBH Museum für Naturkunde, Berlin, Germany.

Distribution maps

Distribution maps for all Chinese *A. ceylonicus* group species were composed from the locality records given in the original descriptions, the records presented in this paper and the records listed in Jaitrong and Yamane (2013) and Liu et al. (2015a). Maps were created by manually adding species localities with the graphical software GIMP 2 (<http://www.gimp.org>) on a map extracted from the R-package “OpenStreetMap” (<http://cran.r-project.org/web/packages/OpenStreetMap>). The numerous Chinese records of *A. ceylonicus* (Mayr, 1866) compiled by Guénard and Dunn 2012 were not taken into account, as this species likely does not occur in China (see Discussion for a detailed explanation).

Results

Systematics

Aenictus ceylonicus species group

Diagnosis. Jaitrong and Yamane (2011) defined this species group as follows:

Antenna 10-segmented; scape reaching or extending beyond half of head length, but not reaching the occipital corner of head in full-face view. Mandible linear; its basal and lateral margins almost parallel; masticatory margin with large apical tooth followed by medium-sized subapical tooth; between subapical tooth and basal tooth 0–6 small denticles present. With mandibles closed, a gap present between mandibles and anterior margin of clypeus. Anterior clypeal margin weakly concave or almost straight, lacking denticles. Frontal carina short and thin, reaching or slightly extending beyond the level of posterior margin of torulus; anterior curved extension of frontal carina reaching or extending beyond the level of anterior clypeal margin in full-face view; parafrontal ridge absent. Promesonotum usually convex dorsally and sloping gradually to propodeum. Subpetiolar process developed. Head and first gastral tergite smooth and shiny. Body yellowish, reddish or dark brown; typhlatta spot absent.

Remarks. The *A. ceylonicus* group can be easily distinguished from other *Aenictus* species groups by the combination of linear mandibles, the presence of a gap between the closed mandibles and the anterior clypeal margin, and an almost straight or feebly concave anterior clypeal margin, which lacks denticles.

Synoptic species list of *A. ceylonicus* group species known from China:

- Aenictus formosensis* Forel, 1913 (Taiwan, Zhejiang)
- Aenictus fuchuanensis* Zhou, 2001 (Guangxi, Hong Kong, Jiangxi)
- Aenictus henanensis* Li & Wang, 2005 (Henan)
- Aenictus hoelldobleri* sp. n. (Jiangxi, Zhejiang)
- Aenictus lifuiiae* Terayama, 1984 (Taiwan)
- Aenictus maneerati* Jaitrong & Yamane, 2013 (Yunnan)
- Aenictus thailandianus* Terayama & Kubota, 1993 (Yunnan, Guizhou)
- Aenictus watanasiti* Jaitrong & Yamane, 2013 (Guizhou)
- Aenictus wudangshanensis* Wang, 2006 (Hubei, Zhejiang)
- Aenictus yangi* Liu, Hita Garcia, Peng & Economo, 2015 (Yunnan)

Key to Chinese *A. ceylonicus* group species

Key to Chinese *A. ceylonicus* group species based on the worker caste, modified and updated after the key of Jaitrong and Yamane (2013), which is freely available online at http://www.antwiki.org/wiki/Key_to_southeastern_Asian_Aenictus_ceylonicus_group_species and the extension of this key by Liu et al. (2015b):

- 1 Mandible with 2-6 teeth/denticles between subapical and basal teeth (mandible with more than 4 teeth/denticles) (Fig. 1A, B) **2**
- Mandible with 0-1 tooth/denticle between subapical and basal teeth (mandible with 3-4 teeth/denticles) (Fig. 1C, D) **7**
- 2 Promesonotum entirely punctate (Fig. 4A), at most lateral face of pronotum partly smooth and shiny; dorsum of postpetiole punctate (Fig. 3A) (Guizhou) **A. thailandianus Terayama & Kubota**
- Promesonotum predominantly smooth and shiny (Fig. 4B, C, D); dorsum of postpetiole smooth and shiny (Figs 3B, 3C, 3D) **3**
- 3 Subpetiolar process weakly developed, low and rounded, not rectangular (Fig. 4B) **4**
- Subpetiolar process well developed and rectangular (Figs 4C, 4D) **5**
- 4 Dorsum of propodeum straight in profile, entirely microreticulate and opaque; promesonotum microreticulate except posterior half of pronotum smooth and shiny; masticatory margin of mandible with large apical tooth, followed by a small preapical tooth, and 5 minute denticles (Henan) **A. henanensis Li & Wang**
- Dorsum of propodeum weakly convex to almost straight in profile, punctate but somewhat shiny; promesonotum entirely smooth and shiny except for reticulate anteriormost portion (Fig. 3B); masticatory margin of mandible with large apical tooth followed by a series of 6-7 denticles of two sizes, the larger alternating with 1-2 smaller (Fig. 1B) (Taiwan) ... **A. lifuiae Terayama**
- 5 Dorsum of mesonotum and petiolus entirely smooth and shiny (Fig. 3C) **A. yangi Liu, Hita Garcia, Peng & Economo**
- Dorsum of mesonotum and petiolus finely reticulate (Fig. 3D) **6**
- 6 Subpetiolar process rectangular-trapezoidal, its ventral outline with a thin almost transparent lamellae (Fig. 4C); masticatory margin of mandible with 4 (rarely 3) denticles (total number of mandibular teeth 6-7, including apical, subapical and basal tooth) (Jiangxi, Zhejiang) **A. hoelldobleri sp. n.**
- Subpetiolar process rectangular, its apex very acute and directed downwards medially (Fig. 4D); masticatory margin of mandible with 6 denticles (total number of mandibular teeth 9 including apical, subapical and basal tooth) (Hubei, Zhejiang) **A. wudangshanensis Wang**
- 7 Mandible with 3 teeth including apical and basal tooth (Fig. 1C) (Guizhou) **A. watanasiti Jaitrong & Yamane**
- Mandible with 4 teeth including apical and basal tooth (Fig. 1D) **8**
- 8 Subpetiolar process well-developed, subrectangular with convex ventral lamella, and with anterior and posterior corners acutely or bluntly angulated (Fig. 4E); head longer than broad, at maximum as broad as long (CI 90-100) (Fig. 2B) (Taiwan, Zhejiang) **A. formosensis Forel**
- Subpetiolar process weakly developed or very low (Fig. 4F, G); head broader than long, at minimum as broad as long (CI 100-112) (Fig. 2C, D) **9**

- 9 Subpetiolar process very low, with anterior and posterior denticles that protrude downwards (Fig. 4G); head in full-face view subrectangular, posterior margin feebly concave (Fig. 2D) (Yunnan).....*A. maneerati* Jaitrong & Yamane
- Subpetiolar process weakly developed, in profile its ventral outline almost straight or weakly convex, without denticles (Fig. 4F); head in full face view not rectangular, posterior margin weakly convex or straight (Fig. 2C) (Guangxi, Hong Kong).....*A. fuchuanensis* Zhou

Description of new species

Aenictus boelldobleri Staab, sp. n.

<http://zoobank.org/8617546B-AAD7-43BF-9215-7BD1B161465E>

Figs 3D, 4C, 5A–D

Holotype. Worker from CHINA, Jiangxi Province, near the village Xingangshan, ca. 15 km SE of Wuyuan, 29°4'39"N / 117°55'20"E, 300 m asl, 6.VII.2013, hand collection on ground, leg. Michael Staab, label "MS1647", deposited in IZAS.

Paratypes. 20 workers in total, all with the same data as holotype (3 in CASC: CASENT0914931, CASENT0914932, CASENT0914933, 4 in HLMD, 10 in IZAS, 3 in ZMBH).

Measurements and indices. Holotype: TL 2.88, HL 0.65, HW 0.57, SL 0.46, ML 0.95, PL 0.25, CI 88, SI 81. **Paratypes** (n=20 measured): TL 2.34–2.88, HL 0.52–0.68, HW 0.48–0.60, SL 0.40–0.50, ML 0.83–1.02, PL 0.20–0.25, CI 84–92, SI 75–86.

Worker description (holotype and paratypes). Head in full-face view slightly longer than broad (CI 84–92), sides slightly convex, posterior margin slightly rounded to almost straight, and occipital corners broadly rounded; occipital margin bearing distinct carina. Antennal scape relatively long (SI 75–86), extending well beyond 2/3 of head length but not reaching posterolateral corner of head; antennal segments II–VIII each broader than long, antennal segments IX and X longer than broad; length of segments II–IX continuously rising; terminal segment (X) longer than VIII and IX taken together; last four segments forming indistinct club. Frontal carina long and distinct, surpassing posterior margin of antennal torulus. Clypeus very short, its anterior margin almost straight to feebly concave, with lateral portions bluntly angled. Masticatory margin of mandible with large acute apical tooth, followed by medium-sized subapical tooth, 4 (rarely 3) small denticles, and medium-sized basal tooth; denticles and basal tooth worn out and hard to see in few paratypes; basal margin straight, lacking denticles. Gap between closed mandibles and anterior clypeal margin relatively small, about 0.5–0.6 times as broad as maximum width of mandible. With mesosoma in profile, promesonotum strongly convex, sloping gradually to the weakly developed but distinct metanotal groove; mesopleuron relatively short, demarcated from metapleuron by distinct groove; metapleural gland bulla moderately large, its

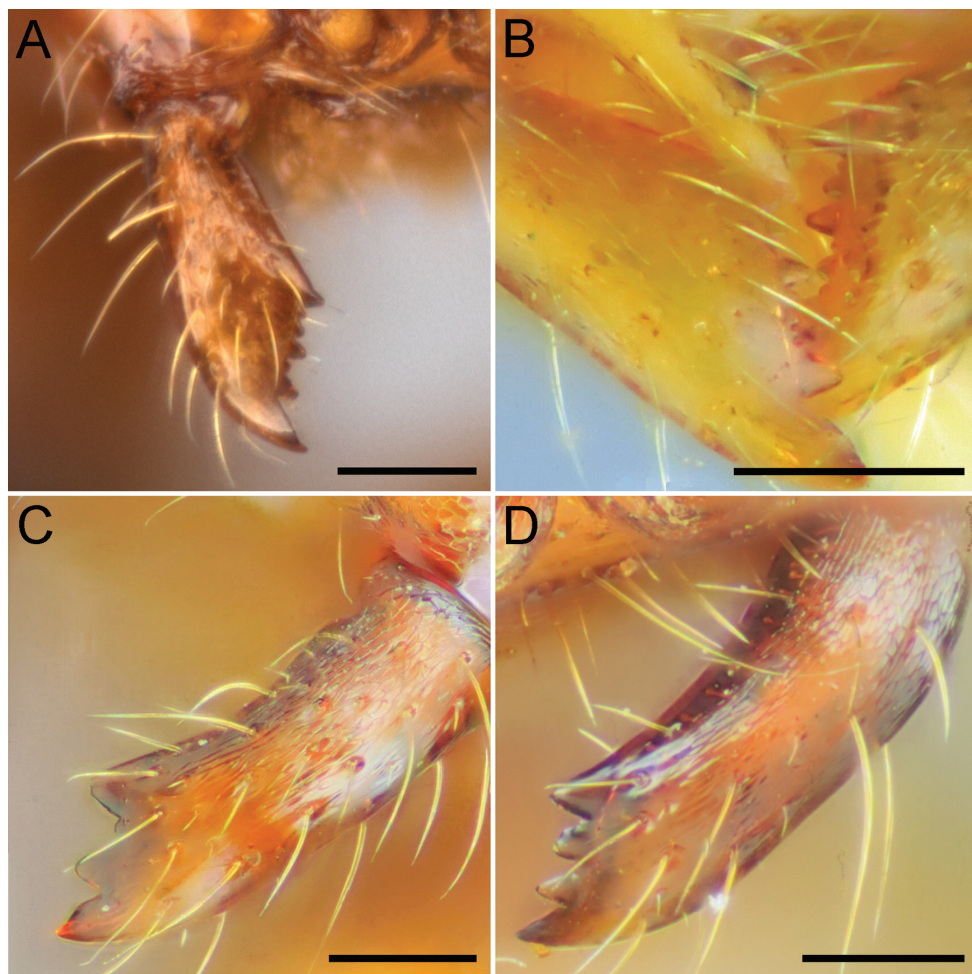


Figure 1. Mandible of Chinese *A. ceylonicus* group species in full face view. **A** *A. yangi* **B** *A. lifuiae* **C** *A. watanasiti* **D** *A. maneerati*. Scale bars – 0.1 mm. Image **A** is from Liu et al. (2015b), all other images are from Jaitrong and Yamane (2013).

maximum diameter about 1.3 times as long as distance between propodeal spiracle and most proximate part of metapleural gland bulla. Dorsal outline of propodeum in profile weakly convex, gently sloping posteriorly; propodeal junction angulated, overhanging declivity of propodeum, which is shallowly concave and encircled with thin but distinct rim. Petiole excluding subpetiolar process in profile slightly higher than long; petiolar node with steep anterior face and broadly convex dorsal outline; subpetiolar process developed, its ventral outline trapezoidal and rectangular, its apex on anterior part of process; ventralmost part of subpetiolar process with thin almost transparent lamellae. Postpetiole slightly shorter than petiole, in profile dorsal outline of node convex with small entirely flat area on dorsum; postpetiolar process developed, angulate, pointing anteriorly.

Head entirely smooth and shiny except for finely punctate antennal torulus. Mandible finely striate. Antennal scape entirely punctate. Mesosoma entirely finely reticulate with exception of pronotum and metapleuron; pronotum finely reticulate with large smooth and shiny median area on sides and dorsum; in few larger paratypes pronotal dorsum very finely and superficially reticulate but still smooth and shiny; anterior part of metapleuron smooth and shiny (with very fine and superficial longitudinal rugae in few larger paratypes). Entire petiole, including subpetiolar process, finely reticulate. Postpetiole finely reticulate, with flat surface on dorsum smooth and shiny. Gaster entirely smooth and shiny. Legs weakly punctate, more strongly so on tibiae, coxae smooth and shiny.

Body except sides of mesosoma with abundant standing and decumbent hairs of variable length; length of longest hairs on dorsum of head and pronotum 0.15–0.20 mm. Antennal scapes and legs with abundant decumbent hairs. Antennae, mesosoma, petiole and postpetiole reddish to yellowish brown, gaster and legs yellowish brown.

Male and female are unknown.

Etymology. The species epithet is a patronym in honor of the great German myrmecologist Berthold ‘Bert’ Hölldobler and his invaluable and outstanding contributions to our understanding of ant societies.

Non-type material examined. eight workers in total; two from CHINA, Zhejiang Province, Gutianshan National Nature Reserve, ca. 30 km NW of Kaihua, 29°12'2"N / 118°7'54"E, 345 m asl, 29.V.2009, pitfall trap, leg. Andreas Schuldt, label: “CSP25/NE4(2009)” (IZAS); one with same data except label “CSP25/SW4(2009)” (CASC: CASENT0914930); one with same data except 14.VI.2009, label “CSP25/NE5(2009)” (IZAS); one with same data except 29°12'53"N / 118°8'5"E, 366 m asl, label “CSP24/NW4(2009)” (IZAS); one with same data except 29°12'53"N / 118°8'5"E, 366 m asl, label “CSP24/SW4(2009)” (CASC: CASENT0914929); one with same data except 29°14'58"N / 118°7'19"E, 620 m asl, 26.VI.2009, label “CSP12/NE6(2009)” (ZMBH); one with same data except 29°14'47"N / 118°6'58"E, 402 m asl, 29.VIII.2009, label “CSP13/NW10(2009)” (IZAS).

Distribution. South-east China, provinces Zhejiang and Jiangxi (Fig. 6A).

Ecology. The species is so far known to inhabit secondary mixed evergreen broad-leaved forests at mid elevations (ca. 300–620 m) where it occurs from young to old successional stages (referred to as “*Aenictus (ceylonicus)* group” sp. CN02” in Staab et al. 2014, where more detailed biological information on the habitat can be found). Workers of a foraging column from one colony (MS1647) were observed during daytime (approximately 3pm) to carry pupae of *Technomyrmex* sp. and ant larvae on the ground. Thus, it is most likely that *A. hoelldobleri* has a similar life history as other *A. ceylonicus* group species by living and foraging on the ground and by being a specialized predator of other small ants.

Remarks. *Aenictus hoelldobleri* is most similar to *A. henanensis* Li & Wang, 2005 and *A. wudangshanensis*, two species that also inhabit subtropical broad-leaved forests in China. *Aenictus hoelldobleri* can easily be distinguished from both species by the shape of the subpetiolar process, which is weakly developed and rounded in *A. henanensis* (characters for *A. hoelldobleri* are given in brackets: rectangular- trapezoidal, with a thin lamellae on the ventral outline) and rectangular with a very acute median apex

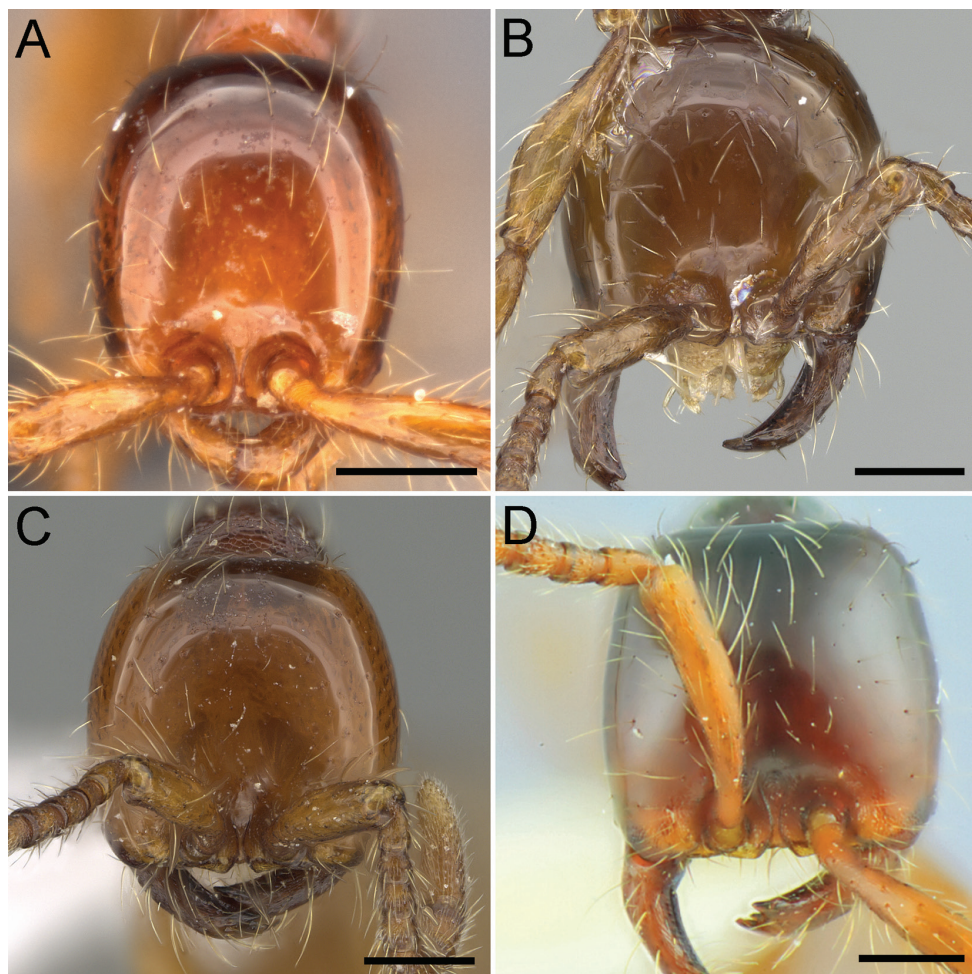


Figure 2. Head of Chinese *A. ceylonicus* group species in full face view. **A** *A. yangi* **B** *A. formosensis* (CASENT0914926) **C** *A. fuchuanensis* (CASENT0914926) **D** *A. maneerati*. Scale bars – 0.2 mm. Image **A** is from Liu et al. (2015b), **B** and **C** are from <http://www.antweb.org> (photographer: Michele Esposito), and **D** is from Jaitrong and Yamane (2013).

that faces downwards in *A. wudangshanensis*. Furthermore, *A. henanensis* has the dorsum of the petiolar node smooth and shiny (finely reticulate) and lacks long, standing hairs on the dorsum of the head (longest hairs 0.15–0.20 mm). *Aenictus wudangshanensis* also has the mandible in total with 9 teeth/denticles (6–7). The three afore discussed species share with *A. thailandianus*, *A. lifuiae* Terayama, 1984, and *A. yangi* Liu, Hita Garcia, Peng & Economo, 2015 the mandible with six or more teeth/denticles and the relatively small gap between the closed mandibles and the anterior clypeal margin. *Aenictus hoelldobleri* can be separated from *A. thailandianus* by the sculpture of the dorsa of promesonotum and postpetiole, which are in *A. thailandianus* entirely punctate and not shiny (smooth and shiny, at most very finely and superficially reticulate but still

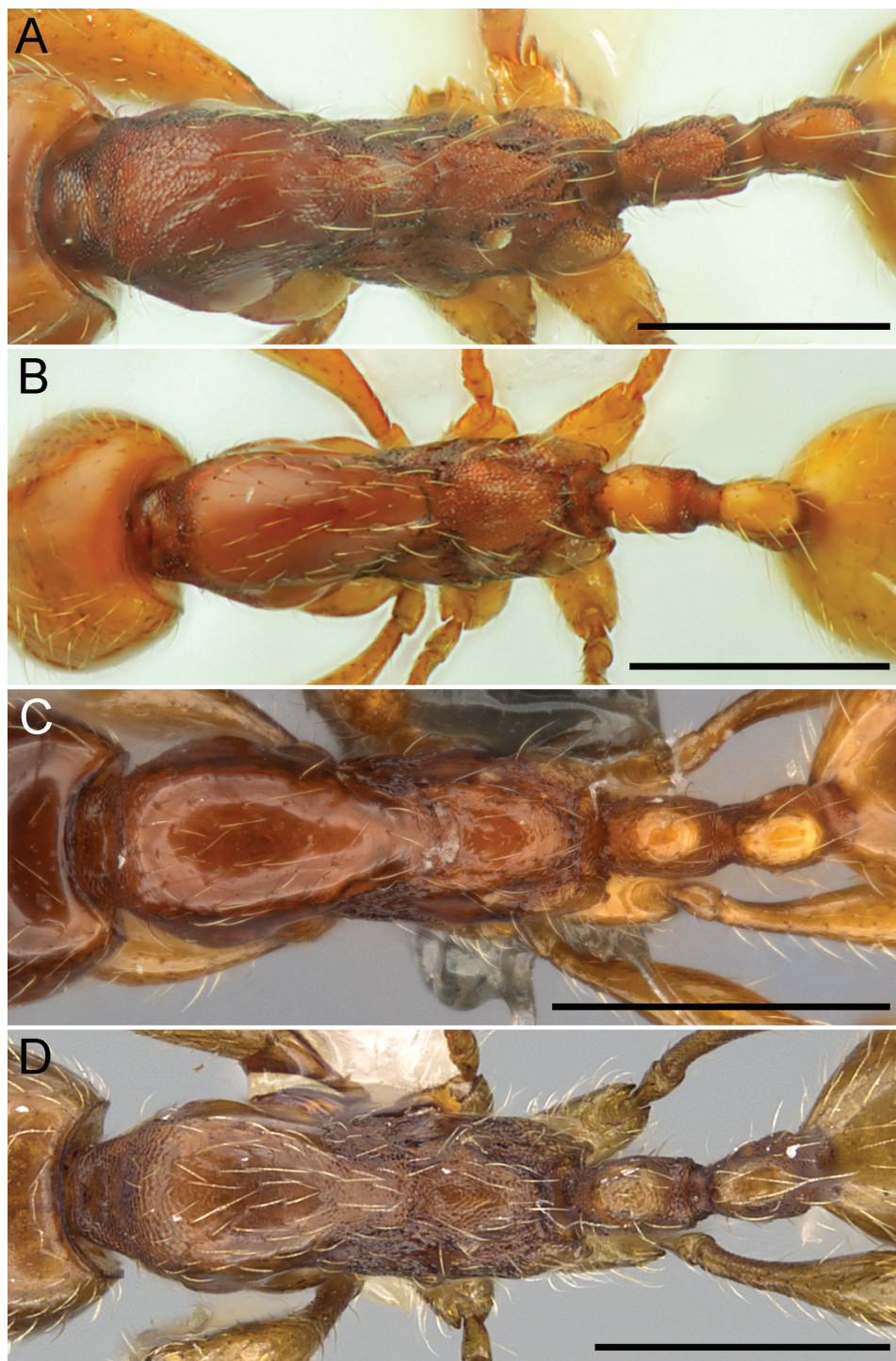


Figure 3. Mesosoma and waist segments of Chinese *A. ceylonicus* group species in dorsal view. **A** *A. thailandianus* **B** *A. lifuiae* **C** *A. yangi* **D** *A. hoelldobleri* sp. n. (CASENT0914932).

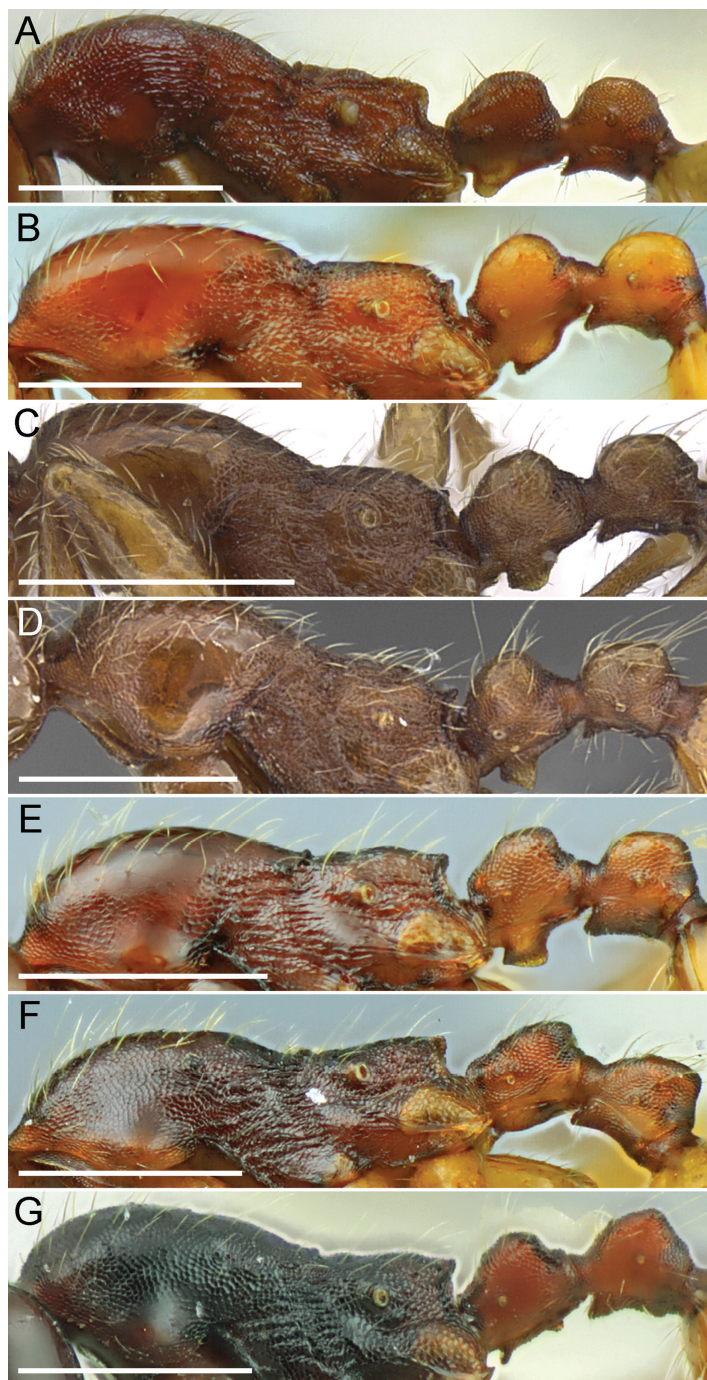


Figure 4. Mesosoma and waist segments of Chinese *A. ceylonicus* group species in profile. **A** *A. thailandianus* **B** *A. lifuiae* **C** *A. hoelldobleri* sp. n. (CASENT0914932) **D** *A. wudangshanensis* (CASENT0914927) **E** *A. formosensis* **F** *A. fuchuanensis* **G** *A. manerati*. Scale bars – 0.5 mm. Images **C** and **D** are from <http://www.antweb.org> (photographer: Michele Esposito). All other images are from Jaitrong and Yamane (2013).

smooth and shiny). *Aenictus lifuiae* and *A. yangi* differ from *A. hoelldobleri* by having the dorsum of the mesonotum and the dorsum of the petiole entirely smooth and shiny (finely reticulate). Furthermore, the legs of *A. lifuiae* are smooth and shiny (legs weakly punctate, most strongly on tibiae, coxae smooth and shiny) and the dentition of the mandible differs by having a large acute apical tooth followed by a series of 6–7 denticles of two sizes, the larger alternating with 1–2 smaller (large acute apical tooth, followed by a medium-sized subapical tooth, 3–4 minute denticles and a medium-sized basal tooth). The dentition of the mandible can also be used to separate *A. hoelldobleri* from *A. yangi*, in which the large acute apical tooth is followed by the medium-sized subapical tooth, one denticle, one medium sized tooth, two denticles, and the medium-sized basal tooth. Also, the maximum width of the gap between the anterior clypeal margin and the closed mandibles is in *A. yangi* at least about as broad as the maximum width of the mandibles (gap clearly smaller than maximum width of mandible).

New records of *A. ceylonicus* group species from China

Aenictus formosensis Forel

Figs 2B, 4E

Non-type material examined. Four workers from CHINA, Zhejiang Province, Gutianshan National Nature Reserve, ca. 30 km NW of Kaihua, 29°14'28"N / 118°6'37"E, 413 m asl, 30.VII.2008, pitfall trap in secondary mixed evergreen broad-leaved forest, leg. Andreas Schuldt, label: "CSP8/SE" (1 each in CASC: CASENT0914928 and IZAS).

Distribution. Taiwan, Zhejiang (Fig. 6B).

Remarks. This is the first record of *A. formosensis* from the Chinese mainland. *Aenictus formosensis* has been described and illustrated in detail by Jaitrong and Yamane (2013, therein fig. 7A–C), who revived the species from synonymy under *A. ceylonicus*. The four examined specimens collected in the Gutianshan National Nature Reserve agree very well with the material from Taiwan illustrated in Jaitrong and Yamane (2013) except that in one specimen the faces and the dorsum of the pronotum are very superficially reticulate but still shiny.

Aenictus fuchuanensis Zhou

Figs 2C, 4F

Non-type material examined. Seven workers from CHINA, Jiangxi Province, near the village Xingangshan, ca. 15 km SE of Wuyuan, 29°5'21"N / 117°55'43"E, 136 m asl, 29.V.2013, hand collection on ground in an early successional tree plantation, leg. Michael Staab, label "MS1422" (1 each in CASC: CASENT0914926, IZAS, and ZMBH).

Distribution. Guangxi, Hong Kong, Jiangxi (Fig. 6B); Cambodia, Laos, Thailand, Vietnam.

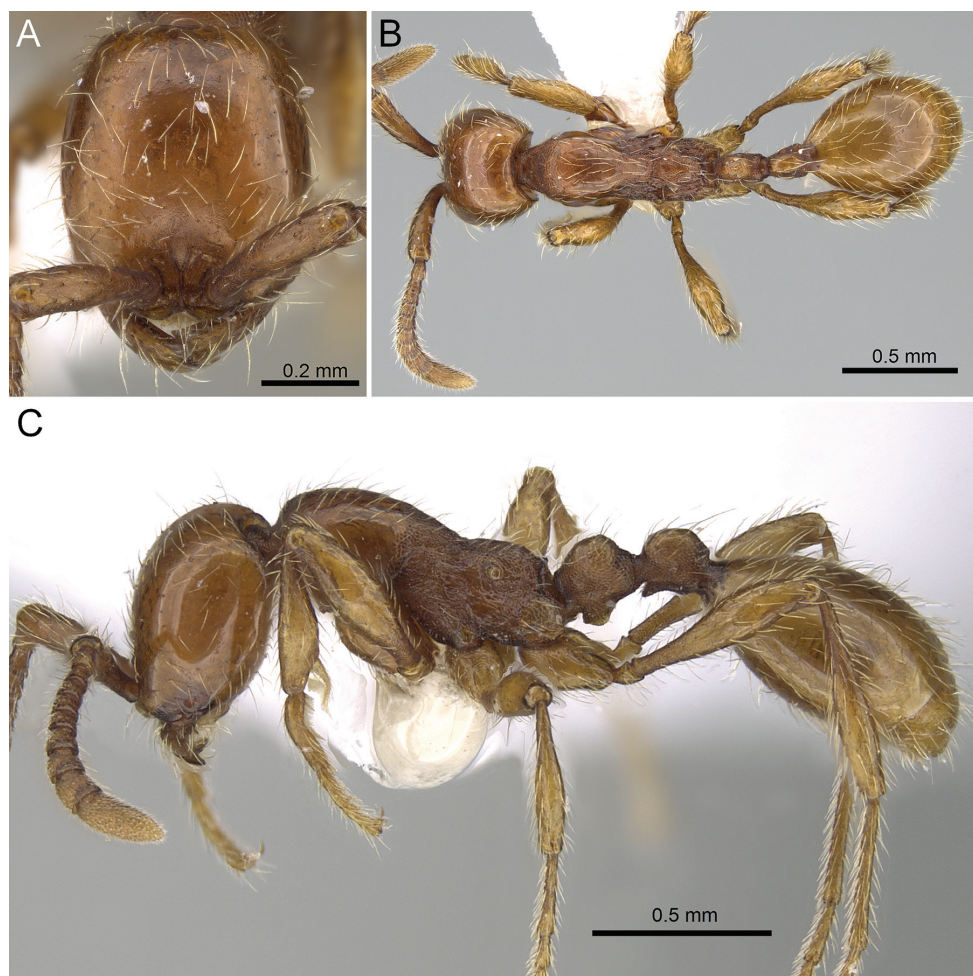
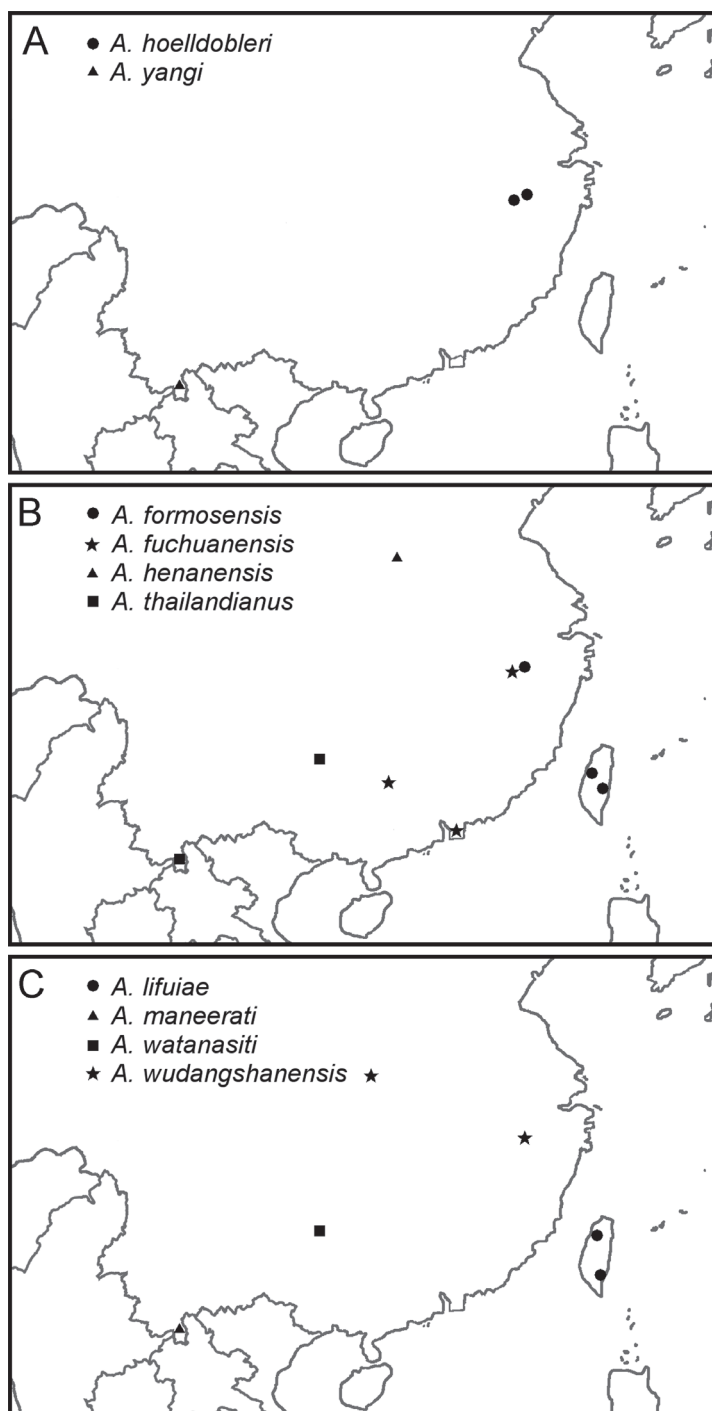


Figure 5. *Aenictus hoelldobleri* sp. n. (CASENT0914932). **A** Head in full face view **B** Body in profile **C** Body in dorsal view. All images are from <http://www.antweb.org> (photographer: Michele Esposito).

Remarks. *Aenictus fuchuanensis* has been described and illustrated in detail by Jaitrong and Yamane (2013, therein fig. 8A–C), who extended the original description from Zhou (2001, therein figs 74–75). The seven examined specimens from the North-East of Jiangxi province agree in all aspects with the descriptions of Zhou (2001) and Jaitrong and Yamane (2013). This is so far the northernmost record of *A. fuchuanensis*. Notably, the species was collected in an experimental tree plantation (see Bruelheide et al. 2014) that was planted four years prior and at the time of collection still had an open character with a maximum tree height of 3 m and abundant patches of bare soil. Hence, *A. fuchuanensis* may be able to inhabit more open landscapes and not be restricted to forests, which may explain the relatively wide distribution of the species, which occurs from south Thailand to south-east China.



Figures 6. Distribution of the *A. ceylonicus* group species in China. **A** *A. hoelldobleri* sp. n. and *A. yangi* **B** *A. formosensis*, *A. fuchuanensis*, *A. henanensis*, and *A. thailandianus* **C** *A. lifuiae*, *A. maneerati*, *A. watanasiti*, and *A. wudangshanensis*.

***Aenictus thailandianus* Terayama & Kubota**

Figs 3A, 4A

Non-type material examined. Three workers from CHINA, Guizhou Province, Leigongshan, 6.VII.1988, leg. Minsheng Wang; original label in Chinese “贵州雷公山 / 1988.VII.6 / 王敏生 / 中科院动物所”; (in IZAS: IOZ(E)1379709, all three workers on a single pin).

Distribution. Guizhou, Yunnan (Fig. 6B); North Thailand, North Vietnam.

Remarks. The three specimens of *A. thailandianus* from Leigong Mountain, Guizhou Province, agree well with the original description of Terayama and Kubota (1993, therein figs 11–13) and the additional descriptions and illustrations of Jaitrong and Yamane (2013, therein fig. 17A–D). This is the so far northernmost record of *A. thailandianus*, which has in China only been recorded from Yunnan (Liu et al. 2015a).

***Aenictus watanasiti* Jaitrong & Yamane**

Fig. 1C

Non-type material examined. Three workers from CHINA, Guizhou Province, Leigongshan, 6.VII.1988, leg. Minsheng Wang; original label in Chinese “贵州雷公山 / 1988.VII.6 / 王敏生 / 中科院动物所”; (in IZAS: IOZ(E)1379710, all three workers on a single pin).

Distribution. Guizhou (Fig. 6C); Thailand, North Vietnam.

Remarks. The three specimens of *A. watanasiti* from Leigong Mountain, Guizhou Province, agree very well with the original description and the illustrations of Jaitrong and Yamane (2013, therein fig. 18A–D). This is the so far northernmost record of *A. watanasiti* and the first record from China.

***Aenictus wudangshanensis* Wang**

Fig. 4D

Non-type material examined. Four workers from CHINA, Zhejiang Province, Gutianshan National Nature Reserve, ca. 30 km NW of Kaihua, 29°15'18"N / 118°8'51"E, 880 m asl, 25.VI.2009, pitfall trap in secondary mixed evergreen broad-leaved forest, leg. Andreas Schuldt, label: “CSP6/SE6(2009)” (1 each in CASC: CASENT0914927 and IZAS).

Distribution. Hubei, Zhejiang (Fig. 6C).

Remarks. So far *A. wudangshanensis* has been known only from the type series collected in the Wudangshan Nature Reserve, Hubei Province. The four specimens from the Gutianshan National Nature Reserve agree very well with the original description of Wang (2006, therein figs 1.2). Like the type series, the specimens were collected at mid elevation in an evergreen broad-leaved forest and *A. wudangshanensis* may be restricted to this habitat type.

Discussion

The genus *Aenictus* with its type-species *A. ambiguus* Shuckard, 1840 was originally established and described based on the male caste. In the Chinese *Aenictus* fauna there are eight species and subspecies only known from males (Guénard and Dunn 2012, AntCat 2015); among the Chinese *A. ceylonicus* group species listed in the present paper, the male is known only for *A. lifuiae* (see figs 5–13 in Terayama 1984). Male-worker associations are as yet unclear for other species. It is thus not impossible that the species described here as new corresponds to one of the already described male-based taxa. To avoid unnecessary synonyms it may be more appropriate to refrain from new descriptions of *Aenictus* species until male-worker combinations are better understood, for example by applying barcoding approaches (see e.g. Huemer et al. 2014). Not describing new species causes, however, a different problem. Only published species names will be included in species lists and be available for further studies (see also Wilson 1964 and Jaitrong and Yamane 2013 for a more detailed discussion), including conservation planning. Weighing these arguments, it was decided to describe the new species. Barcoding data on species level would also help to further strengthen the taxonomic concept in the genus *Aenictus*. So far, species groups and single species (including the species newly described here) are solely based on sometimes rather minor differences in morphological characters such as the shape of the subpetiolar process. As long as no genetic data are available it may be argued that such differences are a form of intraspecific variation, as interpreted by Wilson (1964).

Most *Aenictus* species are largely restricted to forests. Unfortunately, forests in China and elsewhere in Asia have been and are still continuously cleared and transformed into agriculture or tree plantations (e.g. López-Pujol et al. 2006, Hansen et al. 2013). Being top predators of the leaf-litter food web characterized by low dispersal abilities and consequently rather limited distribution ranges (Gotwald 1995, Jaitrong and Yamane 2013), *Aenictus* species are expected to be directly negatively affected by forest loss and anthropogenic land use as shown by Matsumoto et al. (2009). Hence, the ongoing forest conversion may sooner or later endanger ant species with a specialized life-history such as *Aenictus*.

There are many records of *A. ceylonicus* from south and east China (listed in Guénard and Dunn 2012). This species was formerly thought to be widely distributed from India to Australia (Wilson 1964). However, more recent work has shown that the ‘true’ *A. ceylonicus* is almost certainly restricted to India and Sri Lanka (Shattuck 2008, Jaitrong and Yamane 2013). Thus, all Chinese records of this species have to be considered as highly doubtful and should be critically reevaluated. It is likely that these records in fact refer to one or several of the species (such as *A. formosensis*) treated in Jaitrong and Yamane (2013) and in the present paper. Recently, *A. formosensis* was revived from synonymy under *A. ceylonicus* by Jaitrong and Yamane (2013) and is here reported for the first time from the Chinese mainland. I hope that the key to the Chinese *A. ceylonicus*-group species presented here may assist the necessary clarifications and reevaluations.

The diversity center for the *A. ceylonicus* group seems to be in continental South-East Asia (Jaitrong and Yamane 2013). There are several species such as *A. brevipodus* Jaitrong

& Yamane, 2013, which have been described from North Vietnam, close to the Chinese border. It is very likely that most of the *A. ceylonicus*-group species that are so far only known from the North of Vietnam or northern Thailand also extend their range into Southern China, as the finding of *A. thailandianus* and *A. watanasiti* in Guizhou Province demonstrates. Further sampling in the highly endangered tropical and subtropical forests of China is necessary to fully capture the diversity and distribution ranges of ants, including *Aenictus*. Given the limited distribution of most *Aenictus* species and the generally understudied Chinese ant fauna (Guénard and Dunn 2012, Liu et al. 2015a) it is likely that such sampling will also reveal further, as yet undescribed species.

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References

- AntCat (2015) <http://www.antcat.org/catalog/429477> [accessed 29 April 2015]
- Bharti H, Wachkoo AA, Kumar R (2012) Two remarkable new species of *Aenictus* (Hymenoptera: Formicidae) from India. *Journal of Asia-Pacific Entomology* 15: 291–294. doi: 10.1016/j.aspen.2012.02.002
- Brady SG, Fisher BL, Schultz TR, Ward PS (2014) The rise of army ants and their relatives: diversification of specialized predatory doryline ants. *BMC Evolutionary Biology* 14: 93. doi: 10.1186/1471-2148-14-93
- Bruelheide H, Nadrowski K, Assmann T, Bauhus J, Both S, Buscot F, Chen X-Y, Ding B, Durka W, Erfmeier A, Gutknecht JLM, Guo D, Guo L-D, Härdtle W, He J-S, Klein A-M, Kühn P, Liang Y, Liu X, Michalski S, Niklaus PA, Pei K, Scherer-Lorenzen M, Scholten T, Schuldt A, Seidler G, Trogisch S, von Oheimb G, Welk E, Wirth C, Wubet T, Yang X, Yu M, Zhang S, Zhou H, Fischer M, Ma K, Schmid B (2014) Designing forest biodiversity experiments: general considerations illustrated by a new large experiment in subtropical China. *Methods in Ecology and Evolution* 5: 74–89. doi: 10.1111/2041-210x.12126

- Forel A (1913) H. Sauter's Formosa-Ausbeute: Formicidae II. Archiv für Naturgeschichte (A) 79: 183–202. [In German]
- Gotwald WHJ (1995) Army Ants: The Biology of Social Predation. Cornell University Press, Ithaca, NY, 320 pp.
- Guénard B, Dunn RR (2012) A checklist of the ants of China. Zootaxa 3558: 1–77.
- Hansen MC, Potapov PV, Moore R, Hancher M, Turubanova SA, Tyukavina A, Thau D, Stehman SV, Goetz SJ, Loveland TR, Kommareddy A, Egorov A, Chini L, Justice CO, Townshend JRG (2013) High-resolution global maps of 21st-century forest cover change. Science 342: 850–853. doi: 10.1126/science.1244693
- Hashimoto Y, Yamane S (2014) Comparison of foraging habits between four sympatric army ant species of the genus *Aenictus* in Sarawak, Borneo. Asian Myrmecology 6: 95–104.
- Hirosawa H, Higashi S, Mohamed M (2000) Food habits of *Aenictus* army ants and their effects on the ant community in a rain forest of Borneo. Insectes Sociaux 47: 42–49. doi: 10.1007/s000400050007
- Huemer P, Karsholt O, Mutanen M (2014) DNA barcoding as a screening tool for cryptic diversity: an example from *Caryocolum*, with description of a new species (Lepidoptera, Gelechiidae). ZooKeys 404: 91–111. doi: 10.3897/zookeys.404.7234
- Jaitrong W, Hashimoto Y (2012) Revision of the *Aenictus minutulus* species group (Hymenoptera: Formicidae: Aenictinae) from Southeast Asia. Zootaxa 3426: 29–44.
- Jaitrong W, Wiwatwitaya D (2013) Two new species of the *Aenictus pachycerus* species group (Hymenoptera: Formicidae: Aenictinae) from Southeast Asia. Raffles Bulletin of Zoology 61: 97–102.
- Jaitrong W, Yamane S (2010) The army ant *Aenictus silvestrii* and its related species in Southeast Asia, with a description of a new species (Hymenoptera: Formicidae: Aenictinae). Entomological Science 13: 328–333. doi: 10.1111/j.1479-8298.2010.00385.x
- Jaitrong W, Yamane S (2011) Synopsis of *Aenictus* species groups and revision of the *A. currax* and *A. laeviceps* groups in the eastern Oriental, Indo-Australian, and Australasian regions (Hymenoptera: Formicidae: Aenictinae). Zootaxa 3128: 1–46.
- Jaitrong W, Yamane S (2012) Review of the Southeast Asian species of the *Aenictus javanus* and *Aenictus philippinensis* species groups (Hymenoptera, Formicidae, Aenictinae). ZooKeys 193: 49–78. doi: 10.3897/zookeys.193.2768
- Jaitrong W, Yamane S (2013) The *Aenictus ceylonicus* species group (Hymenoptera, Formicidae, Aenictinae) from Southeast Asia. Journal of Hymenoptera Research 31: 165–233. doi: 10.3897/jhr.31.4274
- Jaitrong W, Yamane S, Wiwatwitaya D (2010) The army ant *Aenictus wroughtonii* (Hymenoptera, Formicidae, Aenictinae) and related species in the oriental region, with descriptions of two new species. Japanese Journal of Systematic Entomology 16: 33–46.
- Kronauer DJC (2009) Recent advances in army ant biology (Hymenoptera: Formicidae). Myrmecological News 12: 51–65.
- Li SP, Wang YL (2005) A new species of the ant genus *Aenictus* Shuckard (Hymenoptera: Formicidae) from Henan, China. Entomotaxonomia 27: 157–160.
- Liu C, Guénard B, Hita Garcia F, Yamane S, Blanchard B, Yang D-R, Economo EP (2015a) New records of ant species from Yunnan, China. ZooKeys 477: 17–78. doi: 10.3897/zookeys.477.8775

- Liu C, Hita Garcia F, Peng Y-Q, Economo EP (2015b) *Aenictus yangi* sp. n. – a new species of the *A. ceylonicus* species group (Hymenoptera: Formicidae: Dorylinae) from Yunnan, China. *Journal of Hymenoptera Research* 42: 33–45. doi: 10.3897/JHR.42.8859
- López-Pujol J, Zhang F-M, Ge S (2006) Plant biodiversity in China: richly varied, endangered, and in need of conservation. *Biodiversity and Conservation* 15: 3983–4026. doi: 10.1007/s10531-005-3015-2
- Matsumoto T, Itioka T, Yamane S, Momose K (2009) Traditional land use associated with swidden agriculture changes encounter rates of the top predator, the army ant, in Southeast Asian tropical rain forests. *Biodiversity and Conservation* 18: 3139–3151. doi: 10.1007/s10531-009-9632-4
- Mayr G (1866) Myrmecologische Beiträge. Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften in Wien, Mathematisch-Naturwissenschaftliche Classe, Abteilung I 53: 484–517. [In German]
- Schneirla TC, Reyes AY (1966) Raiding and related behaviour in two surface-adapted species of the Old World Doryline ant, *Aenictus*. *Animal Behavior* 14: 132–148. doi: 10.1016/S0003-3472(66)80022-2
- Shattuck SO (2008) Review of the ant genus *Aenictus* (Hymenoptera: Formicidae) in Australia with notes on *A. ceylonicus* (Mayr). *Zootaxa* 1926: 1–19.
- Shuckard WE (1840) Monograph of the Dorilydae, a family of the Hymenoptera Heterogyna [Continued from p. 201.]. *Annals of Natural History* 5: 258–271.
- Staab M (2014a) A new species of the *Aenictus wroughtonii* group (Hymenoptera, Formicidae) from South-East China. *ZooKeys* 391: 65–73. doi: 10.3897/zookeys.391.7213
- Staab M (2014b) The first observation of honeydew foraging in army ants since 1933: *Aenictus hodgsoni* Forel, 1901 tending *Eutrichosiphum heterotrichum* (Raychaudhuri, 1956) in Southeast China. *Asian Myrmecology* 6: 115–118.
- Staab M, Schuldt A, Assmann T, Bruelheide H, Klein A-M (2014) Ant community structure during forest succession in a subtropical forest in South-East China. *Acta Oecologica* 61: 32–40. doi: 10.1016/j.actao.2014.10.003
- Terayama M (1984) A new species of the army ant genus *Aenictus* from Taiwan. *Bulletin of the Biogeographical Society of Japan* 39: 13–16.
- Terayama M, Kubota S (1993) The army ant genus *Aenictus* (Hymenoptera: Formicidae) from Thailand and Vietnam, with descriptions of three new species. *Bulletin of the Biogeographical Society of Japan* 48: 68–72.
- Wang W (2006) A new species of the genus *Aenictus* Shuckard from China (Hymenoptera, Formicidae). *Acta Zootaxonomica Sinica* 31: 637–639. [In Chinese]
- Wilson EO (1964) The true army ants of the Indo-Australian area (Hymenoptera: Formicidae: Dorylinae). *Pacific Insects* 6: 427–483.
- Wiwatwitaya D, Jaitrong W (2011) The army ant *Aenictus hottai* (Hymenoptera: Formicidae: Aenictinae) and related species in Southeast Asia, with a description of a new species. *Sociobiology* 58: 557–565.
- Zhou SY (2001) *Ants of Guangxi*. Guangxi Normal University Press, Guilin, 255 pp. [in Chinese]

