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Authors: Schwendinger, Peter J., and Košulič, Ondřej

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## Two new species of armoured spiders from Vietnam and Cambodia (Araneae: Tetrablemmidae: Pacullinae)

Peter J. Schwendinger<sup>1</sup> & Ondřej Košulič<sup>2</sup>

<sup>1</sup> *Muséum d'histoire naturelle de la Ville de Genève, c.p. 6404, CH-1211 Genève 6, Switzerland.  
E-mail: peter.schwendinger@ville-ge.ch*

<sup>2</sup> *Department of Forest Protection and Wildlife Management, Faculty of Forestry and Wood Technology, Mendel University, Zemědělská 3, Brno, Czech Republic. E-mail: ondrej.kosulic@mendelu.cz*

**Abstract:** Two new species of paculline spiders are described on the basis of males and females: *Perania annam* sp. nov. from southern Vietnam and *Lamania bokor* sp. nov. from southern Cambodia. Both of them occur distinctly outside the previously known geographical range of each respective genus. The relationships of these species are discussed and morphological variation is illustrated. *Lamania kraui* (Shear, 1978), the closest known relative of *L. bokor* sp. nov., is re-defined on the basis of the types and of newly collected specimens from Peninsular Malaysia and Thailand. Vulva morphology in *Lamania* and scopulae in males of Tetrablemmidae are discussed.

**Keywords:** Taxonomy - *Perania* - *Lamania kraui* - variation - scopula - Thailand - Malaysia.

### INTRODUCTION

Soon after the publication of the latest revision of the genus *Perania* Thorell, 1890 (see Schwendinger, 2013) additional congeneric specimens from Vietnam were made available by Jiří Král at the Charles University in Prague. They belong to a new species and, more surprisingly, they were collected from far outside the previously known distribution area of the genus (southern China, eastern Myanmar, Thailand, peninsular Malaysia and Sumatra; Fig. 1, hatched areas). The second new species described here belongs to the same subfamily (Pacullinae; considered a family prior to Lehtinen, 1981) but to a different genus (*Lamania* Lehtinen, 1981), and it is equally remarkable with respect to biogeography. Specimens of this species were collected in Cambodia (the first specimen was found by the second author), which is even further away from the previously known distribution area of the genus than in the case of the new *Perania* species. *Lamania* species were known from Sulawesi, Borneo and Peninsular Malaysia; the MHNG also holds material of undescribed species from the Kai Islands, East Malaysia, Lingga Archipelago, Peninsular Malaysia and southern Thailand (Fig. 1, grey areas). The new finds presented here show that the geographical ranges of both genera extend much further east into mainland Southeast Asia than previously recognized.

The new *Perania* brings the total number of species in this genus to twenty-one; the new *Lamania* raises the species count to eight. Descriptions of many more paculline species (especially in the genera *Lamania* and *Paculla*) can be expected.

### MATERIAL AND METHODS

External morphology was studied and drawn with a Zeiss SV11 stereomicroscope, the vulvae (cleared in KOH and then temporarily placed in lactic acid for drawing) with a Nikon Optiphot compound microscope (both with a drawing tube). Body measurements were taken with a stereomicroscope and are given in millimetres. The total body length and the carapace length include the clypeal process, if present. The sternum length was measured between the midpoint of the anterior margin of the sternum and the posterior edge of the posterior sternal process, the sternum width between coxae II. Lengths of leg articles and palpal articles were measured on the dorsal side, from midpoint of anterior margin to midpoint of posterior margin (except for the bilobate palpal cymbium of males for which the maximal length is given), and are given in the following order: total (femur + patella + tibia + metatarsus + tarsus). The leg formula is from the shortest to the longest leg. In the legend of each

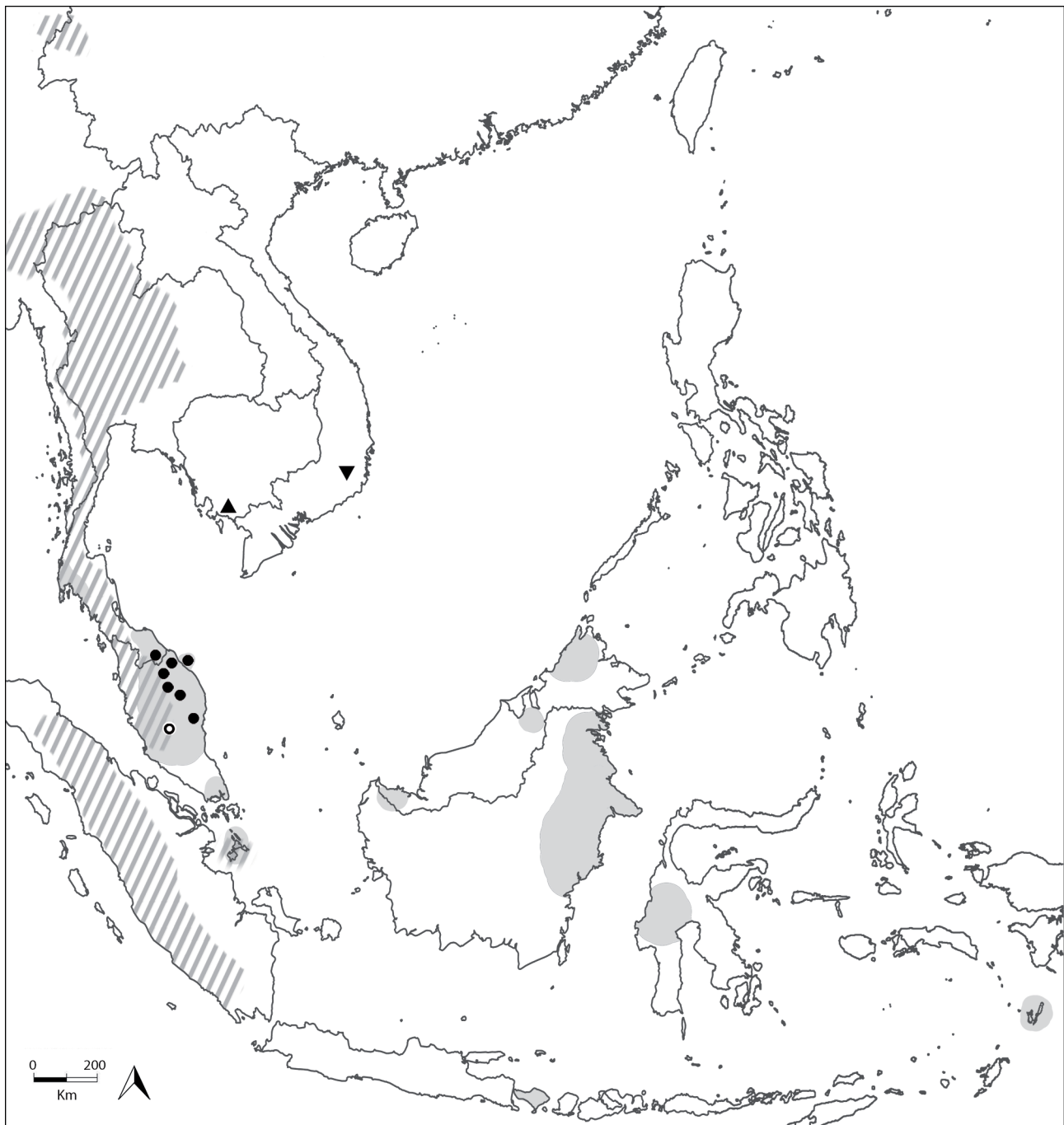


Fig. 1. Map of Southeast Asia showing localities of *Perania annam* sp. nov. (inverted triangle), *Lamania bokor* sp. nov. (triangle) and *L. kraui* Shear, 1978 (circles; empty circle indicates the type locality), and the currently known biogeographic range of the genera *Perania* (hatched areas) and *Lamania* (grey areas).

plate, references to figures that are to different scales are separated by semicolons.

The terminology follows that of Schwendinger (2013). As in *Perania* spp., the upper (dorsal) part of the bifid apex of the embolus of *Lamania* spp. is called the “subterminal lamella”, and the lower (ventral) part is called the “embolic part”.

The informal appellation “allotype” refers to the paratype on which the description of the female of each new species is based. The term “carapace” is used instead of “dorsal plate of prosoma” or “holopeltidium”. The terms “long/short”, “wide/narrow” and “deep/shallow” always relate to the longitudinal axis of the spider body, limb or palpal organ.

Setae on the palps of all species, and setae and tubercles on the carapaces of *Perania* are largely omitted in the line drawings.

Abbreviations not explained in the figure legends are: ALE = anterior lateral eyes; MHNG = Muséum d'histoire naturelle de la Ville de Genève, Switzerland; NMP = National Museum, Prague, Czech Republic; PME = posterior median eyes, PLE = posterior lateral eyes.

## TAXONOMY

### *Perania annam* sp. nov.

Figs 2-3, 8B

**Holotype:** MHNG; male; Vietnam, Lam Dong Province, Dalat; collector unknown, don. J. Král.

**Paratypes:** 1 male, 1 female (MHNG) and 1 male (NMP); same data as for holotype.

**Etymology:** “Annam” is the former name of southern Vietnam. Noun in apposition.

**Diagnosis:** The new species differs from all congeners by the presence of conically elevated hair bases on tibia II of males and on metatarsus II of females. Males

share with those of *P. egregia* Schwendinger, 2013 a very short cymbium (apex reduced) and a palpal organ with a thick embolus without marked transition between bulb and base of embolus; *P. annam* sp. nov. males are distinguished from *P. egregia* males by the apex of the clypeal process being spade-shaped (with broadly rounded distal margin) rather than anvil-shaped (with slightly rounded or straight distal margin), by having a slightly more pronounced cymbial apex, a subterminal lamella which is pointed instead of rounded, and a longer embolic part (Figs 3A-E cf. Schwendinger, 2013: figs 9-10). The female of the new species differs from females of *P. egregia* by retaining a small preanal plate; its spermathecae have inclined instead of horizontal posterior margins; the central sclerite (pe = posterior extension of anterior collar in Fig. 3F) in the dorsal wall of the vulva is much larger and thicker, with a widely rounded posterior margin (straight in *P. egregia*) (Fig. 3F-H cf. Schwendinger, 2013: fig. 10A-E).

**Description of male (holotype):** Colour (in alcohol) of sclerotised parts mostly dark brown, except for lighter patellae and tibiae I-II, patella to metatarsus III and patella to tarsus IV; membranous parts of opisthosoma very light brown. Clypeus with long, distally widened

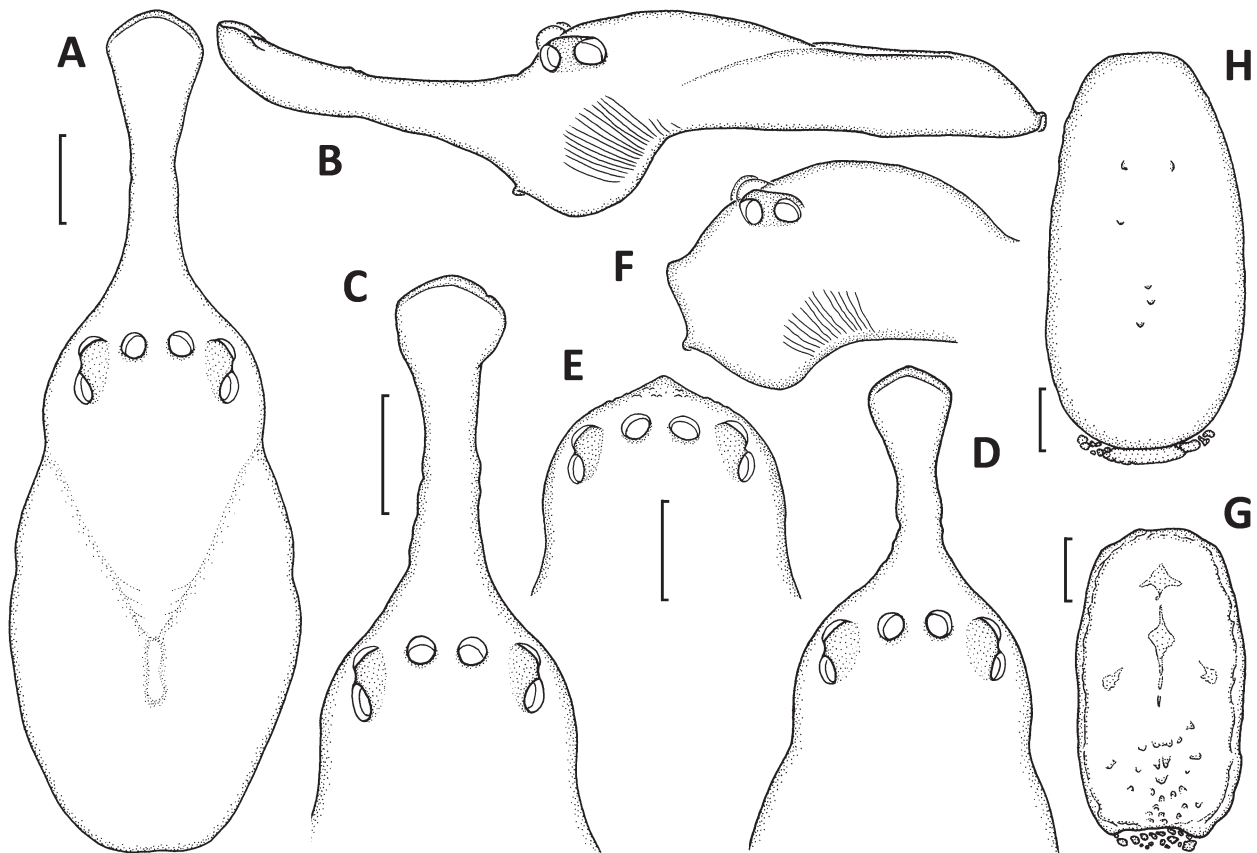


Fig. 2. *Perania annam* sp. nov., male holotype (A-B, H), male paratypes (C-D), female “allotype” (E-G). (A) Carapace, dorsal view. (B) Same, lateral view. (C-E) Anterior portion of carapace, dorsal view. (F) Same, lateral view. (G-H) Dorsal scutum of opisthosoma, dorsal view. Scale lines 1.0 mm (A-B; C-D; E-F; G-H).

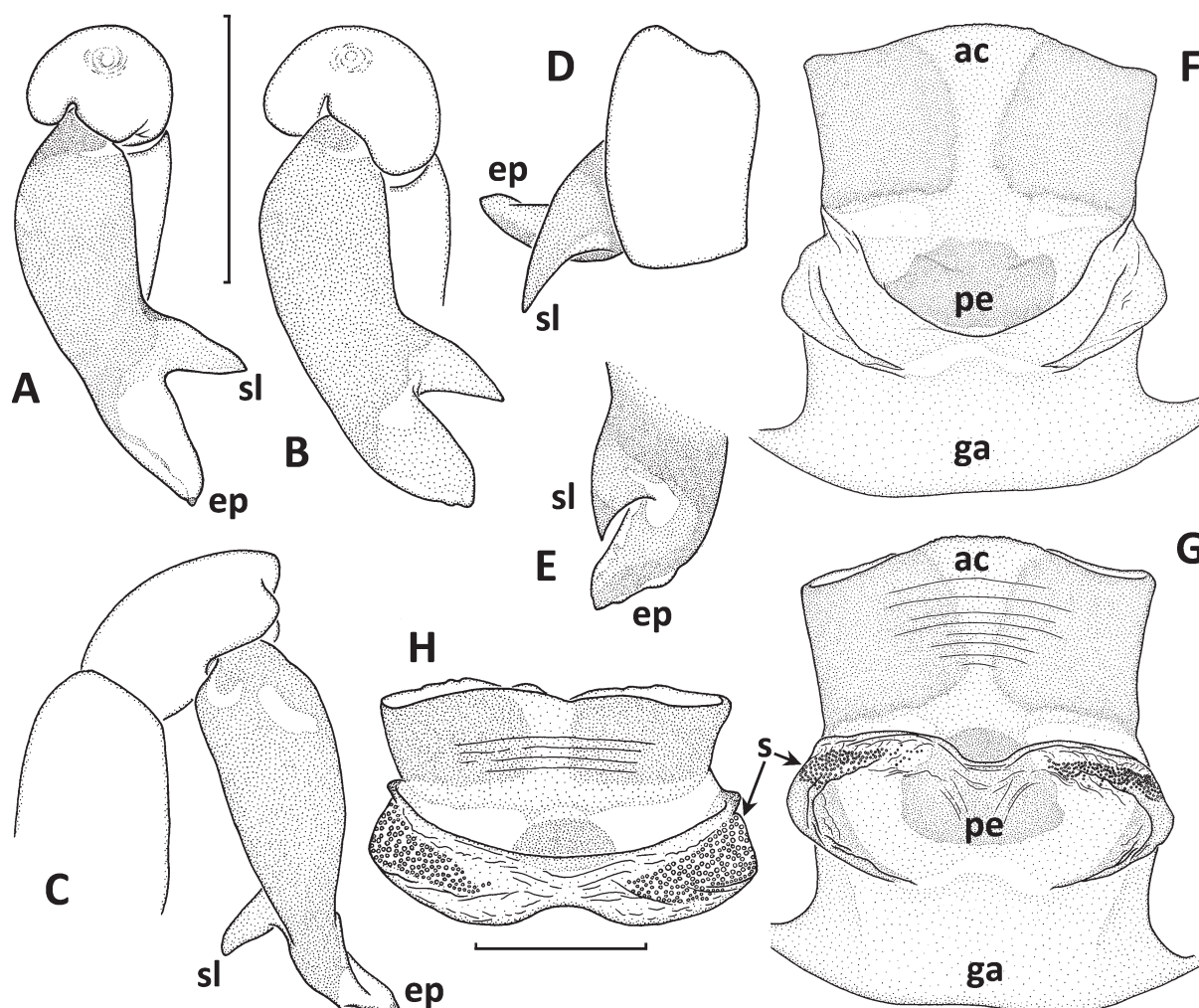


Fig. 3. *Perania annam* sp. nov., male paratype (A), male holotype (B-E), female allotype (F-H). (A-B) Distal portion of left palp, distal view. (C) Same, prolateral view. (D) Left cymbium and palpal organ, dorsal view. (E) Apex of embolus, retrolateral view. (F) Vulva, dorsal view. (G) Same, ventral view. (H) Same, anterior view. Abbreviations: ac = anterior collar; ep = embolic part; ga = genital atrium; pe = posterior extension of anterior collar; s = spermatheca with gland pores; sl = subterminal lamella. Scale lines 0.5 mm (F-H), 1.0 mm (A-E).

and flattened median process projecting forward and slightly upward, occupying 34% of carapace length, its distal margin broadly arched (Fig. 2A-B). Fovea indistinct and narrow, including two shallow pits (Fig. 2A). Total length 15.88. Carapace 8.73 long, 3.09 wide, its cephalic portion only slightly domed (Fig. 2B). Eye sizes and interdistances: PME 0.28 long, separated by 0.24; ALE 0.28 long; ALE-PLE 0.15; PLE 0.37 long, separated by 1.42. Labium 0.98 long, 1.27 wide. Sternum 3.53 long, 2.25 wide; sternal apophysis anvil-shaped. Chelicerae without modifications; two small teeth distal to median lamina.

Palp 5.42 long (1.67+0.71+2.16+0.88). Cymbium (Fig. 3D) short, with indistinct retrorodorsal lobe (apex). Palpal organ (Fig. 3B-E) strongly modified: bulbus and base of embolus of same thickness, without constriction between them; apex of embolus compressed and deeply

split into a triangular, acutely pointed subterminal lamella and a longer and basally wider embolic part with a small, narrowly rounded tip.

Legs 3421. About 50 dark conical setal bases of various sizes prolaterally to ventrally on metatarsus I, about 30 shorter ones proventrally on tibia I; about 25 ones on metatarsus II and six on tibia II. All leg femora ventrally rugose (with wart-like hair bases); palpal femur essentially smooth. Paired leg claws with a row of 11-13 teeth on anterior legs, 8-9 on posteriors; unpaired leg claws with one denticle. Leg I 22.54 long (6.96+2.45+6.76+4.61+1.76), leg II 17.90 long (5.25+1.96+5.10+4.02+1.57), leg III 13.43 long (4.02+1.47+3.43+3.24+1.27), leg IV 16.62 long (5.00+1.57+4.51+4.22+1.32).

Opisthosoma 7.16 long, 3.92 wide. Dorsal scutum (Fig. 2H) exceptionally narrow, 5.88 long, 2.99 wide, somewhat oval, quite smooth, its surface with only few



indistinct elevations. Most lateral microplates flat, only a posterolateral one on each side of second band from above slightly elevated. Most microplates in bands on posterior side of opisthosoma closely packed, those in uppermost band largely fused into strap-like plate (Fig. 2H). Pulmonary plate 4.02 long, 3.33 wide; genital region flat. Anterior pair of ventrolateral plates largely free, only their posterior tips fused with margin of pulmonary plate. Postgenital plate 0.29 long, completely fused to posterior margin of pulmonary plate, both linked by a sclerotised suture. Preanal plate well developed, 0.78 long, 1.27 wide. Anal plate 1.23 long, 1.62 wide.

**Description of female:** As in male, except for the following. Total length 12.94. Carapace 5.29 long, 3.04 wide; cephalic portion more strongly domed than in male, with a short but distinct conical hump on clypeus occupying about 4% of carapace length (Fig. 2E-F). PME 0.34 long, 0.21 apart; ALE 0.30 long; ALE-PLE 0.10; PLE 0.30 long, 1.57 apart. Fovea indistinct, with only one shallow pit. Labium 0.98 long, 1.76 wide. Sternum 3.04 long, 2.11 wide. Palp 4.26 long (1.27+0.59+0.98+1.42). Legs 3421; metatarsus I with about 25 conical setal bases of different sizes prolaterally and proventrally, tibia I with seven quite small ones prolaterally, metatarsus II with six very small ones prolaterally and proventrally; all conical setal bases weaker than those in males. Paired leg claws with a row of 9-14 teeth. Leg I about 17.5 long [5.20+1.82+5.10+3.73+1.7?(distal half missing)], leg II 14.80 long (4.31+1.62+4.12+3.28+1.47), leg III 11.32 long (3.28+1.27+2.84+2.75+1.18), leg IV 14.07 long (4.07+1.37+3.82+3.58+1.23).

Opisthosoma 7.65 long, 4.41 wide; several microplates in posterior half larger than others, slightly elevated and conical; microplates on posterior side of opisthosoma not forming strap-like horizontal plates. Dorsal scutum (Fig. 2G) 4.51 long, 2.55 wide, its anterior margin relatively wider and its surface with more pronounced elevations than in males. Anterior opisthosomal plate completely fragmented into microplates (nine of them slightly larger than others). Pulmonary plate 3.24 long, 3.04 wide. Preanal plate small, spindle-shaped, 0.15 long, 0.69 wide. Anal plate 1.23 long, 1.57 wide.

Vulva (Fig. 3F-H) with very long anterior collar, median zone of its dorsal and ventral walls distinctly lighter than lateral zones, posteriorly extended into a large and thick sclerite; transition between anterior collar and its posterior extensions weakly sclerotised and weakly pigmented, posterior margin of extension in dorsal wall widely rounded. Spermathecae and ventral wall of genital atrium lightly and uniformly pigmented, with a transparent zone between them. Spermathecae elliptical, with a distinct and wide median invagination in common anterior margin and with inclined posterior margins; anterolateral sides with relatively small porepatches on flat surface.

**Variation:** Carapace length in three males (one female) ranges 6.57-8.73 (5.29), carapace width 2.75-3.09 (3.04). In two males (including the holotype) the cleft between the subterminal lamella and the embolic part of the palpal organ is acute at its base (Fig. 3B), in the third male it is narrowly rounded (Fig. 3A). The number of conical hair bases on tibia II of males ranges 3-6. Variation in the shape of clypeus modifications of males see Fig. 2A, C-D. All three males have most microplates in the uppermost band on the posterior side of the opisthosoma fused; one of them (a paratype) also has fused microplates in the second band from above. In all males the postgenital plate is relatively long (in comparison with males of other *Perania* spp.) and completely fused to the pulmonary plate.

**Remarks:** When we received the specimens, they all had their opisthosomata detached, widely cut open and the gonads removed for an examination of the chromosomes. This may have caused some minor deformation of the dorsal plates which may make them look slightly narrower than on intact specimens. The holotype has all legs of the left side missing, the allotype all legs on the right side. The only available female (the allotype) has its only remaining tarsus I incomplete. Since its tarsi II-IV are each one millimetre shorter than those of the male holotype, we assume that this is also the case in tarsus I. This puts its length at 1.7 mm, and the entire length of leg I at 17.5 mm.

**Relationships:** Males of *P. annam* sp. nov. and *P. utara* Schwendinger, 2013 (from Sumatra) share the conspicuous presence of conical setal bases on metatarsus II (not present in males of other congeners), but this is certainly a homoplasy. The strongly apomorphic palps of *P. annam* sp. nov. and *P. egregia* are phylogenetically much more informative than non-genital characters and clearly show that these two species are very closely related. This is also reflected in the female copulatory organs: the dorsal and ventral wall of their anterior collar each has a posterior extension that ends in a more or less pronounced sclerite, the ventral one partly covering the entrance to the spermathecae. Such structures were not observed in other congeners. *Perania egregia* occurs at the northeastern periphery of the previously known range of the genus and thus is – together with *P. quadrifurcata* Schwendinger, 2013, found a bit further south (see Schwendinger, 2013: fig. 1) – the geographically closest conspecific species of *P. annam* sp. nov.

**Distribution:** This species is known only from Dalat (= Da Lat; exact locality unknown; approximately 11°57'N, 108°26'E), situated in the southern part of the Central Highlands of Vietnam, at about 1500 m altitude (Fig. 1, inverted triangle). Further *Perania* species can be expected to occur in Vietnam, Cambodia and Laos.

***Lamania bokor* sp. nov.**

Figs 4-5

**Holotype:** MHNG (sample THKH-13/06); male; Cambodia, Kampot Province, Phnom (= Mount) Bokor, Popokvil Waterfall (10°39'34"N, 104°03'05"E), 910 m; 24.XII.2013; leg. P. Schwendinger.

**Paratypes:** 1 male, 6 females (MHNG) collected together with the holotype. – 1 female (NMP), Phnom Bokor (10°37'42"N, 104°05'36"E), 700 m; 14.XI.2012; leg. O. Košulič.

**Etymology:** Named after the mountain on which the types were found. Noun in apposition.

**Diagnosis:** The new species differs from *L. kraui* Shear, 1978 by larger size [carapace length and width in *L. bokor* sp. nov. 1.95-2.09 and 1.54-1.67 (n=9), in *L. kraui* 1.37-1.61 and 1.09-1.28 (n=22)] and by the cephalic part of the carapace being posteriorly more strongly elevated in both sexes (Fig. 4B cf. Fig. 6A). Embolus of palpal organ with quadrangular (instead of triangular) subterminal lamella and with narrower, scale-like (instead of wide and truncate) embolic part (Fig. 4D-H cf. Fig. 6E-H). Vulva not clearly distinguishable from that of *L. kraui* (Fig. 5 cf. Fig. 7; see also "Taxonomic remarks").

**Description of male (holotype):** Colour (in alcohol) of sclerotised parts mostly dark brown, except for slightly lighter leg patellae and apical portions of leg femora and tibiae, and distinctly lighter basal (bulbous) part of palpal organ; membranous parts of opisthosoma light brown. Clypeus and thoracic part of carapace without modifications, cephalic part of carapace clearly highest in its posterior portion (Fig. 4B). Carapace with numerous elevated setal bases; fovea not discernible (Fig. 4A). Total length 4.46. Carapace 1.98 long, 1.58 wide. Eye sizes and interdistances: PME 0.15 long, separated by 0.08; ALE 0.15 long; ALE-PLE 0.03; PLE 0.13 long, separated by 0.76. Labium 0.47 long, 0.65 wide. Sternum 1.13 long, 1.10 wide; sternal apophysis a small rounded knob carrying strongly conical setal bases. Chelicerae without modifications; two indistinct teeth distal to median lamina.

Palp 1.96 long (0.66+0.35+0.57+0.38). Cymbium (Fig. 4D) short, its apex with two distinct lobes of similar size. Tibia with low, wide proventral process (Fig. 4D); its ventral side with smooth and plane surface (zone of contact with palpal organ, Fig. 4E-F). Palpal organ with large, globular base; embolus short and bifid, its proximal portion with a low boss on anterior side (Fig. 4F, H), its apical portion divided into a quadrangular subterminal lamella with pointed, slightly outward-bent dorsodistal corner, and into a relatively narrow (about as wide as subterminal lamella at base) scale-like embolic part (Fig. 4D-H).

Legs 3241. No conical setal bases present on tibiae

and metatarsi of anterior legs; all articles of legs and palps with essentially smooth surface (apart from pit-like setal bases). Leg I with thin but distinct ventral scopula of short, sigmoid serrate setae spread over almost entire length of tarsus and over distal two-thirds of metatarsus (see paragraph "Scopulae in Tetrablemmidae"); other legs without scopula. Paired leg claws with a row of 11-12 teeth on anterior legs, 8-9 on posteriors; unpaired leg claws with one denticle. Leg I 7.37 long (2.27+0.66+2.08+1.51+0.85), leg II 6.29 long (1.92+0.63+1.64+1.34+0.76), leg III 5.41 long (1.61+0.60+1.31+1.23+0.66), leg IV 7.14 long (2.17+0.63+1.92+1.73+0.69).

Opisthosoma 3.02 long, 2.17 wide. Dorsal scutum large, 2.90 long, 2.17 wide, mostly smooth except for numerous pit-like setal bases and several indistinctly raised mounds (pair near posterior margin being largest). Microplates on anterior side strongly conical, all others flat (Fig. 4B). Three strap-like lateral plates (lower one longest, median one shortest) and three strap-like posterior plates (upper one longest, lower one shortest). Pulmonary plate 2.14 long, 1.58 wide, completely fused with stigmal plates, with anterior pair of ventrolateral plates and with postgenital plate (linked by a sclerotised suture); posterior part evenly covered with wart-like setal bases, booklung covers smooth, anterior part carrying several distinct conical setal bases, including three (on right side) and four (on left side) large ones [corresponding to "large, black, seta-bearing teeth" in *L. kraui* (see Shear, 1978: 43, fig. 116 and Fig. 6B)] above booklung covers (Fig. 4C, minor conical setal bases omitted); genital region elevated to a low volcano-shaped mound with the genital orifice in its centre. Median ventrolateral plates separated, with a single very short but wide bridge fragment between them (see Schwendinger, 2013: 657, 659, fig. 36A-D for explanation). Preanal plate 0.30 long, 0.76 wide, fused with posterior ventrolateral plates (discernible by darker colour and different surface texture). Anal plate 0.28 long, 0.74 wide.

**Description of female (allotype):** As in male, except for the following. Colour (in alcohol) slightly darker than in male holotype, membranous parts of opisthosoma yellowish brown. Total length 4.55. Carapace 1.94 long, 1.59 wide. Eye sizes and interdistances: PME 0.14 long, separated by 0.10; ALE 0.15 long; ALE-PLE 0.03; PLE 0.14 long, separated by 0.80. Labium 0.44 long, 0.66 wide. Sternum 1.20 long, 1.10 wide.

Palp 1.83 long (0.52+0.25+0.38+0.68), without claw. Legs 3214. Leg I without scopula. Paired leg claws with a row of 13-14 teeth on anterior legs, eight on posteriors. Leg I 7.08 long (2.17+0.63+1.95+1.48+0.85), leg II 6.12 long (1.86+0.60+1.58+1.32+0.76), leg III 5.22 long (1.58+0.57+1.23+1.18+0.66), leg IV 7.11 long (2.16+0.63+1.89+1.72+0.71).

Opisthosoma 3.12 long, 2.17 wide. Dorsal scutum 2.77

long, 1.73 wide, distinctly more rugous than in males, pits and elevations more pronounced. Microplates on anterior side smaller and less strongly elevated than in males. Four strap-like lateral plates (uppermost and lowermost longest, second from below shortest) and three strap-like posterior plates. Pulmonary plate 1.89 long, 1.48 wide, not fused with postgenital plate; genital region essentially flat, posterior edge elevated above postgenital plate. Postgenital plate 0.19 long, 0.71 wide. Two bridge fragments lying between pair of median ventrolateral plates. Preanal plate 0.36 long, 0.71 wide. Anal plate 0.28 long, 0.66 wide.

Vulva (Fig. 5 showing five paratypes) with short, wide genital atrium with relatively large porepatches on lateral sides and with a largely transparent (except for base and lateral margins), flattened anterior collar.

**Taxonomic remarks:** The vulva of *L. bokor* sp. nov. is very similar to that of *L. kraui*, and at present a clear distinction cannot be made. Nevertheless two differences were observed which may or may not be consistent and of diagnostic value: 1. The cuticular bases of the gland ducts that stick out of the pores of the porepatches are evenly tapering in *L. bokor* sp. nov., whereas in *L. kraui* they are shaped like papillae, basally wide and abruptly tapering to a tiny pointed tip. 2. In the *L. bokor* sp. nov. vulvae examined the anteromedian wall (roof) of the genital atrium (between the spermathecae and below the anterior collar) in dorsal view is more distinctly arched anteriorly than in *L. kraui*.

**Variation:** Carapace length in two males (seven females) ranges 1.95-1.98 (1.94-2.09), carapace width

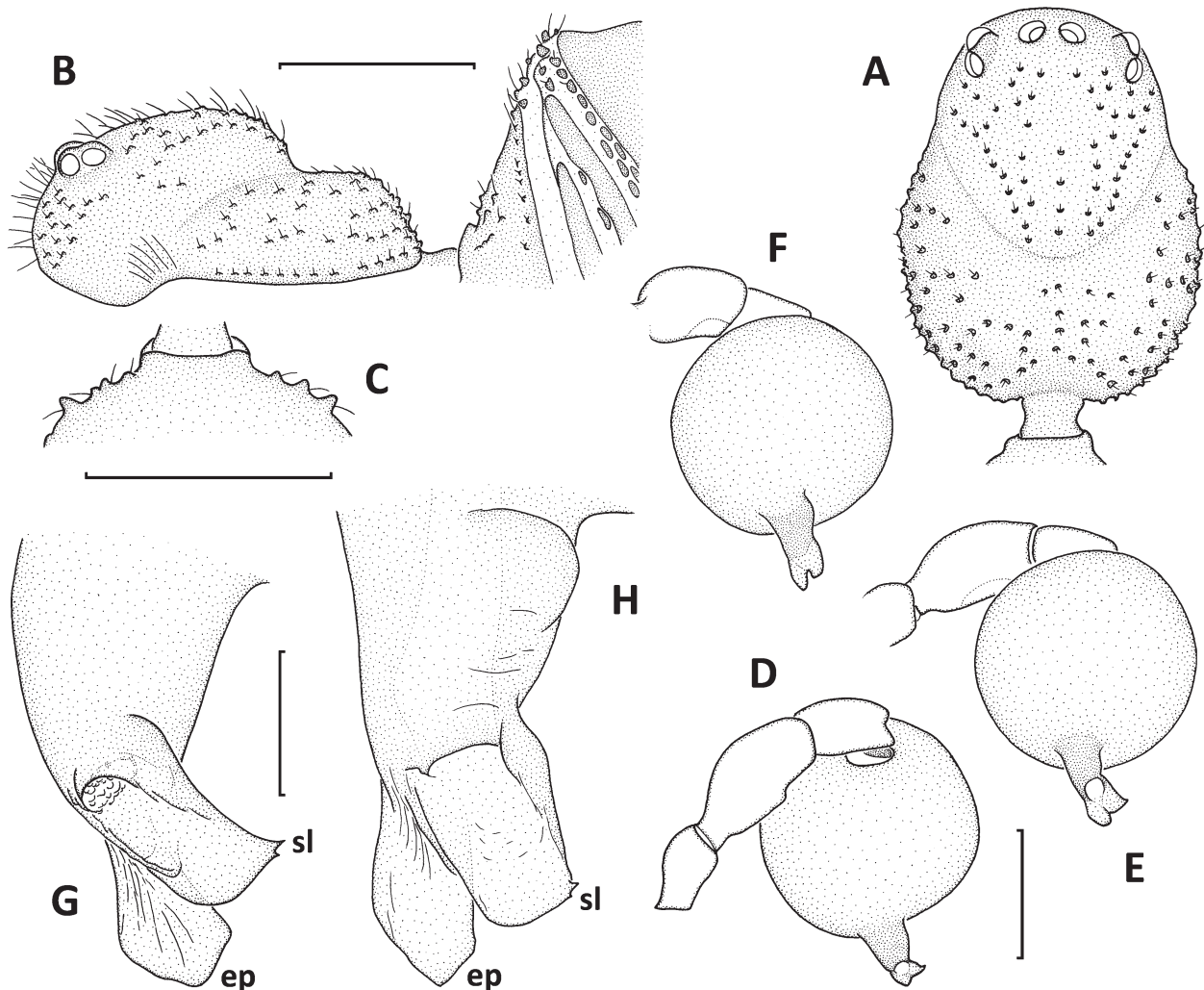


Fig. 4. *Lamania bokor* sp. nov., male holotype. (A) Carapace, dorsal view. (B) Same, plus anterior part of opisthosoma showing conical setal bases, lateral view. (C) Anterodorsal side of pulmonary plate showing enlarged conical setal bases above booklung covers (other setal bases omitted), dorsal view. (D) Distal portion of left palp, prodorsal view. (E) Same, proventral view. (F) Same, proventral and slightly posterior view. (G) Apex of left embolus, proventral view. (H) Same, prolateral and slightly posterior view. Abbreviations: ep = embolic part; sl = subterminal lamella. Scale lines 0.1 mm (G-H), 0.5 mm (D-F), 1.0 mm (A-B; C).



1.54-1.58 (1.56-1.67). Both males and one female have only one bridge fragment between both median ventrolateral plates, five females have two, in the remaining female this is not visible due to a shrunken opisthosoma. The number of enlarged conical setal bases above the booklung covers ranges 3-5. Variation in the shape of the vulva of five females is shown in Fig. 5A-E.

**Relationships:** The new species is most similar (with respect to shape of carapace and of palpal organ) and probably most closely related to an undescribed species from southern Thailand (Phang Nga Province), which is also geographically the closest congeneric species to *L. bokor* sp. nov. available at present. The localities of both species are separated by about 1200 km on the land route and by over 600 km in a direct line across the Gulf of Thailand. The latter route may have been open to spiders in periods of lowered sea levels during the Cenozoic, but it is quite unlikely that the habitats there were suitable for colonization by *Lamania*. Extant

*Lamania* spp. have only been found on the floor of humid evergreen broadleaf forests. Despite intensive sifting of leaf litter in evergreen forests of other parts of Thailand, no *Lamania* (or *Paculla*) have been found there.

**Distribution and habitat:** This species is only known from two localities (separated by about 7 km) on Mount Bokor, at the southern end of the Elephant Mountains, near the coast of Cambodia (Fig. 1, triangle). The specimens examined were sifted from leaf litter and collected from inside pieces of decaying wood on the floor of evergreen forests between about 700 m and 900 m.

***Lamania kraui* (Shear, 1978)**

Figs 6-7, 8A, C-E, J

*Paculla kraui* Shear, 1978: 41-43, figs 112-120 (description of female and male). – Bourne, 1980a: fig. 26 (palp of male paratype redrawn from Shear, 1978: fig. 118).

*Lamania kraui* (Shear, 1978). – Lehtinen, 1981: 21 (transfer).

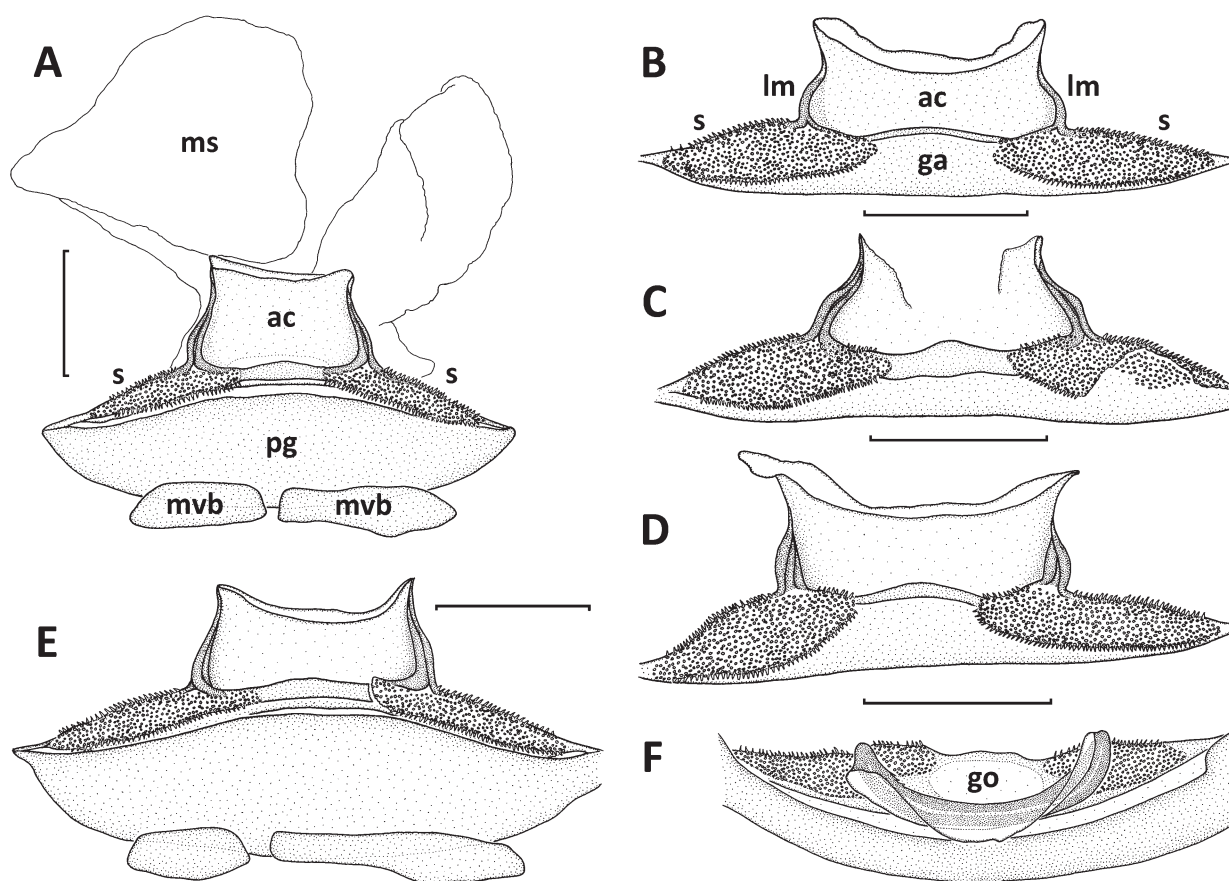


Fig. 5. *Lamania bokor* sp. nov., vulvae of five female paratypes, dorsal view (A-E) and anterior view (F). (A) Entire vulva with membranous sacs, postgenital plate and bridge fragments of median ventrolateral plates. (E) Same, without membranous sacs. (B-F) Vulva without membranous sacs (anterior margins of anterior collar and dorsal wall of right porepatch ruptured in C; roof of genital atrium broken in E). Abbreviations: ac = anterior collar; ga = genital atrium; go = genital orifice; lm = lateral margin of anterior collar; ms = membranous sac; mvp = bridge fragment of median ventrolateral plate; pg = postgenital plate; s = spermatheca with membranous bases of gland ducts sticking out of pores. Scale lines 0.2 mm.

**Material examined:** PENINSULAR MALAYSIA: MCZ 21760 (lot 3452); female holotype; Pahang, Temerloh District, Krau Game Reserve, 30.VI.1973, leg. J. Feagle. – MCZ 25049 (lot 3452); male paratype; same data as for holotype. – MHNG (sample SIM-01/12); 7 males, 6 females, 1 juvenile; Pahang, Bukit Charas, about 3 km north of Panching, 3°54'41.1"N, 103°08'50.2"E, 60 m (evergreen forest on limestone); 9./10.VII.2001; leg. P. Schwendinger. – MHNG (sample MAL-04/08); 4 males, 1 female; Pahang, Bukit

Charas, 60 m (rain forest remnants at foot of limestone hill); 3./4.VI.2004; leg. P. Schwendinger. – MHNG (sample WM93-1a); 2 females; Pahang, Taman Negara, Tembeling Trail, 90-120 m, forêt primaire (tamisage); 10./13.III.1993; leg. I. Löbl & F. Calame. – MHNG (sample WM93-2a); 2 males, 2 females; Pahang, Taman Negara, Gunung Tahan Trail, 90-130 m, forêt primaire (tamisage dans un ravin); 11.III.1993; leg. I. Löbl & F. Calame. – MHNG (sample MAL-04/13); 26 males, 14 females, 3 juveniles; Kelantan, 1 km south of Gua

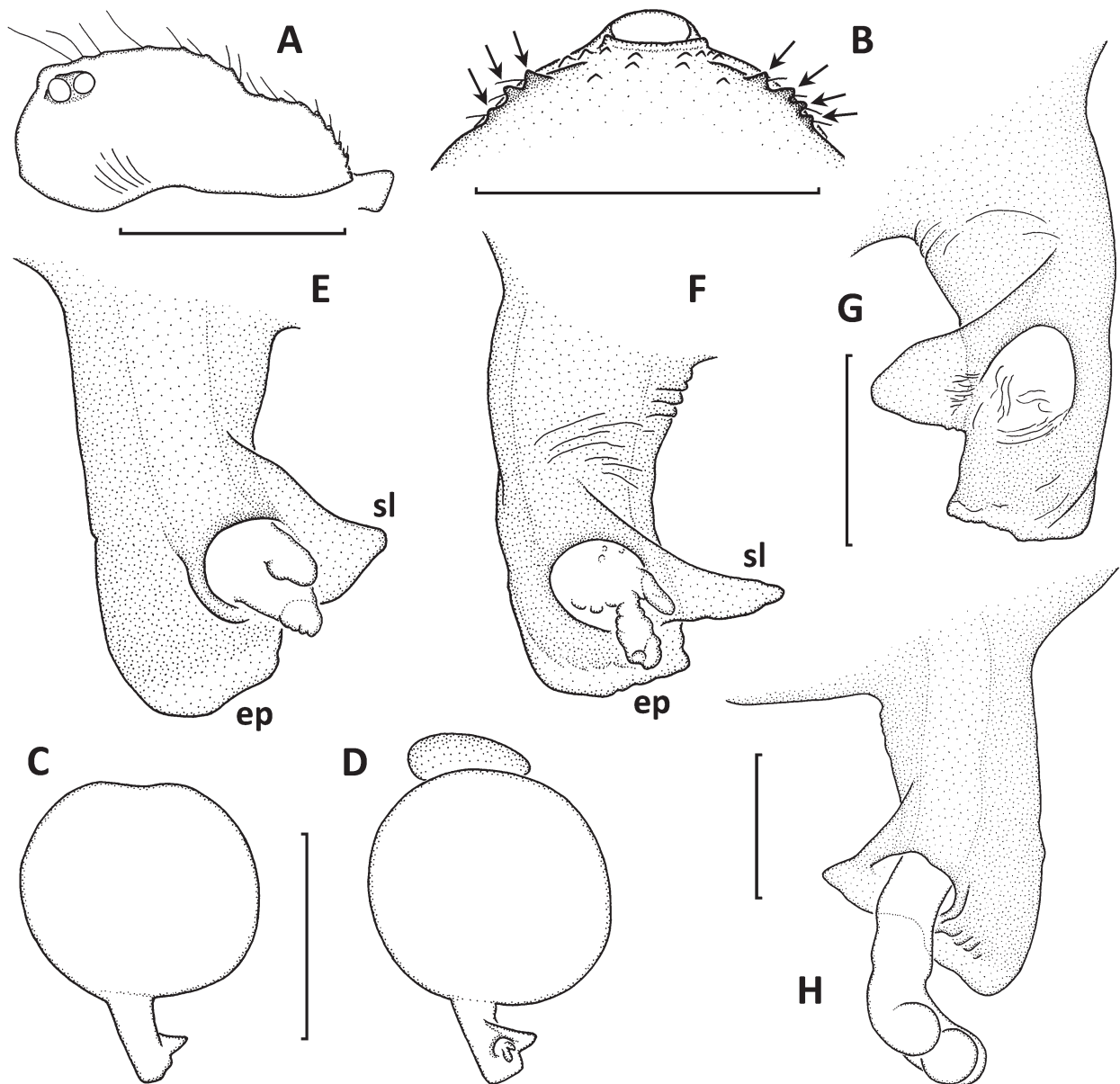


Fig. 6. *Lamania kraui* Shear, 1978, male paratype (A-G) and male from Gua Musang (H). (A) Carapace, lateral view. (B) Anterodorsal side of pulmonary plate showing enlarged conical hair bases (those above booklung covers indicated by arrows). (C) Right palpal organ, retrolateral view. (D) Left palpal organ, prolateral and slightly distal view. (E) Left embolus, prolateral and slightly ventral view. (F) Same, prolateral and slightly more dorsal view. (G) Right embolus, prolateral and slightly distal view. (H) Right embolus, prolateral and slightly ventral view. Abbreviations: ep = embolic part; sl = subterminal lamella. Scale lines 0.1 mm (E-G; H), 0.5 mm (C-D), 1.0 mm (A; B).

Musang railway station, 4°52'31.3"N, 101°58'06.5"E, 120 m (rain forest remnants at foot of limestone hill); 13./14.VI.2004; leg. P. Schwendinger. – MHNG (sample MAL-04/11); 3 males, 7 females, 2 juveniles; Kelantan, 8 km southwest of Dabong, Gunung Stong, 5°20'22.5"N, 101°58'15.2"E, 200 m (rain forest near stream); 10.VI.2004; leg. P. Schwendinger. – MHNG; 13 males, 15 females, 1 juvenile; Kelantan, about 30 km south of Kota Bharu, 8 km west of Kampung Padang Pak Amat, Jeram Pasu Waterfall, 100 m, rain forest; 10./11.I.1999; leg. P. Schwendinger. – MHNG (sample THMA-08/01); 27 males, 32 females, 2 juveniles; Terengganu, Pulau Perhentian Besar, trail across island, from Teluk Pauh to Teluk Dalam, 5°53'51"N, 102°44'53"E, 50-100 m, rain forest; 2.-4.VI.2008; leg. P. Schwendinger. – THAILAND: MHNG; 4 males, 7 females; Narathiwat Province, Waeng District, Hala-Bala Wildlife Sanctuary, 200 m, rain forest; 8.I.1999; leg. P. Schwendinger.

**Taxonomic remarks:** When comparing specimens of *L. bokor* sp. nov. with the types of *L. kraui*, we found that the original description of the latter species is incomplete, incorrect and misleading in the following points. Two “large, black, setae-bearing teeth” (= conical setal bases; thickness of setae much exaggerated in Shear, 1978: fig. 116) are present on both sides of the pulmonary plate above the booklung covers in the female holotype (and in only few other conspecific

specimens), whereas the male paratype has three (on its left side) and four (on its right side; Fig. 6B) slightly smaller such tubercles at the same place (not mentioned in the original description). The number of these tubercles in *L. kraui* specimens examined ranges from one to four, most specimens have three, many specimens have an unequal number of such tubercles on both sides. With regards to this presumably apomorphic character, *L. kraui* does not differ from *L. bokor* sp. nov., which is an indication that both species are closely related (belong to the same lineage). The bulbous base of the palpal organ is not as distinctly flattened on its frontal side as shown in Shear (1978: fig. 118), it is in fact a quite regular globe (Fig. 6C-D). There are some proximal wrinkles (Fig. 6F-G) on the anterior side of the embolus, which can be indistinct, small (in the paratype) or large and bulging, giving the impression of a hump (as in the two males of *L. bokor* sp. nov. examined). The embolus does not have a narrow subterminal lamella that is narrowest at its base as illustrated by Shear (1978: fig. 118), in fact it is widest at its base (Fig. 6C-H). A dark, somewhat crescent-shaped area along the posterior margin of the distal half of the embolus (Shear, 1978: fig. 118) is not (or no longer) discernible on both palps of the paratype, nor on those of other conspecific males examined. The distal margin of the embolic part is not as distinctly jagged as shown for the left palpal organ of the paratype by Shear (1978: fig. 118); it is essentially straight, or with a very

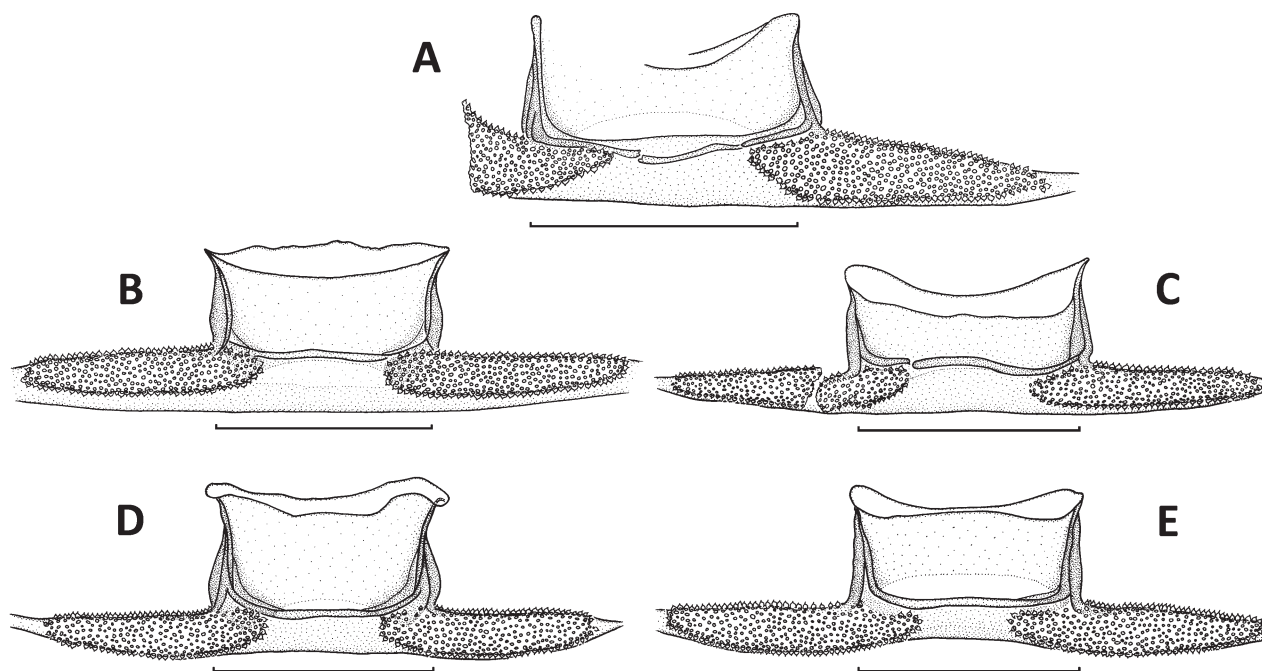


Fig. 7. *Lamania kraui* Shear, 1978, vulvae of five females, dorsal view. (A) Holotype (vulva detached from pulmonary plate, left side broken, roof of genital atrium broken, anterior margins of anterior collar ruptured or indiscernible). (B) Female from Charas Hill. (C) Female from Taman Negara (atrial roof and left porepatch broken). (D) Female from Gua Musang. (E) Female from Hala-Bala. Scale lines 0.2 mm.

wide angle in the middle (Fig. 6C-H). The two small medio-apical teeth shown there by Shear are in fact two peg-like columns (or the split tip of an otherwise cylindrical column) of coagulated sperm pushed out of the opening of the spermatophore (Fig. 6E-F), and thus they are not part of the embolus per se. These columns are not present on the right palp<sup>1</sup> of the same specimen (Fig. 6G). On the palps of a few other conspecific males we found a single cylindrical column (as wide as the diameter of the spermatophore opening) of coagulated sperm which resembles a vermicelli noodle pressed out of the pore of a sieve (Fig. 6H). This was presumably also present on the left palp of the paratype before the larger part of the “noodle” broke off. The original illustration of the holotype vulva (Shear, 1978: fig. 120) does not show the two large spermathecae (Fig. 7A) and it does not show the second distal margin of the anterior collar (Fig. 7A; see Discussion) which would explain that this structure (which is not the entire vulva but only part of it) is not an “open sclerotised tube” as described by Shear (1978: 43).

**Variation:** Carapace length in ten males (plus the male paratype, in parentheses) ranges 1.37-1.53 (1.43), in ten females (plus the holotype, in parentheses) 1.46-1.61 (1.57). Carapace width in males ranges 1.09-1.20 (1.14), in females 1.11-1.28 (1.20). Variation in the shape of the vulva of five females from different localities is shown in Fig. 7.

**Distribution:** This species is widely distributed in the central part of Peninsular Malaysia and northwards to, and across, the Thai border. It also occurs on Perhentian Island off the northeastern corner of Malaysia (Fig. 1, circles). Closely related (same lineage, with enlarged setal bases on anterior side of pulmonary plate and with both apical parts of embolus being equally long), undescribed *Lamania* species are present to the north of its range. Undescribed species, which are not closely related (different lineage without enlarged setal bases on anterior side of pulmonary plate and with unequally long apical parts of embolus), occur to the south and

to the east of the range of *L. kraui*. All other Pacullini specimens in the MHNG collection from the southern and western parts of Peninsular Malaysia belong to the genus *Paculla*.

## DISCUSSION

### Vulvae in *Lamania*

At first glance the vulvae of *Lamania bokor* sp. nov. and *L. kraui* look very different from those of *Perania* spp., but at closer examination similarities in their structure become obvious. Both genera have a wide, undivided genital orifice and atrium [according to Lehtinen (1981: 18) the genital orifice in *Paculla* spp. is paired, divided by a septum], which in the two *Lamania* spp. examined is much shorter than in most *Perania* spp. On each of the lateral sides of the genital atrium of *Lamania* there is an area perforated with gland pores (clearly visible by membranous bases of gland ducts sticking out of the pores; not observed in *Perania* spp.), which extends over the anterior wall (roof of the genital atrium) and equally far backward over most of the anterior and posterior walls [Fig. 5C (dorsal wall of right porepatch ruptured, exposing ventral wall behind), F]. As these are the only parts of the *Lamania* vulva into which glands empty, they must be considered as the spermathecae. They are paired and roughly at the same position as in *Perania*, but more widely separated from each other. Anteriorly between both spermathecae extends a structure which Shear (1978: 43) called an “open sclerotised tube”. At close inspection this proves to be a closed, flattened collar, much like the anterior collar of the *Perania* vulva and probably homologous, but much less sclerotised and unpigmented apart from its base (only visible in anterior view, Fig. 5F) and its sharply bent lateral margins which resemble flagposts in dorsal view (Figs 5, 7). The similarity with the leathery anterior collar of *Perania* is not immediately evident, because the largely transparent dorsal and ventral walls of the anterior collar of *Lamania* lie close to each other and both are bent ventrad against the inside surface of the pulmonary plate (Fig. 5F).

The paired membranous sacs anterior to the genital atrium and anterior collar of *Lamania* are delicate (easily destroyed during preparation) and completely transparent (Fig. 5A). Their function is unclear, as is their connection with the vulva proper. Since there is no evidence for glands emptying into these sacs, it is questionable if they function as sperm-storing organs as suggested by Shear (1978: 39, 43) and Lehtinen (1981: 17). Within the Tetrablemmidae such membranous sacs associated with vulvae are also found in *Paculla* (see Bourne, 1981: fig. 10) and Tetrablemmiinae (see e.g., Lehtinen, 1981: figs 32-37; Burger, 2008: figs 11, 25), but not in *Perania* and apparently also not in *Sabahya*.

Apparently not all *Lamania* vulvae are composed of the same elements as in the species treated here. *Lamania*

<sup>1</sup> Another species described in the same paper and presumably based on an atypical specimen is *Singaporemma singularis* Shear, 1978. The embolus of the male holotype (the only male then available) is said – and illustrated – to be “curving sharply posteriorly” (Shear, 1978: 39, figs 109-110), i.e. being bent at right angles at about mid-length. The MHNG houses five *Singaporemma* males from three localities on Singapore Island, one of them (the McRitchie Reservoir) being the type locality of *S. singularis* (the others are the Botanical Gardens and the Singapore Island Country Club, both close to the type locality). All these males have essentially straight emboli (only slightly bent ventrad) on both palps. Therefore we assume that Shear described a deformed embolus. An examination of the other palp of the holotype is desirable.



*bernhardi* (Deeleman-Reinhold, 1980) from eastern Borneo seems to lack porepatches (see Deeleman-Reinhold, 1980: fig. 6 and Lehtinen, 1981: fig. 23 – both illustrations remarkably dissimilar), and no pores were found in conspecific females (in MHNG) from the Sungai Wain Protected Forest and Bukit Bangkirai (near the type locality). We still know very little about vulva morphology in Pacullini Lehtinen, 1981.

### Scopulae in Tetrablemmidae

Scopula hairs or dense groups of setae on the ventral side of tarsus I and/or metatarsus I of males of several tetrablemmid genera have been mentioned or illustrated several times in the literature. Deeleman-Reinhold (1980: fig. 5) shows a scopula in the distal part of metatarsus I (but not on tarsus I) of *Lamania bernhardi*; Bourne (1981: figs 5, 14) illustrated the same on tarsus I and metatarsus I of *Paculla wanlessi* Bourne, 1981 and *P. mului* Bourne, 1981; Lehtinen (1981: 23) mentioned a scopula on the tarsus I and metatarsus I of males of *P. cameronensis* Shear, 1978 and he illustrated (Lehtinen, 1981: fig. 29), but did not mention, a scopula on leg I of males of *Sabahya kinabaluana* Deeleman-Reinhold, 1980; Burger (2008: 256, fig. 6) presented a scopula on tarsus I of males of *Ablemma unicornis* Burger, 2008.

These scopulae are moderately dense groups of what we here call “short sigmoid serrate setae”. We found this kind of setae in both sexes of all Tetrablemmidae examined, being situated mostly ventrally (very few laterally and dorsally) on all leg tarsi (in Pacullinae also on metatarsi) of the anterior legs. They occur together with other serrate setae on the same leg segments, but those are distinctly longer, slightly bent and arise at a narrower angle (Fig. 8A-I) (see Shear, 1978: fig. 112). Both types of setae have denticles (barbs) only on their ventral (proximal) side, whereas pinnate setae (present on metatarsi of posterior legs of Pacullinae) have denticles on two opposing sides (Fig. 8J). Shear (1978: fig. 112) illustrated long bent serrate setae on the tip of leg I of *L. kraui*. One of them is shown to arise from the claw base, which appears to be a misinterpretation by the artist. Claw bases in spiders do not carry hairs.

In adult males of many Pacullini [most distinctly so in species of *Lamania* (Fig. 8E) and *Sabahya* (Fig. 8G), less so in *Paculla* (Fig. 8F), not so in *Perania* (Fig. 8B)] the short sigmoid serrate setae on the ventral side of tarsus I and metatarsus I are clearly more numerous than in females and juveniles (Fig. 8C-D), forming thin scopulae (Fig. 8E-G). This was observed in all *Lamania* species available to us [*L. bernhardi*, *L. bokor* sp. nov., *L. gracilis* Schwendinger, 1989, *L. kraui* (Fig. 8E), in *Sabahya kinabaluana* (Fig. 8G) and *S. bispinosa* Deeleman-Reinhold, 1980, in *Paculla cameronensis* (Fig. 8F), *P. granulosa* (Thorell, 1881), *P. mului* and *P. wanlessi*], as well as in several undescribed species of these genera. In one undescribed *Lamania* species from the southern

part of Peninsular Malaysia there is no scopula on tarsus I but only on metatarsus I.

In the Tetrablemminae we found a ventral scopula in the distal half of the slightly spindle-shaped tarsus I (but not on metatarsus I) of males of *Ablemma unicornis* (Burger, 2008: 256, fig. 6; Fig. 8H), *A. singalang* Lehtinen, 1981, *A. circumspectans* Deeleman-Reinhold, 1980, *Borneomma roberti* Deeleman-Reinhold, 1980 (Fig. 8I), *Pahanga lilisari* Lehtinen, 1981, *Tetrablemma mardionoi* Lehtinen, 1981 (short and confined to distal third of tarsus I), and it presumably is also present in males of many other species of this subfamily. We could not find such a scopula in males of tetrablemmine species which do not have a swollen tarsus I: *Brignoliella michaeli* Lehtinen, 1981, *B. sarawak* Shear, 1978, *Hexablemma cataphractum* Berland, 1920, *Indicoblemma lannaianum* Burger, 2005, *Caraimatta sbordonii* (Brignoli, 1972), *Shearella browni* (Shear, 1978), *Singaporemma* cf. *singularis*, *Sulaimania vigelandi* Lehtinen, 1981 and *Tetrablemma loebli* Bourne, 1980b.

Considering the microstructure of these setae and the position on the legs where they aggregate, adhesive properties (though certainly much weaker than in the scopulae of e.g. theraphosid spiders) can be expected. They presumably provide a better grip on the female during copulation. The presence of leg scopulae in adult males, but not in penultimate males or adult females, is also known from other spider families, e.g. Liphistiidae, Atypidae, Antrodiaetidae, Ctenizidae, Idiopidae, Migidae, Actinopodidae, Hexathelidae. The scopulae of male liphistiids and also of males of the tetrablemmid *Brignoliella ratnapura* Shear, 1988 (not examined) appear to have a different (in addition to adhesion?) function: they are probably chemosensory (Foelix & Erb, 2010 and Foelix *et al.*, 2010; Shear, 1988).

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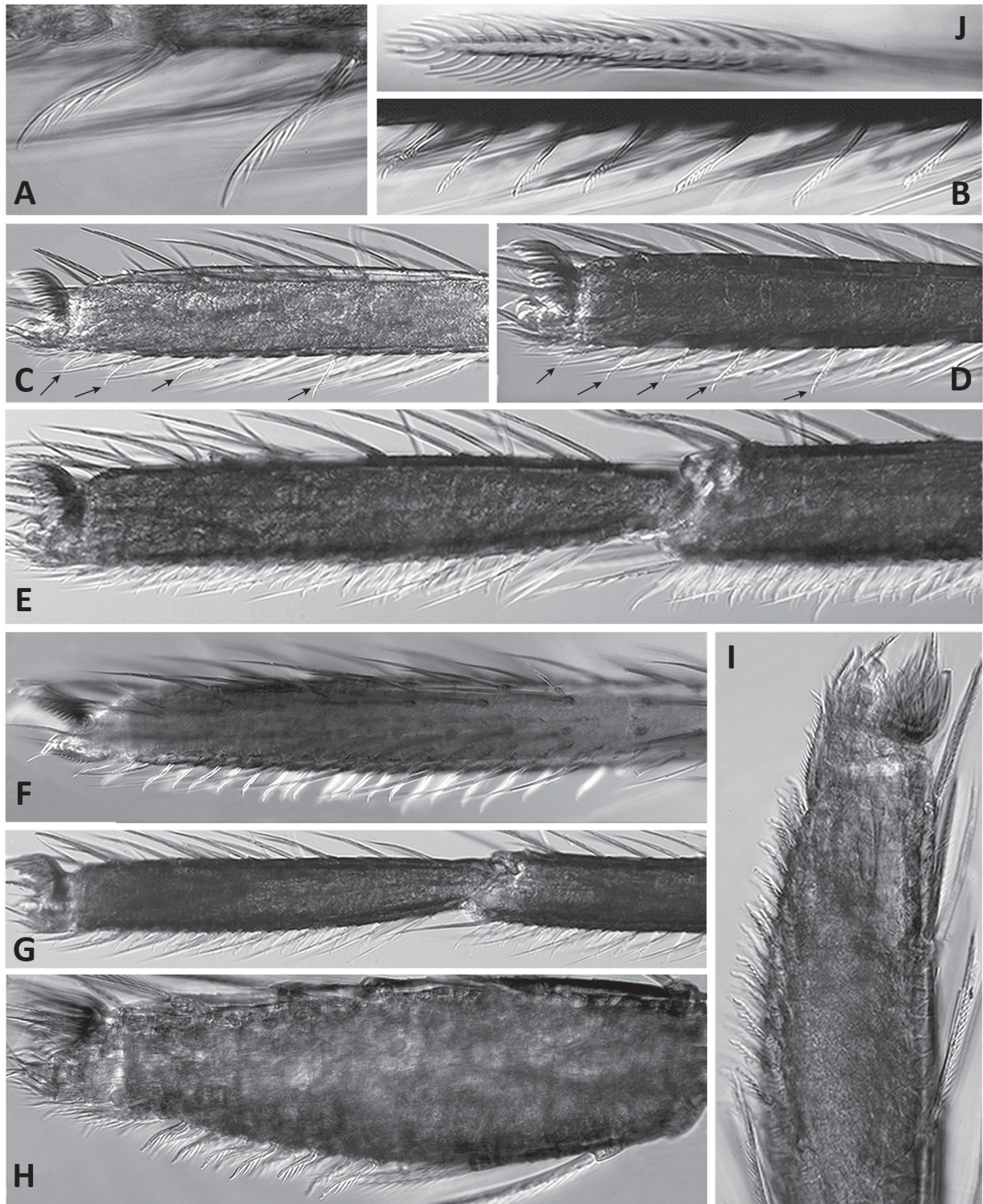


Fig. 8. Setae on legs of Tetrablemmidae. (A) *Lamania kraui* Shear, 1978, two short, sigmoid, serrate setae (SSSS) on tarsus I of subadult male from Gua Musang. (B) *Perania annam* sp. nov., scattered SSSS (not forming scopula) on tarsus I of male paratype. (C) *Lamania kraui*, scattered SSSS (indicated by arrows) on tarsus I of subadult male from Gua Musang. (D) *Lamania kraui*, scattered SSSS (indicated by arrows) on tarsus II of male from Gua Musang. (E) *Lamania kraui*, SSSS forming distinct ventral scopula on tarsus I and metatarsus I of male from Gua Musang. (F) *Paculla cameronensis* Shear, 1978, light scopula on tarsus I of male from Maxwell Hill. (G) *Sabahya kinabaluana* Deeleman-Reinhold, 1980, light scopula on tarsus I and metatarsus I of male from type locality. (H) *Ablemma unicornis* Burger, 2008, light scopula in distal half of tarsus I of male paratype. (I) *Borneomma roberti* Deeleman-Reinhold, 1980, distinct scopula in distal half of tarsus I of male from type locality. (J) *Lamania kraui*, pinnate seta on metatarsus III of female from Gua Musang.

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