



## Research article

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# The *Panjange nigrifrons* group in Borneo (Araneae: Pholcidae): high diversity in Sarawak, apparent absence in Sabah

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**Abstract.** We revise the *Panjange nigrifrons* group in Borneo and document an unexpected diversity in western Sarawak forests. Five species occur within 80 km from Kuching, each species being known from its type locality only. Further species occur east until Niah, but the genus seems to be absent from Sabah. We contrast this with another pholcid genus (*Aetana* Huber, 2005), which is diverse in Sabah and westward until Niah, but does not seem to occur in central and western Sarawak. Five species are newly described: *Panjange kapit* Huber, sp. nov., *Panjange kubah* Huber, sp. nov., *Panjange niah* Huber, sp. nov., *Panjange pueh* Huber, sp. nov., *Panjange seowi* Huber, sp. nov.; *Panjange tahai* (Huber, 2011) comb. nov. is transferred from *Pholcus*.

**Keywords.** Sarawak, Sabah, *Panjange*, taxonomy, biogeography.

Huber B.A. & Leh Moi Ung C. 2016. The *Panjange nigrifrons* group in Borneo (Araneae: Pholcidae): high diversity in Sarawak, apparent absence in Sabah. *European Journal of Taxonomy* 184: 1–32. <http://dx.doi.org/10.5852/ejt.2016.184>

## Introduction

In tropical forests around the world, pholcid spiders occupy a variety of microhabitats such as leaf litter, spaces among rocks, logs, and tree buttresses, and green leaves among the vegetation (Huber 2000, 2005). Leaf-dwelling species either attach the apex of their domed web to the underside of a leaf or else spin a barely visible sheet of silk restricted to the (lower) surface of the leaf (Huber 2009; Huber & Schütte 2009; Huber *et al.* 2013). In Southeast Asia, leaf-dwelling pholcids are particularly diverse, with some genera consisting entirely of leaf-dwellers (e.g., *Calapnita* Simon, 1892; *Leptopholcus* Simon, 1893; *Panjange* Deeleman-Reinhold & Deeleman, 1983) and others including leaf-dwellers and representatives in other microhabitats (e.g., *Belisana* Thorell, 1898; *Pholcus* Walckenaer, 1805) (Deeleman-Reinhold 1986a, 1986b; Huber 2005, 2011). Some of them exhibit unique morphological or behavioral features, such as eye stalks, extreme elongation of certain body parts, asymmetric genitalia, or

highly regular webs consisting of sticky and non-sticky lines in analogy to orbicularian webs (Deeleman-Reinhold 1986a, 1986b; Huber 2005, 2011; Huber & Nuñez 2015).

Unfortunately, little is known about the relationships among leaf-dwellers and between leaf-dwellers and their closest relatives in other microhabitats. In only a few cases, phylogenetic analyses of morphological and molecular data have provided a basis for reconstructing the direction of evolutionary shifts among microhabitats. For example, the leaf-dwelling African *Smeringopus cylingrogaster* (Simon, 1907) and a clade of four Hispaniolan leaf-dwelling species in the genus *Modisimus* Simon, 1893 are quite clearly derived from near-ground dwelling ancestors (Huber *et al.* 2010; Huber 2012; Dimitrov *et al.* 2013); on the other hand, litter-dwelling *Metagonia* Simon, 1893 species in Brazil and the African litter-dwelling *Pholcus kribi* Huber, 2011 are apparently derived from leaf-dwelling ancestors (Dimitrov *et al.* 2013). For Southeast Asian taxa, molecular data have barely been available, and previous efforts at resolving phylogenetic relationships using morphology have often failed to convincingly resolve the relevant nodes (Huber 2011; Huber & Nuñez 2015).

The present paper focuses on taxonomy, but is part of a major effort to resolve relationships among Southeast Asian pholcids and to reconstruct their evolutionary histories. It deals with *Panjange*, a genus that consists of leaf-dwelling species only, but whose internal and external relationships are far from clear. Bornean representatives of *Panjange* (i.e., representatives of the *Panjange nigrifrons* group) are in fact more similar to species currently placed in *Pholcus* from Sumatra, the Malay Peninsula, and Sri Lanka than to other species groups of *Panjange* in the Philippines (including the type species) and east of the Wallace Line (Huber 2011; Huber & Nuñez 2015). It is not yet clear if these similarities are just plesiomorphies or if they reflect the non-monophyly of *Panjange*. Preliminary molecular data suggest the latter (A. Valdez-Mondragón, D. Dimitrov, B.A. Huber, unpubl. data). In this contribution we will deal with the taxonomy of the *Panjange nigrifrons* group, we provide basic microhabitat data, and we document a biogeographic peculiarity that has been known in other groups such as birds (e.g., Gawin *et al.* 2014; Sheldon *et al.* 2015) but to our knowledge not in spiders: an apparent distributional limit between Sarawak and Sabah.

## Material and methods

Most of the material studied herein was collected during a recent expedition to northern Borneo (July–August 2014). The material is currently deposited at Sarawak Museum, Kuching (SMK), Malaysia and Zoologisches Forschungsmuseum Alexander Koenig, Bonn (ZFMK), Germany. Additional material came from the American Museum of Natural History, New York (AMNH), U.S.A. and the Netherlands Centre for Biodiversity Naturalis, Leiden (RMNH), the Netherlands.

Species descriptions are arranged as in the cladogram in Huber & Nuñez (2015). Methods and terminology used are as in recent revisions (Huber 2011, 2013). Measurements are in mm unless otherwise specified. Eye measurements are  $\pm 5 \mu\text{m}$ . Epigyna were cleared in warm NaOH solution and stained with chlorazol black. For SEM photos, specimens were dried in HMDS (Brown 1993) and photographed with a Hitachi S-2460 scanning electron microscope. SEM data are presented within the descriptions but are not based on the holotype specimens described. Locality coordinates are in round brackets when copied from labels and original publications or when received directly from collectors, in square brackets when originating from some other source (such as online gazetteers, Google Earth, etc.). The distribution maps were generated with ArcMap 10.0.

The following abbreviations are used in the text:

ALE = anterior lateral eyes

ALS = anterior lateral spinnerets

AME = anterior median eyes

a.s.l. = above sea level  
L/d = length/diameter  
PME = posterior median eyes

In order to avoid confusion, *Panjange* is abbreviated as “*Pa.*” while *Pholcus* is never abbreviated. Further abbreviations used only in figures are explained directly in the figure legends.

## Results

Class Arachnida Cuvier, 1812  
Order Araneae Clerck, 1757  
Family Pholcidae C.L. Koch, 1851

Genus *Panjange* Deeleman-Reinhold & Deeleman, 1983

*Panjange* Deeleman-Reinhold & Deeleman, 1983: 123–124. Type species by original designation: *Panjange lanthana* Deeleman-Reinhold & Deeleman, 1983.

*Panjange* – Deeleman-Reinhold 1986a: 47, fig. 6; 1986b: 220. — Huber 2001: 118–119; 2011: 108–110. — Huber & Nuñez 2015: 3–8.

### Note on species groups

Previous work on *Panjange* has identified three species groups, the *nigrifrons* group on Borneo (Fig. 1), the *lanthana* group on the Philippines, and the widespread *cavicola* group (Sulawesi to northern Australia) (Deeleman-Reinhold & Platnick 1986; Huber 2011; Huber & Nuñez 2015). From here on, we will deal only with the *nigrifrons* group. A separate paper on the *lanthana* group has recently been published (Huber & Nuñez 2015), and a molecular phylogeny of the entire genus and its closest relatives is in preparation (A. Valdez-Mondragón, D. Dimitrov, B.A. Huber, unpubl. data).

### *Panjange nigrifrons* group

#### Diagnosis

Within *Panjange*, males of the *nigrifrons* group are easily distinguished from other species groups (*lanthana* and *cavicola* groups) by presence of distal cheliceral apophyses (arrow in Fig. 18) and by ventral apophysis on palpal femur (arrow in Fig. 30); also by absence of long elongation of palpal tarsus (convergently also in some species of *lanthana* group) and – females – by absent or very short scape (relatively long in *Pa. nigrifrons* and *Pa. kapit* sp. nov.). From representatives of the very similar *Pholcus minang* group by ridges ventrally on procurus (Figs 17, 26, 34, 49; absent in *Pa. tahai* comb. nov.), by ventral apophysis on palpal femur, and possibly by wide opening of tarsal organ (figs 481 and 686 in Huber 2011). From other similar genera on Borneo (*Pholcus* group of genera *sensu* Huber 2011: *Calapnita* Simon, 1892; *Leptopholcus* Simon, 1893; *Pholcus* Walckenaer, 1805; *Uthina* Simon, 1893) by combination of male coloration (e.g., Figs 8, 61; male ocular area and palps black; similar only in some *Pholcus*), by bipartite distal apophyses on male chelicerae (Figs 35, 47; similar only in some *Calapnita*), by cylindrical rather than worm-shaped abdomen (Figs 8-15, 61–68; in contrast to *Calapnita* and *Leptopholcus*).

#### Description

##### Male

MEASUREMENTS. Total body length ~4–5; carapace width 0.9–1.2; leg 1 length ~35–50; tibia 1 length ~9–12; tibia 2/tibia 4 length 1.05–1.15; tibia 1 L/d ~95–115.

**COLOR.** In life (Figs 8, 10–11, 61, 63–66) mostly pale ochre-yellow to whitish with distinctively black ocular area and palps; sternum whitish; legs with dark patellae and tibia-metatarsus joints; abdomen with darker brown to black marks dorsally and laterally, sometimes slightly reddish-brown.

**BODY.** Carapace without median furrow. Ocular area raised, eye triads on stalks of variable length (Figs 2–7), either with or without pointed processes arising from near PME (Figs 2–7). AME always absent, but sometimes with small pigment marks in AME area. Clypeus unmodified. Abdomen cylindrical, slightly angular above spinnerets (Figs 10, 64). Male gonopore with four epiandrous spigots (Fig. 27); each ALS with large widened spigot, pointed spigot, and six cylindrically-shaped spigots (of varying sizes; Figs 28, 44); PMS with two spigots each.



**Fig. 1.** Known distribution of the *Panjange nigrifrons* group.

**CHELICERAE.** With pair of simple proximal lateral processes and distinctively bipartite pair of distal apophyses (Figs 18, 35, 71); without modified hairs; without stridulatory ridges.

**PALPS.** Coxa unmodified; trochanter with long retrolatero-ventral apophysis (short only in *Pa. nigrifrons*); femur usually with distinctive finger-shaped ventral apophysis (e.g., Figs 30, 70), only in *Pa. pueh* sp. nov. with more conical ventral process (Fig. 17); patella triangular in lateral view; tibia with two trichobothria; palpal tarsus sometimes with small dorsal process (e.g., Fig. 70); palpal tarsal organ capsulate with very wide opening (cf. figs 481 and 686 in Huber 2011); procursus relatively complex, only in *Pa. tahai* comb. nov., with hinge dividing proximal and distal parts; parallel ridges on procursus usually distinct and in high number (e.g., Figs 17, 30, 34, 49), in *Pa. nigrifrons* only three ridges, in *Pa. tahai* comb. nov. without ridges; procursus sometimes with complex membranous processes (Figs 21–23, 77–79), in some species with distinctive process in distal pit (Figs 22, 80; see also figs 478 and 683 in Huber 2011); bulb with strong proximal sclerite (e.g., Figs 16, 29, 33), with relatively simple appendix and weakly sclerotized embolus; embolus with subterminal fringes or processes (Figs 24–25, 51, 75).

**LEGS.** Without spines, without curved hairs, few vertical hairs; retrolateral trichobothrium very proximal (tibia 1: at 1.5–3% of tibia length), prolateral trichobothrium absent on tibia 1, present on other tibiae. Tarsus 1 with ~30–40 pseudosegments, very indistinct except distally. Tarsus 4 with single row of ventral comb-hairs of *Pholcus*-type (cf. Huber & Fleckenstein 2008) (Fig. 45).

### Female

Similar to male but without eye stalks; eye triads on low humps and never with pointed processes (Fig. 38); chelicerae unmodified; legs slightly shorter than in male. Epigynum weakly sclerotized, with distinct ‘knob’; either without scape (Fig. 19), with very short scape (Figs 31, 72, 84), or with medium to long scape (Figs 36, 87). Internal genitalia with pair of pore plates of variable shape, sometimes with very complex system of internal folds of unknown function (Figs 59, 90, 93).

### Monophyly and relationships

The cladistic analysis in Huber & Nuñez (2015) included all available species of *Panjange* except for *Pa. tahai* comb. nov. It resolved the *Pa. nigrifrons* group as monophyletic, but with weak support (only one synapomorphy: the ventral apophysis on the male palpal femur). Internal relationships and relationships to other species groups in *Panjange* and to *Pholcus* also remained unconvincing. Preliminary molecular data (including six species of the *Pa. nigrifrons* group and six species of the *Pa. lanthana* group; A. Valdez-Mondragón, D. Dimitrov, B.A. Huber, unpubl. data) suggest that *Panjange* is not monophyletic and that the *Pa. nigrifrons* group is in fact more closely related to species currently in *Pholcus* than to the *Pa. lanthana* group. Morphological data partly point in the same direction (e.g., the bipartite cheliceral apophyses that occur in the *Pa. nigrifrons* group as well as in the *Pholcus minang* group) but problems arise from character conflict, dubious homologies of bulbal sclerites, and missing SEM data for many species (especially of the potentially closely related *Pholcus minang* group).

*Pholcus tahai* [now *Panjange tahai* (Huber, 2011) comb. nov.] from Kalimantan was not included in the cladistic analysis in Huber & Nuñez (2015). Depending on how the main bulbal process beside the embolus is coded (as unknown, as uncus, or as appendix) the species is either resolved as sister to *Panjange* or as member of the *Pa. nigrifrons* group. Each solution has its problems: the procursus of *Panjange tahai* comb. nov. partly looks very different from that of representatives of the *Pa. nigrifrons* group: it lacks ventral ridges and it has a hinge dividing proximal and distal parts; on the other hand, the tip of the procursus (compare fig. 684 in Huber 2011 with Fig. 80 herein) and the shape of the tarsal organ (compare figs 481 and 685 in Huber 2011) remind strongly of other representatives of the *Pa. nigrifrons* group. One further hint toward a closer affinity with the *Pa. nigrifrons* group is biogeography: *Pa. tahai* comb. nov. occurs on Borneo like all other species of the *Pa. nigrifrons* group, while all

species of the *Pholcus minang* group (to which the species was previously assigned) are from Sumatra and the Malay Peninsula (Huber 2011).

### Natural history

All species observed in the field share a very similar microhabitat and web. They were consistently found in webs among low vegetation in well preserved forests, usually at about 0.5 m above the ground or even lower. The domed webs had a diameter of about 15–20 cm and were at their apex connected to the underside of a leaf where the spiders rested. At some localities, large numbers of cecidomyiid flies were found hanging in the webs together with the spiders. Egg-sacs are slightly elongated and contain approximately 20–30 eggs (e.g., Figs 13, 62).

### Composition

As construed here, the *Panjange nigrifrons* group now includes ten species: *Panjange bako* Huber, 2011; *Pa. iban* Huber, 2011; *Pa. kapit* sp. nov.; *Pa. kubah* sp. nov.; *Pa. niah* sp. nov.; *Pa. nigrifrons* Deeleman-Reinhold & Deeleman, 1983; *Pa. pueh* sp. nov.; *Pa. sedgwicki* Deeleman-Reinhold & Platnick, 1986; *Pa. seowi* sp. nov.; *Pa. tahai* (Huber, 2011) comb. nov. Judging from known distribution patterns in Sarawak and from the large poorly sampled forests of Kalimantan, the group is likely to contain several times as many species. However, the absence of *Panjange* in northeastern Borneo may be real rather than an artifact of poor sampling. Our own collecting at nine localities east of Niah did not produce a single specimen of *Panjange* (Fig. 95; see Discussion).

### Distribution

Known from Borneo only (Fig. 1).

*Panjange pueh* Huber, sp. nov.

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Figs 2, 8–9, 16–28, 52–54

*Panjange* Bor 96: Huber & Nuñez 2015: 5, 43–44.

### Diagnosis

Distinguished from similar species (with pair of pointed processes arising from near PME and ventral apophysis on male palpal femur: *Pa. bako*; *Pa. kapit* sp. nov.; *Pa. niah* sp. nov.; *Pa. sedgwicki*; *Pa. tahai* comb. nov.) by details of male pedipalp (Figs 16–17; simple conical ventral femur apophysis; distinctive prolateral membranous process on procurus; shape of procurus tip; short appendix, similar only in *Pa. niah* sp. nov.); from *Pa. kapit* sp. nov. also by shorter palpal segments and shorter epigynal scape (Figs 17, 19). Females are difficult to distinguish from *Pa. bako* and *Pa. niah* sp. nov. (internal transversal folds much more complex in *Pa. bako*, very similar in *Pa. niah* sp. nov.; unknown in *Pa. sedgwicki*).

### Etymology

Named for the type locality; noun in apposition.

### Type material

MALAYSIA-BORNEO: holotype, ♂, Sarawak, Pueh foothills, forest along river (1.798–1.800° N, 109.708–109.718° E), 100–200 m a.s.l., 16 Jul. 2014 (B.A. Huber, S.B. Huber), ZFMK (Ar 14575).

### Other material examined

MALAYSIA-BORNEO, Sarawak: 3 ♂♂, 5 ♀♀, same data as holotype, ZFMK (Ar 14576–77); 1 ♀, 3 juvs, in absolute ethanol, same data, ZFMK (Bor 231).

## Description

### Male (holotype)

MEASUREMENTS. Total body length 5.0, carapace width 1.1. Leg 1: 44.3 (9.9 + 0.5 + 10.2 + 21.1 + 2.6), tibia 2: 6.3, tibia 3: 3.5, tibia 4: 5.8; tibia 1 L/d: 106. Distance PME–PME 490  $\mu$ m, diameter PME 105  $\mu$ m, distance PME–ALE ~45  $\mu$ m; AME absent.

COLOR. Carapace pale ochre yellow to whitish, posterior mark (Fig. 8) lost in ethanol, ocular area and clypeus dark brown (black in life); sternum whitish; legs ochre-orange with dark brown patellae and tibia-metatarsus joints; abdomen ochre-gray, with black marks dorsally, monochromous ventrally.

BODY. Habitus as in Fig. 8; ocular area raised, each triad on long stalk, with pointed straight process arising from near PME (Figs 2, 18); carapace without median furrow; clypeus unmodified; sternum

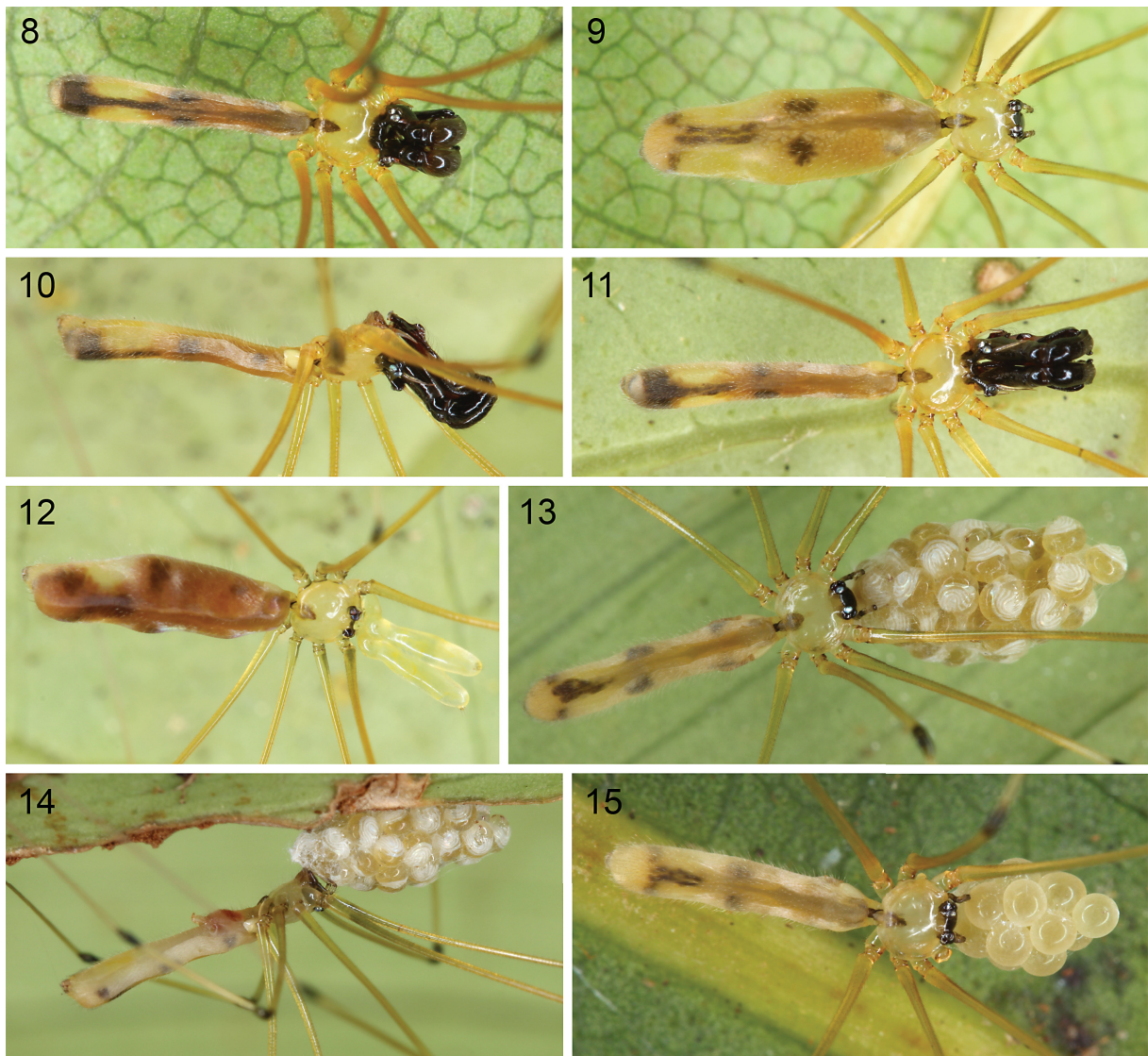


**Figs 2–7.** Male prosomata, oblique frontal views. **2.** *Panjange pueh* Huber, sp. nov. (ZFMK Ar 14576). **3.** *Pa. niah* Huber, sp. nov. (ZFMK Ar 14579). **4.** *Pa. kapit* Huber, sp. nov. (ZFMK Ar 14583). **5.** *Pa. nigrifrons* Deeleman-Reinhold & Deeleman, 1983 (RMNH, Sepaku). **6.** *Pa. kubah* Huber, sp. nov. (ZFMK Ar 14587). **7.** *Pa. seowi* Huber, sp. nov. (ZFMK Ar 14590).

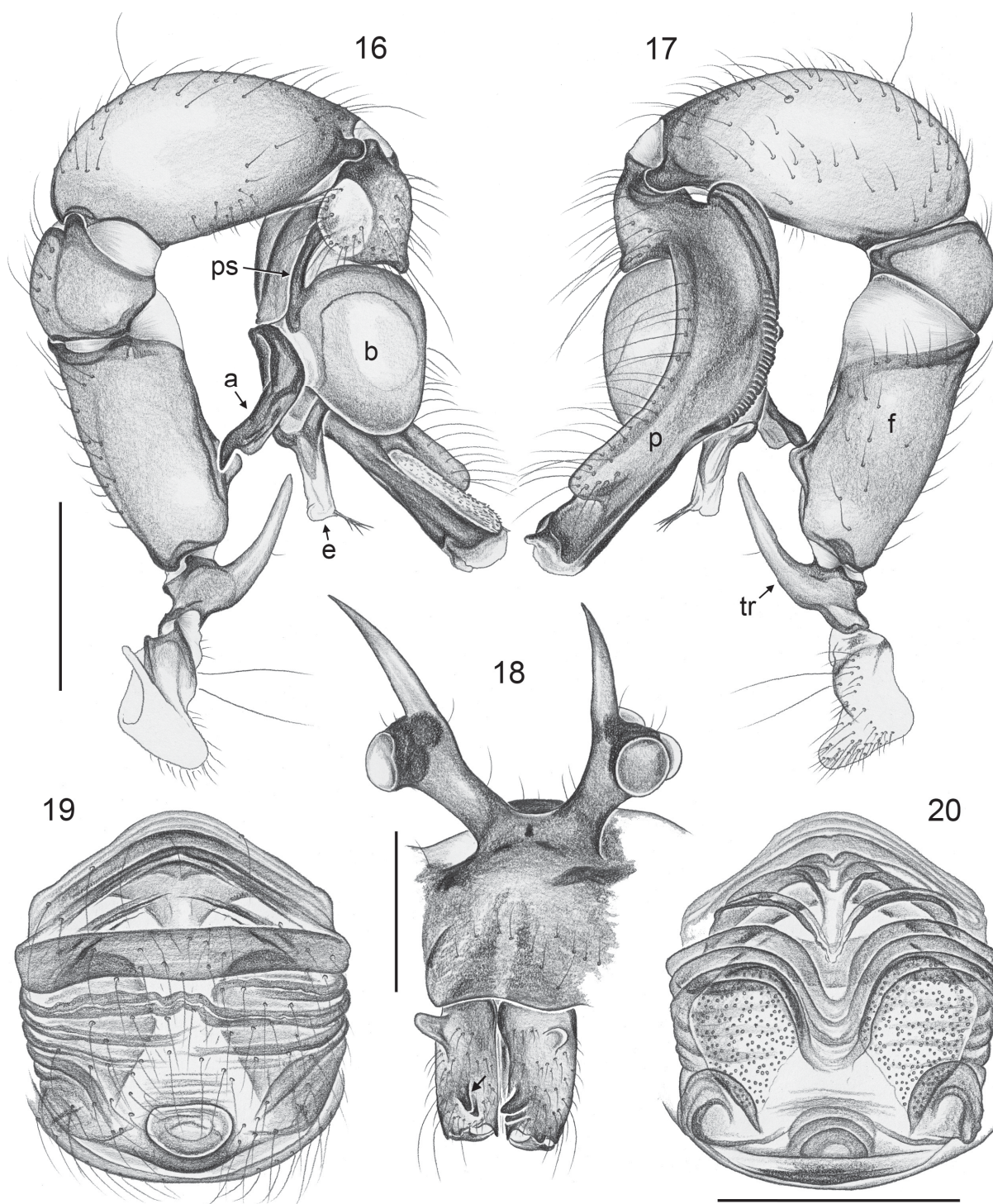
wider than long (0.7/0.6), unmodified. Gonopore with four epiandrous spigots (Fig. 27). ALS as in Fig. 28.

CHELICERAE. Similar to close relatives, with proximal pair of processes and with distinctively bipartite distal apophyses (Fig. 18); without modified hairs; without stridulatory ridges.

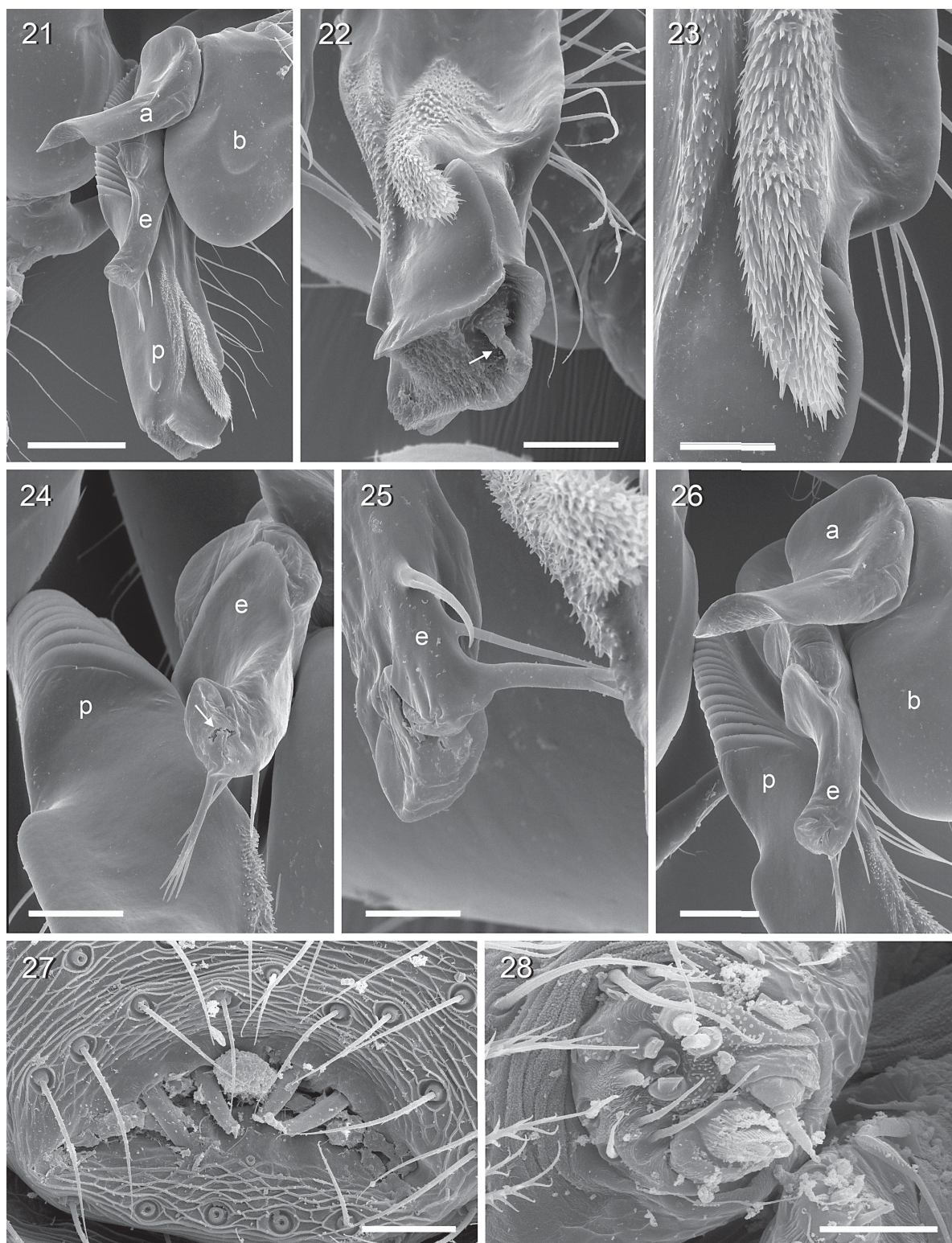
PALPS. As in Figs 16–17; coxa unmodified; trochanter with slightly curved retrolatero-ventral apophysis and low retrolateral hump; femur with conical ventral process; procursus with row of about 26 ventral ridges (Fig. 26), with distinctive prolateral membranous process and distal elements (Figs 21–23); bulb with strong proximal sclerite, short curved appendix, and proximally widened and sclerotized embolus with distal processes and fringes (Figs 24–26).



**Figs 8–15.** Live specimens. **8–9.** *Panjange pueh* Huber, sp. nov., ♂ and ♀ from Pueh. **10–14.** *Pa. kapit* Huber, sp. nov. from Kapit. **10–11.** Adult ♂, **12.** Penultimate instar ♂, **13–14.** ♀ with egg-sac. **15.** *Pa. niah* Huber, sp. nov., ♀ with egg-sac from Niah.



**Figs 16–20.** *Panjange pueh* Huber, sp. nov. (ZFMK Ar 14576–77). **16–17.** Left male palp, prolateral and retrolateral views. **18.** Male ocular area, clypeus, and chelicerae, oblique frontal view (arrow points at distal chelical apophysis). **19–20.** Cleared female genitalia, ventral and dorsal views. Abbreviations: a = appendix; b = genital bulb; e = embolus; f = femur; p = procursus; ps = proximal bulbal sclerite; tr = trochanter. Scale lines: 0.5 mm.



**Figs 21–28.** *Panjange pueh* Huber, sp. nov. (ZFMK Ar 14576). **21.** Left procursus and bulb, prolateral view. **22.** Left procursus, prolateral distal view (arrow points to distinctive process in distal pit). **23.** Prolateral membranous process on left procursus. **24–25.** Tip of embolus, distal views. **26.** Left procursus and bulb, prolatero-distal view. **27.** Male gonopore. **28.** Male ALS. Abbreviations: a = appendix; b = genital bulb; e = embolus; p = procursus. Scale lines: 20 µm (28); 30 µm (25, 27); 40 µm (23); 60 µm (22, 24); 100 µm (26); 200 µm (21).

LEGS. Without spines and curved hairs; few vertical hairs; retrolateral trichobothrium on tibia 1 at 1.5%; prolateral trichobothrium absent on tibia 1, present on other tibiae; tarsus 1 with > 40 indistinct pseudosegments.

### Variation

Tibia 1 in 3 other males: 8.9, 9.3, 9.6.

### Female

In general similar to male but eye triads on low humps, much closer together (distance PME–PME 235 µm), without pointed processes. Tibia 1 in 5 females: 7.6–8.3 (mean 7.9). Epigynum weakly sclerotized plate with large weakly sclerotized posterior ‘knob’ (Figs 19, 52), internal arch and transversal folds visible through cuticle; internal genitalia as in Figs 20, 53–54.

### Distribution

Known from type locality in Sarawak only (Fig. 1).

*Panjange niah* Huber, sp. nov.

[urn:lsid:zoobank.org:act:BBDABF75-A656-4B28-AA6A-88D20F1CC113](https://zoobank.org/urn:lsid:zoobank.org:act:BBDABF75-A656-4B28-AA6A-88D20F1CC113)

Figs 3, 15, 29–32, 38–41, 55–57

*Panjange* Bor 11: Huber & Nuñez 2015: 5, 43–44.

### Diagnosis

Distinguished from similar species (with pair of straight pointed processes arising from near PME and ventral apophysis on male palpal femur: *Pa. bako*; *Pa. kapit* sp. nov.; *Pa. pueh* sp. nov.; *Pa. sedgwicki*; *Pa. tahai* comb. nov.) by shapes of procursus and appendix (Figs 29–30; procursus tip distinctively bifid, similar only in *Pa. bako*; appendix short and curved, similar only to *Pa. pueh* sp. nov.). Females are difficult to distinguish from *Pa. bako* and *Pa. pueh* sp. nov. (internal transversal folds much more complex in *Pa. bako*, very similar in *Pa. pueh* sp. nov.; unknown in *Pa. sedgwicki*).

### Etymology

Named for the type locality; noun in apposition.

### Type material

MALAYSIA-BORNEO: holotype, ♂, Sarawak, Niah Cave National Park, forest near headquarters (3.820° N, 113.763° E), 40 m a.s.l., night collecting, 28 Jul. 2014 (B.A. Huber, S.B. Huber), ZFMK (Ar 14578).

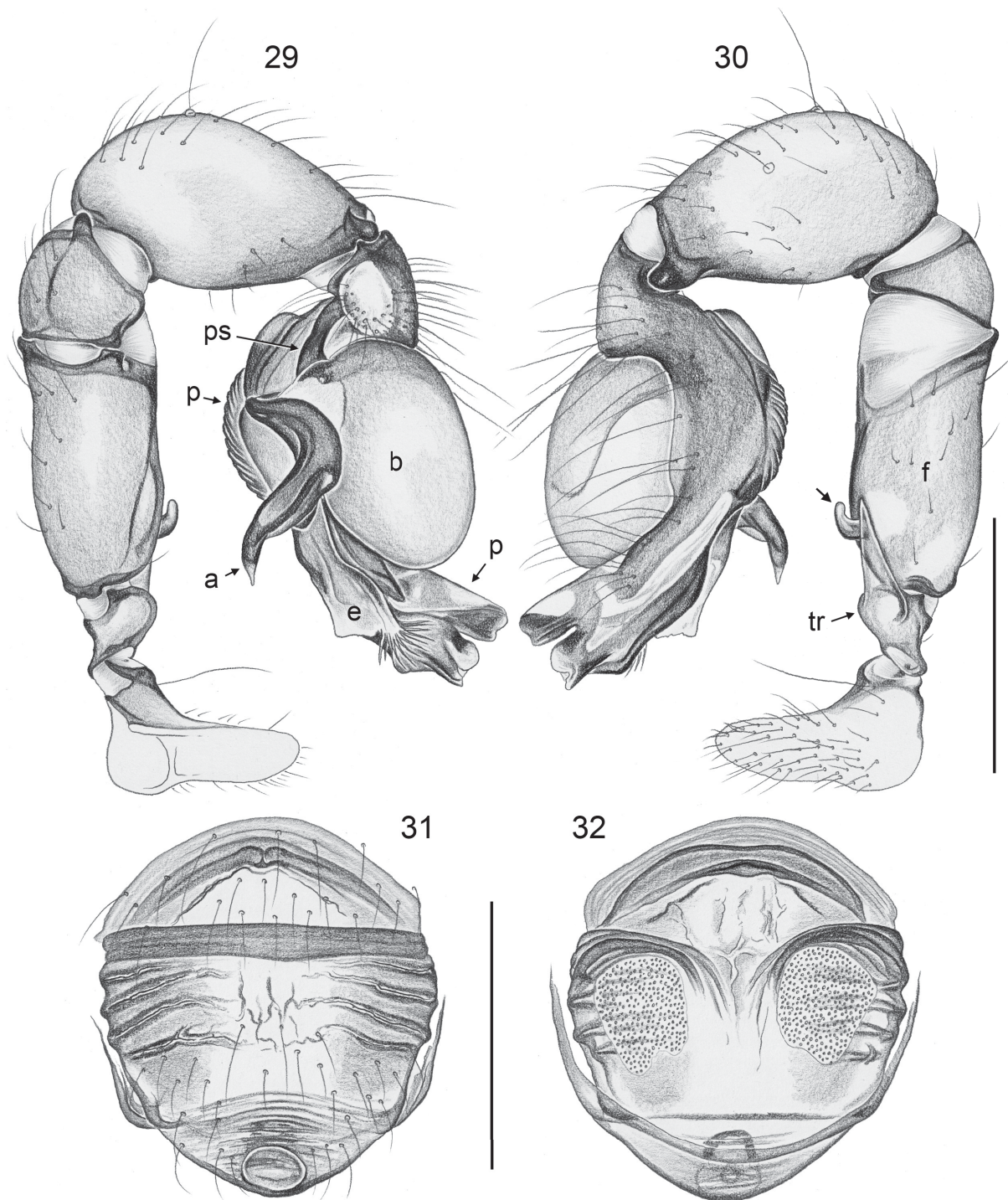
### Other material examined

MALAYSIA-BORNEO, Sarawak: 1 ♂, 8 ♀♀, 1 juv., same data as holotype, ZFMK (Ar 14579–80); 2 ♀♀, same locality, forest along main trail (3.814–3.821° N, 113.763–113.771° E), 20–40 m a.s.l., 27 Jul. 2014 (B.A. Huber, S.B. Huber), ZFMK (Ar 14581); 3 ♀♀, 1 juv., same data, in absolute ethanol, ZFMK (Bor 179).

### Description

#### Male (holotype)

MEASUREMENTS. Total body length 4.5, carapace width 1.1. Leg 1: 41.2 (9.4 + 0.5 + 9.5 + 19.3 + 2.5), tibia 2: 5.7, tibia 3: 3.3, tibia 4: 5.3; tibia 1 L/d: 108. Distance PME–PME 445 µm, diameter PME 105 µm, distance PME–ALE ~45 µm; AME absent.

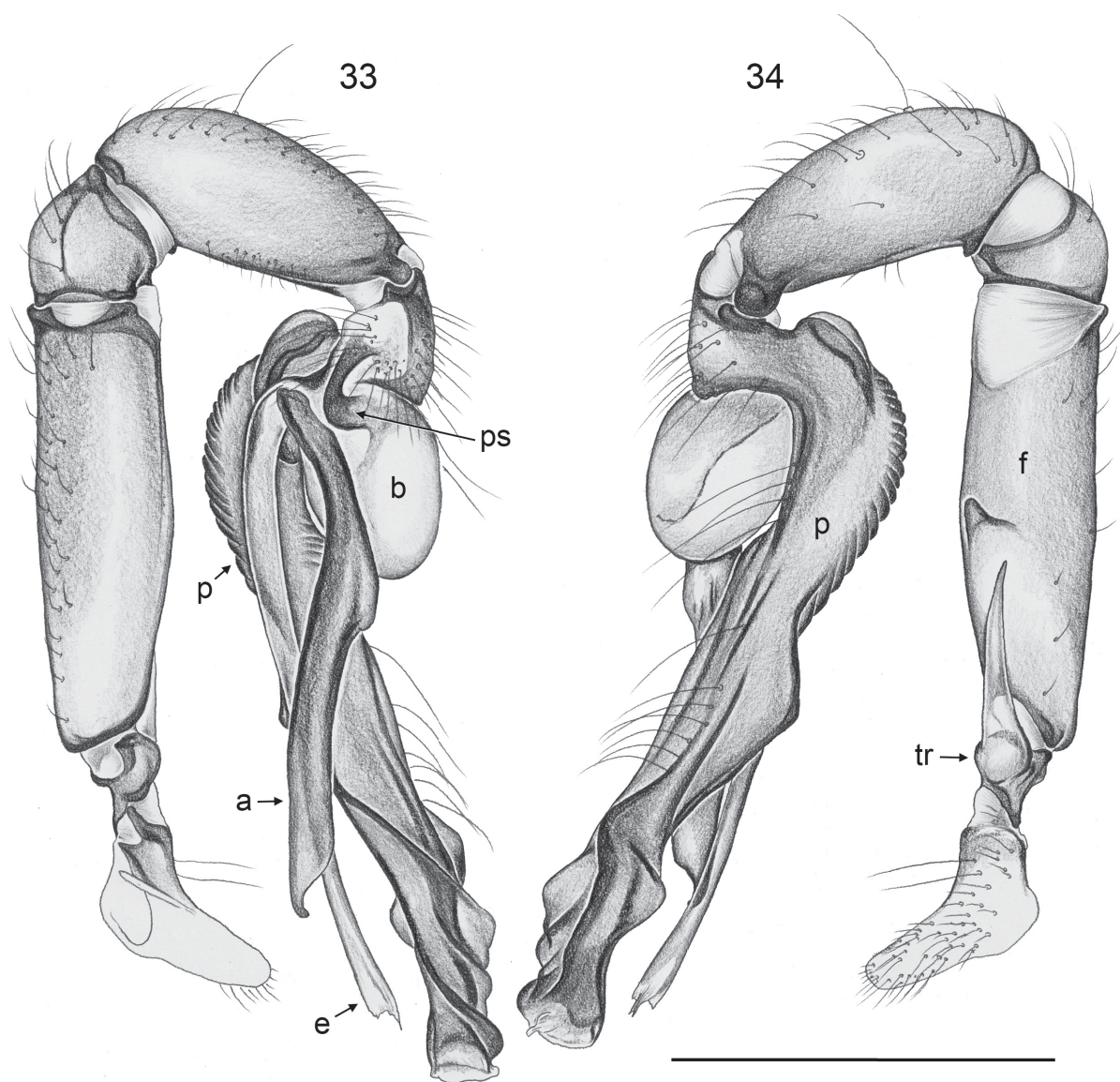


**Figs 29–32.** *Panjange niah* Huber, sp. nov. (ZFMK Ar 14579–80). **29–30.** Left male palp, prolateral and retrolateral views (arrow points at ventral femur apophysis). **31–32.** Cleared female genitalia, ventral and dorsal views. Abbreviations: a = appendix; b = genital bulb; e = embolus; f = femur; p = procursus; ps = proximal bulbal sclerite; tr = trochanter. Scale lines: 0.5 mm.

**COLOR.** Carapace pale ochre yellow to whitish, without posterior mark, ocular area and clypeus dark brown, with single black mark in AME area; sternum whitish; legs ochre-orange with dark brown patellae and tibia-metatarsus joints; abdomen ochre-gray, with black marks dorsally, monochromous ventrally.

**BODY.** Habitus as in *Pa. pueh* sp. nov. (cf. Fig. 8); ocular area raised, each triad on long stalk, with pointed straight process arising from near PME (Fig. 3); carapace without median furrow; clypeus unmodified; sternum wider than long (0.70/0.55), unmodified.

**CHELICERAE.** Similar to *Pa. pueh* sp. nov. and other close relatives (cf. Fig. 18), with distinctively bipartite distal apophyses; proximal pair of processes slightly directed towards distal; without modified hairs; without stridulatory ridges.



**Figs 33–34.** *Panjange kapit* Huber, sp. nov. (ZFMK Ar 14583). Left male palp, prolateral and retrolateral views. Abbreviations: a = appendix; b = genital bulb; e = embolus; f = femur; p = procursus; ps = proximal bulbal sclerite; tr = trochanter. Scale line: 1 mm.

**PALPS.** As in Figs 29–30; coxa unmodified; trochanter with straight pointed retrolatero-ventral apophysis; femur with curved finger-shaped ventral apophysis; procursus with row of about 12 ventral ridges, with distinctive bifid tip; bulb with strong proximal sclerite, strongly curved short appendix, and long partly sclerotized embolus with distinct distal fringes.

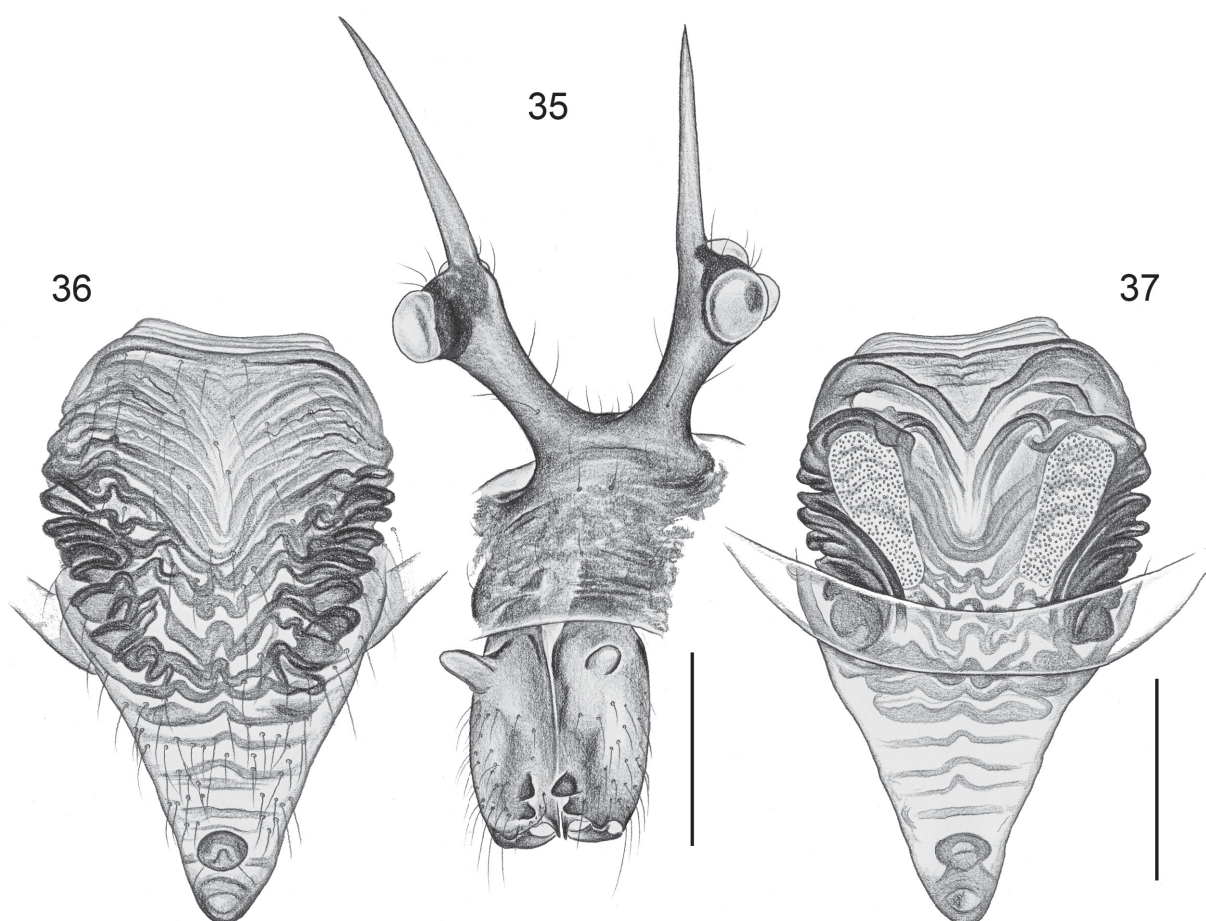
**LEGS.** Without spines and curved hairs; few vertical hairs; retrolateral trichobothrium on tibia 1 at 2.5%; prolateral trichobothrium absent on tibia 1, present on other tibiae; tarsus 1 with > 20 indistinct pseudosegments.

#### Variation

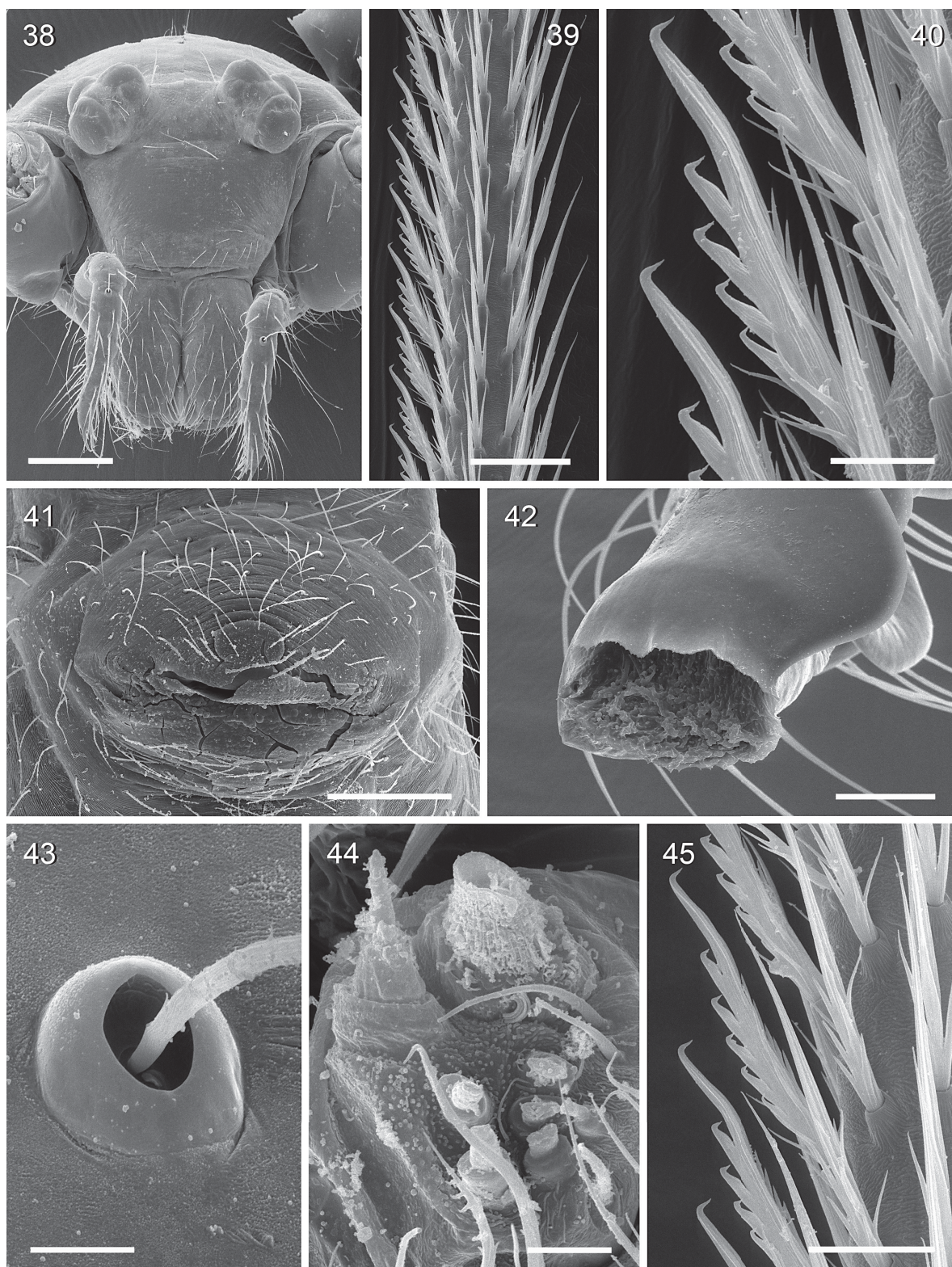
Tibia 1 in other male: 9.0.

#### Female

In general similar to male but eye triads on low humps, much closer together (distance PME–PME 220  $\mu$ m), without pointed processes. Tibia 1 in 9 females: 6.9–7.5 (mean 7.2). Tarsus 4 comb-hairs as in Figs 39–40. Epigynum weakly sclerotized plate with large posterior ‘knob’ (Figs 31, 41, 55), internal anterior arch and transversal folds visible through cuticle; internal genitalia as in Figs 32, 56–57.



**Figs 35–37.** *Panjange kapit* Huber, sp. nov. (ZFMK Ar 14583–84). **35.** Male ocular area, clypeus, and chelicerae, oblique frontal view. **36–37.** Cleared female genitalia, ventral and dorsal views. Scale lines: 0.5 mm.



**Figs 38–45.** — **38–41.** *Panjange niah* Huber, sp. nov. (ZFMK Ar 14580). **38.** Female prosoma, frontal view. **39–40.** Comb-hairs on female tarsus 4. **41.** Epigynum, ventral view. — **42–45.** *Panjange kapit* Huber, sp. nov. (ZFMK Ar 14583). **42.** Tip of left procursus, retrolatero-distal view. **43.** Base of palpal trichobothrium. **44.** Male ALS. **45.** Comb-hairs on male tarsus 4. Scale lines: 10  $\mu\text{m}$  (40, 43–44); 20  $\mu\text{m}$  (45); 40  $\mu\text{m}$  (39); 60  $\mu\text{m}$  (42); 200  $\mu\text{m}$  (38, 41).

### Natural history

The webs were found among the vegetation at 0.5–1 m above the ground, with the apex of the domed sheet connected to the underside of a leaf.

### Distribution

Known from type locality in Sarawak only (Fig. 1).

#### *Panjange bako* Huber, 2011

*Panjange bako* Huber, 2011: 122–124; figs 489–493, 764, 773–774 (♂♀).

### Diagnosis

Distinguished from similar species (with ventral apophysis on palpal femur and with pointed processes on eye stalks: *Pa. kapit* sp. nov.; *Pa. niah* sp. nov.; *Pa. pueh* sp. nov.; *Pa. sedgwicki*; *Pa. tahai* comb. nov.) by shapes of procurus and appendix (procurus tip distinctively bifid, similar only in *Pa. niah* sp. nov.). Females are difficult to distinguish from *Pa. niah* sp. nov. and *Pa. pueh* sp. nov. (internal transversal folds much more complex in *Pa. bako* than in *Pa. niah* sp. nov.; unknown in *Pa. sedgwicki*).

### New material examined

MALAYSIA-BORNEO, Sarawak: 2 ♂♂, 1 ♀, 2 juvs, Bako National Park [~1.72° N, 110.45° E] (type locality), rainforest on slope, 28 Mar. 1985 (C.L. & P.R. Deeleman), RMNH.

### Distribution

Known from type locality in Sarawak only (Fig. 1).

#### *Panjange kapit* Huber, sp. nov.

[urn:lsid:zoobank.org:act:07838D0A-C949-4316-8B22-6892CC371A3F](https://zoobank.org/act:07838D0A-C949-4316-8B22-6892CC371A3F)

Figs 4, 10–14, 33–37, 42–51, 58–60

*Panjange* Bor 78: Huber & Nuñez 2015: 5, 43–44.

### Diagnosis

Distinguished from similar species (with pair of straight pointed processes arising from near PME and ventral apophysis on male palpal femur: *Pa. bako*; *Pa. niah* sp. nov.; *Pa. pueh* sp. nov.; *Pa. sedgwicki*; *Pa. tahai* comb. nov.) by longer palpal segments (especially femur and procurus; Figs 33–34), by shapes of procurus and appendix (Figs 33–34), and by longer epigynal scape (Figs 36–37; female of *Pa. sedgwicki* unknown); from very similar *Pa. sedgwicki* (male holotype examined) by distal structures of procurus, more slender male palpal tibia, and more distal ventral femur apophysis.

### Etymology

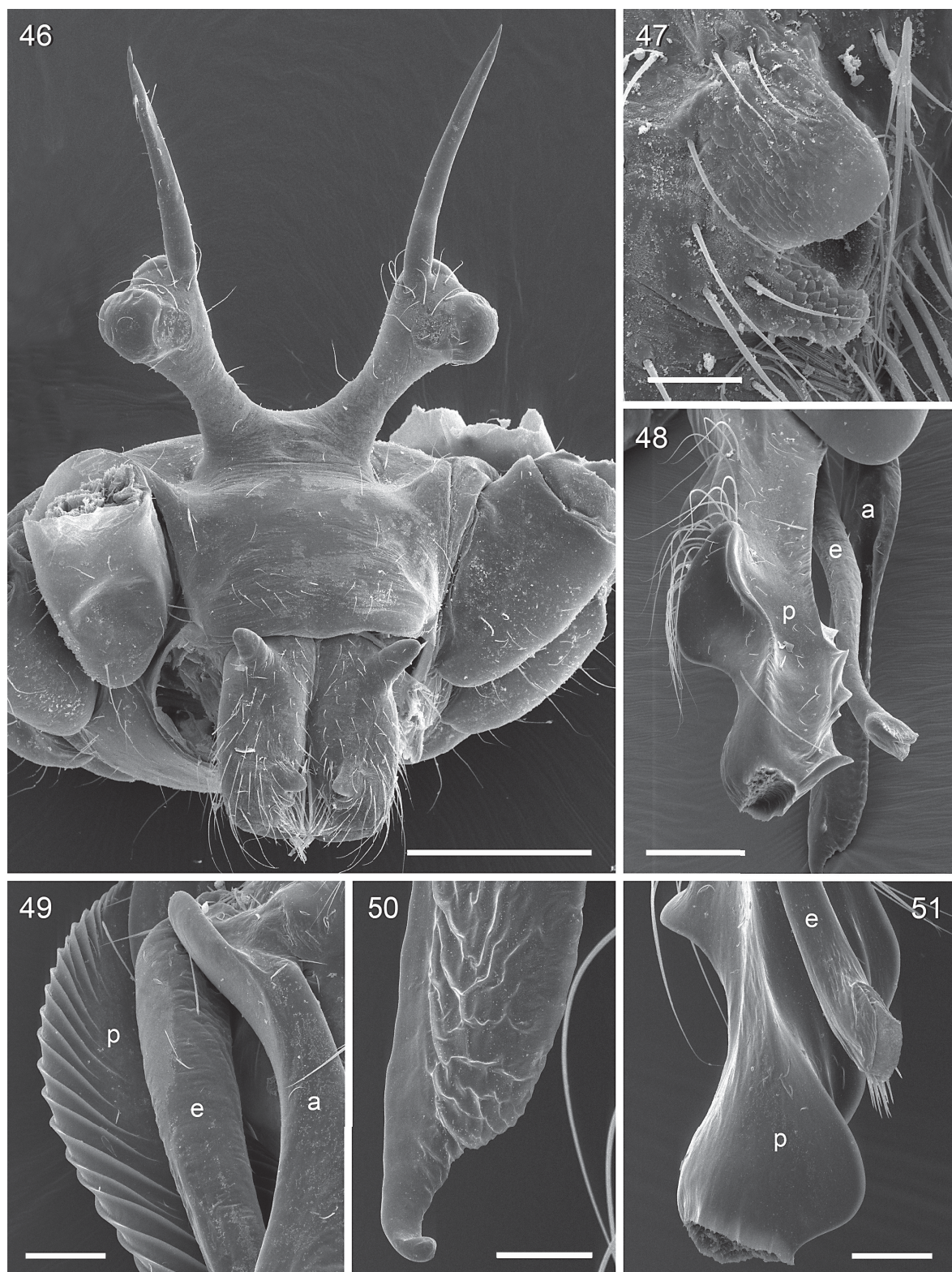
Named for the type locality; noun in apposition.

### Type material

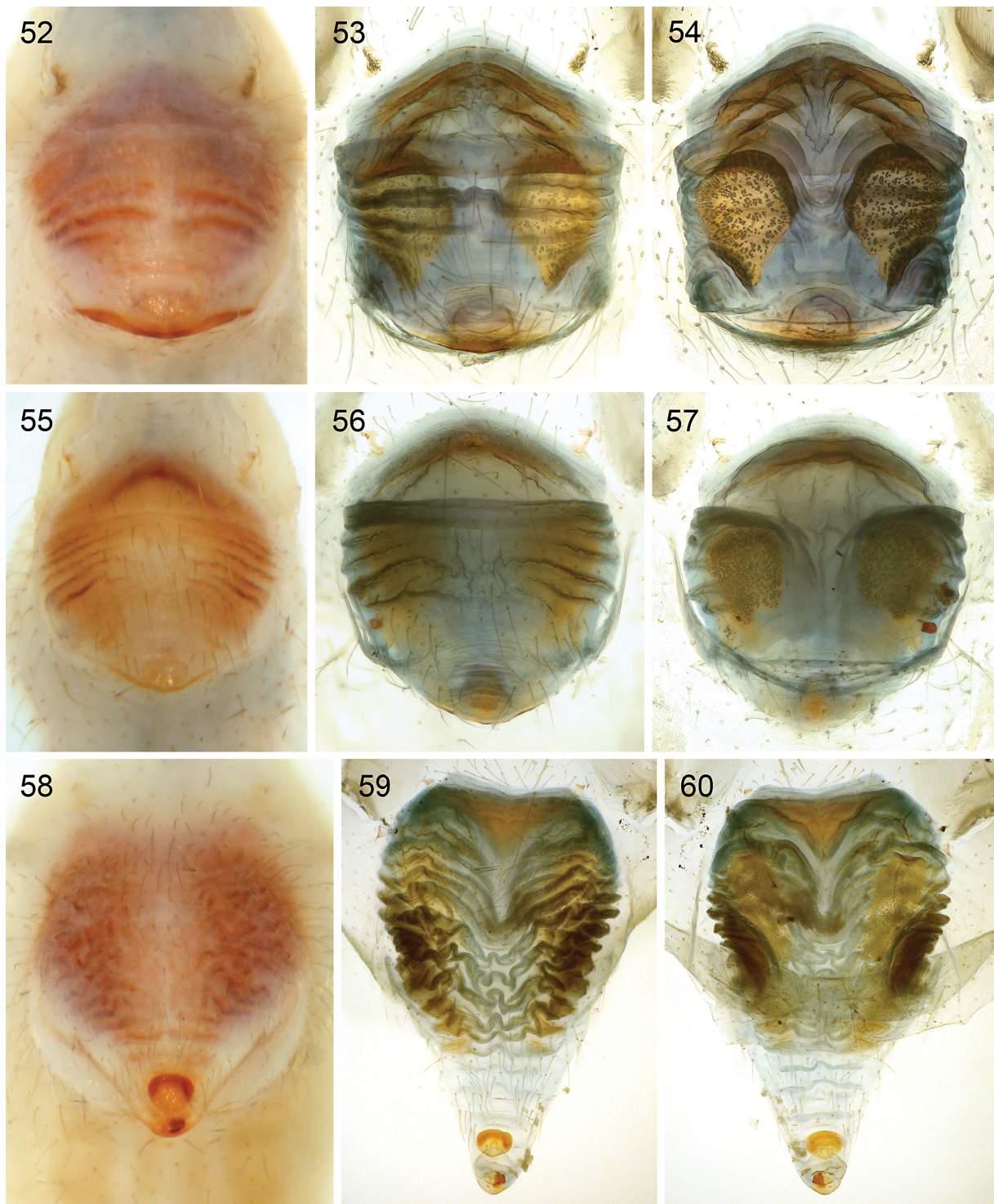
MALAYSIA-BORNEO: holotype, ♂, Sarawak, near Kapit, forest along river (1.937–1.944° N, 112.904–112.910° E), 80–120 m a.s.l., 20 Jul. 2014 (B.A. Huber, S.B. Huber), ZFMK (Ar 14582).

### Other material examined

MALAYSIA-BORNEO: Sarawak: 8 ♂♂, 6 ♀♀, 2 juvs, same data as holotype, ZFMK (Ar 14583–84; 7 ♂♂, 5 ♀♀) and SMK (1 ♂, 1 ♀); 1 ♂, 3 ♀♀, 1 juv., same data, in absolute ethanol, ZFMK (Bor 184).



**Figs 46–51.** *Panjange kapit* Huber, sp. nov. (ZFMK Ar 14583). **46.** Male prosoma, frontal view. **47.** Right distal male cheliceral apophysis. **48.** Right procursus (and bulbal processes), dorsal view. **49.** Ridges on left procursus, prolateral view. **50.** Tip of left appendix, prolateral view. **51.** Tip of left procursus (and embolus), ventral view. Abbreviations: a = appendix; e = embolus; p = procursus. Scale lines: 30  $\mu$ m (47); 60  $\mu$ m (50); 100  $\mu$ m (49, 51); 200  $\mu$ m (48); 400  $\mu$ m (46).



**Figs 52–60.** Female genitalia, untreated in ventral view, cleared in ventral and dorsal views. **52–54.** *Panjange pueh* Huber, sp. nov. (ZFMK Ar 14577). **55–57.** *Pa. niah* Huber, sp. nov. (ZFMK Ar 14580). **58–60.** *Pa. kapit* Huber, sp. nov. (ZFMK Ar 14584).

## Description

### Male (holotype)

MEASUREMENTS. Total body length 5.2, carapace width 1.2. Leg 1: 49.9 (11.1 + 0.5 + 11.6 + 23.8 + 2.9), tibia 2: 7.0, tibia 3: 4.1, tibia 4: 6.3; tibia 1 L/d: 110. Distance PME–PME 520  $\mu$ m, diameter PME 115  $\mu$ m, distance PME–ALE ~45  $\mu$ m; AME absent.

COLOR. Carapace pale ochre yellow to whitish, posterior mark (Fig. 11) lost in ethanol, ocular area and clypeus dark brown (black in life), without black spots in AME area; sternum whitish; legs ochre-orange with dark brown patellae and tibia-metatarsus joints; abdomen ochre-gray, with black marks dorsally, monochromous ventrally.

BODY. Habitus as in Figs 10–11; ocular area raised, each triad on long stalk, with pointed straight process arising from near PME (Fig. 4); carapace without median furrow; clypeus unmodified; sternum wider than long (0.75/0.55), unmodified. ALS as in Fig. 44.

CHELICERAE. Similar to close relatives, with proximal pair of processes and with distinctively bifid distal apophyses (Figs 35, 46–47); without modified hairs; without stridulatory ridges.

PALPS. As in Figs 33–34; coxa unmodified; trochanter with slightly curved pointed retrolatero-ventral apophysis; femur with ventral apophysis; procurus very long, with row of about 18 ventral ridges (Fig. 49) and isolated patch of few prolateral ridges, with distinctive distal processes (Figs 48–49, 51), apparently without process in distal pit (Fig. 42); bulb with strong proximal sclerite, long slender appendix with hooked tip (Fig. 50), and long partly sclerotized embolus with short distal fringes (Fig. 51).

LEGS. Without spines and curved hairs; few vertical hairs; retrolateral trichobothrium on tibia 1 at 1.5%; prolateral trichobothrium absent on tibia 1, present on other tibiae; tarsus 1 with > 40 indistinct pseudosegments.

### Variation

Tibia 1 in 8 other males: 10.6–11.9 (mean 11.3). Some males with black spots in AME area; abdominal marks variably distinct.

### Female

In general similar to male but eye triads on low humps, much closer together (distance PME–PME 220  $\mu$ m), without pointed processes. Tibia 1 in 6 females: 7.9–8.4 (mean 8.2). Epigynum weakly sclerotized plate with variably sclerotized posterior ‘knob’ on extensible scape (Figs 36, 58), internal anterior sclerite and complex transversal folds visible through cuticle; internal genitalia as in Figs 37, 59–60.

## Natural history

Webs were found among vegetation close to the ground, with the apex of the domed sheet connected to the underside of a leaf. Large numbers of Cecidomyiidae (deposited in ZFMK) were seen hanging from the silk lines in most webs. Egg sacs were slightly elongated, and contained about 25–30 eggs each (n = 2).

## Distribution

Known from type locality in Sarawak only (Fig. 1).

***Panjange tahai* (Huber, 2011) comb. nov.**

*Pholcus tahai* Huber, 2011: 158; figs 600–602, 616–617, 673–695 (♂♀).

**Diagnosis**

Easily distinguished from congeners by highly distinctive procurus (very long, with hinge between proximal and distal parts; fig. 674 in Huber 2011); females with distinctive internal genitalia (figs 617, 678 in Huber 2011) but difficult to distinguish externally from other representatives of the *Pa. nigrifrons* group.

**New material examined**

INDONESIA-BORNEO, Central Kalimantan: 1 ♀, Tumbang Tahai (2°02' S, 113°35' E) [type locality], primary bog forest, 3–13 Sep. 1985 (S. Djojosedharmo), RMNH; 9 ♂♂, 12 ♀♀, Kaharian (2°02' S, 113°40' E), marshy primary forest, foliage, 2–16 Sep. 1985 (S. Djojosedharmo), RMNH; 1 ♂, 4 ♀♀, same data but bog forest, RMNH; 5 ♂♂, 5 ♀♀ (2 vials), 40 km NW Palangkaraya [~1.95° S, 113.75° E], secondary forest, leaves, Sep. 1985 (S. Djojosedharmo), RMNH.

**Distribution**

Known from three localities in Central Kalimantan (Fig. 1).

***Panjange iban* Huber, 2011  
Figs 61–62**

*Panjange iban* Huber, 2011: 119–121; figs 469–488, 770–772, 791–792 (♂♀).

**Diagnosis**

Distinguished from similar species (with ventral apophysis on palpal femur, without pointed processes on eye stalks: *Pa. kubah* sp. nov.; *Pa. nigrifrons*; *Pa. seowi* sp. nov.) by distinctive ventral process of procurus (near distal end of ridges; fig. 470 in Huber 2011); females are difficult to distinguish externally from congeners in Sarawak (distinctive internal folds arranged in anterior semicircular pattern; large pore plates); from *Pa. nigrifrons* by very short scape.

**New material examined**

MALAYSIA-BORNEO, Sarawak: 2 ♂♂, 7 ♀♀, Semengoh Arboretum, Masing Trail (1.397–1.399° N, 110.317–110.322° E), 60–80 m a.s.l., 17 July 2014 (B.A. Huber), ZFMK (Ar 14585); 2 ♀♀, 2 juvs, same data, in absolute ethanol, ZFMK (Bor 227); 6 ♂♂, 3 ♀♀, same locality, Apr. 1985 (C.L. & P.R. Deeleman), RMNH.

**Natural history**

The webs had a diameter of about 10–20 cm and were found among vegetation in primary forest close to the ground where the domed sheets were attached to the undersides of leaves.

**Distribution**

Known from type locality in Sarawak only (Fig. 1).

***Panjange nigrifrons* Deeleman-Reinhold & Deeleman, 1983  
Figs 5, 86–88**

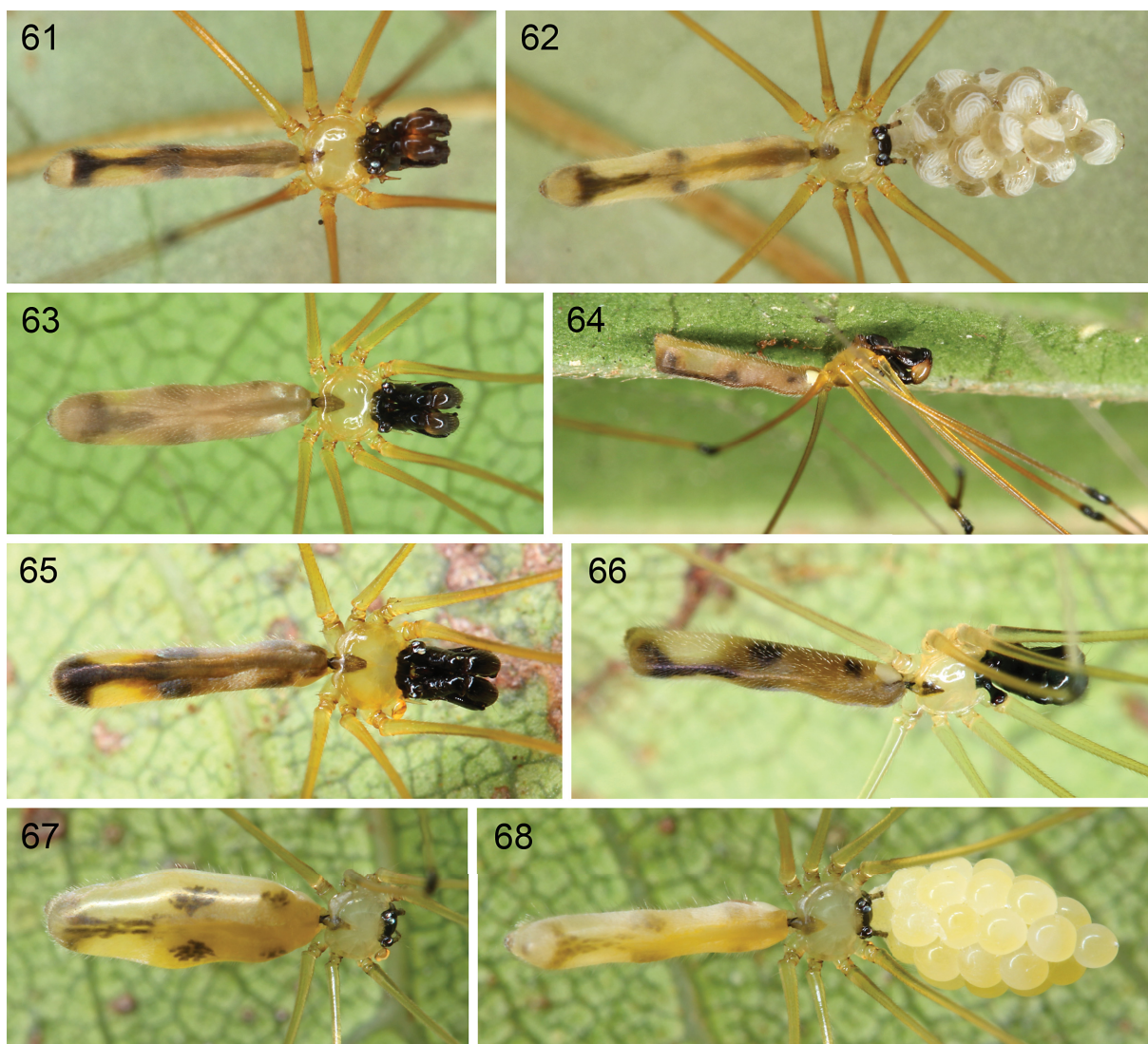
*Panjange nigrifrons* Deeleman-Reinhold & Deeleman, 1983: 126–128; figs 10–16 (♂♀).

### Diagnosis

Distinguished from similar species (with ventral apophysis on palpal femur, without pointed processes on eye stalks: *Pa. iban*; *Pa. kubah* sp. nov.; *Pa. seowi* sp. nov.) by low number of ridges ventrally on procurus (only three; fig. 13 in Deeleman-Reinhold & Deeleman 1983); by short male palpal trochanter apophysis (fig. 15 in Deeleman-Reinhold & Deeleman 1983), and by distinctive female genitalia (Figs 86–88; internal lateral structures visible through cuticle; long scape).

### New material examined

INDONESIA-BORNEO, East Kalimantan: 2 ♂♂, 2 ♀♀, Sepaku [ $\sim 0.91^\circ$  S,  $116.77^\circ$  E], 40 km N of Balikpapan (type locality), primary forest, 20–21 Jul. 1982 (collector unknown), RMNH.



**Figs 61–68.** Live specimens. **61–62.** *Pa. iban* Huber, 2011, ♂ and ♀ with egg-sac from Semengoh. **63–64.** *Pa. kubah* Huber, sp. nov., ♂ from Kubah. **65–68.** *Pa. seowi* Huber, sp. nov., ♂, ♀, and ♀ with egg-sac from Penrissen.

### Description – amendments

Male distal cheliceral apophyses clearly bipartite as in other species described herein (this was correctly noted in the original description but not correctly drawn in fig. 11). Appendix with very distinct and unique pocket at ~60% of its length. Tibia 1 L/d: 100; tibia 2/tibia 4 length: 1.09 (not 1.33 as in original description); distance PME–PME: 420 µm; retrolateral trichobothrium at 2%.

### Distribution

Known from two localities in Kalimantan only (Deeleman-Reinhold & Deeleman 1983; Fig. 1).

*Panjange kubah* Huber, sp. nov.

[urn:lsid:zoobank.org:act:CF978A33-4706-4705-8245-86776DB7E34C](http://urn:lsid:zoobank.org:act:CF978A33-4706-4705-8245-86776DB7E34C)

Figs 6, 63–64, 69–81, 89–91

*Panjange* Bor 109: Huber & Nuñeza 2015: 5, 43–44.

### Diagnosis

Easily distinguished from most congeners by distinctive transversal sclerite on procursus (Fig. 70); from very similar *Pa. seowi* sp. nov. by other details of procursus (unique prolateral process, Figs 69, 77–78; distal element longer, Fig. 70; absence of prolateral ridges on procursus, Fig. 69). Females are easily distinguished from *Pa. nigrifrons* by short scape but difficult to distinguish externally from other congeners in Sarawak (distinctive shape of pore plates and pair of median sclerites; similar only in *Pa. seowi* sp. nov.).

### Etymology

Named for the type locality; noun in apposition.

### Type material

MALAYSIA-BORNEO: holotype, ♂, Sarawak, Kubah National Park, along Waterfall Trail (1.596–1.606° N, 110.180–110.187° E), 200–300 m a.s.l., 12 Jul. 2014 (B.A. Huber, S.B. Huber), ZFMK (Ar 14586).

### Other material examined

MALAYSIA-BORNEO, Sarawak: 2 ♂♂, 7 ♀♀, same data as holotype, ZFMK (Ar 14587–88); 2 ♀♀, 2 juvs, same data, in absolute ethanol, ZFMK (Bor 189).

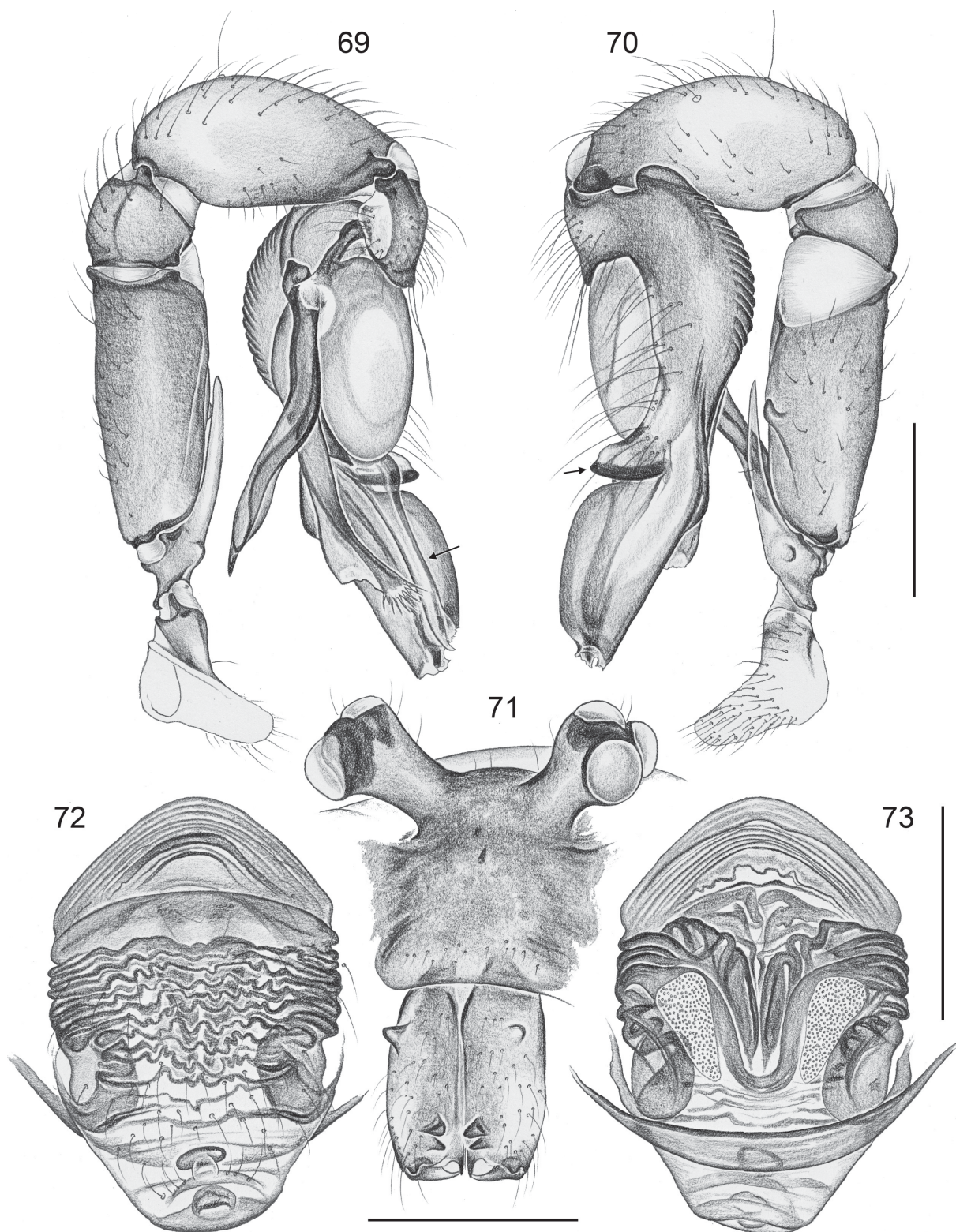
### Description

#### Male (holotype)

MEASUREMENTS. Total body length 4.5, carapace width 1.2. Leg 1: 42.0 (9.3 + 0.5 + 9.6 + 20.1 + 2.5), tibia 2: 6.1, tibia 3: 3.6, tibia 4: 5.6; tibia 1 L/d: 99. Distance PME–PME 445 µm, diameter PME 105 µm, distance PME–ALE ~45 µm; AME absent.

COLOR. Carapace pale ochre yellow to whitish, posterior mark (Fig. 63) lost in ethanol, ocular area and clypeus dark brown (black in life), without black marks in AME area; sternum whitish; legs ochre-orange with dark brown patellae and tibia-metatarsus joints; abdomen ochre-gray, with black marks dorsally, monochromous ventrally.

BODY. Habitus as in Figs 63–64; ocular area raised, each triad on medium long stalk, without pointed process (cf. Fig. 6); carapace without median furrow; clypeus unmodified; sternum wider than long (0.75/0.60), unmodified.



**Figs 69–73.** *Panjange kubah* Huber, sp. nov. (ZFMK Ar 14587–88). **69–70.** Left male palp, prolateral and retrolateral views (arrows point at distinctive processes). **71.** Male ocular area, clypeus, and chelicerae, oblique frontal view. **72–73.** Cleared female genitalia, ventral and dorsal views. Scale lines: 0.5 mm.



**Figs 74–81.** *Panjange kubah* Huber, sp. nov. (ZFMK Ar 14587–88). **74.** Left bulb, prolateral (slightly distal) view. **75.** Tip of left embolus. **76.** Epigynum, ventral view. **77–78.** Left procursus, dorso-distal and prolateral views (arrows point at distinctive membranous process). **79.** Membranous process of left procursus. **80.** Tip of left procursus, distal view. **81.** Female ALS. Abbreviations: a = appendix; b = genital bulb; e = embolus. Scale lines: 10  $\mu$ m (81); 20  $\mu$ m (80); 40  $\mu$ m (79); 80  $\mu$ m (75); 100  $\mu$ m (77–78); 200  $\mu$ m (74, 76).

**CHELICERAE.** Similar to close relatives, with proximal pair of processes and distinctively bipartite distal apophyses (Fig. 71); without modified hairs; without stridulatory ridges.

**PALPS.** As in Figs 69–70; coxa unmodified; trochanter with slightly curved pointed retrolatero-ventral apophysis; femur with curved finger-shaped ventral apophysis; procursus with row of about 17 ventral ridges, with distinctive transversal sclerite and long prolateral process close to large flat distal element (Figs 77–78), with two distinct spiny processes in distal pit (Fig. 80); bulb with strong proximal sclerite, slightly curved appendix, and long partly sclerotized embolus with distinct distal fringes (Figs 74–75).

**LEGS.** Without spines and curved hairs; few vertical hairs; retrolateral trichobothrium on tibia 1 at 2%; prolateral trichobothrium absent on tibia 1, present on other tibiae; tarsus 1 with many pseudosegments but only ~10 distally visible in dissecting microscope.

### Variation

Tibia 1 in 2 other males: 9.1, 9.3. One male with irregular black marks in AME area (Fig. 6).

### Female

In general similar to male but eye triads on low humps, much closer together (distance PME–PME 230 µm). Tibia 1 in 6 females: 6.9–7.9 (mean 7.4). Epigynum weakly sclerotized plate with variably large and variably sclerotized posterior ‘knob’ (Figs 72, 76, 89), internal arch and complex transversal folds visible through cuticle; internal genitalia as in Figs 73, 90–91.

### Natural history

Most specimens were found in a very limited area close to a waterfall. The domed webs had a diameter of about 15–20 cm and in each case the apex of the dome was attached to the underside of a leaf where the spider rested.

### Distribution

Known from type locality in Sarawak only (Fig. 1).

*Panjange seowi* Huber, sp. nov.

[urn:lsid:zoobank.org:act:96424104-A78F-41D3-AA64-65DA79138D21](https://doi.org/10.21203/rs.3.rs-1044441/v1)

Figs 7, 65–68, 82–85, 92–94

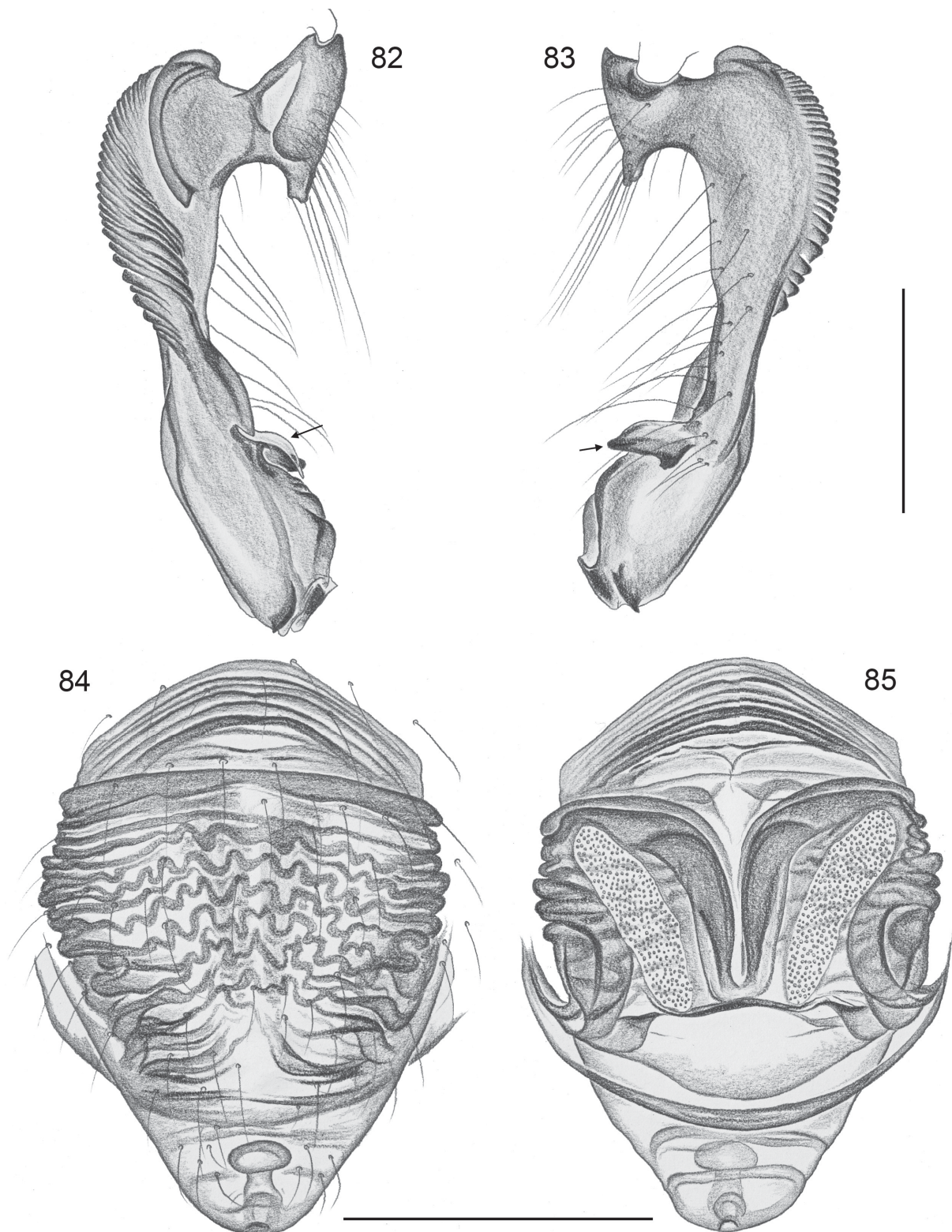
*Panjange* Bor 100: Huber & Nuñez 2015: 5, 43–44.

### Diagnosis

Easily distinguished from most congeners by distinctive transversal sclerite on procursus (Fig. 83); from the very similar *Pa. kubah* sp. nov. by other details of procursus (prolateral ridges on procursus, Fig. 82; small transparent process close to transversal sclerite, Fig. 82; absence of long membranous prolateral process; distal element shorter). Females are easily distinguished from *Pa. nigrifrons* by short scape but difficult to distinguish externally from other congeners in Sarawak (distinctive shape of pore plates and pair of median sclerites; similar only in *Pa. kubah* sp. nov.).

### Etymology

Named for Francis Seow-Choen from Singapore, surgeon and expert on stick insects.



**Figs 82–85.** *Panjange seowi* Huber, sp. nov. (ZFMK Ar 14590–91). **82–83.** Left procursus, prolateral and retrolateral views (arrows point at distinctive processes). **84–85.** Cleared female genitalia, ventral and dorsal views. Scale lines: 0.5 mm.

### Type material

MALAYSIA-BORNEO: holotype, ♂, Sarawak, Mt. Penrissen near Borneo Highland Resort, Ma Gaseng Trail (1.124–1.127° N, 110.217° E), 870–930 m a.s.l., 14 Jul. 2014 (B.A. Huber, S.B. Huber), ZFMK (Ar 14589).

### Other material examined

MALAYSIA-BORNEO, Sarawak: 1 ♂, 4 ♀♀, 1 juv., same data as holotype, ZFMK (Ar 14590-91); 3 ♀♀, 1 juv., same data, in absolute ethanol, ZFMK (Bor 217).

### Description

#### Male (holotype)

MEASUREMENTS. Total body length 4.3, carapace width 1.1. Leg 1: 46.3 (10.4 + 0.5 + 10.5 + 22.1 + 2.8), tibia 2: 6.5, tibia 3: 3.7, tibia 4: 5.7; tibia 1 L/d: 114. Distance PME–PME 375 µm, diameter PME 105 µm, distance PME–ALE ~45 µm; AME absent.

COLOR. Carapace pale ochre yellow to whitish, posterior mark (Fig. 65) lost in ethanol, ocular area and clypeus dark brown (black in life), with pair of black marks in AME area; sternum whitish; legs ochre-orange with dark brown patellae and tibia-metatarsus joints; abdomen ochre-gray, with black marks dorsally, monochromous ventrally.

BODY. Habitus as in Figs 65–66; ocular area raised, each triad on medium long stalk, without pointed process (Fig. 7); carapace without median furrow; clypeus unmodified; sternum wider than long (0.70/0.60), unmodified.

CHELICERAE. Similar to close relatives, with proximal pair of processes and distinctively bipartite distal apophyses (cf. Fig. 71); without modified hairs; without stridulatory ridges.

PALPS. In general very similar to *Pa. kubah* sp. nov. (cf. Figs 69–70), but trochanter apophysis slightly shorter and distally thinner/more pointed; procursus with distinctive prolateral ridges (Fig. 82), with small transparent process close to transversal sclerite (Fig. 82), without long membranous prolateral process, entire distal element shorter (Fig. 83); bulbal processes apparently not distinguishable from those in *Pa. kubah* sp. nov.

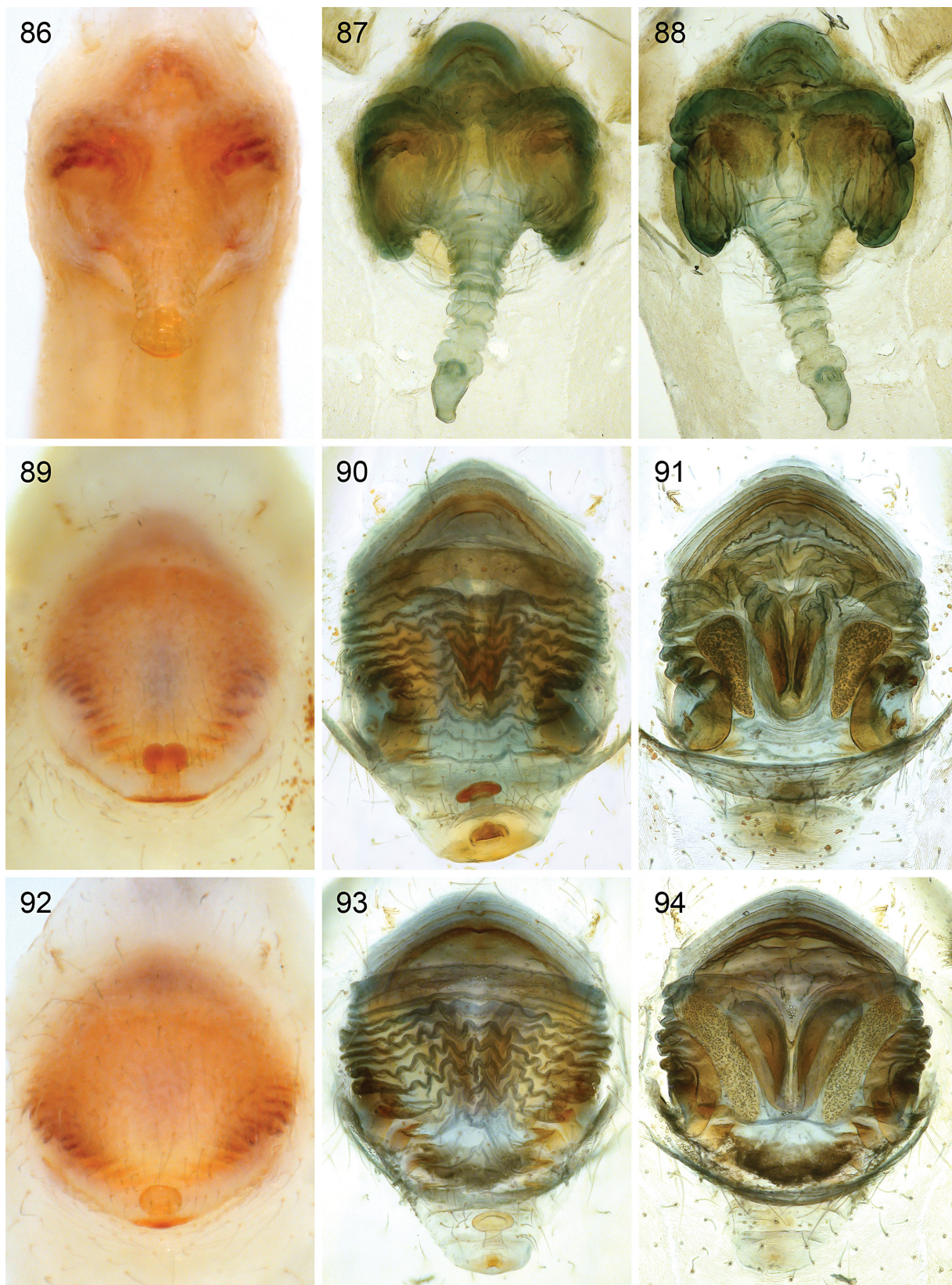
LEGS. Without spines and curved hairs; few vertical hairs; retrolateral trichobothrium on tibia 1 at 2%; prolateral trichobothrium absent on tibia 1, present on other tibiae; tarsus 1 > 40 pseudosegments, proximally very indistinct.

#### Variation

Tibia 1 in other male: 10.3; other male paler and transversal sclerite of procursus without proximal process.

#### Female

In general similar to male but eye triads on low humps, much closer together (distance PME–PME 230 µm). Tibia 1 in 3 females: 7.8, 8.4, 8.8. Epigynum weakly sclerotized plate with large weakly sclerotized posterior ‘knob’ (Figs 84, 92), internal arch and transversal folds visible through cuticle; internal genitalia as in Figs 85, 93–94.



**Figs 86–94.** Female genitalia, untreated in ventral view, cleared in ventral and dorsal views. **86–88.** *Panjange nigrifrons* Deeleman-Reinhold & Deeleman, 1983 (RMNH, Sepaku). **89–91.** *Pa. kubah* Huber, sp. nov. (ZFMK Ar 14588). **92–94.** *Pa. seowi* Huber, sp. nov. (ZFMK Ar 14591).

### Natural history

The domed webs were found under green leaves among vegetation, usually about 0.5 m above the ground.

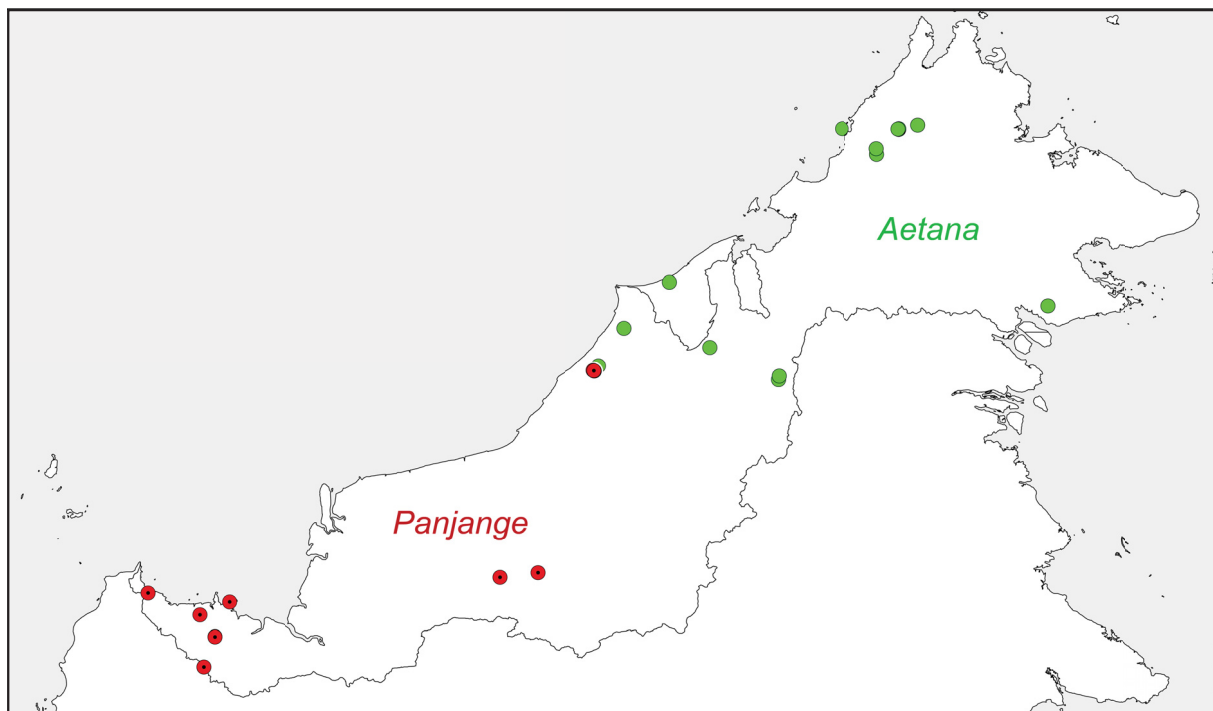
### Distribution

Known from type locality in Sarawak only (Fig. 1).

### Discussion

We document high levels of diversity and endemism of *Panjange* in western Sarawak, but it remains unclear to which extent this can be extrapolated to other, mostly very poorly sampled regions of Borneo. *Panjange* does occur in Kalimantan, but it might be significantly less diverse there than in western Sarawak. A large part of Kalimantan is (or was originally) covered by peat swamp forest that in general is thought to have distinctive but limited diversity (e.g., Mohamedsaid & Holloway 1999; Posa *et al.* 2011). However, at least northern West Kalimantan is expected to have similar high diversity and endemism as western Sarawak, but this region seems to be among the most poorly explored regions worldwide, as far as spiders are concerned.

An extrapolation from Sarawak to unexplored regions in Borneo is particularly problematic in light of our surprising finding that *Panjange* seems to be absent from Sabah. Absence is of course difficult to document but the available data strongly suggest a real pattern rather than an artifact of sampling. First, we sampled with the same methodology and diligence at six localities west of Niah (sea level to 930 m a.s.l.) as we did at nine localities east of Niah (sea level to 1650 m a.s.l.). *Panjange* was found at all six



**Fig. 95.** Known distributions of the genera *Panjange* Deeleman-Reinhold & Deeleman, 1983 and *Aetana* Huber, 2005 in northern Borneo, showing the distinctness of western and eastern regions (distribution of *Aetana* from Huber *et al.* 2015).

localities west of Niah (and in Niah), but in none of the nine localities east of Niah. Second, the same pattern is apparent in the large collections made by C. Deeleman-Reinhold since the 1980s in Sarawak (Bako, Semengoh) and Sabah (Mt. Kinabalu, Poring, Sepilok) (Pholcidae mostly published in Huber 2011). Third, extensive more recent quantitative sampling by A. Floren in Sabah (Crocker Range, Mt. Kinabalu, Tawau) also did not produce a single specimen of *Panjange* (Huber 2011 and B.A. Huber, unpubl. data).

Further evidence suggesting a real pattern comes from another pholcid genus, *Aetana* Huber, 2005. This genus is not particularly close to *Panjange* (same subfamily but not part of the *Pholcus* group of genera like *Panjange*; Huber 2011) but is relevant in this context because it shows the exactly opposite distribution in northern Borneo. We found various species of *Aetana* at eight of nine localities east of Niah (and in Niah), but in none of the six localities west of Niah (Huber *et al.* 2015). Figure 95 summarizes current knowledge about the distributions of *Panjange* and *Aetana* in northern Borneo, combining all known records. Obviously, large sampling gaps remain, and a meaningful interpretation will have to build on a much more intense sampling including Kalimantan. However, data on better studied organisms such as birds have also supported a biogeographical divide between Sabah and Sarawak despite continuous rainforest (Gawin *et al.* 2014; Sheldon *et al.* 2015). These authors mainly suggest historical reasons for this pattern, such as early Pleistocene rainforest refugia in Sabah versus dry habitats in Sarawak (at that time part of central Sundaland). Whether the same explanations apply to spiders as to birds remains to be established.

## Acknowledgements

We thank the Sarawak Museum Department for assistance in field logistics and Samuel B. Huber for help in the field. The Natural History Museum in Kuching kindly offered its facilities as the base of the field work. Permits were received from the Forest Department, Sarawak (Permit No. NCCD.907.4.4(JLD.10)-211, Park Permit No. 174/2014). We thank two anonymous reviewers for commenting on a previous version of the manuscript. The German Research Foundation provided financial support (DFG Project HU 980/11-1).

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*Manuscript received: 5 October 2015*

*Manuscript accepted: 9 December 2015*

*Published on: 24 March 2016*

*Topic editor: Rudy Jocqué*

*Desk editor: Kristiaan Hoedemakers*

Printed versions of all papers are also deposited in the libraries of the institutes that are members of the *EJT* consortium: Muséum national d'Histoire naturelle, Paris, France; Botanic Garden Meise, Belgium; Royal Museum for Central Africa, Tervuren, Belgium; Natural History Museum, London, United Kingdom; Royal Belgian Institute of Natural Sciences, Brussels, Belgium; Natural History Museum of Denmark, Copenhagen, Denmark.

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Autor(en)/Author(s): Huber Bernhard A., Leh Moi Ung Charles

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