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## Research article

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# The Philippine hair wax spiders and their relatives: revision of the *Pholcus bicornutus* species group (Araneae, Pholcidae)

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**Abstract.** We revise the Southeast Asian *Pholcus bicornutus* group in which males are characterized by a unique pair of horns on their ocular area, each of which carries at its tip a brush of hairs. In two species, the two hair brushes are ‘glued’ or ‘waxed’ together by an unidentified substance into a very consistently curved and pointed single median tip. In the other five species known, the hairs are unglued. We present a first revision of ocular modifications in Pholcidae and identify twenty supposedly independent origins. Most cases are in Pholcinae, and all but one case are limited to the male, suggesting sexual selection as the main driving force in the evolution of ocular modifications in Pholcidae. Previously, the *Pholcus bicornutus* group consisted of four species limited to the Philippines. We describe four new species, including three species from the Philippines (*P. olangapo* Huber, sp. nov.; *P. kawit* Huber, sp. nov.; *P. baguio* Huber, sp. nov.) and the first representative from outside the Philippines (*P. mulu* Huber, sp. nov. from Sarawak, NE Borneo) and provide new records and SEM data for three previously described species.

**Keywords.** *Pholcus*, taxonomy, ocular area, sexual dimorphism, ultrastructure.

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## Introduction

When Eugène Simon returned from his expedition to Luzon in 1891, he brought with him, among others, a highly unusual pholcid spider species from caves near Manila. Unlike any other pholcid known at that time, males had a pair of seemingly segmented horns at their ocular region. Simon was clearly

struck by this feature, and devoted the only two figures in the original description of this new species *Pholcus bicornutus* Simon, 1892 to the male ocular region (Simon 1892: figs 3–4). One year later, in his epochal *Histoire Naturelle des Araignées*, he used one of these figures again (Simon 1893: fig. 455). In both editions, the two-segmented horns are illustrated as being more or less parallel in frontal view, with *separate* tips.

More than 100 years later, when preparing the first revision of *Pholcus* Walckenaer, 1805 (Huber 2011a), one of us (BAH) studied Simon's type material of *P. bicornutus*. While one mystery of Simon's 'segmented horns' could be solved, another one appeared. Scanning electron microscopy revealed that what had looked to Simon like 'distal segments' were in fact brushes of hairs that originated at the tips of the 'basal segments'. Strikingly, however, the tips of these hair brushes were not *separate* as illustrated by Simon but appeared like 'glued' or 'waxed' together at their tips (Huber 2011a: figs 1566, 1568). Simon had clearly interpreted this as an artifact, and the latter author tended in the same direction, especially because in all specimens of two newly described close relatives of *P. bicornutus* (*P. arayat* Huber, 2011; *P. pagbilao* Huber, 2011) the hair brushes on the otherwise very similar ocular horns did not look like they were glued together. In addition, sample sizes were small and no scanning electron images could be made of the two new species, so Huber (2011a) did not further dwell on the mysteriously joined hair brushes of *P. bicornutus*.

The present paper revises the *Pholcus bicornutus* group based on much larger samples than previously available and finally presents strong evidence that the 'glued' or 'waxed' hair brushes of *P. bicornutus* are not an artifact. First, in new material of *P. bicornutus* and of a seemingly very closely related species (*P. olangapo* sp. nov.), all twelve available males have the exact same configuration, with the hair brushes joined together and curved in a highly consistent way. Second, photographs of live males of *P. olangapo* sp. nov. show that the joined tips are not an artifact of fixation and preservation. And finally, in none of over 100 studied males of *P. arayat*, *P. pagbilao*, and three newly described species, do the hairs appear glued together in the light microscope, and this impression is supported by scanning electron micrographs of three of these species.

## Material and methods

Most of the material studied herein was collected during recent expeditions to the Philippines (Feb.–Mar. 2014) and to northern Borneo (Jul.–Aug. 2014). Further specimens came from a student project at Mindanao State University - Iligan Institute of Technology dealing with ecological aspects of pholcid diversity in the Philippines. The material is currently deposited at Mindanao State University - Iligan Institute of Technology (MSU-IIT), Philippines; Sarawak Museum, Kuching (SMK), Malaysia; and Zoologisches Forschungsmuseum Alexander Koenig, Bonn (ZFMK), Germany. Additional material came from the California Academy of Sciences, San Francisco (CAS), U.S.A.; the Netherlands Centre for Biodiversity Naturalis, Leiden (RMNH); and the Museum of Zoology, Turku University (ZMT), Finland.

Methods and terminology used are as in Huber (2011a). Measurements are in mm unless otherwise specified. Eye measurements are approx.  $\pm 5 \mu\text{m}$ . Epigyna were cleared in warm NaOH solution and stained with chlorazol black. For SEM photos, specimens were dried in hexamethyldisilazane (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.). Distribution maps were generated with ArcMap 10.0.

**Abbreviations**

a	=	appendix
ALE	=	anterior lateral eye(s)
ALS	=	anterior lateral spinneret(s)
AME	=	anterior median eye(s)
a.s.l.	=	above sea level
b	=	genital bulb
e	=	embolus
f	=	femur
h	=	hinge
L/d	=	length/diameter
p	=	procursus
PME	=	posterior median eye(s)
PMS	=	posterior median spinneret(s)
tr	=	trochanter
u	=	uncus

**Results**

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

*Pholcus* Walckenaer, 1805

*Pholcus* Walckenaer, 1805: 80. Type species by (assumed) monotypy: *Aranea phalangioides* Fuesslin, 1775.

*Pholcus* – Huber 2011a: 124–126.

***Pholcus bicornutus* species group****Diagnosis**

Large, long-legged *Pholcus* (body length ~5–8, male leg 1 length: ~40–60) with cylindrical abdomen, eight eyes, and rather dark coloration; distinguished from similar insular Southeast Asian species groups (*P. gracillimus* group; *P. ancoralis* group; cf. Huber 2011a) by male ocular area with unique pair of processes, each carrying brush of hairs (Figs 12–13, 63–67, 78, 92) (*P. ancoralis* group also with horns but without brushes of hairs), by male palpal tibia very large relative to femur (in contrast to *P. ancoralis* species group), and by paired anterior marks in dorsal abdominal pattern (Figs 3, 36, 50, 55; unpaired in *P. gracillimus* and *P. ancoralis* groups).

**Description – amendments**

The original description of the species group (Huber 2011a) is still largely valid. The following are minor updates and additions: body length ~5–8, carapace width 1.3–1.8. Male distal cheliceral apophyses provided with 2–3 modified hairs each (Figs 20, 73, 85, 96). Tibia 1 length in males ~9.5–16.0, in females ~7.5–14.0; male tibia 1 L/d ~65–80; legs either with curved hairs (tibiae and metatarsi 1–2; *P. bicornutus*, *P. olangapo* sp. nov.) or without curved hairs (other species). Abdomen cylindrical, with cuticular color pattern dorsally (also in *P. bicornutus*), anterior element always paired. ALS with one widened, one pointed, and variable number of smaller spigots: either six cylindrically-shaped spigots

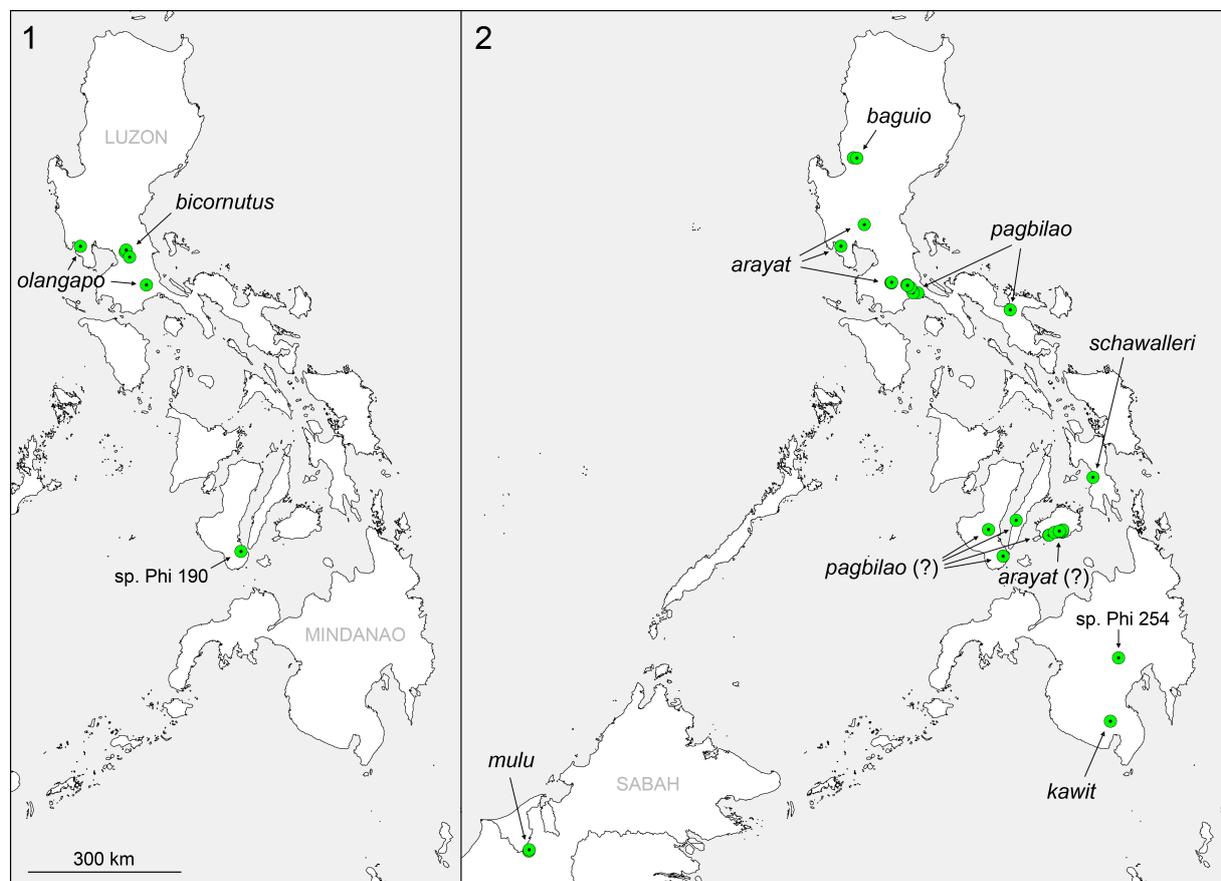
of ‘usual’ size (i.e., ~3–8 µm wide and ~5–8 µm long; Figs 19, 21, 100, 102), or only three to five very small conical spigots (i.e., ~1.5–3 µm wide and ~3–6 µm long; Figs 74, 76, 88, 90).

### Composition

The eight species assigned to this group are here divided into two operational sub-groups:

(1) A sub-group of two species (*P. bicornutus* Simon, 1892; *P. olangapo* sp. nov.), sharing the following similarities: absence of male bulbal appendix (Fig. 7); procurus with hinged distal element and with distinctive prolatero-dorsal process (Figs 8, 17); male palpal tibia ventrally unmodified; hairs of ocular processes ‘glued’ or ‘waxed’ together (Figs 12–13, 15); epigynum with small epigynal plate and large membranous area in front of plate (Fig. 24); proximal lateral processes on male chelicerae large (Fig. 9); and presence of curved hairs on tibiae and metatarsi 1–2. A third (unnamed) species occurs on Negros Island (“sp. Phi 190” in Fig. 1; 1 ♀, 1 juv. from Twin Lakes National Park, in ZFMK).

(2) A sub-group of six species (*P. arayat* Huber, 2011; *P. mulu* sp. nov.; *P. baguio* sp. nov.; *P. kawit* sp. nov.; *P. pagbilao* Huber, 2011; *P. schawalleri* Yao *et al.*, 2014), sharing the alternative character states: presence of male bulbal appendix (Figs 40, 45); procurus without hinged distal element and without dorsal process (Figs 41, 46); male palpal tibia with small ventral cavity to accommodate proximal bulbal sclerite in resting position (arrow in Fig. 45); hairs of ocular processes not ‘glued’ or ‘waxed’ together (Figs 65–66, 78); epigynum with large epigynal plate (Figs 27, 30, 33); proximal lateral processes on male chelicerae small (Figs 42, 47); no curved hairs on legs. A possible further species occurs on Mindanao, but it is represented by two juvenile specimens only (“sp. Phi 254” in Fig. 2; from Marilog



**Figs 1–2.** Known distributions of the two subgroups of the *Pholcus bicornutus* species group.

Distr., Baganihan, in ZFMK). The undescribed species from Mt. Apo mentioned in Huber (2011a: 315) was restudied and found to belong to another species group.

### Natural history

Seven of the eight named species were observed in the field. They occupied a variety of microhabitats, ranging from caves (close to the ground; *P. bicornutus*) and wet rock walls (*P. olangapo* sp. nov.) to dark sheltered spaces among rocks (*P. mulu* sp. nov., *P. baguio* sp. nov., *P. pagbilao*), large holes at tree bases (*P. kawit* sp. nov.), abandoned buildings (*P. pagbilao*), and open space among vegetation exposed to direct sunlight (*P. arayat*). Webs mainly consisted of a domed sheet with a diameter of up to ~50 cm (*P. mulu* sp. nov.), but were much smaller in the rock-dwelling *P. olangapo* sp. nov. (~15 cm). In *P. baguio* sp. nov., webs were connected to each other and formed large communal structures up to 2 m in length. When disturbed, most species were observed to run toward the periphery of the web, seeking shelter at the substrate rather than staying and whirling in the web.

### Distribution

The *Pholcus bicornutus* group is largely restricted to the Philippines, with only one species in NE Borneo (Figs 1–2).

#### *Pholcus bicornutus* Simon, 1892

*Pholcus bicornutus* Simon, 1892: 41–42, pl. 2, figs 3–4.

*Pholcus bicornutus* – Simon 1893: 466–468, figs 455, 458. — Huber 2011a: 315–318, figs 1509–1513, 1539–1540, 1560–1573.

### Diagnosis (updated)

Distinguished from most similar known relative (*P. olangapo* sp. nov.) by absence of dark lateral bands on carapace (in males and females), and by procurus shape (prolatero-dorsal process of proximal part longer and more slender; entire distal hinged part of procurus longer and more slender; distinctive shapes of procurus tip and of unculus; figs 1560–1561 in Huber 2011a). From other species of the *P. bicornutus* group (*P. pagbilao*, *P. arayat*, *P. schawalleri*, *P. baguio* sp. nov., *P. mulu* sp. nov., *P. kawit* sp. nov.) by hinged procurus, small epigynal plate, undivided dark band ventrally on abdomen (also in *P. kawit* sp. nov. and *P. mulu* sp. nov.), and by presence of slightly curved hairs on legs (especially on tibiae and metatarsi 1–2).

### New material examined

PHILIPPINES: 1 ♂, 8 ♀♀, Luzon, Rizal Prov., near Antipolo, Mystical Cave (14.606° N, 121.209° E), 160 m a.s.l., in cave near entrance, 11 Mar. 2014 (B.A. Huber), ZFMK (Ar 15495); 2 ♀♀, 2 juvs, in absolute ethanol, same data, ZFMK (Phi 185).

### Note

Simon (1892) described this species from two caves, “Cueva de San Mateo” and “Cueva de Antipolo”. The first is possibly identical to what is now called “Pamitinan Cave” (14.731° N, 121.190° E) which in turn may be identical to what in Huber (2011a) is cited as “Montalban Cave” (correct spelling: “Montalban Cave”). The second is presumably identical to what is now called “Mystical Cave” (14.606° N, 121.209° E). The distance between these two caves is just 14 km. However, as noted previously after examination of Simon’s type specimens (Huber 2011a), males from the two caves differ slightly in details of the procurus, and the specimens from Mystical Cave are assigned tentatively to this species (the lectotype, designated in Huber 2011a, is from “Cueva de San Mateo”).

### Variation

Tibia 1 in newly examined male: 12.9; in 6 newly examined females: 10.4–12.0 (mean: 11.2).

### Natural history

The spiders were found within the cave close to the cave entrance; no specimen was found deeper in the cave. The spiders built their domed sheets among rocks close to the ground.

### Distribution

Known from two caves near Manila only (Fig. 1).

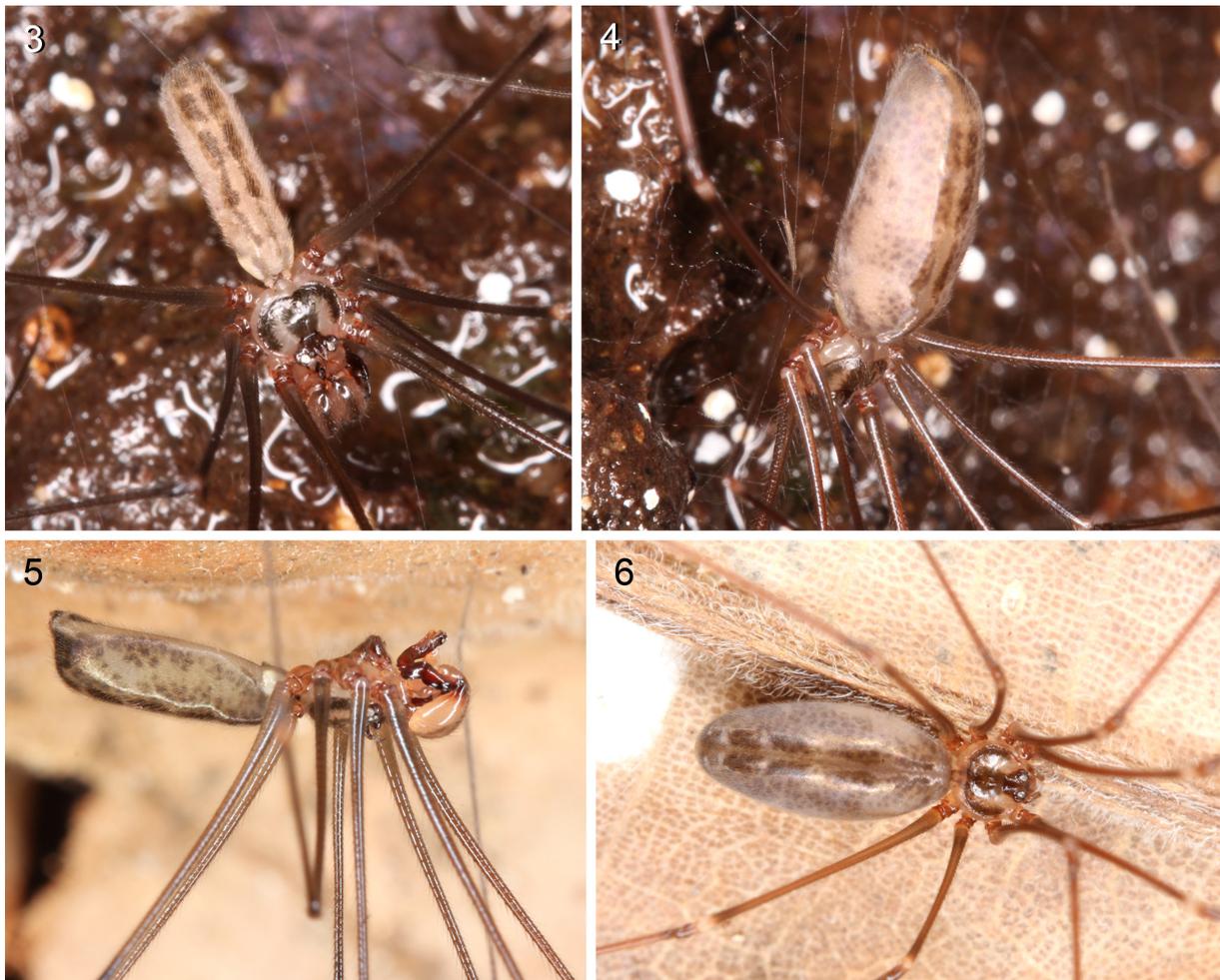
*Pholcus olangapo* Huber, sp. nov.

[urn:lsid:zoobank.org:act:1CD3A2E0-1528-4D37-9BFD-82B752CA13C5](https://zoobank.org/act:1CD3A2E0-1528-4D37-9BFD-82B752CA13C5)

Figs 3–26

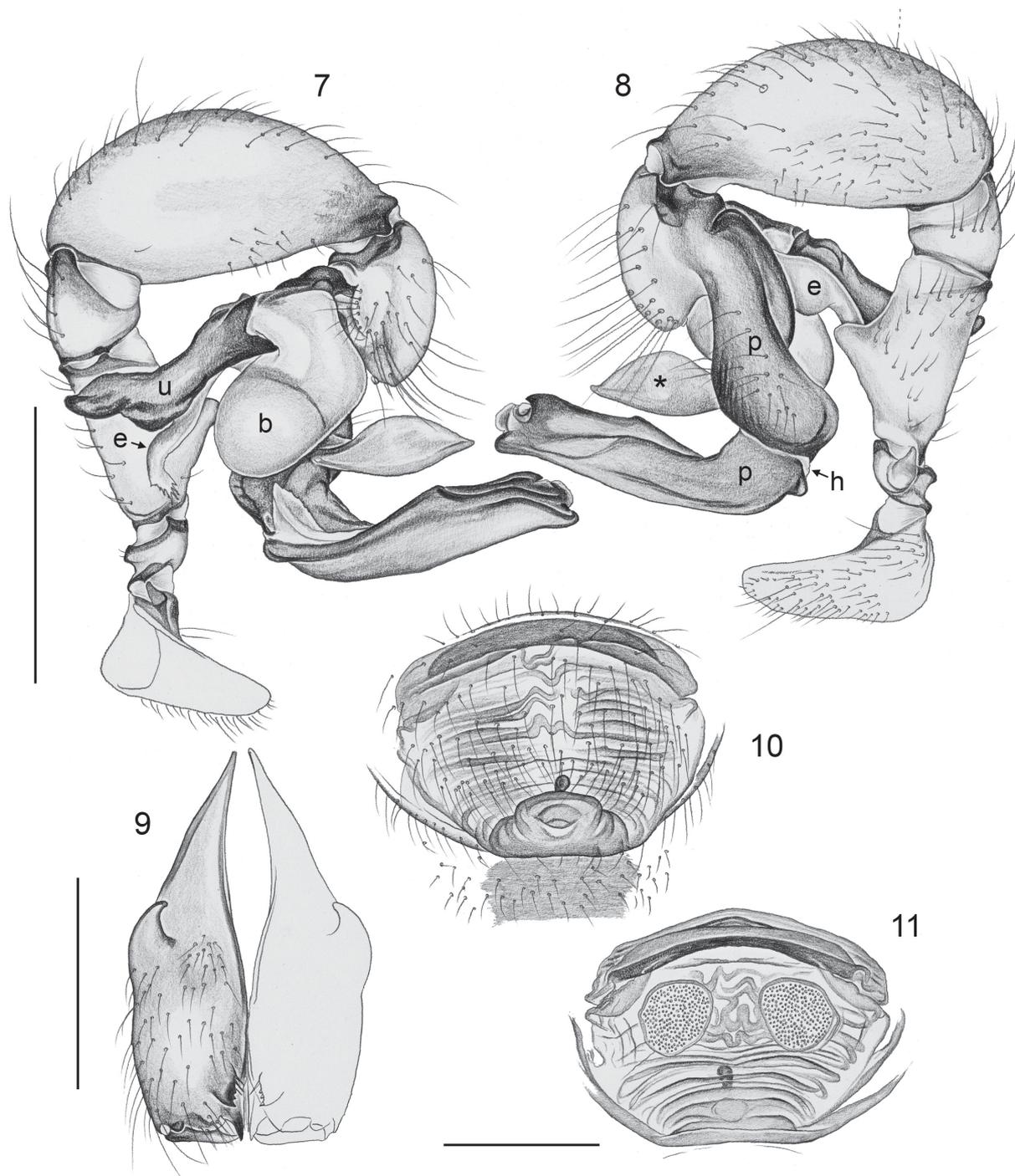
### Diagnosis

Distinguished from most similar known relative (*P. bicornutus*) by dark lateral bands on carapace (in males and females; Figs 3, 6), and by procurus shape (prolatero-dorsal process of proximal part shorter



**Figs 3–6.** Live specimens, *Pholcus olangapo* Huber, sp. nov., Pamulaklakin Forest Trail. **3–4.** ♂ and ♀ in their natural habitat. **5–6.** ♂ and ♀ photographed on a dead leaf.

and wider; entire distal hinged part of procurus shorter and wider; distinctive shapes of procurus tip and of uncus; Figs 7–8). From other species of the *P. bicornutus* group (*P. pagbilao*, *P. arayat*, *P. schawalleri*, *P. baguio* sp. nov., *P. mulu* sp. nov., *P. kawit* sp. nov.) by hinged procurus, small epigynal plate (Fig. 24), undivided dark band ventrally on abdomen (also in *P. kawit* sp. nov. and *P. mulu* sp. nov.), and by presence of slightly curved hairs on legs (especially on tibiae and metatarsi 1–2).



**Figs 7–11.** *Pholcus olangapo* Huber, sp. nov., ZFMK Ar 15497–98. 7–8. Left male palp, prolateral and retrolateral views (asterisk marks prolatero-dorsal process of procurus). 9. Male chelicerae, frontal view. 10–11. Cleared female genitalia, ventral and dorsal views. Scale lines: 7–8 = 1 mm; 9–11 = 0.5 mm.

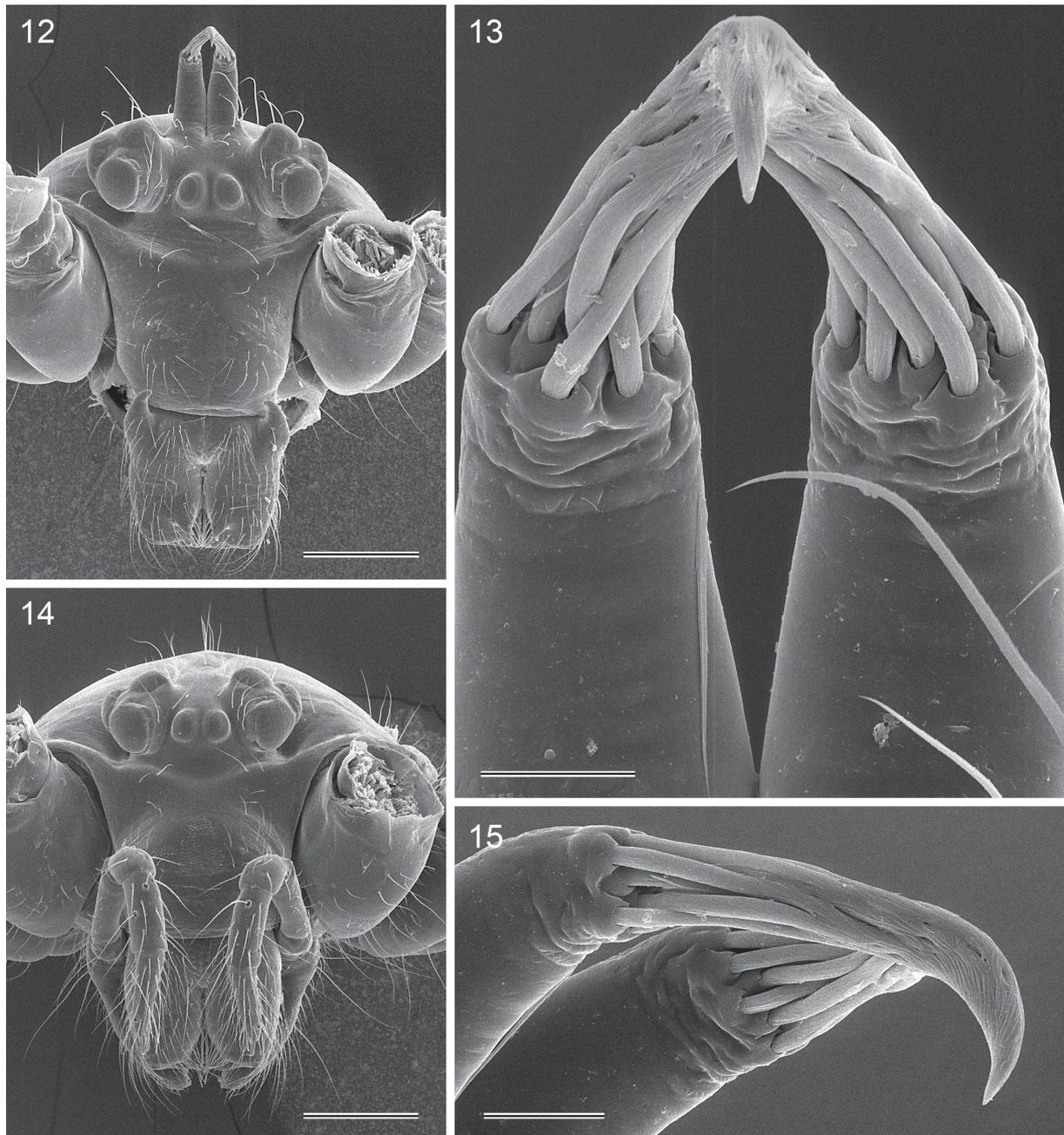
### Etymology

The species name is derived from the type locality; noun in apposition.

### Material examined

#### Holotype

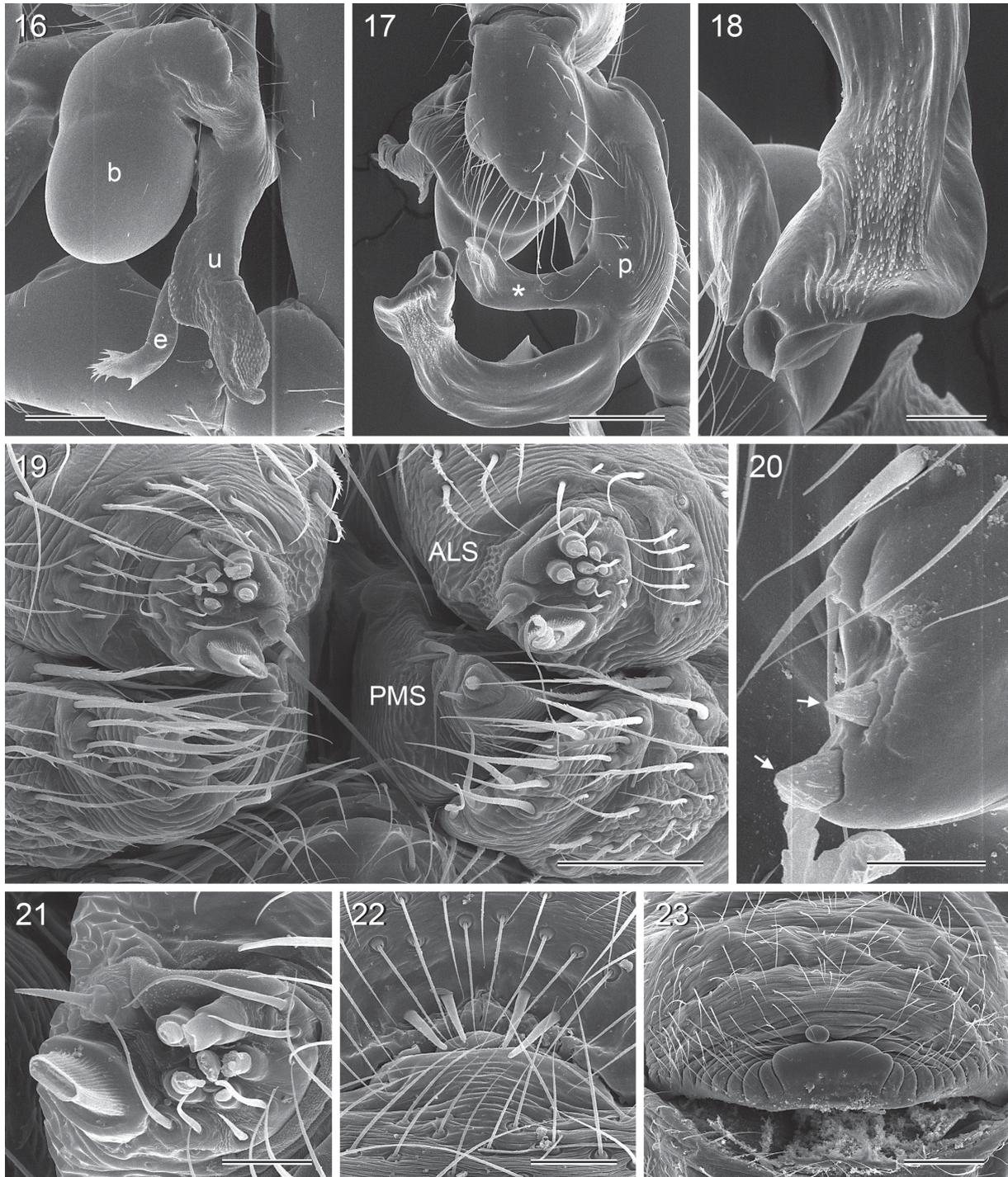
PHILIPPINES: ♂, Luzon, Bataan Prov., near Olangapo, along river near Pamulaklakin Forest Trail (14.798° N, 120.338° E), 80 m a.s.l., on wet rock wall, 28 Feb. 2014 (B.A. Huber), ZFMK (Ar 15496).



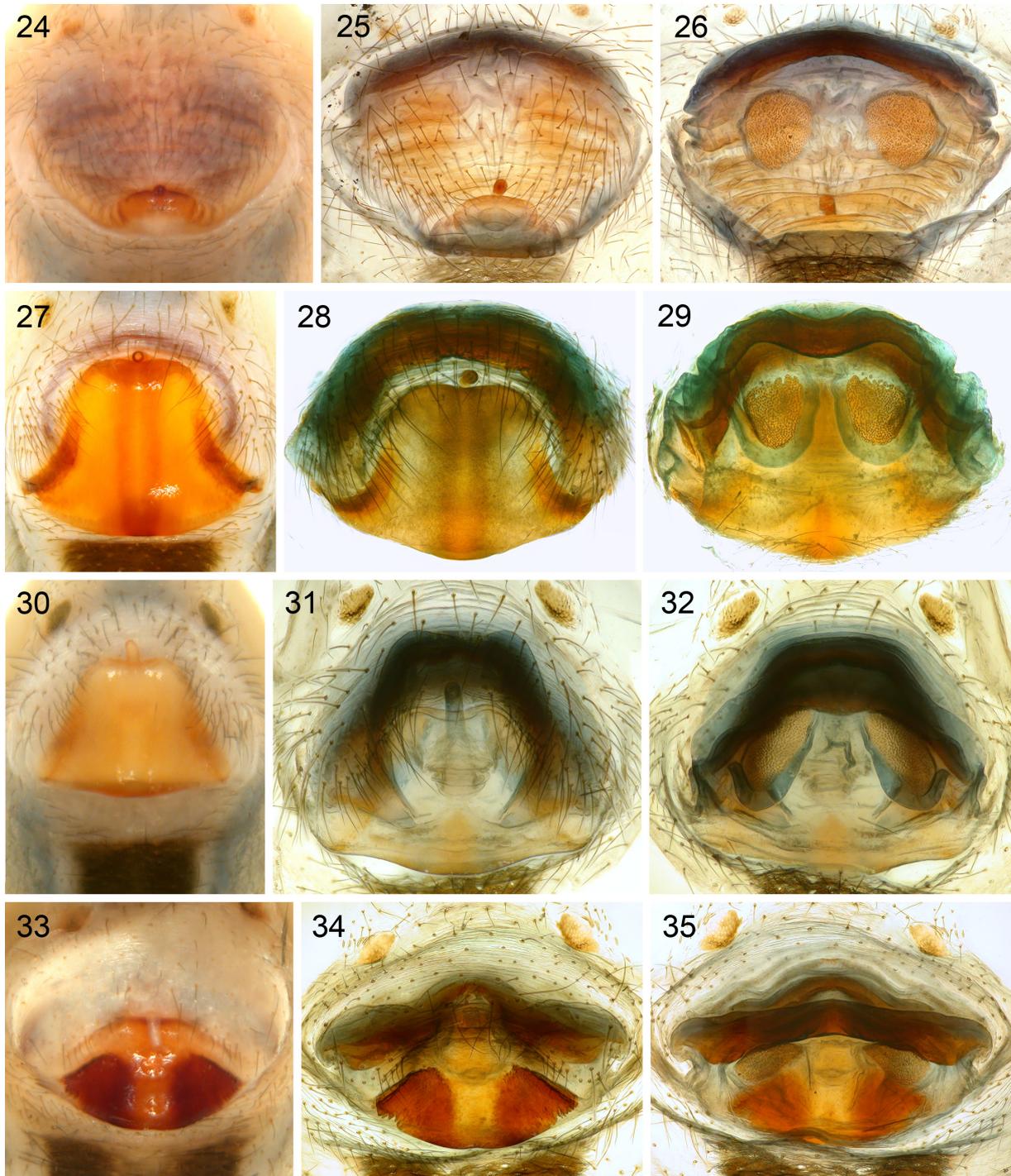
**Figs 12–15.** *Pholcus olangapo* Huber, sp. nov., ZFMK Ar 15497–98. **12.** Male prosoma, frontal view. **13, 15.** Male ocular horns with modified and ‘glued’ or ‘waxed’ hairs, frontal and lateral views. **14.** Female prosoma, frontal view. Scale lines: 12, 14 = 400  $\mu$ m; 13 = 50  $\mu$ m; 15 = 60  $\mu$ m.

**Other material**

PHILIPPINES: 9 ♂♂, 10 ♀♀, 3 juvs, ZFMK (Ar 15497–98) and 1 ♂, 1 ♀, MSU-IIT, same data as holotype; 2 ♀♀, 5 juvs, in absolute ethanol, same data, ZFMK (Phi 207).



**Figs 16–23.** *Pholcus olangapo* Huber, sp. nov., ZFMK Ar 15497–98. **16.** Right genital bulb, prolateral view. **17.** Left tarsus and procurcus, dorsal view (asterisk marks prolatero-dorsal process of procurcus). **18.** Tip of left procurcus, dorsal view. **19.** Female spinnerets. **20.** Male cheliceral apophysis (arrows point at modified hairs). **21.** Male ALS. **22.** Male gonopore. **23.** Epigynum. Scale lines: 16, 23 = 200  $\mu$ m; 17 = 300  $\mu$ m; 18 = 100  $\mu$ m; 19 = 70  $\mu$ m; 20–21 = 20  $\mu$ m; 22 = 40  $\mu$ m.



**Figs 24–35.** Epigyna, ventral views, and cleared female genitalia, ventral and dorsal view. **24–26.** *Pholcus olangapo* Huber, sp. nov., ZFMK Ar 15498. **27–29.** *Pholcus mulu* Huber, sp. nov., ZFMK Ar 15502. **30–32.** *Pholcus kawit* Huber, sp. nov., ZFMK Ar 15505. **33–35.** *Pholcus baguio* Huber, sp. nov., ZFMK Ar 15508.

**Assigned tentatively**

PHILIPPINES: 1 ♀, Luzon, Laguna Prov., Mt. Banahaw, forest near Taytay Falls (14.110° N, 121.507° E), 560 m a.s.l., 26 Feb. 2014 (B.A. Huber), ZFMK (Ar 15499).

**Description****Male (holotype)**

MEASUREMENTS. Total body length 6.0, carapace width 1.6. Leg 1: 42.7 (10.1 + 0.7 + 10.4 + 19.0 + 2.5), tibia 2: 7.2, tibia 3: 4.8, tibia 4: 6.7; tibia 1 L/d: 64. Distance PME-PME 370 µm, diameter PME 150×180 µm, distance PME-ALE ~40 µm, distance AME-AME 30 µm, diameter AME 100 µm.

COLOR. Carapace pale ochre to light brown, with wide median dark brown mark including ocular area and connecting posteriorly to wide lateral marginal bands (Fig. 3); clypeus pale ochre; sternum brown, with three pairs of light ochre marginal marks at bases of coxae 2–4; legs light brown to ochre, dark rings subdistally on femora and tibiae and in patella area, tips of femora and tibiae lighter; abdomen ochre-gray, dorsally with several pairs of indistinct cuticular marks, with distinct internal darker marks visible through cuticle dorsally and laterally; ventrally with undivided wide brown band between gonopore and spinnerets.

BODY. Habitus as in Figs 3 and 5; ocular area raised, each eye triad on additional short hump directed towards lateral (Fig. 12), with pair of long processes between eye triads, each with distal brush of hairs that are ‘glued’ or ‘waxed’ together to form consistently curved pointed tip (Figs 13, 15); carapace without median furrow; clypeus unmodified; sternum wider than long (1.00/0.75), unmodified. ALS with one widened, one pointed, and six cylindrically shaped spigots of variable sizes (Fig. 21). Gonopore with four epiandrous spigots (Fig. 22).

CHELICERAE. As in Fig. 9, with large lateral apophyses and low frontal humps proximally, dark distal apophyses near median line provided with two small modified (cone-shaped) hairs each (Fig. 20); without stridulatory ridges.

PALPS. As in Figs 7–8; coxa unmodified; trochanter with retrolateral pointed process; femur with distinct ventral process and indistinct retrolateral hump proximally; tibia with dark dorsal band, without ventral cavity; procurus complex and hinged, proximal part with distinctive prolatero-dorsal process (Fig. 17), distal part with prolateral membranous flap and distinctive tip (Fig. 18); bulb with long, distinctively curved uncus, weakly sclerotized embolus distally curved, without appendix (Fig. 16).

LEGS. Without spines; with weakly curved hairs on tibiae and metatarsi 1–2; few vertical hairs; retrolateral trichobothrium on tibia 1 at 4%; prolateral trichobothrium absent on tibia 1, present on other tibiae; tarsus 1 with >30 pseudosegments, only distally about 10 fairly distinct.

**Male (variation)**

Tibia 1 in 10 other males: 9.6–11.4 (mean: 10.4).

**Female**

In general similar to male but eye triads closer together (distance PME-PME 210 µm), without processes between eye triads (Fig. 14). Tibia 1 in 11 females from type locality: 8.6–10.5 (mean: 9.2). Epigynum mostly weakly sclerotized, small posterior plate with small ‘knob’ (Figs 23–24); some females with strongly protruding epigynal area (apparently expandable); internal genitalia as in Figs 11 and 26. Spinnerets as in Fig. 19, ALS with one widened, one pointed, and six cylindrically shaped spigots of variable sizes, PMS with two spigots each. The single female specimen from Mt. Banahaw shares the carapace pattern and is thus tentatively assigned to this species rather than to *P. bicornutus* (in which the

female genitalia appear indistinguishable; compare figs 1539 and 1564 in Huber 2011a with Figs 11 and 24 herein); tibia 1: 9.7.

### Natural history

At the type locality, specimens were collected from small webs attached to a perpendicular, dripping wet rock wall beside a small stream (Figs 3–4).

### Distribution

Known from two localities in Luzon only (single female specimen from Mt. Banahaw assigned tentatively, see above; Fig. 1).

*Pholcus mulu* Huber, sp. nov.

[urn:lsid:zoobank.org:act:36311195-45A6-4B19-BFD2-31C0687775FE](https://doi.org/10.3896/eb.2016.225.1.1)

Figs 27–29, 36–37, 40–44

### Diagnosis

Easily distinguished from most similar known relatives (species with horns between eye triads carrying brushes of unglued hairs and with simple, unhinged procursi: *P. arayat*, *P. pagbilao*, *P. schawalleri*, *P. baguio* sp. nov., *P. kawit* sp. nov.) by large round uncus with pointed process (Fig. 40) and by large prolateral sclerite distally on procurus (Fig. 40); from most species (except *P. kawit* sp. nov.) also by undivided median dark band ventrally on abdomen (Fig. 37). From other species of the *P. bicornutus* group (*P. bicornutus* and *P. olangapo* sp. nov.) by unhinged procurus, presence of appendix, large epigynal plate, and by absence of curved hairs on legs.

### Etymology

The species name is derived from the type locality, noun in apposition.

### Material examined

#### Holotype

MALAYSIA-BORNEO: ♂, Sarawak, Gunung Mulu National Park, forest near Deer Cave (4.027° N, 114.818° E), 60 m a.s.l., among rocks, 23 Jul. 2014 (B.A. Huber, S.B. Huber), ZFMK (Ar 15500).

#### Other material

MALAYSIA-BORNEO: 2 ♂♂, 10 ♀♀, ZFMK (Ar 15501–02) and 1 ♂, 1 ♀, SMK, same data as holotype; 1 ♂, 1 ♀, 1 juv., in absolute ethanol, same data, ZFMK (Bor 238); 2 ♂♂, 4 ♀♀, 1 juv., Gunung Mulu National Park, forest near Lagang Cave (4.051° N, 114.822° E), 60 m a.s.l., domed webs among rocks, 24 Jul. 2014 (B.A. Huber, S.B. Huber), ZFMK (Ar 15503).

### Description

#### Male (holotype)

MEASUREMENTS. Total body length 6.8, carapace width 1.7. Leg 1: 62.9 (14.4 + 0.8 + 15.1 + 28.5 + 4.1), tibia 2: 9.6, tibia 3: 6.0, tibia 4: 8.4; tibia 1 L/d: 94. Distance PME-PME 480 µm, diameter PME 180 µm, distance PME-ALE ~40 µm; distance AME-AME 50 µm, diameter AME 80 µm.

COLOR. Carapace pale ochre, with wide median brown mark including ocular area, without lateral marks (Fig. 36); clypeus not darkened; sternum dark brown; legs in live specimens bluish, in alcohol ochre to light brown, tips of femora and tibiae whitish; abdomen pale gray, dorsally with dark cuticular marks that are fused above spinnerets, with indistinct internal darker marks visible through cuticle dorsally and laterally; ventrally with undivided wide brown band between gonopore and spinnerets.

**BODY.** Habitus as in Figs 36–37; ocular area raised, each eye triad on additional short hump directed towards lateral, with pair of processes between eye triads, each with distal brush of hairs; carapace without median furrow; clypeus unmodified; sternum wider than long (1.00/0.85), unmodified.

**CHELICERAE.** As in Fig. 42, with small lateral and frontal apophyses proximally and dark distal apophyses near median line provided with two small modified (cone-shaped) hairs each; without stridulatory ridges.

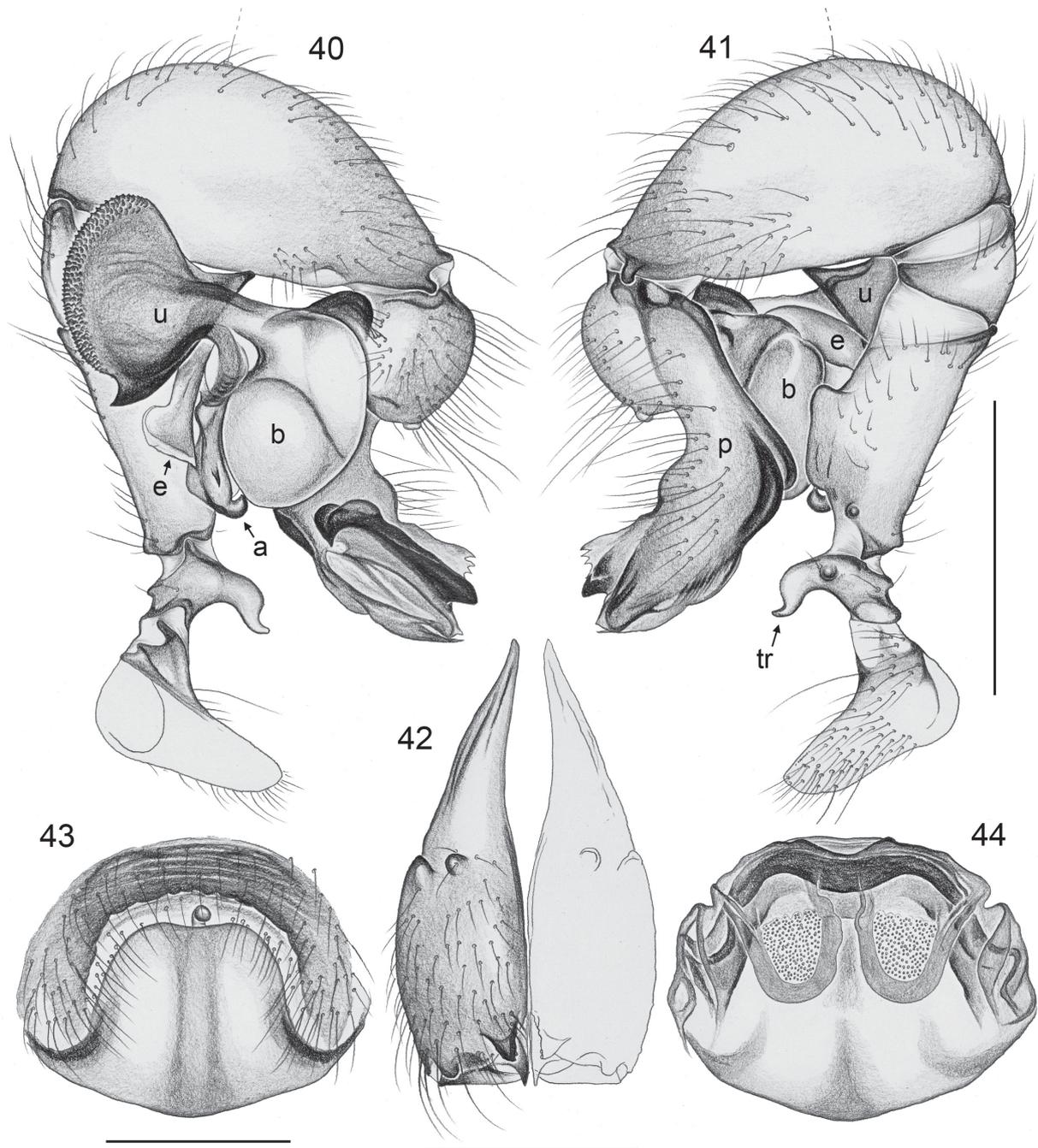
**PALPS.** As in Figs 40–41; coxa unmodified; trochanter with retrolateral process and S-shaped ventral apophysis; femur with small dorsal hump proximally, finger-shaped retrolateral process proximally, and



**Figs 36–39.** Live specimens. **36–37.** *Pholcus mulu* Huber, sp. nov., ♂, Gunung Mulu. **38–39.** *Pholcus kawit* Huber, sp. nov., ♂ and ♀, Mt. Matutum.

distinct ventral process; tibia large, with small but distinct ventral cavity (for proximal bulbal sclerite); procurus complex distally, with distinctive prolateral sclerite and membranous structures; bulb with large rounded uncus with pointed process, weakly sclerotized and distally widening embolus, appendix with small prolateral spine, distally curved towards retrolateral.

LEGS. Without spines or curved hairs; few vertical hairs; retrolateral trichobothrium on tibia 1 at 3.5%; prolateral trichobothrium absent on tibia 1, present on other tibiae; tarsus 1 with >30 pseudosegments, only distally about 20 fairly distinct.



**Figs 40–44.** *Pholcus mulu* Huber, sp. nov., ZFMK Ar 15501–02. **40–41.** Left male palp, prolateral and retrolateral views. **42.** Male chelicerae, frontal view. **43–44.** Cleared female genitalia, ventral and dorsal views. Scale lines: 40–41 = 1 mm; 42–44 = 0.5 mm.

**Male** (variation)

Internal dark abdominal marks more distinct in other males. Tibia 1 in 5 other males: 13.9–16.0 (mean 14.9).

**Female**

In general similar to male but ocular area less elevated, eye triads closer together (distance PME-PME 320  $\mu\text{m}$ ), without processes between eye triads. Tibia 1 in 13 females: 12.3–14.0 (mean 13.3). Epigynum large trapezoidal plate (Figs 27, 43) with anterior ‘knob’; internal genitalia as in Figs 29 and 44, anterior sclerite medially distinctively curved backwards. ALS with one widened, one pointed, and five very small conical spigots ( $\sim 1.5\text{--}3\ \mu\text{m}$  wide and  $\sim 3\text{--}6\ \mu\text{m}$  long).

**Natural history**

Specimens were found in large domed sheet webs (diameter up to  $\sim 50\ \text{cm}$ ) among rocks near the ground. When disturbed they moved very rapidly towards the periphery of the web.

**Distribution**

Known from type locality in Sarawak only (Fig. 2).

*Pholcus kawit* Huber, sp. nov.

[urn:lsid:zoobank.org:act:92029EA1-F343-406C-8D5F-AD6D9F5820C3](https://zoobank.org/urn:lsid:zoobank.org:act:92029EA1-F343-406C-8D5F-AD6D9F5820C3)

Figs 30–32, 38–39, 45–49

**Diagnosis**

Easily distinguished from most similar known relatives (species with horns between eye triads carrying brushes of unglued hairs and with simple, unhinged procursi: *P. arayat*, *P. pagbilao*, *P. schawalleri*, *P. baguio* sp. nov., *P. mulu* sp. nov.) by distal modifications of procursus (dorsal pointed process; Fig. 46); from most species also by female genitalia (epigynum large trapezoidal plate - Fig. 30; similar in *P. pagbilao* and *P. mulu* sp. nov.); from most species (except *P. mulu* sp. nov.) also by undivided dark median band ventrally on abdomen (Fig. 39); from *P. pagbilao* also by simpler appendix (Fig. 45); from *P. arayat* also by wider abdomen (Figs 38–39); from *P. schawalleri* also by more slender uncus (Fig. 45). From other species of the *P. bicornutus* group (*P. bicornutus* and *P. olangapo* sp. nov.) by unhinged procursus, presence of appendix, large epigynal plate, and by absence of curved hairs on legs.

**Etymology**

The species name is derived from the type locality; noun in apposition.

**Material examined****Holotype**

PHILIPPINES: ♂, Mindanao, Mt. Matutum, Kawit Forest, ‘site 1’ (6.338° N, 125.104° E), 950 m a.s.l., along brook, among rocks and tree roots, 13 Feb. 2014 (B.A. Huber), ZFMK (Ar 15504).

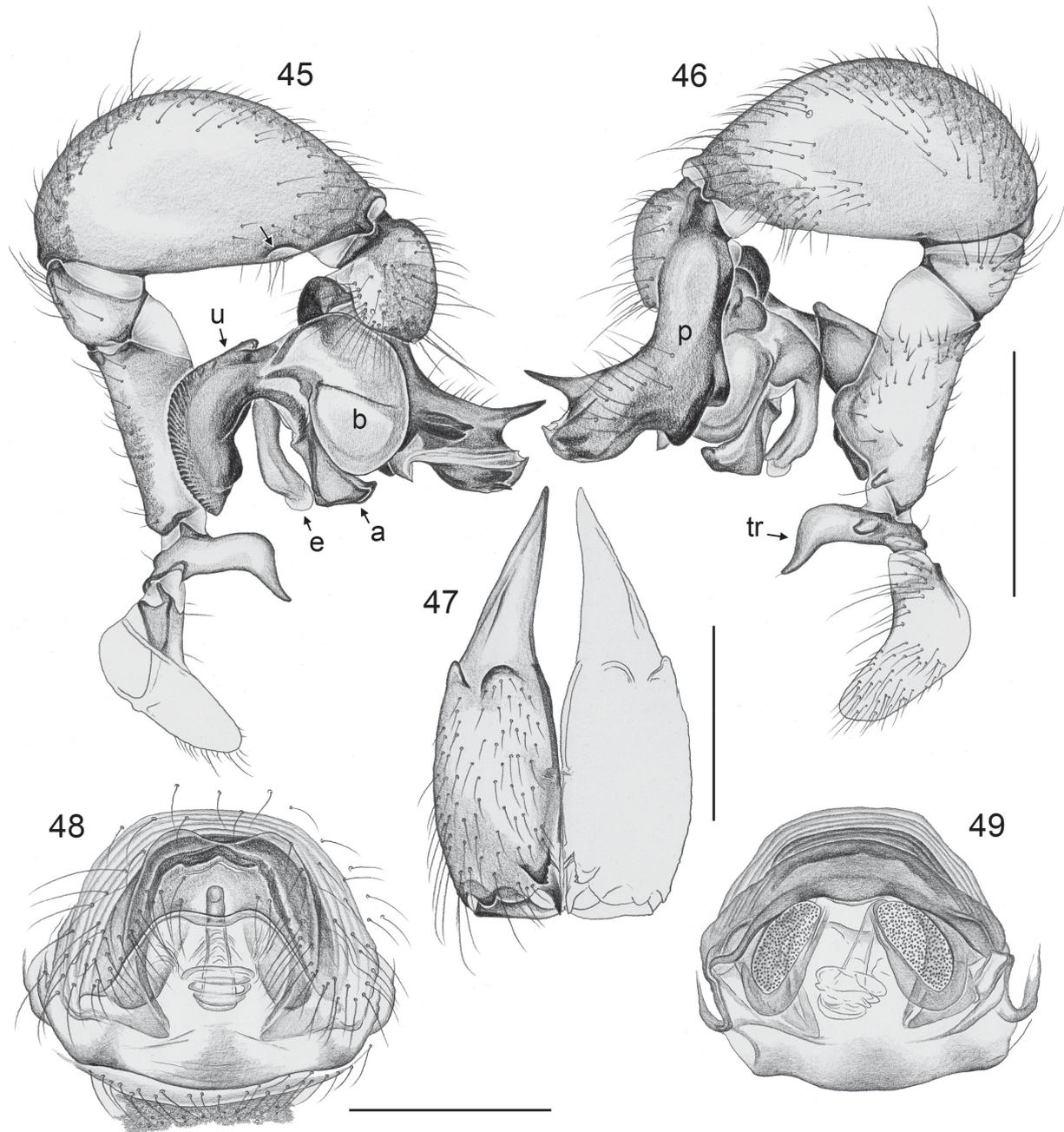
**Other material**

PHILIPPINES: 2 ♂♂, 1 ♀, 3 juvs, ZFMK (Ar 15505), same data as holotype; 3 juvs, in absolute ethanol, ZFMK (Phi 267), same data.

**Description****Male** (holotype)

MEASUREMENTS. Total body length 8.0, carapace width 1.8. Leg 1: 52.5 (12.7 + 0.7 + 12.7 + 23.7 + 2.7), tibia 2: 8.4, tibia 3: 5.3, tibia 4: 7.5; tibia 1 L/d: 78. Distance PME-PME 370  $\mu\text{m}$ , diameter PME 140 $\times$ 170  $\mu\text{m}$ , distance PME-ALE  $\sim 50\ \mu\text{m}$ , distance AME-AME 30  $\mu\text{m}$ , diameter AME 90  $\mu\text{m}$ .

COLOR. Carapace pale ochre to orange, with wide median dark brown mark including ocular area and small brown submarginal marks laterally (Fig. 38); clypeus light brown; sternum monochromous light brown to orange, labium darker; legs light brown to ochre, dark rings subdistally on femora and tibiae and in patella area, tips of femora and tibiae lighter; abdomen ochre-gray, dorsally with several pairs of dark cuticular marks that are fused above spinnerets, with distinct internal darker marks visible through cuticle dorsally and laterally; ventrally with undivided wide brown band between gonopore and spinnerets.



**Figs 45–49.** *Pholcus kawit* Huber, sp. nov., ZFMK Ar 15505. **45–46.** Left male palp, prolateral and retrolateral views (arrow points at ventral cavity of tibia). **47.** Male chelicerae, frontal view. **48–49.** Cleared female genitalia, ventral and dorsal views. Scale lines: 45–46 = 1 mm; 47–49 = 0.5 mm.

**BODY.** Habitus as in Fig. 38; ocular area raised, each eye triad on additional short hump directed towards lateral, with pair of short processes between eye triads, each with distal brush of hairs; carapace without median furrow; clypeus unmodified; sternum wider than long (1.05/0.95), unmodified. ALS with one widened, one pointed, and three to four very small conical spigots (~1.5–3 µm wide and ~3–6 µm long).

**CHELICERAE.** As in Fig. 47, with small lateral and frontal apophyses proximally and dark distal apophyses near median line provided with two small modified (cone-shaped) hairs each; without stridulatory ridges.

**PALPS.** As in Figs 45–46; coxa unmodified; trochanter with short conical retrolateral process and longer ventral apophysis with distinctive tip; femur with finger-shaped retrolateral process proximally and distinct ventral apophysis; tibia with dark dorsal band, also ventrally darkened, with small but distinct ventral cavity (for proximal bulbal sclerite); procurus complex distally, with distinctive pointed process dorsally (more sclerotized and at different angle than in *P. baguio* sp. nov.); bulb with large uncus, weakly sclerotized wide embolus, simple appendix with main branch curved towards retrolateral and shorter prolateral side-branch.

**LEGS.** Without spines or curved hairs; few vertical hairs; retrolateral trichobothrium on tibia 1 at 4%; prolateral trichobothrium absent on tibia 1, present on other tibiae; tarsus 1 with >30 pseudosegments, only distally about 10 fairly distinct.

#### **Male** (variation)

Tibia 1 in other male: 13.5 (missing in third male).

#### **Female**

In general similar to male but sternum dark brown, eye triads closer together (distance PME-PME 230 µm), without processes between eye triads. Tibiae 1 missing. Epigynum large trapezoidal plate surrounded by whitish cuticle (Fig. 30); with anterior ‘knob’; internal genitalia as in Figs 32 and 49.

#### **Natural history**

Adult specimens were only found in large holes at tree bases near a brook in the forest. Juveniles were more common in any dark sheltered spaces along the brook.

#### **Distribution**

Known from type locality in Mindanao only (Fig. 2).

*Pholcus baguio* Huber, sp. nov.

[urn:lsid:zoobank.org:act:753EAC47-AFE0-4704-A564-696C4DD0A14F](https://doi.org/10.21203/rs.3.rs-10000000/v1)

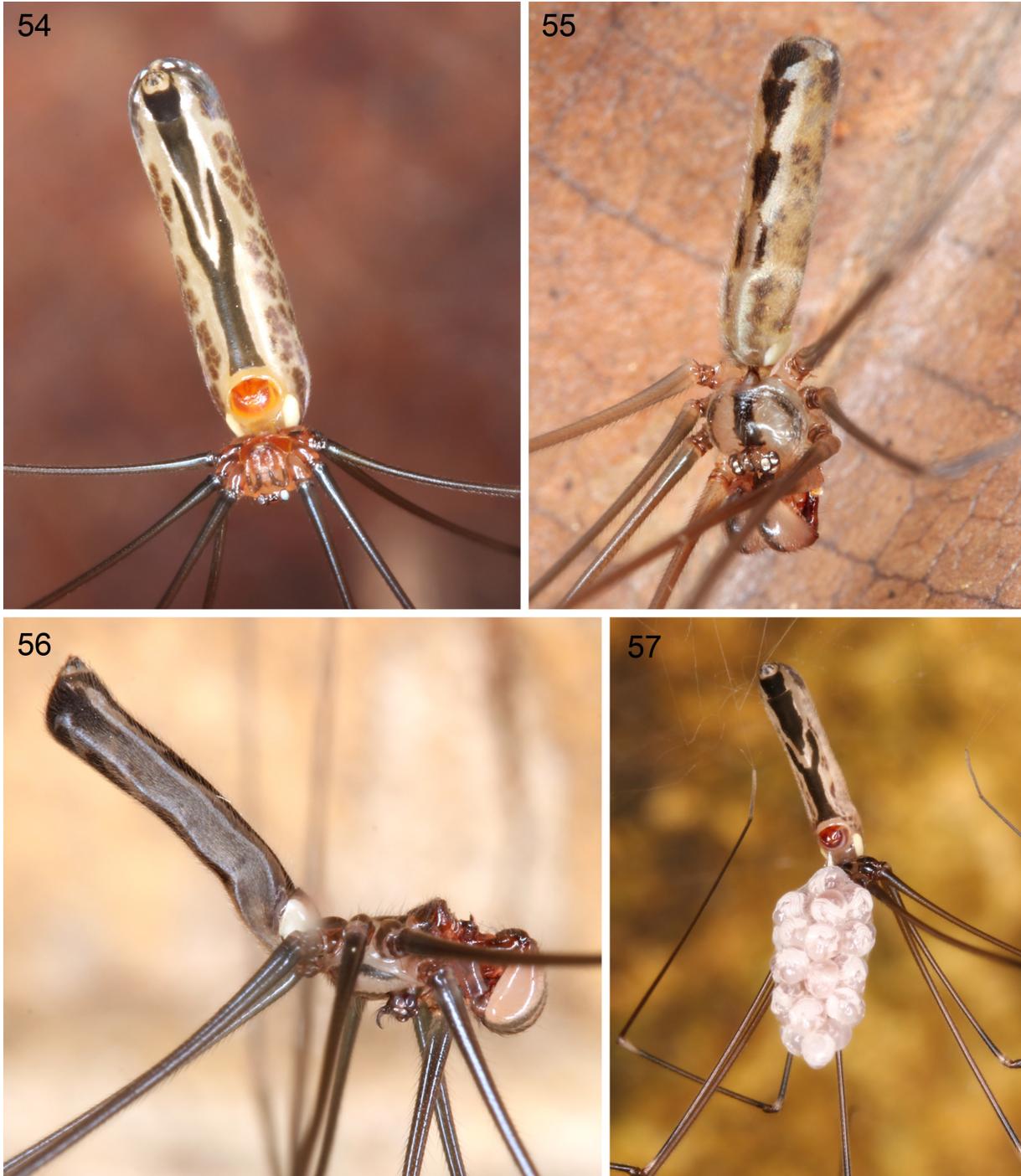
Figs 33–35, 50–52, 58–76

#### **Diagnosis**

Distinguished from most similar known relatives (species with horns between eye triads carrying brushes of unglued hairs and with simple, unhinged procurus: *P. arayat*, *P. pagbilao*, *P. schawalleri*, *P. kawit* sp. nov., *P. mulu* sp. nov.) by distal modifications of procurus (dorsal pointed process; large prolatero-ventral process; Fig. 59), by relatively wide and short palpal femur (Fig. 59), and by female genitalia (epigynum with pair of dark lateral areas; internal genitalia with large transversal sclerite; Figs 33–35); from *P. pagbilao* also by simpler appendix (Figs 58, 71–72); from *P. arayat* also by relatively wider abdomen (Figs 50–52); from *P. kawit* sp. nov. and *P. mulu* sp. nov. also by divided median band ventrally on abdomen (Fig. 51); from *P. schawalleri* also by much more slender uncus (Fig. 58). From other species of the *P. bicornutus* group (*P. bicornutus*; *P. olangapo* sp. nov.) by unhinged procurus, presence of appendix, large epigynal plate, and by absence of curved hairs on legs.



**Figs 50–53.** Live specimens. **50–52.** *Pholcus baguio* Huber, sp. nov., ♂, ♀, and ♀ with egg-sac and emerging juveniles, Mt. Kabuyao. **53.** *Pholcus arayat* Huber, 2011, ♂, Pamulaklakin Forest Trail.



**Figs 54–57.** Live specimens. **54.** *Pholcus arayat* Huber, 2011, ♀, Pamulaklakin Forest Trail. **55–57.** *Pholcus pagbilao* Huber, 2011, ♂ from Loboc (55), ♂ from Mt. Banahaw (56), and ♀ with egg-sac from Loboc (57).

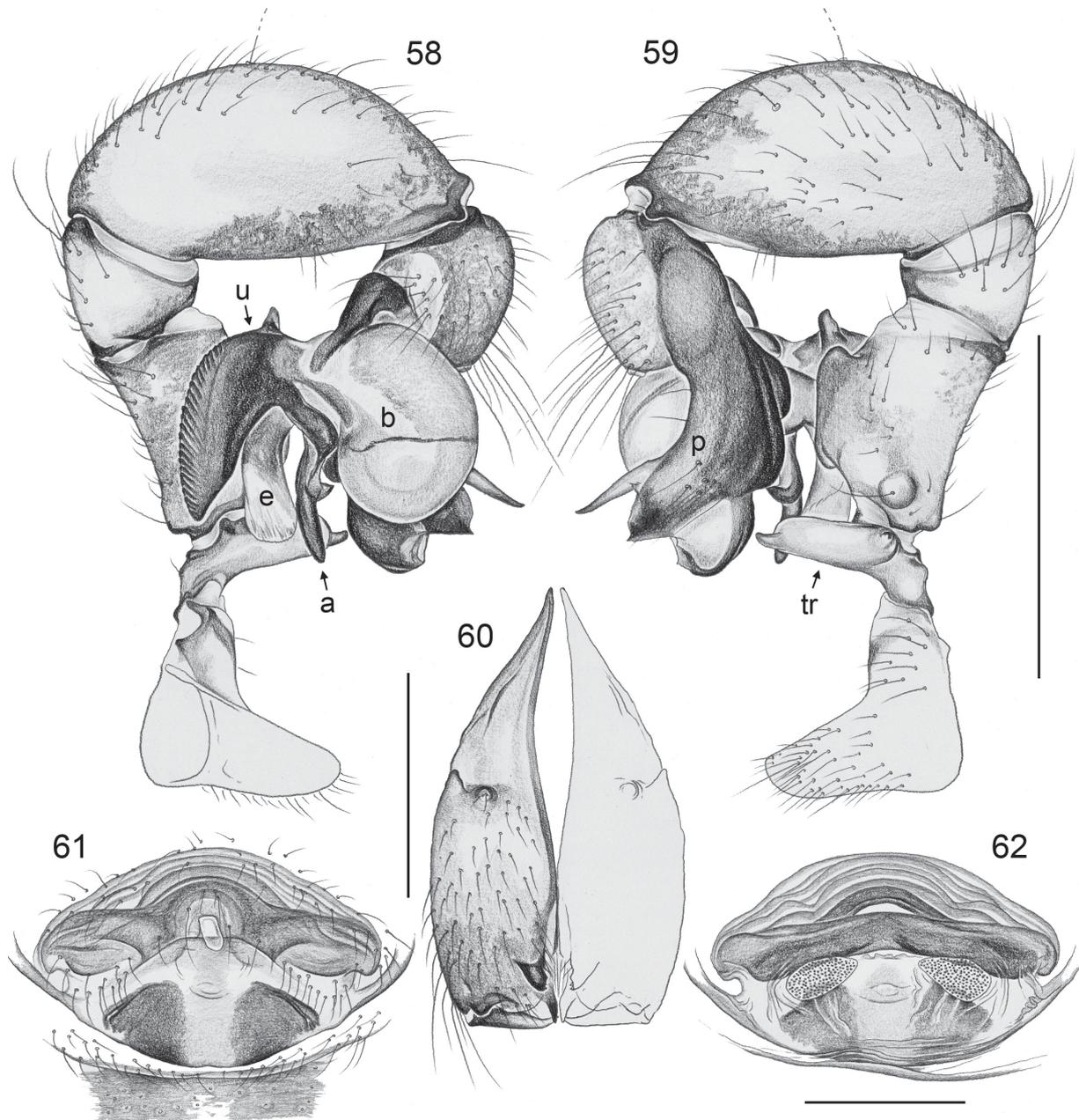
### Etymology

The species name is derived from the type locality; noun in apposition.

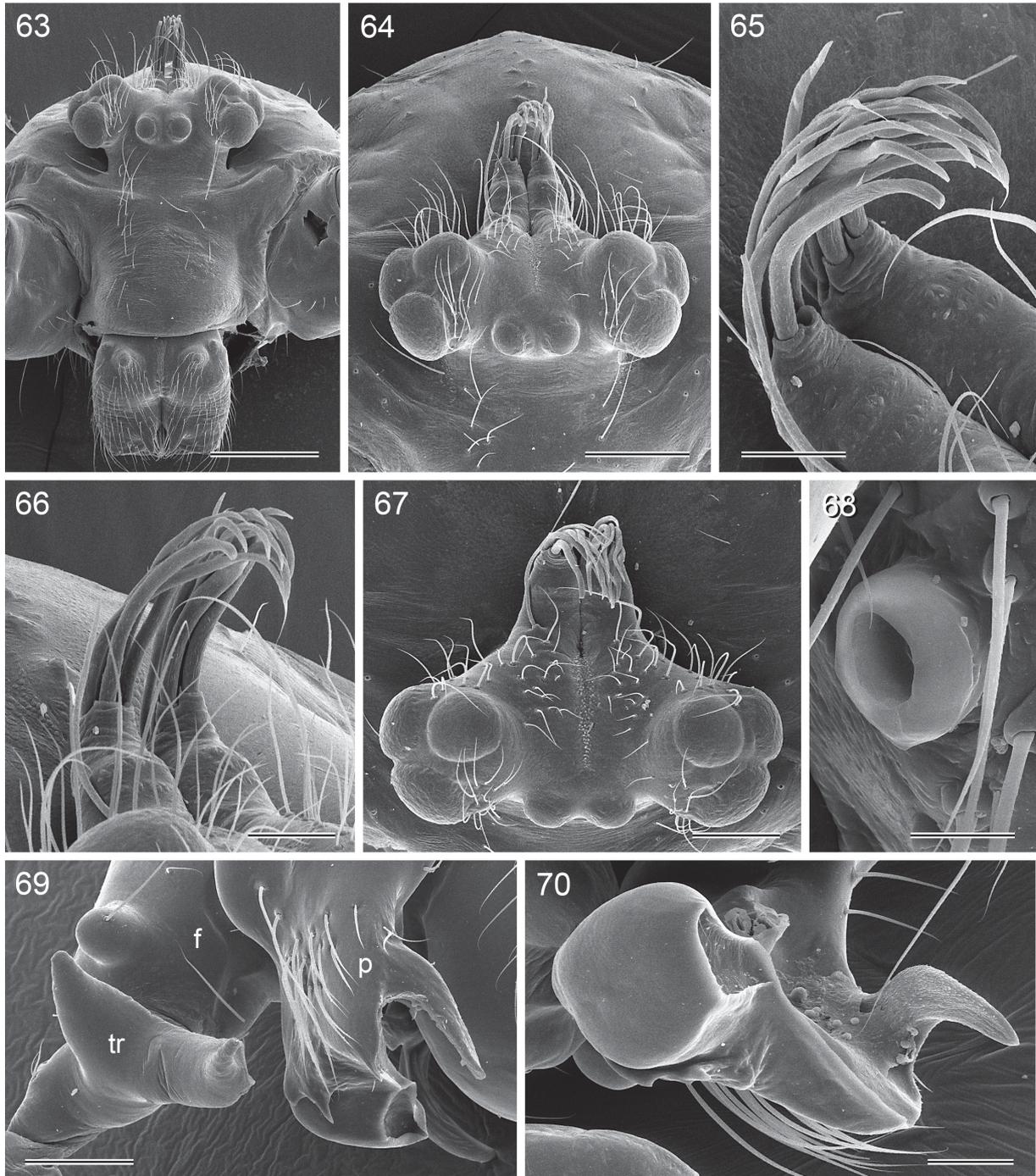
### Material examined

#### Holotype

PHILIPPINES: ♂, Luzon, Benguet Prov., near Baguio, Mt. Kabuyao, N slope (16.374° N, 120.557° E), 1200–1400 m a.s.l., among rocks, 2 Mar. 2014 (B.A. Huber), ZFMK (Ar 15506).



**Figs 58–62.** *Pholcus baguio* Huber, sp. nov., ZFMK Ar 15507–08. **58–59.** Left male palp, prolateral and retrolateral views. **60.** Male chelicerae, frontal view. **61–62.** Cleared female genitalia, ventral and dorsal views. Scale lines: 58–59 = 1 mm; 60–62 = 0.5 mm.



**Figs 63–70.** *Pholcus baguio* Huber, sp. nov., ZFMK Ar 15507. **63.** Male prosoma, frontal view. **64.** Male ocular area, frontal (slightly dorsal) view. **65–66.** Male ocular horns and modified hairs. **67.** Male ocular area, dorsal view. **68.** Male left palpal tarsal organ. **69.** Right male palpal trochanter and procurus, retrolatero-dorsal view. **70.** Left procurus, distal view. Scale lines: 63 = 500  $\mu\text{m}$ ; 64 = 300  $\mu\text{m}$ ; 65 = 80  $\mu\text{m}$ ; 66, 70 = 100  $\mu\text{m}$ ; 67, 69 = 200  $\mu\text{m}$ ; 68 = 30  $\mu\text{m}$ .

### **Other material**

PHILIPPINES: 17 ♂♂, 10 ♀♀, 1 juv., ZFMK (Ar 15507–08) and 1 ♂, 1 ♀, MSU-IIT, same data as holotype, among rocks and vegetation; 1 ♀, 3 juvs, in absolute ethanol, same data, ZFMK (Phi 204); 7 ♂♂, 16 ♀♀, Benguet, “Tuba, Asin road, 10 km S of Baguio” [~16.37° N, 120.62° E], rock wall at waterfall, 12 Nov. 1979 (P. Lehtinen), ZMT.

### **Description**

#### **Male (holotype)**

MEASUREMENTS. Total body length 7.7, carapace width 1.8. Leg 1: 51.2 (12.5 + 0.8 + 12.4 + 22.8 + 2.7), tibia 2: 8.3, tibia 3: 5.3, tibia 4: 7.5; tibia 1 L/d: 67. Distance PME-PME 380 µm, diameter PME 140×160 µm, distance PME-ALE ~40 µm, distance AME-AME 30 µm, diameter AME 100 µm.

COLOR. Carapace ochre to orange, with wide median brown mark including ocular area and clypeus (except rim), connecting posteriorly with lateral submarginal brown bands (Fig. 50); sternum monochromous light brown to orange, labium darker; legs light brown, dark rings subdistally on femora and tibiae and in patella area, tips of femora and tibiae lighter; abdomen ochre-gray, dorsally with several pairs of dark cuticular marks that are fused above spinnerets, laterally with indistinct internal darker marks visible through cuticle; ventrally with wide brown band divided into anterior and posterior parts separated by light V-shaped space.

BODY. Habitus as in Fig. 50; ocular area raised, each eye triad on additional short hump directed towards lateral (Fig. 63), with pair of long processes between eye triads directed towards posterior, each with distal brush of hairs curved upwards, hairs not ‘glued’ together (Figs 64–67); carapace without median furrow (Fig. 64); clypeus unmodified; sternum wider than long (1.10/0.85), unmodified. ALS with one widened, one pointed, and three very small conical spigots (Fig. 74). Gonopore with four epiandrous spigots.

CHELICERAE. As in Fig. 60, small lateral and frontal apophyses proximally and dark distal apophyses near median line provided with two small modified (cone-shaped) hairs each (Fig. 73); without stridulatory ridges.

PALPS. As in Figs 58–59; coxa unmodified; trochanter with short conical retrolateral process and longer ventral apophysis with distinctive tip (Fig. 69); femur with distinct retrolateral process proximally, small dorsal hump, and distinct darkened ventral apophysis; tibia with dark dorsal band, also ventrally darkened, with very small and indistinct ventral cavity; tarsal organ capsulate (Fig. 68); procurus with distinctive pointed process dorsally and large process prolatero-ventrally (Figs 69–70); bulb with large uncus (Figs 58, 71), weakly sclerotized wide embolus, simple appendix with long main branch curved towards prolateral and shorter retrolateral side-branch (Figs 71–72).

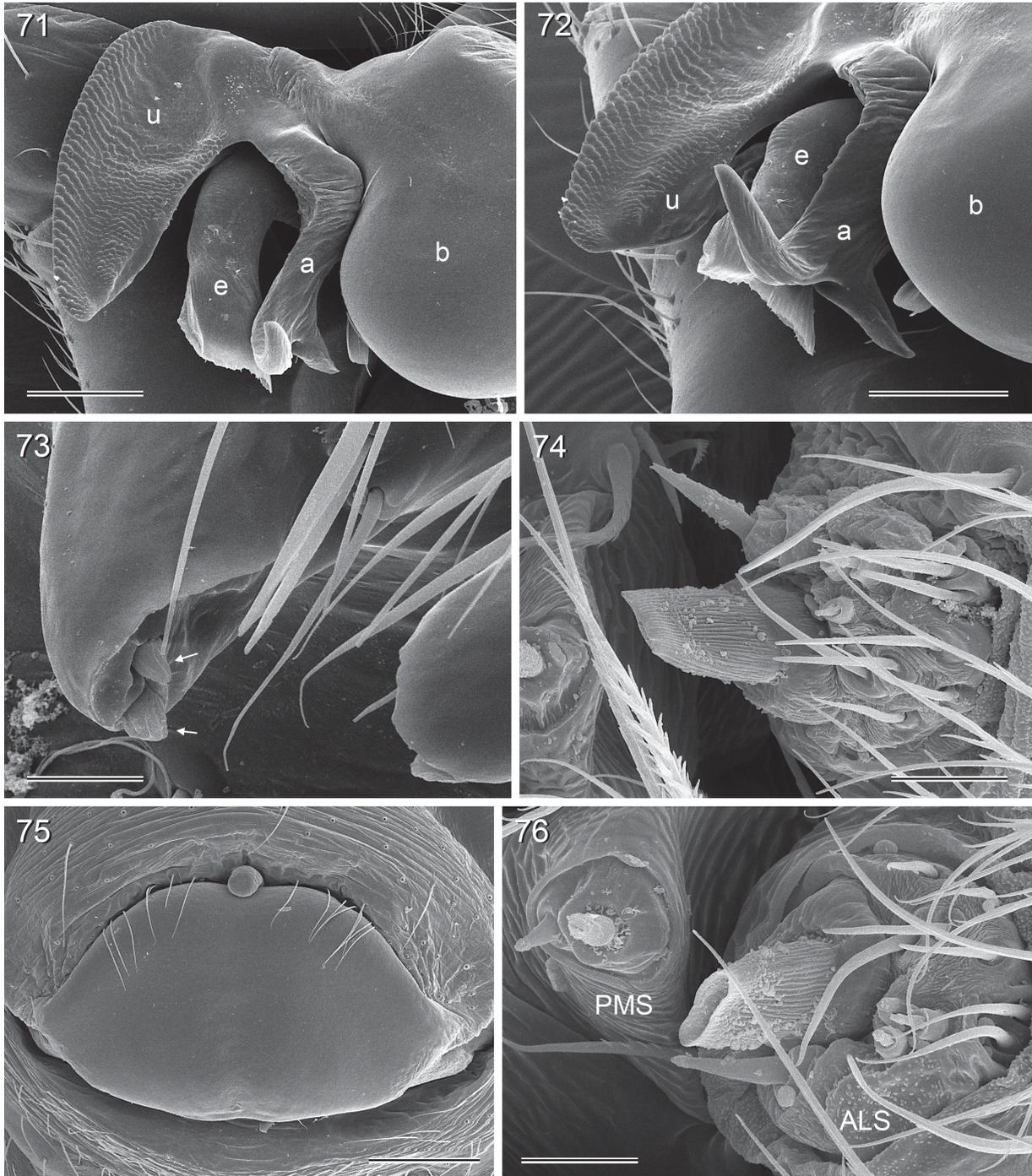
LEGS. Without spines or curved hairs; few vertical hairs; retrolateral trichobothrium on tibia 1 at 3%; prolateral trichobothrium absent on tibia 1, present on other tibiae; tarsus 1 with >30 pseudosegments, only distally about 15 fairly distinct.

#### **Male (variation)**

Most males with distinct internal dark marks dorsally and laterally on abdomen. Tibia 1 in 19 other males: 10.9–14.3 (mean 12.3).

#### **Female**

In general similar to male but sternum dark brown, eye triads closer together (distance PME-PME 250 µm), without processes between eye triads. Tibia 1 in 16 females: 9.6–11.6 (mean 10.7). Epigynum



**Figs 71–76.** *Pholcus baguio* Huber, sp. nov., ZFMK Ar 15507–08. **71–72.** Left genital bulb, prolateral and prolatero-distal views. **73.** Male distal cheliceral apophysis (arrows point at modified hairs). **74.** Male ALS. **75.** Epigynum. **76.** Female ALS and PMS. Scale lines: 71–72, 75 = 200  $\mu\text{m}$ ; 73–74, 76 = 20  $\mu\text{m}$ .

relatively small, roughly oval plate (Figs 33, 75) with pair of dark brown areas and anterior ‘knob’ weakly sclerotized in most specimens; entire epigynal area strongly protruding in some specimens; internal genitalia as in Figs 35 and 62. Spinnerets and spigots as in male (Fig. 76).

### Natural history

The spiders were found in partly extremely high densities in a dry brook bed near the road, among rocks and shaded vegetation. The individual domed sheets were interconnected to form large communal webs of up to 2 m length.

### Distribution

Known from Baguio area in Luzon only (Fig. 2).

*Pholcus arayat* Huber, 2011  
Figs 53–54, 77–90

*Pholcus arayat* Huber, 2011a: 318–320, figs 1514–1515, 1541–1542, 1574–1578.

### Diagnosis (updated)

Distinguished from most similar known relatives (species with horns between eye triads carrying brushes of unglued hairs and with simple, unhinged procursi: *P. pagbilao*, *P. schawalleri*, *P. baguio* sp. nov., *P. kawit* sp. nov., *P. mulu* sp. nov.) by bifid process ventro-distally on procurus (arrows in Figs 82–84; cf. fig. 1575 in Huber 2011a) and by shapes of uncus and appendix (cf. fig. 1574 in Huber 2011a); from *P. pagbilao* also by more slender abdomen and shorter epigynum (cf. fig. 1541 in Huber 2011a); from *P. baguio* sp. nov. also by more slender male palpal femur (cf. fig. 1575 in Huber 2011a) and different shape of epigynum (not with two distinct dark lateral areas); from *P. kawit* sp. nov. and *P. mulu* sp. nov. also by divided median band ventrally on abdomen. From other species of the *P. bicornutus* group (*P. bicornutus*; *P. olangapo* sp. nov.) by unhinged procurus, presence of appendix, large epigynal plate, and by absence of curved hairs on legs.

### Material examined

#### New material

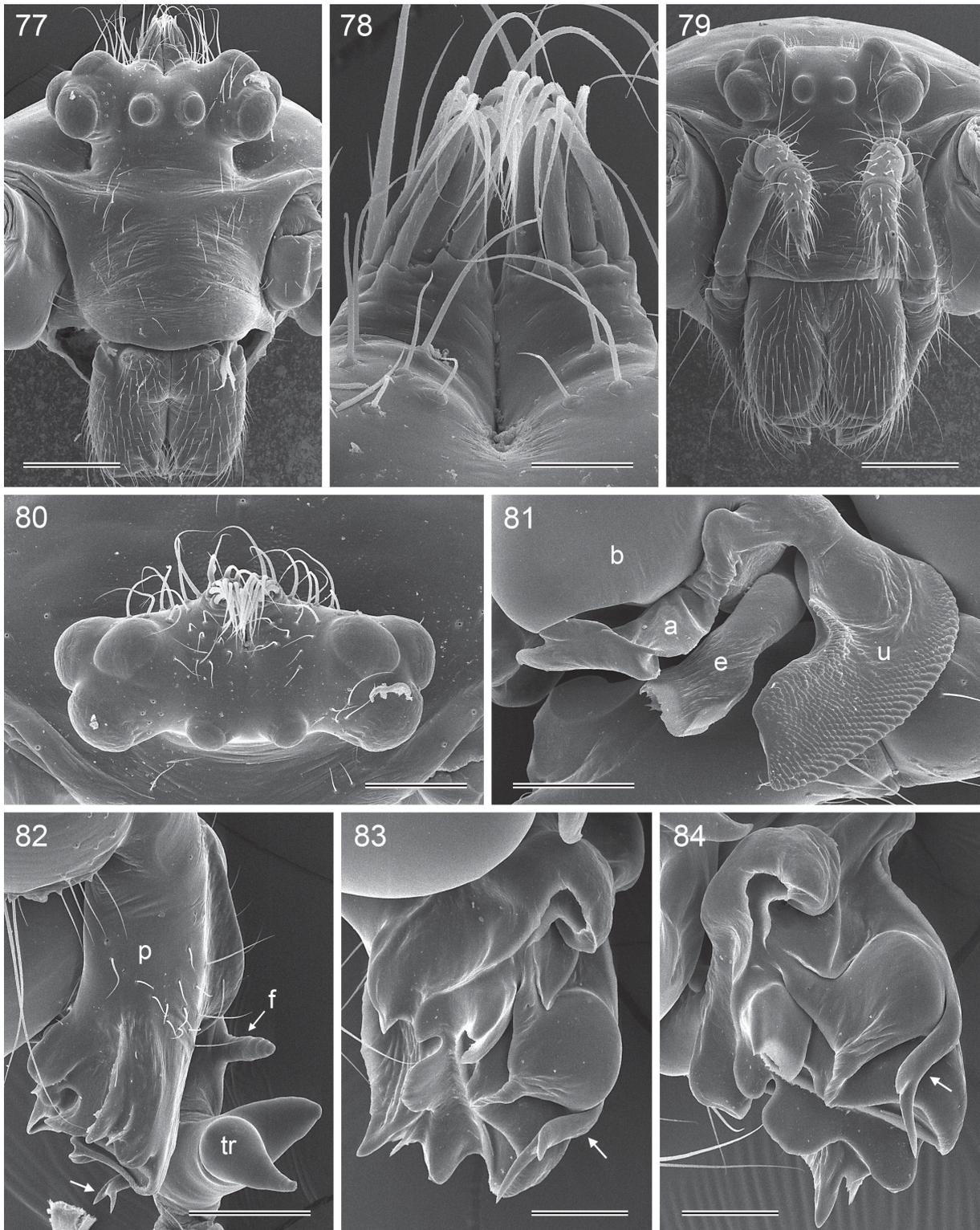
PHILIPPINES, Luzon: 14 ♂♂, 12 ♀♀, ZFMK (Ar 15509) and 1 ♂, 1 ♀, MSU-IIT, Bataan Prov., near Olangapo, along river near Pamulaklakin Forest Trail (14.798° N, 121.338° E), 80 m a.s.l., among rocks and vegetation, 28 Feb. 2014 (B.A. Huber); 2 ♀♀, 1 juv., in absolute ethanol, same data, ZFMK (Phi 208); 2 ♂♂, Laguna Prov., Los Baños, Makiling Forest (14.145° N, 121.230° E), 20 Mar. 2014 (S. Huber), ZFMK (Ar 15510).

#### Assigned tentatively

PHILIPPINES, Bohol Isl.: 3 ♀♀, Rajah Sikatuna (Magsaysay Park) (9.705° N, 124.123° E), 430 m a.s.l., forest, 6 Mar. 2014 (B.A. Huber), ZFMK (Ar 15511); 1 ♂, Valencia, Barangay Marawis, ‘site 3’ (9.723° N, 124.202° E), 440 m a.s.l., 11 Jun. 2015 (M.R.B. Dacar), ZFMK (Ar 15512).

### Note

The single male specimen from “Baybay, VISCA complex”, misidentified as “*Pholcus phalangioides*” by Barrion & Litsinger (1995) was tentatively assigned to *Pholcus arayat* in Huber (2011a). Recently, Yao *et al.* (2014) described *Pholcus schawalleri* from “Visca, N. of Baybay” (which should be ViSCA, Visayas State College of Agriculture, now Visayas State University, approx. 8 km N of Baybay, ~10°45' N, 124°49' E – not 10°39' N, 124°51' E as in Yao *et al.* 2014). These authors did not mention Barrion & Litsinger’s (1995) record, but the identical locality and the shape of the uncus (large and

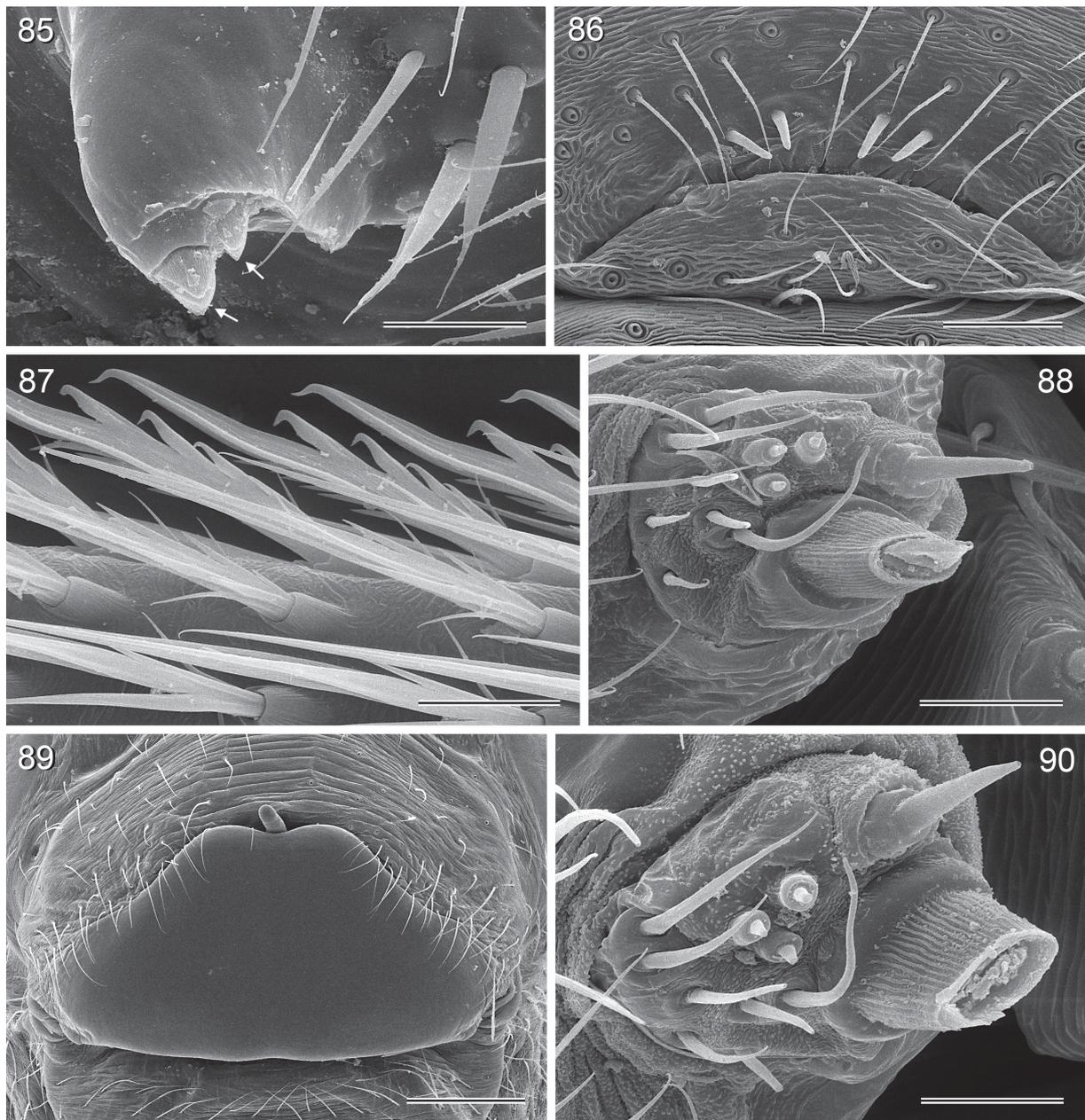


**Figs 77–84.** *Pholcus arayata* Huber, 2011, ZFMK Ar 15509. **77.** Male prosoma, frontal view. **78.** Male ocular horns and modified hairs. **79.** Female prosoma, frontal view. **80.** Male ocular area, dorsal view. **81.** Right genital bulb, prolateral view. **82.** Left male palpal trochanter and procurrus, dorsal view (arrow points at bifid process). **83–84.** Tip of right procurrus, prolateral and prolatero-distal views (arrows point at bifid process). Scale lines: 77, 79 = 300  $\mu$ m; 78 = 50  $\mu$ m; 80–82 = 200  $\mu$ m; 83–84 = 100  $\mu$ m.

roundish) strongly suggest that Barrion & Litsinger's dubious specimen is *P. schawalleri* rather than *P. arayat*.

### Description (amendments)

As noted in Huber (2011a), the holotype is apparently artificially darkened. The new material supports this assumption: carapace in males and females light brown with darker median band (sometimes indistinct; in females medially divided) and lateral bands (sometimes barely visible); sternum light brown to orange in both males and females. Hairs on male ocular processes not 'glued' together (Figs 77–78, 80). Tip of procurus extremely complex (Figs 83–84). Male palpal tibia with small but distinct ventral



**Figs 85–90.** *Pholcus arayat* Huber, 2011, ZFMK Ar 15509. **85.** Male distal cheliceral apophysis (arrows point at modified hairs). **86.** Male gonopore. **87.** Male tarsus 4 comb-hairs. **88.** Male ALS. **89.** Epigynum. **90.** Female ALS. Scale lines: 85, 87–88, 90 = 20  $\mu$ m; 86 = 50  $\mu$ m; 89 = 200  $\mu$ m.

cavity. Distal male cheliceral apophyses with two modified (cone-shaped) hairs each (Fig. 85). Male gonopore with four epiandrous spigots (Fig. 86). Tarsus 4 comb-hairs as in Fig. 87. ALS in both sexes with one widened, one pointed, and three very small conical spigots (Figs 88, 90).

### Variation

Tibia 1 in 15 newly examined males: 10.1–13.5 (mean 11.9); in 12 newly examined females: 9.2–11.1 (mean: 10.3). The specimens from Bohol are overall very similar to those from Luzon but the male differs in some details of the palp: tip of trochanter apophysis not so strongly directed proximad; distal semitransparent process on procurus not clearly bifid; distance between tip of uncus and subterminal process larger. They are thus assigned tentatively.

### Natural history

The spiders were found both in sheltered spaces (among rocks and logs) and among vegetation, with their domed webs sometimes directly exposed to the sun.

### Distribution

Known from several localities in central Luzon (Fig. 2); specimens from Bohol are assigned tentatively (see above).

### *Pholcus pagbilao* Huber, 2011

Figs 55–57, 91–102

*Pholcus pagbilao* Huber, 2011a: 320, figs 1516–1521, 1543–1544, 1579–1584.

### Diagnosis (updated)

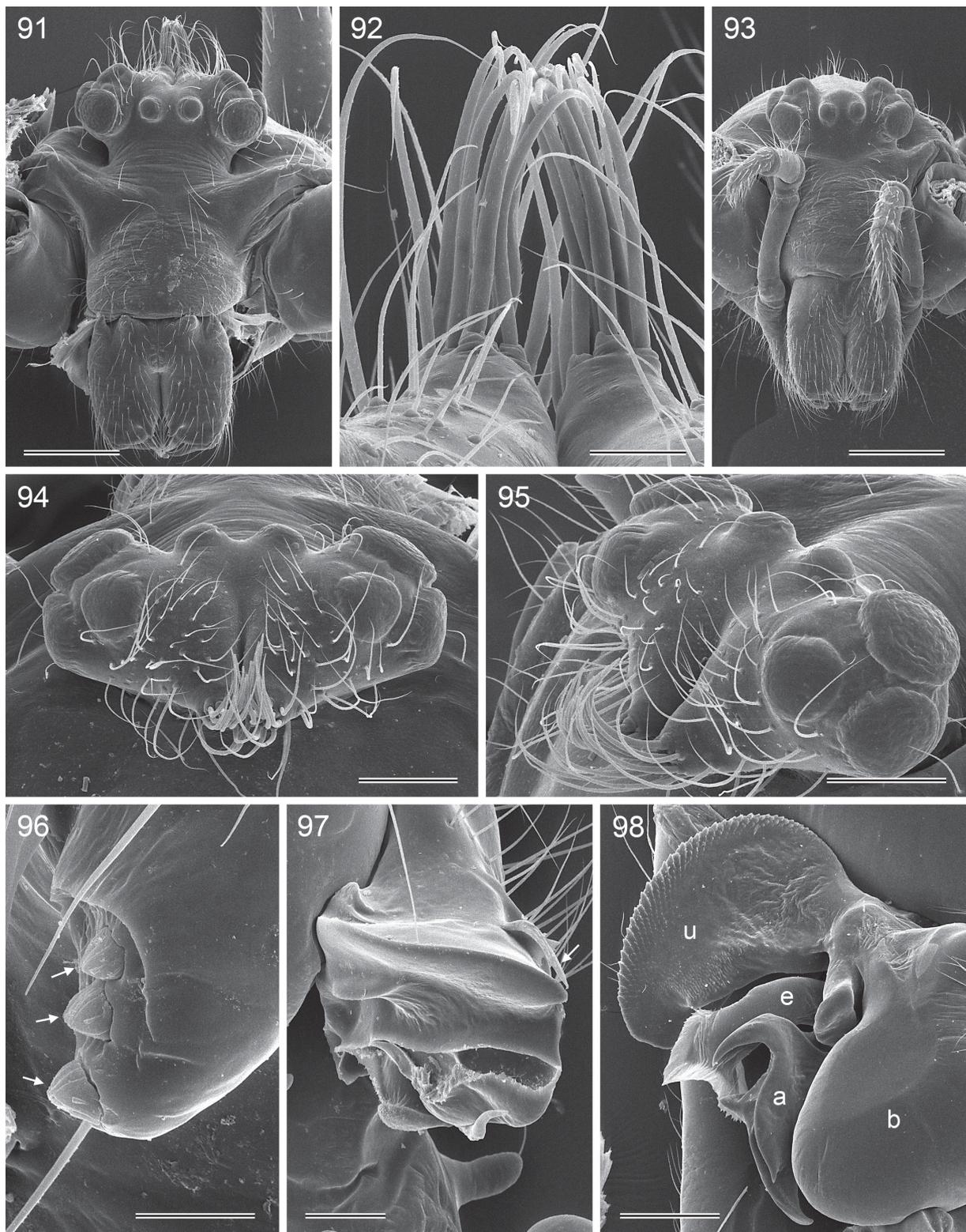
Distinguished from most similar known relatives (species with horns between eye triads carrying brushes of unglued hairs and with simple, unhinged procuri: *P. arayata*, *P. schawalleri*, *P. baguio* sp. nov., *P. kawit* sp. nov., *P. mulu* sp. nov.) by slender semitransparent process distally on procurus (cf. fig. 1580 in Huber 2011a; arrow in Fig. 97) and by shapes of uncus and complex appendix (cf. fig. 1579 in Huber 2011a; see also Fig. 98); from *P. arayata* also by wider abdomen and longer, trapezoidal epigynum (Fig. 101; see also fig. 1543 in Huber 2011a); from *P. baguio* sp. nov. also by more slender male palpal femur (cf. fig. 1580 in Huber 2011a); from *P. kawit* sp. nov. and *P. mulu* sp. nov. also by divided dark median band ventrally on abdomen (Fig. 57). From other species of the *P. bicornutus* group (*P. bicornutus*, *P. olangapo* sp. nov.) by unhinged procurus, presence of appendix, large epigynal plate, and by absence of curved hairs on legs.

### Material examined

#### New material

PHILIPPINES, Luzon: 3 ♂♂, 3 ♀♀, 1 juv., Quezon Prov., between Lucban and Tayabas (14.063° N, 121.567° E), 330 m a.s.l., degraded forest along river, among rocks, 26 Feb. 2014 (B.A. Huber), ZFMK (Ar 15513); 1 ♂, in absolute ethanol, same data, ZFMK (Phi 212); 6 ♂♂, 6 ♀♀, 1 juv., Laguna Prov., Mt. Banahaw, forest near Taytay Falls (14.110° N, 121.507° E), 560 m a.s.l., among rocks, 26 Feb. 2014 (B.A. Huber), ZFMK (Ar 15514); 3 juvs, in absolute ethanol, same data, ZFMK (Phi 218); 17 ♂♂, 6 ♀♀, ZFMK (Ar 15515–16) and 1 ♂, 1 ♀, MSU-IIT, Camarines Sur Prov., Mt. Isarog, forest and (most specimens) abandoned buildings near park entrance (13.663° N, 123.335° E), 500 m a.s.l., 23 Feb. 2014 (B.A. Huber); 2 ♂♂, 1 ♀, 3 juvs, in absolute ethanol, same data, ZFMK (Phi 220).

PHILIPPINES, Bohol Isl.: 1 ♂, 2 ♀♀, Rajah Sikatuna (Magsaysay Park) (9.705° N, 124.123° E), 430 m a.s.l., forest, 6 Mar. 2014 (B.A. Huber), ZFMK (Ar 15517); 1 ♀, 1 juv., in absolute ethanol, same data,



**Figs 91–98.** *Pholcus pagbilao* Huber, 2011, ZFMK Ar 15515–16. **91.** Male prosoma, frontal view. **92.** Male ocular horns and modified hairs. **93.** Female prosoma, frontal view. **94–95.** Male ocular area, dorsal and latero-dorsal views. **96.** Male distal cheliceral apophysis (arrows point at modified hairs). **97.** Left procurus, dorsal view (arrow points at semitransparent process). **98.** Left genital bulb, prolateral view. Scale lines: 91, 93 = 400  $\mu$ m; 92 = 60  $\mu$ m; 94–95, 98 = 200  $\mu$ m; 96 = 20  $\mu$ m; 97 = 100  $\mu$ m.

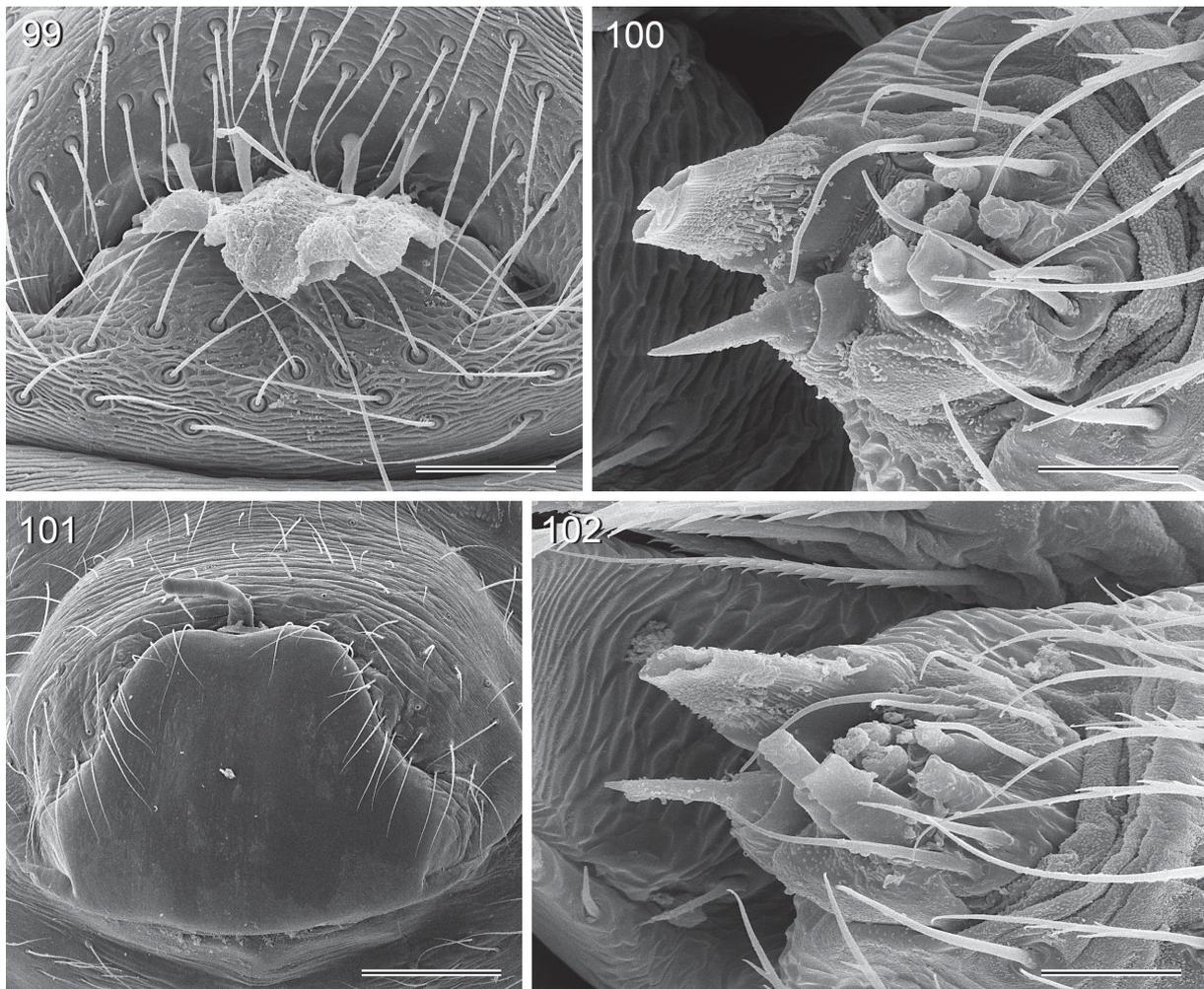
ZFMK (Phi 196); 13 ♂♂, 8 ♀♀, near Loboc, above Loboc River (~9.655° N, 124.015° E), ~250 m a.s.l., in caves near entrances, 5 Mar. 2014 (B.A. Huber), ZFMK (Ar 15518); 5 ♂♂, 6 ♀♀, near Loboc, at Loboc River (9.651° N, 124.022° E), at rocks, 20 m a.s.l., 4 Mar. 2014 (B.A. Huber), ZFMK (Ar 15519); 2 ♀♀, 1 juv., in absolute ethanol, same data, ZFMK (Phi 203).

PHILIPPINES, Cebu Isl.: 1 ♂, 1 ♀, Moalboal, Busay Cave (9.916° N, 123.437° E), cave entrance, 4 Apr. 2014 (S. Huber), ZFMK (Ar 15520).

**Assigned tentatively**

PHILIPPINES, Negros Isl.: 6 ♂♂, 7 ♀♀, Negros Oriental Prov., Casaroro Falls (9.281° N, 123.208° E), 550 m a.s.l., at rocks along river below waterfall, 10 Mar. 2014 (B.A. Huber), ZFMK (Ar 15521); 2 ♀♀, 1 juv., in absolute ethanol, same data, ZFMK (Phi 186).

PHILIPPINES, Bohol Isl.: 2 ♀♀, 14 juvs, MSU-IIT and 1 ♀, ZFMK (Ar 15522), Bilar, Barangay Riverside (9.70° N, 124.12° E), 300–450 m a.s.l., 15 Jun. 2015 (M.R.B. Dacar); 1 ♀, 3 juvs, Garcia Hernandez, Barangay Datag (9.72° N, 124.26° E), 530 m a.s.l., 8 Jun. 2015 (M.R.B. Dacar), ZFMK (Ar 15523); 2 ♀♀, Sierra Bullones, Barangay Nan-od (9.746° N, 124.262° E), 610 m a.s.l., 5 Jun. 2015



**Figs 99–102.** *Pholcus pagbilao* Huber, 2011, ZFMK Ar 15515–16. **99.** Male gonopore. **100.** Male ALS. **101.** Epigynum. **102.** Female ALS. Scale lines: 99 = 50 µm; 100, 102 = 20 µm; 101 = 200 µm.

(M.R.B. Dacar), ZFMK (Ar 15524); 2 ♀♀, 12 juvs, MSU-IIT and 1 ♀, ZFMK (Ar 15525), Valencia, Barangay Marawis (9.724° N, 124.201° E), 450 m a.s.l., 11 Jun. 2015 (M.R.B. Dacar).

### **Description** (amendments)

Hairs on male ocular processes not ‘glued’ together (Figs 91–92, 94–95). Distal male cheliceral apophyses with three modified (cone-shaped) hairs each (Fig. 96). Male palpal tibia with small and indistinct ventral cavity. Male gonopore with four epiandrous spigots (Fig. 99). ALS in both sexes with one widened, one pointed, and six cylindrically-shaped spigots of varying sizes (Figs 100, 102).

### **Variation**

As noted in Huber (2011a), the tip of the procurus differs slightly between males from Negros Island and males from Luzon. Interestingly, males from Bohol Island resemble those from Luzon much more closely than those from neighboring Negros. In addition, there is variation among males from Negros Island: males from Mabinay (see Huber 2011a) differ slightly from the newly collected males from Casaroro Falls. However, all these specimens share the distinctive slender semitransparent process distally on the procurus and the shapes of unculus and appendix (cf. figs 1579–1580 in Huber 2011a). Tibia 1 in 46 newly examined males: 9.6–15.3 (mean 12.7) (42 of these males: 11.2–14.0); in 38 newly examined females: 9.3–12.8 (mean: 11.2). The black ventral band of the abdomen is always clearly divided into anterior and posterior parts but in some specimens (of both sexes) the tip of the posterior part has a narrow connection to the anterior part. Some of the newly collected specimens from Bohol are assigned tentatively because they are not accompanied by males and because the ventral abdominal pattern is partly intermediate between that of *P. pagbilao* and *P. arayat*. Some of these specimens may actually be conspecific with the specimens assigned tentatively to *P. arayat*.

### **Natural history**

The spiders were found in sheltered spaces close to the ground, usually among rocks. In the abandoned buildings near the park entrance of Mt. Isarog, the spiders were found in high numbers in all corners at any height from the ground.

### **Distribution**

Apparently widely distributed in the Philippines (Fig. 2).

### **Discussion**

The male ocular horns with brushes of hairs described herein represent a unique synapomorphy of the *Pholcus bicornutus* group (Huber 2011a), but ocular area modifications in general are widespread in Pholcidae and come in a wide range of shapes (Table 1). Two aspects are particularly remarkable about the overview in Table 1. First, with only one exception (the ‘pseudo-lenses’ accompanying the secondary eyes in *Smeringopus* Simon, 1890 and *Smeringopina* Kraus, 1957) all modifications are restricted to the male, i.e., represent sexual dimorphisms. Second, these modifications appear very unevenly distributed among major taxonomic groups. No case is known in Ninetinae; only six cases are known in Arteminae, Modisiminae, and Smeringopinae together. All other 14 cases are in Pholcinae.

Each of the twenty cases listed in Table 1 is supposed to represent an independent origin. This is derived from available phylogenies (reviewed in Huber 2011b; see also Huber 2013; Dimitrov *et al.* 2013; Huber & Nuñez 2015; Huber *et al.* 2015) and from partly fundamental differences in the quality of the modifications. We admit that some particular modifications may have originated more than once (e.g., the small median elevations in *Pholcus youngae* Huber, 2011 and *Pholcus schwendingeri* Huber, 2011; or the pair of pointed processes near the PME in the *Pholcus minang* group and in *Panjange* Deeleman-Reinhold & Deeleman, 1983), while others may not represent independent origins (e.g., the

**Table 1.** Ocular area modifications in Pholcidae.

<b>Taxon</b>	<b>Ocular area modification</b>	<b>References</b>
<b>Ninetinae</b>	–	
<b>Arteminae</b>		
<i>Trichocyclus septentrionalis</i>	Male AME on median elevation	Huber 2001
<b>Modisiminae</b>		
<i>Modisimus</i> (part)	Male eye turret higher than female turret	Huber <i>et al.</i> 2010
<i>Modisimus culicinus</i>	Male eye turret with hairy cuticular lobe and glands	Huber 1997
<b>Smeringopinae</b>		
<i>Smeringopina</i> & <i>Smeringopus</i>	Secondary eyes with ‘pseudo-lenses’ (males and females)	Huber 2009, 2012
<i>Smeringopina cornigera</i> group	Males with pair of large pointed horns	Huber 2013
<i>Smeringopina cornigera</i> group, part	Males with additional pair of smaller horns	Huber 2013
<b>Pholcinae</b>	Male eye triads on short to long stalks; extremes in, e.g.,: <i>Panjange casaroro</i> , <i>Panjange camiguin</i> , <i>Pholcus schwendingeri</i> , <i>Pholcus minang</i> group	Huber 2011a; Huber & Nuñez 2015
<i>Aetana</i> ( <i>A. lozadae</i> , <i>A. manansalai</i> , <i>A. banahaw</i> )	Males with pair of processes near ALE	Huber <i>et al.</i> 2015
<i>Aetana</i> ( <i>A. loboc</i> , <i>A. pasambai</i> )	Males with median process/hump	Huber <i>et al.</i> 2015
<i>Hantu kapit</i>	Males with two pairs of long horns and one pair of small processes	Huber 2016
<i>Pehrforsskalia</i>	Males with pair of small cone-shaped processes near PME	Huber 2009, 2011a
<i>Pholcus</i> group of genera (part)	Males with higher density of hairs	Huber 2011a
<i>Pholcus ancoralis</i> group (part)	Males with pair of pointed horns (without hairs) between triads	Huber 2011a
<i>Pholcus bicornutus</i> group	Males with pair of horns with brushes of hairs between/behind triads	Huber 2011a; this study
<i>Pholcus calligaster</i> group (part)	Males with pair of sculptured horns (without hairs) between triads	Huber 2011a
<i>Pholcus halabala</i> group	Males with pair of humps near PME with curved spines	Huber 2011a; Huber <i>et al.</i> 2016
<i>Pholcus</i> spp. ( <i>minang</i> group, <i>ethagala</i> group) and <i>Panjange</i> (part)	Males with pair of pointed processes near PME; sometimes forming apparent functional unit ( <i>Panjange casaroro</i> , <i>Panjange camiguin</i> )	Huber 2011a; Huber & Nuñez 2015; Huber & Leh Moi Ung 2016
<i>Pholcus quinquenotatus</i>	Males with median hooked process above AME	Huber 2011a
<i>Pholcus youngae</i> , <i>Pholcus schwendingeri</i>	Males with small median elevation	Huber 2011a
<i>Spermophora</i> , some East African species ( <i>S. bukusu</i> , <i>S. mau</i> , <i>S. berlandi</i> , <i>S. maathaiaie</i> )	Males with pair of rounded anterior horns	Huber & Warui 2012

pointed horns in the *Pholcus ancoralis* group and the sculptured horns in the *Pholcus calligaster* group). An exact count will require phylogenies with denser taxon sampling and better resolution (which is currently in preparation; J. Eberle, A. Valdez-Mondragón, D. Dimitrov & B.A. Huber, unpubl. data), but it seems very unlikely that the number of independent origins will change dramatically.

Unfortunately, we know much less about the function of pholcid ocular modifications. In fact, there is only one study (Huber 1997) that deals in some detail with a sexually dimorphic ocular region. In *Modisimus culicinus* (Simon, 1893), the male ocular turret is provided anteriorly with a cuticular lobe that is densely set with hairs and with pores through which large glands in the male ocular area discharge their products. During copulation, the female mouthparts contact this cuticular lobe, suggesting gustatorial courtship (Huber 1997). At first sight it would seem that such a gustatorial courtship function might be a valid hypothesis for further cases: first, the copulatory position of Pholcidae consistently brings the male ocular area close to the female mouthparts; and secondly, dense sets of hairs occur on the male ocular areas in many other Pholcidae (actually in most *Pholcus* species; Huber 2011a). However, glandular pores have never been found on the male ocular areas in any other species, even though many were examined in detail with the scanning electron microscope. This leaves a wide range of possible explanations, including mechanical functions in an intersexual selection context as well as intrasexual selection (male-male contest) scenarios. Obviously, this is a rich field for future observational and experimental studies.

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