



Three new species of the spider genus *Belisana* Thorell, 1898 (Araneae: Pholcidae) from Xishuangbanna, Yunnan, China

WENHUI ZHU¹, ZHIYUAN YAO^{1*}, GUO ZHENG^{1*} & SHUQIANG LI²

¹College of Life Science, Shenyang Normal University, Shenyang 110034, Liaoning, China

²Institute of Zoology, Chinese Academy of Sciences, Beijing 100101, China

*Corresponding authors. E-mail: yaozy@synu.edu.cn, zhengguo@synu.edu.cn

Abstract

Three new species of the spider genus *Belisana* Thorell, 1898 are described based on material collected in Xishuangbanna, Yunnan, China: *Belisana mengla* Yao & Li **sp. nov.** (male, female), *Belisana menglun* Yao & Li **sp. nov.** (male), and *Belisana mengyang* Yao & Li **sp. nov.** (male, female), bringing the total *Belisana* fauna of Xishuangbanna to 12 species.

Key words: Morphology, Pholcinae, Southeast Asia, taxonomy

Introduction

Pholcidae C.L. Koch, 1850 is among the most species-rich spider families (World Spider Catalog 2019). *Belisana* Thorell, 1898 is the second largest genus in Pholcidae, with 122 species documented so far (World Spider Catalog 2019). It ranges from India to the Pacific Islands and from Korea to Australia and is primarily distributed in tropical and subtropical forests (Huber 2005). The spiders of *Belisana* include many representatives from different microhabitats, e.g., in leaf litter, on the underside of leaves, and in caves (Huber 2005; Chen *et al.* 2009; Yao *et al.* 2015). The latest molecular phylogeny analysis showed that *Hantu* Huber, 2016 is nested within *Belisana* but the algorithm RogueNaRok resolves a monophyletic *Belisana* (Huber *et al.* 2018).

Xishuangbanna belongs to the Indo-Burma biodiversity hotspot (Myers 1988). Up to now, 41 species of *Belisana* have been described from China (World Spider Catalog 2019), of which nine species have been recorded from Xishuangbanna: *B. cas* Yao & Li, 2018, *B. chenjinii* Yao & Li, 2018, *B. dian* Yao & Li, 2018, *B. gupian* Yao & Li, 2018, *B. schwendingeri* Huber, 2005, *B. yangxiaodongii* Yao & Li, 2018, *B. zhengi* Yao, Pham & Li, 2015, *B. menghai* Yao & Li, 2019, and *B. xishuangbanna* Yao & Li, 2019 (Huber 2005; Yao *et al.* 2015; Yao *et al.* 2018; Zhao *et al.* 2019). High diversity of *Belisana* in Xishuangbanna may have been resulted from the microhabitat shift from leaf litter to vegetation canopy (Eberle *et al.* 2018; Yao *et al.* 2018) and the shift within *Belisana* has been confirmed by the recent molecular data in the phylogeny analysis of Pholcidae (Huber *et al.* 2018). The aim of this paper is to describe three new species of *Belisana* from the Xishuangbanna, bringing the total *Belisana* fauna of Xishuangbanna to 12 species.

Material and methods

Specimens were examined and measured with a Leica M205 C stereomicroscope and details were studied with an Olympus BX51 compound microscope. Images were captured with an Olympus C7070 wide zoom digital camera (7.1 megapixels) mounted on a Leica M205 C stereomicroscope and were assembled using Helicon Focus 3.10.3 image stacking software (Khmelik *et al.* 2006). The left male pedipalp was illustrated (exceptions are indicated in figure legends). Epigyna were photographed before the dissection. Vulvae were previously treated in a 10% warm solution of potassium hydroxide (KOH) before illustration. All measurements are given in millimeters. Leg mea-

measurements are shown as: Total length (femur + patella + tibia + metatarsus + tarsus), missing data were coded as ‘-’. Leg podomeres were measured on their dorsal side. Distribution map was generated with ArcView GIS 3.2 (ESRI 2002). All specimens were preserved in 75% ethanol. Type material is deposited in the Institute of Zoology, Chinese Academy of Sciences (IZCAS) in Beijing, China (Curator: Jun Chen).

Terminology and taxonomic descriptions follow Huber (2005), except by leg measurements (see above). The following abbreviations are used in the descriptions: ALE = anterior lateral eye, AME = anterior median eye, PME = posterior median eye, L/d = length/diameter; used in the illustrations: b = bulb, ba = bulbal apophysis, da = distal apophysis, e = embolus, ep = epigynal pocket, pa = proximo-lateral apophysis, pp = pore plate, pr = procurus.

Taxonomy

Family Pholcidae C.L. Koch, 1850

Subfamily Pholcinae C.L. Koch, 1850

Genus *Belisana* Thorell, 1898

Belisana Thorell 1898: 278. Simon 1903: 988. Simon 1909: 81. Deeleman-Reinhold 1986: 46. Huber 2001: 124. Huber 2005: 12.

Type species: *Belisana tauricornis* Thorell, 1898

Diagnosis and description. See Huber (2005).

Belisana mengla Yao & Li sp. nov.

Figs 1–2

Type material. Holotype: Male (IZCAS Ar39745), Xiaolongha Village, (21°24'19.8"N, 101°37'01.3"E, elevation 801 ± 22m), Mengla County, Xishuangbanna, **Yunnan, China**, 30 June 2012, Q. Zhao and Z. Chen leg. **Paratype:** 1 female (IZCAS Ar39746), same data as holotype.

Etymology. The specific name refers to the type locality and is a noun in apposition.

Diagnosis. This species resembles *B. yangxiaodongi* Yao & Li, 2018 (see Yao *et al.* 2018: 255, figs 9–10, 11E, 12E) with similar male chelicerae (Fig. 2D), bulbal apophyses (Fig. 2C) and vulva (Fig. 2B) but can be distinguished by presence of dorsal apophysis proximally on pedipalpal femur (arrow in Fig. 1A), absence of spine distally and membranous flap retrolaterally on procurus (Figs 1A–D), presence of angular distal sclerite retrolaterally (arrow 1 in Fig. 1D) and large, flat, distal membranous lamella (arrow 2 in Fig. 1D) on procurus, and by presence of subcuticular teeth on epigynum (Fig. 2A).

Description. Male (holotype): Total length 1.50 (1.61 with clypeus), carapace 0.73 long, 0.63 wide, opisthosoma 0.77 long, 0.56 wide. Leg I: 11.32 (3.80 + 0.40 + 2.64 + 3.36 + 1.12), leg II: — (2.19 + 0.31 + 2.00 + 2.91 + —), leg III missing, leg IV: — (2.10 + 0.50 + 1.75 + 2.35 + —); tibia I L/d: 42. Habitus as in Figs 2E–F. Carapace and sternum pale, without marks. Legs pale, without darker rings. Opisthosoma pale, without spots. Distance PME–PME 0.13, diameter PME 0.08, distance PME–ALE 0.03, AME absent. Ocular area not elevated. Thoracic furrow absent. Clypeus unmodified. Sternum approximately as wide as long (0.64). Chelicerae (Fig. 2D) with pair of small proximo-lateral apophyses and pair of long, curved distal apophyses each provided with modified seta on its tip (distance between tips: 0.42). Pedipalps as in Figs 1A–B; coxa unmodified; trochanter with very short retrolatero-ventral apophysis (arrow in Fig. 1B); femur with small dorsal apophysis proximally (arrow in Fig. 1A); procurus (Figs 1A–D) simple proximally but complex distally, with angular distal sclerite retrolaterally (arrow 1 in Fig. 1D) and large, flat, distal membranous lamella (arrow 2 in Fig. 1D); bulb (Fig. 2C) with hooked apophysis and wide embolus. Retrolateral trichobothria of tibia I at 13% proximally; legs with short vertical setae on metatarsi, without spines and curved setae; tarsus I with 17 distinct pseudosegments.

Female (IZCAS Ar39746): Similar to male, habitus as in Figs 2G–H. Total length 1.40 (1.52 with clypeus), carapace 0.68 long, 0.56 wide, opisthosoma 0.72 long, 0.68 wide; tibia I: 1.42; tibia I L/d: 37. Distance PME–PME

0.14, diameter PME 0.08, distance PME-ALE 0.03, AME absent. Sternum approximately as wide as long (0.58). Epigynum (Fig. 2A) simple and flat, with pair of pockets 0.47 apart (ep in Figs 2A–B) and several subcuticular teeth. Vulva (Fig. 2B) with ridge-shaped anterior arch and pair of narrow, curved pore plates far apart.

Distribution. China (Yunnan, type locality; Fig. 7).

***Belisana menglun* Yao & Li sp. nov.**

Figs 3–4

Type material. Holotype: Male (IZCAS Ar39747), 48 Kilometer Nature Reserve (21°58′42.2″N, 101°19′44.9″E, elevation 1088 ± 12 m), Menglun Town, Mengla County, Xishuangbanna, **Yunnan, China**, 12 August 2011, G. Zheng, Q. Zhao and C. Gao leg.

Etymology. The specific name refers to the type locality and is a noun in apposition.

Diagnosis. This species resembles *B. colubrina* Zhang & Peng, 2011 (see Zhang & Peng 2011: 40, fig. 9) with similar male chelicerae (Fig. 4B) and bulbal apophyses (Fig. 4A) but can be distinguished by presence of large pro-lateral sclerite distally (arrow 1 in Fig. 3C), bifid pro-lateral apophysis distally (arrow 2 in Fig. 3C) and small dorsal membranous process distally (arrow 3 in Fig. 3C) on procurus, and by absence of lateral marks on carapace (Fig. 4C), along with the absence of spots on opisthosoma (Fig. 4C).

Description. Male (holotype): Total length 1.80 (1.89 with clypeus), carapace 0.72 long, 0.70 wide, opisthosoma 1.08 long, 0.50 wide. Legs I and III missing, leg II: — (3.00 + 0.30 + 2.68 + – + –), leg IV: 6.83 (1.92 + 0.23 + 1.80 + 2.24 + 0.64). Habitus as in Figs 4C–E. Carapace and sternum pale, without marks. Legs II and IV pale, without darker rings. Opisthosoma pale, without spots. Distance PME-PME 0.13, diameter PME 0.08, distance PME-ALE 0.03, AME absent. Ocular area not elevated. Thoracic furrow absent. Clypeus unmodified. Sternum slightly wider than long (0.62/0.58). Chelicerae (Fig. 4B) with pair of small proximo-lateral apophyses and pair of long, curved distal apophyses each provided with modified seta on its tip (distance between tips: 0.62). Pedipalps as in Figs 3A–B; coxa unmodified; trochanter with short retrolatero-ventral apophysis (arrow in Fig. 3A); femur with small dorsal apophysis proximally (arrow in Fig. 3A); procurus (Figs 3A–D) simple proximally but complex distally, with large pro-lateral sclerite distally (arrow 1 in Fig. 3C), bifid pro-lateral apophysis distally (arrow 2 in Fig. 3C) and small dorsal membranous process distally (arrow 3 in Fig. 3C); bulb (Fig. 4A) with long curved apophysis and wide embolus.

Female: Unknown.

Distribution. China (Yunnan, type locality; Fig. 7).

***Belisana mengyang* Yao & Li sp. nov.**

Figs 5–6

Type material. Holotype: Male (IZCAS Ar39748), seasonal rain forest (22°09′45.9″N, 100°52′33.2″E, elevation 862 ± 33 m), Mengyang County, Xishuangbanna, **Yunnan, China**, 22 July 2012, Q. Zhao and Z. Chen leg. **Paratypes:** 5 males (IZCAS Ar39749–Ar39753) and 2 females (IZCAS Ar39754–Ar39755), same data as holotype.

Etymology. The specific name refers to the type locality and is a noun in apposition.

Diagnosis. This species resembles *B. cas* Yao & Li, 2018 (see Yao *et al.* 2018: 250, figs 7–8, 11D, 12D) with similar male chelicerae (Fig. 6C) and bulbal apophyses (Fig. 6D) but can be distinguished by presence of curved pro-lateral sclerite distally (arrow 1 in Fig. 5C) and large retrolateral membranous process distally (arrow 2 in Fig. 5C) on procurus, dorsally strongly protruding procurus (arrow in Fig. 5A), unmodified male pedipalpal coxa (Fig. 5B). The female is recognised by presence of subcuticular teeth on epigynum (Fig. 6A), slightly separated vulval pore plates (Fig. 6B) and by absence of serrated sclerites on vulva (Fig. 6B).

Description. Male (holotype). Total length 1.39 (1.48 with clypeus), carapace 0.53 long, 0.52 wide, opisthosoma 0.86 long, 0.55 wide. Leg I: 10.06 (3.60 + 0.31 + 1.40 + 2.25 + 2.50), leg II: 7.64 (2.50 + 0.31 + 2.19 + 1.88 + 0.76), leg III: 6.20 (1.60 + 0.31 + 1.25 + 2.50 + 0.54), leg IV: 8.60 (2.50 + 0.25 + 2.00 + 3.20 + 0.65); tibia I L/d: 39. Habitus as in Figs 6E–F. Carapace and sternum pale, without marks. Legs pale, without darker rings. Opisthosoma pale, without spots. Distance PME-PME 0.08, diameter PME 0.05, distance PME-ALE 0.03, AME absent.

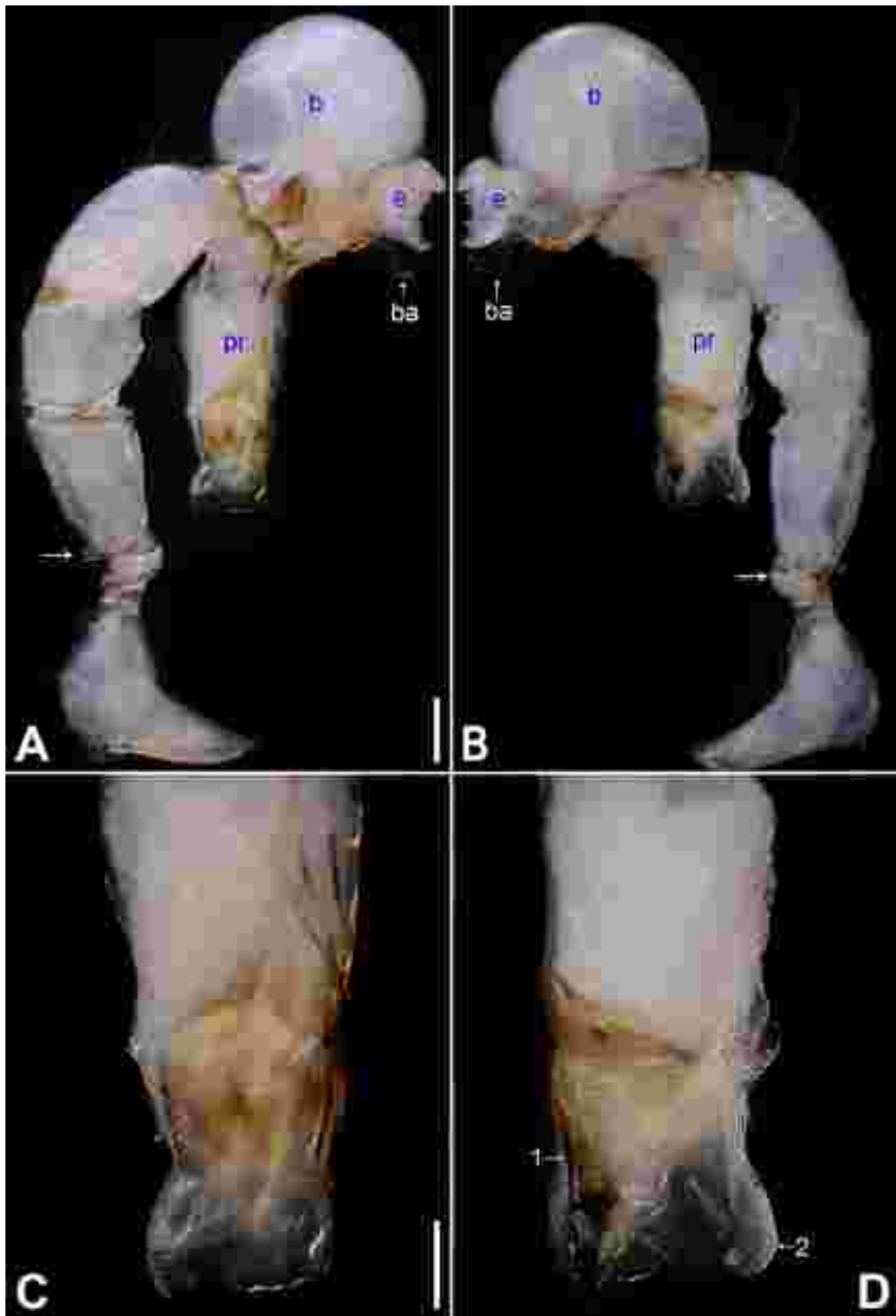


FIGURE 1. *Belisana mengla* **sp. nov.**, holotype male. A–B. Pedipalp (A. Prolateral view, arrow points at dorsal apophysis on pedipalpal femur; B. Retrolateral view, arrow points at retrolatero-ventral apophysis on pedipalpal trochanter); C–D. Distal part of procurus (C. Prolateral view; D. Retrolateral view, arrow 1 points at angular distal sclerite, arrow 2 points at large, flat, distal membranous lamella). b = bulb, ba = bulbal apophysis, e = embolus, pr = procurus. Scale bars: 0.02 (A–B), 0.01 (C–D).

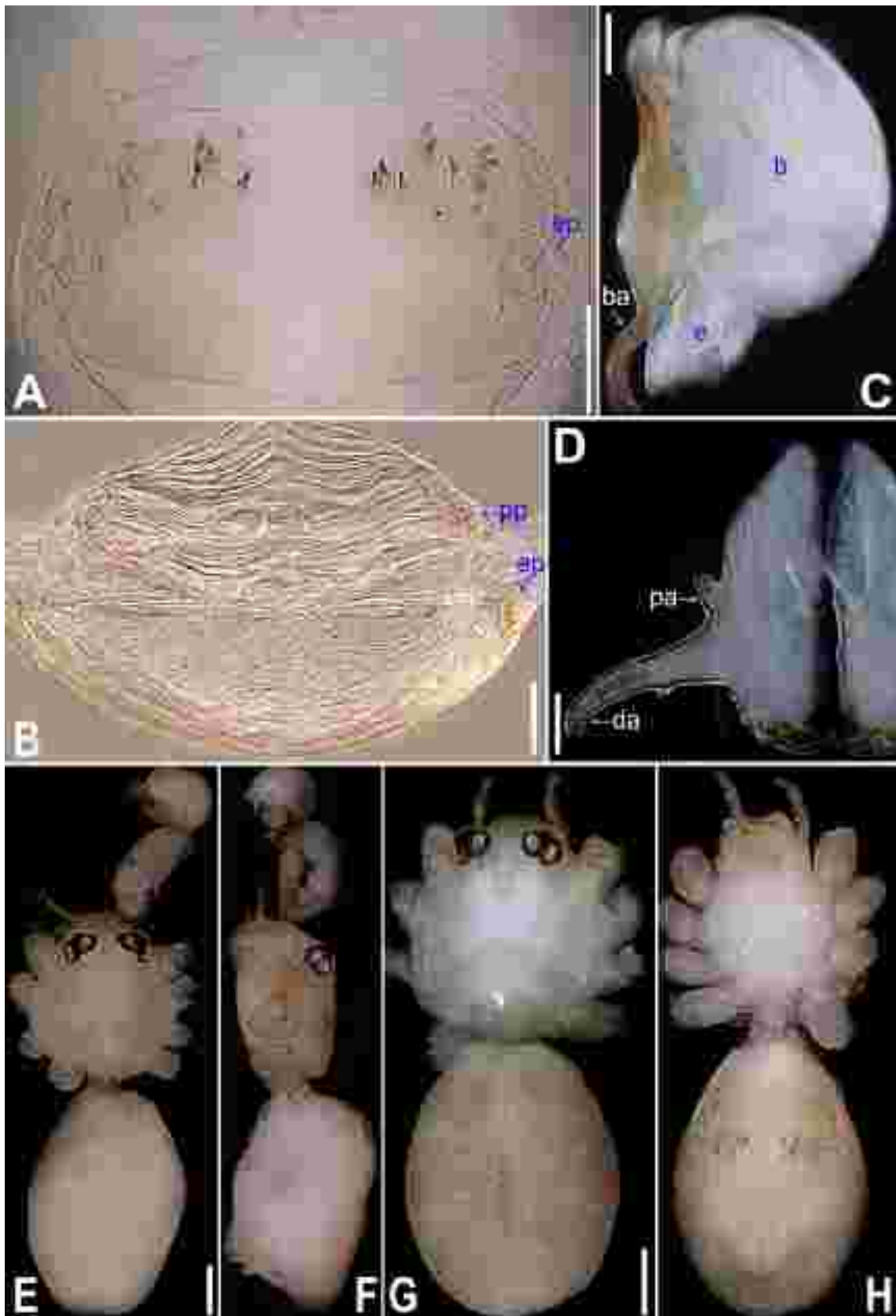


FIGURE 2. *Belisana mengla* sp. nov., holotype male (C–F) and paratype female (A–B, G–H). A. Epigynum, ventral view; B. Vulva, dorsal view; C. Bulb, prolateral view; D. Chelicerae, frontal view; E–H. Habitus (E, G. Dorsal view; F. Lateral view; H. Ventral view). b = bulb, ba = bulbal apophysis, da = distal apophysis, e = embolus, ep = epigynal pocket, pa = proximo-lateral apophysis, pp = pore plate. Scale bars: 0.10 (A–B), 0.05 (C–D), 0.20 (E–H).

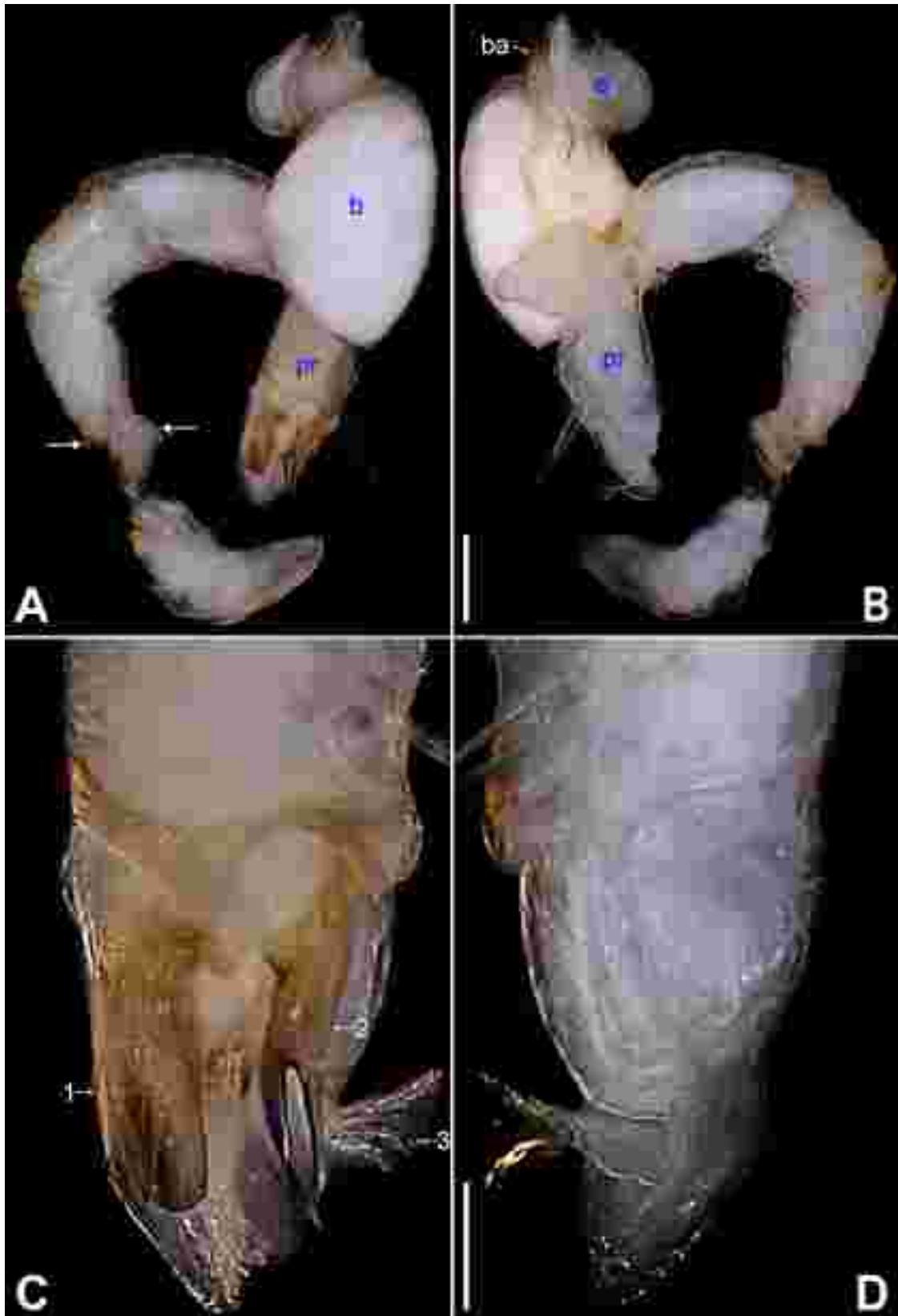


FIGURE 3. *Belisana menglun* sp. nov., holotype male. A–B. Flipped right pedipalp (A. Prolateral view, two arrows point at retrolatero-ventral apophysis on trochanter and dorsal apophysis on femur; B. Retrolateral view); C–D. Distal part of flipped procurus (C. Prolateral view, arrow 1 points at large prolateral sclerite, arrow 2 points at bifid prolateral apophysis, arrow 3 points at small dorsal membranous process; D. Retrolateral view). b = bulb, ba = bulbular apophysis, e = embolus, pr = procurus. Scale bars: 0.02 (A–B), 0.01 (C–D).

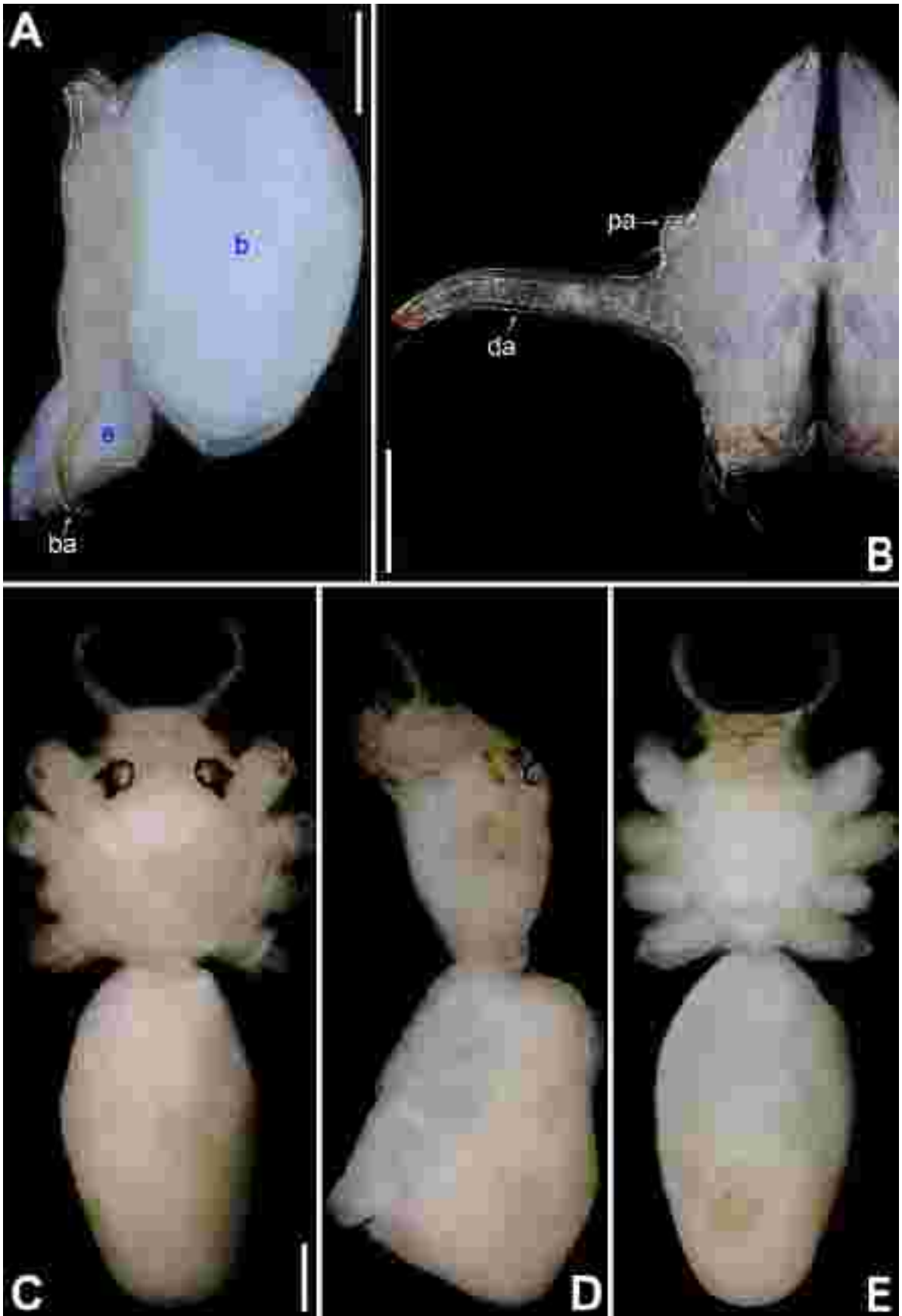


FIGURE 4. *Belisana menglun* sp. nov., holotype male. A. Bulb, prolateral view; B. Chelicerae, frontal view; C–E. Habitus (C. Dorsal view; D. Lateral view; E. Ventral view). b = bulb, ba = bulbal apophysis, da = distal apophysis, e = embolus, pa = proximo-lateral apophysis. Scale bars: 0.10 (A–B), 0.20 (C–E).

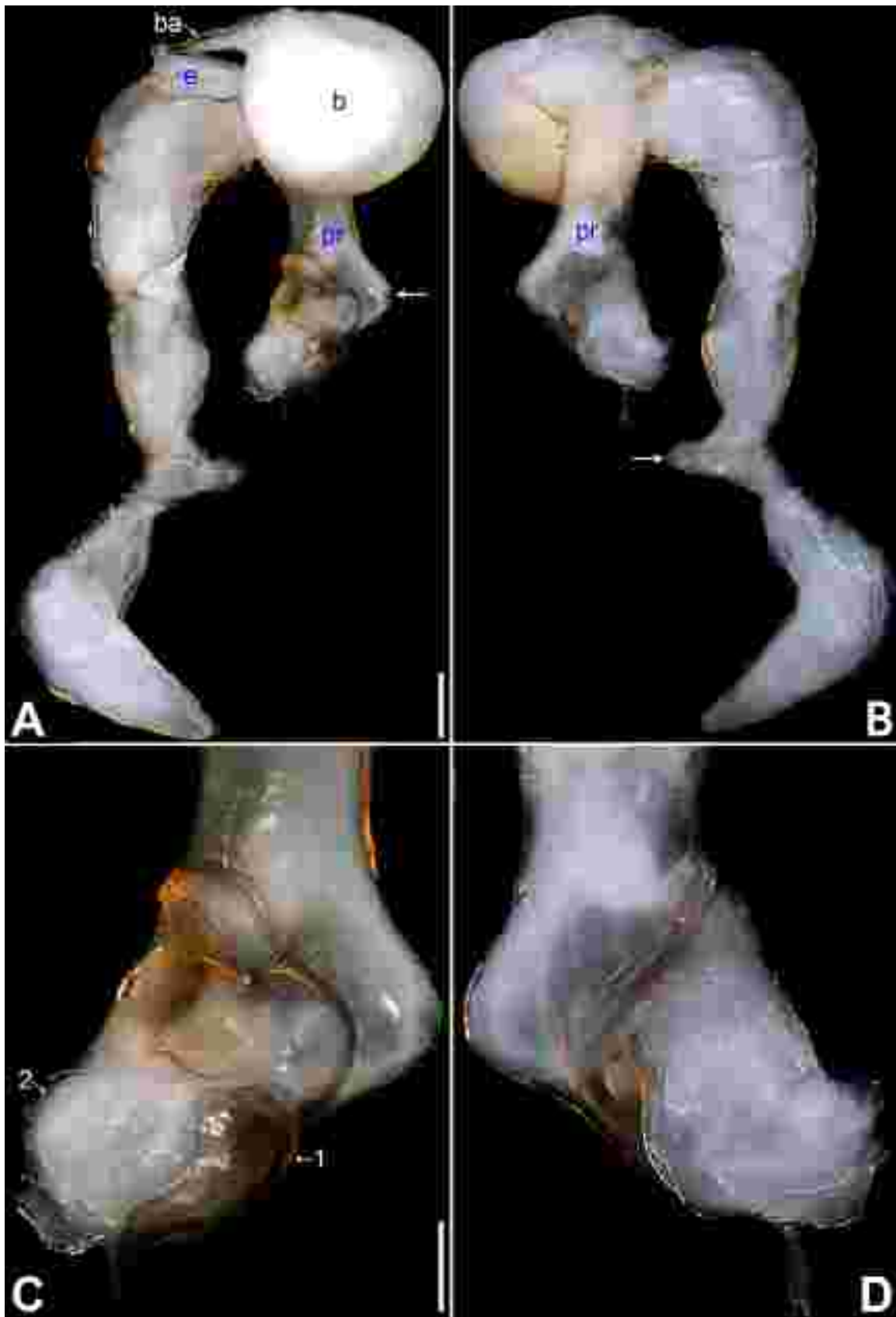


FIGURE 5. *Belisana mengyang* sp. nov., holotype male. A–B. Pedipalp (A. Prolateral view, arrow points at protrusion; B. Retrolateral view, arrow points at retrolatero-ventral apophysis on trochanter); C–D. Distal part of procurus (C. Prolateral view, arrow 1 points at curved prolateral sclerite, arrow 2 points at large retrolateral membranous process; D. Retrolateral view). b = bulb, ba = bulbal apophysis, e = embolus, pr = procurus. Scale bars: 0.02 (A–B), 0.01 (C–D).

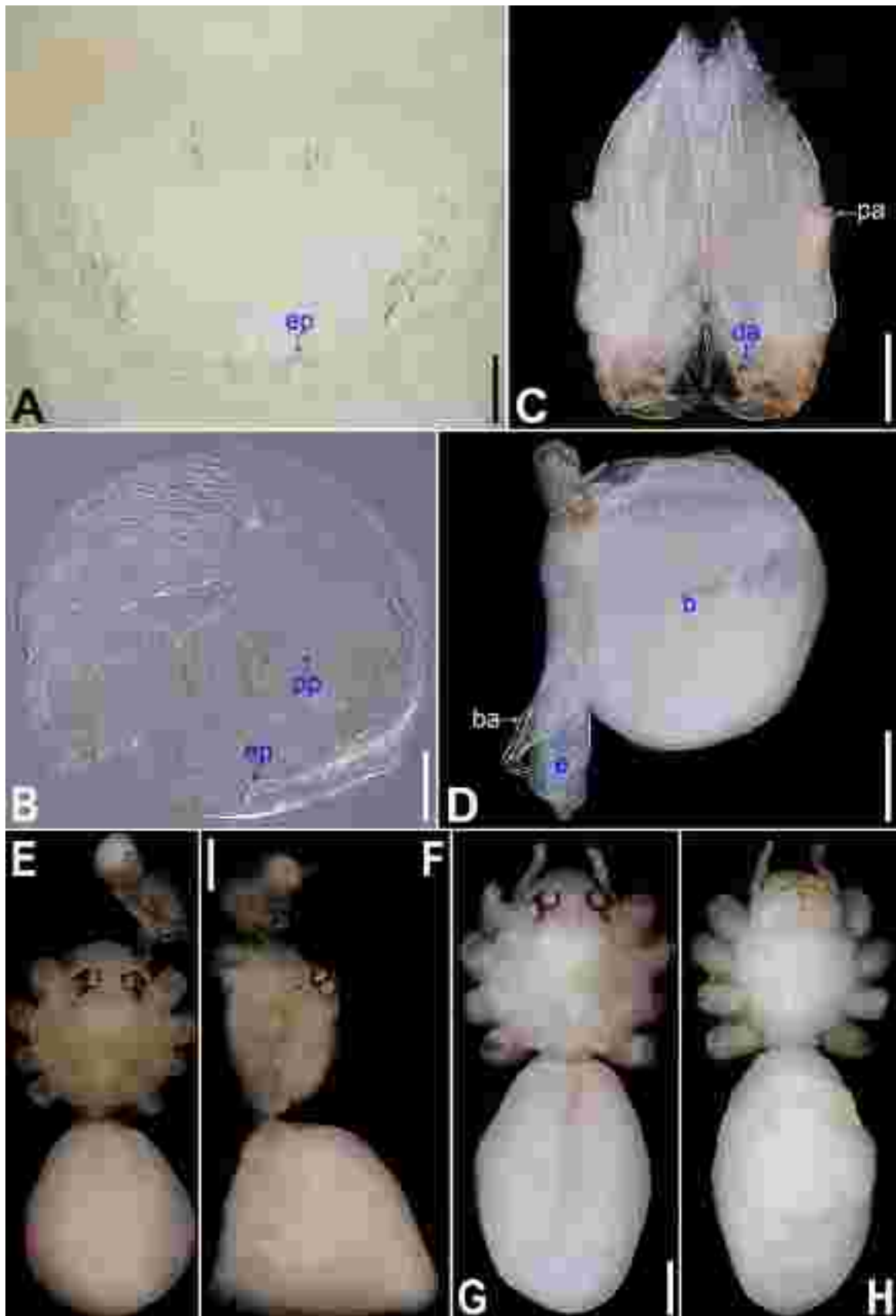


FIGURE 6. *Belisana mengyang* sp. nov., holotype male (C–F) and paratype female (A–B, G–H). A. Epigynum, ventral view; B. Vulva, dorsal view; C. Chelicerae, frontal view; D. Bulb, prolateral view; E–H. Habitus (E, G. Dorsal view; F. Lateral view; H. Ventral view). b = bulb, ba = bulbal apophysis, da = distal apophysis, e = embolus, ep = epigynal pocket, pa = proximo-lateral apophysis, pp = pore plate. Scale bars: 0.05 (A–D), 0.20 (E–H).

Ocular area not elevated. Thoracic furrow absent. Clypeus unmodified. Sternum approximately as wide as long (0.44). Chelicerae (Fig. 6C) with pair of small proximo-lateral apophyses and pair of short distal apophyses (distance between tips: 0.14). Pedipalps as in Figs 5A–B; coxa unmodified; trochanter with short retrolatero-ventral apophysis (arrow in Fig. 5B); femur without dorsal apophysis proximally; procurus (Figs 5A–D) simple proximally and complex distally, strongly protruding subdistally (arrow in Fig. 5A), with curved prolateral sclerite distally (arrow 1 in Fig. 5C) and large retrolateral membranous process distally (arrow 2 in Fig. 5C); bulb (Fig. 6D) with hooked apophysis and simple embolus. Retrolateral trichobothria of tibia I at 23% proximally; legs with short vertical setae on metatarsi, without spines and curved setae; tarsus I with 12 distinct pseudosegments.

Female (IZCAS Ar39754): Similar to male, habitus as in Figs 6G–H. Total length 1.55 (1.65 with clypeus), carapace 0.67 long, 0.63 wide, opisthosoma 0.88 long, 0.65 wide; tibia I: 1.37; tibia I L/d: 35. Distance PME-PME 0.09, diameter PME 0.05, distance PME-ALE 0.03, AME absent. Sternum approximately as wide as long (0.56). Epigynum (Fig. 6A) simple and flat, with pair of pockets 0.12 apart (ep in Figs 6A–B) and several subcuticular teeth. Vulva (Fig. 6B) with curved anterior arch and pair of strongly curved pore plates.

Variation: Tibia I in four male paratypes (IZCAS Ar39749–Ar39752; leg I missing in IZCAS Ar39753): 1.33, 1.35, 1.37, 1.43. Tibia I in another female paratype (IZCAS Ar39755): 1.40.

Distribution. China (Yunnan, type locality; Fig. 7).



FIGURE 7. Distribution records of three new *Belisana* species. 1. *B. mengla* Yao & Li sp. nov.; 2. *B. menglun* Yao & Li sp. nov.; 3. *B. mengyang* Yao & Li sp. nov.

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References

- Chen, H., Zhang, F. & Zhu, M. (2009) Four new troglophilous species of the genus *Belisana* Thorell, 1898 (Araneae, Pholcidae) from Guizhou Province, China. *Zootaxa*, 2092 (1), 58–68.
<https://doi.org/10.11646/zootaxa.2092.1.5>
- Deeleman-Reinhold, C.L. (1986) Leaf-dwelling Pholcidae in Indo-Australian rain forests. In: Eberhard, W.G., Lubin, Y.D. & Robinson, B.C. (Eds.), *Proceedings of the Ninth International Congress of Arachnology, Panama 1983*. Smithsonian Institution Press, Washington, D.C., pp. 45–48.
- Eberle, J., Dimitrov, D., Valdez-Mondragón, A. & Huber, B.A. (2018) Microhabitat change drives diversification in pholcid spiders. *BMC Evolutionary Biology*, 18, 141.
<https://doi.org/10.1186/s12862-018-1244-8>
- ESRI (2002) ArcView GIS 3.2. Environmental Systems Research Institute, Redlands, California. Available from: <http://www.esri.com/software/arcgis/arcview/> (accessed 25 December 2019)
- Huber, B.A. (2001) The pholcids of Australia (Araneae, Pholcidae): taxonomy, biogeography, and relationships. *Bulletin of the American Museum of Natural History*, 260, 1–144.
[https://doi.org/10.1206/0003-0090\(2001\)260<0001:TPOAAP>2.0.CO;2](https://doi.org/10.1206/0003-0090(2001)260<0001:TPOAAP>2.0.CO;2)
- Huber, B.A. (2005) High species diversity, male–female coevolution, and metaphyly in Southeast Asian pholcid spiders: the case of *Belisana* Thorell 1898 (Araneae, Pholcidae). *Zoologica*, 155, 1–126.
- Huber, B.A. (2016) A new genus of ground and litter-dwelling pholcine spiders from *Sarawak* (Araneae, Pholcidae). *European Journal of Taxonomy*, 186, 1–15.
<https://doi.org/10.5852/ejt.2016.186>
- Huber, B.A., Eberle, J. & Dimitrov, D. (2018) The phylogeny of pholcid spiders: a critical evaluation of relationships suggested by molecular data (Araneae, Pholcidae). *ZooKeys*, 789, 51–101.
<https://doi.org/10.3897/zookeys.789.22781>
- Khmelik, V.V., Kozub, D. & Glazunov, A. (2006) Helicon Focus. Version 6.6.1. Available from: <http://www.heliconsoft.com/heliconfocus.html> (accessed 10 March 2018)
- Koch, C.L. (1850) *Übersicht des Arachnidensystems*. Vol. 5. J. L. Lotzbeck Nürnberg, Heft, 77 pp.
- Myers, N. (1988) Threatened biotas: “hot spots” in tropical forests. *The Environmentalist*, 8 (3), 1–20.
<https://doi.org/10.1007/BF02240252>
- Simon, E. (1903) *Histoire Naturelle des Araignées*. Vol. 2. 2nd Edition. Librairie Encyclopédique de Roret, Paris, 412 pp. [pp. 669–1080]
- Simon, E. (1909) Étude sur les arachnides du Tonkin (1^{re} partie). *Bulletin Scientifique de la France et de la Belgique*, 42, 69–147.
<https://doi.org/10.5962/bhl.part.24151>
- Thorell, T. (1898) Viaggio di Leonardo Fea in Birmania e regioni vicine. LXXX. Secondo saggio sui Ragni birmani. II. Retitelariae et Orbitelariae. *Annali del Museo Civico di Storia Naturale di Genova*, 39, 271–378.
- World Spider Catalog (2019) World Spider Catalog. Version 20.5. Natural History Museum Bern, Bern. Available from: <http://wsc.nmbe.ch> (accessed 18 September 2019)
- Yao, Z., Pham, D.S. & Li, S. (2015) Pholcid spiders (Araneae: Pholcidae) from northern Vietnam, with descriptions of nineteen new species. *Zootaxa*, 3909 (1), 1–82.
<https://doi.org/10.11646/zootaxa.3909.1.1>
- Yao, Z., Zhu, K., Du, Z. & Li, S. (2018) The *Belisana* spiders (Araneae: Pholcidae) from Xishuangbanna Tropical Botanical Garden, Yunnan, China. *Zootaxa*, 4425 (2), 243–262.
<https://doi.org/10.11646/zootaxa.4425.2.3>
- Zhang, F. & Peng, Y. (2011) Eleven new species of the genus *Belisana* Thorell (Araneae: Pholcidae) from south China. *Zootaxa*, 2989 (1), 51–68.
<https://doi.org/10.11646/zootaxa.2989.1.2>
- Zhao, X., Yao, Z., Song, Y. & Li, S. (2019) Two new species of the spider genus *Belisana* Thorell (Araneae: Pholcidae) from Xishuangbanna, Yunnan, China. *Zootaxa*, 4603 (3), 559–567.
<https://doi.org/10.11646/zootaxa.4603.3.8>