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Taxonomic study of four closely-related species of the *Pholcus yichengicus* species group (Araneae, Pholcidae) from China's Qinling Mountains: An integrated morphological and molecular approach

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Abstract

Four morphologically similar species of the *Pholcus yichengicus* species group, occurring in geographic proximity of China's Qinling Mountains, were recognised, based on morphology and four methods of molecular species delimitation. They comprise two new species, namely *Pholcus ankang* **sp. nov.** and *P. baoji* **sp. nov.** and two previously described species: *P. ovatus* Yao & Li, 2012 and *P. taibaiensis* Wang & Zhu, 1992. Their DNA barcodes were obtained to estimate p-distances and K2P distances. In addition, an identification key for the four closely-related species is presented.

Key Words

Biodiversity, daddy-long-legs spider, identification key, molecular species delimitation, new species

Introduction

The family Pholcidae C.L. Koch, 1850 is a highly diverse group of spiders, with 97 genera and 1,937 species (World Spider Catalog 2023), classified under five subfamilies: Arteminae Simon, 1893, Modisiminae Simon, 1893, Ninetinae Simon, 1890, Pholcinae C.L. Koch, 1850 and Smeringopinae Simon, 1893 (Huber 2011a; Dimitrov et al. 2013; Huber et al. 2018). *Pholcus* Walckenaer, 1805 is the most diverse genus within Pholcinae, with 389 described species belonging to 21 species groups distributed mainly in the Palaearctic, Oriental, Afrotropical and Australasian biogeographic realms (Huber 2011b; Huber et al. 2018; World Spider Catalog 2023).

Bestriding the Palaearctic and Oriental Regions, China harbours a high diversity of *Pholcus* spiders. Recently, a large number of new species of *Pholcus* have been reported from northern China, based on morphological and molecular data. For instance, the extensive 2020 expedition into the Changbai Mountains, at the border between north-eastern China and North Korea, brings the species count of *Pholcus* in the Changbai Mountains to 27 species, including 13 new species (Lu et al. 2021; Yao et al. 2021; Zhao et al. 2023a). The systematic investigation in the Yanshan-Taihang Mountains in northern China in 2021 recorded 36 *Pholcus* species, of which 14 species were new to science (Lu et al. 2022a, b). In 2022, *Pholcus* spiders were collected for the first time during an expedition to the Lüliang Mountains in Shanxi Province, northern China. The study identified one known species and eight new species (Zhao et al. 2023b). So far, 169 species, 43% of the genus, have been recorded in China (World Spider Catalog 2023).

China's Qinling Mountains is generally regarded as a geographical dividing line between northern China and southern China. It straddles the Provinces of Shanxi, Shaanxi and Henan. To date, 14 species of *Pholcus* have been found to be recorded in the Qinling Mountains (Zhang and Zhu 2009; Yao and Li 2012; Dong et al. 2016; World Spider Catalog 2023). This paper identifies four morphologically similar species from the Qinling Mountains (Shaanxi part, Fig. 1), based on morphological and molecular evidence, including two new species to be described and all belong to the *Pholcus yichengicus* species group.

Materials and methods

Specimens were examined and measured with a Leica M205 C stereomicroscope. Left male pedipalps were photographed. Epigynes were photographed before dissection. Vulvae were illustrated after treating them in a 10% warm solution of potassium hydroxide (KOH) to dissolve soft tissues. Images were captured with a Canon EOS 750D wide zoom digital camera (24.2 megapixels) mounted on the stereomicroscope mentioned above and assembled using Helicon Focus v. 3.10.3 image stacking software (Khmelik et al. 2005). All measurements are given in millimetres (mm). Leg measurements are shown as: total length (femur, patella, tibia, metatarsus, tarsus). Leg segments were measured on their dorsal side. The distribution map was generated with ArcGIS v. 10.2 (ESRI Inc.). The specimens studied are preserved in 75% ethanol and deposited in the College of Life Science, Shenyang Normal University (SYNU) in Liaoning, China.

Terminology and taxonomic descriptions follow Huber (2011b) and Yao et al. (2015, 2021). The following abbreviations are used in the descriptions: **ALE** = anterior lateral eye, **AME** = anterior median eye, **PME** = posterior median eye, **L/d** = length/diameter ratio; used in the illustrations: **a** = appendix, **b** = bulb, **da** = distal apophysis, **e** = embolus, **fa** = frontal apophysis, **pa** = proximo-lateral apophysis, **pp** = pore plate, **pr** = procursus, **u** = uncus.

The mitochondrial gene fragment encoding COI and two nuclear gene fragments encoding H3 and wnt were obtained for 19 samples (Table 1). Primers are listed in Table 2. Two species *Pholcus paralinzhou* and *P. taishan* were selected as outgroups. DNA sequences were checked and edited with BioEdit 7.2.2 (Hall 1999). P-distances and K2P distances from COI were computed using MEGA 5 (Tamura et al. 2011). Phylogenetic trees were constructed using the Maximum Likelihood (ML) method for molecular species delimitation, using both COI and a combined dataset. ML analyses were conducted using RAxML 8.2.9 under a GTRCAT model for all partitions, with 500 rapid bootstrap replicates followed

Table 1. Voucher specimen information.

Species	Voucher code	GenBank accession number			Collection locality
		COI	H3	wnt	
P. ankang sp. nov.	W265	PP082941	PP349964	PP349983	China, Shaanxi, Ankang
	W266	PP082942	PP349965	PP349984	
	W267	PP082943	PP349966	PP349985	
	W268	PP082944	PP349967	PP349986	
	W269	PP082945	PP349968	PP349987	
P. baoji sp. nov.	W270	PP082946	PP349969	PP349988	China, Shaanxi, Baoji
	W271	PP082947	PP349970	PP349989	
	W272	PP082948	PP349971	PP349990	
	W273	PP082949	PP349972	PP349991	
	W274	PP082950	PP349973	PP349992	
P. ovatus	W220	PP082951	PP349955	PP349974	China, Shaanxi, Xi'an
	W221	PP082952	PP349956	PP349975	
	W222	PP082953	PP349957	PP349976	
	W223	PP082954	PP349958	PP349977	
P. taibaiensis	W224	PP082955	PP349959	PP349978	China, Shaanxi, Baoji
	W225	PP082956	PP349960	PP349979	
	W226	PP082957	PP349961	PP349980	
	W227	PP082958	PP349962	PP349981	
	W228	PP082959	PP349963	PP349982	
P. paralinzhou	y046	MW721825	ON375203	ON375294	China, Henan, Jiaozuo
P. taishan	y133	MW721826	ON375204	ON375293	China, Shandong, Taian

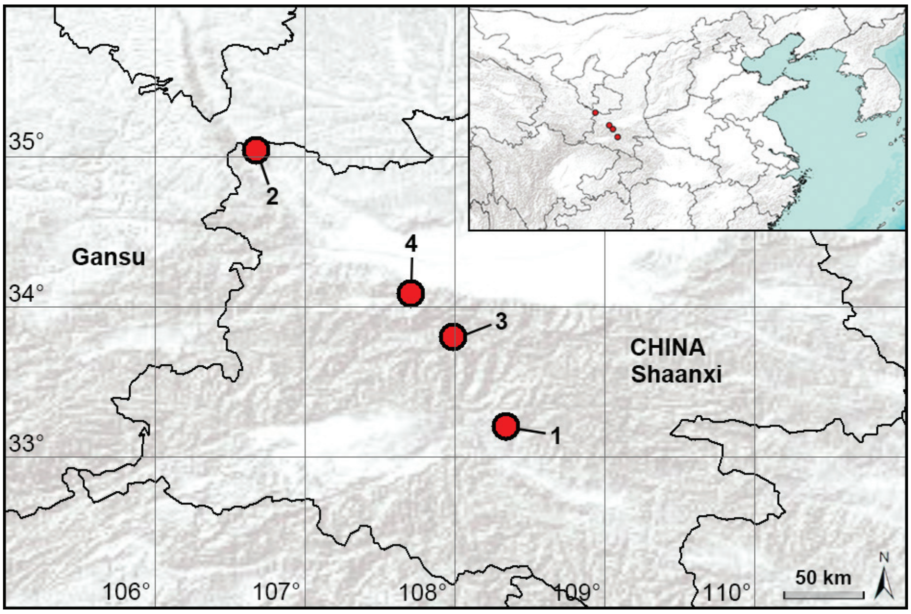

Figure 1. Distribution records of four closely-related species of *Pholcus* from the Qinling Mountains, China. **1.** *Pholcus ankang* sp. nov.; **2.** *P. baoji* sp. nov.; **3.** *P. ovatus*; **4.** *P. taibaiensis*.

Table 2. Primers used for amplification and sequencing.

Gene	Primer	F/R	Sequence 5'–3'	Reference
COI	LCO1490	F	GGTCAACAAATCATAAAGATATTGG	Folmer et al. (1994)
	C1-N-2776	R	GGATAATCAGAATANCGNCGAGG	Vink et al. (2005)
H3	H3af	F	ATGGCTCGTACCAAGCAGACVGC	Colgan et al. (1998)
	H3ar	R	ATATCCTTRGGCATRATRGTGAC	
wnt	Spwgf1	F	GYAAATGCCAYGGWATGTCMGG	Blackledge et al. (2009)
	Spwgr1	R	ACTTGRCAACACCARTGAAAWG	
	Wnt2f	F	CAGTGRAATGTRCARTTG	
	Wnt2r	R	CNGTTCAAACTTGYTGGATG	

by a thorough Maximum Likelihood tree search (Stamatakis 2014). The sequences are deposited in GenBank. For additional information on extraction, amplification and sequencing procedures, see Yao et al. (2016).

We applied four methods for molecular species delimitation. The Automatic Barcode Gap Discovery (ABGD) analyses were conducted using both Jukes–Cantor and Kimura 2-P distance matrices with options: Pmin = 0.001, Pmax = 0.1, Steps = 10, X = 1.0, Nb bins = 20 (Puillandre et al. 2012). The Bayesian implementation of the Poisson Tree Processes (bPTP) analysis was run for 100,000 generations, with a thinning of 100 and burn-in of 0.25 (Zhang et al. 2013). The Generalised Mixed Yule Coalescent (GMYC) analysis was performed under the single threshold model using the R 4.2.2 package SPLITS (R Development Core Team 2023). The phylogenetic tree was converted to an ultrametric format for GMYC analysis using BEAST 1.8.2 (Drummond et al. 2012). Bayesian Phylogenetics and Phylogeography (BPP) requires data from multiple genes and pre-defined candidate species. We used BPP to test the results between the analyses mentioned above. Like Yang (2015), we conducted four different sets of analyses with different values of α and β: $G\theta(2, 1000)$ and $G\tau(2, 2000)$, $G\theta(2, 100)$ and $G\tau(2, 200)$, $G\theta(2, 100)$ and $G\tau(2, 2000)$, $G\theta(2, 1000)$ and $G\tau(2, 200)$. The analyses were performed using the following settings: species delimitation = 1, algorithm = 0, finetune = 5. The reversible-jump MCMC analyses were run for 100,000 generations and sampled every two generations, with 25,000 samples being discarded as burn-in.

Results

We obtained a concatenated alignment of 1767 bp (COI, 1184 bp; H3, 293 bp; wnt, 290 bp). Separate phylogenetic analyses of the individual gene COI and concatenated data found compatible topologies. Fig. 2 presents the phylogenetic tree from the concatenated data. The tree clearly divided the samples into four deeply divergent clades. We defined the four major clades as four candidate species, because the ABGD, GMYC and bPTP analyses unambiguously support their status as separate species and the results were fairly consistent with morphology. We used BPP to validate the four species. The BPP analyses found speciation probabilities of one for all of the nodes tested using all four prior combinations. Furthermore, the smallest p-distance and K2P distance amongst the species is 0.068 and 0.072, respectively (between *P. ovatus* and *P. taibaiensis*) (Table 3). Of the four species, two are new and descriptions are provided below.

Table 3. The average uncorrected p-distances (below diagonal) and K2P distances (above diagonal) amongst the species and the maximum p-distances (on diagonal) within each species.

	***P. ankang* sp. nov.**	***P. baoji* sp. nov.**	***P. ovatus***	***P. taibaiensis***
***P. ankang* sp. nov.**	**0.001**	0.099	0.102	0.119
***P. baoji* sp. nov.**	0.092	**0**	0.096	0.102
P. ovatus	0.094	0.090	**0.001**	0.072
P. taibaiensis	0.109	0.095	0.068	**0.001**

Taxonomy

Family Pholcidae C.L. Koch, 1850
Subfamily Pholcinae C.L. Koch, 1850

Genus *Pholcus* Walckenaer, 1805

Type species. *Aranea phalangioides* Fuesslin, 1775

***Pholcus yichengicus* species group**

Diagnosis and description. See Huber (2011b).

Identification key

Note that males and females must be present for this key to work.

1 Sclerotised prolatero-subdistal apophysis of procursus prolatero-proximally strongly widened (figs 134C, 137A in Yao and Li (2012)); raised prolatero-subdistal membranous edge of procursus laterally strongly curved (figs 134D, 137B in Yao and Li (2012)); appendix with slender median branch (branch length/appendix length ratio: 0.5); vulval anterior arch postero-medially strongly protruding (figs 135B, 137D in Yao and Li (2012)).. *P. ovatus*

– Sclerotised prolatero-subdistal apophysis of procursus not widened prolatero-proximally (e.g. fig. 169C in Yao and Li (2012)); raised prolatero-subdistal membranous edge of procursus laterally angular or rectangular (e.g. fig. 169D in Yao and Li (2012) and Fig. 5D); appendix with slender median branch (branch length/appendix length ratio: 1 or 0.2) or angular branch; vulval anterior arch not protruding postero-medially (e.g. Fig. 4B) 2

2 Raised prolatero-subdistal membranous edge of procursus laterally rectangular (Fig. 5D); appendix with slender median branch (branch length/appendix length ratio: 1, arrow 2 in Fig. 6C); epigynal plate nearly triangular and posteriorly straight (Fig. 6A); vulval pore plates relatively close to each other (Fig. 6B) .... *P. baoji* sp. nov.
– Raised prolatero-subdistal membranous edge of procursus laterally angular; epigynal plate posteriorly strongly curved (e.g. Fig. 4A); vulval pore plates widely separated (e.g. Fig. 4B) 3
3 Sclerotised prolatero-subdistal apophysis of procursus not protruding latero-distally (arrow 4 in Fig. 3D); appendix with angular median branch (arrow 2 in Fig. 4C) .... *P. ankang* sp. nov.
– Sclerotised prolatero-subdistal apophysis of procursus latero-distally protruding (fig. 169D in Yao and Li (2012)); appendix with slender median branch (branch length/appendix length ratio: 0.2) .... *P. taibaiensis*

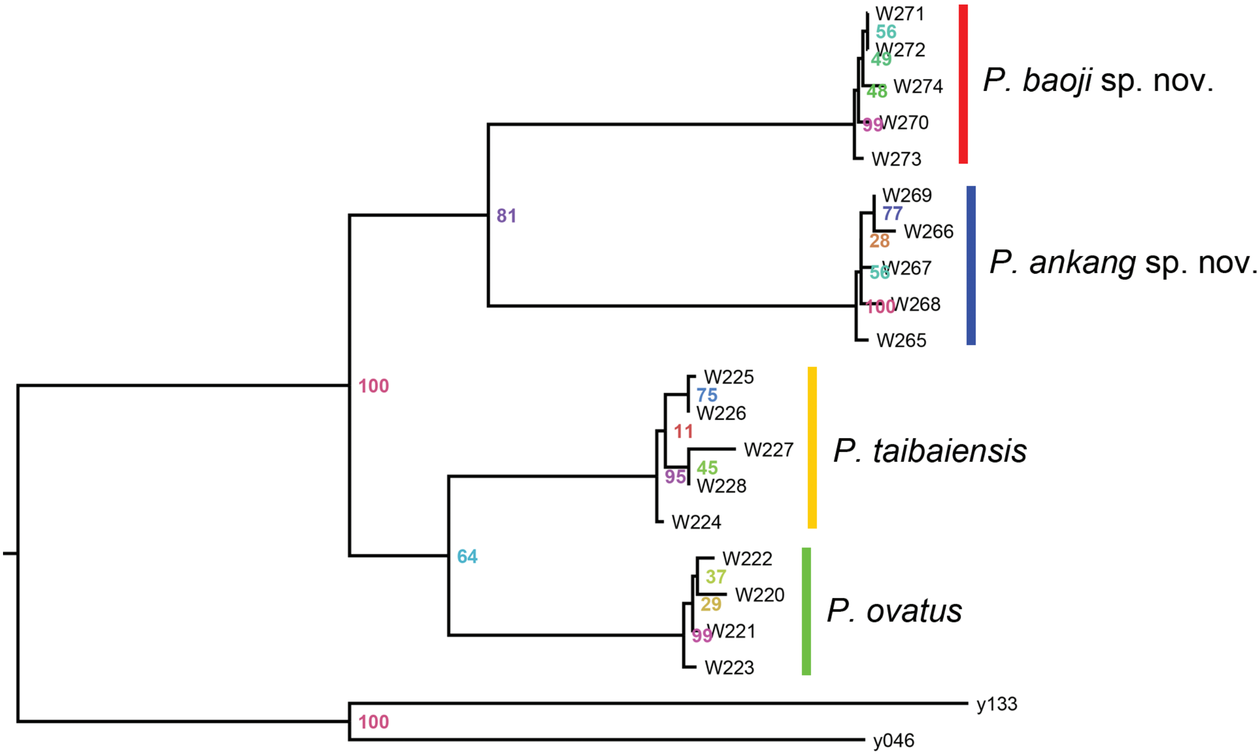

Figure 2. The results of species delimitation conducted by the ABGD, GMYC, bPTP and BPP analyses; different colours of the bars represent the different species (Phylogenetic tree was inferred from ML analysis, bootstrap values are provided at the nodes).

Pholcus ankang sp. nov.

https://zoobank.org/D586922C-E2C7-4C52-BE9F-A9AA9F38BD06

Figs 3, 4

Type material. ***Holotype*** ♂ (SYNU-Ar00398) and ***Paratypes*** 2♂ (SYNU-Ar00399–400) 2♀ (SYNU-Ar00401–02), **China**, **Shaanxi**, Ankang, Shiquan County, Chengguan Town, Guiguling Scenic Spot (33°12.32'N, 108°20.15'E, 1585 m elev.), 24 July 2022, Z. Yao, L. Yang & L. Zhang leg.

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

Diagnosis. The species resembles *P. baoji* sp. nov. with similar male chelicerae and uncus (Fig. 4C, D), but it can be distinguished by raised prolatero-subdistal membranous edge of procursus laterally angular (arrow 3 in Fig. 3D; laterally rectangular in *P. baoji* sp. nov., arrow 3 in Fig. 5D), by appendix with angular median branch (arrow 2 in Fig. 4C; slender median branch, same length as appendix in *P. baoji* sp. nov., arrow 2 in Fig. 6C), by epigynal plate posteriorly strongly curved (Fig. 4A; posteriorly straight and epigynal plate nearly triangular in *P. baoji* sp. nov., Fig. 6A) and by vulval pore plates widely separated (Fig. 4B; relatively close to each other in *P. baoji* sp. nov., Fig. 6B).

Description. Male (holotype): Total length 5.17 (5.26 with clypeus), carapace 1.53 long, 1.62 wide, opisthosoma 3.64 long, 1.58 wide. Leg I: 39.46 (10.13, 0.66, 9.94, 16.54, 2.19), leg II: 26.96 (7.50, 0.63, 6.79, 10.57, 1.47), leg III: 18.30 (5.38, 0.60, 4.45, 6.79, 1.08), leg IV: 24.35 (7.24, 0.61, 6.03, 9.29, 1.18); tibia I L/d: 70. Eye interdistances and diameters: PME-PME 0.25, PME 0.19, PME-ALE 0.06, AME-AME 0.06, AME 0.15. Sternum width/length: 1.12/0.94. Habitus as in Fig. 4E, F. Carapace yellowish, with brown radiating marks and marginal brown bands; ocular area yellowish, with anterior brown marks; clypeus brown; sternum yellowish, with brown marks. Legs yellowish, but dark brown on patellae and whitish on distal parts of femora and tibiae, with darker rings on subdistal parts of femora and proximal and subdistal parts of tibiae. Opisthosoma yellowish, with dorsal and lateral spots. Chelicerae (Fig. 4D) with pair of

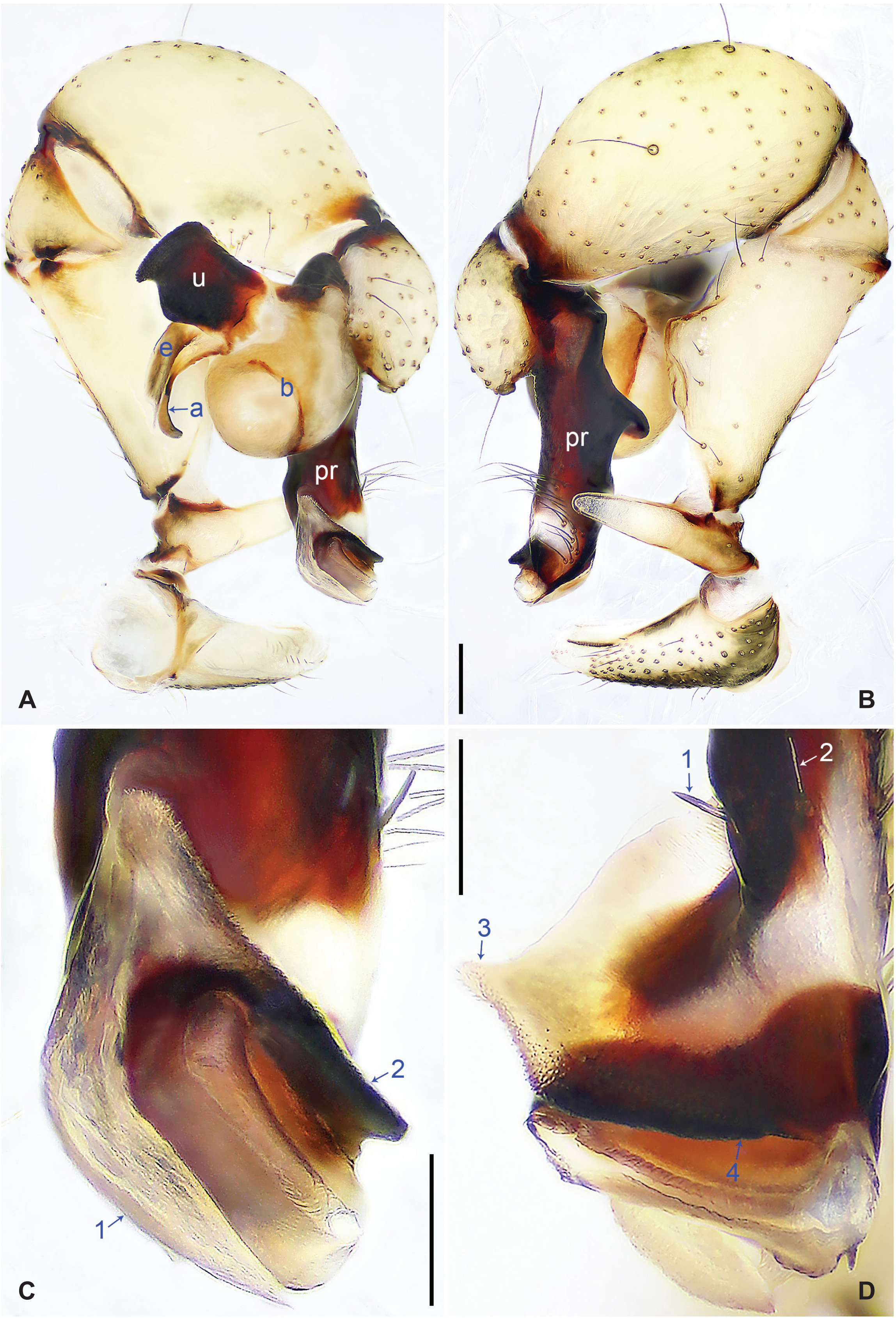

Figure 3. *Pholcus ankang* sp. nov., holotype male **A, B.** Pedipalp (**A.** Prolateral view; **B.** Retrolateral view); **C, D.** Distal part of procursus (**C.** Prolateral view, arrow 1 indicates distal membranous process, arrow 2 indicates sclerotised prolatero-subdistal apophysis; **D.** Dorsal view, arrows 1, 2 indicate dorsal spines, arrow 3 indicates angular part of raised prolatero-subdistal membranous edge, arrow 4 indicates latero-distal part of sclerotised prolatero-subdistal apophysis). Abbreviations: a = appendix, b = bulb, e = embolus, pr = procursus, u = uncus. Scale bars: 0.20 mm (**A, B**); 0.10 mm (**C, D**).

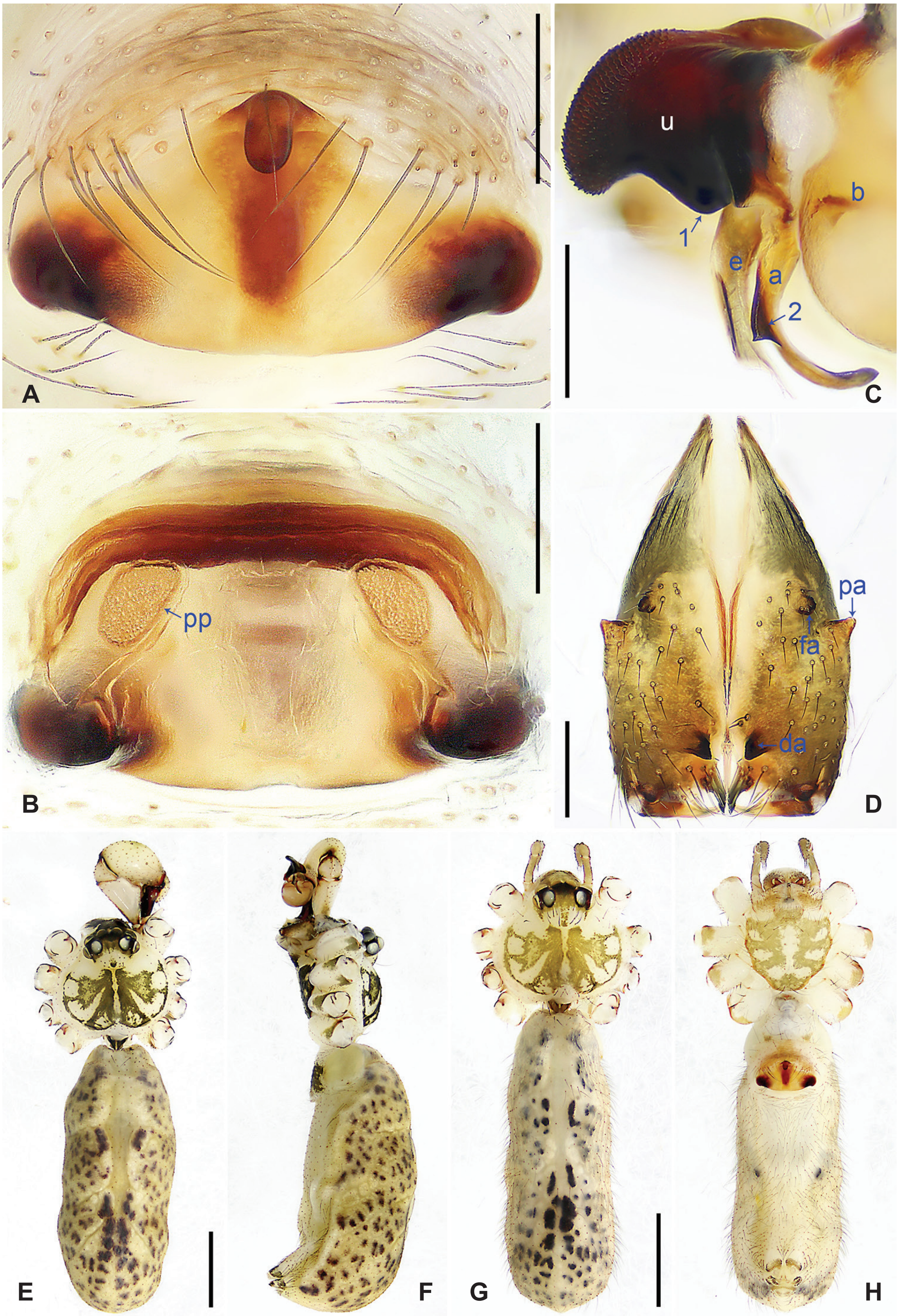

Figure 4. *Pholcus ankang* sp. nov., holotype male (**C–F**) and paratype female (**A, B, G, H**) **A.** Epigyne, ventral view; **B.** Vulva, dorsal view; **C.** Bulbal apophyses, prolateral view, arrow 1 indicates latero-median protrusion, arrow 2 indicates angular median branch; **D.** Chelicerae, frontal view; **E–H.** Habitus (**E, G.** Dorsal view; **F.** Lateral view; **H.** Ventral view). Abbreviations: a = appendix, b = bulb, da = distal apophysis, e = embolus, fa = frontal apophysis, pa = proximo-lateral apophysis, pp = pore plate, u = uncus. Scale bars: 0.20 mm (**A–D**); 1.00 mm (**E–H**).

proximo-lateral apophyses, pair of distal apophyses with two teeth each and pair of frontal apophyses. Pedipalp as in Fig. 3A, B; trochanter with long (longer than wide), retrolaterally strongly bulged ventral apophysis; femur with small retrolatero-proximal apophysis and distinct ventral protuberance; tibia with prolatero-ventral projection; procursus simple proximally, but complex distally, with raised prolatero-subdistal membranous edge bearing distal membranous process (arrow 1 in Fig. 3C), sclerotised prolatero-subdistal apophysis (arrow 2 in Fig. 3C) and two strong dorsal spines (arrows 1 and 2 in Fig. 3D); uncus latero-medially protruding (arrow 1 in Fig. 4C), with proximal apophysis and distal scaly edge; appendix curved, with angular median branch (arrow 2 in Fig. 4C); embolus weakly sclerotised, with some transparent distal projections (Fig. 4C). Retrolateral trichobothrium of tibia I at 7% proximally; legs with short vertical setae on tibiae, metatarsi and tarsi; tarsus I with 38 distinct pseudosegments.

Female (paratype, SYNU-Ar00401): Similar to male, habitus as in Fig. 4G, H. Total length 4.60 (4.75 with clypeus), carapace 1.31 long, 1.44 wide, opisthosoma 3.29 long, 1.22 wide; tibia I: 7.18; tibia I L/d: 51. Eye interdistances and diameters: PME-PME 0.23, PME 0.16, PME-ALE 0.05, AME-AME 0.05, AME 0.13. Sternum width/length: 0.90/0.76. Epigyne (Fig. 4A) posteriorly strongly curved, laterally and medially strongly sclerotised, with column-shaped knob. Vulva (Fig. 4B) with laterally strongly curved, sclerotised anterior arch and pair of nearly elliptic pore plates.

Variation. Tibia I in two paratype males (SYNU-Ar00399–400): 9.04, 9.36. Tibia I in another paratype female (SYNU-Ar00402): 7.12.

Natural history. The species was found on the underside of an overhang on rocky cliffs.

Distribution. China (Shaanxi, type locality; Fig. 1).

Pholcus baoji sp. nov.

https://zoobank.org/EE2818D8-A3D6-4E90-BE29-91278647C486

Figs 5, 6

Type material. ***Holotype*** ♂ (SYNU-Ar00403) and ***Paratypes*** 1♂ (SYNU-Ar00404) 2♀ (SYNU-Ar00405–06), **China**, **Shaanxi**, Baoji, Long County, Xinjichuan Town, Longmendong Scenic Spot (35°2.33'N, 106°40.22'E, 1489 m elev.), 29 July 2022, Z. Yao, L. Yang & L. Zhang leg.

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

Diagnosis. The species resembles *P. ankang* sp. nov. with similar male chelicerae and uncus (Fig. 6C, D), but it can be distinguished by raised prolatero-subdistal membranous edge of procursus laterally rectangular (arrow 3 in Fig. 5D; laterally angular in *P. ankang* sp. nov., arrow 3 in Fig. 3D), by appendix with slender median branch (same length as appendix, arrow 2 in Fig. 6C; angular median branch in *P. ankang* sp. nov., arrow 2 in Fig. 4C), by epigynal plate nearly triangular and posteriorly straight (Fig. 6A; posteriorly strongly curved in *P. ankang* sp. nov., Fig. 4A) and by vulval pore plates relatively close to each other (Fig. 6B; widely separated in *P. ankang* sp. nov., Fig. 4B).

Description. Male (holotype): Total length 4.96 (5.05 with clypeus), carapace 1.48 long, 1.78 wide, opisthosoma 3.48 long, 1.52 wide. Leg I: 42.86 (10.77, 0.75, 11.15, 17.56, 2.63), leg II: 28.13 (7.82, 0.70, 6.98, 10.96, 1.67), leg III missing, leg IV: 25.71 (7.69, 0.65, 6.28, 9.62, 1.47); tibia I L/d: 70. Eye interdistances and diameters: PME-PME 0.26, PME 0.16, PME-ALE 0.06, AME-AME 0.05, AME 0.12. Sternum width/length: 1.08/0.93. Habitus as in Fig. 6E, F. Carapace yellowish, with brown radiating marks and marginal brown bands; ocular area yellowish, with anterior brown marks; clypeus brown; sternum yellowish, with brown marks. Legs yellowish, but dark brown on patellae and whitish on distal parts of femora and tibiae, with darker rings on subdistal parts of femora and proximal and subdistal parts of tibiae. Opisthosoma yellowish, with dorsal and lateral spots. Chelicerae (Fig. 6D) with pair of proximo-lateral apophyses, pair of distal apophyses with two teeth each and pair of frontal apophyses. Pedipalp as in Fig. 5A, B; trochanter with long (longer than wide), retrolaterally strongly bulged ventral apophysis; femur with small retrolatero-proximal apophysis and distinct ventral protuberance; tibia with prolatero-ventral projection; procursus simple proximally, but complex distally, with raised prolatero-subdistal membranous edge bearing distal membranous process (arrow 1 in Fig. 5C), sclerotised prolatero-subdistal apophysis (arrow 2 in Fig. 5C) and two strong dorsal spines (arrows 1 and 2 in Fig. 5D); uncus latero-medially protruding (arrow 1 in Fig. 6C), with proximal apophysis and distal scaly edge; appendix curved, with slender median branch (same length as appendix, arrow 2 in Fig. 6C); embolus weakly sclerotised, with some transparent distal projections (Fig. 6C). Retrolateral trichobothrium of tibia I at 8% proximally; legs with short vertical setae on tibiae, metatarsi and tarsi; tarsus I with 35 distinct pseudosegments.

Female (paratype, SYNU-Ar00405): Similar to male, habitus as in Fig. 6G, H. Total length 4.75 (4.80 with clypeus), carapace 1.35 long, 1.62 wide, opisthosoma 3.40 long, 1.70 wide; tibia I: 7.10; tibia I L/d: 51. Eye interdistances and diameters: PME-PME 0.22, PME 0.15, PME-ALE 0.06, AME-AME 0.05, AME 0.11. Sternum width/length: 1.01/0.79. Epigyne (Fig. 6A) nearly triangular, laterally and medially strongly sclerotised, with column-shaped knob. Vulva (Fig. 6B) with laterally strongly curved, posteriorly sclerotised anterior arch and pair of nearly elliptic pore plates.

Variation. Tibia I in paratype male (SYNU-Ar00404): 10.44. Tibia I in another paratype female (SYNU-Ar00406): 7.18.

Natural history. The species was found on the underside of an overhang on rocky cliffs.

Distribution. China (Shaanxi, type locality; Fig. 1).

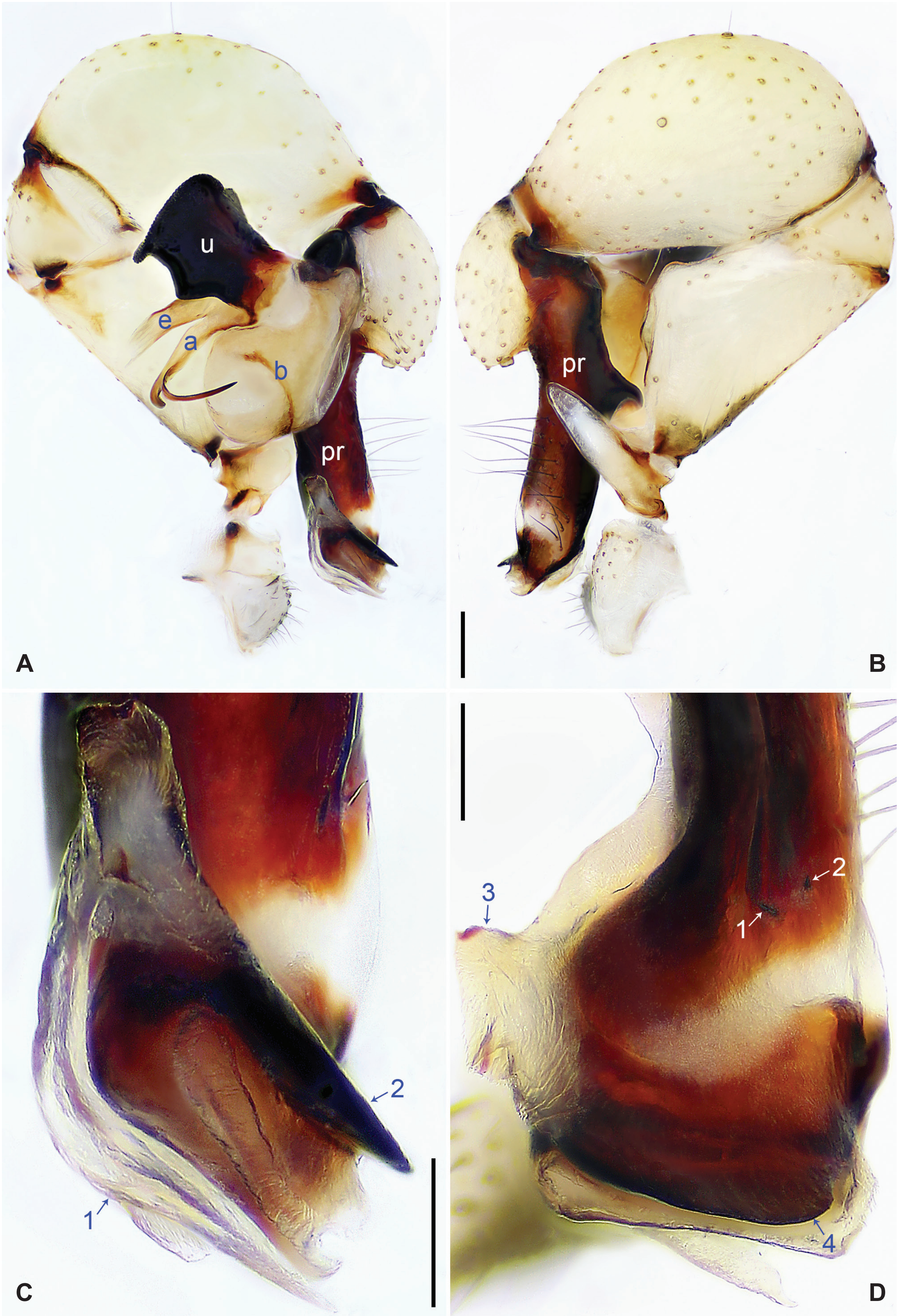

Figure 5. *Pholcus baoji* sp. nov., holotype male **A, B.** Pedipalp (**A.** Prolateral view; **B.** Retrolateral view); **C, D.** Distal part of procursus (**C.** Prolateral view, arrow 1 indicates distal membranous process, arrow 2 indicates sclerotised prolatero-subdistal apophysis; **D.** Dorsal view, arrows 1, 2 indicate dorsal spines, arrow 3 indicates rectangular part of raised prolatero-subdistal membranous edge, arrow 4 indicates latero-distal part of sclerotised prolatero-subdistal apophysis). Abbreviations: a = appendix, b = bulb, e = embolus, pr = procursus, u = uncus. Scale bars: 0.20 mm (**A, B**); 0.10 mm (**C, D**).

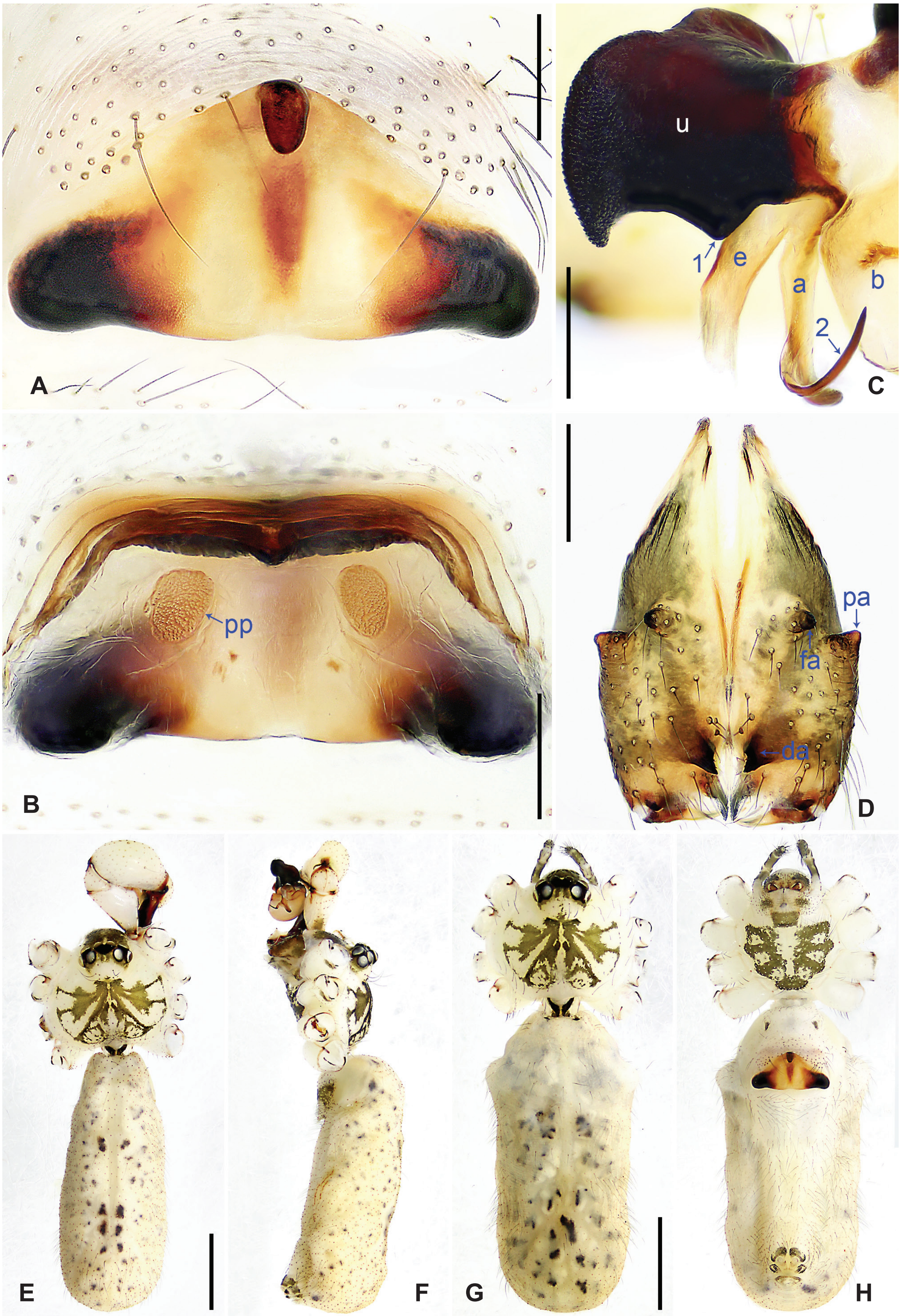

Figure 6. *Pholcus baoji* sp. nov., holotype male (**C–F**) and paratype female (**A, B, G, H**) **A.** Epigyne, ventral view; **B.** Vulva, dorsal view; **C.** Bulbal apophyses, prolateral view, arrow 1 indicates latero-median protrusion, arrow 2 indicates slender median branch; **D.** Chelicerae, frontal view; **E–H.** Habitus (**E, G.** Dorsal view; **F.** Lateral view; **H.** Ventral view). Abbreviations: a = appendix, b = bulb, da = distal apophysis, e = embolus, fa = frontal apophysis, pa = proximo-lateral apophysis, pp = pore plate, u = uncus. Scale bars: 0.20 mm (**A–D**); 1.00 mm (**E–H**).

Pholcus ovatus Yao & Li, 2012

Pholcus ovatus Yao and Li (2012: 28), figs 134A–D, 135A–E, 136A–D, 137A–D.

Material examined. 1♂ (SYNU-Ar00120F) 1♀ (SYNU-Ar00121F), **China**, **Shaanxi**, Xi'an, Zhouzhi County, Banfangzi Town (type locality), roadside of G108 (33°48.02'N, 107°59.08'E, 1165 m elev.), 31 July 2022, Z. Yao, L. Yang & L. Zhang leg.

Diagnosis. The species resembles *P. taibaiensis* Wang & Zhu, 1992 (Yao and Li 2012: 34, figs 169A–D, 170A–C) with similar male chelicerae and epigyne (figs 135A, 136B, C, 137C in Yao and Li (2012)), but it can be distinguished by sclerotised prolatero-subdistal apophysis of procursus prolatero-proximally strongly widened (figs 134C, 137A in Yao and Li (2012); not widened in *P. taibaiensis*, fig. 169C in Yao and Li (2012)), by raised prolatero-subdistal membranous edge of procursus laterally strongly curved (figs 134D, 137B in Yao and Li (2012); laterally angular in *P. taibaiensis*, fig. 169D in Yao and Li 2012), by appendix median branch length/appendix length ratio: 0.5 (figs 134A, 136A in Yao and Li (2012); 0.2 in *P. taibaiensis*, fig. 169A in Yao and Li (2012)) and by vulval anterior arch postero-medially strongly protruding (figs 135B, 137D in Yao and Li (2012); not protruding in *P. taibaiensis*, fig. 170B in Yao and Li (2012)).

Natural history. The species was found on the underside of an overhang on rock cliffs.

Distribution. China (Shaanxi, Fig. 1).

Pholcus taibaiensis Wang & Zhu, 1992

Pholcus taibaiensis Wang and Zhu (1992: 20), figs 1–6. Song, Zhu and Chen (1999: 63), fig. 25I–K. Zhang and Zhu (2009: 90), fig. 52A–I. Huber (2011b: 451), figs 2097–2099, 2124, 2125, 2178–2183, 2185 and 2199. Yao and Li (2012: 34), figs 169A–D, 170A–C.

Material examined. 3♂ (SYNU-Ar00130F–Ar00132F) 3♀ (SYNU-Ar00133F–Ar00135F), **China**, **Shaanxi**, Baoji, Mei County, Yingtou Town, near Haopingsi Temple (type locality) (34°5.32'N, 107°42.33'E, 1101 m elev.), 30 July 2022, Z. Yao, L. Yang & L. Zhang leg.

Diagnosis. The species resembles *P. ovatus* Yao & Li, 2012 (Yao and Li 2012: 28, figs 134A–D, 135A–E, 136A–D, 137A–D) with similar male chelicerae and epigyne (fig. 170A in Yao and Li (2012)), but it can be distinguished by sclerotised prolatero-subdistal apophysis of procursus not widened prolatero-proximally (fig. 169C in Yao and Li (2012); strongly widened in *P. ovatus*, figs 134C, 137A in Yao and Li (2012)), by raised prolatero-subdistal membranous edge of procursus laterally angular (fig. 169D in Yao and Li (2012); laterally strongly curved in *P. ovatus*, figs 134D, 137B in Yao and Li (2012)), by appendix median branch length/appendix length ratio: 0.2 (fig. 169A in Yao and Li (2012); 0.5 in *P. ovatus*, figs 134A, 136A in Yao and Li (2012)) and by vulval anterior arch not protruding postero-medially (fig. 170B in Yao and Li (2012); strongly protruding in *P. ovatus*, figs 135B, 137D in Yao and Li (2012)).

Natural history. The species was found on the underside of an overhang on rocky cliffs.

Distribution. China (Shaanxi, Fig. 1).

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