SOIL ORGANISMS **97** (3) · 2025

pp. 317–326
https://doi.org/10.25674/461

Two new species of the *Cybaeus hiroshimaensis*-group (Araneae: Cybaeidae) from the northern Hida Mountains, Japan

Takafumi Nakano[1]*, Gakuto Ogawa[1], Kei Mori[2], Yu Hatanaka[2], Naoki Koike[1] and Yusuke Sugawara[1]

[1] Department of Zoology, Graduate School of Science, Kyoto University, Sakyo-ku, Kyoto 606-8502, Japan
[2] Faculty of Science, Kyoto University, Sakyo-ku, Kyoto 606-8502, Japan
* Corresponding author, email: nakano@zoo.zool.kyoto-u.ac.jp

Received 28 February 2025 | Accepted 1 August 2025 | Published online 21 November 2025

Abstract

Two small-sized species of the spider genus *Cybaeus* L. Koch, 1868, *C. pycnothrix* sp. nov. and *C. tateyamensis* sp. nov., are described based on both sexes from the Tateyama Mountain Range in the Hida Mountains, central Honshu, Japan. Phylogenetic analyses using nuclear internal transcribed spacer 1, 28S rRNA, and histone H3 markers revealed that the two new species are members of the monophyletic Japanese *Cybaeus hiroshimaensis*-group. Both new species conform to the morphological diagnosis of the *hiroshimaensis*-group — small body size and a short, thick male palp — and build two-opening retreats, indicating that retreat architecture in the group varies and encompasses both two- and three-opening forms.

Keywords Arachnida | RTA clade | core Cybaeidae | molecular phylogeny

1 Introduction

Spiders of the family Cybaeidae, which has a Holarctic distribution, typically inhabit epigean habitats, but several species are found in subterranean habitats (Bennett 2017). A phylogenomic study elucidated robust phylogenetic relationships among cybaeid genera and determined that the "core Cybaeidae" clade within this family includes *Cybaeus* L. Koch, 1868 and *Cybaeus*-like genera endemic to North America and East Asia (Hedin et al. 2025). In Japan, Cybaeidae is represented exclusively by members of this core clade; a recent molecular phylogenetic study further shows that the Japanese cybaeid fauna comprises three genera: *Cybaeus*, *Allocybaeina* Bennett in Bennett et al., 2020, and *Sincybaeus* Wang & Zhang, 2022 (Sugawara et al. 2024). *Cybaeus* is the most species-rich taxon among the three genera indigenous to the Japanese Archipelago, and more than 90 species of this genus have been described from Japan to date (World Spider Catalog 2025).

Within Japanese *Cybaeus*, a recent phylogenetic study based on Sanger sequencing (Sugawara et al. 2024) recognized four major lineages and re-evaluated the species groups traditionally defined by Ihara (2009a, b), including the *hiroshimaensis*-group. The *hiroshimaensis*-group comprises small-sized species — body lengths up to ~5 mm — characterized by a short, thick male palp (Ihara 2009a). In that study, seven of Ihara's original 11 species, together with four additional small-sized species endemic to central Honshu Island, Japan (Kobayashi 2006), formed a well-supported monophyletic lineage, which we follow here as the *hiroshimaensis*-group (Sugawara et al. 2024).

ISSN 1864-6417 · **eISSN** 2509-9523

In the present study, unidentified small-sized *Cybaeus* spiders with a short, thick male palp were collected from the Tateyama Mountain Range in the northern Hida Mountains, Honshu Island, Japan. Their taxonomic accounts are herein clarified along with estimates of their phylogenetic positions within the Japanese *Cybaeus*, using nuclear genetic markers.

2 Materials and Methods

2.1 Samples and morphological examination

Cybaeus spiders were collected from the Tateyama Mountain Range, Toyama Prefecture, Japan (Fig. 1) in 2012 and 2022. Specimens were preserved in 70% ethanol, and legs of some specimens were removed and preserved in 99% ethanol for DNA extraction. Epigynes were dissected from female specimens and then cleared to observe their internal structure following the method described by Matsuda et al. (2020). Examination of the specimens was conducted using a Leica M125 and M125C stereoscopic microscopes (Leica Microsystems, Wetzlar, Germany). Images of the specimens were captured with a Leica MC170 HD digital camera mounted on the Leica M125C and analyzed using Leica Application Suite (LAS) v. 4.12. Measurements were taken to the nearest 0.01 mm in LAS. All specimens examined in this study have been deposited in the Zoological Collection of Kyoto University (KUZ).

Terminology of morphological characters and the chaetotaxy of leg macrosetae followed Ihara et al. (2021). The abbreviations for macrosetae: **p** – prolateral, **pm** – promargin, **r** – retrolateral, **rm** – retromargin, **v** – ventral.

2.2 Molecular phylogenetic analyses

The following three nuclear gene markers were obtained from the male holotype and female paratype of each new species for phylogenetic analyses: internal transcribed spacer 1 (ITS-1), 28S rRNA (28S), and histone H3 (H3). The sequences were deposited with the International Nucleotide Sequence Databases (INSD) through the DNA Data Bank of Japan.

Genomic DNA extraction and cycle sequencing reaction methods were conducted as described by Matsuda et al. (2020); primer sets and conditions for the polymerase chain reactions and cycle sequencing reactions used in this study followed Sugawara et al. (2021).

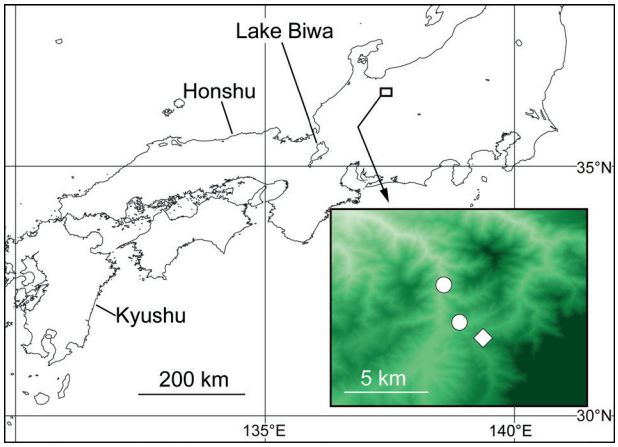

Figure 1. Map showing the collection localities of the specimens examined in this study. Open circles represent the collection sites of *Cybaeus pycnothrix* sp. nov.; an open diamond represents the site of *C. tateyamensis* sp. nov. Shoreline data were; based on Wessel & Smith (1996).

As in the previous study (Sugawara et al. 2024) and preliminary phylogenetic analyses (not shown), 30 sequences of the 11 *hiroshimaensis*-group species and six sequence of *C. fujisanus* Yaginuma, 1972 and *C. jaanaensis* Komatsu, 1968, which were selected as the outgroup, were retrieved from INSD and included in the dataset for the present analyses (Table S1).

The H3 alignment was trivial, as no indels were observed. The ITS-1 and 28S sequences were aligned using MAFFT v. 7.520 with the L-INS-i option (Katoh & Standley 2013). The lengths of the ITS-1, 28S, and H3 aligned datasets were 700, 797, and 328 bp, respectively. Our concatenated final dataset has 1825 bp of aligned positions.

Phylogenetic trees were reconstructed using maximum likelihood (ML) and Bayesian inference (BI). The best-fit partition scheme and optimal models were identified based on Bayesian information criterion using ModelFinder (Chernomor et al. 2016, Kalyaanamoorthy et al. 2017) implemented in IQ-Tree v. 2.2.2.6 (Minh et al. 2020). The selected partition scheme and models are as follows: for 28S and the H3 1st and 2nd positions, HKY + I; and for ITS-1 and the H3 3rd position, HKY + I + G. The ML tree was inferred using IQ-Tree v. 2.2.2.6 with non-parametric bootstrapping (BS) conducted with 1000 replicates. The BI tree and Bayesian posterior probabilities (PP) were estimated using MrBayes v. 3.2.7a (Ronquist et al. 2012). Two independent runs with four Markov chains were conducted for 4 million generations, and the tree was sampled every 100 generations. Parameter estimates and convergence were checked using Tracer v. 1.7.1 (Rambaut et al. 2018), and then the first 10001 trees were discarded (burn-in) based on the results.

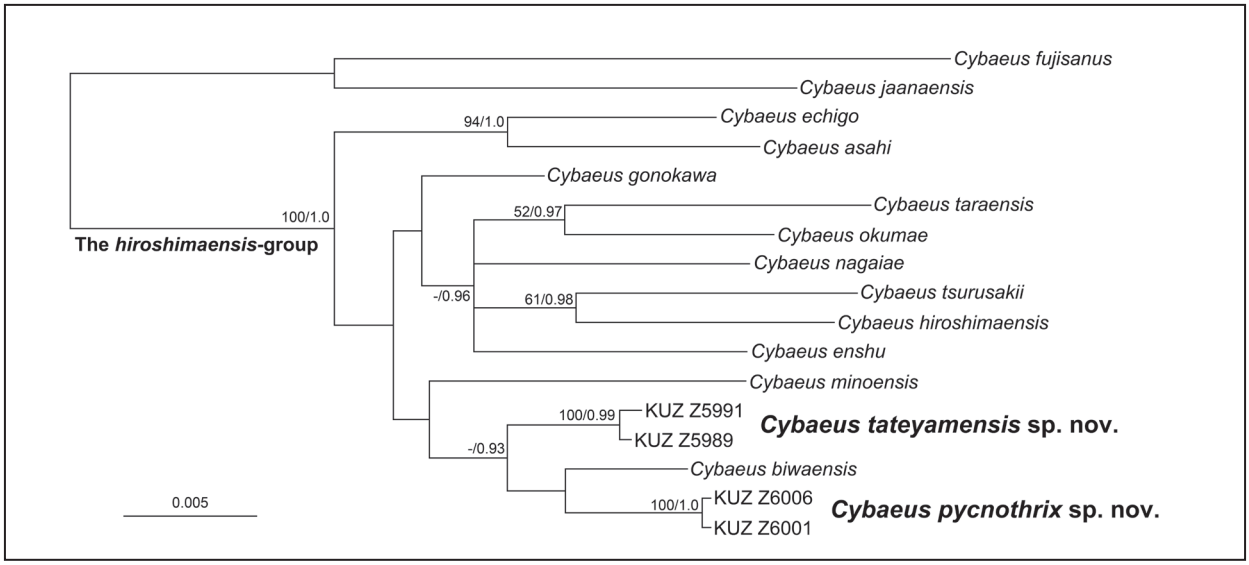

Figure 2. Bayesian inference tree for 1825 bp of nuclear internal transcribed spacer 1, 28S rRNA, and H3 markers. Numbers on nodes indicate bootstrap (BS) values for maximum likelihood ≥ 50 % and Bayesian posterior probabilities (PP) ≥ 0.90.

2.3 ZooBank registration

This work was registered with ZooBank under urn:lsid:zoobank.org:pub:3843721E-F89C-4C36-A034-8CBDD68F610B.

3 Results

3.1 Molecular analyses

The ML (not shown) and BI (Fig. 2) trees had almost identical topologies, and the monophyly of the currently recognized *hiroshimaensis*-group species and the Tateyama Mountain Range specimens was well supported by both analyses (BS = 100 %, PP = 1.0). The unidentified *Cybaeus* species were included in the *hiroshimaensis*-group lineage, but nonetheless, the present analyses failed to estimate robust relationships among the *hiroshimaensis*-group taxa. *Cybaeus asahi* Kobayashi, 2006 and *C. echigo* Kobayashi, 2006 formed a well-supported clade (BS = 94 %, PP = 1.0); those two species are endemic to the southern part of Yamagata Prefecture, Niigata Prefecture, and the northern part of Nagano Prefecture in northern to central Honshu Island (Kobayashi 2006). The BI tree recovered monophyly of six species (PP = 0.96), i. e., *C. taraensis* Irie & Ono, 2001, *C. okumae* Ihara, 2009a, *C. nagaiae* Ihara, 2009a, *C. tsurusakii* Ihara, 1993, *C. hiroshimaensis* Ihara, 1993, and *C. enshu* Kobayashi, 2006. However, this clade was not supported by the ML analysis (BS = 40 %). Within this lineage, *C. taraensis* and *C. okumae*, which are endemic to the northern Kyushu Island, Japan (Ihara 2009a), formed a supported clade in the BI tree (BS = 52 %, PP = 0.97). The remaining four species are distributed in central and western Honshu Island (Ihara 2009a), and monophyly was supported for the two species, *C. hiroshimaensis* and *C. tsurusakii*, known from western Honshu Island (BS = 61 %, PP = 0.98).

The specimens from the Tateyama Mountain Range formed a lineage with *C. biwaensis* Kobayashi, 2006, which is known from montane habitats around Lake Biwa in central Honshu Island (Kobayashi 2006); their monophyly was weakly supported only in the BI analysis (BS = 46 %, PP = 0.93). The specimens from the Tateyama Mountain Range were split into two clades, and the obtained ML and BI trees did not show monophyly of the two new species.

3.2 Taxonomy

***Cybaeus pycnothrix* Ogawa & Nakano, sp. nov.**
(Figs 3–5)

Diagnosis. Male *C. pycnothrix* sp. nov. can be clearly distinguished from male congeners by its palpal patellar apophysis with dense fine setae on its disto-dorsal surface (Fig. 4B, C). Female *C. pycnothrix* sp. nov. is most similar to that of *C. tateyamensis* sp. nov. However, the former is distinguishable from the latter by the position of copulatory pores (located beneath the posterior margin of each spermathecal base in *C. pycnothrix* sp. nov. versus located beneath the anterior margin of each base in *C. tateyamensis* sp. nov.; Figs 4I, J, 5, 6I, J, 7), the

length of copulatory ducts (those of *C. pycnothrix* sp. nov. are longer than those of *C. tateyamensis* sp. nov.; Figs 5, 7), and the position of spermathecal heads and stalks (located anteroventrally to the spermathecal base in *C. pycnothrix* sp. nov. versus located almost horizontal to the base, and the medial margins from head to stalk of each spermatheca closely adhering in *C. tateyamensis* sp. nov.; Figs 4K, 5, 6K, 7).

Cybaeus pycnothrix sp. nov. also differs from *C. tateyamensis* sp. nov. in abdominal coloration (dorsally brownish with chevron-like markings in *C. pycnothrix* sp. nov. versus dorsally grayish without chevron-like markings in *C. tateyamensis* sp. nov.; Figs 4A, H, 6B, H).

Material examined. *Holotype*: 1♂, KUZ Z6006, from near Arimine Visitor Center, Toayama, Toyama Prefecture, Japan (36.49197°N, 137.46050°E), elev. 1172 m, 31.x.2022, Yusuke Sugawara (YS) leg.

Paratypes (11♂♀): 1♂, KUZ Z5994, 2♀♀, KUZ Z5996, Z5998, Okuhirotani, Arimine, Toyama (36.51669°N, 137.44994°E), elev. 902 m, 19.ix.2012, Naoki Koike (NK) leg.; 1♂, KUZ Z5999, same locality data as for holotype, 19.ix.2012, NK leg.; 2♂♂, KUZ Z6002, Z6003, 3♀♀, KUZ Z6001, Z6004, Z6005, same locality data as for paratype KUZ Z5994, 31.x.2022, YS leg.; 3♀♀, KUZ Z6007–Z6009, same data as for holotype.

Additional material: 4♀♀, KUZ Z5995, Z5997, same data as for paratype KUZ Z5994; 1♀, KUZ Z6000, same data as for paratype KUZ Z5999.

Description. *Male* (holotype: Figs 3A, 4A–F). Measurements (mm): Carapace 1.59 long, 1.16 wide; head 0.71 wide; abdomen 1.50 long, 1.07 wide; ocular area 0.21 long, 0.41 wide; sternum 0.73 long, 0.76 wide; carapace width/length = 0.73, leg I tibia length/carapace length = 0.53. Leg measurements (femur + patella + tibia + metatarsus + tarsus) (mm): leg I 3.63 (1.08 + 0.43 + 0.85 + 0.77 + 0.50); leg II 3.36 (0.97 + 0.41 + 0.77 + 0.70 + 0.51); leg III 2.89 (0.86 + 0.36 + 0.56 + 0.66 + 0.45); leg IV 3.86 (1.19 + 0.38 + 0.85 + 0.91 + 0.53).

Carapace (Fig. 3A). Head narrow, ~0.61× as wide as thoracic region; thoracic region slightly higher than head. Anterior eye row (AER) straight in frontal view; posterior eye row (PER) straight in dorsal view; anterior median eyes (AME) smallest, < 1/2 diameter of other eyes; ocular area ~1.9× wider than long. Clypeus shorter than median ocular area.

Mouthparts. Chelicerae slightly geniculate; promargin of fang furrow with 3 teeth (median tooth largest); retromargin with 6 teeth (2 large + 4 small), decreasing in size distally; basally with lateral condyle. Labium wider than long.

Leg macrosetae (left legs). Leg I: tibia p2, r0, v2-2-2; metatarsus p1, r0, v2-2-2. Leg II: tibia p2, r0, v2(pm small)-2(pm small)-1(rm); metatarsus p2, r0, v2-2-3.

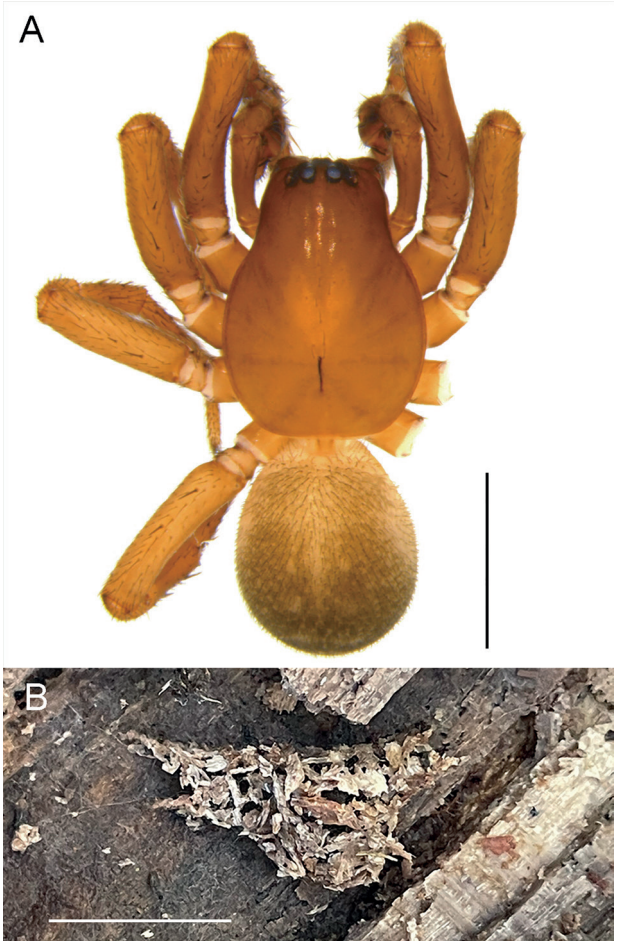

Figure 3. *Cybaeus pycnothrix* sp. nov., male holotype, KUZ Z6006. (**A**) Habitus, dorsal view. (**B**) Retreat, in situ. Scales: A = 1 mm; B = 10 mm.

Abdomen (Fig. 4A). Colulus 1 seta on left side, 2 setae on right side.

Palp (Fig. 4B–F). Short, thick; femur length/width = 3.09; femur length/cymbium length = 0.94. Patellar apophysis conical in dorsal view, disto-dorsal surface with ~15 fine setae. Tibia as long as patella; retrolateral tibial apophysis plate-like, retrolateral margin slightly undulated, occupying 4/5 of length of tibia. Cymbium relatively wide, ~1.8× longer than wide, slightly expanded prolaterally. Genital bulb circular in ventral view. Conductor: distal part short; proximal arm short, thick, slightly curved retrolaterally. Embolus simple, short, originating and terminating, respectively, at ~11 o'clock and ~4 o'clock in ventral view.

Color (Figs 3A, 4A). Carapace: head brown; thoracic region orangish brown, with radiating darkish bands faintly. Chelicerae, maxillary lobe and labium brownish. Sternum yellowish-brown. Legs brownish, without annulations. Abdomen: dorsally pale brown with chevron-like markings; ventrally pale brown.

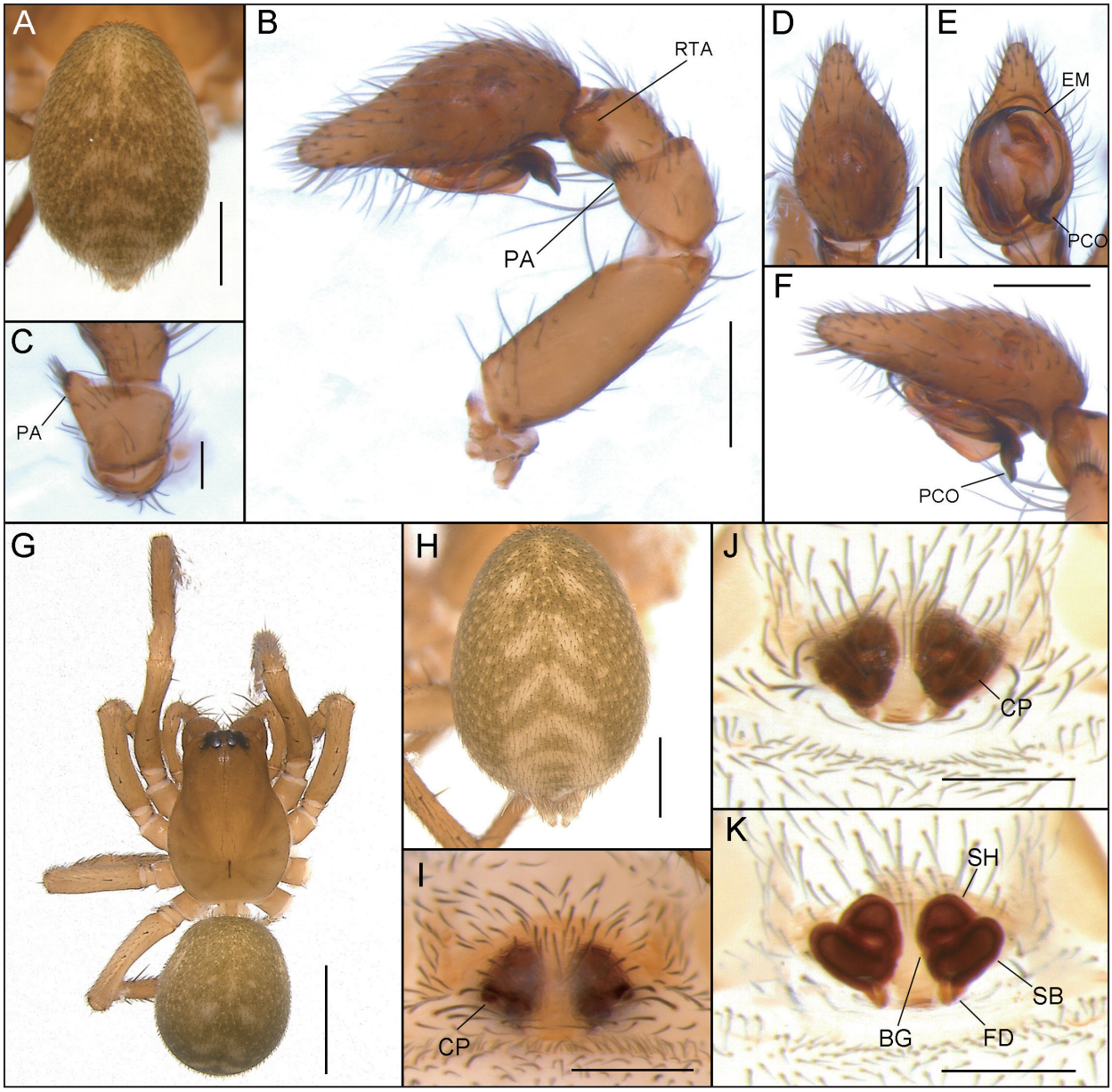

Figure 4. *Cybaeus pycnothrix* sp. nov., male holotype, KUZ Z6006 (A–F), female paratypes, KUZ Z6001 (G–I), KUZ Z6005 (J, K). (**A, H**) Abdomen, dorsal view. (**B**) Left palp, retrolateral view. (**C**) Patella of left palp, dorsal view. (**D**) Cymbium of left palp, dorsal view. (**E**) Bulb of left palp, ventral view. (**F**) Cymbium of left palp, retrolateral view. (**G**) Habitus dorsal view. (**I**) Epigyne, ventral view. (**J**) Epigyne and spermathecae, ventral view. (**K**) Endogyne, dorsal view. Abbreviations: **BG** – Bennett's gland, **CP** – copulatory pore, **EM** – embolus, **FD** – fertilization duct, **PA** – patellar apophysis, **PCO** – proximal arm of conductor, **RTA** – retrolateral tibial apophysis, **SB** – spermathecal base, **SH** – spermathecal head. Scales: A, H = 0.5 mm; B = 0.25 mm; C = 0.1 mm; D–F, I–K = 0.2 mm; G = 1 mm.

Female (paratypes, KUZ Z6001: Fig. 4G–I; KUZ Z6005: Figs 4J, K, 5). Measurements (mm): Carapace 1.58 long, 1.11 wide; head 0.74 wide; abdomen 1.73 long, 1.30 wide; ocular area 0.22 long, 0.46 wide; sternum 0.75 long, 0.76 wide; carapace width/length = 0.71, leg I tibia length/carapace length = 0.54. Leg measurements (femur + patella + tibia + metatarsus + tarsus) (mm): leg I 3.57 (1.05 + 0.46 + 0.86 + 0.71 + 0.49); leg II 3.32 (1.00 + 0.45 + 0.73 + 0.65 + 0.49); leg III 2.86 (0.86 + 0.41 + 0.53 + 0.63 + 0.43); leg IV 3.73 (1.04 + 0.42 + 0.84 + 0.89 + 0.54).

Carapace (Fig. 4G). Head narrow, ~0.67× as wide as thoracic region; thoracic region slightly higher than head. AER straight in frontal view; PER straight in dorsal view; AME smallest, < 1/2 diameter of other eyes; ocular area ~2.1× wider than long. Clypeus shorter than median ocular area.

Mouthparts. Chelicerae slightly geniculate; promargin of fang furrow with 3 teeth (median tooth largest); retromargin with 7 teeth (3 large + 4 small), decreasing

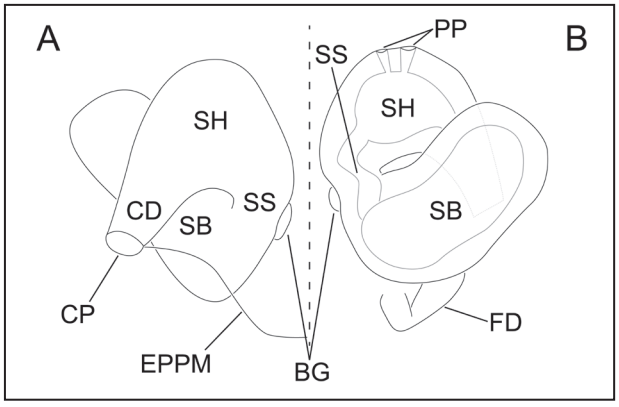

Figure 5. *Cybaeus pycnothrix* sp. nov., schematic drawing of the epigyne and endogyne, based on female paratype, KUZ Z6005. (**A**) Ventral view. (**B**) Dorsal view. Abbreviations: **BG** – Bennett's gland, **CD** – copulatory duct, **CP** – copulatory pore, **EPPM** – epigynal plate posterior margin, **FD** – fertilization duct, **PP** – primary pore, **SB** – spermathecal base, **SH** – spermathecal head, **SS** – spermathecal stalk.

in size distally; basally with lateral condyle. Labium wider than long.

Leg macrosetae (left legs). Leg I: tibia p2, r0, v2-2-2; metatarsus p1, r0, v2-2-2. Leg II: tibia p2, r0, v2(pm small)-2(pm small)-1(rm); metatarsus p2, r0, v2-2-3.

Abdomen (Fig. 4H). Colulus 1 seta on left side, 2 setae on right side.

Copulatory organ (Figs 4I–K, 5). Posterior margin of epigynal plate curved, descending posteromedially toward the midline. No distinct atrium formed; two very shallow posterolateral recesses present. Copulatory pores separate, opening posterolaterally on epigyne, each located beneath posterior margin of corresponding spermathecal base; copulatory ducts thick, running anteriorly. Spermathecal heads developed, each with primary pores located anteriorly; spermathecal stalks tubular; spermathecal bases kidney-shaped, each located dorsal to spermathecal head and stalk, directed anterolaterally; Bennett's gland located posteromedially on spermathecal stalk around junction between stalk and base; fertilization ducts descending posteriorly, and then turning anterodorsally.

Color (Fig. 4G, H). Carapace: head brown; thoracic region orangish brown, with radiating darkish bands faintly. Chelicerae, maxillary lobe and labium brownish. Sternum yellowish-brown. Legs brownish, without annulations. Abdomen: dorsally pale brown with chevron-like markings; ventrally pale brown.

Variation. *Males*. Measurements (mean ± 1SD, followed by ranges in parentheses; n = 5, including holotype): carapace length 1.51 ± 0.07 (1.44–1.59), width 1.12 ± 0.04 (1.07–1.16); carapace width/length = 0.74 ± 0.03 (0.73–0.79); leg I tibia length 0.80 ± 0.09 (0.67–0.90); leg I tibia length/carapace length = 0.53 ± 0.05 (0.47–0.58). Leg macrosetae (left legs): leg I tibia p1, r0, v2-2-2 (KUZ Z6002, Z6003); leg II tibia p2, r0, v1(rm)-1(rm)-1(rm) (KUZ Z6002).

Females. Measurements (mean ± 1SD, followed by ranges in parentheses; n = 12, including KUZ Z6001, Z6005): carapace length 1.50 ± 0.10 (1.38–1.67), width 1.04 ± 0.07 (0.95–1.16); carapace width/length = 0.69 ± 0.01 (0.67–0.72); leg I tibia length 0.79 ± 0.06 (0.71–0.89); leg I tibia length/carapace length = 0.53 ± 0.02 (0.49–0.56). Leg macrosetae (left legs): leg I tibia p2, r0, v2-2-2-1(r) (KUZ Z6004); leg II metatarsus p1, r0, v2-2-3 (KUZ Z6005).

Retreat. In total, nine specimens (KUZ Z6001–Z6009) were found constructing V-shaped retreats (Fig. 3B). Therefore, it is determined that *C. pycnothrix* sp. nov. constructs a V-shaped retreat.

Etymology. The specific name is a compound noun in apposition derived from the Ancient Greek words "pycnos" (dense) and "thrix" (hair) referring the dense hairlike setae of its male palpal patellar apophysis.

Cybaeus tateyamensis Mori, Hatanaka & Nakano, sp. nov.

(Figs 6, 7)

Diagnosis. Male *C. tateyamensis* sp. nov. and *C. biwaensis* share the projected palpal patellar apophysis with two peg setae on its outer margin. However, *C. tateyamensis* sp. nov. is distinguishable from *C. biwaensis* because its palpal patellar apophysis is directed ventroproximally, whereas that of *C. biwaensis* is directed laterodistally (fig. 25 in Kobayashi 2006, fig. 6G in Ihara 2009a). Additionally, male *C. tateyamensis* sp. nov. can be distinguished from other male congeners by its possession of the palpal tegulum with a triangular apophysis on the base of the embolus (Fig. 6C). Female *C. tateyamensis* sp. nov. and *C. pycnothrix* sp. nov. share general epigynal and spermathecae features, but nonetheless, they clearly differ from each other (see Diagnosis of *C. pycnothrix* sp. nov. above). Both sexes of *C. tateyamensis* sp. nov. and *C. pycnothrix* sp. nov. are also distinguishable from each other by abdominal coloration (also see Diagnosis of *C. pycnothrix* sp. nov. above).

Material examined. *Holotype*: 1♂, KUZ Z5989, from near Oritate Hütte, Toyama, Toyama Prefecture, Japan (36.48172°N, 137.47597°E), elev. 1389 m, 31.x.2022, YS leg.

Paratypes (9♂♀): 3♂♂, KUZ Z5982–Z5984, 2♀♀, KUZ Z5985, Z5987, same locality data as for holotype, 19.ix.2012, NK leg.; 1♂, KUZ Z5990, 3♀♀, KUZ Z5991–Z5993, same data as for holotype.

Additional material: 8♀♀, KUZ Z5986, Z5988, same data as for paratype KUZ Z5982.

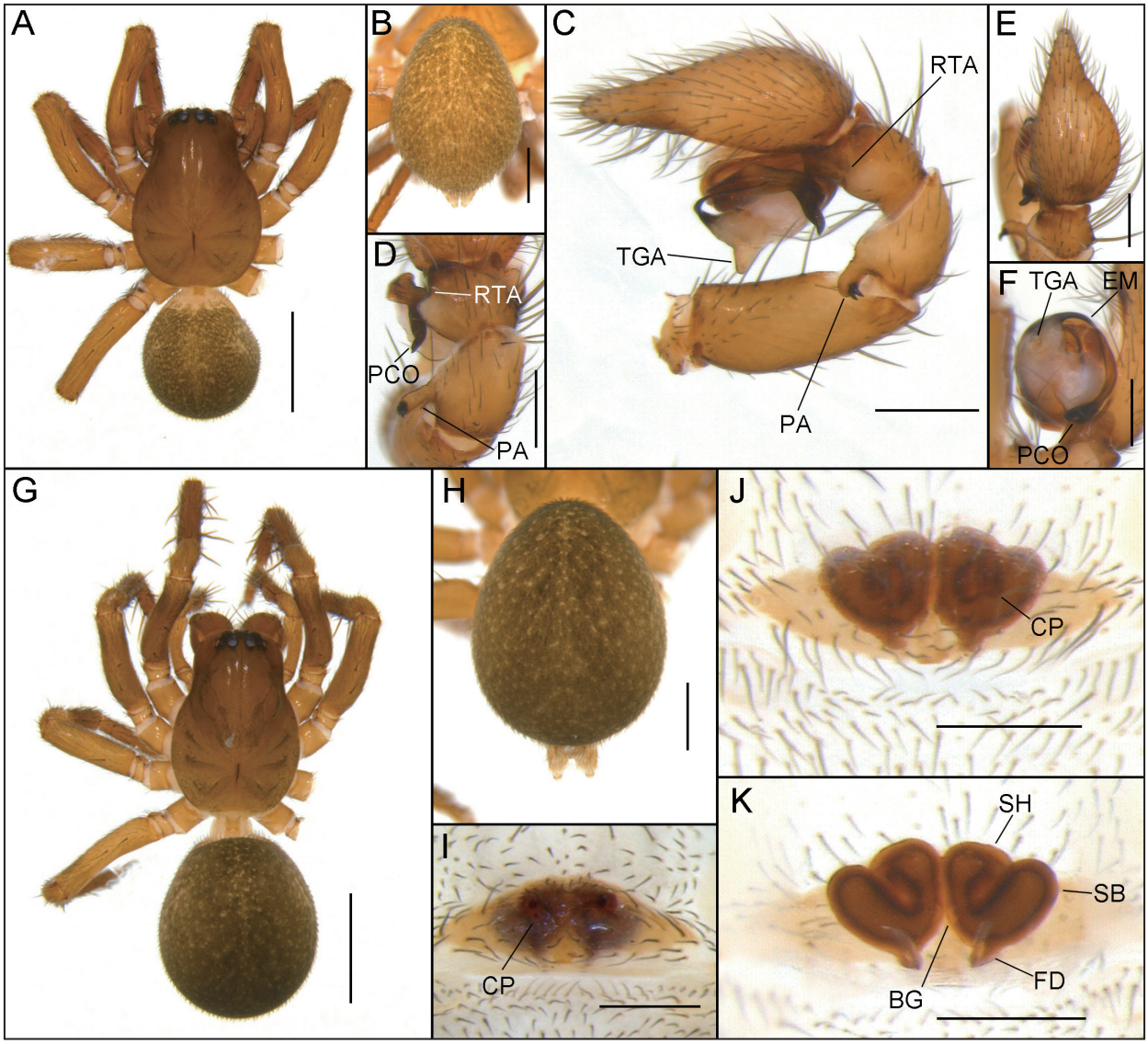

Figure 6. *Cybaeus tateyamensis* sp. nov., male holotype, KUZ Z5989 (A–F), female paratype, KUZ Z5991 (G–K). (**A, G**) Habitus dorsal view. (**B, H**) Abdomen, dorsal view. (**C**) Left palp, retrolateral view. (**D**) Tibia and patella of left palp, dorsal view. (**E**) Cymbium of left palp, dorsal view. (**F**) Bulb of left palp, ventral view. (**I**) Epigyne, ventral view. (**J**) Epigyne and spermathecae, ventral view. (**K**) Endogyne, dorsal view. Abbreviations: **BG** – Bennett's gland, **CP** – copulatory pore, **EM** – embolus, **FD** – fertilization duct, **PA** – patellar apophysis, **PCO** – proximal arm of conductor, **RTA** – retrolateral tibial apophysis, **SB** – spermathecal base, **SH** – spermathecal head, **TGA** – tegulum apophysis. Scales: A, G = 1 mm; B, H = 0.5 mm; C = 0.25 mm; D–F, I–K = 0.2 mm.

Description. *Male* (holotype: Fig. 6A–F). Measurements (mm): Carapace 1.77 long, 1.26 wide; head 0.84 wide; abdomen 1.58 long, 1.20 wide; ocular area 0.23 long, 0.51 wide; sternum 0.78 long, 0.84 wide; carapace width/length = 0.71, leg I tibia length/carapace length = 0.55. Leg measurements (femur + patella + tibia + metatarsus + tarsus) (mm): leg I 4.17 (1.22 + 0.54 + 0.97 + 0.86 + 0.58); leg II 3.89 (1.15 + 0.49 + 0.86 + 0.84 + 0.55); leg III 3.47 (1.00 + 0.46 + 0.69 + 0.79 + 0.53); leg IV 4.32 (1.23 + 0.48 + 0.98 + 1.04 + 0.59).

Carapace (Fig. 6A). Head narrow, ~0.67× as wide as thoracic region; thoracic region slightly higher than head. AER straight in frontal view; PER straight in dorsal view; AME smallest, < 1/2 diameter of other eyes; ocular area ~2.2× wider than long. Clypeus shorter than median ocular area.

Mouthparts. Chelicerae slightly geniculate; promargin of fang furrow with 3 teeth (median tooth largest); retromargin with 7 teeth (2 large and 5 small), decreasing in size distally; basally with lateral condyle. Labium wider than long.

Leg macrosetae (left legs). Leg I: tibia p2, r0, v2-2-2-1(pm small); metatarsus p1, r0, v2-2-2. Leg II: tibia p2, r0, v2(pm small)-2(pm small)-1(rm)-1(pm); metatarsus p2, r0, v2-2-3.

Abdomen (Fig. 6B). Colulus 1 seta on each side.

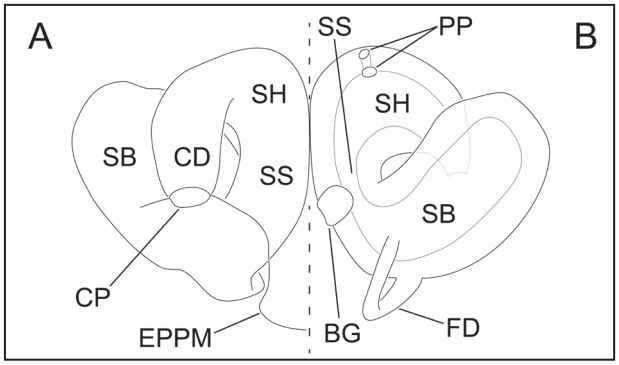

Figure 7. *Cybaeus tateyamensis* sp. nov., schematic drawing of the epigyne and endogyne, based on female paratype, KUZ Z5991. (**A**) Ventral view. (**B**) Dorsal view. Abbreviations: **BG** – Bennett's gland, **CD** – copulatory duct, **CP** – copulatory pore, **EPPM** – epigynal plate posterior margin, **FD** – fertilization duct, **PP** – primary pore, **SB** – spermathecal base, **SH** – spermathecal head, **SS** – spermathecal stalk.

Palp (Fig. 6C–F). Short, thick; femur length/width = 2.54; femur length/cymbium length = 0.83. Patellar apophysis projecting ventroproximally, spatula-like in dorsal view, posterodorsal surface with 2 peg setae. Tibia almost as long as patella; retrolateral tibial apophysis occupying 3/4 of length of tibia, distal part expanded, plate-like, proximal part slightly convex, its color faded. Cymbium relatively wide, ~2.2× longer than wide, slightly expanded prolaterally. Genital bulb circular in ventral view; tegulum with triangular apophysis on base of embolus. Conductor: distal part short; proximal arm short, thick, curved retrolaterally. Embolus simple, short, originating and terminating, respectively, at ~12 o'clock and ~6 o'clock in ventral view.

Color (Fig. 6A, B). Carapace: head brown; thoracic region orangish brown, with radiating darkish bands faintly. Chelicerae, maxillary lobe and labium brownish. Sternum yellowish-brown. Legs brownish, without annulations. Abdomen: dorsally grayish without distinct chevron-like markings; ventrally pale brown.

Female (paratype, KUZ Z5991: Figs 6G–K, 7). Measurements (mm): Carapace 1.66 long, 1.18 wide; head 0.81 wide; abdomen 1.84 long, 1.45 wide; ocular area 0.24 long, 0.50 wide; sternum 0.75 long, 0.80 wide; carapace width/length = 0.71, leg I tibia length/carapace length = 0.53. Leg measurements (femur + patella + tibia + metatarsus + tarsus) (mm): leg I 3.76 (1.13 + 0.49 + 0.87 + 0.75 + 0.52); leg II 3.49 (1.05 + 0.48 + 0.79 + 0.68 + 0.49); leg III 3.09 (0.91 + 0.44 + 0.60 + 0.67 + 0.47); leg IV 3.83 (1.08 + 0.45 + 0.86 + 0.90 + 0.54).

Carapace (Fig. 6G). Head narrow, ~0.68× as wide as thoracic region; thoracic region slightly higher than head. AER straight in frontal view; PER straight in dorsal view; AME smallest, < 1/2 diameter of other eyes; ocular area ~2.1× wider than long. Clypeus shorter than median ocular area.

Mouthparts. Chelicerae slightly geniculate; promargin of fang furrow with 3 teeth (median tooth largest); retromargin with 6 (left) or 7 (right) teeth (on left, 2 large + 4 small; on right, 3 large + 4 small), decreasing in size distally; basally with lateral condyle. Labium wider than long.

Leg macrosetae (left legs). Leg I: tibia p2, r0, v2-2-2; metatarsus p1, r0, v2-2-2. Leg II: tibia p2, r0, v2(pm small)-2(pm small)-1(rm); metatarsus p2, r0, v2-2-3.

Abdomen (Fig. 6H). Colulus 1 seta on each side.

Copulatory organ (Figs 6I–K, 7). Posterior margin of epigynal plate curved, descending posteromedially toward the midline. No distinct atrium formed; two very shallow posterolateral recesses present. Copulatory pores separate, opening laterally on epigyne, each located beneath anterior margin of corresponding spermathecal base; copulatory ducts thick, short, running anterodorsally. Spermathecal heads developed, each with primary pores located anterodorsally; spermathecal stalks tubular; medial margins of spermathecal head and stalk of each spermatheca closely adhering; spermathecal bases kidney-shaped; Bennett's gland located posteromedially on spermathecal stalk around junction between stalk and base; fertilization ducts descending posteriorly, and then turning anterodorsally.

Color (Fig. 6G, H). Carapace: head brown; thoracic region orangish brown, with radiating darkish bands faintly. Chelicerae, maxillary lobe and labium brownish. Sternum yellowish-brown. Legs brownish, without annulations. Abdomen: dorsally grayish without distinct chevron-like markings; ventrally pale brown.

Variation. *Males*. Measurements (mean ± 1SD, followed by ranges in parentheses; n = 5, including holotype): carapace length 1.73 ± 0.03 (1.70–1.77), carapace width 1.24 ± 0.03 (1.19–1.27); carapace width/length = 0.72 ± 0.02 (0.69–0.74); leg I tibia length 0.98 ± 0.02 (0.96–1.00); leg I tibia length/carapace length = 0.57 ± 0.01 (0.54–0.58). Leg macrosetae (left legs): leg I tibia p2, r0, v2-2-2 (KUZ Z5990); leg II tibia p2, r0, v2(pm small)-2(pm small)-1(rm) (KUZ Z5984, Z5990), or v2(pm small)-2(pm small)-2(pm small) (KUZ Z5983).

Females. Measurements (mean ± 1SD, followed by ranges in parentheses; n = 12, including KUZ Z5991): carapace length 1.56 ± 0.08 (1.37–1.67), carapace width 1.11 ± 0.07 (0.95–1.22); carapace width/length = 0.71 ± 0.03 (0.68–0.78); leg I tibia length 0.84 ± 0.05 (0.71–0.88); leg I tibia length/carapace length 0.53 ± 0.01 (0.51–0.55). Leg macrosetae (left legs): leg I tibia p2, r0, v2-2-2-1(pm small) (KUZ Z5988, Z5992); leg II tibia p2, r0, v1(rm)-1(rm)-1(rm) (KUZ Z5987, Z5992, Z5993), or v1(rm)-2(pm small)-1(rm) (KUZ Z5988).

Retreat. In total, five individuals (KUZ Z5989, Z5990, Z5991–Z5993) were found constructing V-shaped retreats.

Therefore, it is determined that *C. tateyamensis* sp. nov. constructs a V-shaped retreat.

Etymology. The specific name is derived from the Tateyama Mountain Range, where the type locality is located.

4 Discussion

The original members of the *hiroshimaensis*-group were recognized for constructing retreats with three openings, which are denoted as a "Y-shaped" or "hexagonal" (Ihara 2009a, Sugawara et al. 2024). In contrast, the common form of Japanese *Cybaeus* retreats is defined as "V-shaped", with two openings (Ihara 2006, Ihara et al. 2021). This study clarifies that some members construct a V-shaped retreat with two openings in situ. However, it remains possible that the species of this group endemic to western Japan construct Y-shaped retreats, whereas those inhabiting central to eastern Honshu construct V-shaped retreats. A future study should address the evolutionary history of the retreat features within the *hiroshimaensis*-group based on a robust phylogenetic tree. This study showed that the *hiroshimaensis*-group can be defined only by the possession of the following morphological features (modified from Sugawara et al. 2024): small-sized Japanese *Cybaeus*, ≤ ~5 mm; body color pale or slightly pale; male palp short and thick, and its tibia generally slightly longer than patella. Phylogenetic analyses will also clarify whether an unidentified small-sized *Cybaeus* from Japan belongs to the *hiroshimaensis*-group.

The monophyly of *C. pycnothrix*, *C. tateyamensis*, and *C. biwaensis* was weakly supported by the present BI analysis. *Cybaeus minoensis* Kobayashi, 2006 was sister to this lineage, but this relationship was not supported by both analyses. However, the monophyly of *C. biwaensis* and *C. minoensis* was moderately supported by the previous phylogenetic study (Sugawara et al. 2024). Both *C. biwaensis* and *C. minoensis* are distributed in the central part of Honshu Island, and their ranges are adjacent to those of the newly described species (Kobayashi 2006). Additionally, males of both *C. tateyamensis* and *C. biwaensis* possess a projected palpal PA with two peg setae on its outer margin (Kobayashi 2006). This feature may reflect their phylogenetic affinities, although the directions of the projected PA of the two species are clearly distinct from each other. Future phylogenetic studies are necessary to elucidate the phylogenetic relationships and evolutionary history among the *hiroshimaensis*-group species endemic to the central part of Honshu Island, Japan.

Acknowledgments

The third and fourth authors are grateful to Eitaro Matsushita (Kyoto University; KU) for his help processing the morphological examination. The authors also thank two anonymous reviewers for their constructive comments on this manuscript. We also express our gratitude to Dr. Mallory Eckstut (Edanz; https://jp.edanz.com/ac) for editing a draft of this manuscript. A part of Sanger sequencing was performed at the Medical Research Support Center, Graduate School of Medicine, KU. This work was supported by the Showa Seitoku Memorial Foundation (FY2020), and by JSPS KAKENHI Grant Number JP22K06371.

References

Bennett, R. G. (2017). Cybaeidae. In D. Ubick, P. Paquin, P.E. Cushing, & V. Roth (Eds.), *Spiders of North America: An Identification Manual* (2nd edition, pp. 96–101). American Arachnological Society.

Bennett, R., Copley, C. & Copley, D. (2020). *Allocybaeina littlewalteri* (Araneae: Cybaeidae): a new genus and species endemic to northwestern California. *Zootaxa, 4845*, 436–446. https://doi.org/10.11646/zootaxa.4845.3.8

Chernomor, O., Haeseler, A. von & Minh, B. Q. (2016). Terrace aware data structure for phylogenomic inference from supermatrices. *Systematic Biology, 65*, 997–1008. https://doi.org/10.1093/sysbio/syw037

Hedin, M., Ramírez, M. J. & Monjaraz-Ruedas, R. (2025). Phylogenomics of North American cybaeid spiders (Araneae, Cybaeidae), including the description of new taxa from the Klamath Mountains Geomorphic Province. *ZooKeys, 1226*, 47–75. https://doi.org/10.3897/zookeys.1226.140204

Ihara, Y. (1993). Five new small-sized species of the genus *Cybaeus* (Araneae: Cybaeidae) from the Chugoku district, Honshu, Japan. *Acta Arachnologica, 42*, 115–127. https://doi.org/10.2476/asjaa.42.115

Ihara, Y. (2006). *Cybaeus jinsekiensis* n. sp., a spider species with protogynous maturation and mating plugs (Araneae: Cybaeidae). *Acta Arachnologica, 55*, 5–13. https://doi.org/10.2476/asjaa.55.5

Ihara, Y. (2009a). Revision of the *Cybaeus hiroshimaensis*-group (Araneae: Cybaeidae) in western Japan. *Acta Arachnologica, 58*, 69–85. https://doi.org/10.2476/asjaa.58.69

Ihara, Y. (2009b). Cybaeidae. In H. Ono (Ed.), The Spiders of Japan: *with Keys to the Families and Genera and Illustrations of the Species* (pp. 152–168). Tokai University Press.

Ihara, Y., Koike, N. & Nakano, T. (2021). Integrative taxonomy reveals multiple lineages of the spider genus *Cybaeus* endemic to the Ryukyu Islands, Japan (Arachnida : Araneae : Cybaeidae).

Invertebrate Systematics, 35, 216–243. https://doi.org/10.1071/IS20070

Irie, T. & Ono, H. (2001). Two new species of the genus *Cybaeus* (Araneae: Cybaeidae) from Kyushu, Japan. *Bulletin of the National Science Museum, Series A (Zoology), 27*, 205–210.

Kalyaanamoorthy, S., Minh, B. Q., Wong, T. K. F., Haeseler, A. von & Jermiin, L. S. (2017). ModelFinder: fast model selection for accurate phylogenetic estimates. *Nature Methods, 14*, 587–589. https://doi.org/10.1038/nmeth.4285

Katoh, K. & Standley, D. M. (2013). MAFFT multiple sequence alignment software version 7: improvements in performance and usability. *Molecular Biology and Evolution, 30*, 772–780. https://doi.org/10.1093/molbev/mst010

Kobayashi, T. (2006). Ten new species of the genus *Cybaeus* (Araneae: Cybaeidae) from central Honshu, Japan. *Acta Arachnologica, 55*, 29–44. https://doi.org/10.2476/asjaa.55.29

Koch, L. (1868). Die Arachnidengattungen *Amaurobius*, *Caelotes* und *Cybaeus*. *Abhandlungen der Naturhistorischen Gesellschaft zu Nürnberg, 4*, 1–52.

Komatsu, T. (1968). Cave Spiders of Japan. II. Cybaeus, *Dolichocybaeus* and *Heterocybaeus* (Cybaeinae). Arachnological Society of East Asia.

Matsuda, K., Ihara, Y. & Nakano, T. (2020). Description of a new species of *Cybaeus* (Araneae: Cybaeidae) from central Honshu, Japan. *Species Diversity, 25*, 145–152. https://doi.org/10.12782/specdiv.25.145

Minh, B. Q., Schmidt, H. A., Chernomor, O., Schrempf, D., Woodhams, M. D., Haeseler, A. von & Lanfear, R. (2020). IQ-TREE 2: New models and efficient methods for phylogenetic inference in the genomic era. *Molecular Biology and Evolution, 37*, 1530–1534. https://doi.org/10.1093/molbev/msaa015

Rambaut, A., Drummond, A. J., Xie, D., Baele, G. & Suchard, M. A. (2018). Posterior summarization in Bayesian phylogenetics using Tracer 1.7. *Systematic Biology, 67*, 901–904. https://doi.org/10.1093/sysbio/syy032

Ronquist, F., Teslenko, M., Mark, P. van der, Ayres, D. L., Darling, A., Höhna, S., Larget, B., Liu, L., Suchard, M. A. & Huelsenbeck, J. P. (2012). MrBayes 3.2: Efficient Bayesian phylogenetic inference and model choice across a large model space. *Systematic Biology, 61*, 539–542. https://doi.org/10.1093/sysbio/sys029

Sugawara, Y., Ihara, Y. & Nakano, T. (2021). A new species of *Cybaeus* L. Koch, 1868 (Araneae, Cybaeidae) with simple genitalia from central Japan is the sister species of *C. melanoparvus* Kobayashi, 2006 with elongated genitalia. *Zoosystematics and Evolution, 97*, 223–233. https://doi.org/10.3897/zse.97.64473

Sugawara, Y., Ihara, Y., Koike, N., Seo, H.-Y., Prozorova, L. A., Zhang, Z.-S. & Nakano, T. (2024). Systematics of cybaeid spiders endemic to the Japanese Archipelago, and their historical biogeographic implications (Araneae: Cybaeidae). *Invertebrate Systematics, 38,* IS24058. https://doi.org/10.1071/IS24058

Wang, L.-Y. & Zhang, Z.-S. (2022). *Sincybaeus liaoning* gen. & sp. nov., a new genus and species of cybaeid spiders from China (Araneae: Cybaeidae). *Acta Arachnologica Sinica, 31*, 92–95. https://doi.org/10.3969/j.issn.1005-9628.2022.02.005

Wessel, P. & Smith, W. H. F. (1996). A global, self-consistent, hierarchical, high-resolution shoreline database. *Journal of Geophysical Research: Solid Earth, 101*, 8741–8743. https://doi.org/10.1029/96jb00104

World Spider Catalog. (2025). Species list for *Cybaeus*. World Spider Catalog. Version 25.5. https://wsc.nmbe.ch/specieslist/686

Yaginuma, T. (1972). The fauna of the lava caves around Mt. Fuji-san. IX. Araneae (Arachnida). *Bulletin of the National Science Museum (Tokyo), 15*, 267–334.