The taxonomic status of the two Japanese species of the spider genus *Cybaeus* L. Koch, 1868, viz., *C. communis* Yaginuma, 1972 and *C. maculosus* Yaginuma, 1972, is revisited on the basis of male and female specimens, which were collected from each type locality and the adjacent areas, along with the holotypes of both species. Mitochondrial cytochrome c oxidase subunit 1 and nuclear internal transcribed spacer 1 sequence data confirmed that *C. communis* and *C. maculosus* are conspecific, and *C. maculosus* is synonymized with *C. communis*. The obtained molecular phylogenies corroborate the monophyly of *C. communis*, *C. kirigaminensis* Komatsu, 1963, *C. shinkaii* (Komatsu, 1970), and *C. daimonji* Matsuda, Ihara, and Nakano, 2020.

**Key Words:** Arachnida, Cave, RTA clade, epigean, new synonym, First Reviser, Mt. Fuji.

**Materials and Methods**

**Samples and morphological examination.** Specimens of *Cybaeus* spiders, including male and female specimens from the respective type localities of *C. communis* and *C. maculosus*, collected in Shizuoka Prefecture, Honshu, Japan (Fig. 1) in 2011 were examined. The holotypes of both species, which are preserved in the arachnological collection at the National Museum of Nature and Science, Tsukuba (NSMT-Ar), were also examined.

Specimens were preserved in 70% ethanol; legs of some specimens were removed and preserved in 99% ethanol for DNA extraction. Epigynes were dissected from several female specimens and then cleared to observe their internal structure following the method described by Matsuda et al. (2020). Morphological examination of the specimens was conducted using a Leica M125C stereoscopic microscope. Images of the specimens were captured with the aid of a Leica MC170 HD digital camera mounted on the Leica M125C, and prepared using a Leica Application Suite (LAS) v. 4.12 software. Measurements were taken to the nearest 0.01 mm using LAS. 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 follows Yaginuma et al. (2021). The following are the abbreviations used for macrosetae: p, prolateral; r, retrolateral; v, ventral. The following are the abbreviations used for other characters: AER, anterior eye row; AME, anterior median eyes; BG, Bennett’s gland; CD, copulatory duct; CL, carapace length; CP, copulatory pore; CW,
sequences. The dataset of Japanese Cybaeus species in Sugawara et al. (2021a) was included in the analyses along with C. nipponicus (Uyemura, 1938), C. kirigaminensis Komatsu, 1963, and C. shinkai (Komatsu, 1970) collected from, or near, their type localities (Table 1). Samples sharing completely identical sequences were excluded from the dataset. In total, 49 sequences of 24 species were included in our dataset (Table 1). Cybaeus striatipes Bösenberg and Strand, 1906 was treated as the outgroup a priori. No indels were observed in the COI sequences. The ITS-1 sequences were aligned using MAFFT L-INS-i v. 7.475 (Katoh and Standley 2013). The COI and ITS-1 fragments were 763 and 774 bp, respectively. Thus, the concatenated sequences yielded 1,537 bp of aligned positions.

Phylogenetic trees were reconstructed using maximum likelihood (ML) and Bayesian inference (BI) methods. The best-fit partition scheme and models for both analyses were identified on the basis of the corrected Akaike information criterion using PartitionFinder v. 2.1.1 (Lanfear et al. 2017) and the ‘greedy’ algorithm (Lanfear et al. 2012). The selected partition scheme and models were as follows: for COI 1st position, TVM+I+G (ML) or GTR+I+G (BI); for COI 2nd position, GTR+I+G; for COI 3rd position, K81UF+G (ML) or GTR+G (BI); and for ITS-1, GTR+I+G. The ML phylogenetic tree was calculated using IQ-TREE v. 1.6.12 (Nguyen et al. 2015) with non-parametric bootstrapping (BS) conducted with 1,000 replicates. The BI tree and Bayesian posterior probabilities (PP) were estimated using MrBayes v. 3.2.7a (Ronquist et al. 2012) with 2.5 million generations and tree sampling every 100 generations. The parameter estimates and convergence were checked using Tracer v. 1.7.1 (Rambaut et al. 2018), and the first 6,250 trees were discarded based on the results.

Results

Molecular analyses. The obtained BI (mean ln $L = −7244.738$, ESS=1684; Fig. 2) and ML (ln $L = −7207.428$; not shown) trees had almost identical topologies. The monophyly of C. communis/C. maculatus specimens was strongly supported (BS=99%, PP=0.99). C. communis/C. maculatus, C. kirigaminensis, C. shinkai, and C. daimonji Matsuda, Ihara, and Nakano, 2020, which share morphological similarities, formed the monophyletic lineage (BS=90%, PP=1.0). However, our analyses failed to resolve the detailed relationship among these four species.

Taxonomy

Genus Cybaeus L. Koch, 1868
Cybaeus communis Yaginuma, 1972
[Japanese name: Zara-namihagumo]
(Figs 3–7)

Cybaeus communis Yaginuma, 1972: 311–312, fig. 37; Yaginuma 1986: 143, 146, fig. 78-10; Ihara 2009: 154, 155, figs 2-2–30-14, 18, 19.
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Table 1. Samples of the Cybaeus species used for DNA sequencing. The voucher information is accompanied by the collection locality and the DNA Data Bank of Japan (DDBJ) accession number. Sequences with an asterisk (*) were obtained for the first time in this study. Samples with two asterisks (**) were excluded from the molecular phylogenetic analyses.

| Taxa | Voucher # | Locality | DDBJ # |
|------|-----------|----------|--------|
| C. communis Yaginuma, 1972/C. maculosus Yaginuma, 1972 | KUZ Z3968** | Yashiki-ana Cave, Shizuoka, Honshu: type locality of C. communis | LC651122* |
| C. communis Yaginuma, 1972/C. maculosus Yaginuma, 1972 | KUZ Z3970 | Yashiki-ana Cave, Shizuoka, Honshu: type locality of C. communis | LC651116* LC651111* |
| C. communis Yaginuma, 1972/C. maculosus Yaginuma, 1972 | KUZ Z3971** | Mado-ana Cave, Shizuoka, Honshu: type locality of C. maculosus | LC651123* |
| C. communis Yaginuma, 1972/C. maculosus Yaginuma, 1972 | KUZ Z3973 | Mado-ana Cave, Shizuoka, Honshu: type locality of C. maculosus | LC651117* LC651112* |
| C. communis Yaginuma, 1972/C. maculosus Yaginuma, 1972 | KUZ Z3962 | Nihondaira Plateau, Shizuoka, Honshu | LC651119* |
| C. communis Yaginuma, 1972/C. maculosus Yaginuma, 1972 | KUZ Z3963** | Nihondaira Plateau, Shizuoka, Honshu | LC651121* LC651110* |
| C. communis Yaginuma, 1972/C. maculosus Yaginuma, 1972 | KUZ Z3965 | Nihondaira Plateau, Shizuoka, Honshu | LC651118* LC651113* |
| C. daimonji Ikeda, Ibaraki, and Nakano, 2020 | KUZ Z2755 | Shiraito Waterfall, Shizuoka, Honshu | LC651120* |
| C. kirigaminensis Komatsu, 1963 | KUZ Z3985 | Kirigamine Plateau, Nagano, Honshu | LC652208 LC522909 |
| C. shinkaii Komatsu, 1970 | KUZ Z3986 | Mt. Takano, Tokyo, Honshu | LC551109* |
| C. aikana Ibaraki, Koike, and Nakano, 2021 | KUZ Z2137 | Mt. Yuwadandake, Amamioshima Island | LC552249 |
| C. amamiensis Ibaraki, Koike, and Nakano, 2021 | KUZ Z2120 | Mt. Yuwandake, Amamioshima Island | LC552239 LC552237 |
| C. ashiikitaiensis (Komatsu, 1968) | KUZ Z2213 | Itsuki, Kumamoto, Kyushu | LC552195 LC551219 |
| C. fujisanus (Komatsu, 1968) | KUZ Z2219 | Fugeku Cave, Komamoto, Kyushu | LC551204 LC552188 |
| C. gotoensis (Yamaguchi and Yaginuma, 1971) | KUZ Z2251 | Iana Cave, Fukuejima Island, Goto Islands | LC552204 LC552202 |
| C. hikidai Ibaraki, Koike, and Nakano, 2021 | KUZ Z2106 | Mt. Nagodake, Okinawajima Island | LC552267 LC552265 |
| C. ishikawai (Kishida, 1940) | KUZ Z2215 | Ne ryugado Cave, Kochi, Shikoku | LC552278 |
| C. ittsukieni Irie, 1998 | KUZ Z2218 | Tsuzurasedo Cave, Kumamoto, Kyushu | LC552185 LC552183 |
| C. kodama Ibaraki, Koike, and Nakano, 2021 | KUZ Z2214 | Hanayama Trail, Yakushima Island | LC552218 LC552216 |
| C. koiyecto Sagawara, Ibaraki, and Nakano, 2021 | KUZ Z3744 | Hanase Pass, Kyoto, Honshu | LC601903 LC601901 |
| C. kompiraeansis (Komatsu, 1968) | KUZ Z2317 | Kompirado Cave, Kochi, Shikoku | LC552181 LC552178 |
| C. kumiaikieni Ibaraki, 2003 | KUZ Z2303 | Mt. Futagosan, Otta, Kyushu | LC552200 LC552198 |
| C. kumadori Ibaraki, Koike, and Nakano, 2021 | KUZ Z2143 | Mt. Yaguradake, Kuroshima Island, Mishima Islands | LC552228 LC552226 |
| C. melanoparvus Kobayashi, 2006 | KUZ Z3764 | Sakauchihirose, Gifu, Honshu | LC601896 LC601894 |
| C. nipponicus (Ueymura, 1938) | KUZ Z3767 | Mt. Kariyose, Tokyo, Honshu | LC651114* LC651108* |
| C. okumurai Ibaraki, Koike, and Nakano, 2021 | KUZ Z2719 | Kunigami, Tanegashima Island | LC552282 |
| C. striatipes Bösenberg and Strand, 1906 | KUZ Z2718 | Mt. Rausudake, Shari, Hokkaido | LC552177 LC552175 |
| C. tokunoshimensis Ibaraki, Koike, and Nakano, 2021 | KUZ Z2113 | Mt. Inokawadake, Tokunoshima Island | LC552256 LC552254 |
| C. yukiokuzenien Ibaraki, Koike, and Nakano, 2021 | KUZ Z2138 | Shiratani-unsuikyo Valley, Yakushima Island | LC552209 |

Cybaeus maculosus Yaginuma, 1972: 312–314, fig. 38; Yaginuma 1986: 144, 146, fig. 78-12; Ibaraka 2009: 154. syn. nov.

Emended diagnosis. “Medium-sized” Japanese Cybaeus (Fig. 3). Both C. communis sexes closely resemble three other medium-sized brown Japanese Cybaeus species: C. kirigaminensis, C. shinkaii, and C. daimonji (see figs 2–2–30–14–23 in Ibaraka 2009; figs 1–5 in Matsuda et al. 2020). Males of C. communis can be clearly distinguished from those of the three species by the lack of a palpal PA (for C. communis, see Fig. 4A, B; for C. kirigaminensis, see figs 2-2-30-15, 16 in Ibaraka 2009; for C. shinkaii, see fig. 2-2-30-17 in Ibaraka 2009; for C. daimonji, see fig. 3 in Matsuda et al. 2020). Females of C. communis can be distinguished from those of the three species by the spermathecal structures: both the SH and SS in C. communis are more bulbous and developed than in the other species (for C. communis, see Figs 5B, 6; for C. kirigaminensis, see fig. 2-2-30-21 in Ibaraka 2009; for C. shinkaii, see fig. 2-2-30-23 in Ibaraka 2009; for C. daimonji, see fig. 5 in Matsuda et al. 2020).

Material examined. Holotype: male, NSMT-Ar 76, from Yashiki-ana Cave, Fujinomiya City, Shizuoka, Japan (cave entrance: 35.2693°N, 138.6210°E), collected by S. Uéno and K. Kato on 13 December 1969.

Additional materials: 1 female, NSMT-Ar 77, holotype of C. maculosus, from Mado-ana Cave, Fujinomiya City, Shizuoka, Japan (cave entrance: 35.2645°N, 138.6282°E), collected by S. Uéno and K. Kato on 13 December 1969, genitalia missing (Ken-ichi Okumura, personal communication); 3 males, KUZ Z3966, from the type locality of C. communis, collected by Naoki Koike on 12 November 2011; male, KUZ Z3967, same collection data as KUZ Z3966; male, KUZ Z3968, same collection data as KUZ Z3966; female, KUZ Z3969, same collection data as KUZ Z3966; female, KUZ Z3970, same collection data as KUZ Z3966; male, KUZ Z3971, from the type locality of C. maculosus, collected by Naoki Koike on 12 November 2011; 3 females, KUZ Z3972, same collection data as KUZ Z3971; female, KUZ Z3973, same collection data as KUZ Z3971; 4 males, KUZ Z3974, from Shiraito Waterfall, Fujinomiya City, Shizuoka,
Japan (35.3141°N, 138.5896°E), collected by Naoki Koike on 12 November 2011; 3 females, KUZ Z3975, same collection data as KUZ Z3974, male, KUZ Z3976, same collection data as KUZ Z3974; 2 males, KUZ Z3961, from Nihondaira Plateau, Shizuoka City, Shizuoka, Japan (34.9855°N, 138.4633°E), collected by Naoki Koike on 11 November 2011; male, KUZ Z3962, same collection data as KUZ Z3961; male, KUZ Z3963, from Nihondaira Plateau, Shizuoka City, Shizuoka, Japan (34.9900°N, 138.4467°E), collected by Naoki Koike on 11 November 2011; female, KUZ Z3964, same collection data as KUZ Z3963; female, KUZ Z3965, from Nihondaira Plateau, Shizuoka City, Shizuoka, Japan (34.9805°N, 138.4524°E), collected by Naoki Koike on 11 November 2011.

**Type locality.** Yashiki-ana Cave, Fujinomiya City, Shizuoka Prefecture, Japan (cave entrance: 35.2693°N, 138.6210°E).

**Description.** Male (KUZ Z3967: Figs 3A, B, 4). Measurements (mm): CL 2.73, CW 1.86; head 1.10 wide; abdomen 2.40 long, 1.73 wide; ocular area 0.33 long, 0.68 wide; sternum 1.34 long, 1.16 wide; CW/CL 0.68, TibIL/CL 0.73. Leg formula, IV > I > II > III; length of legs (femur + patella + tibia + metatarsus + tarsus): leg I 8.03 (2.08 + 0.78 + 2.00 + 1.86 + 1.31); leg II 7.48 (2.03 + 0.77 + 1.77 + 1.72 + 1.18); leg III 6.53 (1.81 + 0.75 + 1.41 + 1.65 + 0.91); leg IV 8.44 (2.16 + 0.77 + 1.94 + 2.32 + 1.25).

Carapace (Fig. 3A). Head narrow, ca. 0.59× as wide as thoracic region; thoracic region almost as high as head. AER almost straight in frontal view; PER slightly recurved in dorsal view; AME smallest, <1/2 diameter of other eyes; ocular area ca. 2.1× wider than long. Clypeus shorter than median ocular area.

Mouthparts. Chelicerae slightly geniculate, promargin of fang furrow with 3 teeth (median one largest), retromargin with 3 teeth and 6 denticles, and basally with lateral condyle. Labium wider than long.
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Leg macrosetae. Leg I: tibia p4, r0, v2-2-2-2; metatarsus p3, r1, v2-2-3. Leg II: tibia p3, r3, v2-2-1-2; metatarsus p3, r2, v2-2-3.

Abdomen (Fig. 3B). Oval; mid-posterior part widest. Colulus two groups of 3 setae.

Palp (Fig. 4). PA lacking. Tibia longer than patella; RTA plate-like, quadrangular, occupying 1/4 of length of tibia. Cymbium relatively wide, ca. 2.2× longer than wide, slightly expanded prolaterally. Genital bulb slightly longer than wide, oval in ventral view. Conductor: distal part short; PCO short, sharply curved at right angle. EM simple, originating and terminating, respectively, at ca. 11 o'clock and ca. 4 o'clock in ventral view.

Color (Fig. 3A, B). Carapace: head brown, with reticulate brownish black markings; thoracic region yellowish brown, with radiating brownish black bands. Chelicerae, maxillary lobe and labium reddish brown. Sternum yellowish brown, darker towards margins. Legs yellowish brown, with brown vague annulations. Abdomen: dorsally brown with beige chevron-like markings, small dots, and curved lines; ventrally pale beige.

**Female** (KUZ Z3969: Figs 3C, D, 5, 6). Measurements (mm): CL 2.75, CW 1.89; head 1.27 wide; abdomen 4.16 long, 2.97 wide; ocular area 0.38 long, 0.79 wide; sternum 1.26 long, 1.11 wide. Leg formula, IV > I > II > III; length of legs (femur + patella + tibia + metatarsus + tarsus): leg I 6.83 (1.85 + 0.79 + 1.72 + 1.52 + 0.95); leg II 6.69 (1.96 + 0.83 +

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**Fig. 3.** *Cybaeus communis*, from the type locality, male (KUZ Z3967; A, B) and female (KUZ Z3969; C, D). A, C, Prosoma, dorsal view; B, D, abdomen, dorsal view. Scale bars: A–D, 1 mm.

**Fig. 4.** *Cybaeus communis*, from the type locality, male (KUZ Z3967). A, Left palp, retrolateral view; B, patella of left palp, retrolateral view; C, patella of left palp, dorsal view; D, cymbium of left palp, dorsal view; E, genital bulb of left palp, ventral view. Abbreviations: EM, embolus; PCO, proximal arm of conductor; RTA, retrolateral tibial apophysis. Scale bars: A, 500 µm; B–E, 250 µm.
1.57 + 1.43 + 0.91); leg III 5.99 (1.68 + 0.78 + 1.25 + 1.45 + 0.83); leg IV 7.69 (1.99 + 0.81 + 1.76 + 2.09 + 1.03).

Carapace (Fig. 3C). Head ca. 0.67 × as wide as thoracic region; thoracic region height slightly shorter than head. AER straight in frontal view; PER straight in dorsal view; AME smallest, <1/2 diameter of other eyes; ocular area ca. 2.1 × wider than long. Clypeus shorter than median ocular area.

Mouthparts. Chelicerae geniculate, promargin of fang furrow with 3 teeth (median one largest), retromargin with 5 teeth and 6 denticles, and basally with lateral condyle. Labium wider than long.

Leg macrosetae. Leg I: tibia p4, r0, v2-2-2-2; metatarsus p2, r1, v2-2-3. Leg II: tibia p4, r1, v2-2-1-2; metatarsus p3, r1, v2-2-3.

Abdomen (Fig. 3D). Oval; mid-posterior part widest. Colulus two groups of 4 or 5 setae.

Genitalia (Figs 5, 6). PME almost straight. Atrium located posteromedially on epigyne. CPs separated on both sides of atrium; CD thick and short, running anteromedially. SH and SS bulbous; PP located on ventral side of SH; BG located posteroventrally on SS; SB spherical, located posterolaterally. FD running from connection part between SS and SB, descending posteriorly, and then turned anterodorsally.

Color (Fig. 3C, D). Carapace: head brown, with reticulate brownish black markings; thoracic region yellowish brown, with radiating light brownish black bands. Chelicerae, maxillary lobe and labium reddish brown. Sternum yellowish brown, darker towards margins. Legs yellowish brown, with brown vague annulations. Abdomen: dorsally pale brown with beige chevron-like markings and random patterns; ventrally pale beige.

Variation. Males. Measurements (mean ± 1SD, followed by ranges in parentheses; n = 10): CL 2.61 ± 0.15 (2.31–2.78); CW 1.83 ± 0.11 (1.58–1.95); CW/CL 0.70 ± 0.02 (0.68–0.72); TibIL 1.94 ± 0.16 (1.68–2.16); TibIL/CL 0.74 ± 0.04 (0.70–0.74). Legs slightly longer than those of females. Females. Measurements (mean ± 1SD, followed by ranges in parentheses; n = 8): CL 2.60 ± 0.26 (2.07–2.80); CW 1.75 ± 0.17 (1.44–1.89); CW/CL 0.68 ± 0.01 (0.66–0.69); TibIL 1.61 ± 0.13 (1.33–1.72); TibIL/CL 0.62 ± 0.02 (0.60–0.64).

Remarks. The female genitalia of the holotype of C. maculosus was not found, but the specimens examined in this study were clearly identified as C. communis/C. maculosus on the basis of previous descriptions (Yaginuma 1972) and because no other similar species were found at the collection localities.

The nuclear ITS-1 sequences were obtained from four specimens: male and female specimens from the respective type localities of C. communis and C. maculosus. The sequences through the overlapping aligned positions were almost identical (354/355 bp). Additionally, the specimens collected at the type locality of C. maculosus bear the genital characteristics (Fig. 7) that are concordant with those of C. communis (Figs 4, 5) in both males and females. The results thus clearly confirmed their conspecificity.

In Yaginuma (1972), C. communis and C. maculosus were distinguished using the length to width ratio of the carapace (= CL/CW in this study: 1.4 in C. communis and 1.5 in C. maculosus). The variation among specimens in this study was as follows: males, CL/CW 1.43 ± 0.03 (1.38–1.47) and females, CL/CW 1.48 ± 0.03 (1.44–1.52). Because the two species were described only on the basis of one sex, as mentioned above, this difference merely reflects sexual dimorphism.

The precedence between the two names by Yaginuma (1972), viz., C. communis and C. maculosus, should be fixed in accordance with Article 24.2 of the International Code of Zoological Nomenclature (hereinafter, Code; International
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Commission on Zoological Nomenclature 1999), because the two species names, C. communis and C. maculosus, were given in the same work. As the First Reviser, we have given precedence to the name C. communis over C. maculosus for the following reasons: 1) the genital part of the holotype of C. communis exists, whereas that of C. maculosus is currently missing; 2) C. communis is stated in Ihara (2009) with figures, whereas C. maculosus without any figures; and 3) the original description of C. communis (Yaginuma 1972: 311–312, fig. 37) appears earlier than that of C. maculosus (Yaginuma 1972: 312–314, fig. 38), and therefore, C. communis has the "position precedence" over C. maculosus in accordance with Recommendation 24A of the 3rd Edition of the Code (International Commission on Zoological Nomenclature 1985). Accordingly, C. communis is the valid name for the species whenever C. communis and C. maculosus are considered as belonging to the same species-group taxon.

Cybaeus communis and C. maculosus were originally described based on specimens collected from caves and were deemed troglobitic. The examined specimens were also collected outside caves, and molecular analyses supported their close genetic distance despite their geographic distance. Judging from the phylogenetic relationships and the dark body color (Fig. 3), C. communis is considered an epigeic species that also inhabits caves.

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