Two new genera of Araneidae (Arachnida: Araneae)

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Abstract — Araneus is a large genus containing many species with various features, and phylogenetic analysis has revealed it to be a polyphyletic group. It has been proposed that nine new genera should be established independently from Araneus. One example is a group that includes Araneus mitificus (Simon 1886) and Araneus praesignis (L. Koch 1872). In this study, we examined specimens from several species that are morphologically similar to them, and confirmed their close relationship by phylogenetic analysis using the data of five genes. All targeted species were united in a monophyletic clade, comprising two groups in detail. The epigynes and male palps of the species in these two groups were clearly distinguishable; therefore, we concluded that they should be recognized as two independent genera. Consequently, we describe two new genera, Aoaraneus n. gen. and Bijoaraneus n. gen. Additionally, previously identified Japanese Araneus mitificus specimens were reexamined and concluded to be misidentified. It is described as a new species under the name Bijoaraneus komachi n. sp. in this study.

Key words — Araneus, Araneini, Aoaraneus, Bijoaraneus, komachi, new genus, new species

Introduction

The genus Araneus Clerck 1757 is the largest spider genus, currently consisting of 575 species (World Spider Catalog 2021). When Clerck established the genus, various spider species, even non-web lycosid, and salticid spiders, were placed in this genus. Although various new families and genera have been described, and many species have moved from Araneus to other genera, the genus presently contains many species with various characteristics. Its polyphyly was revealed by recent molecular phylogenetic analyses (Kallal et al. 2020, Scharff et al. 2020). Scharff et al. (2020) inferred the phylogeny of the family Araneidae using five genes and suggested that at least nine new genera should be established independently of Araneus. One example is a group that includes Araneus mitificus (Simon 1886) and Araneus praesignis (L. Koch 1872), namely NGEN10 in Scharff et al. (2020). In this study, we examined specimens from several species that are morphologically similar to them, and confirmed their close relationships by molecular phylogenetic analysis using the same five genes used by Scharff et al. (2020). Next, we describe two new genera in the present paper.

Simultaneously, the Japanese A. mitificus was taxonomically revised. It was described based on the specimens from Cambodia and widely known in South, Southeast, and East Asia, particularly from India to Japan. However, Japanese specimens are remarkably larger than Thai specimens, and the shape of male palps and epigynes differ from each other. This situation led us to revise their taxonomic positions, particularly in Japanese specimens.

Materials and methods

We examined specimens identified as Araneus amabilis Tanikawa 2001, A. legonensis (Grasshoff & Edmunds 1979), A. pentagrammicus (Karsch 1879), A. postilena (Thorell 1878), and Japanese so-called A. mitificus (abbreviated as JA), along with A. mitificus from Southeast Asia, because their general appearance and web style are similar.

The specimens were preserved in 75% ethanol solution at 18–27°C. Morphological characteristics were examined under an M3Z stereoscopic microscope (Wild Heerbrugg AG, Heerbrugg, Switzerland), and photographs were obtained using an EOS Kiss X7 with an EF-S 60 mm f2.8 macro photo lens and an MT-24EX macro twin flash (Canon Inc., Tokyo,
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The phylogenetic relationships between specimens were inferred by sequencing data of the same five genes used in Scharff et al. (2020), namely, mitochondrial cytochrome oxidase subunit I (COI) and 16S-rRNA (16S), nuclear 18S-rRNA (18S), 28S-rRNA (28S), and Histone 3 (H3). We added the sequence data obtained in the present study to the data set of Scharff et al. (2020) and performed a molecular phylogenetic analysis. The specimens used for molecular study are presented in the appendix.

Genomic DNA was extracted from leg muscle using a DNase Blood & Tissue kit (Qiagen, Inc., Hilden, Germany) or a FavorPrep Tissue Genomic DNA Extraction Mini Kit (Favorgen Biotech Corp, Ping-Tung, Taiwan). The COI partial sequence was amplified using the primer combination LCO1498: 5’-GGT CAA CAA ATC ATA AAG ATA TTG G-3’ and HCO2198: 5’-TAA ACT TCA GGG TGA CCA AAA AAT CA-3’ (Folmer et al. 1994). 16S rRNA was amplified using the primer combination 16S-A: 5’-GGC CTG TTT ATC AAA AAC AT-3’ and 16S-B: 5’-CTC CGG TTT AAA AAT CA-3’ (Folmer et al. 1994). 16S rRNA was amplified using the primer combination 1F: 5’-TAC CTG GTT CAA TAC GGA ACC AGC T-3’ with HCO2198: 5’-TAA ACT TCA GGG TGA CCA AAA AAT CA-3’ (Folmer et al. 1994). The reactants were initially denatured for 2 min at 94 °C, followed by 40 cycles of 15 s at 94°C, 20 s at 47°C, and 30 s at 72°C for both COI and 16S. 18S was amplified using the primer combination 1F: 5’-TAC CTG GTT GAT CCT GCC AGT AG-3’ or 3F: GTT CGA TTC CGG AGA GGG A-3’ with 9R: 5’-GAT CCT TCC GCC GAA GTT G-3’ and HCO2198: 5’-TAA ACT TCA GGG TGA CCA AAA AAT CA-3’ (Folmer et al. 1994). The reactants were initially denatured for 2 min at 94°C, followed by 40 cycles of 30 s at 94°C, 20 s at 47°C, and 2 min at 72°C. 28S was amplified using the primer combination 28S-B: TCG GAA GGA ACC AGC TAC TA-3’ with 28S-O: 5’-GAA ACT GCTCAA AGG TAA AGG G-3’ (Whitting et al. 1997). The reactants were initially denatured for 2 min at 94°C, followed by 40 cycles of 30 s at 94°C, 20 s at 50°C, and 45 s at 72°C. H3 was amplified using the primer combination H3aF: 5’-ATG GCT CGT ACC AAG CAG ACV GC-3’ with H3aR: 5’-ATA TCC TTR GCC ATR GTG AC-3’ (Colgan et al. 1998). The reactants were initially denatured for 2 min at 94°C, followed by 40 cycles of 30 s at 94°C, 20 s at 47°C, and 15 s at 72°C. PCR products were sequenced by the Takara Bio CDS Center (Shiga, Japan) or Fasmac Co., Ltd. (Kanagawa, Japan) using an ABI 3130xl or 3730xl DNA analyzer (Life Technologies Japan Ltd., Tokyo, Japan), using the primers HCO2198, 16S-A, 4F, 28S-B, and H3aF for COI, 16S, 18S, 28S, and H3, respectively. The chromatogram obtained was checked manually using MEGA ver.7 (Kumar et al. 2016). The sequence data used by Scharff et al. (2020) were downloaded from the DDBJ/EMBL/GenBank database. Sequence alignments were performed using the online version of MAFFFT (Katoh & Standley 2013). We used the L-INS-I option for coding genes and the Q-INS-I option for RNA gene alignments. Alignments of protein-coding genes were translated into amino acids and checked for stop codons. Nucleotide sequence data obtained in this study are available in the DDBJ/EMBL/GenBank databases.

The Perl script KAKUSAN 4 (Tanabe 2011) and TREEFINDER (Jobb et al. 2004) were used to determine the appropriate model of DNA evolution by BIC. MrBayes ver.3.1.2 (Ronquist & Huelsenbeck 2003) was employed for Bayesian analyses on a combined dataset. Four concurrent Markov chain Monte Carlo were run for 40 million generations, saving a tree every 1000 generations. Topologies prior to ln stabilization (“burn-in”) were discarded, and posterior clade probabilities were calculated from the remaining trees.

The following abbreviations are used for some collectors: AT, Akio Tanikawa; BP, Booppa Petcharad; YS, Yuya Suzuki.

Results

JA was morphologically different from the holotype of *A. mitificus*, and is describe here as a new species.

We obtained 122–618 bp, 426–438 bp, 664–700 bp, 550–700 bp, and 287–309 bp of COI, 16S, 18S, 28S, and H3 partial sequences, respectively, from the specimens for molecular analysis. The best-fit models of sequence evolution determined by Kakusan 4 for Bayesian analyses were as follows: HKY85+G for 16S, JC69 homologous for the third position of H3, GTR+G for other partitions, and gene proportional and codon proportional, rather than other patterns of mixed models. The phylogeny obtained was almost congruent with Scharff et al. (2020). The target species of this study and their sister groups are shown in Fig. 1. All of the targeted species are united in a monophyletic clade, comprising two groups in detail, namely, *A. pentagrammicus* + *A. amabilis*; clade A, and *A. mitificus* + *A. legonensis* + JA + *A. postilena* + *A. praesignis*; clade B (Fig. 1). Clade B is consistent with NGEN10 in Scharff et al. (2020).

As mentioned in Scharff et al. (2020), although the type species of *Araneus, A. angulatus* Clerck 1757 is not included in the analysis, the clade including *A. diadematus* may be the core *Araneus*, and clade A, B in this study differs from the core *Araneus*. We concluded that it should be treated as an independent genus from *Araneus*, in agreement with Scharff et al. (2020). Furthermore, the species in clade A and B are clearly distinguishable by the morphological features mentioned in the diagnosis given below, so we concluded that these two groups should be treated as independent genera.

Consequently, we describe two new genera, one consisting of *A. pentagrammicus* and *A. amabilis*, and the other consisting of *A. mitificus*, JA, *A. legonensis*, *A. postilena*, and *A. praesignis*. All the species in these two new genera differ morphologically from *A. angulatus* the generotype. Male tibia I and II are similar to each other, but it is modi-
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fried, essentially sinuating or with a characteristic prong, in the core *Araneus*. The embolus of the male palp lacks a cap but has an embolus cap in the core *Araneus*.

The clade consisting of genus *Eriovixia* and *Araneus rotundulus* is inferred to be a sister group of these two genera (Fig. 1). *Araneus rotundulus* should be treated as an independent genus or included in *Eriovixia*, however, we could not examine any specimen of the species, and we will therefore investigate this in the future. Two new genera are distinguishable from *Eriovixia* as follows: the abdomen is a vertically long oval, median ocular area is wider anteriorly, male palpal tibia has two macrosetae, male coxa I has a dorsal tubercle; while in *Eriovixia*, the abdomen is inverted triangle or wide oval, male palpal tibia lacks macroseta, male coxa I lacks a dorsal tubercle, and median ocular area is wider posteriorly.

**Taxonomy**

**Family Araneidae**

*Aoaraneus* new genus

(Japanese name: Ao-onigumo-zoku).

**Type species.** *Miranda pentagrammica* Karsch 1879 from Japan.

**Diagnosis.** *Aoaraneus* n. gen. differs from the related *Bijoaraneus* n. gen. by having long, wrinkled and flexible scape with bent tip (Figs. 3E, 4E), vs. short and inflexible in *Bijoaraneus* n. gen. (Figs. 5D, 6C, 7C, 8B). The male palp of *Aoaraneus* n. gen. has long terminal apophysis (Figs. 2A–B, 3G, 4G), but that of *Bijoaraneus* either lacking terminal apophysis (Figs. 2C–E, 5H, 6G, 7G) or it is small and inconspicuous (Figs. 2F, 8F). The male palp of *Aoaraneus* n. gen. has a subterminal apophysis (Figs. 2A–B, 3G, 4G), lacking in *Bijoaraneus* n. gen. (Figs. 2C–F, 5H, 6G, 7G, 8F). The femur II of *Aoaraneus* ventrally lacking strong spine (Fig. 3I), while that of *Bijoaraneus* n. gen. has a row of strong spines (Fig. 5C). The coxa I of *Aoaraneus* has a tubercle anteriorly, while that of *Bijoaraneus* either lacking a tubercle, or it is slightly swollen.

**Description.** Carapace longer than wide, median ocular area wider anteriorly than posteriorly. Male palpal femur basally with tubercle, tibia with 2 macrosetae; bulb with terminal and subterminal apophyses (Figs. 2A–B), embolus without cap. Male endite with lateral tooth (Fig. 3I). Male coxa I with ventral hook (Fig. 3I), dorsal tubercle, and anterior tubercle (Fig. 3I), femur II with groove. Abdomen oval, longer than wide. Epigynal scape long, wrinkled, flexible, and tip is bent (Figs. 3C–F, 4C–E); with basal plate.

Web with a free sector, silk yellow, signal line leads to retreat made by living leaf and silk.

**Etymology.** Generic name is coined from the Japanese word “Ao,” and *Araneus*. The Japanese word “Ao” means blue or green. Gender is masculine.

**Species included.** *Aoaraneus pentagrammicus* (Karsch 1879) n. comb. and *Aoaraneus amabilis* (Tanikawa 2001) n. comb.

*Aoaraneus pentagrammicus* (Karsch 1879) new combination

(Japanese name: Ao-onigumo).

(Figs. 2A, 3A–I)

*Miranda pentagrammica* Karsch 1879, p. 72, pl. 1, fig. 6 ( ), syntypes
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from Japan, preserved in Museum für Naturkunde, Berlin (ZMB), not examined.

Aranea pentagrammicus: Bösenberg & Strand 1906, p. 219, pl. 4, fig. 35, pl. 11, fig. 211 (♀♂).

Catheistela pentagrammica: Yaginuma & Archer 1959, p. 36.

Araneus pentagrammicus: Yaginuma 1986, p. 100, fig. 53.4 (♀♂);
Tanikawa 2007, p. 84, figs. 248–250, 695–696 (♀♂).

Further literature, see World Spider Catalog (2021).

Specimens examined. JAPAN. GUNMA Pref. 1♀, Kawauchi-cho, Kiryu-shi, 22-VI-1983, AT leg. SAITAMA Pref. 1♀, Han-no, Han-no-shi, 12-VII-1998, AT leg. CHIBA Pref. 1♀, Orikisawa, Kimitsu-shi, 28-VI-2008, AT leg.

Fig. 2. Male palp. A, Aoaraneus pentagrammicus n. comb. B, Aoaraneus amabilis n. comb. C, Bijoaraneus mitificus n. comb. D, Bijoaraneus komachi n. sp. E, Bijoaraneus legonensis n. comb. F, Bijoaraneus postilena n.comb. Scales = 0.2 mm.

Abbreviations: C, conductor; E, embolus; MA, median apophysis; TA, terminal apophysis; ST, subterminal apophysis; STII, subterminal apophysis II.

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Fig. 3. *Aoaraneus pentagrammicus* n. comb. A, female habitus; B, male habitus; C–F, epigyne, ventral (C), posterior (D), lateral (E), and dorsal view (F); G–H, male palp, prolateral (G) and ventral (H) view; I, male leg I and II, ventral view. Scales = 5 mm (A–B); 0.2 mm (C–F); 1 mm (I).
Fig. 4. *Aoaraneus amabilis* n. comb. A, female habitus; B, male habitus; C–F, epigyne, ventral (C), posterior (D), lateral (E), and dorsal (F) view; G–H, male palp, prolateral (G), and ventral view (H). Scales = 5 mm (A–B); 0.2 mm (others).
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Fig. 5. *Bijoaraneus mitificus* n. comb. A, female habitus; B, female in a hide; C, male leg I and II, ventral view; D–G, epigyne, ventral (D), posterior (E), lateral (F), and dorsal (G) view; H–I, male palp, prolateral (H) and ventral (I) view. Scales = 5 mm (A–B); 1 mm (C); 0.2 mm (others).
Fig. 6. Bijoaraneus komachi n. sp. A, female habitus; B, male habitus; C–F, epigyne, ventral (C), posterior (D), lateral (E), and dorsal (F) view; G–H, male palp, prolateral (G) and ventral (H) view. Scales = 5 mm (A–B); 0.2 mm (others).
Fig. 7. *Bijoaraneus legonensis* n. comb. A, free sector web; B, female habitus; C–F, epigyne, ventral (C), posterior (D), lateral (E), and dorsal (F) view; G–H, male palp, prolateral (G), and ventral (H) view. Scales = 5 mm (B); 0.2 mm (others).
Fig. 8. *Bijoaraneus postilena* n. comb. A, female habitus; B–E, epigyne, ventral (B), posterior (C), lateral (D), and dorsal (E) view; F–H, male palp, prolateral (F), ventral (G), and retrolateral (H) view. Scales = 5 mm (A); 0.2 mm (others).
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TOKYO, 1♂*, Midori-cho, Nishi-tokyo-shi. 9-VII-1995, AT leg. 1♀, Motohachiouji-machi, Hachiouji-shi, 21-V-1989, AT leg. KANAGAWA Pref. 1♀, Noba-cho, Konan-ku, Yokohama-shi, 9-V-1981, AT leg. 1♀1♂, Hitorizawa-cho, Isogo-ku, Yokohama-shi, 29-IV-1987, AT leg. 1♀, Numama, Zushi-shi, 19-VI-1974, K. Kumada leg. 1♀, Iriya-higashi, Zama-shi, 12-V-2000, AT leg. 1♀, Obara, Midori-ku, Sagamihara-shi, 18-V-2021, AT leg. 1♀1♂, Negoya, Midori-ku, Sagamara-shi, 10-V-1987, AT leg. 1♀, Hasugesan, Aikawa-machi, Aiko-gun, 12-V-2021, AT leg. 1♂, Iriya-higashi, Zama-shi, 12-V-2000, AT leg. 1♀, Nanasawa, Atsugi-shi, 6-VI-1993, AT leg. 1♀, Zenba, Isehara-shi, 28-IV-2021, AT leg. SHIZUOKA Pref. 1♀, Minaminizu-cho, Kamo-gun, 25-VII-1992, AT leg. 1♀, Iwamoto, Fuji-shi 19-V-2014, AT leg. 1♀, Kitamatsunou, Fuji-shi, 19-V-2014, AT leg. 1♀, Yainaba, Fujieda-shi, 16-V-2013, AT leg. 1♀, Hagino, Kakegawa-shi, 26-VI-2015, AT leg. 1♀1♂, Ryokukaidai, Tenryu-ku, Hamamatsu-shi, 10-IV-2013, YS leg. AICHI Pref. 1♀, Iwasaki-cho, Toyohashi-shi, 25-VIII-1993, AT leg. MIE Pref. 1♀, Kogawaguchi, Kiwa-cho, 30-VIII-1990, AT leg. 2♀, WAKAYAMA Pref. 1♀, Kumanogawa-cho, Shingu-shi, 3-VIII-1991, AT leg. SAGA Pref. 1♀, Kinryu, Kinryu-machi, Saga-shi, 31-VII-2005, AT leg. KAGOSHIMA Pref. 1♀, Miyanoura, Yakushima Is., 15-VII-1990, AT leg. 1♀, Kusukawa, Yakushima Is., 17-VII-1990, AT leg.

Diagnosis. *Aoaraneus pentagrammicus* resembles *A. amabilis*. However, they are distinguishable as follows: basal plate of the epigyne is small and invisible in ventral view in *A. pentagrammicus* (Fig. 3C), while large and visible in the ventral view in *A. amabilis* (Fig. 4C). Subterminal apophysis is leaf-shaped in *A. pentagrammicus* (Figs. 2A, 3G–H), terminal apophysis longer than median plate, wrinkled, flexible, with bent shape and with hole at the center in posterior view; scape reaching conductor; with 2 subterminal apophyses, median apophysis with apical and basal projections.

Range. Japan (Honshu, Shikoku, Kyushu), Korea, China, Taiwan.

*Aoaraneus amabilis* (Tanikawa 2001) new combination
(Japanese name: Chura-onigumo)
(Figs. 2B, 4A–H)

*Araneus amabilis* Tanikawa 2001, p. 82, figs. 69–72, 75–76, holotype ♀ from Iriomotejima Is., Japan, preserved in National Science Museum of Nature and Science, Tsukuba (NSMT), examined. Further literature, see World Spider Catalog (2021).

Specimens examined. JAPAN. KAGOSHIMA Pref. 1♀, Yakushima Is., 14-VII-2006, AT leg. 1♀, Nakanoshima Is., Tokara Isls., 5-VII-2006, AT leg. 1♂, Setouchi-cho, Amami-oshima Is., 21-II-2005, AT leg. 1♀, Nishiakina, Tokunoshima Is., 12-IX-2005, AT leg. OKINAWA Pref. 1♀, Nishime, Kumejima Is., 15-VI-2004, AT leg. 1♀1♂, Urauchi, Iriomotejima Is., Okinawa Pref., 1-I-2000, AT leg.

Diagnosis. *Aoaraneus amabilis* resembles *A. pentagrammicus* see the diagnosis of the latter species for the discriminating points.

Description. See Tanikawa (2001).

Range. Japan (Nansei Islands).

**Bijoaraneus** new genus
(Japanese name: Bijo-onigumo-zoku)

Type species. *Epeira mitifica* Simon 1886, from Cambodia.

Diagnosis. See diagnosis in *Aoaraneus* n. gen.

Description. median ocular area wider anteriorly than posteriorly. Male palpal femur basally with tubercle, tibia 2 macrosetae. Male endite with lateral tooth. Male coxa I with ventral hook (Fig. 5C), and dorsal tubercle, femur II with groove, femur II with a row of ventral spines (Fig. 5C). Abdomen oval, longer than wide. Epigynal scape short, well sclerotized, inflexible (Figs. 5D, 6C, 7C, 8B); without differentiation between median plate and lateral lamella. Male palp without terminal apophysis, or small and not reaching conductor.

Web with a free sector (Fig. 7A), silk yellow, with signal line lead to retreat made by living leaf and silk (Fig. 5B).

Etymology. Generic name is coined from the Japanese word “Bijo” and *Araneus*. The Japanese word “Bijo” means beautiful lady. Gender is masculine.

Species included. Bijoaraneus mitificus (Simon 1886) n. comb., Bijoaraneus komachi n. sp., Bijoaraneus legonisens (Grasshoff & Edmunds 1979) n. comb., Bijoaraneus postilea (Thorell 1878) n. comb., and Bijoaraneus praesegnis (L. Koch 1872) n. comb.
*Bijoaraneus mitificus* (Simon 1886) new combination
(Thai name: Mangmoum-Yai-Klom-Tong-Lai-Huajai)
(Figs. 2C, 5A–I)

*Epeira mitifica* Simon 1886, p. 150, holotype ♀ from Cambodia, preserved in Muséum National d’Histoire Naturelle, Paris, examined.

*Araneus mitificus*: Simon 1909, p. 109.

Further literature, see World Spider Catalog (2021).

**Specimens examined.** Holotype ♀ with label ‘Pavie 28-85’, ‘Cambodia’. TAIWAN. 1♂, Tunghai University, Xitun District, Taichung City, 27-III-2012, Tamati Suguro leg. THAILAND. 1♂, Ban Pangdam, Tambon Chiang Dao, Amphoe Chiang Dao, Chiang Mai Prov., 3-VII-2014, AT & BP leg. 1♀1♂, Tambon Khlong Sam, Amphoe Khlong Luang, Pathum Thani Prov., 13-XI-2018, AT & BP leg. 1♀, Tambon Ronpiboon, Amphoe Ronpiboon, Nakhon Si Thammarat Prov., 7-X-2013, AT & BP leg. 1♀, Tambon Bo Dan, Amphoe Sathing Phra, Songkhla Prov., 22-II-2016, AT & BP leg. 1♀, Tambon Sakom, Amphoe Chana, Songkhla Prov., 15-XI-2013, BP leg. 1♀, Tambon Sakom, Amphoe Chana, Songkhla Prov., 14-II-2015, BP leg. 1♀, Tambon Khao Tuo, Amphoe Hat Yai, Songkhla Prov., 28-II-2016, AT & BP leg. 1♀, Ban Thung Chang, Tambon Phatong, Amphoe Hat Yai, Songkhla Prov., 10-III-2018, AT & BP leg. SINGAPORE. 1♀, Pasir Ris Park, 6-VI-2016, Nicky Bay & Joseph K. H. Koh leg. (Collection permit no. NP/RP12-070-3).

**Diagnosis.** *Bijoaraneus mitificus* resembles *B. komachi* n. sp. and *B. legonensis* (Figs. 5A, 6A–B, 7B). *Bijoaraneus mitificus* females are distinguishable by the heart-shaped epigyne in ventral view (cf. Fig. 5D and Figs. 6C, 7C). *Bijoaraneus mitificus* males can be separated from *B. komachi* n. sp. by the apically bent embolus (cf. Fig. 2C and 2D) and can be separated from *B. legonensis* by the shape of median apophysis; in the prolateral view, it is an inverted triangle in *B. legonensis*, but not in *B. mitificus* (cf. Fig. 2C and 2E).

**Description.** Based on a female and a male specimen from Thailand. Coloration and markings when living (Fig. 5A): carapace greenish orange; abdomen dorsally whitish green with black markings, ventrally green; legs green.

**Measurements.** Female / male. Body 5.94 / 4.19 long. Carapace 2.80 / 1.88 long; 2.24 / 1.60 wide. Length of legs [tarsus, metatarsus, tibia, patella, femur = total]: I, 1.00, 2.48, 2.12, 1.24, 2.64 = 9.48 / 0.80, 1.88, 1.64, 0.84, 2.04 = 7.20; II, 0.84, 2.00, 1.68, 1.12, 2.32 = 7.96 / 0.64, 1.56, 1.12, 0.72, 1.80 = 5.84; III, 0.60, 1.00, 0.84, 0.76, 1.52 = 4.72 / 0.48, 0.72, 0.60, 0.48, 1.16 = 3.44; IV, 0.68, 1.84, 1.56, 1.12, 2.70 = 7.90 / 0.52, 1.28, 1.04, 0.64, 1.60 = 5.08. Abdomen 3.52 / 2.15 long; 3.00 / 1.95 wide.

**Body and legs.** Male / female. Carapace 1.25 / 1.17 times longer than wide. Median ocular area length / width ratio 0.84 / 0.94, anterior width / posterior width ratio 2.38 / 1.45. Labium length / width ratio 0.68 / 0.62. Sternum 1.25 / 1.24 times longer than wide. Length of leg I / carapace length ratio 3.39 / 3.83. Abdomen 1.17 / 1.10 times longer than wide.

**Copulatory organs.** Epigyne as in Figs. 5D–G, well sclerotized, heart shaped in ventral view, inverted triangle in posterior view. Male palp as in Figs. 2C, 5H–I, without terminal apophysis, embolus apically bent.

**Range.** Thailand, Cambodia, Singapore, Taiwan, China.

*Bijoaraneus komachi* new species
(Japanese name: Bijio-onigumo)
(Figs. 2D, 6A–H)

*Aranea mitifica*: Boessenb & Strand 1906, p. 221, pl. 4, fig. 20, pl. 11, fig. 207 (♀). *Misidentification.*

*Araneus mitificus*: Saito 1939, p. 19, fig. 3; Saito 1959, p. 87, pl. 11, fig. 94a, pl. 13, fig. 94b; Yaginuma 1986, p. 100, fig. 53.5; Chikuni 1989, p. 66, fig. 14; Namkung 2002, p. 246, figs. 19.8a–b; Tanikawa 2007, p. 85, figs. 256, 699–701; Tanikawa 2009, p. 457, figs. 275–277; Kim & Lee 2012, p. 24, figs. 12A–C. *Misidentification.*

*Afaranea mitifica*: Yaginuma & Archer 1959, p. 37. *Misidentification.*

**Types.** Holotype ♀, Oda, Tsukuba-shi, Ibaraki Pref., Japan, 8-IX-2020, YS leg. (COI barcode = LC637702). Paratypes: same locality as holotype. 1♂, 16-IX-2019, AT & YS leg. 1♀, 14-IX-2020, AT & YS leg. 1♀, 14-IX-2020, AT & YS leg.

**Other specimens examined.** JAPAN. IBARAKI Pref. 1♀, Tsukuba-shi, 29-IX-1975, Toshiyuki Takai leg. CHIBA Pref. 2♀, Abiko-shi, 7-XII-2013, Yasunori Hageno leg. TOKYO. 1♀, Midori-cho, Nishitokyo-shi, 15-X-1995, AT leg. KANAGAWA Pref. 1♀, Terayama-cho, Midori-ku, Yokohama-shi, 9-IX-1989, AT leg. 3♂, Izumi-ku, Yokohama-shi, 19-IX-1998, AT leg. 4♀, 25-VIII-1980, AT & Miyako Mori leg. 4♀, 28-VIII-1980, AT & Hisako Iijima leg. 1♂, 13-IX-1980, Hisako Iijima leg. 4♀, 18-IX-1982, AT & Kuzuaki Sato leg. 1♀, 13-IX-1983, AT leg. 1♀, 14-IX-1985, Sachiko Tazoe leg. Noba-cho, Yokohama-shi. 1♂, Ikekou, Chishi-shi, 23-IX-1983, Kauzaki SATO leg. 1♀, Kiyama, Atsugi-shi, 21-IX-1986, AT leg. 1♀, Tsurumaki, Hadano-shi, 15-IX-1989, AT leg. 1♀, Ikusawa, Oiso-Machi, Naka-gun, 17-IX-2020, AT leg. 1♀, Kuno, Odawara-shi, 14-X-2012, AT leg. SHIZUOKA Pref. 1♀, Izu-shi, 18-X-1986, AT leg. AICHI Pref. 1♀, Fusuh, Toyota-shi, 28-VIII-2014, Kyoto Ogata leg.

**Diagnosis.** *Bijoaraneus komachi* n. sp. resembles *B. mitificus*. in general appearance, and has been misidentified as the latter species by many authors as shown in the synonym list, but is distinguishable from the latter by larger body size, epigyne, and the male palpal range of body size in *B. komachi* is: female (N = 26) = 7.70–11.60; male (N = 8) = 5.60–6.50. In *B. mitificus*, female (N = 8) = 5.50–9.20; male (N = 4) = 4.00–4.30. In *B. mitificus*, the contour on the anterior side of the epigyne is double-humped, so it appears heart shaped, but not in *B. komachi*. The posterior view of the epigyne of *B. mitificus* appears as an inverted triangle, while in *B. komachi*, the outline is constricted and appears as snowman shape. Male palpal median apophysis of *B. komachi* is vertically long in the prolateral view (Figs. 2D, 6G), but horizontally long in *B. mitificus* (Figs. 2C, 5H); embolus of *B. komachi* is straight (Figs. 2D, 6G), but apically bent in...
**B. mitificus** (Figs. 2C, 5H).

**Description.** Based on the holotype female and a male paratype. Coloration and markings when living (Figs. 6A–B): carapace greenish orange; abdomen dorsally whitish green with black markings, ventrally green; legs greenish orange with dark colored annulation; sternum green.

**Measurements.** Female / male. Body 8.60 / 6.50 long. Carapace 4.00 / 3.40 long; 3.25 / 2.72 wide. Length of legs [tarus, metatarsus, tibia, patella, femur = total]: I, 1.36, 3.76, 3.28, 1.72, 3.92 = 14.04 / 1.32, 3.56, 3.00, 1.36, 3.52 = 12.76; II, 1.16, 3.00, 2.48, 1.56, 3.40 = 11.60 / 1.08, 2.84, 1.88, 1.12, 3.16 = 10.08; III, 0.84, 1.48, 1.20, 1.12, 2.20 = 6.84 / 0.76, 1.32, 1.04, 0.84, 1.92 = 5.88; IV, 0.92, 2.72, 2.24, 1.56, 3.28 = 10.72 / 0.84, 2.36, 1.84, 1.12, 2.76 = 8.92. Abdomen 5.44 / 3.36 long; 5.00 / 2.76 wide.

**Body and legs.** Female / male. Carapace length / width ratio 1.23 / 1.25. Median ocular area length / width ratio 0.96 / 0.87; anterior width / posterior width ratio 1.35 / 1.53. Labium length / width ratio 0.85 / 0.85. Sternum length / width ratio 1.25 / 1.31. Length of leg I / length of carapace ratio 3.51 / 3.75. Abdomen length / width ratio 1.09 / 1.22.

**Copulatory organs.** Epigyne as in Figs. 6C–F, snowman shaped in posterior view (Fig. 6D). Male palp as in Figs. 2D, 6G–H, embolus apically straight, median apophysis with a projection towards anteriorly (Figs. 2D, 6G–H).

**Etymology.** The specific epithet was derived from the Japanese word “Komachi” meaning “a beautiful lady”.

**Range.** Japan (Hokkaido, Honshu, Shikoku, Kyushu), Korea.

**Bijoaraneus legonensis** (Grasshoff & Edmunds 1979) new combination
(Thai name: Mangmoum-Yai-Klom-Tong-Lai-Kangkaw)
(Figs. 2E, 7A–H)

*Araneus legonensis* Grasshoff & Edmunds 1979, p. 303, figs. 1–11 (♀♂), holotype male from Ghana, preserved in Senckenberg Museum, Frankfurt am Main, not examined.

**Specimens examined.** THAILAND. 1♀, Tambon Huai Kao, Amphoe Mae On, Chang Mai Prov., 6-VII-2014, AT & BP leg. 1♂1♀, Tambon Tha Kha-nun, Amphoe Thong Pha Phum, Kanchanaburi Prov., 16-II-2019, AT & BP leg.

**Diagnosis.** *Bijoaraneus legonensis* resembles *B. mitificus* in general appearance but is distinguishable from the latter by the shape of epigyne and male palp. the contour on the anterior side of the epigyne in *B. mitificus*, is double-humped, and appears as heart-shaped (Fig. 5D), unlike in *B. legonensis* (Fig. 7C). The posterior view of the epigyne of *B. mitificus* appears as an inverted triangle (Fig. 5E), while in *B. legonensis*, the outlines of both sides are almost parallel (Fig. 7D). median apophysis of *B. mitificus* is transversal in prolateral view (Figs. 2C, 5H); however, is an inverted triangle in *B. legonensis* (Figs. 2E, 7G).

**Description.** Based on a female and a male specimen from Thailand. Coloration and markings when living (Fig. 7B): carapace greenish orange; abdomen dorsally whitish green with black markings, ventrally green; legs greenish orange with weak annulation.

**Measurements.** Female / male. Body 6.40 / 3.64 long. Carapace 2.64 / 2.05 long; 2.20 / 1.70 wide. Length of legs [tarus, metatarsus, tibia, patella, femur = total]: I, 0.92, 2.60, 2.08, 1.16, 2.60 = 9.36 / 0.80, 2.08, 1.78, 0.83, 2.23 = 7.72; II, 0.80, 2.04, 1.60, 1.04, 2.24 = 7.72 / 0.68, 1.68, 1.15, 0.75, 1.93 = 6.19; III, 0.60, 1.00, 0.80, 0.76, 1.44 = 4.60 / 0.48, 0.80, 0.60, 0.50, 1.18 = 3.56; IV, 0.64, 1.88, 1.48, 1.04, 2.20 = 7.24 / 0.53, 1.40, 1.08, 0.65, 1.68 = 5.34. Abdomen 4.06 / 1.90 long; 3.56 / 1.38 wide.

**Body and legs.** Female / male. Carapace length / width ratio 1.20 / 1.21. Median ocular area length / width ratio 0.94 / 0.88; anterior width / posterior width ratio 1.31 / 1.33. Labium length / width ratio 0.76 / 0.83. Sternum length / width ratio 1.21 / 1.27. Length of leg I / length of carapace ratio 3.55 / 3.77. Abdomen length / width ratio 1.14 / 1.38.

**Genital organs.** Epigyne as in Figs. 7C–F, an outline of both sides almost parallel in ventral and posterior view (Fig. 7C–D). Male palp as in Figs. 2E, 7G–H; median apophysis inverted triangle in prolateral view, embolus apically bent.

**Range.** Thailand, Ghana.

**Notes.** The specimens from Thailand show a slight difference from the original description. But the difference is not distinct enough to separate Thai specimens from *B. legonensis*. The type locality of the species is in Ghana, namely far apart from Thailand, so the difference might be geographical variation. Although the species has never been recorded between Ghana and Thailand, it might be overlooked or misidentified in this area. A future faunal survey in this area is desired.

**Bijoaraneus postilena** (Thorell 1878) new combination
(Thai name: Mangmoum-Yai-Klom-Tong-Lai-Kled)
(Figs. 2F, 8A–H)

*Epeira postilena* Thorell 1878, p. 70, syntypes ♀♂ from Amboina, not examined.

**Specimens examined.** THAILAND. 1♂, Tambon Na Chaluai, Amphoe Na Chaluai, Ubon Ratchathani Prov., 27-VII-2013, BP leg. 1♂, Tambon Yaek, Amphoe Muang, Sa Kaeo Prov., 16-XI-2018, AT & BP leg. 2♀, Tambon Bu Fai, Amphoe Prachantakham, Prachin Buri Prov., 11-XII-2019, AT & BP leg. 1♂, Tambon Chong, Amphoe Na Yong, Trang Prov., 22-II-2016, AT & BP leg. 1♀, Ban Khuan Khao Wang, Tambon Chalong, Amphoe Hat Yai, Songkhla Prov., 26-II-2008, BP leg.

**Diagnosis.** *Bijoaraneus postilena* resembles *B. mitificus*, *B. komachi* n. sp., and *B. legonensis*, but can be distinguished from them as follows: epigynal scape of *B. postilena* is inverted triangle in ventral view (Fig. 8B), but...
those of the latters are small and knob like shape in ventral view; male palpal median apophysis of B. postilena is sideways-protruding (Figs. 8F, H), but those of the latters are short and not protruding (Figs. 5H–I, 6G–H, 7G–H).

**Description.** Coloration and markings when living (Fig. 8A): carapace greenish orange; abdomen dorsally whitish green with black markings, ventrally green; legs greenish orange with weak annulation.

**Measurements.** Female / male. Body 5.06 / 3.60 long. Carapace 2.00 / 1.80 long; 1.70 / 1.45 wide. Length of legs [tarsus, metatarsus, tibia, patella, femur = total]: I, 0.83, 2.00, 1.80, 0.95, 2.13 = 7.71 / 0.75, 1.78, 1.68, 0.73, 1.93 = 6.87; II, 0.70, 1.58, 1.33, 0.83, 1.83 = 6.27 / 0.63, 1.38, 1.13, 0.63, 1.63 = 5.40; III, 0.48, 0.80, 0.65, 0.63, 1.23 = 3.79 / 0.48, 0.70, 0.60, 0.45, 1.10 = 3.33; IV, 0.58, 1.45, 1.25, 0.85, 1.83 = 5.96 / 0.48, 1.23, 1.03, 0.63, 1.50 = 4.87. Abdomen 2.92 / 1.68 long; 2.64 / 1.25 wide.

**Body and legs.** Female / male. Carapace length / width ratio 1.18 / 1.24. Median ocular area length / width ratio 1.00 / 0.94; anterior width / posterior width ratio 1.25 / 1.45. Labium length / width ratio 0.75 / 0.58. Sternum length / width ratio 1.27 / 1.22. Length of leg I / length of carapace ratio 3.86 / 3.82. Abdomen length / width ratio 1.11 / 1.34.

**Genital organs.** Epigyne as in Figs. 8B–E; scape inverted triangle in ventral view (Fig. 8B). Male palp as in Figs. 2F, 8F–H; with terminal apophysis, median apophysis protruding sideways.

**Range.** Thailand, Indonesia.

**Bijoaraneus praesignis** (L. Koch 1872) new combination

_Epeira praesignis_ L. Koch 1872, p. 110, pl. 9, fig. 3, holotype ♀ from Queensland, Australia, preserved in Zoologisches Museum Hamburg, Hamburg, not examined.

Notes. Although no specimen of this species is available in this study, its phylogenetic position (Fig. 1, Scharff et al. 2020) shows that it should be included in this genus.

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Appendix
Species, specimen numbers, locality, and accession numbers of specimens used for molecular work in this study.

| Species and specimen number | locality                  | COI      | 16S     | H3     | 18S     | 28S     |
|-----------------------------|---------------------------|----------|---------|--------|---------|---------|
| *Aoaraneus pentagrammicus* 1345 | Chiba, Japan              | LC637703 | LC637712 | LC637721 | LC637730 | LC637739 |
| *Aoaraneus pentagrammicus* 71 | Kanagawa, Japan           | LC637704 | LC637713 | LC637722 | LC637731 | LC637740 |
| *Aoaraneus amabilis* 72     | Iriomotejima Is., Japan   | LC637705 | LC637714 | LC637723 | LC637732 | LC637741 |
| *Bijoaraneus mitificus* 4799 | Pathum Thani, Thailand    | LC637706 | LC637715 | LC637724 | LC637733 | LC637742 |
| *Bijoaraneus komachi* 1346  | Tokyo, Japan              | LC637707 | LC637716 | LC637725 | LC637734 | LC637743 |
| *Bijoaraneus komachi* 80    | Kanagawa, Japan           | LC637708 | LC637717 | LC637726 | LC637735 | LC637744 |
| *Bijoaraneus legonensis* 4936 | Kanchanaburi, Thailand    | LC637709 | LC637718 | LC637727 | LC637736 | LC637745 |
| *Bijoaraneus postilena* 4801 | Sa Kaeo, Thailand         | LC637710 | LC637719 | LC637728 | LC637737 | LC637746 |
| *Bijoaraneus postilena* 4935 | Prachin Buri, Thailand    | LC637711 | LC637720 | LC637729 | LC637738 | LC637747 |