Three New Species and a New Record of Cycloneuroterus (Hymenoptera: Cynipidae: Cynipini) Inducing Galls on Cycllobalanopsis in Japan

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ABSTRACT The following three new species of Cycloneuroterus Melika et Tang (Hymenoptera: Cynipidae: Cynipini) from Japan are described: C. akagashiphilus from Quercus (Cycllobalanopsis) acuta and C. hisashii and C. arakashiphagus from Q. (C.) glauca. Quercus (C.) acuta is recorded as a host plant of Cycloneuroterus for the first time. Cycloneuroterus fortuitusus Tang et Melika, previously known from Taiwan, is newly recorded for Japan. A key to all eight recognized species of Cycloneuroterus is provided. The hitherto known five species of Cycloneuroterus were recorded in Taiwan only and four of them induce galls on the strictly Asian subgenus Cycllobalanopsis. Therefore, the discovery of the three new species of Cycloneuroterus in Japan confirms the close association between Cycloneuroterus and Cycllobalanopsis, and suggests the existence of the potentially diverse cynipid fauna on this subgenus in Asia. More extensive sampling is expected to reveal the species richness in the Cynipini in the region.

KEY WORDS Quercus, oak gall wasp, species richness, Asia

The oak gall wasps (tribe Cynipini) consist of ≈1,000 species worldwide, almost all of which species induce galls on the subgenus Quercus (Ronquist 1999; Stone et al. 2002, 2009; Csóka et al. 2005; Abe et al. 2007; Liljeblad et al. 2008). The genus Quercus (the oaks) is divided into the following two subgenera: the strictly Asian subgenus Cyclabalanopsis (the ring-cupped oaks, 76 spp.) (Govaerts and Frodin 1998), or ≈150 spp. (Huang et al. 1999); and the Holarctic subgenus Quercus (455 spp.) (Govaerts and Frodin 1998). Seven cynipid species (two species of Plagiotrochus Mayr, Synergus itoensis Abe, Ide et Wachi, and four species of Cycloneuroterus Melika et Tang) have been recorded as gall inducers on Cyclabalanopsis (Ide et al. 2010; Abe et al. 2011; Tang et al. 2011a, b); two species of Andricus Hartig described by Shinji (1940, 1941) as gall inducers on Cyclabalanopsis are considered to be inquilines on the basis of the characteristics of their galls (Yukawa and Masuda 1996, Wachi et al. 2011). However, the abundance of this subgenus in Asia suggests the existence of a rich cynipid fauna associated with it in the region (Abe et al. 2007).

The genus Cycloneuroterus, resembling the genera Neoroterus Hartig, Cerroneuroterus Melika et Pujade-Villar, and Trichagalma Mayr, was established based on five species from Taiwan: four species of Cycloneuroterus induce galls on Cyclabalanopsis and one on the genus Lithocarpus (Tang et al. 2011b). This genus differs from the other three genera in having distinct and complete lateral propodeal carinae (Tang et al. 2011b).

Here, we describe three new species of Cycloneuroterus from two species of ring-cupped oak Cyclabalanopsis. Two of the three new species emerge from galls on Q. (C.) glauca and one new species from galls on Q. (C.) acuta, which is a new host record for the Cyclineuroterus. The galls induced by the former two species were described by Yukawa and Masuda (1996), but the gall-inducing wasps have not yet been described. Moreover, we first record C. fortuitusus Tang et Melika, which induces galls on Q. (C.) glauca, from Japan. The significance of the discovery of Cycloneuroterus from Japan is discussed.

Materials and Methods

Specimens Examined. Twenty specimens were examined for each gall wasp. The collection and rearing data of these specimens are shown in “Type Material” for three new species and in “Material Examined” for C. fortuitusus. All specimens are deposited in the collection of BLKU (the Biosystematics Laboratory, Graduate School of Social and Cultural Studies, Kyushu University, Motooka, Fukuoka, Japan) and the H. Masuda Collection of KUM (Kyushu University Museum, Hakoizaki, Fukuoka, Japan).

Examination of External Morphology. The external structure of dry-mounted wasp and gall specimens was studied with binocular stereomicroscopes (model...
SZ60, Olympus, Tokyo, Japan; model MZ12, Leica, Solms, Germany, fitted with model DS-L1, Nikon, Tokyo, Japan), and the lengths of the forewing and hind tibia of the 50 specimens were measured using an ocular micrometer. Two specimens of each species (one sexual female and one sexual male) were gold-coated with a sputter coater and examined with a scanning electron microscope (model JSM-5600LV, JEOL, Tokyo, Japan). The right forewing of a female wasp of each species was slide mounted in Euparal.

Abbreviations and Terminology. The following morphological abbreviations are used: the postocular line (POL), the distance between the inner edges of the two lateral ocelli; the ocellar-postocular line (OOL), the distance from the outer edge of a lateral ocellus to the compound eye; and the lateral-ocellar line (LOL), the distance between the median and lateral ocelli. Morphological terminology follows Richards (1977), Ronquist and Nordlander (1989), and Liljeblad et al. (2008); description of surface sculpture follows Harris (1979).

Results

Cycloneuroterus akagashiphilus Ide, Wachi et Abe, sp. nov.
(Fig. 1)

Type Material. HOLOTYPE. Sexual female, with three labels of “Mt. Sefuri, Saga Pref., Japan, 21-V-2010, T. Ide leg.”, “host: Q. (C.) acuta, em. early June, 2010” and “Holotype”. PARATYPES. Nine females and 10 males with the same data as holotype.

Depository of Specimens. BLKU.

Holotype (Sexual Female). Head black, except for yellow antenna, lower face, clypeus, mandible, and palpi. Mesosoma yellow except for black mesoscutum, scutellum, and tarsal claws. Metasoma black.

Head 1.26× as broad as high in anterior view, mainly smooth; vertex rugulose with some transverse rugae medially, imbricate laterally; POL:OOL:LOL = 7:11:4; distance between antennal rims 0.50× distance between antennal rim and inner edge of compound eye; inner margins of compound eyes slightly converging ventrally; face pubescent; ventral margin of clypeus incised medially; gena imbricate, sparsely pubescent, not broadened behind compound eye; malar space narrow, 0.12× as long as eye height. Antenna 14-segmented, relative lengths of flagellomeres 1–12: 2.3, 1.9, 1.5, 1.2, 1.0, 1.1, 1.0, 1.5.

Mesosoma mainly smooth; notaulus absent, but row of sparse setae present, indicating trace of notaulus; anteromedian and parapsidal signa and median mesoscutal impression absent; posterior mesoscutal margin incised, middle part curved anteriorly; mesoscutum fused with scutellum, transscutal fissure absent; scutellum sparsely pubescent, with scutellar fovea as transverse furrow on anterior margin; posterior margin of scutellar fovea without clear border to rest of scutellum; lateral scutellar margin reticulate rugose; posterior scutellar margin rugulose; axillula pubescent; metascutellum and metanotal trough smooth; propodeum pubescent laterally; lateral propodeal carina bent outward, branched; median propodeal carina absent, but median propodeal area with carinae; mesopleural triangle and median area of mesopleuron slightly and longitudinally wrinkled.

Tarsal claws without basal lobe.

Marginal cell of forewing open on anterior margin, 4.52× as long as broad; wing surface ciliate.

Metasoma polished; metastomal tergum II with sparse setae laterally; projecting part of hypopygal spine pointed to apex, 3.2× as long as wide in ventral view, with sparse subapical setae.

Length of forewing 2.48 mm; length of hind tibia 0.64 mm.

Sexual Male. Differs from the sexual female as follows: Head in anterior view 1.29× as broad as high (mean, n = 10); POL:OOL:LOL = 8:8:3; distance between antennal rims 0.45× distance between antennal rim and inner edge of compound eye; antenna 15-segmented, relative lengths of flagellomeres 1–13: 2.9, 2.2, 2.0, 1.6, 1.6, 1.5, 1.5, 1.5, 1.4, 1.3, 1.2, 1.4; first flagellomere incised on outer margin; marginal cell of forewing 4.32× as long as broad; length of forewing 2.66 mm; length of hind tibia 0.68 mm. Lateral propodeal carina in many specimens indistinct, discontinuous. Median propodeal area with indistinct carinae.

Variation. Length of forewing (mean ± SD, n = 10) 2.48–2.75 (2.66 ± 0.08) mm in females, 2.40–2.77 (2.66 ± 0.11) mm in males; length of hind tibia 0.64–0.70 (0.68 ± 0.02) mm in females, 0.62–0.71 (0.68 ± 0.03) mm in males; marginal cell of forewing 4.18–4.53 (4.41 ± 0.13) times as long as broad in females, 4.06–4.67 (4.32 ± 0.19) times as long as broad in males. Vertical carinae on median propodeal area variable in number and shape.

Gall. Oval gall ≈2.0 mm in diameter, induced on lateral margin or apex of young leaf of Q. (C.) acuta, usually two to eight galls clustered (Fig. 5a). Immature galls yellowish green, mature ones brown.

Etymology. Named after its host plant [akagashi = Q. (C.) acuta in Japanese, philus = loving in Greek].

Diagnosis. Cycloneuroterus akagashiphilus resembles C. longinuxus Tang et Melika and C. lirongchiuea Melika et Tang in having yellow-light brown mesopleuron but differs from them as follows: Ventral margin of clypeus not incised in C. longinuxus and C. lirongchiuea, but incised medially in C. akagashiphilus. Mesoscutum without setae in C. longinuxus and C. lirongchiuea, but with row of setae indicating trace of notaulus in C. akagashiphilus. Posterior margin of transverse scutellar fovea with clear border to rest of scutellum in C. longinuxus and C. lirongchiuea, but without clear border in C. akagashiphilus.

Host Plant. Quercus (Cyclobalanopsis) acuta. New host record in Cynipini.

Geographic Distribution. Japan: Kyushu.

Biology. The gall of the sexual generation is induced on young leaf of Q. acuta just after bud burst in late May. The gall matures in ≈1 wk after the appearance. The adult of the sexual generation emerges from it.
Fig. 1. Sexual female of *C. akagashiphilus*. (a) Head, anterior view (scale bar = 100 μm); (b) Head, dorsal view (scale bar = 100 μm); (c) Mesosoma, dorsal view (scale bar = 200 μm); (d) Mesosoma, posterodorsal view (scale bar = 100 μm); (e) Mesosoma, lateral view (scale bar = 200 μm); (f) Mesosoma, lateral view (scale bar = 200 μm); (g) Hypopygial spine, ventral view (scale bar = 50 μm); (h) Right forewing (scale bar = 500 μm).
from late May to early June. The asexual generation is unknown.

Cycloneuroterus hisashii Ide, Wachi et Abe, sp. nov. (Fig. 2)

Type Material. HOLOTYPE. Sexual female deposited in the H. Masuda Collection, with labels of “Isawa, Yamanashi Pref., Japan, 21–IV–1973, H. Masuda leg.,” “host: Q. (C.) glauca, em. early May, 1973” and “Holotype”. PARATYPES. Nine females and 10 males with the same data as holotype.

Depository of Specimens. KUM.

Holotype (Sexual Female). Body uniformly black; antenna, palpi, tegula, and legs yellow except for black tarsal claws; hypopygial spine brown.

Head 1.24× as broad as high in anterior view, mainly smooth; vertex rugulose medially, irminate laterally; upper face irminate; POL:OOL:LOL = 9:12:4; distance between antennal rims 0.64× distance between antennal rim and inner edge of compound eye; inner margins of compound eyes converging ventrally; lower face coarsely irminate, pubescent; ventral margin of clypeus slightly incised medially; gena irminate, pubescent, not broadened behind compound eye; malar sulcus absent; malar space with obscure striae. Antenna 14-segmented, relative lengths of flagellomeres 1–12: 1.8, 1.6, 1.3, 1.2, 1.1, 1.0, 1.0, 1.0, 1.0, 0.9, 1.6.

Mesosoma mainly smooth; pronotum slightly irminate, sparsely pubescent posteriorly; notaulus absent, but with pit on anterior margin of mesoscutum; anterolateral median and parapsidal signa and median mesocutal impression absent; posterior mesocutal margin incised, middle part curved anteriorly; mesoscutum fused with scutellum, transscutal fissure absent; scutellum sparsely pubescent, with scutellar fovea as narrow transverse furrow on anterior margin; posterior margin of scutellar fovea with clear border to rest of scutellum; lateral and posterior scutellar margin reticulate rugose; axillula pubescent; metasternum slightly rugose; metaventral trough smooth; propodeum pubescent laterally; lateral propodeal carina distinct, bent outward; median propodeal area with indistinct carinae; mesopleuron slightly irminate; mesopleural triangle and lower area of mesopleuron with sparse setae.

Tarsal claws without basal lobe. Marginal cell of forewing open on anterior margin, 4.60× as long as broad; wing surface ciliate.

Metasoma polished; metasomal tergum II with sparse setae laterally; projecting part of hypopygial spine pointed to apex, 1.5× as long as wide in ventral view, with long subapical setae not forming tuft but beyond apex of spine.

Length of forewing 2.06 mm; length of hind tibia 0.55 mm.

Sexual Male. Differs from the sexual female as follows: Head in anterior view 1.28× as broad as high (mean, n = 10); POL:OOL:LOL = 8:10:3; distance between antennal rims 0.56× distance between antennal rim and inner edge of compound eye; antenna 15-segmented, relative lengths of flagellomeres 1–13: 2.0, 1.8, 1.7, 1.5, 1.3, 1.2, 1.2, 1.2, 1.2, 1.1, 1.1, 1.3; first flagellomere incised on outer margin; marginal cell of forewing 4.62× as long as broad; length of forewing 1.89 mm; length of hind tibia 0.51 mm.

Variation. Length of forewing (mean ± SD, n = 10) 1.41–2.13 (1.92 ± 0.22) mm in females, 1.60–2.08 (1.95 ± 0.18) mm in males; length of hind tibia 0.41–0.55 (0.49 ± 0.04) mm in females, 0.41–0.57 (0.51 ± 0.05) mm in males; marginal cell of forewing 4.12–4.60 (4.49 ± 0.14) times as long as broad in females, 4.44–5.14 (4.62 ± 0.24) times as long as broad in males. Indistinct carinae on median propodeal area variable in number and shape.

Gall. Globular gall 5–7 mm in diameter and 10–13 mm in height, induced in basal portion of bud of Q. (C.) glauca (Fig. 5b). Galled bud somewhat swollen, with 15 or less larval chambers. Larval chamber wall thin.

Etymology. Named in honor of the late Hisashi Masuda, who contributed much to our knowledge of gall wasps.

Diagnosis. Cycloneuroterus hisashii resembles C. litungi Tang, Melika et Yang, C. formosanus Tang et Melika, and C. fortuitusus in having dark brown to black body, but differs from them as follows: Ventral margin of clypeus not incised in C. litungi, but slightly incised medially in C. hisashii. Pit on anterior margin of mesoscutum absent in C. litungi and C. formosanus, but present in C. hisashii. Inner margins of compound eyes parallel in C. fortuitusus, but converging ventrally in C. hisashii.

Host Plant. Quercus (Cyclobalanopsis) glauca.

Geographic Distribution. Japan: Honshu. The gall was recorded from Honshu by Yukawa and Masuda (1996).

Biology. According to Yukawa and Masuda (1996), the biology of this new species can be summarized as follows. The gall of the sexual generation (Fig. C-055, Japanese name: kashi-me-fukure-zui-fushi) matures fall to the ground. The asexual generation is unknown.

Cycloneuroterus arakashiphagus Ide, Wachi et Abe, sp. nov. (Fig. 3)

Type Material. HOLOTYPE. Sexual female deposited in the H. Masuda Collection, with three labels of “Kofu-kitayama, Yamanashi Pref., Japan, 18-IV-1974, H. Masuda leg.,” “host: Q. (C.) glauca, em. late April, 1974” and “Holotype”. PARATYPES. Nine females and ten males with the same data as holotype.

Depository of Specimens. KUM.

Holotype (Sexual Female). Body uniformly dark brown; antenna, mandible, palpi, tegula, and legs yellow except for black tarsal claws.

Head 1.29× as broad as high in anterior view; vertex and upper face slightly irminate; POL:OOL:LOL = 8:10:4; distance between antennal rims 0.70× distance
Fig. 2. Sexual female of *C. hisashii*. (a) Head, anterior view (scale bar = 100 μm); (b) Head, dorsal view (scale bar = 100 μm); (c) Mesosoma, dorsal view (scale bar = 100 μm); (d) Mesosoma, posterodorsal view (scale bar = 100 μm); (e) Mesosoma, lateral view (scale bar = 100 μm); (f) Metasoma, lateral view (scale bar = 200 μm); (g) Hypopygial spine, ventral view (scale bar = 100 μm); (h) Right forewing (scale bar = 500 μm).
Fig. 3. Sexual female of *C. arakashiphagus*. (a) Head, anterior view (scale bar = 100 μm); (b) Head, dorsal view (scale bar = 100 μm); (c) Mesosoma, dorsal view (scale bar = 100 μm); (d) Mesosoma, posterodorsal view (scale bar = 100 μm); (e) Mesosoma, lateral view (scale bar = 100 μm); (f) Metasoma, lateral view (scale bar = 100 μm); (g) Minute processes on metasomal tergum VII (scale bar = 10 μm); (h) Hypopygial spine, ventral view (scale bar = 50 μm); (i) Right forewing (scale bar = 500 μm).
between antennal rim and inner edge of compound eye; inner margins of compound eyes parallel; lower face slightly imbricate, sparsely pubescent; anterior margin of Clypeus rounded; gena imbricate, pubescent, not broadened behind compound eye; malar sulcus absent, malar space with obscure strigae. Antenna 14-segmented, relative lengths of flagellomeres 1–2: 1.7, 1.5, 1.5, 1.3, 1.2, 1.1, 1.1, 1.0, 1.0, 1.0, 1.0.

Mesosoma mainly smooth; pronotum spuriously pubescent posteriorly with indistinct longitudinal strigae on lateral margin; anterior one-fifths of rudimentary notaule present; antero-dorsal and parapsidal signa and median mesoscutal impression absent; posterior mesoscutal margin incised, middle part curved anteriorly; mesoscutum slightly imbricate, fused with scutellum, transscutal fissure absent; scutellum slightly imbricate, sparsely pubescent, with scutellar fovea as transverse furrow on anterior margin; posterior margin of scutellar fovea with clear border to rest of scutellum; lateral and posterior scutellar margin reticulate rugose to rugulose; axillula pubescent; metasternum slightly rugose; metanotal trough smooth; propodeum pubescent laterally, without median carina, lateral propodeal carina distinct, sharply bent outward, branched; median propodeal area without carinae; mesopleuron slightly imbricate; mesopleural triangle sparsely pubescent.

Tarsal claws without basal lobe.

Marginal cell of forewing open on anterior margin, 4.38 × as long as broad; wing surface ciliate.

Metasoma polished; metasomal tergum II with sparse setae laterally; metasomal tergum VI and VII with minute processes (Fig. 3g); projecting part of hypopygium spine thin, slightly tapered to apex, 1.8 × as long as wide in ventral view, with sparse subapical setae not forming tuft but beyond apex of spine.

Length of forewing 2.11 mm; length of hind tibia 0.49 mm.

**Sexual Male.** Differs from the sexual female as follows: Head in anterior view 1.28 × as broad as high (mean, n = 10); POL:OOL:LOL = 8.7:3; distance between antennal rims 0.67 × distance between antennal rim and inner edge of compound eye; antenna 15-segmented, relative lengths of flagellomeres 1–13: 2.1, 2.0, 1.8, 1.5, 1.4, 1.3, 1.3, 1.3, 1.2, 1.1, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0; length of hind tibia 0.52 mm. Antenna 14-segmented, relative lengths of flagellomeres 1–2: 1.7, 1.5, 1.5, 1.3, 1.2, 1.1, 1.1, 1.0, 1.0, 1.0, 1.0.

**Variation.** Length of forewing (mean ± SD, n = 10) 2.06–3.01 (2.59 ± 0.43) mm in females, 2.69–3.02 (2.84 ± 0.11) mm in males; length of hind tibia 0.50–0.75 (0.65 ± 0.11) mm in females, 0.74–0.81 (0.78 ± 0.02) mm in males; marginal cell of forewing 4.28–4.55 (4.30 ± 0.30) times as long as broad in males; 4.38–4.55 (4.30 ± 0.30) times as long as broad in males.

**Remarks.** In dorsal view, notaule appear to be absent; in lateral view, notaule appear to be present, indicated by anterior pits (Fig. 3e).

**Gall.** Gall oval, pale green, or yellowish brown, 1.5–2.0 mm in diameter and 2.0–2.5 mm in height, usually clustered, induced in sprout of Q. (C.) glauca (Fig. 5c).

**Etymology.** Named after its host plant [arakashi = Q. (C.) glauca in Japanese, phagus = eating in Greek].

**Diagnosis.** Cycloneuroterus arakashiphagus resembles C. liungi, C. formosanus, C. fortuitusus, and C. hisashii in having dark brown to black body, but differs from them as follows: Mesoscutum smooth in C. liungi, C. formosanus, and C. hisashii, but slightly imbricate in C. arakashiphagus. In females, POL is longer than OOL in C. liungi and C. fortuitusus but POL shorter than OOL in C. arakashiphagus. Ventral margin of clypeus incised mediately in C. formosanus, C. fortuitusus and C. hisashii, but not incised in C. arakashiphagus.

**Host Plant.** Quercus (Cyclobalanopsis) glauca.

**Geographic Distribution.** Japan: Honshu, Shikoku, Kyushu. The gall was recorded from Honshu and Shikoku by Yakawa and Masuda (1996).

**Biological.** According to Yakawa and Masuda (1996), the life cycle of this new species can be summarized as follows: The gall of the sexual generation (fig. C-054, Japanese name: kashi-wakame-ko-mure-tama-fushi) appears in early April at the same time as the bud burst of the host plant. The adult of the sexual generation emerges from the mature gall in middle April. The female adult lays eggs in the veins of underside of young leaves. The gall of the asexual generation (fig. C-059, Japanese name: kashi-ha-tsu-tama-fushi) begins to appear on the leaf veins in early June. After maturity, the asexual generation gall falls to the ground. The adult of the asexual generation is unknown.

**Cycloneuroterus fortuitusus** Tang et Melika (Fig. 4)

**Material Examined.** Four females and 10 males, Kitayama, Kofu City, Yamanashi Prefecture, Japan, 20-IV-1992, H. Masuda leg. Two females, Mt. Sakurei, Saga Prefecture, Japan, 20-IV-1992, H. Masuda leg. Two females, 19-IV, H. Masuda leg. Two females, Mt. Sakurei, Saga Prefecture, Japan, 19-IV-2009, Y. Abe and T. Ide leg., emerged late April, 2009. Two females, same place and collectors, 29-IV-2009, emerged early May 2009.

**Depository of Specimens.** BLKU and KUM.
Fig. 4. Sexual female of *C. fortitonus* (Japanese population). (a) Head, anterior view (scale bar = 100 μm); (b) Head, dorsal view (scale bar = 100 μm); (c) Mesosoma, dorsal view (scale bar = 100 μm); (d) Mesosoma, posterodorsal view (scale bar = 100 μm); (e) Mesosoma, lateral view (scale bar = 200 μm); (f) Metasoma, lateral view (scale bar = 200 μm); (g) Hypopygial spine, ventral view (scale bar = 100 μm); (h) Right forewing scale (scale bar = 500 μm).
lomeres is considered to occur infrequently (Abe 1998). Therefore, we consider that the difference in the number of flagellomeres in female wasps between the two populations of this species does not have a taxonomic value. In dorsal view, notauli appear to be absent; in lateral view, notauli appear to be present, indicated by anterior pits (fig. 63 in Tang et al. 2011b; Fig. 4e). Setae on the prominent part of hypopygial spine do not extend beyond the apex of spine in the Taiwanese population (Tang et al. 2011b), but some setae extend beyond it in the Japanese population (Fig. 4g).

Gall. Tang et al. (2011b) report: “The gall of *C. fortuitusus* resembles the gall morphotypes of indet. cynipids showed on pictures C-053 and/or C-054 in Yukawa and Masuda (1996)”, but adults of *C. fortuitusus* emerge from the oval gall induced in the base of a young shoot of *Q. (C.) glauca* (fig. C-053 in Yukawa and Masuda (1996); Fig. 5d). Thus, we regard the gall in fig. C-053 as the gall induced by *C. fortuitusus*.

**Geographic Distribution.** Japan (first record): Shikoku, Kyushu. The gall was recorded from Shikoku by Yukawa and Masuda (1996). Taiwan: Taitung County, Donghe Township (Tang et al. 2011b).

**Key to species of *Cycloneuroterus***

1. Head, mesosoma, and metasoma dark brown to black .............................................. 2
   - Head black to dark brown with yellow lower face; mesopleuron yellow or light brown; metasoma light brown to black ........................................... 6
2. Ventral margin of clypeus not incised medially (Fig. 3a) ............................................. 3
   - Ventral margin of clypeus incised medially (Figs. 1a, 2a, 4a) .................................... 4
3. POL longer than OOL in females; mesoscutum, scutellum, and mesopleuron smooth in females and males ................................................................. *C. lilungi* Tang, Melika et Yang
   - POL shorter than OOL in females (Fig. 3b); mesoscutum, scutellum, and mesopleuron slightly imbricate in females and males (Fig. 3c, e) ........................................... *C. arakashiphagus* Ide, Wachi et Abe sp. nov.
4. Posterior margin of scutellar fovea with foveolate line ........................................... *C. formosanus* Tang et Melika
   - Posterior margin of scutellar fovea without foveolate line ........................................ 5
5. Inner margins of compound eyes parallel (Fig. 4a) .................................................. *C. fortuitusus* Tang et Melika
   - Inner margins of compound eyes converging ventrally (Fig. 2a) ............................... *C. hisashii* Ide, Wachi et Abe sp. nov.
6. Ventral margin of clypeus incised medially (Fig. 1a); mesoscutum with row of setae indicating trace of notaulus (Fig. 1c); posterior margin of scutellar fovea without clear border to rest of scutellum (Fig. 1c) ........................................... *C. akagashiphilus* Ide, Wachi et Abe sp. nov.
   - Ventral margin of clypeus not incised medially; mesoscutum without rows of setae indicating trace of notaulus (Fig. 1c); posterior margin of scutellar fovea with clear border to rest of scutellum (Fig. 1c) ................................. *C. akagashiphilus* Ide, Wachi et Abe sp. nov.

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Fig. 5. Galls of four species of *Cycloneuroterus* on *Cyclobalanopsis* (the arrows indicate the galls). (a) A cluster of galls of *C. arakashiphagus* induced on a leaf of *Q. (C.) acuta* (bud scales are removed to show a gall containing many larval chambers); (b) A cluster of galls of *C. akagashiphilus* induced on two sprouts of *Q. (C.) acuta*; (c) Two clusters of galls of *C. fortuitusus* induced on two sprouts of *Q. (C.) glauca* (bud scales are removed to show two galls).
traces of notaularis, posterior margin of scutellum fovea with clear border to rest of scutellum... 7

7. POL shorter than OOL; marginal cell 5.0 times as long as broad; metasoma dark brown to black. ............................ 7
- POL longer than OOL; marginal cell 3.5 times as long as broad; metasomal tergum II light brown, subsequent terga slightly darker. ............................ C. lironchiaeua Melika et Tang

Discussion

Here, we describe three new species of Cycloneuroterus and first record C. fortuitusus from Japan. The three new species are gall inducers on the strictly Asian subgenus Cyclobalanopsis in Japan, and C. fortuitusus on Q. (C.) glauca was described from Taiwan (Tang et al. 2011b). The remaining four species of Cycloneuroterus have been recorded from Taiwan, and three of them depend on Cyclobalanopsis other than Q. (C.) glauca (Tang et al. 2011b). Japan is located at the northern and eastern edge of the distribution range of this plant subgenus (Govaerts and Frodin 1998). Because trees of Cyclobalanopsis are abundant in Asia, the geographical range of Cycloneuroterus may be extensive in the region. In Japan, Q. (C.) glauca is at present the known host plant of five cynipid species: C. hisashii; C. arakashiphagus; C. fortuitusus; Plagiotrochus nasudai Ide, Wachi et Abe; and C. toensiss (Ide et al. 2010. Abe et al. 2011, current study). However, in Taiwan, Plagiotrochus glaucus Melika et Tang and C. fortuitusus also induce galls on this plant (Tang et al. 2011a, b). Because Q. (C.) glauca is distributed widely from Japan to the Himalayas and Vietnam (Govaerts and Frodin 1998), it may support other cynipid species in regions other than Japan and Taiwan. This is the first record of Q. (C.) acuta as the host plant of an oak gall wasp. As suggested previously by Abe et al. (2007), the findings presented in Ide et al. (2010), Abe et al. (2011), Tang et al. (2011a, b) and this paper support the existence of potentially diverse cynipid fauna associated with Cyclobalanopsis in Asia. More extensive sampling of galls and wasps from Cyclobalanopsis is expected to reveal the species richness of oak gall wasps in Asia.

Although numerous gall wasp genera are highly host specific, some species of Andricus and Callirhytis exhibit heteroecy where one generation is obligatorily dependent upon the section Cerris and the other on the section Quercus (Askew 1984, Liljeblad and Ronquist 1998). Heteroecy may occur in Cyclobalanopsis galling species of gall wasps (Abe et al. 2007). However, although the galls of the asexual generation of C. arakashiphagus and C. fortuitusus on Q. (C.) glauca have been illustrated by Yukawa and Masuda (1996), clarification of the asexual generation of the other five species of Cycloneuroterus is crucial for assessing the likelihood of heteroecy involving Cyclobalanopsis.

Morphological similarity among the adults of the sexual generation may indicate that Cycloneuroterus, Neuroterus, Cerroneuroterus, and Trichagalma are closely related. The adults of the asexual generation of some species of the latter three genera have been described previously (Ashmead 1904, Abe 2006, Melika 2006, Melika et al. 2010). However, the adults of the asexual generation of Cycloneuroterus currently are not known. On the basis of the adult morphology of both the asexual and sexual generations, a phylogenetic study including the four genera may corroborate the close relationship between these taxa in the future but it may do the contrary, certainly.

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