

ORIGINAL ARTICLE

New species of gallwasps inducing in *Quercus fabri* and its inquiline (Hymenoptera: Cynipidae) in China

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Abstract New species of gallwasps, *Andricus flavus* **sp. nov.**, and its inquiline related to its gall, *Saphonecrus fabris* **sp. nov.** are described. Both species are included and illustrated their distribution and biology here. The type materials are deposited in the Parasitic Hymenoptera Collection, Zhejiang Agricultural and Forest University, Lin'an, China, and University of Barcelona Barcelona, Spain.

Key words Cynipidae, *Andricus*, *Saphonecrus*, taxonomy, biology, China.

1 Introduction

Species of the family Cynipidae (Hymenoptera) are exclusively phytophagous. Tribe Cynipini, the most important group of cynipids, make galls on Fagaceae, while species of another tribe Synergini inquiline on these galls. Inquilines have retained the ability to modify the gall tissue directly surrounding them into the characteristic nutritive tissue but they have lost the ability to induce the gall. However, few inquiline species are mentioned as gallforming (Abe *et al.*, 2011; Liu *et al.*, 2012; Bernardo *et al.*, in press). Phylogenetic analyses indicated that cynipid inquilines have evolved from gall-making ancestors (Ronquist, 1994; Ronquist & Liljeblad, 2001). In this work, we describe a species of Cynipini and a species of Synergini from China.

The cynipid gallwasp fauna of the Eastern Palaearctic and Oriental Regions is poorly known. The tribe Cynipini includes more than 1 000 species (Melika, 2006) in more than 30 genera. Genus *Andricus* is represented by 15 species in the Eastern Palaearctic and Oriental Regions, respectively (Abe *et al.*, 2007; Tang *et al.*, 2009, 2011, 2012), but only four of them are mentioned from mainland of China: *A. mairei* (Kieffer, 1906), *A. pseudoflos* (Monzen, 1854), *A. targionii* Kieffer, 1903 and *A. xishuangbannaus* Melika & Tang, 2012. All of these species are characterized to found galls on leaves of *Quercus*.

The inquiline gallwasp fauna of the Eastern Palaearctic and Oriental Regions is also poorly known. Synergini includes about 100 species (Melika, 2006) in nine genera. *Saphonecrus* Dalla, Torre & Kieffer, 1910 is represented by 24 species distributed in the northern hemisphere (Wang *et al.*, 2010; Liu *et al.*, 2012) but only four species reported from China: *S. flavitibilis* Wang, Chen & Pujade-Villar, *S. tianmushanus* Wang, Chen & Pujade-Villar, *S. sinicus* Belizin, 1968 and *S. hupingshanensis* Liu, Yang & Zhu, 2012. The systematic status of the genus has been considered to be in need of revision for a long time (Pujade-Villar & Nieves-Aldrey, 1990; Pujade-Villar *et al.*, 2003; Melika, 2006; Penzes *et al.*, 2009), and a recently phylogenetic study indicated the genus to be paraphyletic based on sequence data (Acs *et al.*, 2010).

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The revision is not formally published, and we report a new species of *Saphonecrus* according to the current definition of the genus in this paper.

2 Materials and methods

All the specimens from China used in this study are from the Hymenoptera Collection, Zhejiang Agricultural and Forest University, Lin'an, China (ZAFU). Type specimens are separately deposited in ZAFU and University of Barcelona (UB).

Terminology of cynipid gallwasp morphology follows Liljeblad and Ronquist (1998) and Melika (2006). Abbreviations for the forewing venation follow Ronquist and Nordlander (1989), cuticular surface terminology follows Harris (1979). Measurements and abbreviations used here include: F1–F12, first and subsequent flagellomeres; post-ocellar distance (POL) is the distance between the inner margins of the posterior ocelli; ocellar–ocular distance (OOL) is the distance from the outer edge of the posterior ocellus to the inner margin of the compound eye; LOL, the distance between lateral and frontal ocelli. The width of the forewing radial cell was measured from the margin of the wing to the Rs vein.

Descriptions and measurements were made under a Leica MZ 12.5 stereomicroscope (Wetzlar, Germany), and optical photos taken by a digital camera (Q-Imaging, Micropublisher 3.3 RTV) attached to a Leica MZ APO stereomicroscope (Wetzlar, Germany) using Synoptics Auto-Montage version 5.0 software. The tarsal claws were photographed using a field-emission gun environmental scanning electron microscope (FEI Quanta 200 ESEM) for high-resolution imaging without gold-coating of specimens.

3 Taxonomy

3.1 *Andricus flavus* sp. nov. (Figs 1–11)

Holotype ♀, deposited in ZAFU, China, Zhejiang, Tianmushan (119°27'E, 30°19'N), 8 May 2010, Rui Guo, collected from gall reared in lab. Paratype 1♀, deposited in UB with same label as holotype.

Description. Length: female 1.6 mm; male unknown.

Color. Head dark yellow, except for mandibles blackish brown apically (teeth); antennae yellowish; mesosoma chestnut with some areas darker; legs yellowish, with fore tibia brown dorsally; metasoma dark red dorsally; hypopygium pale yellow. Wing veins brown.

Head (Figs 1–2). Head trapezoidal in front view, coriaceous bellow toruli, with sparse white setae, 2.4 times broader than long from dorsal view, 1.4 times broader than high and slightly narrower than mesosoma in front view. Gena delicately coriaceous, slightly broadened behind eye. Malar space coriaceous, with dense setae and without irradiating striae, 0.3 times as long as height of eye. POL: OOL: LOL = 5.5: 3.0: 3.0 and lateral ocellus 2. Diameter of antennal toruli 0.3 times larger than distance between them, distance between torulus and inner margin of eye 0.6 times diameter of torulus; lower face coriaceous, with evenly dense white setation. Transfacial line equal to height of eye. Clypeus trapezoid, wider than high, emarginate, without median incision ventrally, glabrous; anterior tentorial pit deep and large, the epistomal sulcus and clypeo-pleurostomal line distinctly deep. Frons alutaceous and shining, with sparse white setae medially and dense laterally; interocellar area weakly rugosed and with sparse white setae. Vertex and occiput uniformly coriaceous.

Antenna (Fig. 7). Antenna with 14 segments, slightly longer than mesosoma; F1 1.3 times as long as F2, and 1.4 times as long as pedicel; F2 and following segments similar in length. Antennal formula: 4.0: 2.8: 4.0: 3.0: 3.0: 3.0: 3.0: 3.0: 2.8: 2.8: 2.5: 3.0. Placodella sensillas present from F2.

Mesosoma (Figs 2–4, 8). Mesosoma strongly convex, with long white setae. Pronotum coriaceous, with dense white setae, laterally with distinctly transversal striate and dense white setae. Mesonotum smooth and shiny, anteriorly coarsely coriaceous around notauli except for notauli rugosed, with sparse long setae and denser along notauli. Notauli complete, deeply impressed and wide, strongly converging at posterior end; anterior parallel lines inconspicuous but visible, extending to 1/2 of entirely length of mesosoma; parapsidal lines defined, narrow and reaching the tegula level; median



Figs 1–11. *Andricus flavus* **sp. nov.**, female. 1. Head, frontal view. 2. Head and anterior part of mesoscutum, dorsal view. 3. Mesosoma, dorsal view. 4. Head and mesosoma, lateral view. 5. Forewing. 6. Metasoma, lateral view. 7. Antenna. 8. Metanotum and propodeum. 9–11. Galls.

mesoscutal line absent. Mesoscutellum rounded, broader in posterior 3/4, longer than broad, overhanging metanotum very slightly, uniformly dull, rugose, with irregular strong rugae, areas between rugae alutaceous and shiny; scutellar foveae slightly ovate, transverse, occupying 1/4 of length of mesoscutellum, separated by a median carina, bottom smooth; mesopleuron smooth and shining, with sparse setae dorsally and ventrally. Metapleural sulcus reaching mesopleuron in the upper around 4/5 of entirely mesopleuron height, area delimited by the inferior and superior parts of metapleural sulcus, with dense white setae; lateral propodeal carinae distinct, divergent in the anterior part but curved outwards in posterior third, rugose inside; lateral propodeal area alutaceous to smooth and shiny, with dense, long and white setae.

Legs. Tarsal claws with basal lobe.

Forewing (Fig. 5). Forewing longer than body, hyaline, with short and dense ciliation along margin, radial cell around 3.2 times as long as its maximum width; vein R1 nearly straight, vein Rs not reaching wing margin and for a short distance following margin; areolet inconspicuous, small, triangular and closed. Vein 2r weakly curved. Vein Rs+M short and only visible basally.

Metasoma (Fig. 6). Metasoma slightly shorter than head+mesosoma, distinctly longer than its high in lateral view; 2nd metasomal tergite occupying to 1/3 of entirely metasoma in dorsal view, with sparse setae laterally in the anterior part, smooth and shiny all subsequent tergites punctured dorsally. Ventral spine of hypopygium very long, prominent part 3.2 times longer than broad, with some white subapical setae not extending beyond apex of spine, with dense long setae ventrally.

Gall (Figs 9–11). Individual galls, approximately spherical, usually locate on the underside of leaves. They are independent never in clusters. The young gall is juicy and freshly green, covered with small raised tubercles on the surface. With the gall development, it becomes brown or grey with a tough woody wall, and reaches approximately 2.0–3.0 mm in diameter. The gall turns dry and dark brown when mature. The mature gall contains outer gall tissues and inner, fully larval chambers. The interior space contains about 4–5 larval chambers with 0.5–0.7 mm in diameter.

Biology. Only the sexual generation is known, inducing twigs galls on *Quercus fabri* Hance. Galls appear on the host plant from early April. Mature galls were collected in early May, adults emerging immediately after the galls were collected.

Distribution. China: Zhejiang (Tianmushan).

Etymology. The name is related with its body color.

Diagnosis. *Andricus flavus* **sp. nov.** morphologically resembles *A. xishuangbannaus* Melika & Tang from China, *A. moriokae* Monzen from Japan, and *A. formosanus* Tang & Melika, *A. pseudocurvator* Tang & Melika and *A. songshui* Tang & Melika from Taiwan. In *A. flavus* **sp. nov.** the female has 12 flagellomeres as *A. formosanus* and *A. xishuangbannaus* (11 flagellomeres in the other species, sometimes with a indistinct suture in F11 in *A. pseudocurvator*), flagellomeres with dense white setae as *A. formosanus* (with few sparse short white setae in the rest of species), 2nd metasomal tergite with very few setae antero-laterally as *A. moriokae* (2nd metasomal tergite with numerous setae antero-laterally in others), the forewing without areolet as *A. moriokae* (with a distinct areolet in others), the ventral spine of the hypopygium around 3 times as long as wide as *A. formosanus* (shorter in *A. moriokae* and longer in *A. xishuangbannaus*, *A. pseudocurvator* and *A. songshui*). However, the new species differs of all mentioned species on color (dark yellow in *A. flavus* **sp. nov.** but dark brown to black in others), and in sculpture of mesoscutum smooth and shiny, anteriorly coarsely coriaceous around notauli in *Andricus flavus* **sp. nov.** (alutaceous to smooth, especially in between notauli, shining in *A. xishuangbannaus*, *A. formosanus* and *A. pseudocurvator*; and uniformly sculptured in *A. moriokae* and *A. songshui*). Both Chinese species also differs in anterior parallel and parapsidal mesoscutal lines (present in *A. flavus* **sp. nov.** absent in *A. xishuangbannaus*), radial cell (around 3 times as long as broad in *A. flavus* **sp. nov.**, 4 times in *A. xishuangbannaus*), in prominent part of ventral spine of hypopygium (around 3.0 times longer than broad in *A. flavus* **sp. nov.**, 4 times in *A. xishuangbannaus*) and in host (*Q. fabri* in *A. flavus* **sp. nov.**, *Q. griffithii* in *A. xishuangbannaus*).

3.2 *Saphonecrus fabris* **sp. nov.** (Figs 12–19)

Holotype ♀, deposited in ZAFU, China, Zhejiang, Tianmushan (119°27'E, 30°19'N), 31 October 2011, Rui Guo. Paratypes 5♀, same data as holotype (1♀ deposited in UB).

Description. Length: female 1.2–1.5 mm; male unknown.

Color. Head and mesosoma chesnut, darker in some areas; mandibles brownish red with dark brown tips, maxillae and labium yellow; antennae and legs yellowish; metasoma dark red, chestnut collar around the distal part of the petiole;



Figs 12–19. *Saphonecrus fabris* **sp. nov.**, female. 12. Head, frontal view. 13. Head, dorsal view. 14. Head and mesosoma, lateral view. 15. Metasoma, lateral view. 16. Forewing. 17. Mesosoma, dorsal view. 18. Antenna. 19. Tarsal claw.

hypopygium pale red. Wing veins pale yellow.

Head (Figs 12–14). Subquadrate in frontal view, around 1.1 times as broad as high and slightly broader as mesosoma, with sparse short white setae. Gena alutaceous and shiny, not broadened behind compound eye. Clypeus inconspicuous, anterior tentorial pits distinct but small; epistomal sulcus and clypeo-pleurostomal lines indistinct. Lower face shiny, with delicate carinae radiating from clypeus, reaching ventral margin of eye and antennal socket. Transfacial 1.15 times as long as height of eye. Malar space 0.8 times as long as height of compound eye. Distance between inner margin of compound eye and antennal socket equal to diameter of antennal socket. Head in dorsal view 2.3 times as wide as long. POL: OOL: LOL=5: 3: 2, diameter of lateral ocellus 1.25. Frons vertex and occiput uniformly alutaceous and shiny, frontal carinae absent.

Antenna (Fig. 18). Antenna 13-segmented, pedicel nearly 2.0 times as long as its broad; F1 1.2 times as long as F2, 1.5 times as long as pedicel; F3 to F5 equals in length, F4 and followings broader than first flagellomeres segments; F11 around 2.0 times as long as F10. The antennal formula: 19: 14: 24: 18: 19: 19: 18: 17: 16: 15: 15: 14: 26. Placodea sensillas present from F4.

Mesosoma (Figs 14, 17). Mesosoma 1.1 times as long as high in lateral view uniformly pubescent with short white setae. Pronotum coriaceous dorsally, with some carinae laterally; pronotal carina present. Mesoscutum nearly as long as broad in dorsal view, with weakly interrupted transversal rugae, interspaces between rugae coriaceous. Notauli complete, wide and deep, slightly broader posteriorly and narrowed down anteriorly; anterior parallel line, median mesoscutal line and parapsidal lines absent. Mesopleuron shiny with conspicuous transverse striate. Scutellum slightly wider than long, rugose; scutellar foveae superficial, bottom shiny and smooth, separated by a carina. Metapleural sulcus reaching mesopleuron in upper 4/5 of its height. Propodeum pubescent, alutaceous and shiny; lateral propodeal carinae straight, slightly convergent inferiorly; central propodeal area alutaceous, with short white setae.

Legs (Fig. 19). Tarsal claws simple and without basal lobe.

Forewing (Fig. 16). Forewing margin ciliated; radial cell opened, 2.7–2.8 times as long as wide; areolet inconspicuous; Rs vein only lightly curved apically, not reaching the margin wing as vein R1; vein R1+Sc hardly interrupted before reaching basal vein.

Metasoma (Fig. 15). As long as head+mesosoma, longer than high in lateral view. The fused metasomal tergites second and third with short white setae antero-laterally, without punctuate apically and very slightly incised apically; hypopygium with very minute dense punctures, ventral ridge with short white setae, prominent part of ventral spine of hypopygium short.

Etymology. The name is related with host plant scientific name, *Q. fabri*.

Distribution. China (Zhejiang).

Biology. Obtained from leaf galls induced by *Andricus flavus* on *Q. fabri*. Under the laboratory conditions, adults emerged from late September.

Diagnosis. This new species is characterized by the following characters: malar space long, lateral frontal carinae absent, lateral pronotal carinae present, mesoscutum with distinct short irregular transverse striate, notauli percurrent, mesopleura completely carinated, radial cell longer and tarsal claws simple. Morphologically, *S. fabris* **sp. nov.** is similar to *S. haymi* but different from latter by having a quadrangular head, notauli percurrent and tarsal claws simple. Only three species have simple tarsal claws in this genus *Saphonecrus* (*S. excisus* (Kieffer, 1904) from India-Bengal, *S. areolatus* Weld, 1926 from Philippines and *S. serratus* Weld, 1926 from Philippines) but the pronotal carinae is absent in these species. Moreover, *S. serratus* has frontal carinae, *S. areolatus* has punctures dorso-posteriorly of metasomal terga 3 + 4 and *S. excisus* has the metasoma incised dorsally.

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References

- Abe, Y., Melika, G. and Stone, G. N. 2007. The diversity and phylogeography of cynipid gallwasps (Hymenoptera: Cynipidae) of the Oriental and Eastern Palaearctic Regions, and their associated communities. *Oriental Insects*, 41, 169–212.

- Abe, Y., Ide, T. and Wachi, N. 2011. Discovery of a new gall-inducing species in the Inquiline tribe Synergini (Hymenoptera: Cynipidae): inconsistent implications from biology and morphology. *Annals of the Entomological Society of America*, 104: 115–120.
- Acs, Z., Challis, R. J., Bihari, P., Blaxter, M., Hayward, A., Melika, G., Csoka, G., Penzes, Z., Pujade-Villar, J., Nieves-Aldrey, J.-L., Schönrogge, K. and Stone, G. N. 2010. Phylogeny and DNA barcoding of inquiline oak gallwasps (Hymenoptera: Cynipidae) of the Western Palaearctic. *Molecular Phylogenetics and Evolution*, 55: 210–225.
- Bernardo, U., Gebiola, M., Xiao, Z., Zhu, D., Pujade-Villar, J. and Viggiani, G. 2013. Description of *Synergus castaneus* n. sp. (Hymenoptera: Cynipidae: Synergini), associated with an unknown gall on *Castanea* spp. (Fagaceae) in China. *Annals of the Entomological Society of America*, (in press).
- Harris, R. 1979. A glossary of surface sculpturing. State of California, department of food and agriculture. *Occasional Papers of Entomology*, 28: 1–31.
- Liljeblad, J. and Ronquist, F. 1998. A phylogenetic analysis of higher-level gall wasp relationships (Hymenoptera: Cynipidae). *Systematic Entomology*, 23: 229–252.
- Liu, Z., Yang, X-H, Zhu, D-H and He, Y-Y 2012. A new species of *Saphonecrus* (Hymenoptera, Cynipoidea) associated with plant galls on *Castanopsis* (Fagaceae) in China. *Annals of the Entomological Society of America*, 105(4): 555–561.
- Melika, G. 2006. Gall wasps of Ukraine. Cynipidae. *Vestnik Zoologii*, Suppl. 21: 1–644.
- Penzes, Z., Melika, G., Bozsoki, Z., Bihari, P., Miko, I., Tavakoli, M., Pujade-Villar, J., Feher, B., Fulop, D., Szabo, K., Bozso, M., Sipos, B., Somogyi, K. and Stone, G. 2009. Systematic reappraisal of the gall-usurping wasp genus *Synophrus* Hartig, 1843 (Hymenoptera: Cynipidae: Synergini). *Systematic Entomology*, 34: 688–711.
- Pujade-Villar, J., Melika, G., Ros-Farre, P., Ács, Z. and Csoka, G. 2003. Cynipid inquiline wasps of Hungary, with taxonomic notes on the Western Palaearctic fauna (Hymenoptera: Cynipidae, Cynipinae, Synergini). *Folia Entomologica Hungarica*, 64: 121–170.
- Pujade-Villar, J. and Nieves-Aldrey, J. L. 1990. Revisión de las especies europeas del género *Saphonecrus* Dalla Torre y Kieffer, 910 (Hym., Cynipidae, Cynipinae). *Butlletí de la Institució Catalana d'Història Natural* (Ser. Zool.), 58: 45–55.
- Ronquist, F. 1994. Evolution of parasitism among closely related species: phylogenetic relationships and the origin of inquilinism in gallwasps (Hymenoptera, Cynipidae). *Evolution*, 48: 241–266.
- Ronquist, F. and Liljeblad, J. 2001. Evolution of the gall wasp: host plant association. *Evolution*, 55: 2503–2522.
- Ronquist, F. and Nordlander, G. 1989. Skeletal morphology of an archaic cynipoid, *Ibalia rufipes* (Hymenoptera: Ibalidae). *Entomological Scandinavica* (supplement), 33: 1–60.
- Tang, C-T, Melika, G., Yang, M-M, Nicholls, J. A., Csoka, Gy. and Stone, G. N. 2009. First record of an oak gall wasp from the Oriental Region: new species of *Andricus* (Hymenoptera: Cynipidae: Cynipini) from Taiwan. *Zootaxa*, 2175, 57–65.
- Tang, C-T, Melika, G., Yang, M-M, Nicholls, J. and Stone, G. N. 2011. New species of oak gall wasps from Taiwan (Hymenoptera: Cynipidae: Cynipini). *Zootaxa*, 2865, 37–52.
- Tang, C-T, Sinclair, F., Yang, M-M and Melika, G. 2012. A new *Andricus* Hartig oak gallwasp species from China (Hymenoptera: Cynipidae: Cynipini). *Journal of Asia-Pacific Entomology*, 15: 601–605.
- Wang, Y-P, Chen, X-X, Pujade-Villar, J., Wu, H and He, J-H 2010. The genus *Saphonecrus* Dalla Torre et Kieffer, 1910 (Hymenoptera: Cynipidae) in China, with descriptions of two new species. *Biologia*, 65(6): 1034–1039.