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Taxonomy of *Sierola* Cameron (Hymenoptera, Bethylidae) from China with three new species

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Abstract

The genus *Sierola* Cameron, 1881 (Hymenoptera, Bethylidae) from China is revised for the first time and three new species, i.e., *S. brevicaputa* **sp. nov.**, *S. limatulifascia* **sp. nov.**, and *S. leleji* **sp. nov.** are described. A key to the Oriental species is provided.

Keywords

Bethylinae, Chrysidoidea, *Haplochrois theae*, Oriental region

Introduction

The genus *Sierola* Cameron, 1881 belongs to the subfamily Bethylinae (Hymenoptera: Bethylidae). It is the largest genus in Bethylinae with 250 species and subspecies known to the world (Fullaway 1920, 1934; Gordh and Móczár 1990; Gordh 1998; Terayama 2004, 2006; Ward 2013; Santhosh 2017; Azevedo et al. 2018; Magnacca 2019, 2020). This genus is very similar to *Goniozus* Förster, 1856 in having suture of

metapectal-propodeal disc and dentate process of mesopectus absent, but can be distinguished from the latter by having $2R1_2c$ of forewing closed.

According to Gordh (1998), this genus may originate in Asia, and then invaded the Hawaiian Islands within the past few million years and radiated rapidly. Till now 214 species of this genus have been recorded from Hawaiian Islands, however, only one species, *Sierola sinensis* Fullaway, 1920, is known from China. In this paper, another three new species found in China are described. According to the label attached to the specimens, all the new species are parasitoids of *Haplochrois theae* (Kusnezov, 1916) (Lepidoptera, Elachistidae), which is a pest on tea plantations.

Materials and methods

Specimens examined in this study are deposited in the Institute of Insect Sciences, Zhejiang University, Hangzhou (**ZJUH**).

A Nikon stereomicroscope (SMZ800N) was used for observation. We used digital microscope Keyence (VHX-7000) to gain the photographs. Then edited them with the help of Adobe Photoshop CC 2018. The morphological terms follow Lanes et al. (2020) and the setation of forewing follows Magnacca (2020).

The methods as well as abbreviations for biometric measurements are as follows: **AOL** width between anterior and posterior ocellus, measured as minimum length in frontal view. **DAO** diameter of anterior ocellus, measured in frontal view. **DEV** distance between supra-ocular line and vertex crest in frontal view. **DH** maximum depth of the head in lateral view. **DT** depth (height) of the thorax, measured in lateral view from between the meso-and metacoxa ventrally to the dorsal surface of the mesonotum. **LE** maximum length of eye in lateral view. **LH** length of head, measured in lateral view, from apex of clypeus to vertex. **LT** length of the mesosoma excluding the pronotal collar. **OOL** shortest distance from a posterior ocellus to nearest eye margin. **POL** posterior ocellus line, measured as minimum width between posterior ocelli in frontal view. **WF** width of frons, measured in frontal view, its minimum width. **WH** width of head, measured in frontal view, its maximum width including eyes. **WOT** width of ocellar triangle, measured in frontal view, maximum width including ocelli.

Taxonomy

Sierola Cameron, 1881

Sierola Cameron 1881: 556. Type species: *Sierola testaceipes* Cameron, 1881.
Lelejola Gorbatovsky, 1998: 680. Type species: *Sierola ashmeadi* Gorbatovsky, 1995. Synonymized by Terayama, 2006: 235.

Diagnosis. Antenna with 11 flagellomeres; notauli absent; pre-and pterostigma large; forewing with five closed cells.

Biology. The *Sierola* species are parasitoids of lepidopterous larvae, e.g., Batrachedridae, Cosmopterigidae, Gelechiidae, Gracillariidae, Pyraustidae, Tineidae, Tortricidae (Azevedo et al. 2018) and Elachistidae (current data).

Distribution. 253 species as well as subspecies, including the new species described in this paper, are known to world, mainly distributed in circum-Pacific belt (Table 1).

Key to the Oriental *Sierola* species

1 Metapostnotum with basal smooth triangular area **2**
– Metapostnotum without basal smooth triangular area **3**
2 Vertex crest slightly incurved; gena smooth and polished; antenna distinctly longer than head in frontal view; mandible yellow .... ***S. nasseri*** **Santhosh, 2017**
– Vertex crest outcurved; gena weakly coriaceous; antenna as long as head in frontal view; mandible black ..... ***S. narendrani*** **Santhosh, 2017**
3 Transverse posterior carina of metapectal-propodeal disc present **4**
– Transverse posterior carina of metapectal-propodeal disc absent **5**
4 WH/LH = 0.83; metapostnotum with smooth median longitudinal stripe medially; metapectal-propodeal disc 0.85 × wide .. ***S. indra*** **Terayama, 2004**
– WH/LH = 0.89; metapostnotum without smooth median longitudinal stripe medially; metapectal-propodeal disc 0.68 × wide ..... ***S. mawarajo*** **Terayama, 2004**
5 DH/LH = 0.61; head about as wide as long, WH/LH = 0.96; metapectal-propodeal disc barely half as long as wide..... ***S. brevicaputa*** **sp. nov.**
– DH/LH less than 0.57; head longer than wide, WH at most 0.83 × LH; metapectal-propodeal disc more than 0.70 × wide **6**
6 DH/LH = 0.53; antennomere II about as long as wide; frons with dense setae; sides of head behind eyes converging posteriorly ..... ***S. sinensis*** **Fullaway, 1920**
– DH/LH = 0.56–0.57; antennomere II at least 1.53 × wide; frons with sparse setae; sides of head behind eyes parallel or slightly outcurved **7**
7 Metapostnotum with smooth median longitudinal stripe medially; $R1_2v$ intersect apical portion of Rs_2v at acute angle..... ***S. limatulifascia*** **sp. nov.**
– Metapostnotum without smooth median longitudinal stripe medially; $R1_2v$ intersect apical portion of Rs_2v at right angle ..... ***S. leleji*** **sp. nov.**

Sierola brevicaputa **sp. nov.**

http://zoobank.org/D701BB14-B319-4754-B1EA-FB37F2F86C24

Figure 1

Material examined. ***Holotype*****:** China • ♀; Zhejiang Province, Changshan; 28°54.42'N, 118°31.05'E; Aug. 1980; Sh.J. Yang leg.; No. 202016911.

Description. ***Holotype*****: Female.** Body length = 1.52 mm. ***Color.*** Body light castaneous. Mandible light castaneous, teeth yellowish. Antenna yellow. Legs yellow to

Table 1. Distribution of genus *Sierola*. (The two extinct species from Baltic and Rovno ambers are excluded)

Distribution	Number of species
Hawaiian Islands	214+1
Marquesas Islands	11+2
New Zealand	5
Australia	4
India	3
Japan	2
China	4
Far East Russia	1
Fiji	1
Thailand	1
America	1
Australia & New Zealand	1

light castaneous. Forewing hyaline; veins, prestigma and pterostigma pale yellow nearly colorless. ***Pubescence.*** Body with short sparse setae. Forewing with dense setae; R_2c and $1Cu_2c$ nearly glabrous. ***Head*** (Fig. 1A–C). Head about as wide as long, WH/LH = 0.96; DH/LH = 0.61. Mandible moderately narrow at base, distinctly broader on apical half, ventral margin distinctly concave; not twisted, outwardly coriaceous; apex of mandible vertical, with four equally strong teeth. Median clypeal lobe weakly protuberant with apex rounded; median clypeal carina extending back into frons, not recurved apically in lateral view. Antennal scrobal carina absent. Eye protuberant. Frons and vertex coriaceous with punctures separate more than 2.0 × its own diameter. WF/LE = 1.18; LE/DEV = 1.45. Anterior ocellus distinctly far away from supra-ocular line; POL/AOL = 1.38; OOL/WOT = 1.22; DAO = 0.025 mm. Vertex crest almost straight; sides of head behind eyes rounded. Occipital carina absent. Malar space absent. Gena coriaceous. Head thickened in lateral view (Fig. 1C). ***Mesosoma*** (Fig. 1D, E). DT/LT = 0.41. Pronotum coriaceous; dorsal pronotal area shorter than wide, with shallow punctures; pronotum distinctly sloping in lateral view (Fig. 1E). Mesoscutum coriaceous with shallow sparse punctures; parapsidal signum weak; mesoscutellum coriaceous, mesoscutellar fovea present. Metanotum coriaceous, 0.24 × mesoscutellum. Metapectal-propodeal complex coriaceous; metapectal-propodeal disc half as long as wide; lateral marginal carina complete; prespiracular propodeal depression oblong; anterior metapleural area smooth; metapleural line with three pits. Propleuron coriaceous. Mesopectus coriaceous; subalar impression present; mesopleural pit present; ventral surface of mesopectus with fovea near mesocoxa; mesodiscrimen present as trace. ***Forewing*** (Fig. 1F). Rs_2v 0.97 × Rs&M_2v. ***Metasoma.*** Smooth. Metasomal sternum I with median longitudinal carina; metasomal sterna II–IV with 'V' shaped depression medially.

Male. Unknown.

Etymology. The specific name "*brevicaputa*" is a compound Latin word of "*brevi*" (= short) and "*caput*" (= head) which refers to the head of this species wider than long.

Host. Larvae of *Haplochrois theae* (Kusnezov, 1916).

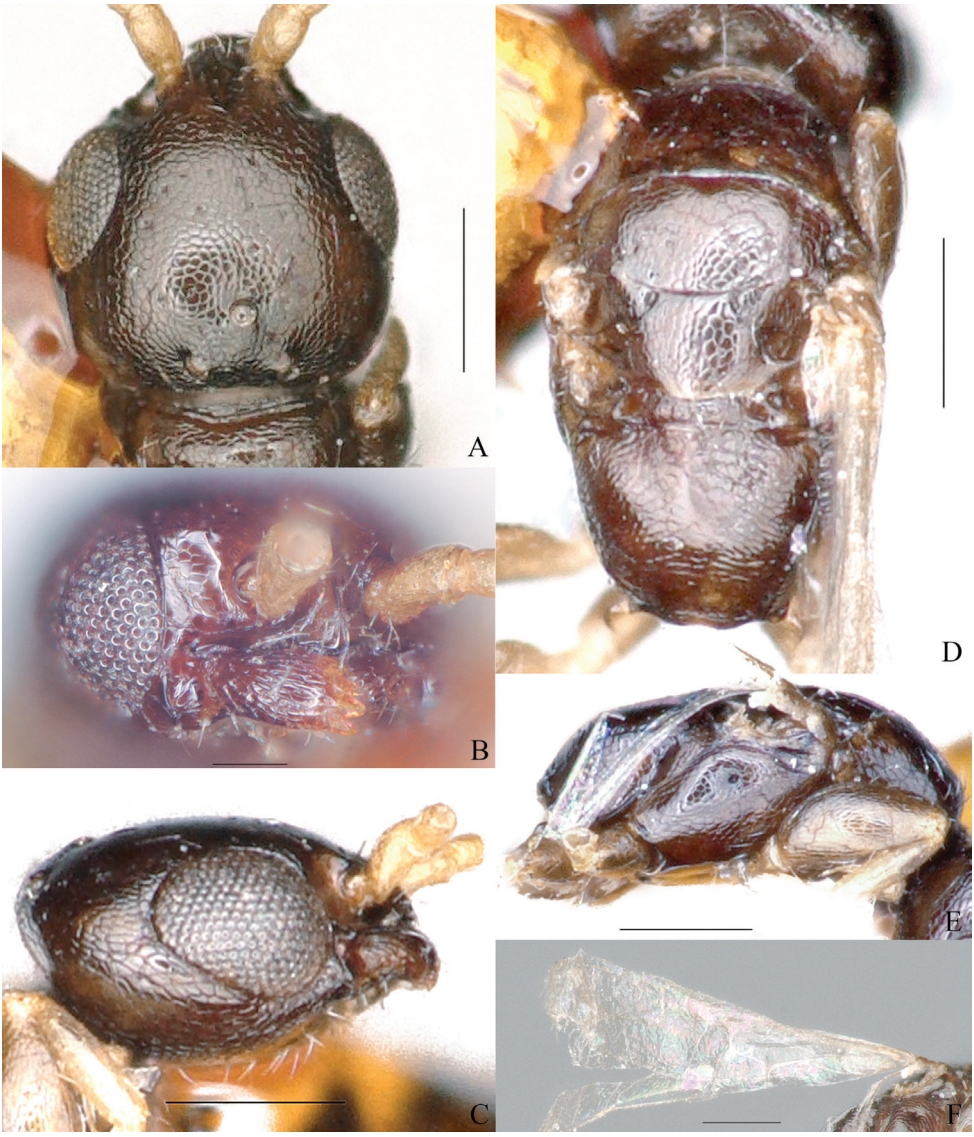

Figure 1. *Sierola brevicaputa* sp. nov., holotype, female **A** head, frontal view **B** mandible **C** head, lateral view **D** mesosoma (except prothorax), dorsal view **E** mesosoma, lateral view **F** forewing. Scale bars: 0.15 mm (**A, C–F**); 0.05 mm (**B**).

Distribution. China (Zhejiang).

Comments. This species can be distinguished from other species of this genus by having head about as long as wide, sides of head behind eyes rounded, pronotum distinctly sloping in lateral view, mesoscutum longer than mesoscutellum, and body light castaneous.

***Sierola leleji* sp. nov.**
http://zoobank.org/B4494476-E24A-4825-BBCD-78EF923B4438
Figure 2

Material examined. ***Holotype*:** China • ♀; Zhejiang Province, Changshan; 28°54.42'N, 118°31.05'E; Aug. 1980; Sh.J. Yang leg.; No. 202016914. ***Paratypes*:** China • 3♀; same collection data as for preceding; No. 202016912, No. 202016913, No. 202016916.

Description. ***Holotype*:** (Fig. 2A). **Female.** Body length = 1.60 mm. Length of forewing = 1.15 mm. ***Color***. Body light castaneous. Mandible light castaneous. Antenna yellow, darker distad. Legs yellow, coxae and femora yellowish castaneous. Forewing hyaline; veins almost colorless; prestigma and pterostigma pale yellowish nearly colorless. ***Pubescence.*** Body cover with short sparse setae, denser in dorsal surface of propleuron and mesopectus. Antenna with dense appressed setae. Forewing with dense setae; R_2c and $1Cu_2c$ with sparse setae. ***Head*** (Fig. 2B–E). Head longer than wide, WH/LH = 0.82; DH/LH = 0.57. Mandible moderately narrow at base, distinctly broader on apical half, ventral margin distinctly concave; not twisted, outwardly coriaceous; apex of mandible vertical, with four equally strong teeth. Median clypeal lobe weakly protuberant with apex rounded; median clypeal carina slightly extending back into frons, not recurved apically in lateral view. Antennomeres II–VI in ratio of 1.63: 0.91: 0.81: 1.03: 1.0 in length and respectively 1.53, 0.94, 0.68, 0.80, 0.80 × wide; antennal scrobal carina absent. Frons and vertex coriaceous with shallow punctures separate 1.5–4.0 × its diameter. Eye protuberant. WF/LE = 1.09; LE/DEV = 1.24. Anterior ocellus distinctly far away from supra-ocular line; POL/AOL = 1.53; OOL/WOT = 1.40; DAO = 0.03 mm. Vertex crest straight; sides of head behind eyes slightly outcurved. Occipital carina absent. Malar space absent. Gena coriaceous; ventral area of gena elevated in lateral view. ***Mesosoma*** (Fig. 2F, G). DT/LT = 0.37. Pronotum coriaceous; dorsal pronotal area shorter than wide, with shallow punctures; pronotum slightly sloping in lateral view. Mesoscutum coriaceous with shallow punctures; parapsidal signum weak; mesoscutellum coriaceous with shallow punctures, mesoscutellar fovea present. Metanotum coriaceous, 0.12 × mesoscutellum. Metapectal-propodeal complex coriaceous; prespiracular propodeal depression oblong; metapostnotum without median shiny longitudinal stripe; lateral marginal carina complete; anterior metapleural area smooth; metapleural line with three pits. Propleuron coriaceous. Mesopectus coriaceous; subalar impression present; mesopleural pits present; ventral surface of mesopectus with fovea near mesocoxa; mesodiscrimen weak. ***Forewing*** (Fig. 2H). Rs_2v 0.85 × Rs&M_2v; $R1_2v$ intersect apical portion of Rs_2v at right angle; length of pterostigma 0.53 × its width. ***Metasoma.*** Smooth. Metasomal sternum I with median longitudinal carina; metasomal sternum III with 'V' shape depression medially.

Variation. Body length 1.60–1.90 mm; length of forewing 1.15–1.47 mm. Body light castaneous to castaneous; mandible light castaneous to dark castaneous. WH/LH 0.80–0.83; DH/LH 0.56–0.57; POL/AOL = 1.45–1.69; OOL/WOT = 1.27–1.40; DAO = 0.03–0.04 mm.

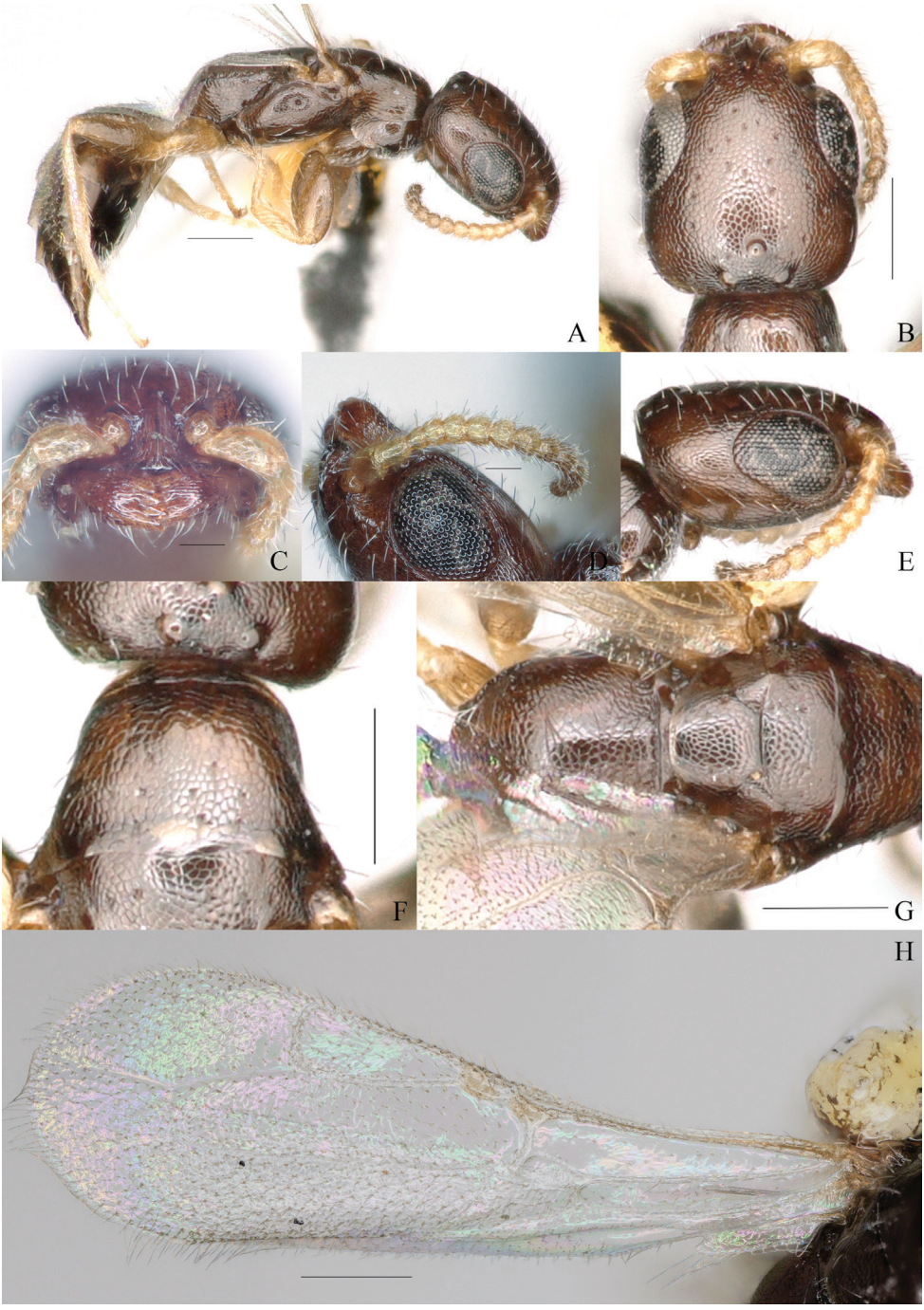

Figure 2. *Sierola leleji* sp. nov., holotype, female **A** habitus lateral **B** head, frontal view **C** mandible **D** antenna **E** head, lateral view **F** pronotum, dorsal view **G** mesosoma (except prothorax), dorsal view **H** forewing. Scale bars: 0.15 mm (**A, B, E–H**); 0.05mm (**C, D**).

Male. Unknown.

Etymology. This species is named in honor of the well-known Russian entomologist, an expert of Aculeata, Professor Arkady S. Lelej for celebrating his 75-anniversary.

Host. Larvae of *Haplochrois theae* (Kusnezov, 1916).

Distribution. China (Zhejiang).

Comments. This species is similar to the species *Sierola shimotsukeana* Terayama, 2006 for the shape of head. But it can be distinguished by having $1M_2c$ nearly rectangular, metapostnotal-propodeal disc coriaceous, and mandible light castaneous while *S. shimotsukeana* having $1M_2c$ oval, posterior area of metapostnotal-propodeal disc smooth medially, and mandible black.

***Sierola limatulifascia* sp. nov.**

http://zoobank.org/C8D03C2B-70F7-49BB-98B5-D124159406BB

Figure 3

Material examined. ***Holotype*:** China • ♀; Zhejiang Province, Changshan; 28°54.42'N, 118°31.05'E; Aug. 1980; Sh.J. Yang leg.; No. 202016915.

Description. ***Holotype*:** (Fig. 3A). **Female.** Body length = 2.05 mm. Length of forewing = 1.49 mm. ***Color*.** Body castaneous. Mandible dark castaneous, teeth light castaneous. Antenna yellow, scape light castaneous dorsally, darker distad. Forewing hyaline; veins almost colorless; prestigma and pterostigma light castaneous. ***Pubescence*.** Body covered with short sparse setae, denser in dorsal surface of propleuron and mesopectus. Antenna with dense appressed setae. Forewing with dense setae; R_2c and $1Cu_2c$ with sparse setae. ***Head*** (Fig. 3B–E). Head longer than wide, WH/LH = 0.83; DH/LH = 0.57; head thickened in lateral view. Mandible moderately narrow at base, distinctly broader on apical half, ventral margin distinctly concave; not twisted, outwardly coriaceous; apex of mandible vertical, with four equally strong teeth. Median clypeal lobe weakly protuberant with apex rounded; median clypeal carina slightly extending back into frons, recurved apically in lateral view. Antennomeres II–VI in ratio of 1.54: 0.95: 0.90: 1.02: 1.0 in length and respectively 1.62, 1.05, 0.84, 0.88, 0.89 × wide; antennal scrobal carina weak. Frons and vertex coriaceous with punctures separate 1.5–4.0 × its diameter. Eye protuberant. WF/LE = 1.12; LE/EV = 1.11. Anterior ocellus distinctly far away from eyes; POL/AOL = 1.57; OOL/WOT = 1.30; DAO = 0.038 mm. Vertex crest straight; sides of head behind eyes almost parallel. Occipital carina absent. Malar space absent. Gena coriaceous; ventral area of gena elevated in lateral view. ***Mesosoma*** (Fig. 3F–H). DT/LT = 0.39. Pronotum coriaceous; dorsal pronotal area slightly convex, shorter than wide, with punctures; pronotum sloping in lateral view. Mesoscutum coriaceous with punctures; parapsidal signum weak; mesoscutellum coriaceous with punctures, mesoscutellar fovea present. Metanotum coriaceous, 0.17 × mesoscutellum. Metapectal-propodeal complex coriaceous; metapectal-propodeal disc 0.77 × wide; prespiracular propodeal depression oblong; metapostnotum with median shiny longitudinal stripe elevated; lateral marginal carina complete; anterior metapleural area smooth; metapleural line with three pits. Propleuron coriaceous. Mesopectus coria-

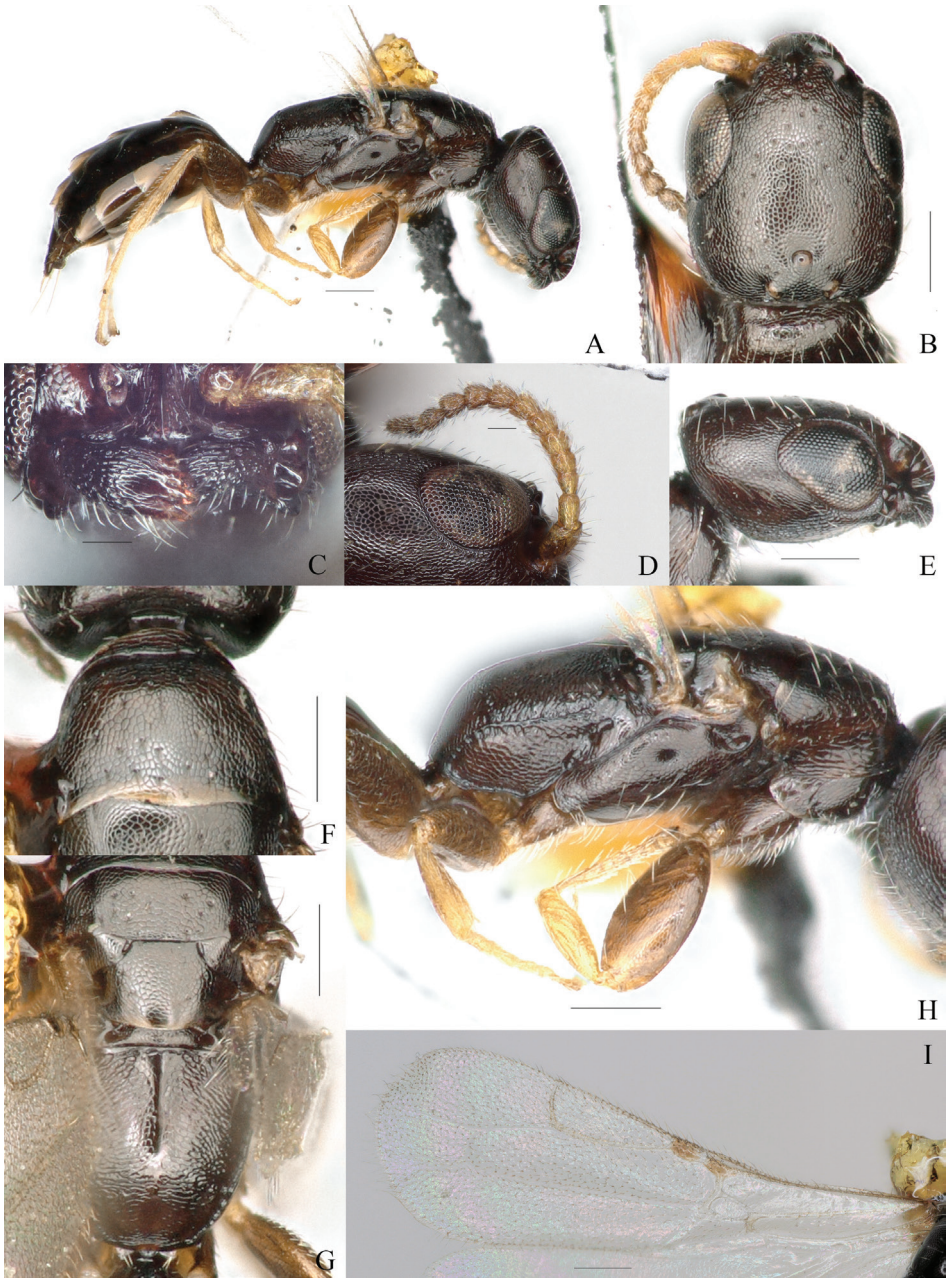

Figure 3. *Sierola limatulifascia* sp. nov., holotype, female **A** habitus lateral **B** head, frontal view **C** mandible **D** antenna **E** head, lateral view **F** pronotum, dorsal view **G** mesosoma (except prothorax), dorsal view **H** mesosoma, lateral view **I** forewing. Scale bars: 0.15 mm (**A, B, E–I**); 0.05 mm (**C, D**).

ceous; subalar impression present; mesopleural pits present; ventral surface of mesopectus with fovea near mesocoxa; mesodiscrimen present as trace. ***Forewing*** (Fig. 3I). Rs_2v 0.57 × Rs&M_2v; $R1_2v$ intersect apical portion of Rs_2v at acute angle; length of

pterostigma 0.45 × its width. ***Metasoma.*** Smooth. Metasomal sternum I with longitudinal carina; metasomal sternum III with 'V' shaped depression medially.

Male. Unknown.

Etymology. The specific name "*limatulifascia*" is a combination of "*limatulus*" (=smoothed, polished) and "*fascia*" (= band, stripe) referring to the median shiny longitudinal stripe in the metapostnotum.

Host. Larvae of *Haplochrois theae* (Kusnezov, 1916).

Distribution. China (Zhejiang).

Comments. This species can be distinguished from other species by having $R1_2v$ intersect apical portion of Rs_2v at acute angle, and metapostnotum with median shiny longitudinal stripe elevated.

Discussion

The only record of this genus in China, *Sierola sinensis*, was published by Fullaway in 1920, and this paper is the first report about this genus from China after a hundred years since then. This genus was previously recorded in Macao (22°11.39'N, 113°32.54'E), and the new species reported in this paper were collected in Zhejiang Province (28°54.42'N, 118°31.05'E), which distinctly expanded the potential distribution of this genus in China.

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