

A new species of the genus *Ecphylyus* (Hymenoptera: Braconidae: Doryctinae) from Taiwan, with a diagnostic character previously unknown in the genus

Новый вид рода *Ecphylyus* (Hymenoptera: Braconidae: Doryctinae) из Тайваня, с ранее неизвестным в роде диагностическим признаком

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Abstract. A short review of the genera *Ecphylyus* Foerster, 1863 and *Sycosoter* Picard et Lichtenstein, 1917 is given. A new species, *Ecphylyus lini* sp. nov., from Taiwan Island is described. Unlike all other species in the genus, it has the strongly striate second metasomal tergite. The species was reared from the bark beetle *Scolytus japonicus* Chapuis, 1875 (Coleoptera: Curculionidae: Scolytinae). The genus *Ecphylyus* is recorded in the Oriental fauna for the first time. The following new combinations are suggested: *Sycosoter alboapicalis* (Belokobylskij, 1993), **comb. nov.**; *S. brevitergum* (Belokobylskij, 1993), **comb. nov.**; *S. conformis* (Belokobylskij, 2009), **comb. nov.**; *S. hahajimus* (Belokobylskij et Maeto, 2008), **comb. nov.**; *S. konishii* (Belokobylskij, 2009), **comb. nov.**; *S. medianus* (Belokobylskij, Iqbal et Austin, 2004), **comb. nov.**; *S. subtropicalis* (Belokobylskij, 2009), **comb. nov.**; and *S. topali* (Papp, 1993), **comb. nov.**

Резюме. Дан краткий обзор родов *Ecphylyus* Foerster, 1863 и *Sycosoter* Picard et Lichtenstein, 1917. С острова Тайвань описан новый вид *Ecphylyus lini* sp. nov. В отличие от всех других видов рода, он имеет сильно продольно морщинистый второй тергит метасомы. Вид был выведен из жука-подкорника *Scolytus japonicus* Chapuis, 1875 (Coleoptera: Curculionidae: Scolytinae). Род *Ecphylyus* впервые достоверно указывается для фауны Ориентальной области. Предложены следующие новые комбинации: *Sycosoter alboapicalis* (Belokobylskij, 1993), **comb. nov.**; *S. brevitergum* (Belokobylskij, 1993), **comb. nov.**; *S. conformis* (Belokobylskij, 2009), **comb. nov.**; *S. hahajimus* (Belokobylskij et Maeto, 2008), **comb. nov.**; *S. konishii* (Belokobylskij, 2009), **comb. nov.**; *S. medianus* (Belokobylskij, Iqbal et Austin, 2004), **comb. nov.**; *S. subtropicalis* (Belokobylskij, 2009), **comb. nov.**; *S. topali* (Papp, 1993), **comb. nov.**

Key words: ectoparasitoids of Scolytinae larvae, striate second metasomal tergite, Oriental Region, Braconidae, Doryctinae, Ecphylini, *Sactopus*, *Sycosoter*, new species

Ключевые слова: эктопаразитоид личинок Scolytinae, морщинистый второй тергит метасомы, Ориентальная область, Braconidae, Doryctinae, Ecphylini, *Sactopus*, *Sycosoter*, новый вид

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Introduction

The braconid genus *Ecphylus* Foerster, 1863 (Hymenoptera: Braconidae: Ecphylini) is a specialised and perhaps widespread group of idiobiont ectoparasitoids that usually attack the larvae of small bark beetles (Coleoptera: Curculionidae: Scolytinae: Scolytini) (Belokobylskij & Maeto, 2009; Yu et al., 2016). According to the recent molecular phylogenetic analysis of the subfamily Doryctinae (Zaldivar-Riveron et al., 2008), the genus *Ecphylus* probably originated in the New World (where it is the most diverse and abundant: Marsh, 1965, 2002) and subsequently penetrated to the Palaearctic and Oriental Regions via the Trans-Atlantic and/or the Trans-Beringian land-bridges.

Previous taxonomic study of the species assigned to *Ecphylus* (Belokobylskij, 1993a) revealed the presence of two groups of species, which were designated initially as the subgenera *Ecphylus* s. str. and *Sactopus* Ashmead, 1900. A subsequent morphological and molecular study of *Ecphylus* species (Gebiola et al., 2015) showed that the Old World species, previously included in the subgenus *Sactopus* (Belokobylskij, 2009), actually belong to the genus *Sycosoter* Picard et Lichtenstein, 1917, which is rather abundant and distributed in the Eastern Palaearctic, Oriental and Australasian Regions.

Eight species of the genus *Ecphylus* were described from the Western Palaearctic, and most of them were later synonymised with the widely distributed Palaearctic species *E. silesiacus* (Ratzeburg, 1848) (Russo, 1938; Shenefelt & Marsh, 1976; Belokobylskij & Tobias, 1986; Belokobylskij, 2009; Yu et al., 2016). However, a recent molecular study of specimens from Spain, Italy and Russia, which were identified as *E. silesiacus* s.l., led to the conclusion that the species may contain cryptic species (Gebiola et al., 2015). Molecular data also showed that the New World species of *Ecphylus* belong to another species-group, possibly deserving subgeneric status (Gebiola et al., 2015). However, this hypothesis requires further scrutiny.

In current paper, a new species of *Ecphylus* from Taiwan with the sculptured second metasomal tergite, a character previously unknown in the genus, is described and illustrated.

Material and methods

The material used in this study were collected and partly reared by Mr Ching-Shan Lin in Dasyue Mountain (Nantou County, Taiwan) from the wood of *Zelkova serrata* (Ulmaceae) infested by *Scolytus japonicus* Chapuis, 1875. Specimens were examined using an Olympus SZX12 stereomicroscope. Photographs of species morphology were taken with a Canon EOS 70D digital camera mounted on an Olympus SZX10 microscope at the Zoological Institute RAS (St Petersburg, Russia).

The terminology employed for morphological features, sculpture and body measurements follows Belokobylskij and Maetô (2009). Wing venation nomenclature follows Belokobylskij and Maetô (2009), with the terminology of van Achterberg (1993) shown in parentheses.

The holotype of the new species is deposited in the collection of the National Museum of Natural Science, Taichung, Taiwan (NMNS); the paratypes are in NMNS, Taiwan Agricultural Research Institute, Taichung, Taiwan (TARI) and the Zoological Institute of the Russian Academy of Sciences, St Petersburg, Russia (ZISP).

Taxonomic part

Order **Hymenoptera**

Family **Braconidae**

Subfamily **Doryctinae**

Genus ***Ecphylus*** Foerster, 1863

Type species: *Bracon silesiacus* Ratzeburg, 1848, by original designation.

Characteristics of the genus. Head weakly transverse (dorsal view). Ocelli arranged in triangle with base large than its sides. Eyes glabrous. Malar suture absent. Occipital carina present, not joined with hypostomal carina, being obliterated below. Postgenal bridge narrow. Maxillary palpus 5-segmented, labial palpus 3-segmented. Scape wide and short, without apical lobe or flange. First flagellar segment distinctly shorter than second segment. Mesonotum (lateral view) usually highly and almost perpendicularly elevated above pronotum. Median lobe of mesonotum (dorsal view) with obtuse or pointed anterolateral angles. Notauli entirely rather deep. Sternaulus more or less

shallow, rather short and straight. Prepectal carina distinct and complete. Propodeum often with areola delineated by carinae; lateral tubercles and propodeal bridge absent. Radial (marginal) cell of fore wing usually not or weakly shortened. Second radiomedial vein (*r-m*) absent. Discoidal (discal) cell petiolate anteriorly. Recurrent vein (*m-cu*) distinctly or strongly antefurcal. Nervulus (*cu-a*) always absent. Fused submedial (subbasal) and brachial (subdiscal) cells closed apically on or before recurrent vein (*m-cu*). Parallel vein (*CU1a*) interstitial. In hind wing, nervellus (*cu-a*) and submedial (subbasal) cell absent. Recurrent vein (*m-cu*) absent. Medial (basal) cell narrow, always closed antero-distally. Fore tibia with small spines arranged almost in single line. Hind coxa with rather distinct basoventral corner and rounded tubercle. All femora without dorsal protuberances. Hind femur of male not or only weakly wider than female femur. Hind basitarsus 0.7–1.0 times as long as second–fifth segments combined. First metasomal tergite not petiolate, rather wide, with distinct dorsope. Acrosternite of first segment about 0.2 times as long as first tergite. Second suture shallow and straight or absent. Second tergite without furrows or delineated area, often smooth, but rarely entirely striate. Ovipositor usually shorter than metasoma; its apical part with two small dorsal nodes and serrate ventrally.

Ecphylus lini Belokobylskij, **sp. nov.**
(Figs 1, 2)

Holotype. Female, **Taiwan**, *Nantou County*, Dasyue Mt., 782 m, 24°12.1110' N; 120°53.3170' E, 13.V.2019, Ching Shan Lin leg.; host: *Scolytus japonicus* Chapuis on *Zelkova serrata* (Ulmaceae) (NMNS).

Paratypes. 1 female, 2 males, with same labels as in holotype (ZISP); 4 females, 3 males, same labels, but 24.III.2019 (TARI, ZISP); 12 females, 12 males, same labels, but 29.V.2019 (NMNS, TARI, ZISP).

Description. Female. Body length 1.6–2.7 mm; fore wing length 1.4–2.1 mm.

Head width (dorsal view) 1.6–1.7 times its median length, 1.0–1.1 times width of mesoscutum. Head behind eyes (dorsal view) weakly and convex-roundly narrowed; transverse diameter of eye 1.5–1.7 (rarely, in small specimens, as little as 1.2) times length of temple. Ocelli rather small, arranged in triangle with base 1.3–1.4 times its sides; POL 1.2–1.8 times Od, 0.45–0.55 times OOL. Eye

glabrous, 1.3–1.5 times as high as broad. Malar space about 0.5 times height of eye, 0.9–1.0 times basal width of mandible. Face width almost equal to height of eye and 1.15–1.20 times height of face and clypeus combined. Hypoclypeal depression round, its width 0.6–0.7 times distance from edge of depression to eye, 0.35–0.40 times width of face. Occipital carina ventrally almost joined with hypostomal carina by additional ruga distinctly above base of mandible. Head below eyes (front view) distinctly and roundly narrowed.

Antenna slender, filiform, 17–21-segmented, 1.1–1.2 times longer than body. Scape 1.5–1.6 times longer than its maximum width, 1.8–2.0 times longer than pedicel. First flagellar segment 4.0–4.5 times longer than its apical width, 0.80–0.85 times as long as second segment. Penultimate segment 3.0–3.6 times longer than wide, about as long as first flagellar segment, 0.7–0.8 times as long as apical segment; the latter weakly acuminate apically.

Mesosoma. Length 1.7–1.8 times height. Pronotum (dorsal view) with its anterior margin straight and with pointed antero-lateral angles. Pronotal carina distinct and high, situated in anterior third or quarter of pronotum. Mesoscutum (lateral view) highly and almost perpendicularly elevated above pronotum; anteriorly (dorsal view) almost straight, with distinct anterolateral angles; 1.0–1.1 times as wide as median length; median lobe with shallow but distinct and almost complete longitudinal median furrow. Notauli complete, mainly deep, wide, distinctly crenulate. Prescutellar depression (scutal sulcus) deep, rather short, with six–seven carinae, smooth between them, 0.35–0.40 times as long as scutellum. Scutellum weakly convex, with distinct lateral carinae. Subalar depression rather deep, narrow, striate-rugose and sometimes partly smooth. Sternaulus deep, rather wide, straight, mainly smooth, but sometimes with weak curved striae below, short, running along anterior 0.4–0.5 of lower part of mesopleuron. Metanotum (lateral view) with short, but distinct, basally wide and apically acuminate dorsal tooth. Metapleural lobe rather short, wide, rounded apically.

Wings. Fore wing 3.4–3.6 times its maximum width. Pterostigma rather narrow, 5.0–5.5 times longer than maximum width. Radial (marginal) cell wide, weakly shortened, 3.5–3.7 times longer than wide. Metacarp (*1-R1*) 1.2–1.4 times longer

than pterostigma. Radial vein (r) arising almost from middle of pterostigma, its first abscissa (r) 1.8–2.0 times longer than maximum width of pterostigma. Second radial abscissa ($3-SR+SR1$) almost straight in anterior half and weakly curved posteriorly or sometimes weakly evenly curved, 5.0–5.5 times longer than first radial abscissa (r), 5.8–8.1 times longer than first radiomedial vein ($2-SR$). First radiomedial vein ($2-SR$) (0.4) 0.6–0.9 times as long as first radial abscissa (r), (0.4) 0.8–1.3 times as long as second medial abscissa ($2-SR+M$), 0.9–1.3 times as long as recurrent vein ($m-cu$). First medial abscissa ($1-SR+M$) weakly or very weakly sinuate. Discoidal (discal) cell 1.8–2.3 times longer than wide. Second (posterior) abscissa of basal vein ($1-M$) 1.5–1.7 times longer than first (anterior) abscissa ($1-SR$), weakly convergent with recurrent vein ($m-cu$) and 2.0–2.6 times longer than it. Mediocubital vein ($M+CU1$) evenly curved. Fused submedial (subbasal) and brachial (subdiscal) cells closed weakly before level of recurrent vein ($m-cu$). Hind wing 4.7–5.2 times longer than wide.

Legs. Hind femur without dorsal protuberance, its length 3.1–3.4 times maximum width. Hind tarsus 0.8–0.9 times as long as hind tibia. Hind basitarsus weakly thickened, 0.75–0.85 times combined length of second to fifth segments. Second segment of hind tarsus 0.3–0.4 times as long as basitarsus, about as long as fifth segment (without pretarsus).

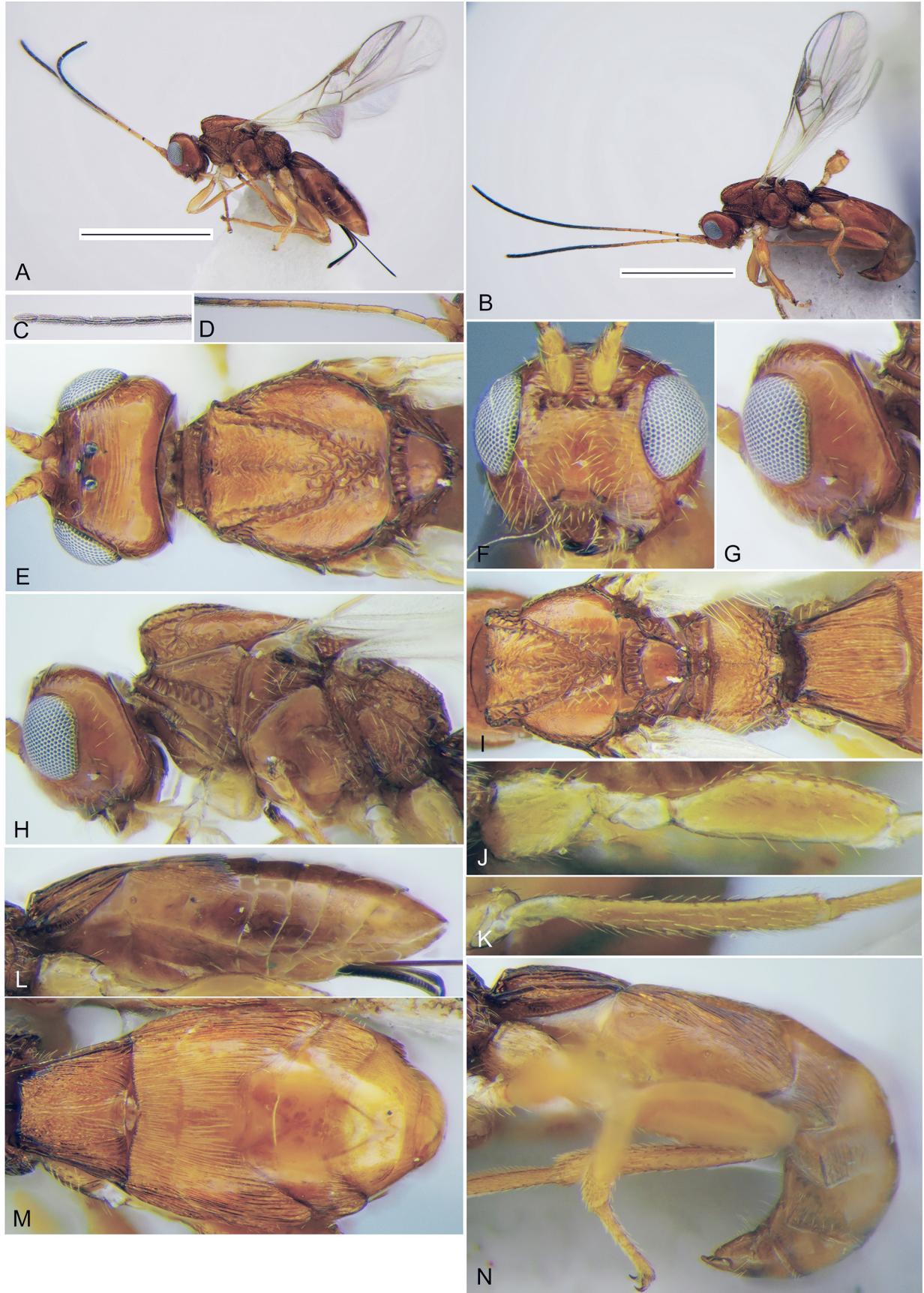
Metasoma 0.9–1.0 times as long as head and mesosoma combined. First tergite with distinct dorsope, without spiracular tubercles, evenly, strongly and linearly widened from base to apex. Maximum width of first tergite 2.0–2.5 times its basal width; its length 0.75–0.80 times apical width, 1.2–1.4 times length of propodeum. Second suture very fine and weakly curved. Median length of second tergite 0.30–0.35 times its basal width, 1.2–1.5 times length of third tergite. Combined length of second and third tergites 0.5–0.6 times basal width of second tergite and 0.4–0.5 times their maximum width. Ovipositor sheath (lateral view) 0.4–0.7 times as long as metasoma,

0.6–0.8 times as long as mesosoma, and 0.25–0.35 times as long as fore wing.

Sculpture and pubescence. Vertex coarsely transversely striate in anterior half and finely striate to almost smooth in posterior half (rarely, in small specimens, vertex finely striate in anterior half and smooth in posterior half), with complete coarse transverse curved carina between median and lateral ocelli; frons entirely coarsely transversely striate. Temple entirely smooth. Face usually with some smoothed, fine or sometimes with rather distinct transverse striation. Lateral lobes of mesoscutum weakly and densely granulate-reticulate, median lobe rather coarsely rugulose, sometimes partly with fine granulation between rugae, coarse undulate striate with rugosity in its posterior half. Scutellum smooth. Mesopleuron mostly smooth. Propodeum entirely coarsely and densely rugose-reticulate, with undulate median longitudinal carina in basal half, without delineated areola. Hind coxa and femur mostly smooth, coxa dorsally finely rugulose. First tergite with distinct, convex and subparallel complete dorsal carinae, with coarse lateral carinae; entirely coarsely longitudinally striate, without rugulosity. Second tergite entirely and third tergite baso-laterally with coarse straight striae, most posterior part of third tergite smooth. Remaining tergites smooth. Vertex with short and very sparse yellow setae medially and laterally, otherwise almost glabrous. Mesoscutum with sparse, very short and semi-erect pale setae arranged in narrow stripes along notauli and marginally. Hind tibia dorsally with short, rather dense and semi-erect pale setae; length of these setae 0.4–0.6 times maximum width of hind tibia.

Colour. Body mainly reddish brown, sometimes faintly darker dorsally, head sometimes darker, mesosoma with yellowish tint laterally. Antenna mainly dark reddish brown to black, 6th to 8th basal segments yellow to brownish yellow. Palpi pale yellow. Legs mostly yellow, trochanters whitish, hind leg sometimes faintly infuscate. Ovipositor sheath black. Fore wing subhyaline. Pterostigma brown to pale brown, yellowish apically.

Fig. 1. *Ecphylyus lini* sp. nov., holotype, female (A, C–L) and paratype, male (B, M, N). **A, B**, habitus; **C**, antenna apically; **D**, antenna basally; **E**, head and mesoscutum; **F**, head; **G**, head; **H**, head and mesosoma; **I**, mesosoma and first metasomal tergite; **J**, hind coxa and femur; **K**, hind tibia; **L–M**, metasoma. Lateral (A, B, G, H, J–N), dorsal (E, I, M) and frontal (F) view. Scale bars: 1 mm. 



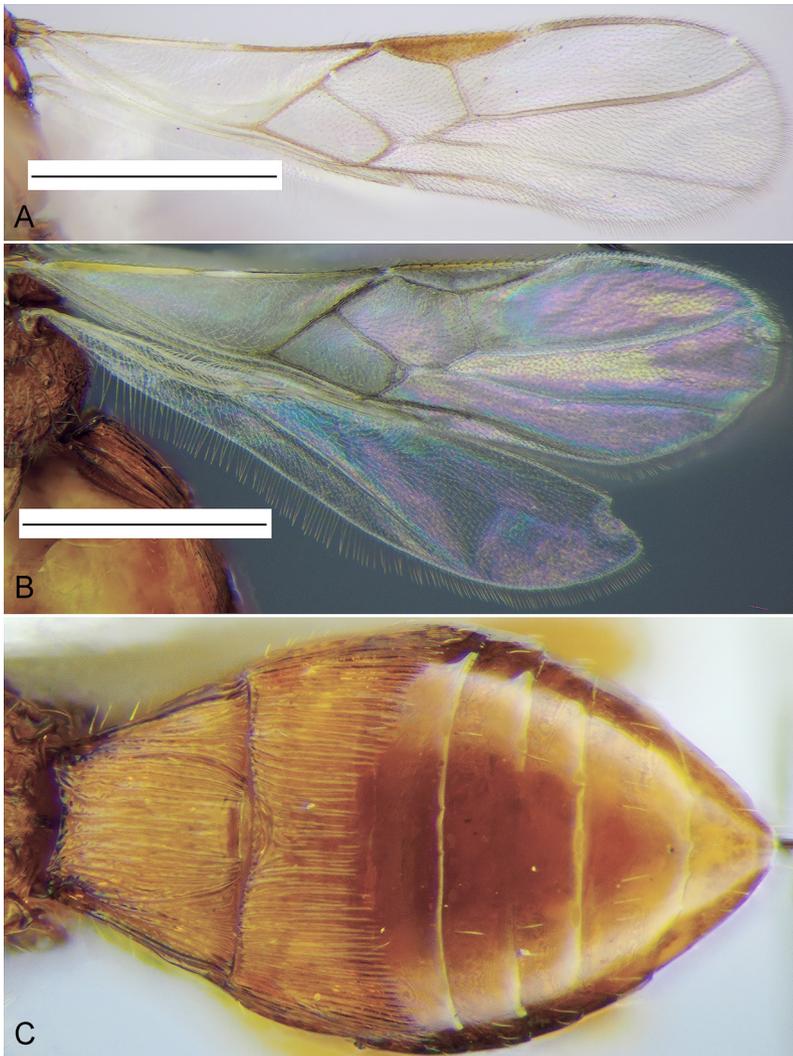


Fig. 2. *Ecphylyus lini* sp. nov., holotype (A, C) and paratype (B), female. **A**, fore wing; **B**, fore and hind wings; **C**, metasoma, dorsal view. Scale bars: 0.5 mm.

Male. Body length 1.1–3.0 mm; fore wing length 0.9–2.3 mm. Antenna 17–20-segmented. In fore wing, second medial abscissa ($2-SR+M$) longer; first radiomedial vein ($2-SR$) 0.5–0.6 times as long as first radial abscissa (r), 0.3–0.8 times as long as second medial abscissa ($2-SR+M$), 0.6–1.0 times as long as recurrent vein ($m-cu$). Hind femur length 3.0–3.3 times its maximum width. Metasoma distinctly curved down posteriorly; third–fifth tergites laterally prolonged posteriorly (dorsal view), laterally distinctly and completely striate (lateral view). First metasomal tergite longer, 0.9–1.0 times as long as apical width. Otherwise similar to female.

Etymology. The new species is named in honor of Mr Ching-Shan Lin who collected the type material.

Comparative diagnosis. This new species distinctly differs from all the known species of *Ecphylyus* by the presence of a distinct striate sculpture on the second metasomal tergite and the coarsely transversely striate vertex, at least in its anterior half. A previously unknown character, the sculptured second metasomal tergite, is unique among species of *Ecphylyus* and demonstrates the isolated position of *E. lini* sp. nov. in the genus.

Host. *Scolytus japonicus* Chapuis, 1875 (Curculionidae: Scolytinae) on *Zelkova serrata* (Thunb.) Makino (Ulmaceae).

Distribution. Taiwan Island.

Biological notes. The larvae of *Ecphylyus lini* sp. nov. feed on the larvae of *Scolytus japonicus* and later form the cocoons in the pupal cells of their host (Figs 3 A–D). After emergence from their cocoons, adults gnaw holes through the bark of *Zelkova serrata*, go out on the tree surface and stretch their wings (Figs 3 E–H, 4 A, B). Usually several males sought newly emerged adults and waited for them near bark holes for mating attempts with newly emerged wasps, irrespective of whether they were male or female (Figs 4 C–H).

Remarks. The measurement of length of the second medial abscissa ($2-SR+M$) of fore wing in the studied material of the new species collected in one place and over the same days show distinct variation correlated with the length of the first radiomedial vein ($2-SR$) [female: 0.7–1.0 (up to 2.3) times; male: 0.8–1.6 (up to 2.0–3.0) times] and with the length of the recurrent vein ($m-cu$) [female: 0.8–1.1 (up to 1.8) times; male: 0.7–1.8 times]. These data additionally support the opinion of Russo (1938), who demonstrated a strong variation of this character in reared specimens of *E. silesiacus*, and suggest that this character should not to be used as a diagnostic character in *Ecphylyus* taxa.

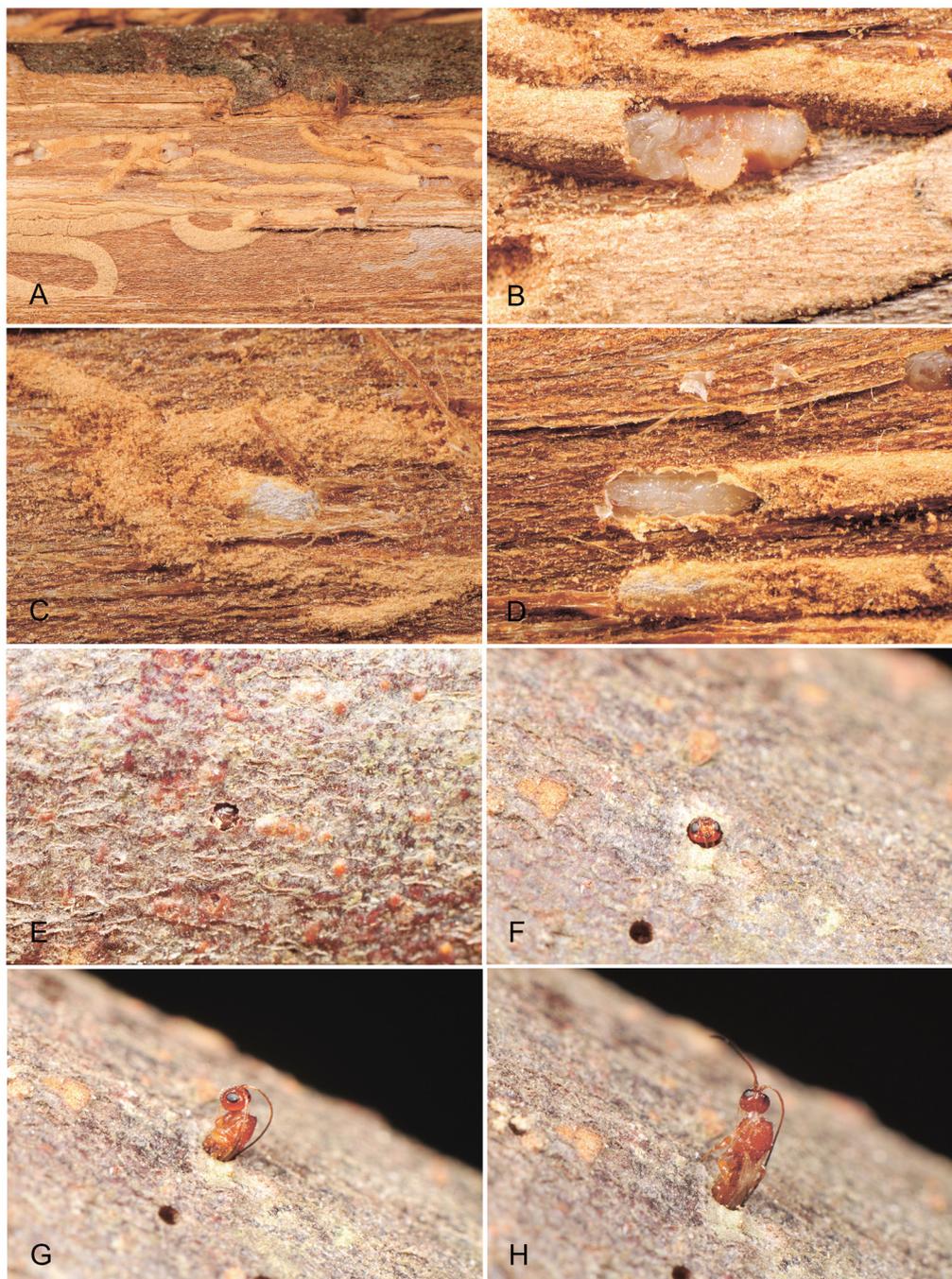


Fig. 3. Biological properties of *Ecphylus lini* sp. nov. **A**, galleries of the host *Scolytus japonicus* under bark of *Zelkova serrata*; **B**, ectoparasitoid larva on the host larva; **C**, ectoparasitoid cocoon; **D**, ectoparasitoid pupa; **E–H**, adult egressing from host gallery via a gnawed hole through the tree bark.

Key to Asian species of the genus *Ecphylus*

1. Second and third metasomal tergites of female entirely smooth. Vertex usually mainly smooth, only sometimes with transverse submedian carina. Body length 2.0–4.0 mm. *Ecphylus silesiacus*

– Second metasomal tergite entirely and third tergite baso-laterally distinctly striate in female. Vertex coarsely transversely striate in anterior half and finely striate to almost smooth in posterior half. Body length 1.1–3.0 mm *Ecphylus lini* sp. nov.

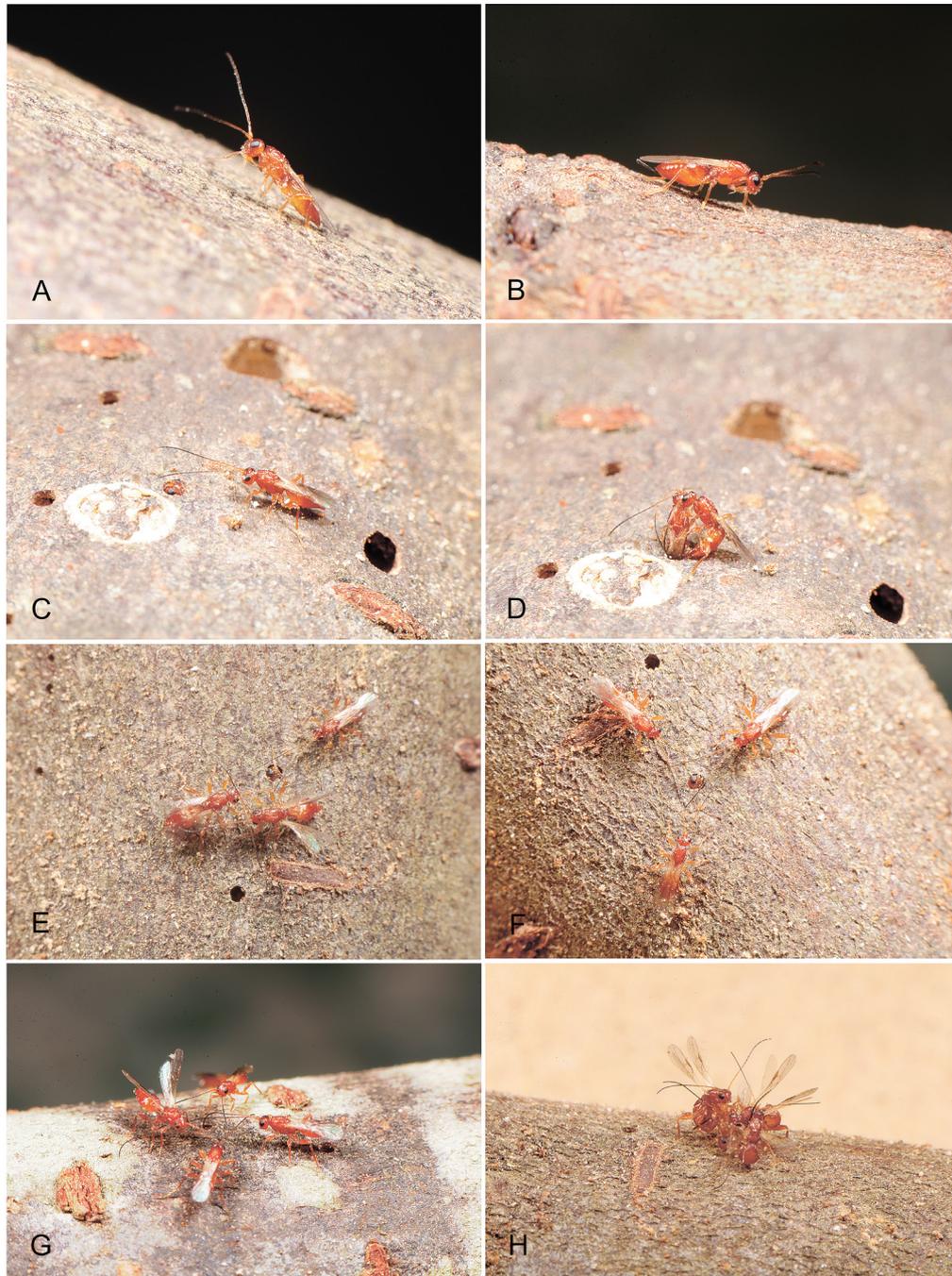


Fig. 4. Behavior of *Ecphylus lini* sp. nov. **A, B**, parasitoid male (A) and female (B) on surface of tree after hatching and stretching wings; **C–H**, newly emerged adults (males) waiting near bark holes for mating attempts with newborns.

Discussion

The genus *Ecphylus* Foerster, 1863 differs from related *Sycosoter* Picard et Lichtenstein, 1917 by the following morphological characters: hind coxa with basoventral corner and distinct rounded tubercle (*vs* without corner and tubercle or tooth);

notauli complete and developed in posterior half of mesoscutum (*vs* always absent or indistinct in posterior half); second abscissa of costal vein of hind wing present (*vs* always absent); hind femur of male only weakly thickened (*vs* distinctly thickened); and metasoma of male not flattened dorsoventrally, relatively short and curved down poste-

riorly, and its tergites, beginning with third one, with distinct oblique lateral carinae (*vs* metasoma of male flattened dorsoventrally, elongate and not curved down posteriorly, its tergites beginning from third one, without oblique lateral carinae).

The following *Sycosoter* species are currently known in the Old World fauna: *S. alboapicalis* (Belokobylskij, 1993), **comb. nov.** (Vietnam), *S. arephini* (Belokobylskij, 1993) (Russian Far East); *S. brevitergum* (Belokobylskij, 1993), **comb. nov.** (Vietnam); *S. caudatus* (Ruschka, 1916) (Europe, European part of Russia, Morocco, Algeria, Tunisia, Israel); *S. conformis* (Belokobylskij, 2009), **comb. nov.** (Korea, Japan); *S. hahajimus* (Belokobylskij et Maeto, 2008), **comb. nov.** (Japan); *S. hattorii* (Kôno et Watanabe, 1935) (China, Russian Far East, Korea, Japan); *S. konishii* (Belokobylskij, 2009), **comb. nov.** (Japan); *S. medianus* (Belokobylskij, Iqbal et Austin, 2004), **comb. nov.** (Australia); *S. subtropicalis* (Belokobylskij, 2009), **comb. nov.** (Japan); and *S. topali* (Papp, 1993), **comb. nov.** (India) (Belokobylskij, 1993a, 1993b, 2009; Papp, 1993; Belokobylskij et al., 2004, 2019; Belokobylskij & Maetô, 2008; Gebiola et al., 2015; Yu et al., 2016). The type material of the numerous New World species of *Ecphylus*, as well as a single Afrotropical species, *E. wernerii* Fahringer, 1924, described from Sudan, need to be checked to determine their correct generic placement.

Thereby, the all Asian species previously described in the genus *Ecphylus* belong exclusively to the genus *Sycosoter*. The true member of the genus *Ecphylus* is currently recorded in the Oriental Region for the first time.

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