

## Two Heptageniid Mayfly Species of *Thalerosphyrus* Eaton (Ephemeroptera: Heptageniidae) from Vietnam

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### ABSTRACT

Two species of the heptageniid mayfly genus *Thalerosphyrus* Eaton, *T. vietnamensis* (Dang) and *T. separatus* n. sp., are described from Vietnam. *Thalerosphyrus separatus* can be distinguished by the basally detached posterolateral expansions of pronotum in larva and by the Y-shaped penes in male adult. Their larval and adult stages are described with line-drawings of diagnostic characters. Their diagnoses, distributions, habitat and ecological data, and taxonomic remarks are provided.

Key words: *Thalerosphyrus separatus*, *Thalerosphyrus vietnamensis*, Taxonomy, tropical Asia

### INTRODUCTION

The heptageniid mayfly genus *Thalerosphyrus* Eaton is originally known in tropical Southeast Asia, but some African species were recently assigned to the genus (McCafferty, 2003). Eaton (1881) established the genus based on the type species *T. determinatus* (Walker) from the Philippines and Borneo. Eaton (1885) redescribed the genus and the type species. Ulmer (1925)

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described *T. melli* based on adults from southern China. Ulmer (1939) provided descriptions of the adult and larval stages of both *T. determinatus* (Walker) and *T. sinuosus* (Navás) based on materials from Java and Sumatra. Dang (1967) described the genus *Ecdyonuroides* and the type species *Ecdyonuroides vietnamensis* based on larval materials from northern Vietnam. Braasch & Soldán (1984) synonymized *Ecdyonuroides* Dang with *Thalerosphyrus* Eaton and redescribed the adult and larval stages of *T. vietnamensis* (Dang). Braasch & Soldán (1986) additionally described the adult and larva of *T. bishopi* from Malaysia.

Although the generic status of *Thalerosphyrus* has been questioned by some mayfly taxonomists (e.g., Kluge, 1988), its larva can be generally characterized by the laterally and posterolaterally greatly expanded pronotum, well developed posterolateral projections on abdominal segments 3-8, and other characters (Tshernova, 1976; Braasch and Soldán, 1984). However, the genus has not been well defined by adult although such mayfly taxonomist as Ulmer (1932-33) tried to characterize the adult of *Thalerosphyrus* by limited characters, e.g., ratio of tarsal segments and shape of penes. Recently, Wang and McCafferty (2004) reviewed *Thalerosphyrus* and related genera and suggested a generic synapomorphy of acute and well developed supracoxal processes in midlegs and hindlegs.

In a series of systematic study of Vietnamese mayflies, we describe a new species of *Thalerosphyrus*. Since the original description of *T. vietnamensis* is written in Vietnamese (Dang, 1967) and the redescription is written in Germany (Braasch and Soldán, 1984), we provide English redescription based on our material.

Larval, male and female adult materials (indicated as L, M and F, respectively) used in this study were collected throughout Vietnam during the field trips in 2000-2002. Larvae were collected by Surber nets and kick nets, and adults were collected by light traps and sweeping nets. When available, adults were reared in the field. All the materials are preserved in 80% ethyl alcohol and deposited in the Aquatic Insect Collection of Seoul Women's University (SWU-AIC). In the future, the holotype material will be appropriately returned to the places where it originated (e.g., Hanoi University of Science or an authorized museum in Vietnam).

## SYSTEMATIC ACCOUNTS

### ***Thalerosphyrus vietnamensis* (Dang, 1967) (Figs. 1-3)**

*Ecdyonuroides vietnamensis* Dang, 1967, p. 160.

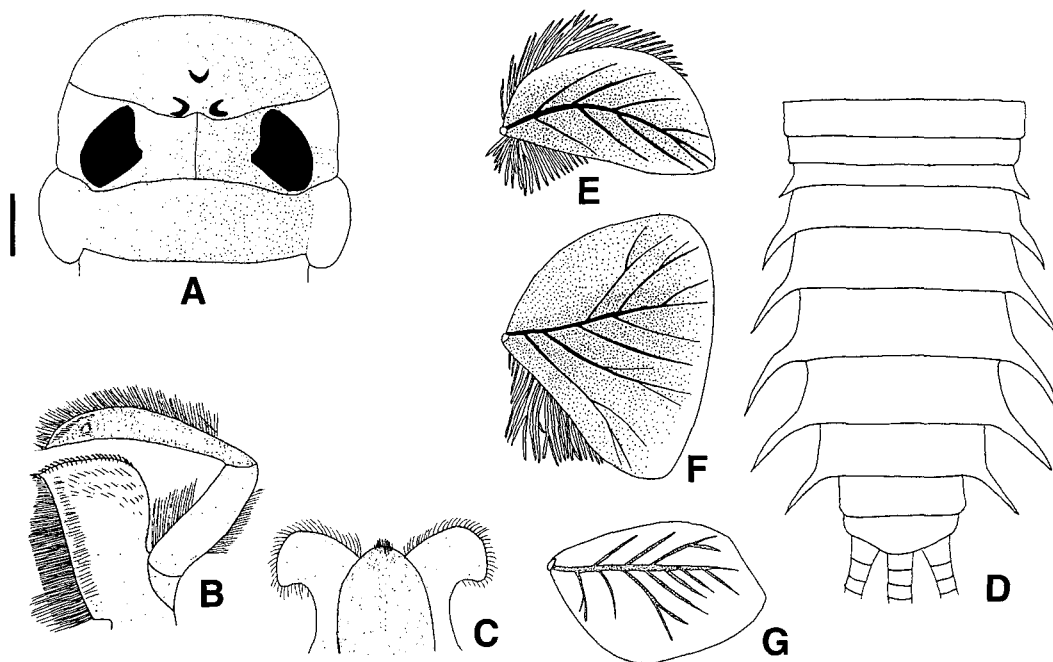
*Thalerosphyrus vietnamensis* (Dang): Braasch & Soldan, 1984, p. 202.

**Material examined.** 1 L, Ha Giang Prov., Tay Con Linh, 9 Dec. 2000 (V. V. Nguyen); 5 L, Cao Bang Prov., Pac Po, Lenin Cr., 15 Dec. 2000 (V. V. Nguyen); 4 L, Lao Cai Prov., Sa Pa, Muong Hoa, 20 Oct. 2000 (V. V. Nguyen); 1 L, Lao Cai Prov., Sa Pa, Cat Cat, 18 Oct. 2000 (V. V. Nguyen); 4 L, Lao Cai Prov., Sa Pa, Cau May, 28 Dec. 2000 (T. K. T. Cao); 5 L, Lao Cai Prov., Sa Pa, Trung Trai, 29 Dec. 2000 (T. K. T. Cao); 27 L, Vinh Phuc Prov., Tam Dao N. P. (alt. 200, 300, 700, 900 m), 16 Oct. 2000, 14-15 Feb. 2001 (V. V. Nguyen); 10 L, Ha Tay Prov., Ba Vi N. P., Huong Cr., 22 Dec. 2000 (V. V. Nguyen); 16 L, Ha Tay Prov., Ba Vi N. P., Tien Cr., 23 Dec. 2000 (V. V. Nguyen); 3 L, 3 M & 2 F, Nghe An Prov., Con Cuong, Khe Choang Cr., 12 Jan.

2001 (V. V. Nguyen); 5 L, Dak Lak Prov., Dak Mil, Dak Mol, Dak Pri'Cr. (alt. 450-770 m), 4, 13 Mar. 2001 (D. H. Hoang).

**Diagnosis.** The larva of *Thalerosphyrus vietnamensis* can be distinguished by the combination of the following characters: the posterolateral expansions of pronotum fused to mesonotum (Fig. 1A); the posterolateral projections of the abdominal segments 2-8 acute and greatly developed (Fig. 1D). The male adult can be distinguished by the fused penes (Fig. 2C).

**Description. Mature larva.** Male body length 7.5 mm; caudal filaments 14.5 mm. Female body length 11.4 mm; caudal filaments 19.5 mm. Body generally brown, with dark brown and pale yellow markings. **HEAD:** Head (Fig. 1A) 2.6 mm in length and 4.0 mm in width, subrectangular, brown with submedian round pale yellow markings on anterior margin, with pale yellow areas beside compound eyes and ocelli; anterior and lateral margins round and posterior margins somewhat concave. Compound eyes black; male compound eyes 0.90 mm in length, 1.30 mm in width, and 0.15 mm in distance between compound eyes in last instar larva; female compound eyes 1.00 mm in length, 0.95 mm in width, and 1.30 mm in distance between compound eyes. Antennae 1.9 mm in length; pedicel light brown; flagellum pale yellow. Mandibles lateral margin with dense hairlike setae; medial side of outer incisor serrate; inner incisor slender, with long hairlike setae basally. Maxillae (Fig. 1B) with pectinate setae on crown of galea-lacinia, with rowed long hairlike setae on medial margin, with rowed hairlike setae submedially on ventral surface, and with scattered hairlike setae on apical half of ventral surface; maxillary palp basal segment 0.97 mm, with rowed dense hairlike setae laterally; apical segment 1.32 mm, with rowed hairlike setae along anterior margin. Hypopharynx (Fig. 1C) lingua conical, with field of hairlike setae apically; superlinguae expanded laterally, with row of dense hairlike setae. Labium with broad U-shaped separation between glossae, with fine setae on apex of glossae; glossae apically somewhat pointed; paraglossae expanded laterally, with dense hairlike setal field on anterior margin; labial palp basal segment 1.20 mm; apical segment 1.10 mm, with rows of dense pectinate setae on outer margin (pectinate setal rows dark brown). **THORAX:** Pronotum (Fig. 1A) light brown with dark brown markings, 4.6 mm in width, wider than head, strongly expanded laterally and posterolaterally; lateral expansions pale yellow; posterolateral expansions basally fused to mesonotum. Legs pale yellow, with light brown irregular markings. Midlegs and hindlegs with acute and well developed supracoxal process. Forefemora light yellow, with light brown irregular markings dorsally and with dark brown marking apically, with simple stout setae on anterior and posterior margins and on dorsal surface, and with rowed hairlike setae on posterior margin; foretibiae and foretarsi with sparse hairlike setae along dorsal surface; foretibiae with dark brown markings basally and at mid-length; foretarsi and foreclaws dark brown. Midlegs and hindlegs similar to forelegs in color pattern and setation; dorsal hairlike setal row on midtibiae and hindtibiae and midtarsi and hindtarsi more dense and well developed. Forefemora 3.9 mm, foretibiae 3.2 mm, foretarsi 0.9 mm, and foreclaws 0.3 mm in length. Midfemora 4.1 mm, midtibiae 3.0 mm, midtarsi 0.7 mm, and midclaws 0.3 mm in length. Hindfemora 4.0 mm, hindtibiae 2.7 mm, hindtarsi 0.7 mm, and hindclaws 0.3 mm in length. **ABDOMEN:** Terga 1-6 brown with one pair of nearly round pale markings submedially and two pairs of irregular pale markings laterally; terga 6-10 brown with large pale yellow area medially; terga 7 with distinct dark brown marking posteromedially; terga 1-10 with rowed posteromarginal spines; terga 3-8 with greatly developed posterolateral projections (Fig. 1D);

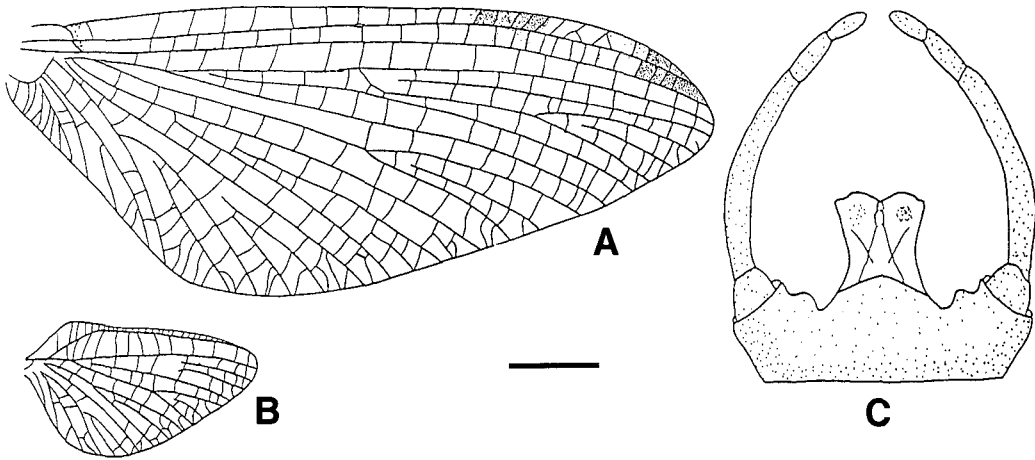


**Fig. 1.** *Thalerosphyrus vietnamensis*, larva. A, head (bar = 1 mm); B, right maxilla; C, hypopharynx; D, abdomen, dorsal view; E, gill 1; F, gill 3; G, Gill 7.

sterna pale yellow, with brown markings on sterna 9 or 9-10. Gills on abdominal segments 1-7; gills 1-6 (Fig. 1E, F) lamellae semicircular to subtriangular, with well developed fibrilliform portion, with well developed tracheae; gills 7 (Fig. 1G) lamellae ovoid, without fibrilliform portion. Caudal filaments ca.  $1.7 \times$  length of body, pale yellow with unique dark brown bands; each segment with whorl of stout setae apically.

**Male adult.** Body length 8.6-9.0 mm; caudal filaments 19.5-21.5 mm. Body light brown, with dark brown markings. HEAD: Compound eyes black in alcohol, moderately large, separated dorsally; anterior margin of head moderately produced ventrally, evenly convex. Antennae 1.1-1.3 mm; basal segment light yellow; flagellum white. THORAX: Pronotum light brown with dark brown markings. Legs light yellow, with dark purplish brown markings; forefemora 2.5 mm, foretibiae 1.9 mm, and foretarsi 1.7 mm in length; midfemora 2.6 mm, midtibiae 2.0 mm, and midtarsi 1.2 mm in length; hindfemora 2.5 mm, hindtibiae 1.9 mm, and hindtarsi 0.9 mm in length. Claws dissimilar. Forewings (Fig. 2A) hyaline, with dark purplish brown markings in stigmatic area, 15.0-16.2 mm in length, 6.5-7.1 mm in width; veins dark purplish brown; crossveins between C and Sc 23; crossveins between Sc and  $R_1$  25; crossveins between  $R_1$  and  $R_2$  17; bullae present on Sc and  $R_2$ . Hindwings (Fig. 2B) hyaline, 5.1-5.4 mm in length, 2.8-3.0 mm in width. ABDOMEN: Terga 1-6 white; terga 7-10 purplish brown to dark purplish brown. Genitalia as in Fig. 2C; penes fused; genital forceps 4-segmented; subgenital plate convex.

**Female adult.** Body length 12.5-13.1 mm; caudal filaments 25.5-27.5 mm. Body light yellow, with dark purplish brown markings. HEAD: Compound eyes black in alcohol. Antennae 1.2-1.3



**Fig. 2.** *Thalerosphyrus vietnamensis*, male adult. A, forewing (bar = 2 mm); B, hindwing (bar = 2 mm); C, genitalia, ventral view.

mm. THORAX: Color as in male. ABDOMEN: Terga 1-6 light brown, with blackish brown markings; terga 7-10 purplish brown.

**Distribution.** Vietnam.

**Habitat and biology.** We collected larvae and adults of this species from the holotype locality and other places in Vietnam. This species is distributed throughout Vietnam. Larvae of this species occur in mountain streams ranging 200-1500 m in altitude where the streams contain diverse microhabitats such as riffles and pools. The larvae are found moderately deep (15-20 cm) and slow current areas in the stream habitats.

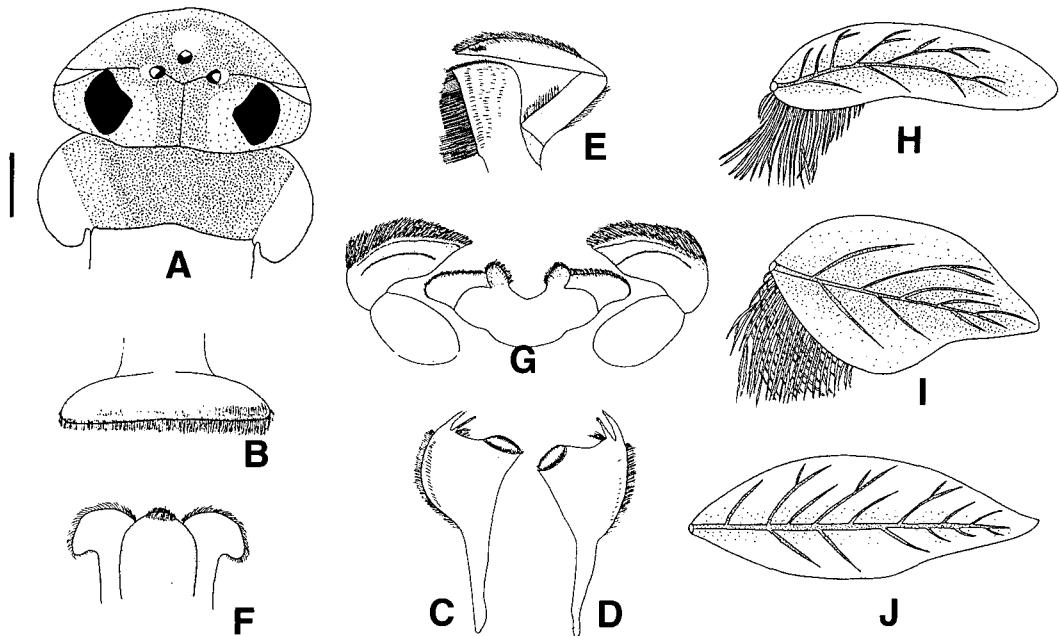
***Thalerosphyrus separatus*, n. sp. (Figs. 3-4)**

**Material examined.** *Holotype:* Female larva (SWU-EPH-3212), VIETNAM, Lao Cai Prov., Sa Pa, Thac Bac Cr. (alt. 2400 m), 19 Oct. 2000 (V. V. Nguyen). *Paratypes:* 8 larvae (SWU-EPH-3213): same data as holotype. *Other materials:* 10 L, Lao Cai Prov., Sa Pa, Thac Bac Cr. (alt. 2300 m), 19 Oct. 2000 (V. V. Nguyen); 2 L, 2 M (reared) & 1 F, Lao Cai Prov., Sa Pa, Cat Cat (alt. 1400 m), 21 Apr. 2002 (V. V. Nguyen, D. H. Hoang & Y. J. Bae); 2 M & 14 F, Lao Cai Prov., Sa Pa, Muong Hoa Ho R., Thac Bac, 2000 m, 22 Apr. 2002, at black light (7-10 pm) (V. V. Nguyen, D. H. Hoang & Y. J. Bae).

**Diagnosis.** The larva of *T. separatus* n. sp. can be distinguished by the combination of the following characters: the pronotum is strongly expanded laterally and posterolaterally; the posterolateral expansions of pronotum are basally separated from the mesonotum (Fig. 3A). The male adult can be distinguished by the Y-shaped penes (Fig. 4C).

**Description. Mature larva.** Male body length 7.9 mm; caudal filaments 12.5 mm. Female body length 11.2 mm; caudal filaments 17.5 mm. Body generally brown, with pale yellow markings. HEAD: Head (Fig. 3A) 2.1 mm in length, and 3.7 mm in width, anteriorly round and posteriorly almost straight, brown, and lighter in color in marginal areas. Compound eyes black; male

compound eyes 0.87 mm in length, 1.10 mm in width, and 0.37 mm in distance between compound eyes; female compound eyes 1.10 mm in length, 1.00 mm in width, and 1.10 mm in distance between compound eyes. Antennae 2.8 mm in length; pedicel brown; flagellum pale yellow. Labrum (Fig. 3B) 1.50 mm in width; anterior margin somewhat concave, with dense hairlike setae; row of stout setae on ventral surface. Mandibles (Fig. 3C, D) lateral margin with dense hairlike setae; medial side of outer incisor serrate; inner incisor slender, with long hairlike setae basally. Maxillae (Fig. 3E) with pectinate setae on crown of galea-lacinia, with rowed long hairlike setae on medial margin, with rowed hairlike setae submedially on ventral surface, and with scattered hairlike setae on apical half of ventral surface; maxillary palp basal segment 0.95 mm, with rowed dense hairlike setae laterally; apical segment 1.40 mm, with rowed hairlike setae along outer margin. Hypopharynx (Fig. 3F) lingua conical, with field of hairlike setae apically; superlinguae expanded laterally, with row of dense hairlike setae. Labium (Fig. 3G) with broad U-shaped separation between glossae, with rowed brown setae on apical margin, with field of hairlike setae anteromedially; paraglossae expanded laterally, with dense hairlike setal field on anterior margin; labial palp basal segment 1.10 mm; apical segment 1.37 mm, with rows of hairlike setae on outer margin. THORAX: Pronotum (Fig. 3A) 4.0 mm in width, wider than head, strongly expanded laterally and posterolaterally; posterolateral expansions basally detached from mesonotum. Legs pale yellow, with brown markings. Midlegs and hindlegs with round and weakly developed supracoxal process. Forefemora pale yellow with dark brown marking apically, with scattered stout setae on anterior margin and dorsal surface, and with stout setae and rowed long hairlike setae on posterior margin; foretibiae and foretarsi with rowed hairlike setae dorsally.

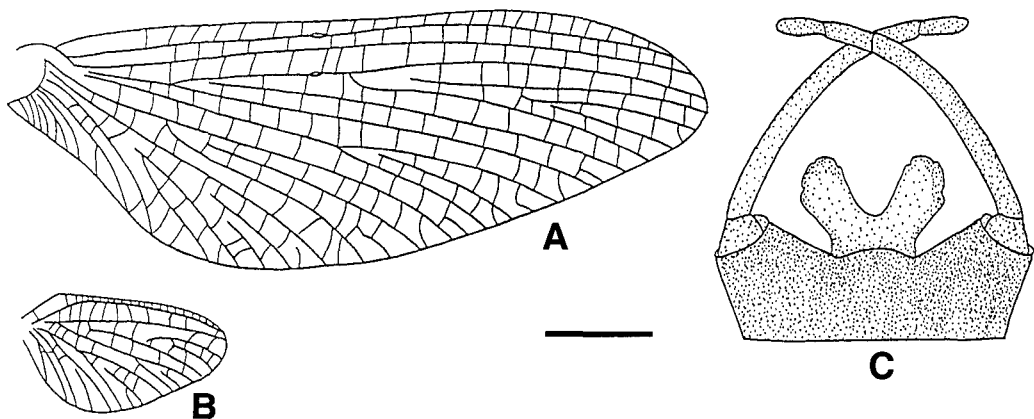


**Fig. 3.** *Thalerosphyrus separatus* n. sp., larva. A, head (bar = 1 mm); B, labrum, C, left mandible; D, right mandible; E, right maxilla; F, hypopharynx; G, labium; H, gill 1; I, gill 3; J, gill 7.

Midlegs and hindlegs similar to forelegs in color pattern and setation. Forefemora 2.7 mm, foretibiae 2.0 mm, foretarsi 0.7 mm, and foreclaws 0.2 mm in length. Midfemora 2.6 mm, midtibiae 1.8 mm, midtarsi 0.6 mm, and midclaws 0.2 mm in length. Hindfemora 2.9 mm, hindtibiae 1.9 mm, hindtarsi 0.5 mm, and hindclaws 0.2 mm in length. ABDOMEN: Terga 1-7 brown with submedian triangular pale yellow markings (submedian markings on terga 4-5 merged and forming large median marking); terga 8-9 pale yellow; terga 1-10 with posteromarginal spines (large and small spines alternating); terga 3-8 with moderately developed posterolateral projections; sterna pale yellow. Gills on abdominal segments 1-7; gills 1-6 (Fig. 3H, I) lamellae elongated, with weakly developed tracheae, with well developed fibrilliform portion; gills 7 (Fig. 3J) lamellae lanceolate, without fibrilliform portion. Caudal filaments ca.  $1.6 \times$  length of body, pale yellow, without bands; each segment with whorl of small stout setae apically.

**Male adult.** Body length 9.1 mm; caudal filaments 27.5 mm. Body brown, with pale markings. HEAD: Compound eyes gray in apical portion and dark gray in basal portion in alcohol, 1.20 mm in dorsal diameter, 0.10 mm in distance between compound eyes. Antennae 0.9 mm, pale yellow. THORAX: Pronotum light brown with reddish brown markings. Forelegs light brown, with joints and foreclaws dark brown; forefemora 2.9 mm, foretibiae 3.1 mm, foretarsi 4.4 mm (each segment 0.9 mm, 1.2 mm, 1.1 mm, 0.7 mm, and 0.5 mm, respectively). Midlegs light yellow basally and light brown apically; midfemora 2.9 mm, midtibiae 2.0 mm, and midtarsi 1.2 mm in length. Hindlegs brown, hindfemora 2.7 mm, hindtibiae 2.2 mm, and hindtarsi 0.9 mm in length. Claws dissimilar. Forewings (Fig. 4A) hyaline, without markings, white in stigmatic area, 13.1 mm in length, 4.8 mm in width; crossveins between C and Sc 24; crossveins between Sc and  $R_1$  21; crossveins between  $R_1$  and  $R_2$  18; bullae present on Sc and  $R_2$ . Hindwings (Fig. 4B) hyaline, without markings, 4.0 mm in length, 2.3 mm in width. ABDOMEN: Terga 1-6 brown, darker in posterior margin; terga 7-10 reddish brown. Genitalia as in Fig. 4C; penes Y-shaped, apicomediaally notched; genital forceps 4-segmented; subgenital plate slightly convex. Cerci light yellow basally, light brown apically, with joints dark brown.

**Female adult.** Body length 9.5 mm; caudal filaments 26.5 mm. Body light brown, with dark



**Fig. 4.** *Thalerosphyrus separatus* n. sp., male adult. A, forewing (bar = 2 mm); B, hindwing (bar = 2 mm); C, genitalia, ventral view.

brown markings. HEAD: Compound eyes black in alcohol. Antennae 1.1 mm; basal segment light yellow with a black spot apically; flagellum white. THORAX: Color as in male. Wing veins stained light brown. ABDOMEN: Similar to male.

**Etymology.** The specific name *separatus* is from *separate* (Latin), an allusion of distinct posterolateral expansions of pronotum in the larva.

**Distribution.** Vietnam.

**Habitat and biology.** Larvae of *T. separatus* occur in high mountain streams ranging 1400–2400 m in altitude in northern Vietnam. The streams are 12–15 m wide and 10–40 cm deep in the dry season (November–April). The water temperature ranges 18–22°C, and pH ranges 7.2–7.8. The larvae are found underneath stones in moderately flowing areas of the streams where the substrate is mostly stony and sandy.

**Remarks.** Although the larva of *T. separatus* does not possess the character of acute and well developed supracoxal processes in midlegs and hindlegs, which is regarded as a synapomorphy of the genus (Wang and McCafferty, 2004), we provisionally assign this species to *Thalerosphyrus* based on general phenetic morphology of the larva.

## ACKNOWLEDGEMENTS

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베트남산 *Thalerosphyrus*속 (하루살이목: 납작하루살이과)의 납작하루살이 2종

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## 요 약

*Thalerosphyrus*에 속하는 2종의 베트남산 납작하루살이 *Thalerosphyrus vietnamensis* (Dang)과 신종인 *T. separatus* n. sp.를 기재하였다. 신종인 *T. separatus*의 유충은 앞가슴 등판의 후측팽창부가 기부에서 분리되어 있고, 수컷 성충은 Y자 모양의 음경으로 구별된다. 두 종의 유충 및 성충기에 대하여 진단 형질의 삽화와 함께 기재하였고, 진단문, 분포, 서식처와 생태자료, 분류적 고찰을 제공하였다.