Tropical Biomedicine 28(3): 577–588 (2011)

Simulium (*Gomphostilbia*) *taitungense*, a new species of black fly (Diptera: Simuliidae) from Taiwan, with description of the male of *Simulium (Gomphostilbia) tuenense* Takaoka

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Received 24 April 2011; received in revised form 17 May 2011; accepted 28 May 2011

Abstract. *Simulium* (*Gomphostilbia*) *taitungense* sp. nov. is described on the basis of reared adult, pupal and mature larval specimens collected from Taitung, Taiwan. This new species is placed in the *ceylonicum* species-group within the subgenus *Gomphostilbia* and is distinguished from related known species by the characteristic colour markings on the ventral surface of the head capsule and on the dorsal surface of the abdomen in the larva. The male of *Simulium (Gomphostilbia) tuenense* Takaoka, which was originally described from a pharate pupa and a larva, is described for the first time; the association of the adult stage with the larval stage was confirmed by the comparison of the sequences of the mitochondrial 16S rRNA gene; this species is also placed in the *ceylonicum* species-group.

INTRODUCTION

The black fly fauna of Taiwan consists of 27 species of the genus *Simulium* Latreille which were placed in the following six subgenera: one in *Eusimulium* Roubaud, three in *Gomphostilbia* Enderlein, one in *Montisimulium* Rubtsov, five in *Nevermannia* Enderlein, 16 in *Simulium* Latreille s. str. and one in *Wallacellum* Takaoka (Shiraki, 1935; Takaoka, 1979; Chung, 1986; Takaoka & Huang, 2006; Huang & Takaoka, 2008a,b, 2009).

Among the three Taiwanese species of the subgenus *Gomphostilbia*, *Simulium (Gomphostilbia) metatarsale* Brunetti, 1911 and *Simulium (Gomphostilbia) shuhaiense* Huang & Takaoka, 2008 were placed in the *ceylonicum* and the *batoense* species-groups, respectively (Takaoka, 1979; Huang & Takaoka, 2008a), and *Simulium (Gomphostilbia) tuenense* Takaoka, 1979, which was originally described from a pharate pupa and a mature larva (Takaoka, 1979), remained unplaced in any species-group though it was tentatively placed in the *batoense* species-group (Adler & Crosskey, 2010).

Recently we collected one more species of the *ceylonicum* species-group from Taitung County, southern Taiwan, which is easily distinguished from *S.* (*G.*) *metatarsale* by the number of enlarged male upper-eye facets and the color markings of the larval head capsule and abdomen. In this paper we describe this species as new to science on the basis of reared adult, pupal and larval specimens. In addition, the male of *S.* (*G.*) *tuenense* is described for the first time based on a specimen reared from a pupa. The association of the male with the larval stage was confirmed by the comparison of the sequence of the mitochondrial 16S rRNA gene extracted from the thorax of the male

with that extracted from the whole body of a mature larva. The sequence of the same gene region of *S.* (*G.*) *tuenense* was compared with those of the new species and *S.* (*G.*) *metatarsale*.

The terms for morphological features used here follow those of Takaoka (2003). The holotype and paratypes are deposited at the Department of Infectious Disease Control, Faculty of Medicine, Oita University, Oita, Japan.

***Simulium* (*Gomphostilbia*) *taitungense* Huang & Takaoka sp. nov.**

DESCRIPTION. **Female**. Body length 2.0–2.3 mm. ***Head***. Slightly narrower than width of thorax. Frons dark brown, not shiny, densely covered with whitish-yellow scale-like recumbent short hairs interspersed with few dark simple longer hairs along each lateral margin; frontal ratio 1.90–1.91:1.00:2.43–2.76; frons-head ratio 1.00:4.30–4.63. Fronto-ocular area (Fig. 1A) well developed, narrow, directed dorsolaterally. Clypeus medium to dark brown, grayish-white pruinose when illuminated at certain angle of light, densely covered with whitish-yellow scale-like recumbent short hairs interspersed with dark longer hairs on lower 3/4. Labrum 0.56–0.60 times as long as clypeus. Antenna composed of scape, pedicel and 9 flagellomeres, medium brown except scape, pedicel, and base of 1st flagellomere whitish-yellow. Maxillary palp composed of 5 segments, light to medium brown, proportional lengths of 3rd, 4th, and 5th segments 1.00:1.14–1.21: 2.58–2.73; 3rd segment (Fig. 1B) somewhat swollen; sensory vesicle (Fig. 1B) ellipsoidal, 0.23–0.33 times as long as 3rd segment, with medium-sized opening. Maxillary lacinia with 11 inner and 16 outer teeth. Mandible (Fig. 1C) with 24–26 inner teeth and 6–8 outer teeth at some distance from apex. Cibarium (Fig. 1D) medially forming sclerotized plate folded forward from posterior margin, with moderately sclerotized medial longitudinal ridge. ***Thorax***. Scutum dark brown, shiny, thinly grayish-white pruinose with 3 faint non-pruinose brownish-black longitudinal vittae (1 medial and 2 submedial) when illuminated dorsally and viewed anteriorly or posteriorly, densely covered with whitish-yellow scale-like recumbent hairs except 3 non-pruinose longitudinal vittae covered with dark brown scale-like recumbent hairs. Scutellum light brown, covered with whitish-yellow short hairs and dark brown long upright hairs along posterior margin. Postnotum medium to dark brown, shiny and grayish-white pruinose when illuminated at certain angle of light, and bare. Pleural membrane bare. Katepisternum medium to dark brown, longer than deep, shiny, grayish-white pruinose when illuminated at certain angle of light, moderately covered with whitish-yellow fine short hairs interspersed with dark fine short hairs. ***Legs***. Foreleg: coxa whitish-yellow; trochanter light brown except base whitish-yellow; femur light brown with apical 1/2 medium brown; tibia whitish-yellow with apical 1/5 dark brown and narrow area along posterior margin somewhat darkened; tarsus brownish-black, with moderate dorsal hair crest; basitarsus moderately dilated, 5.08–5.13 times as long as its greatest width. Midleg: coxa medium brown except posterior surface brownish-black; trochanter whitish-yellow with small area on outer surface light brown; femur light to medium brown with base whitish-yellow; tibia medium to dark brown with basal 1/3 whitish-yellow, densely covered with whitish fine hairs on basal 3/4 of outer surface; tarsus dark brown except basal 1/2 of basitarsus dark yellow. Hind leg: coxa light to medium brown; trochanter whitish-yellow; femur light to medium brown with base whitish-yellow and apical cap dark brown; tibia (Fig. 1E) light to dark brown with slightly less than basal 1/2 whitish-yellow and apical cap brownish-black, densely covered with whitish fine hairs on basal 3/4 on outer and posterior surface; tarsus dark brown to brownish-black except basal 3/5 of basitarsus (though base medium brown) and basal 1/2 of 2nd tarsomere whitish-yellow; basitarsus (Fig. 1F) narrow, nearly parallel-sided, 5.73–5.80 times as long as wide, and 0.63–0.67 and 0.54–0.58 times as wide as greatest width of tibia and femur, respectively; calcipala (Fig. 1F) nearly as long as wide, and 0.52 times as wide as greatest width of basitarsus. Pedisulcus (Fig. 1F) well defined. Claw (Fig. 1G) with large basal tooth 0.49 times as long as claw. ***Wing***.

Length 2.0 mm. Costa with dark spinules and hairs except hairs on basal portion yellow. Subcosta with dark hairs except apical 1/6 bare. Hair tuft on stem vein whitish-yellow. Basal portion of radius fully haired; R_1 with dark spinules and hairs; R_2 with hairs only. Basal cell absent. ***Abdomen***. Basal scale light brown, with fringe of whitish-yellow hairs. Dorsal surface of abdomen dark brown to brownish-black except basal 4/5 of segment 2 whitish-yellow, moderately covered with dark short to long hairs; tergite of segment 2 shiny, silvery iridescent when illuminated at certain angle of light, and tergites of segments 6–9 shiny, bluish iridescent when illuminated at certain angle of light. Ventral surface of segment 2 entirely whitish-yellow, and those of other segments medium to dark brown; sternal plate on segment 7 undeveloped. ***Genitalia***. Sternite 8 (Fig. 1H) bare medially, with 26–34 medium-long to very long hairs together with few slender short hairs on each side. Ovipositor valves (Fig. 1H) triangular (though medioposterior corners rounded), thin, membranous, moderately covered with microsetae interspersed with 3 or 4 short hairs; inner margins straight or very slightly sinuous, slightly sclerotized, and moderately separated from each other. Genital fork (Fig. 1I) of usual inverted-Y form, with slender stem; arms of moderate width and moderately folded medially. Paraproct in ventral view (Fig. 1J) nearly triangular, pointed medially, with 2–6 sensilla on anteromedial surface; paraproct in lateral view (Fig. 1K) somewhat

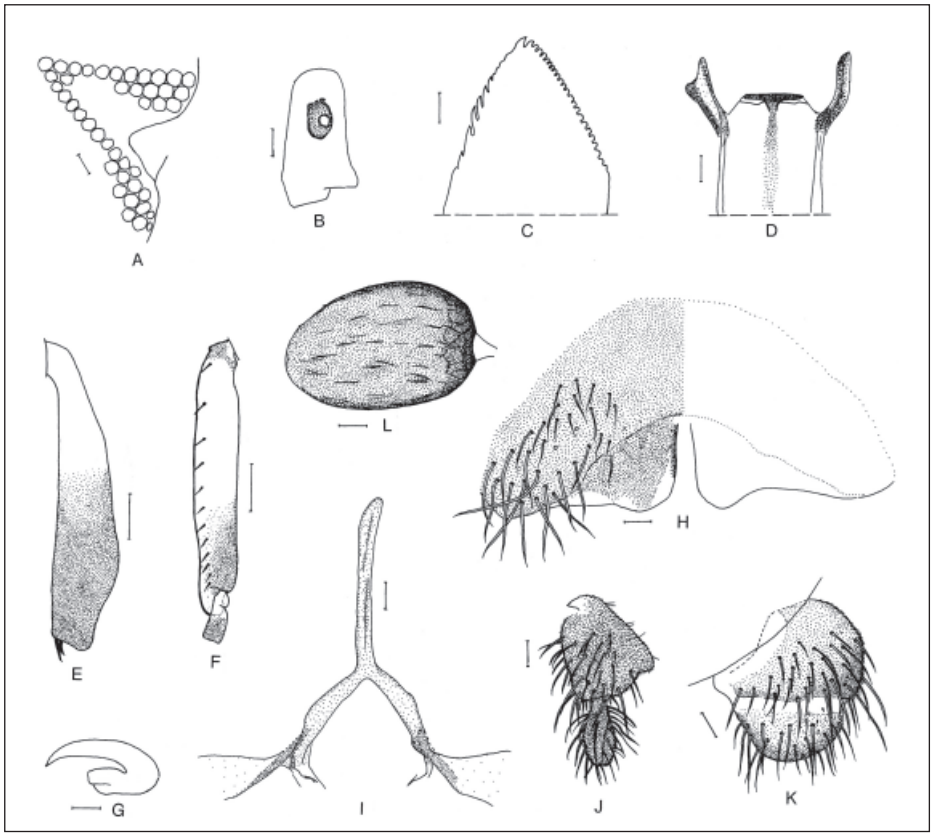

Figure 1. Female of *Simulium* (*Gomphostilbia*) *taitungense* sp. nov. A, fronto-ocular area (right side); B, 3rd segment of right maxillary palp with sensory vesicle (front view); C, mandible; D, cibarium; E, left hind tibia (outer view); F, basitarsus and 2nd tarsomere of left hind leg showing calcipala and pedisulcus (outer view); G, claw; H, sternite 8 and ovipositor valves (ventral view); I, genital fork (ventral view); J and K, right paraprocts and cerci (J, ventral view; K, lateral view); L, spermatheca (lateral view). Scale bars. 0.1 mm for E and F; 0.02 mm for A, B, D and H–L; 0.01 mm for C and G

produced ventrally, 0.58–0.87 times as long as wide, with 26–30 medium-long to long hairs on ventral and lateral surface. Cercus in lateral view (Fig. 1K) short, rounded posteriorly, 0.45–0.46 times as long as wide. Spermatheca (Fig. 1L) ellipsoidal, 1.45–1.48 times as long as its greatest width, well sclerotized except duct and small area near juncture with duct unsclerotized, and with many fissures on surface; internal setae absent; both accessory ducts slender, slightly larger in diameter than major one.

Male. Body length 2.0–2.3 mm. ***Head***. Wider than thorax. Upper eye consisting of 15 vertical columns and 15 or 16 horizontal rows of large facets. Face dark brown, grayish-white pruinose. Clypeus dark brown, whitish pruinose, densely covered with golden yellow scale-like medium-long hairs (mostly directed upward) interspersed with several dark brown simple longer hairs. Antenna composed of scape, pedicel and 9 flagellomeres, yellowish except 5 apical flagellomeres medium brown when viewed anteriorly, or light to medium brown except scape, pedicel and base of 1st flagellomere yellowish when viewed posteriorly; 1st flagellomere elongate, 1.72–1.86 times as long as 2nd one. Maxillary palp light to medium brown, with 5 segments, proportional lengths of 3rd, 4th, and 5th segments 1.00:1.06–1.28:2.49–2.81; 3rd segment (Fig. 2A) widened apically; sensory vesicle (Fig. 2A) globular, 0.16 times as long as 3rd segment, and with very small opening. ***Thorax***. Scutum dark brown, shiny, grayish-white pruinose leaving 3 longitudinal vittae (1 medial, 2 submedial) non-pruinose when illuminated at certain angle of light; scutum densely covered with golden yellow recumbent short hairs. Scutellum medium brown, with golden yellow short hairs and dark brown long upright hairs along posterior margin. Postnotum dark brown, whitish to bluish pruinose and slightly shiny when illuminated at certain angle of light, and bare. Pleural membrane and katepisternum as in female. ***Legs***. Foreleg: coxa yellow; trochanter dark yellow to light brown; femur light brown with apical cap medium brown; tibia light brown with apical 1/4 medium brown and basal 3/4 of outer surface yellow; tarsus brownish-black; basitarsus moderately dilated, 6.40 times as long as its greatest width. Midleg: coxa medium brown except posterior surface brownish-black; trochanter yellow to light brown; femur light brown; tibia dark brown except basal 1/4 yellow; tarsus dark brown except basal 1/3 of basitarsus yellow (though border not well defined). Hind leg: coxa light brown; trochanter yellow; femur medium brown with base yellow and apical cap dark brown; tibia (Fig. 2B) dark brown to brownish-black except basal 2/5 yellow; tarsus (Fig. 2C) dark brown to brownish-black except basal 1/2 of basitarsus and basal 1/2 of 2nd tarsomere yellow; basitarsus (Fig. 2C) enlarged, widened from base to basal 1/3, nearly parallel-sided medially, then narrowed from apical 1/4 to apex, 3.95–4.13 times as long as wide, and 0.83–0.84 and 0.87–0.89 times as wide as greatest widths of tibia and femur, respectively; calcipala (Fig. 2C) nearly as long as wide, and 0.26 times as wide as greatest width of basitarsus. Pedisulcus (Fig. 2C) well defined. ***Wing***. As in female except subcosta bare or with few hairs. ***Abdomen***. Basal scale medium brown, with fringe of light to medium brown hairs. Dorsal surface of abdomen medium brown to brownish-black except anterior 1/2 of segment 2 yellow, covered with dark brown short to long hairs; segments 2 and 5–7 each with pair of shiny whitish to bluish pruinose dorsolateral patches, of which those on segment 2 broadly connected in middle to each other, those on segments 5 and 6 narrowly connected to each other along anterior margin and those on segment 7 not connected; ventral surface of segment 2 yellowish-white, those of other segments medium to dark brown. ***Genitalia***. Coxite in ventral view (Fig. 2D) nearly rectangular, 1.75 times as long as its greatest width. Style in medial view (Fig. 2E) slender, 0.75 times as long as coxite, gently bent inward, nearly parallel-sided, with apical spine (additional small spine in right style of 1 male); style in ventrolateral view (Fig. 2F) and in end view (Fig. 2G) slightly tapered to apex. Ventral plate in ventral view (Fig. 2D) with body transverse, 0.54 times as long as wide, with anterior margin produced anteromedially, lateral margins slightly

concave medially and posterior margin slightly concave medially (though ventral plate slightly produced posteromedially when viewed at slightly different angle, Fig. 2H), densely covered with microsetae on ventral surface; basal arms of moderate length, directed forward, then slightly convergent apically; ventral plate in lateral view (Fig. 2I) moderately produced ventrally; ventral plate in end view (Fig. 2J) rounded ventrally, densely covered with microsetae on posterior surface. Median sclerite (Fig. 2H,K) thin, plate-like, wide. Paramere (Fig. 2L,M) of moderate size, each with 3 distinct long and stout hooks and several smaller ones close together near apex. Aedeagal membrane (Fig. 2M) sparsely setose, not sclerotized at base without pigmented dorsal plate. Ventral surface of abdominal segment 10 (Fig. 2N,O) without distinct hairs near posterior margin. Cercus (Fig. 2N,O) rounded, with 14–16 hairs.

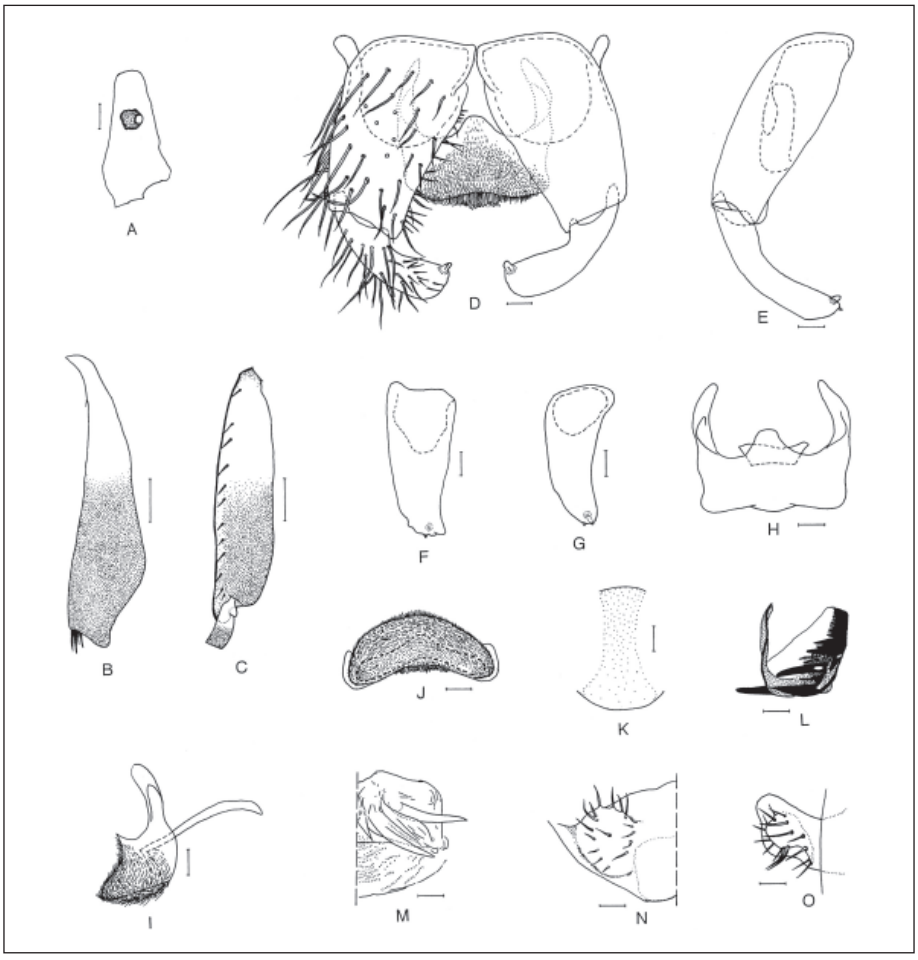

Figure 2. Male of *Simulium* (*Gomphostilbia*) *taitungense* sp. nov. A, 3rd segment of left maxillary palp with sensory vesicle (front view); B, hind tibia (left side and outer view); C, basitarsus and 2nd tarsomere of left hind leg showing calcipala and pedisulcus (outer view); D, coxites, styles, ventral plate and median sclerite (ventral view); E, right coxite and style (medial view); F and G, right styles (F, ventrolateral view; G, end view); H and I, ventral plates and median sclerites (H, ventral view though slightly different from that of Fig. 2D, microsetae on ventral surface omitted; I, lateral view); J, ventral plate (end view); K, median sclerite (anterior view); L, left paramere (dorsal view); M, paramere and aedeagal membrane (left side and end view); N and O, 10th abdominal segments and cerci (N, right side and end view; O, left side and lateral view). Scale bars. 0.1 mm for B and C; 0.02 mm for A and D–O

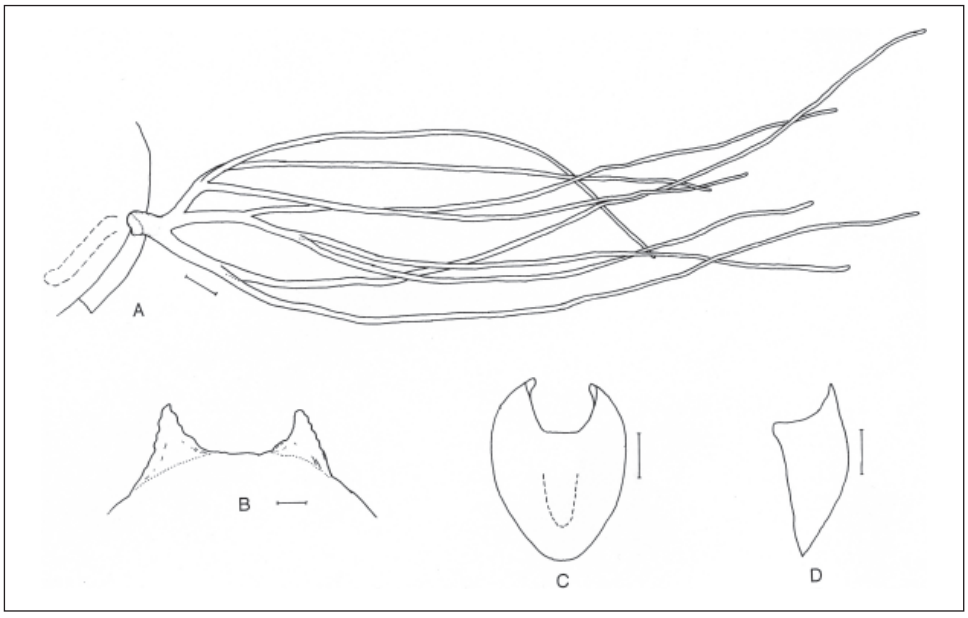

Figure 3. Pupa of *Simulium* (*Gomphostilbia*) *taitungense* sp. nov. A, right gill filaments (outer view); B, terminal hooks (end view); C and D, cocoons (C, dorsal view; D, lateral view). Scale bars. 1.0 mm for C and D; 0.1 mm for A; 0.01 mm for B

Pupa. Body length 2.2–2.5 mm. ***Head***. Integument light yellow, moderately covered with small round tubercles on frons and each lateral surface but bare on antennal sheath and ventral surface of face; antennal sheath without any protuberances; face with pair of simple long trichomes with coiled or uncoiled apices, and frons with 3 pairs of simple very long trichomes with uncoiled apices; 3 frontal trichomes on each side arising close together, subequal in length to one another and longer than facial one. ***Thorax***. Integument yellow to yellowish-brown, moderately covered with round tubercles except dorsomedial wide area sparsely covered with tubercles, with 3 simple very long dorsomedial trichomes with coiled or uncoiled apices, 2 simple anterolateral trichomes (1 very long with coiled apex, 1 long with uncoiled apex), 1 simple medium-long posterolateral trichome with uncoiled apex, and 3 simple ventrolateral trichomes with uncoiled apices (1 medium-long and 2 short) on each side. Gill (Fig. 3A) composed of 8 slender thread-like filaments, longer than pupal body, arranged as [(1+2)+(1+2)]+2 or [3+(1+2)]+2 filaments from dorsal to ventral, with somewhat swollen transparent organ ventrally (partially broken) at base; dorsal and middle triplets share very short to short stalk arising from short common basal stalk; dorsal triplet composed of 1 individual and 2 paired filaments with short stalk or rarely 3 individual filaments arising at same level; middle triplet composed of 1 individual and 2 paired filaments with short stalk; stalk of ventral paired filaments of medium length, slightly thinner than interspiracular trunk, and somewhat thicker than primary stalk of middle triplet which is somewhat thicker than stalk of dorsal triplet; stalk of dorsal triplet lying against that of lower pair at angle of 90 degrees or slightly less when viewed laterally; all filaments light to medium brown, gradually tapered toward apex; 3 filaments of dorsal triplet subequal in length (2.0–2.5 mm long) and thickness to one another, those of middle triplet subequal in length (2.3–2.6 mm long) and thickness to one another, and 2 filaments of ventral pair subequal in length (2.7–3.0 mm long) and thickness to each other and much longer and thicker than 6 other filaments of dorsal and middle triplets; cuticle of all filaments with well-marked annular ridges and furrows though becoming less marked apically, densely covered with

minute tubercles. ***Abdomen***. Dorsally, segments 1 and 2 light brown and without tubercles; segment 1 with 1 simple slender medium-long hair-like seta on each side; segment 2 with 1 simple slender medium-long hair-like seta and 5 very short somewhat spinous setae submedially on each side; segments 3 and 4 each with 4 hooked spines (segment 3 with 3 hooked spines on each side and segment 4 with 3 hooked spines on left side and 4 hooked spines on right side in 1 pupa) and 1 very short somewhat spinous seta on each side; segment 5 lacking spine-combs (with 1 or 2 spine on each side in 1 pupa); segments 6–9 each with spine-combs in transverse row and comb-like groups of minute spines on each side; segment 9 with pair of distinct triangular flat terminal hooks of which outer margin is undulate when viewed posteriorly (Fig. 3B). Ventrally, segment 4 with 2 simple hooks and few simple slender very short setae on each side; segment 5 with pair of bifid hooks submedially and few very short simple slender setae on each side; segments 6 and 7 each with pair of bifid inner and simple outer hooks somewhat spaced from each other and few very short simple slender setae on each side; segments 4–8 with comb-like groups of minute spines. Each side of segment 9 with 3 grapnel-shaped hooklets. ***Cocoon*** (Fig. 3C,D). Wall-pocket-shaped, thinly and neatly woven, extended ventrolaterally; anterior margin somewhat thickly woven, posterior 1/2 with floor roughly or moderately woven; individual threads invisible; 3.5–4.0 mm long by 2.0–2.2 mm wide.

Mature larva. Body length 4.3–5.6 mm. Body colour creamy though thoracic segment 1 nearly entirely light gray, thoracic segments 2 and 3 light to dark gray on ventral surface, abdominal segments 1–4 entirely light gray, and other abdominal segments light gray on dorsal and dorsolateral surface; distinctive reddish-brown markings present: i.e., abdominal segments 3 and 4 rarely with spot on each lateral surface, abdominal segments 5 and 6 each with round medial spot connected or unconnected to transverse band on each side of dorsal surface, and abdominal segments 7–9 usually with colored area on each dorsolateral surface (Fig. 4A,B). Cephalic apotome (Fig. 4C) pale yellow, with positive head spots though intensity of darkness varying by spots: anteromedial and lateromedial spots usually very faintly to moderately darkened and rarely almost indistinct, posteromedial and posterolateral spots usually moderately to markedly darkened; lateral surface of head capsule pale yellow except dark brown wide area along posterior margin and 1 or 2 dark brown isolated spots below eye-spot region; ventral surface of head capsule pale yellow except medial area dark brown in form of letter X (Fig. 4D). Antenna composed of 3 segments and apical sensillum, somewhat longer than stem of labral fan; proportional lengths of 1st, 2nd, and 3rd segments 1.00:0.78–0.83:0.86–1.00; unpigmented secondary annular bands absent. Labral fan with 33–41 main rays. Mandible (Fig. 4E) with 1st comb-tooth much longer than 2nd comb-tooth, which is slightly longer than 3rd one; mandibular serration composed of 2 teeth (1 medium-sized and 1 small); major tooth at acute angle against mandible on apical side; supernumerary serrations absent. Hypostoma (Fig. 4F) with row of 9 apical teeth; median and each corner tooth prominent, subequal in length to each other, and much longer than 3 intermediate teeth on each side; lateral margin smooth; 4 or 5 hypostomal bristles per side, lying parallel to lateral margin. Postgenal cleft (Fig. 4D,G) varying in size (0.96–1.75 times as long as postgenal bridge), and in shape (anterior margin nearly straight or rounded or somewhat pointed medially). Cervical sclerite composed of 2 yellow slender rod-like pieces, not fused to occiput, widely separated medially from each other. Thoracic cuticle bare. Abdominal cuticle almost bare except few posterior segments sparsely covered with simple colorless minute setae dorsally and last segment moderately covered with similar setae on each side of anal sclerite. Rectal scales absent. Rectal papilla compound, each of 3 lobes with 5–7 finger-like secondary lobules. Anal sclerite of usual X-form, with anterior arms subequal in length to posterior ones, broadly sclerotized at base; accessory sclerite absent. Last abdominal segment expanded ventrolaterally forming double

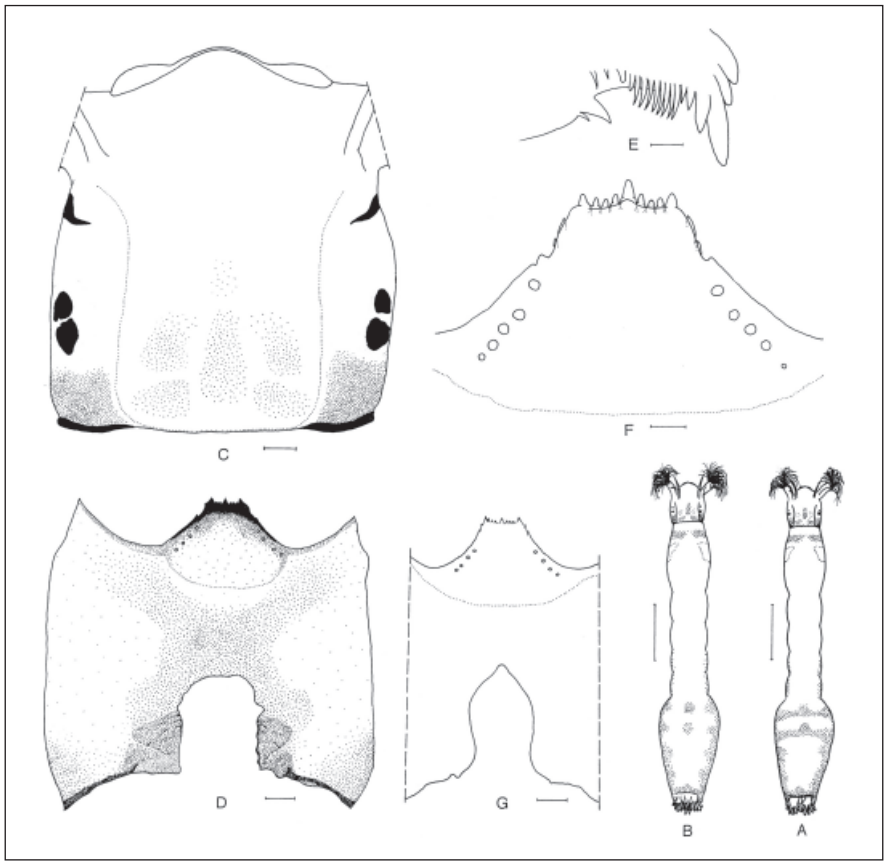

Figure 4. Mature larva of *Simulium* (*Gomphostilbia*) *taitungense* sp. nov. A and B, whole body (dorsal view); C, head capsule (dorsal view); D, head capsule showing X-shaped dark marking and postgenal cleft with anterior margin nearly straight (ventral view); E, apical portion of mandible; F, hypostoma; G, middle portion of ventral surface of head capsule showing postgenal cleft with pointed apex. Scale bars. 1.0 mm for A and B; 0.05 mm for C, D and G; 0.02 mm for F; 0.01 mm for E

bulges on each side, visible as large conical ventral papilla when viewed from side. Posterior circlet with 82–84 rows of up to 12 hooklets per row.

TYPE SPECIMENS. Holotype female (with associated pupal exuviae and cocoon) (preserved in 80% ethanol) reared from pupa, collected from a small slow-flowing stream (width 0.3 m, exposed to sun, altitude 320 m) densely covered by grasses, Hongye, Yanping, Taitung County, Taiwan, 1. II. 2008, by Y.T. Huang. Paratypes: 4 females, 3 males (all with associated pupal exuviae and cocoons), 8 pupae and 4 mature larvae, same data as those of the holotype; 3 females, 3 males (with associated pupal exuviae and cocoons) and 7 mature larvae, collected from a small slow-flowing stream (width 0.3 m, exposed to sun, altitude 781 m), Wulu, Haiduan, Taitung County, Taiwan, 1. II. 2008, by Y.T. Huang; 2 males (with associated pupal exuviae and cocoons) and 5 mature larvae, collected from a small slow-flowing stream (width 0.5–1.0 m, partially shaded, altitude 153 m), Leshan, Taimali, Taitung County, Taiwan, 2. II. 2008, by Y.T. Huang; 4 females, 3 males (with associated pupal exuviae and cocoons) and 5 mature larvae, collected from a small slow-flowing stream (width 1.5–2.0 m, partially shaded, altitude 79 m), Shihmen, Mudan, Pingtung County, Taiwan, 3. II. 2008, by Y.T. Huang.

ECOLOGICAL NOTES. The pupae and larvae of this new species were collected from fallen tree leaves in the water, together with *S.* (*G.*) *syuhaiense*, and *Simulium* (*Nevermannia*) *chitoense* Takaoka.

ETYMOLOGY. The species name *taitungense* refers to the name of the county, Taitung, where this new species was collected.

REMARKS. According to the keys (Takaoka, 2003), S. (*G.*) *taitungense* sp. nov. is readily assigned to the *ceylonicum* species-group within the subgenus *Gomphostilbia* by having the adult antenna with 11 segments, pleural membrane bare, katepisternum haired, female claw with a large basal tooth (Fig. 1G), male hind basitarsus enlarged (Fig. 2C), and eight gill filaments (Fig. 3A).

This new species is characterized in the male by the greater number of the upper-eye facets, i.e. 15 vertical columns and 15 or 16 horizontal rows, and the spindle-shaped hind basitarsus (Fig. 2C) which is, though, somewhat narrower than the hind tibia, and in the larva by the dark X-shaped markings around the postgenal cleft (Fig. 4D), as well as the distinct reddish-brown markings on the dorsal surface of abdominal segments 5 and 6 (Fig. 4A,B).

None of the 41 described species of the *ceylonicum* species-group listed in Adler & Crosskey (2010) has such a great number of the vertical columns or horizontal rows in the male upper-eye facets except two species, *Simulium (Gomphostilbia) inthanonense* Takaoka & Suzuki, 1984 described from Thailand, and *Simulium (Gomphostilbia) sofiani* Takaoka & Hashim, 2011 desribed from peninsular Malaysia, which have the enlarged male upper-eye facets in 15 or 16 vertical columns and 15 or 16 horizonal rows (Takaoka & Suzuki, 1984; Takaoka *et al.*, 2011) and five other species, i.e., *Simulium (Gomphostilbia) jianfengense* Long, An & Hao, 1994 from China, *Simulium (Gomphostilbia) doisaketense* Jitklang *et al.*, 2008, from Thailand, *Simulium (Gomphostilbia) laoshanstum* Ren, An & Kang, 1998 from China, *Simulium (Gomphostilbia) nepalense* Lewis, 1964 from Nepal, and *Simulium (Gomphostilbia) ogatai* (Rubtsov, 1962) from Japan, of which relevant data on the enlarged male upper-eye facets are not available. However, *S. (G.) jianfengense* and *S. (G.) laoshanstum* differ from this new species by the wedge-shaped male hind basitarsus and the larval postgenal cleft which is twice as long as the postgenal cleft (Chen & An, 2003); *S.* (*G.*) *doisaketense*, which is known only from pupal and larval specimens, differs in the larva by the abdomen without any reddish-brown markings (Jitklang *et al.*, 2008); *S.* (*G.*) *nepalense* differs from this new species by the shape of the ventral plate of which the ventral margin is concave medially when viewed posteriorly (Lewis, 1964); *S.* (*G.*) *inthanonense* and *S.* (*G.*) *ogatai* differ by having a cocoon with an anterodorsal projection (Takaoka & Suzuki, 1984; Rubtsov, 1959–1964); *S.* (*G.*) *sofiani* differs from this new species by the long common basal stalk and the absence of the dark marking on the ventral surface of the larval head capsule (Takaoka *et al.*, 2011)

Simulium (*G.*) *dudgeoni* Takaoka and Davies described from female and male specimens collected from Hong Kong, appears to be somewhat related to *S.* (*G.*) *taitungense* sp. nov. in having the similar spindle-shaped male hind basitarsus and also a nearly similar number of enlarged male upper-eye facets (i.e., 13 or 14 vertical columns and 15 or 16 horizontal rows), but is distinguished by the entirely darkened male hind tibia and the ventral plate which is widened posteriorly when viewed ventrally (Takaoka *et al.*, 1995). In addition, *Simulium (Gomphostiibia) namense* Takaoka, described from adult specimens collected from Myanmar, shows a nearly similar number of enlarged male upper-eye facets (i.e., 14 vertical columns and 15 horizontal rows) but differs by having the male hind basitarsus wedge-shaped (Takaoka, 1989).

***Simulium* (*Gomphostilbia*) *tuenense* Takaoka**

Simulium (*Gomphostilbia*) *tuenense* Takaoka, 1979: 387–388 (pharate pupa and larva).

This species was originally described from a pharate pupa and a mature larva

collected near Sun Moon Lake, Taiwan (Takaoka, 1979). This species is similar in the pupal stage to *S.* (*G.*) *metatarsale* but is readily distinguished in the larval stage from the latter species by possessing the characteristic colour markings on the abdomen (i.e., abdomen creamy except segments 1 and 2 each encircled by a broad dark gray band, segments 7 and 8 mostly or partially gray on dorsal and dorsolateral surface, and segments 5 and 6 each with a reddish-brown transverse band, though often broken to various extent submedially, on the dorsal surface, as shown in Fig. 5E)(Takaoka, 1979). In this study, the male of *S.* (*G.*) *tuenense* is described on the basis of one male reared from a pupa. The morphological identification of the male was confirmed by the fact that there was no difference in the sequence of the mitochondrial 16S rRNA gene (516 bp) between the male (Genbank Accession Number: AB591245) and the mature larva of *S.* (*G.*) *tuenense* (Genbank Accession Number: AB591244).

The gene sequence of *S.* (*G.*) *tuenense* differs from that (516 bp) of *S.* (*G.*) *taitungense* sp. nov. (Genbank Accession Number: AB591243) by 8 bp and from that (514 bp) of *S.* (*G.*) *metatarsale* (Genbank Accession Number: AB591242) by 13 bp.

DESCRIPTION. **Male**. Nearly as in *S.* (*G.*) *taitungense* sp. nov. except following features: Body length 2.3 mm. ***Head***. Slightly wider than thorax. Upper eye consisting of 16 vertical columns and 16 horizontal rows of large facets; face and clypeus medium brown; 1st flagellomere of antenna 1.79 times as long as 2nd one; proportional lengths of 3rd, 4th, and 5th segments of maxillary palp 1.00:1.12–1.16:2.58; 3rd segment widened apically; sensory vesicle globular, 0.15–0.16 times as long as 3rd segment, and with very small opening. ***Thorax***. Scutum medium brown. ***Legs***. Foreleg: coxa and trochanter whitish-yellow; femur medium brown with apical cap light brown; tibia light brown with apical 1/4 medium brown; tarsus brownish-black; basitarsus moderately dilated, 6.89 times as long as its greatest width. Midleg: coxa medium brown except posterior surface brownish-black; trochanter yellow to light brown; femur light to medium brown; tibia light to medium brown except basal 1/4 yellow; tarsus medium brown except basal 1/3 of basitarsus yellow (though border not well defined). Hind leg: coxa light brown; trochanter yellow; femur medium brown with base yellow and apical cap dark brown; tibia (Fig. 5A) yellow on basal 2/5, with light brown subbasal band, and dark brown on apical 3/5; tarsus dark brown except basal 1/2 of basitarsus and basal 1/2 of 2nd tarsomere yellow; basitarsus (Fig. 5B) enlarged, widened from base to basal 1/3, nearly parallel-sided medially, then narrowed from apical 1/4 to apex, 4.04 times as long as wide, and 0.81 and 0.86 times as wide as greatest width of tibia and femur, respectively; calcipala nearly as long as wide, and 0.36 times as wide as greatest width of basitarsus. Pedisulcus well defined. ***Wing***. Length 2.0 mm. ***Genitalia***. Coxite in ventral view 1.78 times as long as its greatest width. Style slender, 0.79 times as long as coxite. Ventral plate in ventral view (Fig. 5C) with body transverse, 0.57 times as long as wide, with lateral margins nearly straight. Cercus with 13 hairs.

SPECIMENS EXAMINED. One male (with associated pupal exuviae and cocoon) (preserved in 80% ethanol), reared from pupa, and 12 mature larvae, collected from a small irrigation canal (width 0.6 m, water temperature 13ºC, exposed to the sun) slowly flowing along the road, Shuanglienpi, Yilan County, Taiwan, 2. III. 2006, by Y.T. Huang and H. Takaoka.

ECOLOGICAL NOTES. The pupa and larvae of this new species were collected from grass leaves trailing in the water, together with *S.* (*G.*) *metatarsale*, *S.* (*G.*) sp. and *S.* (*N.*) *aureohirtum* Brunetti.

REMARKS. In this study, *S.* (*G.*) *tuenense* is confirmed to be assigned to the subgenus *Gomphostilbia* by having the basal portion of the radial vein haired, the pleural membrane bare and the katepisternum haired in the male, and is reliably placed in the *ceylonicum* species-group by having the enlarged male hind basitarsus (Fig. 5B).

The male of *S.* (*G.*) *tuenense* described here is very similar to that of *S.* (*G.*) *taitungense* sp. nov. but barely distinguished from the latter species by the hind tibia with

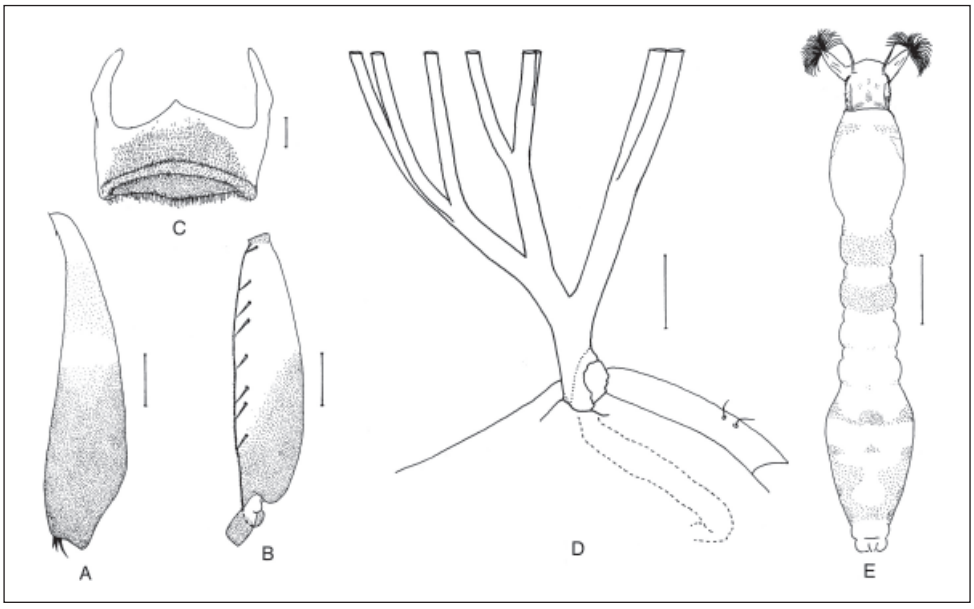

Figure 5. Male, pupa and larva of *Simulium* (*Gomphostilbia*) *tuenense* Takaoka. A, left male hind tibia (outer view); B, left male hind basitarsus (outer view); C, male ventral plate (ventral view); D, basal portion of right pupal gill filaments (outer view); E, whole body of larva showing distinct colour markings (dorsal view). Scale bars. 1.0 mm for E; 0.1 mm for A, B and D; 0.02 mm for C

a dark subbasal band (Fig. 5A) and the ventral plate with lateral margins not concave (Fig. 5C). On the other hand, the male of this species is readily distinguished from that of *S.* (*G.*) *metatarsale* by the numbers of the enlarged upper-eye facets (16 vertical columns and 16 horizontal rows in this species versus 11 or 12 vertical columns and 13 or 14 horizontal rows in *S.* (*G.*) *metatarsale*) and the shape of the hind basitarsus (spindle-shaped in this species versus wedge-shaped in *S.* (*G.*) *metatarsale*).

The pupa of *S.* (*G.*) *tuenense* is very similar to those of *S.* (*G.*) *taitungense* sp. nov. and *S.* (*G.*) *metatarsale* in many features including the simple cocoon and the arrangement of the gill filaments (Fig. 5D) although there seems to be a slight difference in the thoracic integument, of which most of the dorsomedial portion is moderately covered with round tubercles in *S.* (*G.*) *tuenense* and *S.* (*G.*) *metatarsale* but sparsely in *S.* (*G.*) *taitungense* sp. nov.

The mature larvae of these three species are easily distinguished by the colour markings on the abdomen [i.e., dark gray bands on abdominal segments 1 and 2 (Fig. 5E) in *S.* (*G.*) *tuenense*, neither dark gray bands nor distinct reddish-brown markings in *S.* (*G.*) *metatarsale* and no dark gray band on abdominal segments 1 and 2 (Fig. 4A,B) in *S.* (*G.*) *taitungense* sp. nov.].

Acknowledgements. We are grateful to Dr. C.L. Chung, Center for Disease Control, R.O.C., Taiwan, and Prof. K.J. Lin, National Chiayi University, Taiwan, who kindly supported our surveys. Thanks are due to Mr. W.L. Wu, Fo Guang College of Humanities and Social Sciences, for his kind cooperation in surveys in Yilan County. Our sincere appreciation goes to Prof. P.H. Adler, Clemson University, Clemson, USA, for reading the current manuscript and providing valuable comments.

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