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MORPHOLOGY, SYSTEMATICS, EVOLUTION

Two New Species of *Simulium* (*Gomphostilbia*) (Diptera: Simuliidae) From Peninsular Malaysia

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ABSTRACT Two new species of black flies, *Simulium* (*Gomphostilbia*) *terengganuense* sp. nov. and *Simulium* (*Gomphostilbia*) *aziruni* sp. nov. (Diptera: Simuliidae), are described on the basis of reared adult, pupal, and larval specimens collected from Peninsular Malaysia. Both species are placed in the *batoense* species-group within the subgenus *Gomphostilbia*, one of two dominant subgenera of the genus *Simulium* in Peninsular Malaysia as well as in the Oriental Region. Strikingly, three morphological characteristics that rarely occur in the subgenus *Gomphostilbia* are found in these two new species: the very narrow female frons and the mushroom-like pupal terminal hooks in *S.* (*G.*) *terengganuense* sp. nov. and the pupal gill composed of an inflated horn-like structure and eight slender filaments in *S.* (*G.*) *aziruni* sp. nov.

KEY WORDS black fly, Malaysia, *Simulium*, new species

The fauna of black flies (Diptera: Simuliidae) in Peninsular Malaysia is represented by 41 named and three unnamed species, all of which are classified in the genus *Simulium* Latreille and are further placed in four subgenera: one species in *Daviesellum* Takaoka & Adler, 20 species (19 named and one unnamed) in *Gomphostilbia* Enderlein, four species in *Nevermannia* Enderlein, and 19 species (17 named and two unnamed) in *Simulium* Latreille (Edwards 1928; Crosskey 1973; Takaoka and Davies 1995, 1997; Takaoka and Adler 1997; Takaoka 2000, 2008a; Takaoka et al. 2010a, 2011a,b, 2012; Adler and Crosskey 2011).

In recent surveys of pupae and larvae of black flies in Peninsular Malaysia, we collected two new species, both of which are assignable to the subgenus *Gomphostilbia*, redefined by Takaoka (2003). One of the two new species is very similar to *Simulium* (*Gomphostilbia*) *sheilae* Takaoka & Davies, 1995, originally described from Peninsular Malaysia, in the arrangement of the eight pupal gill filaments, one of the key morphological features most frequently used to identify the species in the pupal stage (Takaoka and Davies 1995). However, it is readily distinguished in the pupa from *S.* (*G.*) *sheilae* and the other 19 Peninsular Malaysian species of the subgenus *Gomphostilbia* by the mushroom-like terminal hooks. The other new species, of which only one pupal exuviae and one mature larva are available, is distinctive with the pupa having the gill composed of an inflated horn-like structure and eight slender filaments, a characteristic rarely occurring in the subgenus *Gomphostilbia*.

These two new species are described here on the basis of five adults reared from pupae, nine pupal exuviae and cocoons and eight mature larvae, and one pupal exuviae with its cocoon and one mature larva, respectively. The methods of collection, description, and illustration, as well as terms for morphological features used here, follow those of Takaoka (2003). The holotypes and paratypes are deposited at the Institute of Biological Sciences, Faculty of Science, University of Malaya, Kuala Lumpur, Malaysia.

*Simulium* (*Gomphostilbia*) *terengganuense* Takaoka, Sofian-Azirun & Ya’Cob sp. nov.

Female. Body length 2.4–2.6 mm. Head. Slightly wider than width of thorax. Frons (Fig. 1A) very narrow, with narrowest width in middle, black, moderately covered with whitish yellow scale-like recurved short hairs interspersed with few dark simple longer hairs along each lateral margin; frontal ratio 1.41–1.58:1.00–4.35–5.00; frons-head ratio 1.00:5.04–8.32. Fronto-ocular area (Fig. 1A) well developed, narrow, directed dorsolaterally. Clypeus black, gray pruinose, densely covered with yellow hairs interspersed with several dark longer hairs on each side. Labrum 0.50–0.57 times as long as clypeus. Antenna composed of scape, pedicel, and nine flagellomeres, scape yellow, pedicel yellow except little less than apical one half medium brown, and flagellomeres greyish brown except base of first flagellomere whitish yellow. Maxillary palp composed of five segments, light to medium brown, proportional lengths of third, fourth, and fifth segments 1.00:1.16–1.19:2.20–2.91.
third segment (Fig. 1B) widened apically; sensory vesicle (Fig. 1B) small, globular or slightly ellipsoidal, 0.20–0.22 times as long as third segment and with small opening. Maxillary lacinia with eight or nine inner and 11 or 12 outer teeth. Mandible with 21 inner and 12 outer teeth. Cibarium (Fig. 1C) medially forming sclerotized plate folded forward from posterior margin, with strongly sclerotized medial longitudinal ridge.

Thorax. Scutum brownish black to black except anterolateral calli dark brown, thinly gray-pruinose except narrow median and submedian longitudinal vittae nonpruinose, shiny when illuminated at certain angle of light, densely covered with whitish and whitish yellow scale-like recumbent hairs interspersed with dark brown short hairs on prescutellar area. Scutellum brownish black, covered with dark brown short hairs and dark brown long upright hairs along posterior margin. Postnotum brownish black, shiny when illuminated at certain angle of light, and bare. Pleural membrane bare. Katepisternum dark brown to brownish black, longer than deep, shiny when illuminated at certain angle of light, moderately covered

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**Fig. 1.** Female of *S. (G.) terengganuense* sp. nov. (A) Head (antennae omitted) showing narrow frons (front view). (B) Third segment of right maxillary palp with sensory vesicle (front view). (C) Cibarium (front view). (D) Left hind tibia (outer view). (E) Basitarsus and second tarsomere of left hind leg showing calcipala and pedisulcus (outer view). (F) Claw. (G) Sternite 8 and ovipositor valve (only left half shown) (ventral view). (H) Genital fork (ventral view). (I) Left paraproct and cercus (ventral view). (J) Right paraproct and cercus (lateral view). (K) Spermatheca. Scale bars = 0.1 mm (A, D, E) 0.02 mm (B, C, G–K), and 0.01 mm (F).
with dark brown short hairs. **Legs.** Foreleg: coxa whitish yellow; trochanter medium brown except base whitish yellow; femur medium brown; tibia white on basal two thirds although base and inner surface light brown, and brownish black on apical one third, with whitish fine scale-like hairs on outer surface of basal five sixths; tarsus brownish black, with moderate dorsal hair crest; basitarsus moderately dilated, 5.44–6.00 times as long as its greatest width. Midleg: coxa medium brown except posterior surface dark brown; trochanter light brown except base yellowish; femur medium brown, with apical cap dark brown; tibia whitish on basal one third with medium brown subbasal spot, light brown on middle one third, brownish black on apical one third, and covered with whitish fine scale-like hairs on posterior and outer surfaces of basal five sixths; tarsus brownish black except basal one half of basitarsus dark brown. Hind leg: coxa medium brown; trochanter yellow; femur medium brown with extreme base yellow and apical cap brownish black; tibia (Fig. 1D) whitish to yellowish white on basal two fifths (although whitish area extended up to little over basal one half on posterior surface), with light brown subbasal spot, light to medium brown on middle one third, brownish black on apical one third, and densely covered with whitish fine scale-like hairs on outer and posterior surfaces of basal three fourths; tarsus brownish black except little more than basal one half of basitarsus (although base dark brown) and basal one half of second tarsomere white; basitarsus (Fig. 1E) narrow, nearly parallel-sided, 5.91–6.29 times as long as wide, and 0.66–0.71 and 0.58–0.60 times as wide as greatest width of tibia and femur, respectively; calcipala (Fig. 1E) nearly as long as width at base, and 0.55 times as wide as greatest width of basitarsus. **Pedisculus** (Fig. 1E) well defined. Claw (Fig. 1F) with large basal tooth 0.50 times as long as claw. **Wing.** Length 2.0–2.2 mm. Costa with brownish black spinules and dark brown hairs intermixed with basal patch of yellowish white hairs. Subcosta with dark brown hairs except near apex bare. Hair tuft on stem vein dark brown. Basal portion of radius fully haired; R1 with except near apex bare. Hair tuft on stem vein dark brownish black to black except fore coxa, hind trochanter and basal tip of hind femur yellow, and bases of mid- and hind tibiae and basal one half of basitarsus and basal one half of second tarsomere of hind tarsus yellowish or whitish. **Body.** Body length 2.7–2.9 mm. **Head.** Length 2.0–2.1 mm; other characters as (Fig. 1H) of usual inverted-Y form, with slender stem; arms of moderate width, moderately folded medially. **Paraproct in ventral view (Fig. 1I) nearly triangular, with two to four sensilla on anteromedial surface; paraproct in lateral view (Fig. 1J) somewhat produced ventrally, 0.78 times as long as wide, with 20–22 medium-long to long hairs on ventral and lateral surfaces. Cercus in lateral view (Fig. 1J) short, rounded posteriorly, 0.61 times as long as wide. **Halter.** White except basal stem darkened. **Abdomen.** Basal scale medium brown, with fringe of yellowish white hairs. Dorsal surface of abdomen dark brown to brownish black except basal one fifth to three fourths of segment two whitish, moderately covered with dark short to long hairs; tergites of segments 2 and 6–9 shiny when illuminated at certain angle of light. Ventral surface of segment 2 whitish, those of segments 3–5 light brown, and those on other segments medium to dark brown; sternal plate on segment 7 undeveloped. **Genitalia.** Sternite 8 (Fig. 1G) bare medially, with 25–30 medium-long to very long hairs together with few slender short hairs on each side. Ovispositor valves (Fig. 1G) triangular (although medioposterior corners rounded), thin, membranous, moderately covered with microsetae interspersed with few short hairs; inner margins nearly straight, somewhat sclerotized, and somewhat separated from each other. Genital fork (Fig. 1H) of usual inverted-Y form, with slender stem; arms of moderate width, moderately folded medially. **Paraproct in ventral view (Fig. 1I) nearly triangular, with two to four sensilla on anteromedial surface; paraproct in lateral view (Fig. 1J) somewhat produced ventrally, 0.78 times as long as wide, with 20–22 medium-long to long hairs on ventral and lateral surfaces. Cercus in lateral view (Fig. 1J) short, rounded posteriorly, 0.61 times as long as wide. **Spermatheca** (Fig. 1K) oblong, 1.50 times as long as greatest width, well sclerotized except duct and small area near junction with duct un sclerotized, and with several fissures on surface; internal setae absent; both accessory ducts slender, subequal in diameter to major duct. **Male.** Body length 2.7–2.9 mm. **Head.** Somewhat wider than thorax. Upper eye medium brown, consisting of 12 vertical columns and 13 horizontal rows of large facets. Face dark brown, grayish white pruinose. Clypeus brownish black, whitish pruinose, densely covered with golden yellow scale-like medium-long hairs (mostly directed upward) interspersed with several light brown simple longer hairs. Antenna composed of scape, pedicel and nine flagellomeres, grayish yellow except scape and pedicel and first flagellomere somewhat darkened and ninth flagellomere somewhat grayish; first flagellomere elongate, 1.54 times as long as second one. Maxillary palp medium to dark brown, with five segments, proportional lengths of third, fourth, and fifth segments 1.00:1.33–1.42:3.38–3.50; third segment (Fig. 2A) much widened apically; sensory vesicle (Fig. 2A) globular, small, 0.13–0.14 times as long as third segment, and with small opening. **Thorax.** Scutellum black, entirely shiny when illuminated at certain angle of light and moderately covered with yellowish and brassy recumbent short hairs interspersed with few dark longer upright hairs on prescutellar area. Scutellum black, with brassy short hairs and dark brown long upright hairs along posterior margin. Postnotum black and bare. Pleural membrane bare. Katepisternum brownish black, shiny, moderately covered with fine brassy hairs. **Legs.** Nearly brownish black to black except fore coxa, hind trochanter and basal tip of hind femur yellow, and bases of mid- and hind tibiae and basal one half of basitarsus and basal one half of second tarsomere of hind tarsus yellowish or whitish yellow (Fig. 2B and C); fore tibia densely covered with whitish yellow fine hairs on outer surface, and mid- and hind tibiae densely covered with whitish yellow fine hairs on posterior and outer surfaces of basal three fourths (all these whitish yellow fine hairs brilliantly shiny when illuminated at certain angle of light); fore basitarsus moderately dilated, 6.00–6.25 times as long as its greatest width; hind basitarsus (Fig. 2C) somewhat swollen, nearly parallel-sided, 4.48–4.56 times as long as wide, and 0.72–0.73 and 0.68–0.69 times as wide as greatest width of tibia and femur, respectively; calcipala (Fig. 2C) nearly as long as basal width, and 0.43 times as wide as greatest width of basitarsus; pedisculus (Fig. 2C) well defined. **Wing.** Length 2.0–2.1 mm; other characters as in female except subcostal without hairs. **Abdomen.** Basal scale black, with fringe of light brown hairs.
Dorsal surface of abdomen brownish black to black except anterior one half of second segment yellow, moderately covered with dark brown short to long hairs interspersed with yellow short hairs on few posterior segments; segments 2 and 5–8 each with pair of shiny dorsolateral patches; ventral surface of segment 2 yellow, and those of other segments dark brown to black. **Genitalia.** Coxite in ventral view (Fig. 2D) nearly rectangular, 1.60 times as long as its greatest width. Style in ventral view (Fig. 2D) bent inward, tapered from base toward apex, and with apical spine; style in medial view (Fig. 2E) shorter than coxite (0.94 times as long as coxite), gently bent inward, nearly parallel-sided from basal one third to apex; style in
ventrolateral view (Fig. 2F) moderately tapered from base toward apex and with truncate apex. Ventral plate in ventral view (Fig. 2D) with body transverse, 0.55 times as long as wide, with anterior and posterior margins convex, densely covered with microsetae on ventral surface except narrow area along anterior margin and lateral areas bare; basal arms of moderate length, directed forward; ventral plate in lateral view (Fig. 2G) slightly produced ventrally; ventral plate in caudal view (Fig. 2H) with ventral margin triangular, densely covered with microsetae on posterior surface except lateral small areas. Median sclerite (Fig. 2G and I) thin, plate-like, wide. Parameres (Fig. 2J) of moderate size, each with several short to long distinct stout hooks. Aedeagal membrane (Fig. 2J) sparsely covered with very minute setae, dorsal plate not defined. Ventral surface of abdominal segment 10 slightly sclerotized anteriorly and without distinct hairs near posterior margin. Cercus (Fig. 2K and L) small, thin, with 15 or 16 hairs.

**Pupa.** Body length 2.8 mm. **Head.** Integument yellow, moderately covered with small round tubercles; antennal sheath without any protuberances; frons with three pairs of simple very long trichomes (one with coiled apex, two with uncoiled apices) (Fig. 3A); face with pair of simple long trichomes with coiled apices (Fig. 3B); three frontal trichomes on each side arising close together, subequal in length to one another and somewhat longer than facial one. **Thorax.** Integument yellow, sparsely covered with small round tubercles, with three simple long to very long mediadorsal trichomes (two with coiled apices, one with uncoiled apex) (Fig. 3C), two simple anterolateral trichomes (one long with coiled apex, one medium-long with uncoiled apex) (Fig. 3D), one simple medium-long mediolateral trichome with uncoiled apex (Fig. 3E), and three simple ventrolateral trichomes with uncoiled apices (one medium-long, two short) (Fig. 3F) on each side. Gill (Fig. 3G) composed of eight slender thread-like filaments, arranged in (2+1 or 1+2) + (1+2) +2, or (2+1 or 1+2) + (1+2) +2 filaments from dorsal to ventral, with medium-long common basal stalk having somewhat swollen transparent organ ventrally (often partially broken) at base; common basal stalk 0.68 times as long as interspiracular trunk; dorsal and middle triplets sharing very short stalk or not; dorsal and middle triplets each composed of one individual and two paired filaments, with very short to short primary and secondary stalks; ventral paired filaments with medium-long stalk which is 1.29 times as long as common basal stalk and 0.85 times as long as interspiracular trunk; stalk of ventral pair nearly as thick as primary stalks of dorsal and middle triplets; primary stalk of dorsal triplet lying against stalk of lower pair at angle of 90–120 degrees when viewed laterally; all filaments grayish light brown, gradually tapered toward apex; all filaments subequal in length to one another (2.5–3.0 mm in length); two filaments of ventral pair subequal in thickness to each other and slightly thicker than three filaments of middle triplet, which are as thick as or very slightly thicker than three filaments of dorsal triplet; cuticle of all filaments with well-defined annular ridges and furrows though gradually becoming indistinct from middle to apex, densely covered with minute tubercles. **Abdomen.** Dorsally, all segments nearly transparent or slightly grayish yellow except segment 9 yellowish; segments 1 and 2 without tubercles; segment 1 with one simple slender short hair-like seta and few very short spinous setae submedially on each side (Fig. 3H); segment 2 with one simple slender short hair-like seta and five very short somewhat spinous setae submedially near posterior margin on each side; segments 3 and 4 each with four hooked spines and one very short somewhat spinous seta near posterior margin on each side; segments 2–4 each with additional simple very short seta submedially near anterior margin on each side; segment 5 with four simple very short setae near posterior margin on each side; segments 6–8 each with spine-combs in transverse row, comb-like groups of minute spines near anterior margin and two simple very short setae near posterior margin on each side; segment 9 with comb-like groups of minute spines in transverse row near anterior margin on each side and pair of small terminal hooks each with round apex (Fig. 3I), appearing as mushroom when viewed laterally (Fig. 3J) and as oval flat plate when viewed dorsally (Fig. 3K). Ventrally, segment 4 with four 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 three grapnel-shaped hooklets. Cocoon. Wall pocket-shaped, thinly and moderately or somewhat roughly woven, widely extended ventrolaterally; anterior margin not thickly woven, with dorsal portion somewhat produced anteriorly or not when viewed dorsally; posterior one half with floor roughly or moderately woven; individual threads invisible; 3.0–3.5 mm in length by 1.8–2.0 mm in width.

**Mature Larva.** Body length 5.3–6.0 mm. Body (Fig. 4A and B) creamy with reddish brown markings as follows: thoracic segment 1 encircled with broad transverse band (although disconnected dorsomedially and ventromedially), thoracic segment 2 encircled with similar less distinct band (though disconnected dorsomedially and often laterally), thoracic segment 3 rarely with spot ventrally, abdominal segments 2–4 each with three spots on each side (one dorsomedially, one laterally, one ventrolaterally, although ventrolateral spots usually less distinct and that on segment 2 often indistinct), abdominal segment 5 with two spots dorsomedially (one anteriorly, one posteriorly along posterior margin, both sometimes connected to each other), one spot laterally (sometimes connected to dorsal spots), and one faint spot ventrolaterally, on each side, and abdominal segments 6–8 each with colored areas of various extent dorsomedially and laterally, and abdominal segments 6 and 7 each with transverse band ventrally. Cephalic apotome yellow, and sparsely or moderately covered with
simple minute setae; head spots faintly or moderately positive. Lateral surface of head capsule yellow or sometimes light brown except eyespot region whitish, and sparsely covered with simple minute setae; eyebrow distinct; two relatively large spots and two small spots near posterior margin as well as one small spot below eye-spot region faintly or moderately positive. Ventral surface of head capsule yellow or sometimes light to medium brown except darkened area near posterior margin on each side of postgenal cleft, and sparsely covered with simple minute setae; one elongate spot and one round spot on each side of postgenal cleft faintly or moderately positive, or faintly negative when background color is medium brown. Antenna composed of three segments and apical sensillum, somewhat longer than stem of labral fan; proportional lengths of first, second, and third segments 1.00:1.00–1.23:0.81–0.83. Labral fan with 46 or 47 main rays. Mandible with three comb-teeth decreasing in length from first tooth to third; mandibular serration composed of two teeth (one medium-sized, one small); major tooth at acute angle against mandible on apical side; supernumerary serrations absent. Hypostoma (Fig. 4C and D) with row of nine apical teeth; median

![Diagram](image.png)

**Fig. 3.** Pupa of *S. (G.) terengganuense* sp. nov. (A) Frontal trichomes. (B) Facial trichome. (C–F) Thoracic trichomes. (G) Mediodorsal. (D) Anterolateral. (E) Mediolateral. (F) Ventrolateral. (G) Right gill filaments (outer view). (H) One short and three very short setae on left side of dorsal surface of first abdominal segment (dorsal view). (I–K) Terminal hooks (I, caudal view; J, lateral view; K, dorsal view). Scale bars = 0.1 mm (G), 0.04 mm (A–F, H), and 0.02 mm (I–K).
tooth most prominent, followed by each corner tooth and three intermediate teeth on each side subequal in size to one another and shortest of all; lateral margin smooth; four or five hypostomal bristles per side lying parallel to lateral margin. Postgenal cleft (Fig. 4C) arrow-head shaped, medium-long, 3.0–3.9 times as long as postgenal bridge. Cervical sclerite composed of two very pale small pieces, not fused to occiput, widely separated medially from each other. Thoracic cuticle almost bare. Abdominal cuticle almost bare or sparsely covered with simple minute colorless setae except few posterior segments moderately covered with simple minute colorless setae dorsally and dorsolaterally and last segment densely covered with colorless simple setae on each side of anal sclerite. Rectal scales present although indistinct because of colorlessness and small size. Rectal papilla compound, each of three lobes with 8–11 finger-like secondary lobules. Anal sclerite of usual X-form, with anterior arms nearly as long as posterior ones, broadly sclerotized at base; accessory sclerite absent. Last abdominal segment expanded ventrolaterally forming double bulges on each side, visible as large conical ventral papilla when viewed from side. Posterior circlet with 78–84 rows of up to 14 hooklets per row.

Type Materials. HOLOTYPE: 1 female (with associated pupal exuviae and cocoon) (preserved in 50% ethanol) reared from pupa, MALAYSIA: Terengganu, 12-X-2011, Z. Ya’Cob. Paratypes: 1 female, 3 males (each with associated pupal exuviae and cocoon), and 4 pupal exuviae and cocoons, all preserved in 50% ethanol, and 8 mature larvae preserved in acetic alcohol, same data as those of the holotype, and 1 female with associated pupal skin and cocoon, same data as those of the holotype but the date, 14-IX-2011.

Distribution. Peninsular Malaysia.

Etymology. The species name terengganuense refers to the name of the province, Terengganu, where this new species was collected.

Biology. All the pupae and larvae were collected from dead tree leaves and grasses trailing in the water of a small shallow stream (width, 0.5 m; bottom mud; water temperature, 24.0°C; shaded; altitude, 310 m) (04° 35'12.5" N, 102° 57'35.5" E) slowly flowing in an open area recently logged near natural forests. Associated species were Simulium (Gomphostilbia) gombakense Takaoka & Davies, 1995; S. (G.) sheilae; Simulium (Gomphostilbia) cheongi Takaoka & Davies, 1995; Simulium (Gomphostilbia) whartonii Takaoka & Davies, 1995; Simulium (Gomphostilbia) sp. (ceylonicum species-group); and Simulium (Simulium) nobile De Meijere, 1907.

Discussion. This new species is assigned to the batoense species-group of the subgenus Gomphostilbia redefined by Takaoka (2003) in having the antenna with 11 segments, pleural membrane bare, the claw with a large basal tooth in the female (Fig. 1F), a slender parallel-sided hind basitarsus (Fig. 2C) in the male, and the gill with eight filaments (Fig. 3G) in the pupa.

The pupa of S. (G.) terengganuense sp. nov. is most striking in having the mushroom-like terminal hooks (Fig. 3I–K), a characteristic rarely reported in the subgenus Gomphostilbia. Only two known species, Simulium (Gomphostilbia) hiroshii Takaoka, 1994 from Solomon Islands, South Pacific, and Simulium (Gomphostilbia) palawanense Stone, 1964 from Palau, Micronesia, have such unique terminal hooks, although these two known species have the pupal gill with four filaments (Takaoka 1994, Takaoka and Craig 1999). The pupa of this new species is also characterized by the presence of a few very short setae (in addition to one short hair-like seta) on each side of the dorsal surface of the first abdominal segment (Fig. 3H). None of the known species of the subgenus Gomphostilbia has been reported to have these excess setae on the dorsal surface of the first pupal abdominal segment.

The female of this new species is characterized by the very narrow frons that has the narrowest portion medially (Fig. 1A), a characteristic recorded in none of the species of the batoense species-group but in two species of the varicornis species-group of the subgenus Gomphostilbia: Simulium (Gomphostilbia) novemar-

Fig. 4. Larva of S. (G.) terengganuense sp. nov. (A and B) Whole body showing reddish brown markings on thorax and abdomen (A, dorsal view; B, lateral view). (C) Hypostoma and postgenal cleft (ventral view). (D) Hypostoma (ventral view). Scale bars = 1.0 mm (A, B), 0.05 mm (C), and 0.04 mm (D).
ticolatum Takaoka & Davies, 1995 from Peninsular Malaysia and southern Thailand and Simulium (Gomphostilbia) charlesi Takaoka, 2008 from Sarawak, both of which are distinguished by the adult antenna composed of the scape, pedicel, and seven flagellomeres (Takaoka and Davies 1995, Takaoka 2008b).

The male of this new species has an unusual color pattern for the antenna: grayish yellow except the scape, pedicel, and first flagellomere; these structures are somewhat darkened and the ninth flagellomere, somewhat grayish, as well as the unique shape of the ventral plate, of which the posterior margin is convex when viewed ventrally (Fig. 2D). These two characteristics combined separate this new species from all the six Peninsular Malaysian species of the batoven group, of which the male is known [i.e., Simulium (Gomphostilbia) angulistylatum Takaoka & Davies, 1995; S. (G.) cheongi; Simulium (Gomphostilbia) dentistentylatum Takaoka & Davies, 1995; Simulium (Gomphostilbia) duolongum Takaoka & Davies, 1995; Simulium (Gomphostilbia) parahijangum Takaoka & Sitgit, 1992; and S. (G.) ehartoni].

In addition, the larva of S. (G.) terengganuense sp. nov. is distinguished from those of all the nine Peninsular Malaysian species of the batoven species-group by the reddish brown patterns on the thorax and abdomen (Fig. 4A and B).

**Simulium (Gomphostilbia) aziruni** Takaoka, Hashim & Chen sp. nov

**Female and Male.** Unknown.

**Pupa.** Body length 2.8 mm. **Head.** Integument yellow, sparsely covered with round tubercles; antennal sheath without any protuberances and tubercles; frons with three pairs of simple very long trichomes with uncoiled apices (Fig. 5A); face with pair of simple long trichomes with uncoiled apices (Fig. 5B). **Thorax.** Integument yellow, very sparsely covered with round tubercles, with three long mediiodorsal trichomes with uncoiled apices (two simple, one bifid) (Fig. 5C), two simple anterolateral trichomes with uncoiled apices (one long, one medium-long) (Fig. 5D), one simple medium-long mediolateral trichome with uncoiled apex (Fig. 5E), three simple ventrolateral trichomes with uncoiled apices (one long, two short) (Fig. 5F), on each side. Gill (Fig. 5G and H) composed of three inflated horn-like structure bearing eight slender thread-like filaments, of which two individual filaments arising from apex and base of inflated structure respectively, and six others arising close together from common basal stalk (i.e., three filaments individually from dorsal surface and three other filaments arranged as 1+2 filaments with very short primary and short secondary stalks and arising from inner surface); inflated horn-like structure (=1 mm in length) directed forward and downward, subequal in width from base to middle, and then gradually tapered toward apex, with dorsobasal corner angulate, when viewed laterally, bearing nipple-like projection (on right gill, Fig. 5H) or not (on left gill, Fig. 5G); cuticle of inflated horn-like structure light grayish, with faintly defined surface patterns (Fig. 5I) and densely covered with minute tubercles; all filaments light grayish, subequal in thickness to one another (exact lengths of filaments are not measurable because apical portions of all filaments were lost); cuticle of filaments without annular ridges and furrows and densely covered with very minute tubercles. **Abdomen.** Not available. **Cocoon.** Wall-pocket shaped, moderately woven, extended ventrolaterally; anterior margin not thickly woven; floor roughly woven; individual threads invisible; 2.8 mm in length by 1.8 mm in width.

**Mature Larva.** Body length 4.8 mm. Body color yellowish to light ochreous though anterior portion of thoracic segment 1, some lateral portions of thoracic segments 2 and 3, intersegmental portions of abdominal segments 1–4 and entire ventral surfaces of abdominal segments 5–9 white or creamy; body with color markings as follows: thoracic segment 1 encircled with bright reddish brown broad transverse band although disconnected on ventral surface, abdominal segments 3–5 each with light purplish narrow transverse band on each dorsolateral surface though bands on segments 3 and 4 appearing less distinct than those on segment 5, abdominal segments 7 and 8 widely dark purplish on dorsal and dorsolateral surfaces, and abdominal segment 7 with pair of purplish submedial spots on ventral surface. Cephalic apotome whitish yellow; head spots indistinct. Lateral surface of head capsule yellow except eye-spot region whitish; spots indistinct. Ventral surface of head capsule yellow except somewhat darkened area near posterior margin on each side of postgenal cleft. Antenna composed of three segments and apical sensillum, somewhat longer than stem of labral fan; proportional lengths of first, second, and third segments 1.00: 0.74:0.84. Labral fan with 32 main rays. **Mandible** (Fig. 5J) with three comb-teeth, of which first tooth longest, second and third teeth subequal in length to each other; mandibular serration composed of two teeth (one medium-sized, one small); major tooth at acute angle against mandible on apical side; supernumerary serrations absent. **Hypostoma** (Fig. 5K) with row of nine apical teeth; median and each corner tooth prominent and much longer than three intermediate teeth on each side; lateral margin smooth; four hypostomal bristles per side lying parallel to lateral margin. **Postgenal cleft** (Fig. 5L) nearly quadrate with anterior margin rounded, 1.2 times as long as postgenal bridge. Cervical sclerite composed of two pale small pieces, not fused to occiput, widely separated medially from each other. **Histoblast of pupal gill** (Fig. 5M) composed of inflated structure with eight slender filaments (i.e., three inner filaments in triplet with very short primary stalk and short secondary stalk, and three outer individual filaments all, together with primary stalk of triplet, arising close together side by side from common basal stalk, and one outer individual filament arising from apex of inflated structure, and one inner individual filament arising from base of inflated structure); all slender filaments without annular ridges and subequal in length and thickness to one another except apical filament much shorter than others. **Rectal
papilla compound, each of three lobes with five or six finger-like secondary lobules. Posterior circlet with 72 rows of up to 12 hooklets per row. Thoracic and abdominal cuticles, anal sclerite, and ventral papilla similar to those of S. (G.) terengganuense sp. nov.


**Distribution.** Peninsular Malaysia.

**Etymology.** The species name aziruni is in honor of the father of Prof. M. Sofian-Azirun.

**Biology.** The pupal exuviae of this new species was collected from a dead tree leaf in the water of a small stream (width, 0.5–1.0 m; shaded; water temperature, 27°C; altitude, 250 m) (03°18′22.9″N, 101°52′50.0″E) slowly flowing in a palm oil plantation. The mature larva was collected from a blade of grass trailing in the water of a small stream (width, 20–30 cm; depth, 10 cm; water temperature, 23.5°C; exposed to sun; altitude, 450 m), slowly flowing in a grass field. Associated species were S. (G.) sheilae, S. (G.) sp. (ceylonicum species-group), and S. (Nevermannia) aureohirtum Brunetti, 1911.

**Discussion.** S. (G.) aziruni sp. nov. is assigned to the subgenus Gomphostilbia, based on several diagnostic characteristics, such as main tooth of the mandibular serrations at an acute angle against the mandible (Fig. 5J) and hypostoma with smooth lateral margins (Fig. 5K) as well as the ventral papillae in the larva.

Among Gomphostilbia species, this new species is distinctive in having the pupal gill with an inflated papilla compound, each of three lobes with five or six finger-like secondary lobules.

Fig. 5. Pupa and larva of S. (G.) aziruni sp. nov. (A–I) Pupa. (J–M) Larva. (A) Frontal trichome. (B) Facial trichome. (C–F) Thoracic trichomes. (C) Mediodorsal. (D) Anterolateral. (E) Mediolateral. (F) Ventrolateral. (G) Left gill (outer view). (H) Right gill (inner view). (I) Surface patterns on cuticle of inflated horn-like structure of gill. (J) Mandible (lateral view). (K) Hypostoma (ventral view). (L) Hypostoma and postgenal cleft (ventral view). (M) Histoblast of gill (filaments are unfolded) (right side; outer view). Scale bars. 0.1 mm (G, H, M), 0.05 mm (L), 0.02 mm (A–F, K), 0.01 mm (I, J).
horn-like structure bearing eight slender filaments (Fig. 5G and H). An essentially similar pupal gill is seen only in *Simulium* (*Gomphostilbia*) *williei* Takaoka & Thapa, 2010 from Darjeeling, India (Takaoka et al. 2010b). However, there are differences in the shape of the inflated structure and the arrangement of eight slender filaments between the two species. In *S. (G.) williei*, the inflated structure is cigar-like, with 8–10 transverse constrictions, and two individual filaments arising from the middle and sub-apical portions of the inflated structure, respectively (Takaoka et al. 2010b). The larva of *S. (G.) williei* is easily distinguished from that of *S. (G.) aziruni* sp. nov. by the deep postgenal cleft (Takaoka et al. 2010b).

The adults are necessary to assign this new species with certainty to a species-group. However, this new species is tentatively placed in the *batoense* species-group because its related species *S. (G.) williei* is seen only in the *batoense* species-group (Unpublished data).

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