

A New Species of Simulium (Gomphostilbia) (Diptera: Simuliidae) From Kalimantan, Indonesia, With Keys to Identify 19 Bornean Species of the Subgenus Gomphostilbia

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A new species and seven new records of black flies (Diptera: Simuliidae) from Kalimantan, Indonesia

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Abstract. A new species of black fly, *Simulium (Gomphostilbia) paserense* sp. nov., is described based on a pharate pupa and mature larvae from East Kalimantan, Indonesia. *Simulium (G.) paserense* sp. nov. is placed in the *Simulium epistum* species-group of the subgenus *Gomphostilbia* and is characterized by the pupal gill with 13 short, slender filaments arising at the same level from a short common basal stalk and three dorsomedial trichomes (plus three ventrolateral trichomes) on each side of the pupal thorax closely arising from one another, both characters rarely occurring in *Gomphostilbia* species. Taxonomic notes are given to separate this new species from its close allies, *S. (G.) barioense* Takaoka and *S. (G.) fulgidum* Takaoka, both described from Sarawak. Seven known species, *S. (G.) cheongi* Takaoka & Davies, *S. (G.) lehi* Takaoka, *S. (G.) sarawakense* Takaoka, *S. (G.) tahanense* Takaoka & Davies, *S. (Simulium) mirum* Takaoka, Sofian-Azirun & Low, *S. (S.) keningauense* Takaoka and *S. (S.) sabahense* Smart & Clifford, are newly recorded from Kalimantan. The male and larva of *S. (G.) sarawakense* are described for the first time.

INTRODUCTION

Until recently, no black flies (Diptera: Simuliidae) had been recorded from Kalimantan, which occupies the vast southern and eastern regions of Borneo, the largest continental island in Southeast Asia. However, 38 species of the genus *Simulium* have been recorded from the Malaysian states of Sabah and Sarawak in the northern and northwestern regions of the island (Adler & Crosskey 2016; Takaoka *et al.*, 2015a,b; Ya'cob *et al.*, 2015a,b).

The biting habits and possible vectorial role of these Bornean species of black flies are unknown, although three Southeast Asian species of black flies, *S. (G.) asakoeae*, Takaoka & Davies, *S. (S.) nigrogilvum* Summers and *S. (S.) nodosum* Puri, bite

humans and transmit different kinds of filariae of wild mammals and birds in northern Thailand (Fukuda *et al.*, 2003; Takaoka *et al.*, 2003).

Our recent survey of larval and pupal black flies in Paser, East Kalimantan Province, Indonesia, in September 2015, revealed nine species consisting of two new and seven known species. One of the two new species was described as *Simulium (Gomphostilbia) kalimantanense* Takaoka & Sofian-Azirun (Takaoka *et al.*, 2016b). In this paper, we describe another new species based on the pharate pupa and mature larvae, and we record seven other species from Kalimantan. The male and mature larva of *S. (G.) sarawakense* Takaoka are described for the first time.

MATERIAL AND METHODS

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Collections of pupae and larvae of black flies were carried out in the eight streams in Paser, East Kalimantan, Indonesia, by M. Sofian-Azirun, Z. Ya'cob, C.D. Chen, V.L. Low, and Harmonis. Collection data in eight streams are shown in Table 1.

The methods of collection, description and illustration, and the terms for morphological features, follow those of Takaoka (2003). All the pupae and larvae were collected from leaves and sticks of trees and grasses in the water.

The holotype of the new species is deposited in the Institute of Biological Sciences, Faculty of Science, University of Malaya, Kuala Lumpur, Malaysia.

Simulium (Gomphostilbia) paserense Takaoka & Sofian-Azirun, sp. nov.

Pharate pupa. Only following characters observable: Frons moderately covered with small round tubercles, with three unbranched long trichomes closely arising on each side (Fig. 1A); face with one unbranched long trichome on each side (Fig. 1B). Thoracic integument densely covered with small round tubercles (Fig. 1C), with three mediodorsal trichomes arising close to one another (Fig. 1D), two anterolateral trichomes arising close to each other (one trichome slightly longer than other) (Fig. 1E), mediolateral trichome (Fig. 1F) and three ventrolateral trichomes arising close to one another (Fig. 1G), on each side; all trichomes medium-long and unbranched. Histoblast of gill (Fig. 1H) with 13 short, slender filaments arising at same level from short common basal stalk; all filaments subequal in length and thickness to one another; cuticle of filaments smooth, lacking annular ridges and furrows. Dorsal surface of abdominal segments 3 and 4 each with four pairs of hooked spines on each side; at least abdominal segments 7–9 each with spine-combs on each side. Terminal hooks (Fig. 1I) cone-shaped. Abdominal segment 9 with three grapnel-shaped hooklets on each lateral surface (Fig. 1J).

Mature larva. Body length 4.0–4.4 mm. Body whitish yellow except abdominal segments 1–4 grayish green, encircled with

reddish-brown or purplish transverse broad bands each on thoracic segment 1 and abdominal segment 4 (rarely also segment 3) though often disconnected ventromedially and dorsomedially, reddish brown or purplish entirely on dorsal and dorsolateral surfaces of abdominal segments 5–8 and even on lateral surfaces of abdominal segments 5 and 6 (though narrow portion along anterior margin of segment 5 unpigmented), and with concolorous transverse bands each on ventral surface of thoracic segments 2 and 3 and abdominal segment 7. Head capsule whitish yellow to yellow except eye-spot region whitish, with faint positive head spots on cephalic apotome, faint spots along posterior margin on each lateral surface and faint elongated spots on both sides of postgenal cleft, and sparsely covered with unpigmented minute setae (though moderately on dorsal surface). Antenna composed of three segments and apical sensillum, longer than stem of labral fan; proportional lengths of first, second, and third segments 1.00:0.78:0.69. Labral fan with 32–34 main rays. Mandible (Fig. 1K) 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. 1L) with row of nine apical teeth, of which median tooth is longer than each corner tooth; lateral margin smooth; four hypostomal bristles per side lying nearly parallel-sided or slightly divergent posteriorly from lateral margin. Postgenal cleft (Fig. 1M) arrow-head shaped, long, 5.6–8.6 times length of postgenal bridge. Cervical sclerites indistinct. Thoracic proleg without hairs; thoracic cuticle almost bare. Abdominal cuticle of segments 1–4 almost bare, and that of segments 5–9 moderately or densely covered with dark spinous setae, each split into two to nine branches (majority of setae with six to eight branches) (Fig. 1N) dorsally and dorsolaterally; last abdominal segment moderately covered also with unbranched colorless setae on each side of anal sclerite even down to tip of ventral papillae; thorax and abdomen without dorsal protuberances. Rectal scales not discernible.

Table 1. Collection data for eight streams where pupae and larvae of black flies were surveyed in Kalimantan, Indonesia ²

Stream number	Locality	GPS	Date	Elevation	Width	Depth	Water temperature	Streambed	Flow	Riparian vegetation	Canopy cover
1	Longikis	01°33'28.590"S 116°06'33.118"E	3-IX-2015	204 m	0.2 m	5 cm	24.0°C	Rocky	Slow	Forest	Open
2	Longikis	01°33'04.414"S 116°06'01.340"E	3-IX-2015	120 m	1.5 m	5–7 cm	24.0°C	Pebbles	Slow	Oil palm plantation	Partial
3	Longikis	01°33'28.150"S 116°05'44.395"E	3-IX-2015	118 m	2 m	7–10 cm	25.0°C	Pebbles	Slow	Forest	Partial
4	Longikis	01°32'56.079"S 116°03'19.814"E	3-IX-2015	230 m	1 m	11 cm	25.0°C	Rocky	Slow	Forest	Partial
5	Moloy	01°26'20.643"S S115°57'46.241"E	3-IX-2015	285 m	1.5 m	9–12 cm	23.0°C	Rocky	Slow	Forest	Partial
6	Moloy	01°26'31.881"S 115°57'42.354"E	3-IX-2015	435 m	1.5 m	7–10 cm	22.0°C	Boulders	Moderate to fast	Forest	Complete
7	Moloy	01°26'02.143"S 116°57'49.453"E	3-IX-2015	406 m	2.5 m	10–12 cm	22.0°C	Sandy	Slow	Forest	Partial
8	Lempesu Waterfall	01°57'24.171"S 116°01'50.687"E	4-IX-2015	62 m	1–2 m	5–10 cm	24.0°C	Rocky	Slow	Forest	Partial

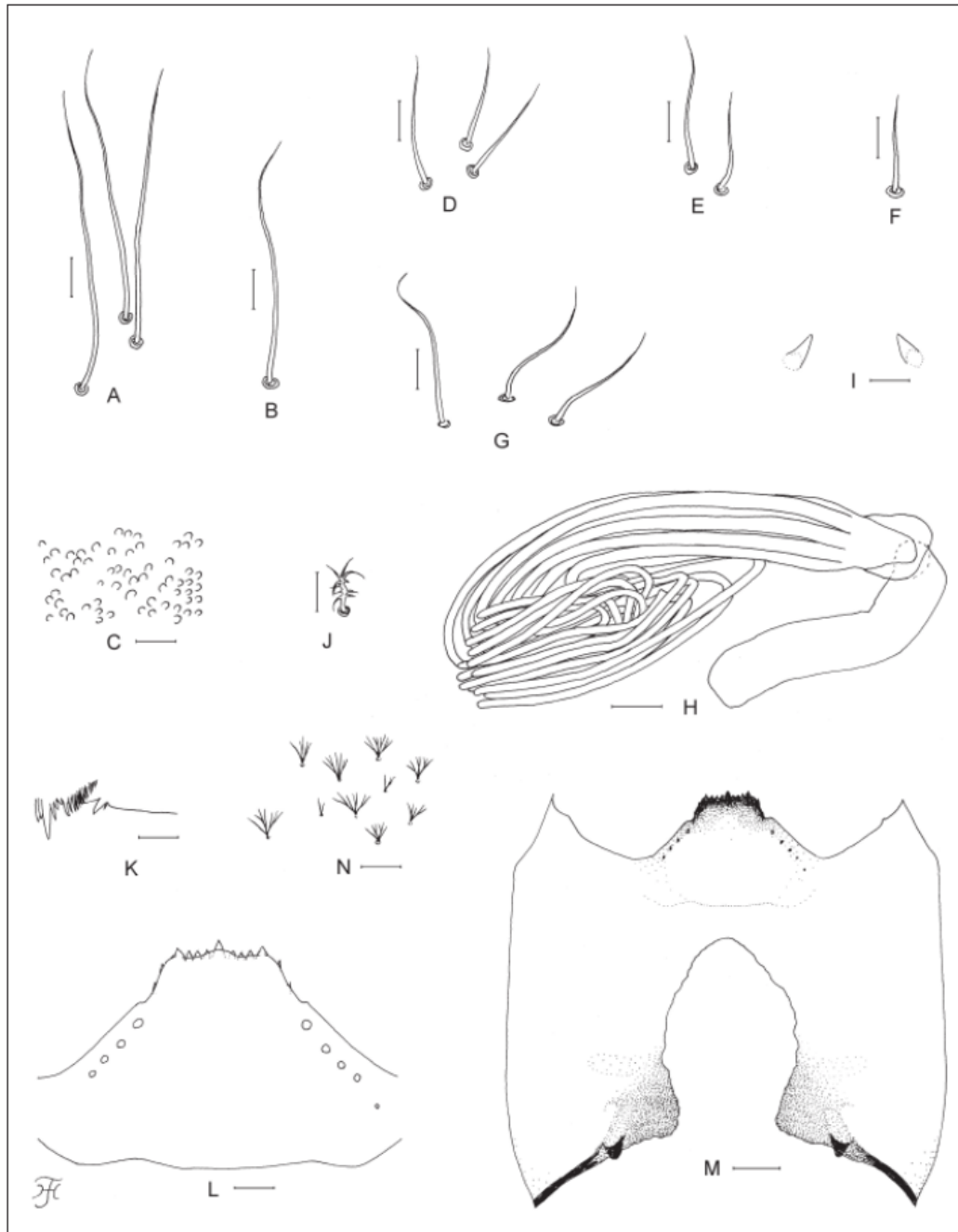


Figure 1. Pharate pupa and mature larva of *S. (G.) paserense* sp. nov. Pharate pupa (A)–(J) and mature larva (K)–(N). (A) Frontal trichomes (arranged as *in situ*). (B) Facial trichome. (C) Tubercles on dorsal surface of thorax. (D)–(G) Thoracic trichomes (D, mediodorsal; E, anterolateral; F, mediolateral; G, ventrolateral; D, E and G arranged as *in situ*). (H) Histoblast of gill filaments (left side; outer view). (I) Terminal hooks (dorsal view). (J) Grapnel-shaped hooklet. (K) Mandible. (L) Hypostoma. (M) Head capsule showing postgenal cleft (ventral view). (N) Dark minute setae on dorsal surface of abdominal segment 6. Scale bars. 0.05 mm for M; 0.04 mm for H; 0.02 mm for A–G, I–L and N.

Rectal organ compound, each of three lobes with seven or eight finger-like secondary projections. Anal sclerite of usual X-form, with anterior arms 1.08 times length of posterior ones, broadly sclerotized at base; no sensilla on broad base and posterior to posterior arms; accessory sclerite absent. Last abdominal segment with pair of large conical ventral papillae. Posterior circlet with 73–80 rows of hooklets with up to 13 hooklets per row.

Female, male and Cocoon. Unknown.

Type material. HOLOTYPE. Pharate pupa (Stream-6). PARATYPES: One pharate pupa, and three mature larvae (Stream-6).

Biological notes. Associated species were *S. (G.) sarawakense* and *S. (S.) sabahense* Smart & Clifford.

Etymology. The species name *paserense* refers to the district name, Paser, where this new species was collected.

Remarks. *Simulium (G.) passerense* sp. nov. is placed in the subgenus *Gomphostilbia* on the basis of possession of grapnel-shaped hooklets on pupal abdominal segment 9 (Fig. 1J), and smooth lateral margins of the larval hypostoma (Fig. 1L). The pupa of this new species is characterized by a gill with 13 short, slender filaments arising at the same level from a short common basal stalk and three dorsomedial trichomes (and also three ventrolateral trichomes) on each side of the thorax arising close to one another (Fig. 1D, G). No other species of *Gomphostilbia* have such a combination of pupal characters. This new species is similar to *S. (G.) barioense* Takaoka and *S. (G.) fulgidum* Takaoka, both described from Sarawak, in having the dorsomedial and ventrolateral trichomes, each arising close to one another (Takaoka 2008b, 2009). However, *S. (G.) barioense* has 13 or 16 gill filaments of different arrangements, and *S. (G.) fulgidum* has eight gill filaments, which, however, arise at the same level from a short common basal stalk, like *S. (G.) passerense* sp. nov.

S. (G.) passerense sp. nov. is placed in the *S. epistum* species-group, defined by Takaoka (2012), to which both *S. (G.) barioense* and *S. (G.) fulgidum* are assigned.

***Simulium (Gomphostilbia) cheongi* Takaoka & Davies, 1995**

Simulium (Gomphostilbia) cheongi Takaoka & Davies, 1995: 37–42 (Female, male, pupa and larva).

Specimens examined. Four females, two males, 21 mature larvae and 130 immature larvae (Stream-4); two females, two males, one pupal exuviae, two mature larvae and 13 immature larvae (Stream-5); one male, one mature larva and six immature larvae (Stream-7).

Biological note. Associated species were *S. (G.) lehi* Takaoka, *S. (G.) kalimantanense*, *S. (G.) sarawakense*, *S. (S.) keningauense* Takaoka and *S. (S.) mirum* Takaoka, Sofian-Azirun & Low.

Distribution. Peninsular Malaysia, Sumatra and Kalimantan (**New record**).

Remarks. *Simulium (G.) cheongi* is a member of the *S. epistum* species-group, defined by Takaoka (2012). This species is characterized by the male antenna which is entirely yellow (Takaoka and Davies 1995).

***Simulium (Gomphostilbia) lehi* Takaoka, 2001**

Simulium (Gomphostilbia) lehi Takaoka, 2001b: 243–247 (Female, male, pupa and larva).

Specimens examined. Two males, one mature larva and nine immature larvae (Stream-1); one female, three males, three pupae, four pupal exuviae, 12 mature larvae and 21 immature larvae (Stream-8); one immature larva (Stream-2); one mature larva (Stream-5).

Biological notes. Associated species were *S. (G.) cheongi*, *S. (G.) kalimantanense*, *S. (G.) tahanese* and *S. (S.) keningauense*.

Distribution. Sarawak and Kalimantan (**New record**).

Remarks. *Simulium (G.) lehi* is a member of the *S. epistum* species-group, like the preceding species. This species is characterized by pupal abdominal segment 9 lacking grapnel-shaped hooklets on each lateral side, and a dark larval body (Takaoka 2001b).

***Simulium (Gomphostilbia) sarawakense* Takaoka, 2001**

Simulium (Gomphostilbia) sarawakense Takaoka, 2001: 247–250 (Female and pupa).

Simulium (G.) sarawakense was described from a female and its associated pupal exuviae collected in Sarawak (Takaoka 2001). This species is a member of the *S. epistum* species-group, like the two preceding species. The male and mature larva of this species are here described for the first time.

Male. Body length 2.2–2.4 mm. **Head.** Slightly wider than thorax. Upper eye medium brown, with large facets in 11 or 12 vertical columns and 12 horizontal rows. Face brownish black, whitish-gray pruinose when illuminated at certain angles. Clypeus brownish black, whitish-gray pruinose when illuminated at certain angles, and densely covered with yellow short scale-like hairs interspersed with three to five dark-brown longer hairs on each side of lower portion. Antenna composed of scape, pedicel and nine flagellomeres, yellowish except apical four or five flagellomeres somewhat darkened; first flagellomere elongated, 1.75 times length of second one. Maxillary palp with five segments, dark gray except segments 1 and 2 dark yellow, proportional lengths of third, fourth, and fifth segments 1.00:1.11:2.89; third segment (Fig. 2A) widened apically; sensory vesicle (Fig. 2A) small, globular, 0.21 times length of third segment, with small opening. **Thorax.** Scutum dark brown except anterolateral calli medium brown, with three dark longitudinal vittae (one median and two submedian), shiny entirely and thinly white pruinose when illuminated at certain angles, densely covered with golden-yellow short hairs. Scutellum medium brown, with golden-yellow short hairs and dark-brown long upright hairs. Postnotum dark brown, slightly shiny when illuminated at certain angles, and bare. Pleural membrane bare. Katepisternum longer than deep, dark brown, and shiny when illuminated at certain angles, moderately covered with pale and dark short hairs. **Legs.** Foreleg: coxa whitish yellow; trochanter light brown except base whitish yellow; femur light brown with apical cap medium brown (though

extreme tip whitish yellow); tibia light to medium brown except extreme base whitish yellow; tarsus dark brown to brownish black, with moderate dorsal hair crest; basitarsus somewhat dilated, 6.3 times as long as its greatest width. Midleg: coxa medium brown except posterolateral surface dark brown; trochanter whitish yellow; femur light brown except base whitish yellow and apical cap medium brown (though extreme tip yellow); tibia medium brown except basal one-third whitish yellow, with slightly darkened subbasal spot; tarsus dark brown except basal half of basitarsus yellow. Hind leg: coxa light brown; trochanter yellow; femur light brown except base yellow and apical cap dark brown (though tip whitish yellow); tibia (Fig. 2B) whitish yellow to yellow on little more than basal half and medium to dark brown on rest, and with light-brown triangular subbasal spot; tarsus (Fig. 2C) dark brown except basal two-thirds of basitarsus (though base light brown) and basal half of second tarsomere yellowish white; basitarsus (Fig. 2C) narrow, parallel-sided, 5.86 times as long as wide, and 0.58 and 0.55 times as wide as greatest widths of tibia and femur, respectively; calcipala (Fig. 2C) well developed, slightly longer than wide, and 0.5 times as wide as greatest width of basitarsus; pedisulcus (Fig. 2C) well developed. **Wing.** Length 1.6 mm. Costa with dark-brown spinules and light-brown hairs except basal patch of yellow hairs. Subcosta bare. Hair tuft on base of radius yellow. Basal portion of radius fully haired. Basal cell absent. **Halter.** Ochreous with basal portion darkened. **Abdomen.** Basal scale ochreous, with fringe of yellow long hairs. Dorsal surface of abdomen dark brown to brownish black except segments 2 and 3 yellow or dark yellow though medial portion light to dark brown, moderately covered with yellow hairs on segments 2 and 3 and with dark short to long hairs on other segments; tergites 2, 3 and 5–7 each with pair of dorsolateral iridescent spots when illuminated at certain angles (though spots on tergite 3 smaller and less distinct); spots on tergite 2 connected in middle to each other; tergites 8 and 9 each also with pair of lateral shiny spots when illuminated at certain angles. Ventral surface

of segments 2 and 3 yellow, those of other segments dark brown. **Genitalia.** Coxites, styles and ventral plate in ventral view as in Fig. 2D. Coxite in ventral view nearly rectangular, 1.67 times as long as its greatest width and 1.13 times length of style; coxite in ventrolateral view (Fig. 2E) 1.11 times as long as wide. Style in ventral view (Fig. 2D) curved inward, tapered from base to basal one-third, then nearly parallel-sided toward apex, with

subapical spine; style in ventrolateral view (Fig. 2F) 2.25 times as long as basal width, gradually tapered from base to apex, with rounded apex. Ventral plate in ventral view (Fig. 2D) transverse, 0.55 times as long as greatest width at base, with anterior margin produced anteromedially, posterior margin concave, angulated outward at base of body, then narrowed posteriorly, and densely covered with microsetae on ventral surface

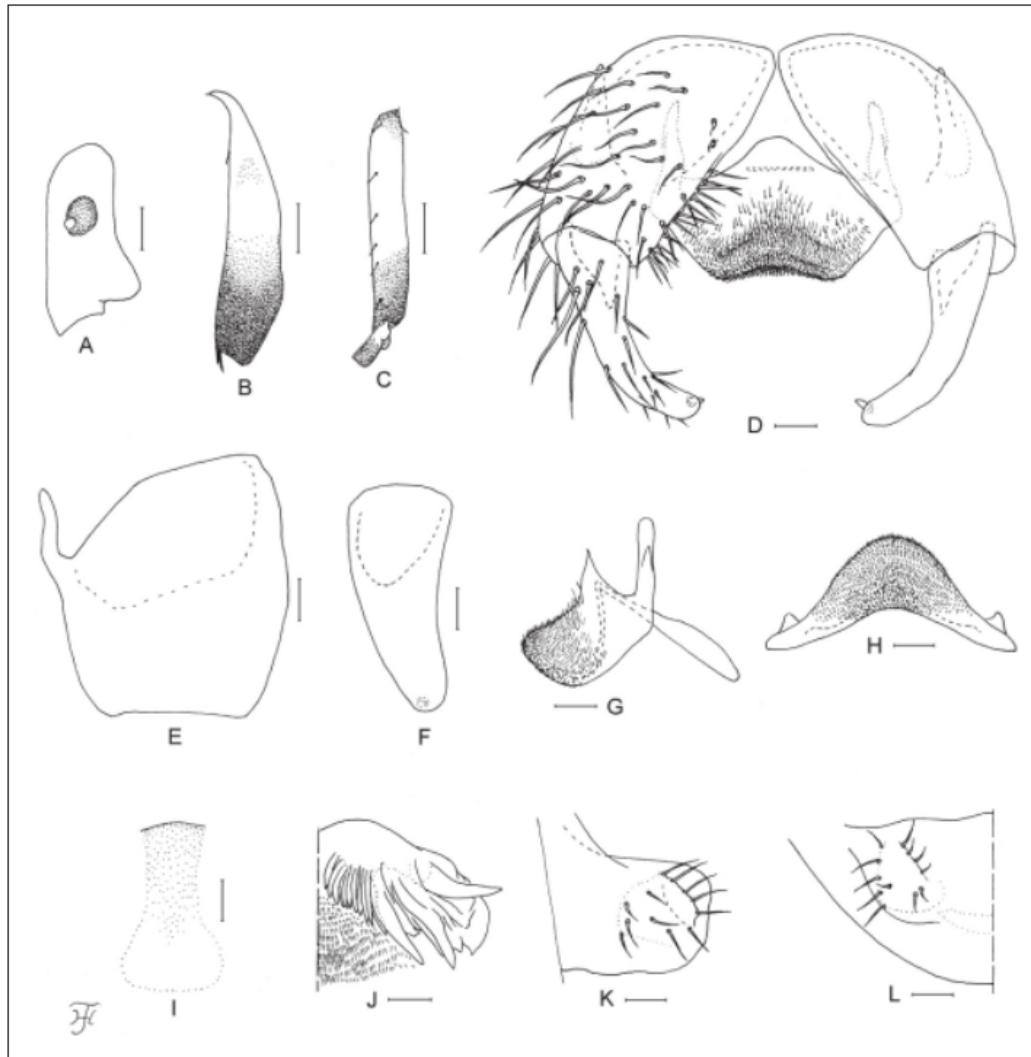


Figure 2. Male of *S. (G.) sarawakense*. (A) Third segment of maxillary palp showing sensory vesicle (right side; front view). (B) Hind tibia (left side; outer view). (C) Basitarsus and second tarsomere of hind leg (left side; outer view). (D) Coxites, styles and ventral plate (ventral view). (E) Coxite (right side; ventrolateral view). (F) Style (right side; ventrolateral view). (G) Ventral plate and median sclerite (lateral view). (H) Ventral plate (caudal view). (I) Median sclerite (caudal view). (J) Paramere and aedeagal membrane (left half; caudal view). (K) and (L) Tenth abdominal segments and cerci (right side; K, lateral view; L, caudal view). Scale bars. 0.1 mm for B and C; 0.02 mm for A and D–L.

except anterior one-third bare; basal arms of moderate length, nearly parallel-sided; ventral plate in lateral view (Fig. 2G) with posterior portion of body much produced ventrally; ventral plate in caudal view (Fig. 2H) rounded ventromedially (width:height=1.00:0.45), with dorsal margin concave medially, densely covered with microsetae on posterior surface. Median sclerite (Fig. 2G, I) plate-like, arising from level near anteromedial tip of dorsal part of ventral plate, and directed posterodorsally. Paramere (Fig. 2J) with three distinct hooks and several smaller ones. Aedeagal membrane (Fig. 2J) moderately covered with microsetae, and with no sclerotized dorsal plate. Abdominal segment 10 (Fig. 2K, L) without distinct hair ventrally or laterally near posterolateral margin on each side. Cercus (Fig. 2K, L) rounded, slightly produced ventrally, with 9–12 distinct hairs.

Mature larva. Body length 4.0–4.4 mm. Body whitish yellow except thorax (including proleg) and abdominal segments 1–4 grayish green, with or without faint reddish-brown transverse band on thoracic segment 1, with two distinct reddish-brown transverse bands each on dorsal surface of abdominal segments 4 and 5 (though band on segment 4 disconnected medially), thinly reddish brown entirely or partially on dorsal and dorsolateral surfaces of abdominal segments 6–8, and reddish-brown transverse band ventrally on abdominal segment 7. Head capsule whitish yellow, with no distinct head spots, and sparsely covered with unpigmented minute setae (though moderately on dorsal surface). Antenna composed of three segments and apical sensillum, longer than stem of labral fan; proportional lengths of first, second, and third segments 1.00:0.81–0.82:0.91–1.04. Labral fan with 32–38 main rays. Mandible (Fig. 3A) 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. 3B) with row of nine apical teeth, of which median tooth longer than each corner tooth; lateral margin smooth; four

or five hypostomal bristles per side lying nearly parallel-sided or slightly divergent posteriorly from lateral margin. Postgenal cleft (Fig. 3C) arrow-head shaped, long, 10.5–12.6 times length of postgenal bridge. Cervical sclerites indistinct. Thoracic proleg without hairs; thoracic cuticle bare; abdominal cuticle of segments 1–4 bare and that of segments 5–9 moderately or densely covered with dark minute setae each with two to seven branches (majority of setae with four or six branches) (Fig. 3D), dorsally and dorsolaterally; last abdominal segment moderately covered with colorless unbranched longer setae on each side of anal sclerite and even down to base of ventral papillae; thorax and abdomen without dorsal protuberances. Rectal scales not discernible. Rectal organ compound, each of three lobes with five or six finger-like secondary lobules. Anal sclerite of usual X-form, with anterior arms 0.75–0.93 times length of posterior ones, broadly sclerotized at base; no sensilla on broad base and posterior to posterior arms; accessory sclerite absent. Last abdominal segment with pair of large conical ventral papillae. Posterior circlet with 77–80 rows of hooklets with up to 13 hooklets per row.

Specimens examined. Three females, five pupal exuviae, 10 mature larvae and 30 immature larvae (Stream-4); four males and seven mature larvae (Stream-6); four females, three mature larvae and 20 immature larvae (Stream-5); two females, one male, five mature larvae and nine immature larvae (Stream-7).

Biological notes. Associated species were *S. (G.) cheongi*, *S. (G.) kalimantanense*, *S. (G.) paserense* sp. nov., *S. (S.) keningauense*, *S. (S.) mirum* and *S. (S.) sabahense*. One of 19 immature larvae of this species was infected with a microsporidium.

Distribution. Sarawak and Kalimantan (New record).

Remarks. The male of *S. (G.) sarawakense* is similar to that of *S. (G.) rayohense* in many characters including the number of upper-eye facets (11 or 12 vertical columns and 12 horizontal rows versus 9–11 vertical columns and 10 or 11 horizontal rows) and color of antennae (yellow except

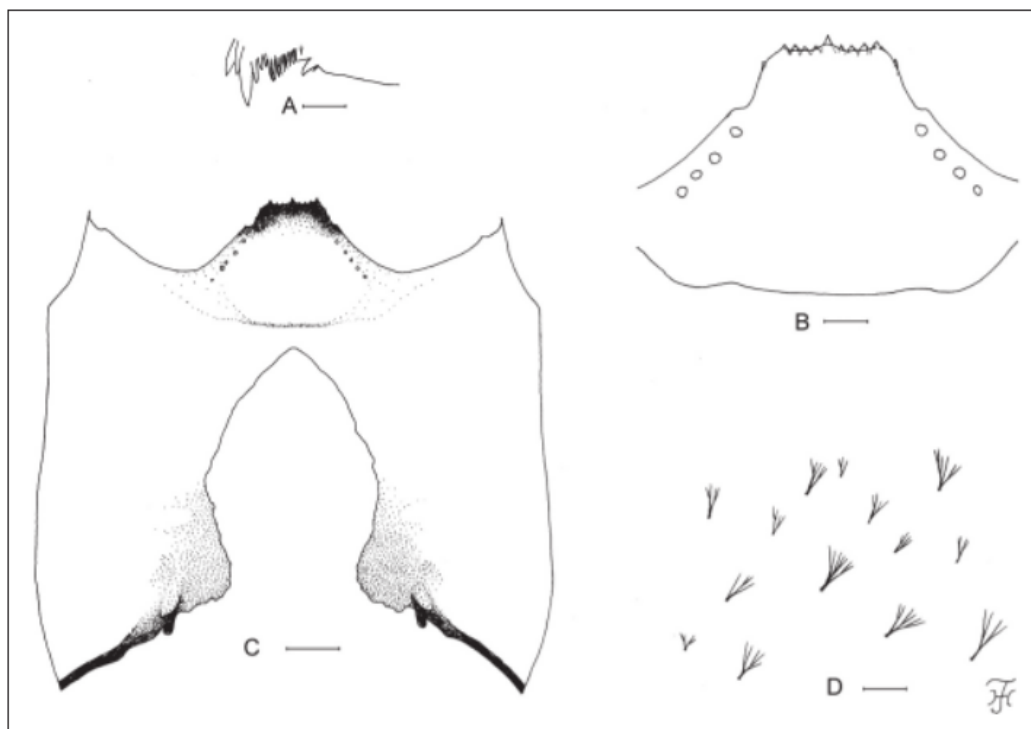


Figure 3. Mature larva of *S. (G.) sarawakense*. (A) Mandible. (B) Hypostoma. (C) Head capsule showing postgenal cleft. (D) Dark minute setae on dorsal surface of abdominal segment 6. Scale bars. 0.05 mm for C; 0.02 mm for A, B and D.

four or five apical flagellomeres darkened) and genitalia (ventral plate angulated laterally) (Smart and Clifford 1969). There are some differences in the color of the male foreleg and abdomen: the fore tibia is light to medium brown except the extreme base whitish yellow in *S. (G.) sarawakense* but yellow on the basal two-thirds and dark brown on the apical one-third in *S. (G.) rayohense*. The dorsal surface of the abdomen is dark brown to brownish black except segments 2 and 3 are yellow or dark yellow, though the medial portion is light to dark brown in *S. (G.) sarawakense*, but dark brown except the tergite of segment 2 is yellow in *S. (G.) rayohense*.

The pupa of *S. (G.) rayohense* is morphologically indistinguishable from that of *S. (G.) sarawakense*. The length of the six gill filaments of the dorsal and middle triplets is about 2.3 mm, according to the illustration of Smart and Clifford (1969) but ranges from

1.3 mm to 2.0 mm in the paratype specimens loaned from The Natural History Museum, thus not differing from the length of the six gill filaments of *S. (G.) sarawakense*.

The larva of *S. (G.) sarawakense* is distinguished from that of *S. (G.) rayohense* by the thorax and abdominal segments 1–4 lacking dark minute setae, and the number of branches of dark minute setae (majority of setae with four or six branches) on the dorsal and dorsolateral surfaces of abdominal segments 5–9 (Fig. 6D) (the thorax and abdominal segments 1–4 are covered with dark minute setae on the dorsal surface, and the number of branches of dark minute setae is nine in *S. (G.) rayohense*).

***Simulium (Gomphostilbia) tahanense* Takaoka & Davies, 1995**

Simulium (Gomphostilbia) tahanense Takaoka & Davies, 1995: 24–28 (Female, pupa and larva).

Specimens examined. One female, two males and one pupal exuviae (Stream-2); three females, two males, one pupal exuviae, two mature larvae and eight immature larvae (Stream-3).

Biological note. Associated species were *S. (G.) kalimantanense* and *S. (G.) lehi*.

Distribution. Peninsular Malaysia, Sarawak and Kalimantan (**New record**).

Remarks. *Simulium (G.) tahanense* is a member of the *S. batoense* species-group, redefined by Takaoka (2012). This species is characterized by the elongated female proboscis (Takaoka and Davies 1995).

***Simulium (Simulium) mirum* Takaoka, Sofian-Azirun & Low, 2016**

Simulium (Simulium) mirum Takaoka, Sofian-Azirun & Low, 2016: 1–12 (Female, male, pupa and larva).

Specimens examined. One mature larva and two immature larvae (Stream-7).

Biological note. Associated species were *S. (G.) cheongi*, *S. (G.) sarawakense* and *S. (S.) keningauense*.

Distribution. Sabah, Sarawak and Kalimantan (**New record**).

Remarks. *Simulium (S.) mirum* was described from Sabah and Sarawak (Takaoka ¹ al., 2016a). This species is a member of the *S. melanopus* species-group, defined by Takaoka (1983). The morphological identification of larvae collected in Kalimantan was supported by the analysis of DNA sequences of the COI gene. The sequence of COI gene (GenBank accession number KX525237) of a larva from stream 7 has a high degree of sequence similarity (97–98%) with the sequences of *S. (S.) mirum* from Sabah and Sarawak. We, therefore, consider the material from Kalimantan, Sabah and Sarawak to be conspecific. The genetic distances between the present larva from Kalimantan and four related species of the *S. melanopus* species-group are 10.11% for *S. (S.) nigripilosum*, 10.02% for *S. (S.) crassimanum*, 9.84% for *S. (S.) maklarini* and 8.59% for *S. (S.) laterale*.

***Simulium (Simulium) keningauense* Takaoka, 2008**

Simulium (Gomph¹ilbia) keningauense Takaoka, 2008a: 72–75 (Female, male, pupa and larva).

Specimens examined. Eight females, two males, four pupal exuviae, seven mature larvae and eight immature larvae (Stream-¹); six females, one male, three pupae, four mature larvae and 14 immature larvae (Stream-7); one male, two pupae and five immature larvae (Stream-8).

Biological note. Associated species were *S. (G.) cheongi*, *S. (G.) kalimantanense*, *S. (G.) lehi*, *S. (G.) sarawakense*, and *S. (S.) mirum*.

Distribution. Sabah, Sarawak and Kalimantan (**New record**).

Remarks. This is a member of the *S. tuberosum* species-group, redefined by Takaoka and Davies (1996). This species is characterized by the pupal thoracic integument covered with cone-shaped tubercles each with a sharply pointed apex (Takaoka 2008a).

***Simulium (Simulium) sabahense* Smart & Clifford, 1969**

Simulium (Simulium)¹ abahense Smart & Clifford, 1969: 31–35 (Female, male, pupa and larva); Takaoka, 2008a: 68–72 (Female, male, pupa and larva).

Specimens examined. Four females, two males, three mature larvae and four immature larvae (Stream-6).

Biological note. Associated species were *S. (G.) paserense* sp. nov. and *S. (G.) sarawakense*.

Distribution. Sabah, Sarawak and Kalimantan (**New record**).

Remarks. This species was originally described from Sabah (Smart and Clifford 1969) and later redescribed (Takaoka 2008a). Is is a member of the *S. tuberosum* species-group.

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