DESCRIPTION OF TWO NEW SPECIES OF BLACK FLIES (DIPTERA: SIMULIIDAE) FROM SARAWAK, MALAYSIA

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Abstract: Two new black-fly species, Simulium (Gomphostilbia) lehi sp. nov. and S. (G.) sarawakense sp. nov., are described from adult flies reared from pupae, collected in Sarawak State, Malaysia. In addition, three known species of Simulium s.l., i.e., S. (G.) sheilae, S. (Nevermannia) aureohirtum, S. (Simulium) laterale, are newly recorded from Sarawak.

Key words: Simuliidae, Black fly, Malaysia, Sabah, New species, Fauna

Since Smart and Clifford (1969) recorded Simulium sabahense from Sarawak, Malaysia, no other black-fly species has been added to the simulid fauna of this state.

In 1998, I made faunistic surveys on Simuliidae in several localities of Sarawak in Malaysia, and collected six species of Simulium s.l. consisting of S. sabahense, two new species and three newly recorded ones. I herein describe these new species.

The morphological features and terms used herein follow mostly those of Crosskey (1969), and partially those of Takaoka (1983). All type specimens of new species will be in due course deposited at the Natural History Museum, London, U.K.

DESCRIPTION OF NEW SPECIES

Simulium (Gomphostilbia) lehi sp. nov.

Female. Body length 1.8-2.0 mm. Head. As wide as thorax. Frons (Fig. 1) brownish black, semishiny, densely covered with yellowish white scale-like recumbent hairs, and with several dark stout hairs in vertical row along each lateral margin; frontal ratio 1.9:1.0:2.4; frons-head ratio 1.0:4.7. Fronto-ocular area (Fig. 2) well developed, narrow. Clypeus brownish black, semishiny, densely covered with yellowish-white scale-like recumbent hairs interspersed with 10-12 dark hairs on each side. Proboscis ca. 0.54× as long as clypeus. Antenna composed of 2+9 segments, medium brown except scape, pedicel and base of 1st flagellar segment pale yellow. Maxillary palp composed of 5 segments, light brown, proportional lengths of 3rd, 4th and 5th segments 1.0:1.1:2.9; 3rd segment (Fig. 3) widened slightly; sensory vesicle of small (or moderate in the other female, Fig. 4) size, nearly ellipsoidal, 0.21× (or 0.26× in the other female, Fig. 4) as long as 3rd segment, with medium (or large in the other female, Fig. 4) opening. Maxillary lacinia with 7 or 8 inner teeth and 9 or 10 outer teeth. Mandible (Fig. 6) with 12-14 small inner teeth and lacking outer ones. Cibarium (Fig. 7) smooth, without any processes or tubercles. Thorax. Scutum dark brown with anterolateral calli somewhat paler, subshiny, thinly white pruinose, with 3 faint longitudinal vittae (1 medial and 2 submedial), densely covered with yellowish-white scale-like recumbent hairs; scutellum medium brown, covered with short, yellowish-white scale-like hairs as well as long up-right dark hairs along posterior margin. Postscutellum dark brown, bare. Pleural membrane bare. Katepisternum brownish black, longer than deep, with fine short dark hairs. Legs (Coloration appeared to be still incomplete). Foreleg: coxa pale yellowish white; trochanter and femur light brown; tibia light to medium brown; tarsus medium to dark brown, without distinct dorsal hair crest; basitarsus slightly dilated, ca. 6.7× as long as its greatest width. Midleg: coxa dark brown; trochanter dark yellow; femur light brown; tibia medium brown with basal 2/5 dark yellow; tarsus medium brown with basal 2/3 of basitarsus, and base of 2nd tarsal segment dark yellow or light brown. Hind leg: coxa light brown, trochanter pale yellow; femur dark yellow or light brown with apical cap medium brown; tibia yellowish white on basal 3/4 and medium brown on distal 1/4; tarsus medium brown except basal 2/3 of basitarsus, basal 1/2 of 2nd tarsal segment yellowish white; basitarsus (Fig. 8) narrow, nearly parallel-sided, ca. 6.0× as long as wide, and ca. 0.63× and ca. 0.48× as wide as greatest width of

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Maxillary palp with 5 segments, light to medium brown; intermixed with several dark longer simple hairs on each ple and scale-like hairs (except median portion widely bare), Face dark brown, white pruinose. Clypeus dark brown, Head. Much wider than thorax. Upper eye consisting of male (dissected out of the pupa). Body length 2.0 mm. Rounded posteriorly. Spermatheca ellipsoidal, ca. 1.5 times as long as wide, posteriorly. Claws (Fig. 10) each with large basal tooth, 0.47 times as long as claw. Wing. Length 1.6 mm. Costa with dark spinules as well as dark hairs except basal hair tuft pale. Subcosta haired except near apex bare. Hair tuft on stem vein pale. Basal portion of radius fully haired. Abdomen. Basal scale light brown, with fringe of pale hairs. Abdomen dark brown except base of 2nd segment paler, sparsely or moderately covered with short dark hairs; tergites of segments 2, 6, 7 and 8 subshiny; sternal plate on segment 7 undeveloped. Genitalia (Figs. 11-13). Sternite 8 bare medially, with 21-28 long hairs and a few short hairs on each side. Anterior gonapophyses nearly triangular, rounded posteroomedially, thin, membraneous, covered densely with microsetae (though posteromedial corner somewhat widely bare), interspersed with 1 or 2 short setae; inner margins sinuous, narrowly sclerotized, moderately separated from each other. Genital fork of usual inverted-Y form; arms slender, folded medially, with a small projection directed forward. Paraproct somewhat produced ventrally, with 12-16 long hairs on outer surface, and with 4 or 5 sensilla on inside surface. Cercus ca. 0.5 times as long as wide, rounded posteriorly. Spermaphetha ellipsoidal, ca. 1.5 times as long as wide, well sclerotized except near tubal juncture and tube unsclerotized, and with many fissures on surface; internal setae appear to be absent; both accessory tubes together, subequal in length to one another and slightly longer than facial one. Parameres of moderate size, each with 3 large hooks (of which 1 is very wide) and ca. 10 smaller ones. Aedeagal membrane moderately covered with microsetae, weakly sclerotized along dorsal base forming dorsal plate. Median sclerite thin, plate-like, wide, with apex rounded. Ventral surface of 10th abdominal segment without short setae near posterior margin on each side. Cerci small, rounded, each with 12 or 13 short hairs.

Pupa. Body length ca. 2.2 mm. Head. Integument yellowish, densely covered with round tubercles; antennal sheath normal, with no spinous projections, and almost bare; face with 1 pair of simple long trichomes with coiled apex, and frons with 3 pairs of simple long trichomes with coiled apex; 3 frontal trichomes on each side arising close together, subequal in length to one another and slightly longer than facial one. Thorax. Integument yellowish, densely covered with round tubercles, with 3 pairs of simple long trichomes dorsally, 2 pairs of simple trichomes (1 long and 1 medium) anterolaterally, 1 pair of simple medium-long trichomes posterolaterally, and 3 pairs of simple trichomes (1 long and 2 medium) ventrolaterally; all long trichomes with coiled apex. Gill (Fig. 21) composed of 8 slender filaments, arranged in groups of 3+3+2 filaments from dorsal to ventral, with somewhat swollen transparent organ ventrally at base; stalks of all 3 groups of filaments as well as basal common stalk short; all filaments pale yellowish, subequal in length (ca. 2.0 mm) and thickness to one another; cuticular surface of filaments with distinct annular ridges and furrows gradually becoming indistinct apically, and densely covered with minute tubercles. Abdomen. Terga 1 and 2 pale yellow, almost bare; tergum 1 with 1 simple slender medium-long seta on each side; tergum 2 with 1 medium-long simple slender seta and 5 short setae (of which 2 or 3 spinous), submedially on each side; terga 3 and 4 pale, each with 4 hooked spines and 1 short somewhat spinous seta on each side; tergum 5 lacking.

tibia and femur, respectively; calcipala (Fig. 8) ca. 1.2 times as long as wide, and ca. 0.8 times as wide as distal portion of basitarsus. All femora, tibiae and parts of tarsus densely covered with dark (and also pale), scale-like hairs on outer and posterior surfaces. Claws (Fig. 10) each with large basal tooth, 0.47 times as long as claw. Wing. Length 1.6 mm. Costa with dark spinules as well as dark hairs except basal hair tuft pale. Subcosta haired except near apex bare. Hair tuft on stem vein pale. Basal portion of radius fully haired. Abdomen. Basal scale light brown, with fringe of pale hairs. Abdomen dark brown except base of 2nd segment paler, sparsely or moderately covered with short dark hairs; tergites of segments 2, 6, 7 and 8 subshiny; sternal plate on segment 7 undeveloped. Genitalia (Figs. 11-20). Cephalic fork in ventral view, subequal, ca. 1.5 times as long as wide. Style ca. 0.9 times as long as coxite, gradually tapered toward apex, curved inward, with apical spine (right style with additional spine near apex though somewhat smaller than main one). Ventral plate transverse, densely covered with microsetae on ventral surface (except along anterior and lateral margins rather broadly bare) and on posterior surface (except both lateral areas bare); basal arms directed forward, then converged apically. Parameres of moderate size, each with 3 large hooks (of which 1 is very wide) and ca. 10 smaller ones. Aedeagal membrane moderately covered with microsetae, weakly sclerotized along dorsal base forming dorsal plate. Median sclerite thin, plate-like, wide, with apex rounded. Ventral surface of 10th abdominal segment without short setae near posterior margin on each side. Cerci small, rounded, each with 12 or 13 short hairs.

Male (dissected out of the pupa). Body length 2.0 mm. Head. Much wider than thorax. Upper eye consisting of 10 vertical columns and 11 horizontal rows of large facets. Face dark brown, white pruinose. Clypeus dark brown, thinly white pruinose, moderately covered with yellow simple and scale-like hairs (except median portion widely bare), intermixed with several dark longer simple hairs on each side. Antenna composed of 2+9 segments, dark brown. Maxillary palp with 5 segments, light to medium brown; 3rd segment (Fig. 5) widened apically; sensory vesicle ellipsoidal, 0.24 times as long as 3rd segment, with medium opening apically. Thorax. Scutum light brown, shiny, densely covered with yellow scale-like recumbent hairs. Scutellum pale, covered with yellow scale-like short hairs and several dark hairs near posterior margin. Postscutellum light brown, bare. Pleural membrane bare. Katepisternum as in female. Legs. Colorings (though incomplete) nearly as in female; fore basitarsus ca. 7.2 times as long as greatest width; hind basitarsus (still bent) (Fig. 9) slender, nearly parallel-sided like that of female. Calcipala (Fig. 9) enlarged, ca. 1.6 times as long as wide. Pedisulcus well developed. Wing. As in female except subcosta bare; length not measurable. Abdomen. Basal scale light brown, with fringe of dark hairs. Dorsal surface of abdomen light brown, covered with dark hairs; segments 2, 5, 6 and 7 each with a pair of shiny dorsolateral patches. Genitalia (Figs. 14-20). Cephalic fork in ventral view, subequal, ca. 1.5 times as long as wide. Style ca. 0.9 times as long as coxite, gradually tapered toward apex, curved inward, with apical spine (right style with additional spine near apex though somewhat smaller than main one). Ventral plate transverse, densely covered with microsetae on ventral surface (except along anterior and lateral margins rather broadly bare) and on posterior surface (except both lateral areas bare); basal arms directed forward, then converged apically. Parameres of moderate size, each with 3 large hooks (of which 1 is very wide) and ca. 10 smaller ones. Aedeagal membrane moderately covered with microsetae, weakly sclerotized along dorsal base forming dorsal plate. Median sclerite thin, plate-like, wide, with apex rounded. Ventral surface of 10th abdominal segment without short setae near posterior margin on each side. Cerci small, rounded, each with 12 or 13 short hairs.
Figures 1-20  Morphological characters of *S. lehi* sp. nov. 1, female frons; 2, female fronto-ocular area; 3-5, 3rd segment of maxillary palp with sensory vesicle (3 and 4, female; 5, male); 6, apex of female mandible; 7, female cibarium; 8 and 9, basitarsus and 2nd tarsal segment of hind leg (8, female; 9, male); 10, female claw of hind leg; 11, sternite 8, anterior gonapophyses, genital fork, spermatheca, paraproct and cercus of female genitalia *in situ* (ventral view); 12, paraproct and cercus *in situ* (lateral view); 13, genital fork (lateral view); 14, coxite and style of male genitalia *in situ* (ventral view); 15, right style (ventrolateral view); 16-18, ventral plate (16, ventral view; 17, lateral view; 18, end view); 19, left paramere and aedeagal membrane (end view); 20, right cercus (end view). Scale bars: 0.1 mm for figs. 8 and 9; 0.05 mm for figs. 1 and 2; 0.02 mm for figs. 3-5, 7, and 11-20; 0.01 mm for figs. 6 and 10.
spine-combs; terga 6-9 each with distinct spine-combs in transverse row, together with comb-like groups of minute spines on each side; tergum 9 with 1 pair of distinct plate-like terminal hooks, extending laterally, and with serrated outer margin (Fig. 22). Sternum 4 with 1 simple hook (somewhat smaller than those on sternum 7) and a few simple minute setae on each side; sternum 5 with 1 pair of bifid hooks submedially on each side; sterna 6 and 7 each with 1 pair of bifid inner and simple outer hooks somewhat spaced from each other, and a few simple short minute setae on each side. Each side of segment 9 with 1 simple hooklet and 1 minute seta, but lacking grapnel-like hooklets. **Cocon.** Simple, wall-pocket-shaped, moderately woven without open spaces in webs; some cocoons with a narrow anteroventral collar; posterior 1/2 with floor roughly woven; individual threads distinct; 2.6-2.9 mm long × 0.8-0.9 mm wide.

**Mature larva.** Body length 4.3-5.1 mm. Body entirely greyish green. Cephalic apotome yellow, moderately covered with minute setae, with distinct dark usual head spots. Cervical sclerite composed of 2 small rod-like pieces, not fused to occiput, widely separated medi ally from each other. Antenna consisting of 3 segments and apical sensillum, longer than stem of labral fan; proportional lengths of 1st, 2nd and 3rd segments 1.0:1.0:0.5. Labral fan with ca. 38 main rays. Mandible (Fig. 23) with 2 usual mandibular serrations; comb-teeth composed of 3 teeth, 1st tooth largest of all, 2nd and 3rd ones subequal in size to each other; super-numerary serrations absent. Hypostomium (Fig. 24) with a row of 9 apical teeth; median and corner teeth well developed; inner and median teeth of 3 intermediate teeth on each side subequal in size to each other, and somewhat shorter than outermost tooth; lateral serrations undeveloped; 6 hypostomal bristles lying parallel to lateral margin on each side. Postgenal cleft (Fig. 25) medium, arrow-head shaped, and ca. 2.9 × as long as postgenal bridge. Thoracic and abdominal cuticle almost bare except last segment densely covered with colorless simple setae on each side. Rectal papilla of 3 lobes, each lobe with 7 or 8 finger-like secondary lobules. Anal sclerite of usual X-form, with posterior arms ca. 1.3 × as long as anterior ones; basal portion of arms widely sclerotized. Accessory sclerite absent. Ventral papillae large, conical, placed ventrally, then, well discernible when the larva is viewed laterally. Posterior circler with ca. 100 rows of up to 17 hooklets per row.

**TYPE SPECIMENS.** Holotype, female, reared from pupa, collected at Pueh, Sematan, Sarawak, Malaysia, 18.III.1998. Paratype 1 female, reared from pupa, 1 pharate male, 3 pupae, 8 mature larvae, same data and date as holotype; 1 pharate male, collected in Hot spring Park, at Poring, Sabah, 12.III.1998.

**ECOLOGICAL NOTES.** Six pupae were collected, three from slender tree sticks, and the others from rocks, in water of a small clean shaded stream (0.5-3.0 m wide) flowing down on the rocky streambed in natural forest of Mt. Pueh.
One pupa of this species was collected from a slender stick in a slowly-flowing stream with its width of ca. 20 cm, shaded, at Hot spring Park in Poring. The water temperature was 23-25°C. This species was collected together with *S. laterale*, *S. sabahense*, and *S. sarawakense* sp. nov. or with *S. sabahense* and *S. sheilae*.

**DISTRIBUTION.** Sabah and Sarawak.

**ETYMOLOGY.** The species *lehi* is given after Dr. Charles Leh, Curator, Zoology Department, Sarawak Museum, Kuching, Sarawak State.

**REMARKS.** This new species is assigned to the *batoense* species-group within the subgenus *Gomphostilbia*, defined by Takaoka and Davies (1996), by having 2+9 antennal segments, slender male hind basitarsus (Fig. 9), and 8-filamented pupal gill (Fig. 21).

*S. lehi* is very similar to *S. miblosi* described from females and pupae collected from Mindanao Island, Philippines (Takaoka, 1983), by the mandible with serration only on inner margin (Fig. 6), simple cibarium (Fig. 7) and enlarged calicipa (Fig. 8) in the female, and the absence of the grapnel-like hooklets on the last abdominal segment in the pupa. However, this species differs from the latter in the female by the reduced number of small teeth on inner margin of the mandible (12-14 versus ca. 24), of stout hairs on the eighth sternite (21-28 versus ca. 50 on each side), and in the pupa by the usual number of trichomes on the frons (3 versus 2 on each side).

The male of *S. lehi* is characterized by the very wide and high ventral plate (Figs. 16-18), and the paramere with one of the three major hooks very wide (Fig. 19), together with the reduced number of enlarged facets. The male of *S. rayohense*, described from Sabah (Smart and Clifford, 1969), has the similar ventral plate and the reduced number of enlarged facets. However, this known species differs from *S. lehi* by the usual short calicipa. The pupal gill filaments of *S. rayohense* are arranged in different manner, having the longer stalk of the ventral paired filaments; and the larval postgenal cleft of this known species is much deeper than that of *S. lehi*, according to the illustrations given by Smart and Clifford (1969).

**Simulium (Gomphostilbia) sarawakense** sp. nov.

**Female.** Body length 2.0 mm. **Head.** Somewhat narrower than width of thorax. Frons (Fig. 26) narrow, dark brown, dull, covered moderately with yellowish-white scale-like recumbent hairs, interspersed with several dark simple long hairs along each lateral margin; frontal ratio 1.8:1.0:3.6; frons-head ratio 1.0:5.8. Fronto-ocular area (Fig. 27) well developed, narrow. Clypeus dark brown, covered moderately with yellowish-white scale-like recumbent hairs, interspersed with several dark simple long hairs on each side. Proboscs ca. 0.67× as long as clypeus. Antenna composed of 2+8 segments (this female appears to be an abnormal individual, showing the incomplete segmentation between the 1st and 2nd flagellar segments, since both of the 1st flagellar segments are unusually longer, and that of the right antenna has an transverse incision, as shown in Figs. 28 and 29; normal females of this species must have 2+9 antennal segments, since the pharate male examined shows usual 2+9 antennal segments on both sides), whitish yellow on basal 1/2 and gradually darkened toward apex, though its border not well defined. Maxillary palp composed of 5 segments, light to medium brown, proportional length of 3rd, 4th and 5th segments 1.0:1.2:3.3; 3rd segment somewhat swollen apically; sensory vesicle (Fig. 30) ellipsoidal, ca. 0.26× as long as 3rd segment, with medium opening medially. Maxillary lacinia with 9 or 10 inner teeth and 12 or 13 outer ones. Mandible with ca. 20 inner teeth and ca. 10 outer ones. Cibarium (Fig. 31) medially forming round sclerotized plate folded forward from posterior margin, and with well sclerotized, medial longitudinal ridge with forked apex. **Thorax.** Scutum medium brown, with 3 faint dark longitudinal vittae (1 medial and 2 submedial), shiny, densely covered with yellowish-white scale-like recumbent hairs interspersed with a few dark upright long hairs on prescutellar area; scutellum medium brown, covered with yellowish short hairs as well as dark upright long hairs along posterior margin. Postscutellum medium brown, bare. Pleural membrane bare. Katepisternum medium brown, longer than deep, moderately covered with dark hairs. **Legs.** Foreleg: coxa whitish yellow; trochanter whitish yellow except outer surface slightly darker; femur light brown; tibia light brown except base whitish yellow; tarsus dark brown, with moderate dorsal hair crest; basitarsus slightly dilated, ca. 6.5× as long as its greatest width. Midleg: coxa medium brown with posterior surface dark brown; trochanter whitish yellow; femur light brown except base yellow; tibia whitish yellow on basal 2/5 with slightly dark subbasal band, and medium brown on apical 3/5; tibia densely covered with whitish fine hairs on outer and posterior surfaces of basal 2/5; tarsus medium brown with basal 1/2 of basitar sus whitish yellow. Hind leg: coxa light brown, trochanter whitish yellow; femur light brown except base yellow; tibia whitish yellow on basal 2/5 with slightly dark subbasal band, and medium brown on apical 3/5; tibia densely covered with whitish fine hairs on outer and posterior surfaces of basal 2/3; tarsus brownish black...
Figures 26-37  Morphological characters of S. sarawakense sp. nov. 26-35, female; 36 and 37, pupa. 26, frons; 27, fronto-ocular area; 28 and 29, antennae (dorsal view; 28, right; 29, left); 30, 3rd segment of maxillary palp with sensory vesicle; 31, cibarium; 32, tibia, basitarsus and 2nd tarsal segment of hind leg; 33, claw of hind leg; 34, sternite 8, anterior gonapophyses, genital fork, spermatheca, paraproct and cercus of genitalia in situ (ventral view); 35, paraproct and cercus in situ (lateral view); 36, basal portion of right gill filaments (lateral view); 37, terminal hook (end view). Scale bars: 0.1 mm for figs. 32 and 36; 0.05 mm for figs. 26-29; 0.02 mm for figs. 30, 31, 34 and 35; 0.01 mm for figs. 33 and 37.
except basal 3/4 of basitarsus, basal 1/2 of 2nd tarsal segment yellowish white; basitarsus narrow, nearly parallel-sided, ca. 6.7 × as long as wide, and ca. 0.67 × and ca. 0.55 × as wide as greatest width of tibia and femur, respectively; calcipala ca. 1.35 × as long as wide, and ca. 0.72 × as wide as apical portion of basitarsus. All femora, tibia and parts of tarsus also moderately covered with dark scale-like hairs. Claws (Fig. 33) each with large basal tooth, 0.51 × as long as claw. **Wing.** Length 1.7 mm. Costa with dark spinules as well as dark hairs. Subcosta with dark hairs except near apex bare. Hair tuft on stem vein yellowish. Basal portion of radius fully haired. Basal cell absent. **Abdomen.** Basal scale dark yellow, with fringe of pale fine hairs. Dorsal surface of abdomen dark brown except that of segment 2 yellow, moderately covered with short dark hairs; tergites of segments 2, 6, 7 and 8 shiny; sternal plate on segment 7 undeveloped. **Genitalia** (Figs. 34 and 35). Sternite 8 bare medially, with 22 or 23 long stout hairs and 4 or 5 short hairs on each side. Anterior gonapophyses nearly triangular, with round medioposterior corners, thin, membranous, covered moderately with microsetae, interspersed with no short setae; inner margins nearly straight or slightly sinuous, moderately sclerotized, and somewhat separated form each other. Genital fork of usual inverted-Y form, with arms of moderate width; arm moderately folded medially, with small projection directed anterodorsally. Paraprocpt moderately produced ventrally, with 22 long hairs on ventral and lateral surfaces, and with 3 sensilla on inside surface. Cercus ca. 0.5 × as long as wide, rounded. Spermatheca ellipsoidal, ca. 1.33 × as long as wide, well sclerotized except tube and small area of tubal base, and with many fissures on surface; internal setae appear to be absent; both accessory tubes slender, slightly larger in diameter than major one.

**Male.** Unknown.

**Pupa.** Body length 2.2 mm. **Head.** Integument yellow, moderately covered with round tubercles; antennal sheath normal, with no spinous projections, and almost bare; face with 1 pair of simple long trichomes with uncoiled apex, and frons with 3 pairs of similar trichomes; 3 frontal trichomes on each side arising close together, subequal in size to one another. **Thorax.** Integument yellow, moderately covered with round tubercles; and with 3 pairs of simple long trichomes with coiled or uncoiled apex dorsally, 2 pairs of simple trichomes (1 long and 1 medium) anterolaterally, 1 pair of medium-long simple trichomes posterolaterally, and 3 pairs of simple trichomes (2 medium and 1 short) ventrolaterally. Gill (Fig. 36) composed of 8 slender thread-like filaments, arranged in groups of 3+3+2 filaments from dorsal to ventral; upper and middle triplets sharing short stalk; each triplet consisting of 2 paired filaments with very short stalk and 1 individual filament; lower pair with stalk of medium length; basal common stalk short, with somewhat swollen transparent organ ventrally; all filaments pale yellowish, subequal in length (1.2-1.6 mm) and thickness to one another except outer filament (ca. 3.0 mm long) of lower pair ca. 2.0 × length and thickness of the other filaments (when basal portion of each filament is compared); cuticular surface of apical 3/4 of stalk of lower pair and basal 1/2 of outer filament of lower pair with distinct annular ridges and furrows but those of other filaments and stalks smooth; cuticular surface of all filaments densely covered with minute tubercles. **Abdomen.** Tergum 1 mostly pale, bare, with 1 simple slender medium-long seta on each side; tergum 2 mostly pale, bare, and with 1 simple slender medium-long seta and 5 short setae on each side; terga 3 and 4 mostly pale, each with 4 hooked spines and 1 short seta on each side; tergum 5 lacking spine-combs; terga 6-9 each with distinct spine-combs in transverse row (though those on tergum 9 much smaller in size), together with comb-like groups of minute spines on each side; tergium 9 with 1 pair of distinct plate-like terminal hooks, extending laterally, and with serrated outer margin (Fig. 37). Sternum 4 with 1 simple or bifid hook and a few simple slender minute setae on each side. Sternum 5 with 1 pair of bifid or trifid hooks submedially and a few simple slender minute setae on each side; sternum 6 and 7 each with 1 pair of bifid or trifid inner and simple outer hooks somewhat spaced from each other, and a few simple slender minute setae on each side. Each side of segment 9 with 3 grapnel-like hooklets. **Cocoon.** Simple, wall-pocket-shaped, neatly and moderately woven, somewhat extending ventrolaterally; anterior margin not thickly woven; posterior 1/2 with floor roughly woven; individual threads visible; 2.5-2.8 mm long × 1.5-1.9 mm wide.

**Mature larva.** Unknown.

**TYPE SPECIMENS.** Holotype, female, reared from pupa, collected at Pueh, Sematan, Sarawak, Malaysia, 18.III.1998. Paratype 1 pupa, same data and date as holotype.

**ECOLOGICAL NOTES.** Two pupae were collected, one from a dead leaf, and the other from a rock, in water of a small clean shaded stream (0.5-3.0 m wide) flowing down on the rocky streambed in natural forest of Mt. Pueh. The water temperature was 25°C. This species was collected together with *S. laterale*, *S. lehi* and *S. sabahense*.

**DISTRIBUTION.** Sarawak.
ETYMOLOGY. The species *sarawakensis* is named after the name of state where this species was collected.

REMARKS. This new species is assigned in the *batoense* species-group by the slender male hind basitarsus (dissected out of the pharate male) as well as the usual 2+9 segments of the adult antennae. The pupa of *S. sarawakensis* is characterized by the gill composed of one long and seven short filaments which are about half the length and thickness of the longer filament (Fig. 36). The similar arrangement of the pupal gill filaments, coupled with plate-like terminal hooks with a serrated outer margin, has been seen in *S. epistum* Delfinado and *S. luzonicum* Takaoka, both from Philippines (Takaoka, 1983). However, stalks of upper and middle triplets of these two species share a very short common stalk. This new species is distinguished in the female from these known species by the narrower frons and smaller sensory vesicle. The frons-head ratio is 1:5.8 in this new species, while that is 1:52 in *S. epistum* and 1:4.3 in *S. luzonicum*; and the relative length of sensory vesicle to the third segment is 0.26 in this new species but it is 0.4 in the other two species. The pupal gills of *S. rayohense* Smart and Clifford described from Sabah, seem to be similar to those of *S. sarawakensis*, but seven shorter filaments of this known species are much longer (i.e., 2.0-2.3 mm), according to the illustration given by Smart and Clifford (1969). The pupa of *S. pegalanense* Smart and Clifford, described from Sabah, also differs from that of this new species by the terminal hooks not serrated. In the pupal gills of *S. pegalanense*, it is the outer filament of the ventral pair but the counter inner filament that is somewhat thicker and longer than its counter filament and six other filaments of upper and middle triplets. This was confirmed with slide-mounted type specimen.

**NOTES ON OTHER SPECIES NEWLY RECORDED FROM SARAWAK**

*Simulium (Gomphostilbia) sheilae* Takaoka and Davies, 1995


SPECIMENS EXAMINED. 1 female, 1 male, both reared from pupae, and 2 larvae, collected at Saya Bakti, 10 km from Kuching, 17.III.1998; 6 females, 5 males, all reared from pupae, and 10 larvae, collected from Jau R., at Santobung, 30 km from Kuching, 17.III.1998; 2 males, reared from pupae, 2 larvae, collected at Damai Look-out Point, 17.III.1998; 1 male, reared from pupa, and 3 larvae, collected at Lundu, in Gunung Gading National Park, 18.III.1998.

ECOLOGICAL NOTES. The pupae and larvae of this species were collected from fallen leaves and trailing grasses in slowly-flowing lowland streams 0.1-4.0 m wide, exposed to the sun or partially shaded. The water temperature of the stream was 26 or 27°C. This species was collected together with *S. sabahensis*.

**DISTRIBUTION.** Peninsular Malaysia, Sabah, Sarawak (new record), Sumatra and Thailand.

**REMARKS.** *S. sheilae* was originally described from Peninsular Malaysia, and was assigned to the *ceylonicum* species-group by Takaoka and Davies (1995). It was also recorded from Thailand (Kuvangkadilok and Takaoka, 2000), Sumatra (Takaoka et al., 2000) and Sabah (Takaoka, 2001).

The reared adult female and male specimens, as well as pupal and larval ones examined in this study, are morphologically almost the same as those originally described, with an exception that the scutum of the present male specimens is whitish pruinose on each shoulder, along both lateral margins and on the prescutellar area (not entirely whitish pruinose, as in the type male specimen). The same difference in the male scutal pattern has been noted for specimens of this species collected from Sabah (Takaoka, 2001).

*Simulium (Nevermannia) aureohirtum* Brunetti, 1911

*Simulium aureohirtum* Brunetti, 1911: 283-288 (male); Edwards, 1934: 134-137 (female, pupa and larva).


**SPECIMENS EXAMINED.** 1 female reared from pupa, and 1 larva, collected from Bunga R., Kuching, Sarawak, 16.III.1998.
ECOLOGICAL NOTES. The one pupa and one larva of this species were collected from grass leaves trailing in the water of a stream with width of 2-5 m, running in a cacao plantation, exposed to the sun. The water temperature was 26°C. Many pupae and larvae of S. sabahense were collected together with this species.

DISTRIBUTION. Indonesia, Japan, Malaysia (Peninsular Malaysia, Sabah, and Sarawak (new record)), Nepal, Pakistan, Sri Lanka, Taiwan and Thailand.

REMARKS. This species belongs to the ruficorne species-group of the subgenus Nevermannia (Crosskey, 1969) and is known to be widely distributed in the Oriental Region and parts of the Palaearctic Region (Crosskey and Howard, 1997). The female, its associated pupa and larva collected from Sarawak agree in morphological characters with the redescription of this species given by Takaoka (1979).

Simulium (Simulium) laterale Edwards, 1933
Simulium laterale Edwards, 1933: 256 (female).
Simulium (Simulium) laterale: Smart and Clifford, 1969: 22-26 (female, male, pupa and larva); Takaoka, 1983: 164 (only female genitalia illustrated).

SPECIMENS EXAMINED. 1 male reared from pupa, 2 pupae and 5 mature larvae, collected at Pueh, Sematan, Sarawak, 18.III.1998.

ECOLOGICAL NOTES. Pupae and larvae were attached on stones and rocks in water of a small clean shaded stream 0.5-3.0 m wide, flowing down on the rocky streambed in a natural forest of Mt. Pueh. The water temperature was 25°C. This species was collected together with S. lehi, S. sabahense and S. sarawakense.

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