Morphology, Systematics, Evolution

Simulium maleewongae, a New Species of Simulium (Gomphostilbia) (Diptera: Simuliidae) From Thailand

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Abstract

Simulium (Gomphostilbia) maleewongae sp. nov. is described based on the adult males and females, their pupal exuviae, and larvae from Thailand. This new species is placed in the Simulium gombakense species-group of Simulium (Gomphostilbia). It is characterized by the female cibarium with a cup-like appendage, male ventral plate deeply depressed ventromedially, pupal gill composed of an inflated structure and eight slender filaments, cone-shaped pupal terminal hooks, and cocoon with an anterodorsal projection. Taxonomic notes are given to separate this new species from 10 other species of the same species-group known from China, India, Malaysia, Thailand, Nepal, and Vietnam. Keys to identify all 11 species of the S. gombakense species-group are provided for females, males, pupae, and larvae.

Key words: black fly, Gomphostilbia, Simuliidae, Thailand, new species

The fauna of black flies (Diptera: Simuliidae) in Thailand is rich, consisting of 85 species (16.2% of the total number, 524, of species in the Oriental Region), all of which are in the genus Simulium Latreille and are further placed in six subgenera (three species in Asissimulium Takaoka & Choochote, two species in Daviesellum Takaoka & Adler, six species in Montsimulium Rubtsov, 20 species in Gomphostilbia Enderlein, nine species in Nevermannia Enderlein, and 45 species in Simulium; Adler and Crosskey 2016). In Thailand, three species (S. (G.) askoae Takaoka & Davies, S. (S.) nigrogilvum Summer, and S. (S.) nodosum Puri) are reported to be vectors of unidentified filarial parasites (Fukuda et al. 2003, Takaoka et al. 2003, Ishii et al. 2008).

In a recent survey of pupae and larvae of black flies in Mae Hong Son Province in northern Thailand, we collected one undescribed species, the pupa of which has the gill composed of an inflated structure and eight slender filaments. It is assignable to the Simulium gombakense species-group of subgenus Gomphostilbia, defined by Takaoka (2012), and differs from all 10 species of the same species-group including S. (G.) gombakense Takaoka & Davies known from Peninsular Malaysia and Thailand and S. (G.) prayongi Takaoka & Choochote from Thailand, by the configuration of the pupal gills or shape of the male ventral plate (Takaoka and Davies 1995, Kuvangkadilok and Takaoka 2000, Takaoka 2000, Takaoka and Choochote 2005, Takaoka et al. 2010a).

This species is described as new, based on adult female, male, pupal, and larval specimens, and taxonomic notes are given to separate it from other related species from China, India, Malaysia, Nepal, Thailand, and Vietnam. Keys to identify all 11 species of the S. gombakense species-group are provided.

The methods of collection, description, and illustration, as well as terms for morphological features, follow those of Takaoka (2003). The holotype and paratypes are deposited at the Queen Sirikit Botanic Garden, Chiang Mai, Thailand.

Nomenclature

This paper and the nomenclatural act it contains have been registered in Zoobank (www.zoobank.org), the official register of the International Commission on Zoological Nomenclature. The LSID (Life Science Identifier) number of the publication is:


Simulium (Gomphostilbia) maleewongae Takaoka, Srisuka & Saeung sp. nov.

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The female of this new species is almost identical to that of S. (G.) thuathienense (Takaoka et al. 2015) as "Female. Body length 2.0 mm. Head. As wide as thorax. Frons black, thinly, densely covered with whitish-yellow recumbent short hairs interspersed with several dark simple longer hairs along each lateral margin; frontal ratio 1.71–1.73:1.00:3.07–3.49; fromshead ratio 1.0:5.71–5.83.

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Fronto-ocular area well developed, narrow, directed dorsolaterally. Clypeus black, densely covered with whitish yellow recumbent short hairs (though mediolongitudinal portion on posterior half narrowly bare) interspersed with seven to ten dark-brown longer hairs along each lateral margin. Labrum 0.61–0.66 times as long as clypeus. Antenna composed of scape, pedicel, and nine flagellomeres; medium to dark brown except scape, pedicel, and basal half of first flagellomere whitish-yellow, though first flagellomere entirely yellow when viewed anteriorly. Maxillary palp composed of five segments, light to medium brown, proportional lengths of third, fourth, and fifth segments 1.00:1.00–1.02:2.07–2.21; third segment (Fig. 1A) somewhat produced inward; sensory vesicle (Fig. 1A) of medium size, 0.29–0.32 times as long as third segment, with medium-longitudinal ridge with well-sclerotized cup-like apex. Thorax. Scutum brownish black, slightly shiny, thinly grayish-white pruinose with three faint nonpruinose longitudinal vittae (one medial and two submedial) when illuminated anterodorsally and viewed dorsally, densely covered with whitish-yellow recumbent hairs (except three longitudinal vittae bare). Scutellum light brown, covered with whitish-yellow short hairs and with dark-brown short upright hairs along posterior margin. Postnotum dark brown to brownish black, bare. Pleural membrane bare. Kategisternum dark brown, longer than deep, moderately covered with whitish-yellow hairs interspersed with dark-brown hairs. Legs. Foreleg: coxa whitish yellow; trochanter light brown except anterodorsal portion whitish yellow; femur light brown with apical cap medium brown (though extreme tip whitish yellow); tibia light brown with apical cap medium brown; tarsus brownish black, with moderate dorsal hair crest; basitarsus moderately dilated, 6.60–6.78 times as long as its greatest width. Midleg: coxa medium brown except postero-lateral surface dark brown; trochanter light brown except anterior portion whitish yellow; femur light brown with apical cap medium brown (though extreme apex whitish yellow); tibia light to medium brown except basal one-third whitish yellow; tarsus dark brown except basal half whitish yellow. Hind leg: coxa light brown; trochanter whitish yellow; femur light brown except base whitish yellow and apical cap dark brown (though extreme tip whitish yellow); tibia (Fig. 1C) whitish yellow on basal one-half with light-brown narrow spot subbasally, then light brown on middle one-fourth and dark brown on apical one-fourth; tibia densely covered with yellowish-white fine hairs on posterior and outer surfaces of basal three-fourths; tarsus dark brown except basal three-fifths of basitarsus (though base light brown) and basal half of second tarsomere whitish yellow; coxite in ventral view as in Fig. 2C. Coxite in ventral view (Fig. 2C) subquadrate, somewhat produced ventrally, with 22–26 medium-long to long hairs on ventral and lateral surfaces. Cercus in lateral view (Fig. 1H) short, rounded posteriorly, 0.48 times as long as wide. Spermatheca (Fig. 1I) ellipsoidal, 1.3–1.5 times as long as wide, well sclerotized without duct and small area at juncture with duct unsclerotized, and with many fissures on surface; internal setae absent; both accessory ducts slender, subequal in diameter to each other and slightly thicker than major duct.

The male of this new species is almost identical to that of S. muwakotense (Takaoka and Shrestha 2010) as “Male. Body length 2.6 mm. Head. Much wider than thorax. Holoptic, upper eye consisting of large facets in 15 vertical columns and in 15 horizontal rows. Face dark brown, white pruinose, bare. Clypeus dark brown, white pruinose, densely covered with golden-yellow scale-like short hairs interspersed with dark longer hairs. Antenna composed of scape, pedicel, and nine flagellomeres, medium to dark brown except scape, pedicel, and base of first flagellomere yellow; first flagellomere somewhat elongate, 1.5 times as long as second flagellomere. Maxillary palp composed of five segments, proportional lengths of third, fourth, and fifth segments 1.00:1.10:2.29; third segment (Fig. 2A) moderately enlarged; sensory vesicle (Fig. 2A) ellipsoidal, 0.22–0.24 times as long as third segment, with small opening apically. Thorax. Scutum brownish black, slightly shiny when illuminated at certain angles, densely covered with golden-yellow scale-like recumbent hairs. Scutellum medium brown, with golden-yellow short hairs and dark upright long hairs. Postnotum dark brown, shiny when illuminated at certain angles, and bare. Pleural membrane bare. Kategisternum longer than deep, with dark hairs intermixed with yellow hairs. Legs. Coloration nearly as in female except basitarsus of midleg whitish yellow on basal one-third (though its border not well defined). Fore basitarsus, 8.2 times as long as its greatest width. Hind basitarsus (Fig. 2B) slightly widened to basal three-fifths, then narrowed to apex, 4.84 times as long as its greatest width, and 0.68 and 0.67 times as wide as hind tibia and femur, respectively; calcipala moderately developed, nearly as long as wide, and 0.42 times as wide as greatest width of basitarsus; pedisulcus moderately developed. Wing. Length 2.0 mm; other characters as in female except subcosta bare. Halter. Light gray with darkened base. Abdomen. Basal scale dark brown with fringe of dark long hairs laterally. Dorsal surface of abdomen medium to dark brown, moderately covered with dark short hairs; segments 2 and 5–7 each with pair of shiny dorsolateral plates, those on segment 2 connected in middle to each other. Genitalia. Coxite, styles, and ventral plate in ventral view as in Fig. 2C. Coxite in ventral view (Fig. 2C) subquadrate, 2.00 times as long as wide. Style in ventral view (Fig. 2C) slender, 0.79 times as long as coxite, gently curved inward, tapered toward apex and with one apical spine; style in ventrolateral view (Fig. 2D).
gradually tapered from base toward apex. Ventral plate in ventral view (Fig. 2C) transverse, much wider than long, somewhat widened posteriorly, with anterior margin produced medially, with posterior margin deeply concave in middle, and moderately covered with microsetae on ventral surface, though portions along anterior margin bare or sparsely covered with microsetae; basal arms nearly parallel-sided, though somewhat convergent apically; ventral plate in lateral view (Fig. 2E) with ventral margin undulate; ventral plate in caudal view (Fig. 2F) deeply depressed medially so that ventral margin appearing flattened letter M, and densely covered with microsetae on most medial portion of posterior surface. Median sclerite (Fig. 2G) broad, plate-like, though lateral margins not well defined. Paramere (Fig. 2H) of moderate size, with several hooks decreasing in length from posterior to anterior. Aedeagal membrane (Fig. 2I) sparsely covered with microsetae. Ventral surface of abdominal segment 10 (Fig. 2J, K).

Fig. 1. Female of *Simulium* (*Gomphostilbia*) maleewongae sp. nov. (A) Third segment of right maxillary palp with sensory vesicle (front view). (B) Cibarium. (C) Left hind tibia (outer view). (D) Basitarsus and second tarsomere of left hind leg showing calcipala and pedisulcus (outer view). (E) Claw. (F) Sternite 8 and ovispositor valve (right half; ventral view). (G) Genital fork (ventral view). (H, I) Right paraprocts and cerci (H, ventral view; I, lateral view). (J) Spermatheca. Scale bars = 0.1 mm for C and D; 0.02 mm for A, B, and F–J; 0.01 mm for E.
Fig. 2. Male of *Simulium* (Gomphostilbia) maleewongae sp. nov. (A) Third segment of right maxillary palp with sensory vesicle (front view). (B) Basitarsus and second tarsomere of left hind leg showing calcipala and pedisulcus (outer view). (C) Coxites, styles and ventral plate (ventral view). (D) Right style (ventrolateral view). (E) Ventral plate and median sclerite (lateral view). (F) Ventral plate (caudal view). (G) Median sclerite (caudal view). (H) Right paramere (dorsal view). (I) Left paramere and aedeagal membrane (caudal view). (J, K) Abdominal segment 10 and cerci (right half; J, lateral view; K, caudal view). Scale bars = 0.1 mm for B; 0.02 mm for A and C–K.
without distinct hairs. Cercus (Fig. 2J, K) small, encircled with 19 or 20 short hairs”.

The pupa and larva of this new species are similar to those of S. aziruni (Takaoka et al. 2013) as “Pupa. Body length 2.4–2.5 mm.

Head. Integument yellow, moderately covered with round tubercles on frons and parts of each lateral surface; antennal sheath bare, and without projections. Frons with three unbranched long trichomes with straight apices (Fig. 3A) on each side; all trichomes subequal in length and stoutness to one another. Face with one unbranched long trichome with coiled or straight apex (Fig. 3B) on each side. Thorax. Integument yellow, sparsely to moderately covered with round tubercles except dorsal surface of posterior portion almost bare, with three long dorso-medial trichomes with coiled or straight apices (Fig. 3C), two anterolateral trichomes with straight apices (one medium-long, one long; Fig. 3D), one medium-long mediolateral trichome with straight apex (Fig. 3E), and three ventrolateral trichomes with straight apices (one medium-long, two short; Fig. 3F), on each side. Gill (Fig. 3G) of much inflated structure (1.0–1.2 mm long) arising from medium-long basal common stalk, and with eight slender filaments, of which one arising from anterior tip of inflated structure, one arising from ventral surface of basal portion of inflated structure, three arising close together as one individual and two paired filaments with medium-long stalk from inner dorsal surface near apex of common basal stalk and three individually arising close together from dorsal surface of middle of common basal stalk; inflated structure divided into two portions, one long, directed forward another short, directed upward, and both rounded apically; all filaments subequal in length (0.8–1.0 mm) and thickness to one another; surface of inflated portion and all filaments light yellow, with no pattern on inflated portion and no transverse ridges or furrows on filaments, and densely covered with minute tubercles.

Abdomen. Dorsally, all segments unpigmented except segments 1, 2, and 9 light yellowish and without tubercles; segment 1 with one slender short seta (Fig. 3H) on each side; segment 2 with one slender short seta and five minute setae (Fig. 3I) on each side; segments 3 and 4 each with four hooked spines and one minute seta on each side; segment 5 with four minute setae on each side and lacking spine-combs and comb-like groups of minute spines; segment 6–9 each with spine-combs and comb-like groups of minute spines in transverse row (though spine-combs on segment 9 much smaller than those on other segments) on each side; segment 6 with three minute setae and segments 7 and 8 each with two minute setae; segment 9 with pair of distinct horn-like terminal hooks somewhat bent anteriorly (Fig. 3J). Ventrally, segment 4 with four minute setae (or one of which is unbranched hook in one pupa) on each side; segment 5 with pair of bifid submediolaterally and few minute setae on each side; segments 6 and 7 each with pair of bifid inner and unbranched outer hooks somewhat spaced from each other, and few minute setae on each side; three grapnel-shaped hooklets on each side of segment 9. Cocoon (Fig. 3K). Wall-pocket-shaped, pale yellow, thinly woven with no open spaces in weave, extended ventrolaterally, with short anterodorsal projection; floor moderately woven on posterior two-thirds of cocoon; individual threads not visible or slightly visible; 2.9–3.0 mm long by 2.2–2.8 mm wide.

Mature larva. Body length 5.0–6.0 mm. Body white except ventral surface of thoracic segments 2 and 3 ochreous (in addition, dorsal and lateral surfaces of these segments thinly ochreous in some larvae), and entire surface of abdominal segments 1 and 2 dark gray, with following reddish-brown markings: thoracic segment 1 encircled with distinct transverse band though narrowly disconnected mediodorsally and widely disconnected ventrally; abdominal segments 1–4 each encircled with transverse band, though narrowly disconnected mediodorsally, and faintly connected or disconnected dorso-laterally, ventrolaterally, and ventromedially; abdominal segment 5 encircled with transverse band, though disconnected dorso-medially and ventromedially; dorsal and ventral ends of transverse band directed forward and backward, respectively in one larva, while only ventral end of this band directed backward in other larva; abdominal segments 6–8 each with somewhat faint transverse band on dorsal surface, though disconnected in middle; abdominal segment 7 with pair of round spots ventrally. Head capsule whitish yellow except eye-spot region white, sparsely covered with simple minute setae. Head spots faintly to moderately positive; eyebrow indistinct. Cervical sclerites composed of two small light brown rod-like pieces, not fused to occiput, widely separated from each other. Antenna composed of three segments and apical sensillum, much longer than stem of labral fan; proportional lengths of first, second, and third segments 1.00:0.61–0.67:0.89–0.99. Labral fan with 33–40 primary rays. Mandible (Fig. 4A) with three comb-teeth decreasing in length from first to third; mandibular serration composed of two teeth (one large and one small); large tooth at acute angle to mandible on apical side; accessory serrations absent. Hypostoma (Fig. 4B) with row of nine apical teeth, of which median and corner teeth prominent, and intermediate teeth lowest; lateral margins smooth; five or six hypostomal bristles in row, nearly parallel to lateral margin on each side. Postgenal cleft (Fig. 4C, D) medium-sized, rounded or pointed apically, 0.74–1.17 times as long as postgenal bridge. Pharate pupal gill with wrinkled enlarged portion with eight slender thread-like filaments. Thoracic cuticle bare. Abdominal cuticle almost bare except both sides of anal sclerite (down to base of ventral papillae) moderately covered with colorless simple setae. Rectal scales present and unpigmented. Rectal organ compound, each of three lobes with 9–11 finger-like secondary lobules. Anal sclerite X-shaped, anterior arms nearly as long as posterior ones; accessory sclerites absent; sensilla absent. Ventral papillae well developed, conical. Posterior circler with 83–94 rows of up to 14–16 hooks per row”.

Type Material

HOLOTYPE. Female, with associated pupal exuviae and cocoon (in 80% ethanol) reared from pupa (QSBG-2015-206), THAILAND: Mae Hong Son Province, Meung District, Mae Suai Au Village, Chong stream, 9-VII-2015, by W. Srisuka and A. Saeung.

PARATYPES: Three females, one male (all with associated pupal exuviae and cocoons) reared from pupae, and seven mature larvae (all in 80% ethanol), same data as those of the holotype.

Biological Notes

The pupae and larvae of this new species were collected from fallen leaves and pebbles in a small, slow-flowing stream (partially shaded by canopy, water temperature 21.9°C, pH 6.94, altitude 605 m, 19°15′59.1″N, 97°51′12.7″E).

Etymology

The species name maleewongae is in honor of Prof. Pewpan Maleewong Intapan, Department of Parasitology and Research and Diagnostic Center for Emerging Infectious Diseases, Faculty of Medicine, Khon Kaen University, who kindly supported W. Srisuka to collect black flies in Myanmar and Laos.
Discussion

Simulium (G.) maleewongae sp. nov. is placed in the S. gombakense species-group, defined by Takaoka (2012), by having the male hind basitarsus spindle-shaped, ventral plate gradually widened posteriorly when viewed ventrally, and pupal gill composed of an inflated structure with eight slender filaments. This new species is the third member of the S. gombakense species-group recorded from Thailand.

Among 10 known species of this species-group (Adler and Crosskey 2016), it is similar to S. (G.) aziruni Takaoka, Hashim & Chen, originally described from a pupal exuviae and a mature larva collected from Peninsular Malaysia (Takaoka et al. 2012) in having the pupal gill with an elongate inflated structure and eight slender...
filaments (Fig. 3G), simple pupal terminal hooks (Fig. 3J), and cocon with an anterodorsal projection (Fig. 3K). However, the pupa of this new species is distinguished from that of \textit{S. (G.) aziruni} by the following characters (those of \textit{S. (G.) aziruni} in parentheses): the gill with two inflated portions (only one portion), forwardly directed inflated portion with same width up to the apex (tapered from the middle to the apex), cuticular surface of the inflated structure lacking any pattern (with finely defined reticulate pattern), thoracic integument sparsely covered with tubercles on the dorsal surface of the anterior half (almost bare). The pupa of \textit{S. (G.) thuathienense} Takaoka & Sofian-Azirun from Vietnam has also simple, cone-shaped terminal hooks, but differs from this new species by the different configuration of the gills and simple cocoon (Takaoka et al. 2015).

The deeply depressed ventral margin of the ventral plate (Fig. 2F) in this new species, a rare character in the subgenus \textit{Gomphostilbia}, is shared by \textit{S. (G.) nuwakotense} Takaoka & Shrestha from Nepal and \textit{S. (G.) sachini} Takaoka & Willie from India and Nepal (Takaoka and Shrestha 2010). However, the pupae of these two species differ from that of this new species by having the inflated gills of different configuration, wide terminal hooks with crenulated outer margins, and simple cocoons.

This new species is distinguished from \textit{S. (G.) dudgeoni} Takaoka & Davies, described based on four males and one female from Hong Kong (Takaoka et al. 1995), by the male ventral plate deeply concave ventromedially when viewed posteriorly (Fig. 2F; convex in \textit{S. (G.) dudgeoni}).

This new species is easily distinguished in the pupa from five other species of the same species-group (\textit{S. (G.) antlerum} Chen from Hainan Island, China, \textit{S. (G.) gombakense}, \textit{S. (G.) langkawiense} from Peninsular Malaysia, \textit{S. (G.) prayongi}, and \textit{S. (G.) willie} Takaoka & Thapa from India) by the different configuration of the gills, simple, cone-shaped terminal hooks, and cocoon with an anterodorsal projection (Takaoka 2000; Chen 2001; Takaoka and Choochote 2005; Takaoka et al. 2010b, 2013).

### Keys to Identify 11 Species of the Simulium gombakense Species-Group

**Females**

1. Hind tibia whitish yellow on basal one-fourth (at least on anterior surface) and darkened on rest. \textit{S. dudgeoni}
   Hind tibia whitish yellow on basal half and darkened on apical half (Fig. 1C) ................................... 2
2. Sensory vesicle elongate, over 0.52 times length of third maxillary palpal segment. \textit{S. langkawiense}
   Sensory vesicle medium-long, less than 0.5 times length of third maxillary palpal segment ........................... 4
3. Sensory vesicle 0.52 times length of third maxillary palpal segment; claw tooth 0.46 times length of claw. \textit{S. gombakense}
   Sensory vesicle 0.61 times length of third maxillary palpal segment; claw tooth 0.53 times length of claw \textit{S. gombakense} 4
4. Fore basitarsus 6.60–6.78 times as long as its greatest width \textit{S. maleewongae} sp. nov.
   Fore basitarsus 5.58 times as long as its greatest width .......................... \textit{S. thuathienense}
Males**

1. Hind tibia whitish yellow on basal one-fourth and darkened on rest. ........................................ S. dudgeoni
2. Ventral plate deeply concave ventromedially when viewed posteriorly (Fig. 2F) ........................................ 3
   Ventral plate not concave ventromedially when viewed posteriorly ......................................................... 5
3. Upper eye with large facets in 15 vertical columns and 15 horizontal rows. ........................................... S. maleewongae sp. nov.
   Upper eye with large facets in 17 vertical columns and 18 horizontal rows. ........................................... 4
4. Ratio of width of hind basitarsus against that of hind femur equal to 0.75. ........................................... S. nuwakotense
   Ratio of width of hind basitarsus against that of hind femur equal to 0.80–0.83 ........................................... S. sachini
5. Upper-eye facets in 11 or 12 vertical columns and 12 or 13 horizontal rows. ........................................... 6
   Upper-eye facets in 14 or 15 vertical columns and 15 or 16 horizontal rows. ........................................... 7
6. Pleural membrane haired. .................................................................................................................. S. antlerum
   Pleural membrane bare. .................................................................................................................. S. langkawiense
7. Hind basitarsus 4.75 times as long as its greatest width. .................................. S. prayongi
   Hind basitarsus 5.00 times as long as its greatest width .......................................................... S. gombakense

Pupae***

1. Cocoon with anterodorsal projection (Fig. 3K) ........ 2
2. Gill with one inflated portion tapered apically. ................................................................. S. aziruni
   Gill with two inflated portions, one long, forwardly directed, with same width, and one short, directed dorsally (Fig. 3G) ........................................... S. maleewongae sp. nov.
3. Gill with one inflated portion, without nipple-like or finger-like projections. ......................................... S. williei
   Gill with two inflated portions, each with nipple-like or finger-like projections ........................................... 4
4. Gill with 10 slender filaments ........................................................................................................ S. antlerum
   Gill with 8 slender filaments ........................................................................................................ 5
5. Inflated portions of gill with only nipple-like short projections .............................................................. S. przayongi
   Inflated portions of gill with only finger-like long projections or finger-like long and nipple-like short projections ...... 6
6. Dorsally directed inflated portion of gill without constriction basally .................................................... 7
   Dorsally directed inflated portion of gill with one constriction or two ..................................................... 8
7. Ratio of width:length of inflated portion of gill equal to 0.24S. langkawiense
   Ratio of width:length of inflated portion of gill equal to 0.30 .......................................................... S. gombakense
8. Forwardly directed inflated portion of gill with one constriction; terminal hooks simple, cone-shaped (similar to Fig. 3J) ........................................... S. thuathienense
   Forwardly directed inflated portion of gill with two constrictions; terminal hooks wide, with crenulated outer margins . 9
9. Dorsally directed inflated portion of gill with one constriction .................................................................. S. sachini
   Dorsally directed inflated portion of gill with two constrictions .......................................................... S. nuwakotense

Larvae****

1. Postgenal cleft medium-long, 0.7–1.2 times length of postgenal bridge ........................................... 2
   Postgenal cleft long, over 3.0 times length of postgenal bridge .......................................................... 4
2. Abdominal segments 1 and 2 dark gray. ................................................................................. S. maleewongae sp. nov.
   Abdominal segments 1 and 2 not gray .......................................................... 3
3. Posterior circler with 84–88 rows of hooklets ................................................................. S. thuathienense
   Posterior circler with 72 rows of hooklets ................................................................. S. aziruni
4. Postgenal cleft long, approaching posterior margin of hypostoma leaving narrow postgenal bridge; labral fan with 22 or 23 primary rays .......................................................... S. williei
   Postgenal cleft long, but not approaching posterior margin of hypostoma, about 3.0 times length of postgenal bridge; labral fan with 25–34 primary rays ........................................... 5
5. Posterior circler with 96–100 rows of hooks ................................................................. S. langkawiense
   Posterior circler with 74–88 rows of hooks ........................................................................ 6
6. Posterior circler with 84–88 rows of hooks ........................................................................ 7
   Posterior circler with 74–82 rows of hooks ............................................................................... S. gombakense
   * The females of S. antlerum, S. aziruni, S. nuwakotense, S. prayongi, S. sachini, and S. williei are unknown.
   ** The males of S. aziruni, S. thuathienense, and S. williei are unknown.
   *** The pupa of S. dudgeoni is unknown.
   **** The larvae of S. antlerum, S. dudgeoni, S. nuwakotense, and S. prayongi are unknown.

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