Two new species of Simulium (Simulium) (Diptera: Simuliidae) from northern Thailand

Hiroyuki Takaoka\(^1\) and Wej Choochote\(^2\)

\(^1\) Department of Infectious Disease Control, Faculty of Medicine, Oita University, Hasama, Oita, 879–5593 Japan
\(^2\) Department of Parasitology, Faculty of Medicine, Chiang Mai University, Chiang Mai 50200, Thailand

(Received: 7 February 2005; Accepted: 28 March 2005)

Abstract: Simulium (Simulium) manooi sp. nov. and S. (S.) doipuiense sp. nov. (formerly S. (S.) sp. E reported by Takaoka and Suzuki, 1984) are described based on reared female and male adult, pupal and larval specimens collected in northern Thailand. Both new species are assigned to the tuberosum species-group of the subgenus Simulium (Simulium) Latreille. Simulium (S.) manooi sp. nov. seems to be most closely related to S. (S.) ramosum Puri from India, while S. (S.) doipuiense sp. nov. is related to S. (S.) rufibasis fasciatum Puri also from India. The morphological differences between these new species and their known related species are noted.

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

In Thailand, the tuberosum species-group, one of the 10 species-groups of the subgenus Simulium (Simulium) Latreille s. str. in the Oriental Region, is represented by five species, i.e., S. (S.) brevipar Takaoka and Davies, S. (S.) rufibasis rufibasis Brunetti (including S. (S.) sp. E reported by Takaoka and Suzuki, 1984), S. (S.) setsukoaee Takaoka and Choochote, S. (S.) tani Takaoka and Davies and S. (S.) weji Takaoka (Takaoka and Choochote, 2004b). Recently we collected one more species belonging to this species-group, which is very similar in the female to S. (S.) rufibasis rufibasis and S. (S.) ramosum Puri, both originally described from India (Brunetti, 1911; Puri, 1932) by having paired median clusters of dark long stout hairs on the ventral surface of the seventh abdominal segment. This is here described as a new species based on the reared female and male adults, pupae and mature larvae collected in northern Thailand.

In addition, S. (S.) sp. E, originally reported from female and pupal specimens captured in Doi Inthanon National Park, northern Thailand (Takaoka and Suzuki, 1984), and tentatively treated under the name of S. (S.) rufibasis in a list of Thailand Simuliidae (Takaoka and Choochote, 2004b), is also described as a new species.

The terms for morphological features used here follow those of Takaoka (2003). Holotype and paratype specimens of the new species are deposited at the Department of Infectious Disease Control, Oita University, Oita, Japan.

Simulium (Simulium) manooi sp. nov.

DESCRIPTION. Female. Body length 2.6–2.8 mm. Head. Narrower than width of thorax. Frons brownish black, shiny, with several dark stout hairs along lateral margins; frontal ratio 1.3–1.4 : 1.0 : 1.4; frons-head ratio 1.0 : 4.3–5.6. Fronto-ocular area (Fig. 1A) moderately developed, directed laterally and slightly upward. Clypeus brownish black, shiny, with scattered dark stout hairs only marginally (widely bare medially). Labrum about 0.6 times as long as clypeus. Antenna composed of 2 + 9 segments,
dark brown except scape, pedicel, and 1st flagellar segment yellow (though scape, pedicel, and basal 1/3 to 1/2 of 1st flagellar segment yellow when viewed ventrally or inwardly). Maxillary palp brownish black, composed of 5 segments with proportional lengths of 3rd, 4th, and 5th segments 1.0:1.1:2.4-2.5; 3rd segment (Fig. 1B) of moderate size; sensory vesicle medium in size, elliptical, with rugged surface, 0.3-0.4 times length of 3rd segment, with
medium-sized round opening. Maxillary lacinia with 13 inner and 15 outer teeth. Mandible with ca. 32 inner and 11 or 12 outer teeth. Cibarium (Fig. 1C) with numerous minute tubercles. **Thorax.** Scutum black (except anterolateral calli medium brown), shiny, not patterned, moderately covered with dark brown recumbent short hairs intermixed with copper-colored (some hairs appearing yellow when illuminated) recumbent short ones, interspersed with dark-brown long upright hairs on pre-scutellar area; scutum thinly grey pruinose when illuminated at certain angle of light. Scutellum brownish black, with dark long hairs as well as dark short ones. Postnotum blackish brown, shiny, without hairs. Pleural membrane bare. Katepisternum longer than deep, and bare. **Legs.** Foreleg: coxa yellow; trochanter medium brown except basal 1/2 yellow; femur medium to dark brown (gradually becoming dark toward apical tip) though somewhat yellowish basally on anterior surface; tibia white except base dark yellow and apical 1/4 to 1/5 brownish black, with large white sheen medi ally on outer surface; tarsus brownish black to black, with short dorsal hair crest; basitarsus dilated, 5.0 times as long as its greatest width. Midleg: coxa, trochanter and femur dark brown to brownish black except base of trochanter dark yellow to light brown; tibia brownish black except basal 2/5 (basal 1/2 or a little less on anterior and posterior surfaces) yellowish white, and with white sheen on posterior surface when illuminated; tarsus medium to dark brown except basal 1/3 to 1/2 of basitarsus dark yellow (though its border not well defined). Hind leg: coxa brownish black; trochanter dark yellow to light brown; femur dark brown to brownish black (though base of femur somewhat paler on inner surface); tibia brownish black except a little more than basal 2/5 yellowish white, and with white sheen on posterior surface when illuminated; tarsus dark brown to brownish black except basal 3/5 or a little more of basitarsus, and basal 1/2 of 2nd segment yellowish white; basitarsus (Fig. 1D) parallel-sided, 6.6 times as long as its width, and 0.72 and 0.60 times as wide as greatest widths of hind tibia and femur, respectively; calcipala short, slightly shorter than its width; pedisculus distinct. All tarsal claws simple, without basal or subbasal tooth. **Wing.** Length 2.2 mm; costa with dark spinules and hairs; subcosta haired except apical 1/3 bare; basal section of vein R bare; R1 with dark spinules and hairs; R2 with hairs; hair tuft at base of stem vein dark brown; basal cell absent. **Abdomen.** Basal scale brownish black with fringe of dark long hairs; dorsal and ventral surfaces of abdomen dark brown to brownish black, with dark hairs; 2nd tergite with a pair of large dorsolateral whitish iridescent spots broadly connected in middle to each other; tergites 3, 4 and 5 small and dull; tergites 6–8 large and shiny; ventral surface of segment 7 (Fig. 1E) with a pair of moderately developed submedial sternal plates (which are connected in middle or not), and with 13–16 clustered long stout hairs as well as about 10 scattered similar hairs (though some hairs shorter and thinner than clustered hairs) on each sternal plate. **Genitalia.** Sternite 8 (Fig. 1F) well sclerotized, bare medi ally but with 7 or 8 long stout hairs as well as several short fine hairs laterally on each side; ovipositor valves (Fig. 1F) triangular in shape, membranous, covered with 4–6 short fine hairs as well as numerous microsetae; inner border slightly curved, narrowly sclerotized. Genital fork (Fig. 1G) of inverted-Y form, with well sclerotized stem; arms somewhat wide, each with strongly sclerotized ridge on apical 1/2 having a short projection directed anterodorsally. Paraproct in ventral view (Fig. 1H) with depressed area anteriorly; medial surface well sclerotized. Paraproct in lateral view (Fig. 1I) much shorter than wide, only slightly protruding ventrally beyond level of cercus, densely covered with numerous short stout hairs. Cercus in lateral view (Fig. 1I) rounded posteriorly, about half as long as wide, covered with several short stout hairs. Spermatheca (Fig. 1J) nearly ovoid, well sclerotized (ducts and small basal area around junction to duct unsclerotized), with no definite reticulate pattern, with minute internal setae. **Male.** Body length 2.8–3.0 mm. **Head.** Width slightly wider than thorax. Upper eye consisting of large facets in 18 or 19 horizontal rows and in 17 or 18 vertical columns. Clypeus black, thickly white pruinose (silvery iridescent when illuminated), sparsely covered with dark brown hairs along lateral and lower margins. Antenna composed of 2+9 segments, dark brown to blackish brown except basal 1/5 to 1/2 of 1st flagellar segment yellow; 1st flagellar segment elongated, 1.9 times as long as 2nd one. Maxillary palp brownish black, composed of 5 segments with proportional lengths
Fig. 2. Adult male of *Simulium* (*Simulium*) manooni sp. nov. A, 3rd segment of maxillary palp (right side, front view); B, hind basitarsus and 2nd tarsal segment (left side, outer view); C, coxites, styles and ventral plate *in situ* (ventral view); D and E, coxites and styles *in situ* (right side, D, ventrolateral view; E, outer view); F and G, styles (right side, F, medial view; G, dorsomedial view); H and I, ventral plates (H, end view; I, lateral view); J, median sclerite (end view); K, paramere (left side, end view); L, dorsal plate; M and N, 10th abdominal segments and cerci (right side, M, end view; N, lateral view). Scales. 0.1 mm for B; 0.02 mm for A and C–N.
of 3rd, 4th, and 5th segments 1.0:1.2:2.7; 3rd segment (Fig. 2A) of normal size; sensory vesicle small (0.25 times as long as 3rd segment), ellipsoidal, and with small opening. **Thorax.** Scutum black, with white pruinose pattern composed of anterior pair of rectangular spots with rounded apex on shoulders extending posteriorly along lateral margins up to base of wing and large transverse spot entirely covering prescutellar area which is not contiguous, or very narrowly connected, to anterior spots; these pruinose areas silvery iridescent when illuminated at certain angles of light; scutum uniformly covered with copper-colored (appearing yellow when illuminated) recumbent short hairs, interspersed with dark brown long upright hairs on prescutellar area. Scutellum brownish black, shiny, white pruinose, with several upright dark hairs. Postnotum brownish black, shiny, white pruinose, without hairs. Pleural membrane and katepisternum as in female. **Legs.** Foreleg: coxa light brown except most of inner and posterior surfaces yellow; trochanter medium brown; femur medium brown to brownish black (gradually darkened toward apical tip); tibia medium brown to brownish black except median large portion of outer surface white, and with large white sheen when illuminated; tarsus brownish black to black, with short dorsal hair crest; basitarsus somewhat dilated, 6.6 times as long as its greatest width. Midleg: brownish black except base of trochanter medium brown, basal tip of tibia dark yellow, subbasal small area of anterior and inner surfaces of tibia light brown, and in some males basal 1/3 (or more) of basitarsus dark yellow to light brown. Hind leg: coxa dark brown; trochanter light brown except most of inner surface dark yellow; femur brownish black except basal tip somewhat lighter; tibia brownish black except basal tip whitish yellow; tarsus dark brown except basal 1/3 to a little less than basal 1/2 of basitarsus and basal 1/2 of 2nd segment whitish yellow; basitarsus (Fig. 2B) much enlarged, spindle-shaped, nearly parallel-sided medially and tapered towards both ends, about 4.0 times as long as its greatest width, and subequal in greatest width to hind tibia and femur; calci-pala small, nearly as long as wide; pedisulcus well marked. **Wing.** Length 2.0 mm; other features as in female except subcosta bare. **Abdomen.** Basal scale brownish black, with fringe of dark long hairs. Dorsal surface of abdomen medium brown to brownish black (gradually darkened toward posterior tip), with dark short hairs; segments 2, 6 and 7 each with pair of silvery iridescent spots dorsolaterally, those on segment 2 connected broadly to each other in middle; ventral surface of abdomen light to medium brown except tergal plates dark brown. **Genitalia.** Coxite in ventral view (Fig. 2C) nearly quadrate, and much shorter than style; style (Fig. 2D) elongate, about 2.9 times as long as its greatest width near base, gently curved inward, somewhat tapered apically, with subterminal spine; style (Fig. 2F, G) with round protuberance basally on dorsal surface, bearing numerous spinules on its surface; style (Fig. 2E) spatulate dorsoventrally. Ventral plate (Fig. 2C, H, I) with base nearly quadrate in shape, having ventrally produced hairy process with toothed posterolateral margins on basal 1/2; posterior margin concave when viewed ventrally; basal arms moderately diverging from each other. Median sclerite (Fig. 2J) well sclerotized, plate-like, widening toward middle, then nearly parallel-sided. Parameres (Fig. 2K) each with several distinct hooks. Aedeagal membrane covered with minute setae, and with well sclerotized dorsal plate (Fig. 2L). Abdominal segment 10 (Fig. 2M, N) with 2 hairs on ventral surface and 2 hairs on lateral surface on each side. Cercus (Fig. 2M, N) small, rounded, with 7 or 8 hairs.

**Pupa.** Body length (excluding gill filaments) 2.6–3.0 mm. **Head.** Integument (Fig. 3A) yellowish brown, moderately covered with rounded tubercles, with 1 facial and 2 frontal pairs of simple medium-long trichomes (except left trichome on face of 1 pupa bifid); facial trichomes somewhat longer than frontal ones. **Thorax.** Integument yellowish brown, moderately covered with rounded tubercles on anterior 1/2, and smaller conical tubercles dorsally on posterior 1/2, and almost bare on each postero-lateral surface; thorax on each side with 2 long trichomes mediodorsally, 1 long and 1 medium-long trichomes dorsolaterally, 1 medium-long trichome posterolaterally, and 2 medium-long and 1 short trichomes ventrolaterally, all simple. Gill (Fig. 3B) with 6 slender filaments arranged in short-stalked pairs; stalk of dorsal pair directed forward and slightly upward forming an acute angle with that of ventral pair when viewed laterally; filaments decreasing in length from dorsal to ventral, with outer filament of dorsal pair longest of all
Fig. 3. Pupa and mature larva of *Simulium (Simulium) manooni* sp. nov. A, frons and upper part of face of pupa (left half); B, gill filaments of pupa (right side, outer view); C, apical part of larval mandible; D, hypostomium of larva. Scales. 0.1 mm for A and B; 0.02 mm for D; 0.01 mm for C.
(ca. 1.9 mm), and lower filament of ventral pair shortest (ca. 1.2 mm); when basal portions of filaments compared, outer filament of dorsal pair thickest of all, followed by inner filament of dorsal pair which is slightly thicker than outer filament of middle pair, and 3 other filaments subequal in thickness to one another and slightly thinner than outer filament of middle pair; all filaments tapered toward apex, greyish brown, darker than coloring of thoracic integument, with well-marked annular ridges and furrows throughout their length, densely covered with minute tubercles. **Abdomen.** Dorsally, all segments not sclerotized, transparent and without tubercles except segment 1 weakly sclerotized and pale yellow; segment 1 with 1 medium-long slender seta on each side; segment 2 with 1 short slender seta and 5 short spinous setae on each side; segments 3 and 4 each with 4 hooks and 1 short spinous seta on each side; segments 5 and 6 bare; segments 7–9 each with spine-combs directed backward in transverse row and with comb-like groups of minute spines on each side; terminal hooks absent. Laterally, segments 2–4 each with 3 short spinous setae on each side; segment 9 without grapnel-like hooklets. Ventrally, all segments nearly transparent except last segment weakly sclerotized and yellow; segments 4–8 with comb-like groups of minute spines; segment 4 with 1 simple hook submedially and a few slender setae on each side; segment 5 with pair of bifid hooks submedially and a few slender setae on each side; segments 6 and 7 each with pair of bifid inner and simple or bifid outer hooks and a few slender setae on each side. **Cocoon.** Wall-pocket-shaped, moderately woven with no open spaces in webs, without anterodorsal projection, and not extending ventrolaterally; individual threads visible; 2.8–3.1 mm long by 1.3–1.6 mm wide.

**Mature larva.** Body length 5.2–5.8 mm. Abdomen gradually increasing in width from 1st to 7th segment, then narrowed toward posterior tip when viewed laterally. Body color dark grey. Cephalic apomere (Fig. 5A) pale yellowish white on anterior 1/2, pale yellow on posterior 1/2 except median longitudinal dark area including posterior one of mediolongitudinal spots and median space between posterolateral spots down to posterior margin; posterior one of mediolateral spots and areas surrounding posterolateral spots faintly light brown; anterior or one of mediolongitudinal spots indistinct or faintly darkened; anterior one of mediolateral spots and posterolateral spots usually lighter than surrounding area, then appearing faintly negative; lateral surface of head capsule (Fig. 5B) yellow with somewhat dark area above and posterior to eye-spot region; spots just before posterior margin and below eye-spot region pale, then indistinct or sometimes appearing negative; ventral surface of head capsule (Fig. 5C) yellow except areas along lateral margins of postgenal cleft somewhat darkened; basal area on each side of postgenal cleft darkened as usual; transverse spot on each side of postgenal cleft indistinct or appearing somewhat negative. Cervical sclerite (Fig. 5A) composed of 1 elongate piece and 1 elliptical one situated close together on each side; both sclerites not fused to occiput, moderately separated mediately from each other. Antenna composed of 3 segments and apical sensillum, much longer than stem of labral fan; proportional lengths of 1st, 2nd, and 3rd segments 1:0.6: 0.8. Labral fan with about 38 main rays. Mandible (Fig. 3C) with mandibular serrations composed of usual 2 teeth (1 medium-sized, 1 small), medium-sized tooth at right angle or at a little greater angle to mandible on apical side; supernumerary serrations absent; 1st tooth of comb-teeth longest, 2nd and 3rd teeth subequal in length to each other. Hypostomium (Fig. 3D) with 9 apical teeth in row, median and corner teeth well developed; lateral margins moderately serrate apically; 5 or 6 hypostomal bristles per side, slightly diverging posteriorly from lateral margin on each side. Postgenal cleft (Fig. 5C) deep, spear-head-shaped, nearly parallel-sided near base, pointed anteriorly, and 2.7–3.7 times as long as postgenal bridge. Thoracic cuticle almost bare. Abdominal cuticle bare except last segment moderately covered with short colorless setae on each side of anal sclerite. Rectal scales minute. Rectal organ compound, each of 3 lobes with 9 or 10 finger-like secondary lobules. Anal sclerite X-shaped, with broadened anterior arms about 0.8 times as long as posterior ones; 7–9 sensilla present medially posterior to posterior arms. Last abdominal segment slightly bulged ventrolaterally, barely visible as small ventral papilla when viewed laterally. Posterior circlot with about 80 rows of up to 14 hooklets per row.
TYPE SPECIMENS. Holotype female, together with its associated pupal exuvia and cocoon, Doi Pui National Park, Chiang Mai Province, Thailand, 18 XI. 2004, by Wej Choochote. Paratypes: 3 males (reared from pupae), 2 pupae and 3 mature larvae, same data as holotype; 3 females and 8 males (all reared from pupae), same data as holotype except date, 12. I. 2005.

ECOLOGICAL NOTES. The pupae and larvae were collected on trailing grasses in a stream (width ca. 1 m, depth ca. 0.2 m, shaded, water temperature 18.5°C, altitude 1,360 m above sea level). Associated species were Simulium (Simulium) brevipar Takaoka and Davies, S. (S.) bullatum Takaoka and Choochote, S. (S.) doipuiense sp. nov., S. (S.) mediooloratum Takaoka and Choochote, and S. (Gomphostilbia) asakoe Takaoka and Davies.

DISTRIBUTION. Thailand.

ETYMOLOGY. The species name manooni is in honor of Professor Emeritus Manoon Bhaibulaya, formerly Head of the Department of Parasitology, Faculty of Medicine at Siriraj Hospital, Mahidol University, Bangkok, Thailand, from whom WC learned much during his master course.

REMARKS. Simulium (Simulium) manooni sp. nov. is assigned to the tuberosum species-group (Takaoka and Davies, 1996) by the shape of the genitalia of both sexes and the 6-filamented pupal gill, and is very similar in the female to S. (S.) rufibasis Brunetti and S. (S.) ramosum Puri, both from India (Brunetti, 1911; Puri, 1932) by having a pair of the submedian clusters of long stout hairs on the ventral surface of the seventh abdominal segment (Fig. 1E), and the dark short hairs on the scutum. However, the female of this new species is different from those of these two Indian species by the hind basitarsus which is yellowish-white on basal 3/5 or a little more (Fig. 1D) (cf., yellowish on basal 1/2 or 1/3 in the two Indian known species). Simulium (S.) manooni differs from these two species in the male by the absence of the dorsolateral silvery spots on the fifth abdominal segment, and in the pupa by the absence of the terminal hooks and also in the pupa from S. (S.) rufibasis rufibasis by the arrangement of the gill filaments (cf., gill filaments of S. (S.) rufibasis rufibasis arranged in a similar manner to Fig. 4F), and from S. (S.) ramosum by the simple trichomes on the thoracic integument (cf., branched in S. (S.) ramosum). The larva of S. (S.) manooni is distinguished from that of S. (S.) rufibasis rufibasis described from specimens collected at the type locality (Datta, 1974) by the dark mediolongitudinal spot on the cephalic apotome (Fig. 5A).

Simulium (S.) manooni is also very similar in the female to S. (S.) setsukoe described from female specimens collected in northern Thailand (Takaoka and Choochote, 2004a), but differs from the latter by the much longer clustered hairs on the ventral surface of the seventh abdominal segment.

Simulium (Simulium) doipuiense sp. nov.
Simulium (Simulium) sp. E, Takaoka and Suzuki, 1984: 42–44 (female and pupa)

DESCRIPTION. Female. Body length 2.4–2.6 mm. Head. As in female of S. manooni except following characters. Frontal ratio 1.3 : 1.0 : 1.3; frons-head ratio 1.0 : 3.8. Maxillary palp brownish black, composed of 5 segments with proportional lengths of 3rd, 4th, and 5th segments 1.0 : 1.1 : 2.1. Sensory vesicle with opening near apex. Maxillary lacinia with 13 or 14 inner and 13–15 outer teeth. Thorax. Scutum brownish black (except anterolateral calli dark brown), shiny, not patterned, covered moderately with yellow recumbent short hairs interspersed with dark brown long upstanding hairs on prescutellar area; scutum thinly grey pruinose when illuminated at certain angle of light. Scutellum dark brown, with dark long hairs as well as yellow short ones. Postnotum dark brown, shiny, without hairs. Pleural membrane bare. Katepisternum longer than
deep, and bare. **Legs.** Foreleg: coxa yellow; trochanter medium brown except basal 1/2 on outer surface and most of inner surface yellow; femur light to dark brown (gradually becoming dark toward apical tip) though yellowish basally on inner surface; tibia white except apical 3/10 to 1/7 brownish black, with large white sheen mediolaterally on outer surface when illuminated; tarsus brownish black, with short dorsal hair crest; basitarsus dilated, 4.9 times as long as its greatest width. Midleg: coxa blackish brown; trochanter medium brown except base yellow; femur medium to dark brown; tibia whitish yellow except a little less than apical 1/3 dark brown, and with large white sheen on posterior surface when illuminated; tarsus medium to dark brown except basal 2/3 of basitarsus and base of 2nd segment yellow. Hind leg: coxa medium brown; trochanter yellow (though somewhat dark yellow on outer surface); femur medium to dark brown except base yellow; tibia yellowish white except apical 2/5 medium to dark brown, and with large white sheen on posterior surface when illuminated; tarsus brown to brownish black except basal 3/5 of basitarsus, and basal 1/2 of 2nd segment yellowish white; basitarsus parallel-sided, 5.9 times as long as its width, and 0.74 and 0.64 times as wide as greatest widths of hind tibia and femur, respectively; calcipala short, slightly shorter than its width; pedisulcus distinct. All tarsal claws simple, without basal or subbasal tooth. **Wing.** Length 2.0 mm; other features as in *S. manooni* except subcosta haired except apical 1/3 to 1/4 bare. **Abdomen.** Basal scale medium brown with fringe of pale long hairs; dorsal surface of abdomen medium to dark brown, with pale fine hairs as well as dark stout hairs; 2nd tergite with pair of large dorsolateral whitish iridescent spots broadly connected in middle to each other; tergites 3, 4 and 5 small and dull; tergites 6–8 large and shiny; ventral surface of abdomen light brown; segment 7 nearly as in *S. manooni* female. **Genitalia.** Nearly as in *S. manooni* female.

**Male.** Body length 2.8–3.1 mm. **Head.** As in male of *S. manooni* except following characters: Upper eye consisting of large facets in 16 or 17 horizontal rows and in 17 vertical columns. Antenna composed of 2 + 9 segments, dark brown to blackish brown except extreme base of 1st flagellar segment yellow. **Thorax.** As in male of *S. manooni*. **Legs.** Nearly as in male of *S. manooni* except following characters: Fore coxa yellow to dark yellow. Hind basitarsus yellow or dark yellow on basal 1/3 to a little more than basal 2/5, dark brown on rest. Fore basitarsus somewhat dilated, 5.9–6.1 times as long as its greatest width. Hind basitarsus (Fig. 4A, B) much enlarged, nearly wedge-shaped, widening from base toward apical 2/5, then nearly parallel-sided or slightly narrowed, 3.5 times as long as its greatest width, and 1.05 and 1.18–1.21 times as wide as greatest widths of hind tibia and femur, respectively. **Wing** and **Abdomen.** As in male of *S. manooni*. **Genitalia.** Nearly as in male of *S. manooni* except style of which basal protuberance bare or with a few to several spines (Fig. 4C, D).

**Pupa.** Nearly as in *S. manooni* except following characters: Body length 2.5–3.1 mm. **Head.** Integument (Fig. 4E) moderately covered with round tubercles, and with frontal trichomes much longer than facial ones. **Thorax.** Integument densely covered with round tubercles, and with longer trichomes than those of *S. manooni*. Gill (Fig. 4F) with 6 slender filaments arranged in short-stalked pairs; stalk of dorsal pair directed upward and slightly forward forming a right angle with that of ventral pair when viewed laterally; filaments slightly decreasing in length and thickness from dorsal to ventral, with outer filament of dorsal pair longest (1.5–1.8 mm) and lower filament of ventral pair shortest (0.8–1.0 mm).

**Mature larva.** Body length 5.2–5.6 mm. Body color light to dark grey though somewhat brownish on posterior segments of abdomen. Cephalic apotome (Fig. 5D) pale on anterior 1/2, yellowish on posterior 1/2 with somewhat darkened area medially just before posterior margin; all head spots usually indistinct or sometimes very faintly negative; lateral surface of head capsule (Fig. 5E) yellow; eye brow faintly defined; spots just before posterior margin and below eye-spot region indistinct; ventral surface of head capsule (Fig. 5F) usually pale yellow or sometimes slightly darkened along both lateral margins of postgenal cleft; basal area on each side of postgenal cleft darkened as usual; transverse spot on each side of postgenal cleft indistinct or negative. Cervical sclerite composed of 1 elongate piece (faintly to moderately pigmented) and 1 elliptical one (usually very faint) situated close together on each side; each elongate piece of sclerite appearing to be faintly fused to occiput, moder-
Fig. 4. Adult male and pupa of *Simulium (Simulium) doipuiense* sp. nov. A and B, hind basitarsi and 2nd tarsal segments (left side, outer view); C and D, styles (right side, C, medial view; D, dorsal view); E, frons and upper part of face of pupa (front view); F, gill filaments of pupa (right side, outer view). Scales. 0.1 mm for A, B and F; 0.05 mm for E; 0.02 mm for C and D.
Fig. 5. Larval head capsules of Simulium (Simulium) manooni sp. nov. and S. (S.) doipuiense sp. nov. A, B and C: S. (S.) manooni; D, E and F: S. (S.) doipuiense sp. nov. A and D, dorsal view; B and E, lateral view; C and F, ventral view.

ately separated medially from each other. Antenna composed of 3 segments and apical sensillum, much longer than stem of labral fan; proportional lengths of 1st, 2nd, and 3rd segments 1.0 : 1.2 : 0.7. Labral fan with 36–40 main rays. Mandible and hypostomium as in S. manooni. Postgenal cleft (Fig. 5F) shaped as in S. manooni and 3.2–3.7 times as long as postgenal bridge. Rectal organ compound, each of 3 lobes with 8–13 finger-like secondary lobules. Posterior cirrlet with about 80 rows of up to 16 hooklets per row. Body shape, thoracic and abdominal cuticles, rectal scales, and anal sclerite as in S. manooni.

TYPE SPECIMENS. Holotype female, together with its associated pupal exuvia and cocoon, Doi Pui National Park, Chiang Mai Province, Thailand, 16.IX.2004, by Wej Choochote. Paratypes: 1 female, 2 males, 2 pupae and 8 mature larvae, same data as holotype; 13 females, 6 males, 4 pupae, 10 mature larvae, Siribhume waterfall, Doi Inthanon National Park, Chiang Mai Province, Thailand, 23.VI.2004, by Wej Choochote.

ECOLOGICAL NOTES. The pupae and larvae were collected on trailing grasses in a stream (width ca. 1 m, depth ca. 0.2 m, shaded, water temperature 18.5°C, altitude 1,360 m above sea level), and in another stream (width 2–5 m, shaded, water temperature 20°C, altitude 1,360 m above sea level). Many other species were collected together with this new species.

DISTRIBUTION. Thailand.

ETYMOLOGY. The species name doipuiense refers to the locality name, Doi Pui, where this new species was collected.

RRMARKS. Simulium (Simulium) doipuiense sp. nov. is also assigned to the tuberosum species-group (Takaoka and Davies, 1996) and is more similar in the
female to S. (S.) rufibasis fasciatum Puri described from India (Puri, 1932) than S. (S.) rufibasis rufibasis by having all the tibiae widely whitish. However, the male of this new species is different from that of S. (S.) rufibasis fasciatum by lacking three longitudinal vittae on the scutum, which are present in S. (S.) rufibasis fasciatum. The pupa of S. (S.) doipuiense is similar to those of S. (S.) rufibasis fasciatum and S. (S.) rufibasis rufibasis in the arrangement of the gill filaments (Fig. 4F), but differs from the latter two species by lacking the terminal hooks. The larva of S. (S.) doipuiense is similar to that of S. (S.) rufibasis rufibasis described by Datta (1974) and also probably to that of S. (S.) rufibasis fasciatum, which is unknown as yet.

This new species is easily distinguished from S. (S.) manooni in the female by the colorations of legs and short hairs on the scutum, in the male by the shape of the hind basitarsus, in the pupa by the arrangement of the gill filaments, and in the larva by the head-spot pattern of the cephalic apotome.

ACKNOWLEDGEMENTS

We are grateful to Mr. Surachai Tuamsomboon, Chief, Headquarters of Doi Inthanon National Park, Wildlife and Plant Conservation Department, Ministry of National Resources and Environment, for his permission to conduct this survey inside the park. We thank Ms. Chiharu Aoki who kindly helped to take photographs of larval head capsules.

This work was financially supported by a Grant-in-Aid of Japan-US Medical Research Cooperation Program (the fiscal year 2004).

References


Datta, M. 1974. Some black flies (Diptera: Simuliidae) of the subgenus Simulium Latreille (s. str.) from the Darjeeling area (India). Oriental Insects, 8: 15–27.


