

## TAXONOMIC NOTES ON THE *GRISEIFRONS* SPECIES-GROUP OF *SIMULIUM* (*SIMULIUM*) (DIPTERA: SIMULIIDAE) IN NORTHERN THAILAND

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**Abstract:** Two known and two new species of the *griseifrons* species-group of the subgenus *Simulium* (*Simulium*) in Northern Thailand are reported. The male, pupa and mature larva of *S. (S.) rudnicki* Takaoka and Davies, and the pupa and mature larva of *S. (S.) suchariti* Takaoka and Choochote, are described for the first time. Furthermore, two new simuliid species, *S. (S.) mediocoloratum* sp. nov. and *S. (S.) crocinum* sp. nov., both of which are very similar to *S. (S.) rudnicki*, are also described.

**Key words:** black fly, Simuliidae, *Simulium*, Thailand, new species, *griseifrons* species-group

In Thailand, the *griseifrons* species-group of the subgenus *Simulium* (*Simulium*) is represented by eight species [1]. During recent surveys on the immature stages of black flies in Northern Thailand, we collected *S. rudnicki* Takaoka and Davies [2], *S. suchariti* Takaoka and Choochote [3], and two new species, all of which are assigned to this species-group. The male, pupa and mature larva of *S. rudnicki*, and the pupa and mature larva of *S. suchariti* (only females of both species were so far known) are described here for the first time. The two new species are also described based on adult, pupal and larval specimens.

The terms for morphological features used here follow those of Takaoka [4]. Holotype and most paratype specimens of the new species will be deposited at the Department of Infectious Disease Control, Oita University.

### *Simulium* (*Simulium*) *rudnicki* Takaoka and Davies, 1995

*Simulium* (*Simulium*) *rudnicki* Takaoka and Davies,  
1995: 155 (female only).

**DESCRIPTION. Male.** Body length 3.8–4.0 mm. **Head.** Slightly wider than thorax. Upper eye consisting of large facets in 24 horizontal and 22 or 23 vertical rows. Clypeus black, white pruinose, iridescent when illuminated, sparsely covered with dark brown hairs. Antenna composed of 2+9 segments, pale yellow on scape, pedicel, and base of 1st flagellar segment, dark yellow on the rest except 3 or 4 apical flagellar segments dark brown, (in 1 male, pale yellow on scape, pedicel, and base of 1st flagellar segment, light to

medium brown on the rest of 1st flagellar segment, 2nd and 3rd flagellar segments, and dark brown on 4th to 9th flagellar segments); 1st flagellar segment elongate, about twice as long as 2nd one. Maxillary palp composed of 5 segments, proportional lengths of 3rd, 4th, and 5th segments 1.0:1.2:2.8; 3rd segment (Fig. 1A) of normal size, with a small globular sensory vesicle having a very small opening. **Thorax.** Scutum black, with silvery iridescent pattern differing with angles of light: when illuminated anteriorly and viewed dorsally scutum shows subanteriorly a transverse pair of narrow silvery iridescent spots widely spaced in middle (distance between spots about one-third that of scutum); when illuminated laterally or posterolaterally and viewed dorsolaterally, the subanterior paired spots fade and are replaced by an anterior pair of narrow iridescent spots on shoulders which extend posteriorly along lateral margins in a wide band and connect to a large transverse posterior spot on prescutellar area; when illuminated anterolaterally and viewed dorsolaterally, scutum on each shoulder has a large anterior iridescent spot including anterior and subanterior narrow spots mentioned above, which is also contiguous to a broad lateral iridescent band along lateral border; scutum uniformly covered with yellow recumbent short hairs interspersed with dark long upright hairs on prescutellar area and dark short and medium-long hairs near anterior margin. Scutellum black except posterior margin brownish, with several dark long upright hairs as well as yellow short hairs. Postnotum black, silvery iridescent when illuminated, and bare. Pleural membrane bare. Katepisternum longer than deep, and bare. **Legs.** Foreleg: coxa pale yellow; trochanter

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and femur medium or dark yellow with narrow apical portion light brown on outer surface; tibia brownish black with basal 3/4 narrowly white on outer surface (white sheeny when illuminated); tarsus black, with moderate dorsal hair crest; basitarsus somewhat dilated, about 6.4 times as long as its greatest width. Midleg: coxa dark brown or blackish brown; trochanter pale yellow with apical 1/2 or a little more dark yellow to light brown; femur entirely yellow; tibia entirely yellow, with a broad white sheen on posterior surface when illuminated; tarsus brownish black except basal 1/2 or 2/3 yellow, though its border not well defined. Hind leg: coxa dark brown or brownish black; trochanter yellow; femur yellow except apical cap dark brown; tibia brownish black with base narrowly whitish yellow; tarsus brownish black except basal 1/2 of basitarsus and basal 1/2 of 2nd tarsal segment whitish yellow; basitarsus (Fig. 1B) somewhat widened from base toward apical 3/4, then somewhat narrowed toward apex, 4.5 times as long as its greatest

width, and 0.8 times as wide as the greatest width of hind tibia, which is as wide as that of femur; calcipala of medium size, nearly as long as wide; pedisulcus distinct. **Wing.** Length 2.9–3.0 mm; costa with spinules and hairs; subcosta bare; basal section of vein R bare; R<sub>1</sub> with spinules and hairs; R<sub>2</sub> with hairs only; hair tuft at base of stem vein dark brown; basal cell absent. **Abdomen.** Basal scale blackish with a fringe of long dark hairs. Abdomen brownish black with dark hairs; segments 2, 5–7, each with a pair of silvery iridescent spots dorsolaterally, those on segment 2 broadly connected in middle. **Genitalia** (Fig. 1C–L). Coxite in ventral view nearly quadrate. Style elongate, spatulate ventrodorsally, 2.2 times as long as coxite, gradually narrowed from base to apical 1/3, then widened to rounded apex (widths at base and near apex subequal to each other and about 1.4 times as wide as the narrowest width at middle), with a slender subterminal spine; style with a prominent basal protuberance pointed dorsally and furnished at and near

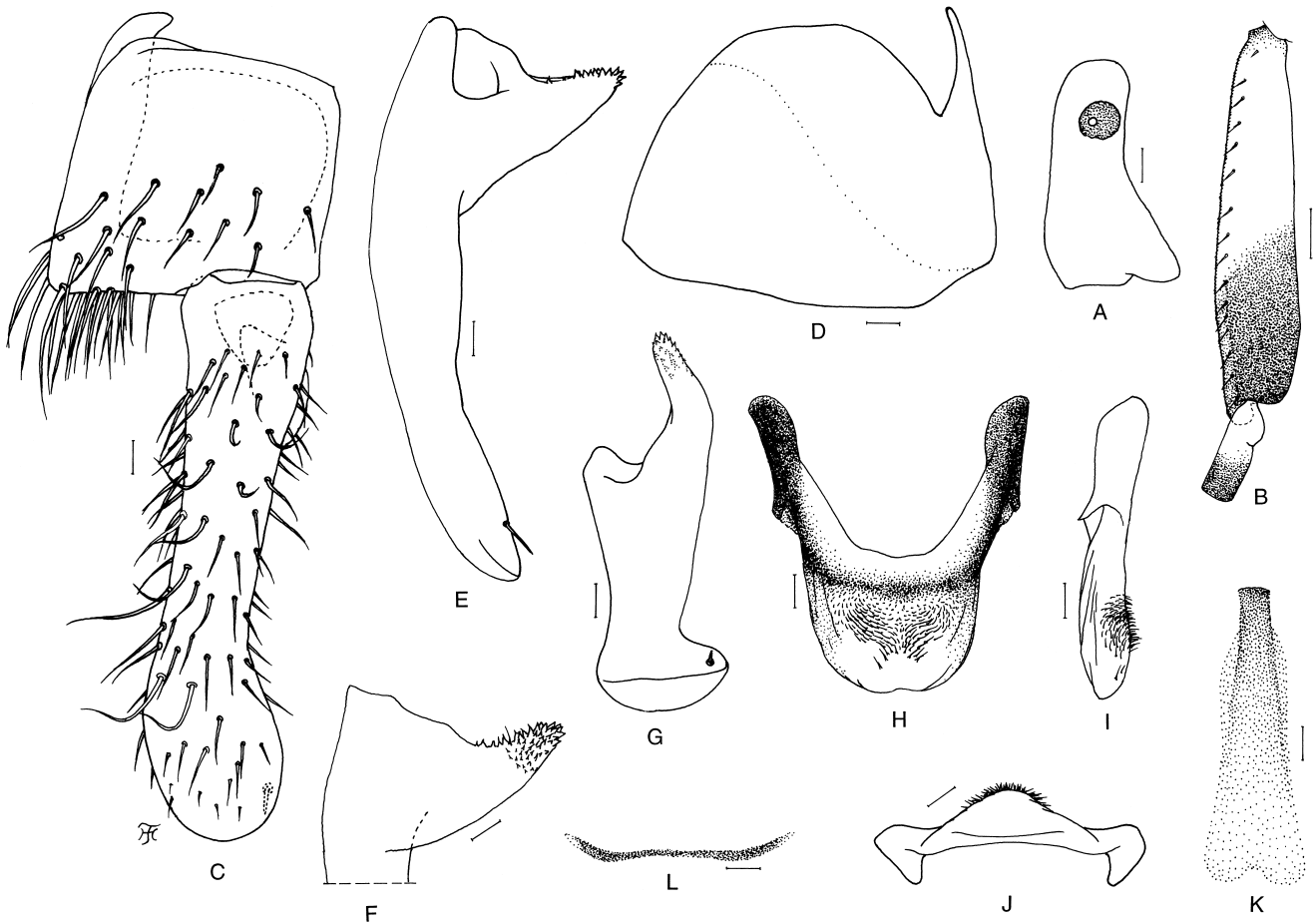


Fig. 1. Adult male of *Simulium (Simulium) rudnicki* Takaoka and Davies. A, 3rd segment of maxillary palp (right side, frontal view); B, hind basitarsus and 2nd tarsal segment (left side, outer view); C, coxite and style (right side, ventral view); D, coxite (left side, lateral view); E, style (left side, outer view); F, basal portion of style (right side, inner view); G, style (left side, end view); H–J, ventral plates (H, ventral view; I, lateral view; J, end view); K, median sclerite; L, dorsal plate. Scales: 0.02 mm for A, C–L; 0.1 mm for B.

apex with many conical spines on anterior and inside surfaces. Ventral plate in ventral view transverse, somewhat wider than its length, rounded posterolaterally, with posterior margin untoothed and somewhat concave medially, and covered with fine setae centrally on ventral surface; basal arms long and stout, curved outwardly and forwardly. Parameres wide basally, each with numerous parameral hooks. Median sclerite narrow, moderately widened toward apex. Aedeagal membrane densely covered with needle-like setae and with well-sclerotized narrow dorsal plate. Segment 10 without any distinct hair. Cercus rounded with 9–13 distinct hairs.

**Pupa.** Body length (excluding gill filaments) ca. 4.0 mm. **Head.** Integument yellowish brown, bare; face with a pair of long simple trichomes; frons with 2 pairs of long simple and bifid trichomes; antennal sheath bare. **Thorax.** Integument yellowish brown, bare on anterior 1/2 including a small raised area at base of gill, moderately covered with small cone-shaped tubercles dorsally on posterior 1/2; thorax anteriorly with 3 dorsal and 2 lateral pairs of long branched trichomes (split into 2–4), posteriorly with 1 lateral pair of long bifid trichomes, and ventrolaterally with 3 pairs of long simple or bifid trichomes. Gill (Fig. 2A) with 6 filaments arranged in sessile pairs; all filaments dark brown, subequal in length (1.5–2.2 mm) and thickness except inner filament of lower pair somewhat thinner than others; all filaments gradually tapered toward apical tip, with annular ridges and furrows throughout their length (though

not marked near base), and densely covered with minute tubercles. **Abdomen.** Dorsally, segment 1 yellow with dark grey narrow portion along posterior margin, with 1 simple slender hair-like seta on each side; segment 2 dark grey on anterior 2/5, transparent on posterior 3/5, with 1 long simple hair-like seta (Fig. 2B), 4 short simple hooked spines of equal size (Fig. 2C) (much smaller than those on segments 3 and 4) and 1 short spinous seta (Fig. 2D) on each side; segments 3 and 4 each with 4 hooked spines along posterior margin on each side; segment 5 bare; segments 6, 7 and 9 each with a transverse row of comb-like groups of minute spines but lacking spine-combs on each side; segment 8 with a transverse row of spine-combs as well as a transverse row of comb-like groups of minute spines on each side; segment 9 lacking terminal hooks. Ventrally, segment 4 with 1 bifid hook, 1 slender medium-long seta and 2 short setae on each side; segment 5 with a pair of bifid hooks submedially on each side; segments 6 and 7 each with a pair of bifid inner and simple outer hooks somewhat separated from each other, on each side. Grapnel-like hooklets absent. **Cocoon** (Fig. 2E). Wall-pocket-shaped, with a large anterolateral window on each side; thin, film-like, individual threads not visible; anterior margin not well defined, often broken; about 4.5 mm long by 2.5 mm wide.

**Mature larva.** Body length 8.5–11.0 mm. Body color dark grey to greyish black. Abdomen gradually widened toward posterior tip, with the widest portion on segment 8, and abruptly narrowed to posterior tip. Cephalic apotome

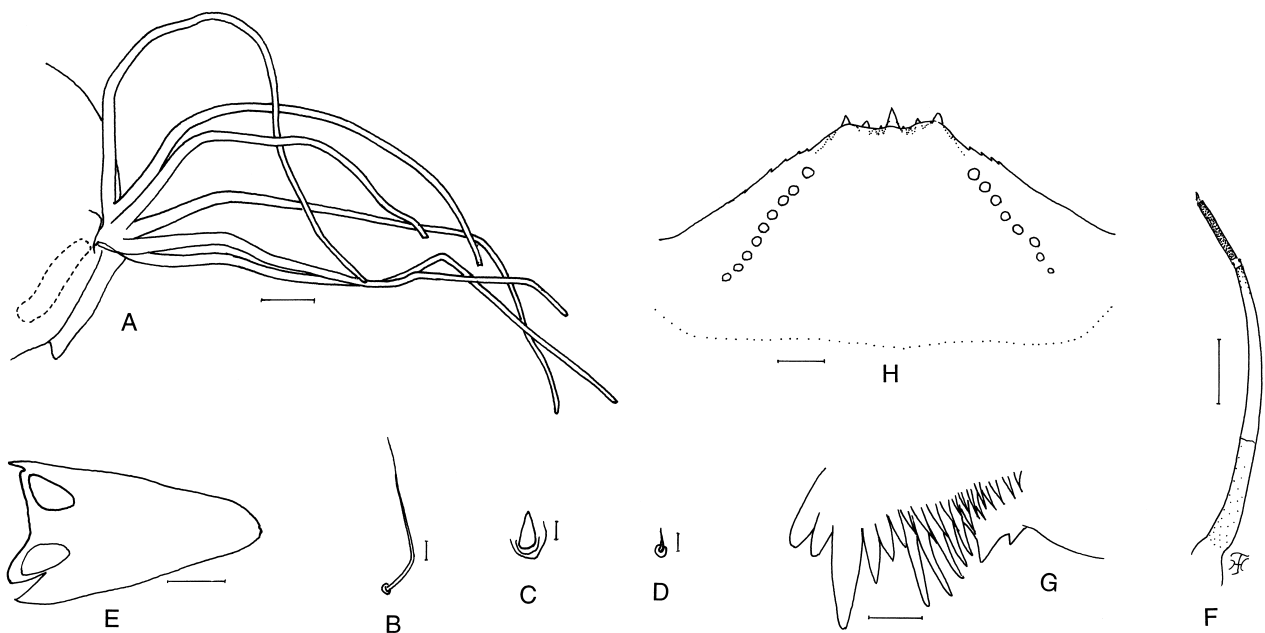


Fig. 2. Pupa and mature larva of *Simulium (Simulium) rudnicki* Takaoka and Davies. A, pupal gill filaments; B–D, hair-like seta, hooked seta and minute seta on the dorsal surface of the 2nd abdominal segment of pupa, respectively; E, cocoon (dorsal view); F, larval antenna (left side, dorsal view); G, larval mandible; H, larval hypostomium. Scales. 0.01 mm for B–D; 0.02 mm for G and H; 0.1 mm for F; 0.2 mm for A; 1.0 mm for E.

almost entirely medium to dark brown except narrow area along each lateral margin of anterior 1/3 pale; head spots distinctively positive except posterolateral ones usually merged into ground color (Plate 1A); lateral and ventral surfaces medium to dark brown except eye-spot region pale; spots around eye-spot region, and those on both sides of postgenal cleft faintly negative or merged into ground color (Plate 1E). Antenna (Fig. 2F) composed of 3 segments and apical sensillum, much longer than stem of labral fan; length ratio of segments (from base to tip) 1.0:1.1 1.2:0.5; all segments pale white to yellow except 3rd segment entirely brownish black, and apical small portion of 2nd segment somewhat darkened. Labral fan with 60–64 main rays. Mandible (Fig. 2G) with usual mandibular serration of 1 medium-sized tooth and 1 small one; main tooth at an obtuse angle apically to mandible; supernumerary serrations absent; comb-teeth decreased in length from 1st to 3rd. Hypostomium (Fig. 2H) with 9 apical teeth, of which median tooth slightly longer than each corner tooth; 3 intermediate teeth on each side shorter than corner teeth; lateral margins moderately serrate apically; 7–9 hypostomal bristles diverging posteriorly from lateral border on each side. Postgenal cleft (Plate 1E) narrow, subtriangular, 1.7–1.9 times as long as postgenal bridge; lateral margins on posterior 1/2 nearly parallel-sided or slightly converged at base, and pointed apically; subesophageal ganglion well pigmented, wine-glass shaped. Thoracic cuticle almost bare. Abdominal cuticle bare except last segment moderately covered with short, colorless setae on each side of anal sclerite. Rectal scales present. Rectal organ of 3 lobes, each with 14–19 finger-like secondary lobules. Anal sclerite X-shaped, with broadened anterior arms about 0.7 times as long as posterior ones; 3–5 sensilla on the basal juncture area, and 6–12 sensilla just posterior to posterior arms. Ventral papillae absent. Posterior circlet with 144–160 rows of hooklets, with up to 20–22 hooklets per row.

**SPECIMENS EXAMINED.** 5 females, 5 males (all reared from pupae), 10 pupae, 5 pupal exuviae and 50 mature larvae, collected from a stream, Mae Klang Waterfall, Doi Inthanon National Park, Chiang Mai, Thailand, 31. XII. 2003, by W. Choochote.

**ECOLOGICAL NOTES.** The pupae and larvae of *S. rudnicki* were found in great numbers on the surface of the rocky stream-bed of a stream 5.0 m wide, with moderate to rapid flows, exposed to the sun. Water temperature was 19.5 °C. Altitude was ca. 400 m. No other species was collected together with *S. rudnicki*.

**DISTRIBUTION.** Peninsular Malaysia and Thailand.

**REMARKS.** The male of *S. rudnicki* is very similar to *S. yongi* Takaoka and Davies, originally described from Malaysia [5] in most features including the genitalia, but is readily distinguished from the latter by the entirely yellow femur and tibia of the midleg, which are almost brownish black in *S. yongi* [5].

The pupa of *S. rudnicki* is also very similar to that of *S. yongi* [5] but differs in that it has the inner filament of the ventral pair not narrowed basally, and the small raised area of the thoracic integument near the base of the gill filaments without tubercles (Fig. 2A), and the cocoon with a large anterolateral window on each side (Fig. 2B). The larva of *S. rudnicki* has a dark cephalic apotome (Plate 1A) while that of *S. yongi* has a pale one [5].

***Simulium (Simulium) mediocoloratum* sp. nov.**

**DESCRIPTION. Female.** Body length 3.0–3.4 mm. **Head.** Narrower than width of thorax. Frons brownish black, shiny, not pruinose, with several dark stout hairs along lateral margins; frontal ratio 1.2–1.3:1.0:1.2; frons-head ratio 1.0:4.0–4.3. Fronto-ocular area (Fig. 3A) well developed, triangular. Clypeus brownish black, shiny, with silvery iridescent pruinosity, moderately covered with dark stout hairs except medial portion of upper part bare. Labrum 0.62–0.67 times as long as clypeus. Antenna composed of 2+9 segments, brownish black except scape, pedicel, and base of 1st flagellar segment yellow when viewed posteriorly, or brownish black except scape, pedicel, and a few basal flagellar segments yellow to dark yellow when viewed anteriorly; each flagellar segment with a distinct pit apically on each lateral surface gradually becoming smaller in size toward apical tip except those on segment 9 located medially; each pit provided with numerous minute sensilla; each flagellar segment also with a small pit apically on dorsal surface except that on segment 9 located medially. Maxillary palp brownish black, with 5 segments, proportional lengths of 3rd, 4th and 5th segments 1.0:1.2–1.3:2.8–2.9; 3rd segment (Fig. 3B) not enlarged; sensory vesicle ellipsoidal, with rugged surface, 0.36–0.39 times length of 3rd segment, with medium to large round opening apically. Maxillary lacinia with 13 inner and 13 or 14 outer teeth. Mandible with 28–31 inner and 12–14 outer teeth. Cibarium (Fig. 3C) with a cluster of ca. 90 conical processes medially. **Thorax.** Scutum brownish black, shiny, whitish-grey pruinose (there appear to be faint scutal patterns formed by pruinose and non-pruinose portions differing by the angles of light: e.g. when illuminated dorsally and viewed laterally, 1 medial and 2 submedial narrow longitudinal whitish-grey pruinose vittae and 2 wide longitudinal whitish-grey pruinose bands along lateral margins connected to large whitish-grey pruinose portions on

shoulders), moderately covered with yellow recumbent short hairs as well as dark brown ones interspersed with long upright dark hairs on prescutellar area. Scutellum brownish black, with long dark hairs as well as yellow short hairs. Postnotum brownish black, shiny, whitish-grey pruinose, and bare. Pleural membrane bare. Katepisternum longer than deep, and bare. **Legs.** Foreleg (Fig. 3D): coxa pale yellowish-white; trochanter pale yellowish-white with outer surfaces somewhat darkened; femur yellowish on inside surface but light yellowish-brown to light brown on outer surface; tibia largely white except apical 1/5 dark brown and inner surface of apical 1/2 light to dark brown, and with a large white sheen on outer surface when illuminated; tarsus dark brown; basitarsus dilated, 5.5 times as long as its greatest width. Midleg (Fig. 3E): coxa dark

brown; trochanter dark yellow or light yellowish-brown with base yellowish white; femur yellowish white to dark yellow (light brown in some females); tibia yellowish white except apical cap light to medium brown, with a large white sheen on posterior surface when illuminated; tarsus medium to dark brown except basal 3/5 or 3/4 of basitarsus yellowish white. Hind leg (Fig. 3F): coxa medium brown; trochanter yellowish white; femur light to medium brown with base pale yellowish-white and apical cap medium to dark brown; tibia light to dark brown with basal 1/3 and posterior surface of basal 2/3 white (its margin obliquely demarcated when viewed laterally), and with a large white sheen on posterior surface when illuminated; tarsus dark brown except a little more than basal 1/2 of basitarsus yellowish white and basal 1/2 of 2nd tarsal segment yellow; basitarsus

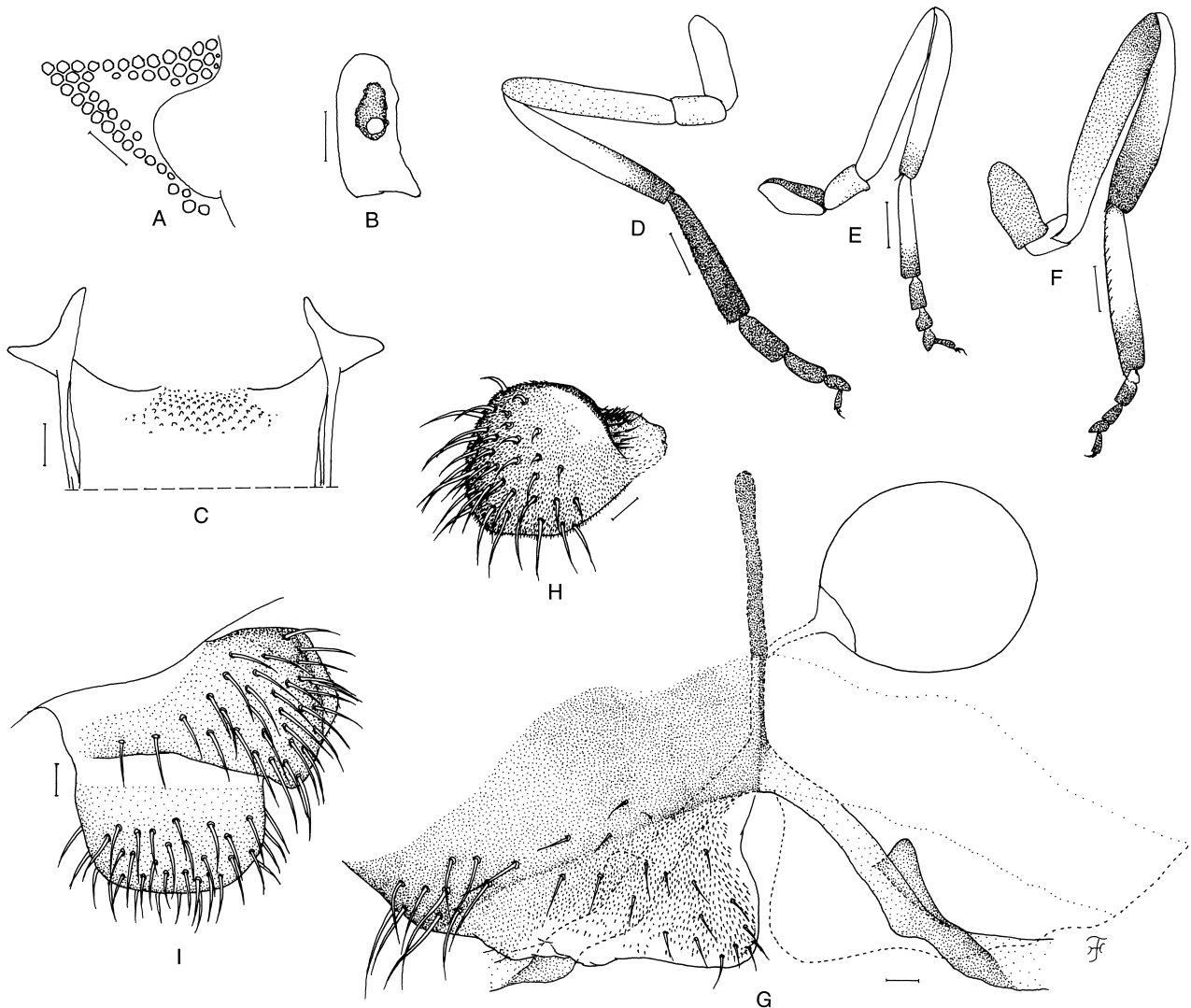


Fig. 3. Adult female of *Simulium (Simulium) medicoloratum* sp. nov. A, fronto-ocular area (right side, frontal view); B, 3rd segment of maxillary palp (right side, frontal view); C, cibarium; D F, foreleg, midleg and hind leg, respectively (all left side); G, 8th sternite, ovipositor valves, genital fork and spermatheca (ventral view); H, paraproct (right side, ventral view); I, paraproct and cercus (right side, lateral view). Scales. 0.02 mm for C and G I; 0.05 mm for A and B; 0.2 mm for D F.

nearly parallel-sided, 6.0 times as long as wide, and 0.8 and 0.7 times as wide as the greatest widths of hind tibia and femur, respectively; calcipala short, 0.9 times as long as its basal width and 0.4 times as wide as the greatest width of basitarsus; pedisulcus distinct at basal 1/3 of 2nd tarsal segment. Tarsal claws simple without any tooth. **Wing.** Length 2.8–3.0 mm; costa with dark spinules and hairs; subcosta fully haired; basal section of vein R bare; R<sub>1</sub> with spinules and hairs; R<sub>2</sub> with hairs only; hair tuft at base of stem vein dark brown; basal cell absent. **Abdomen.** Basal scale light to medium brown, with a fringe of pale hairs; segment 2 yellowish white except posterior 1/3 or 2/5 medium brown dorsally, with a dorsolateral pair of shiny whitish spots broadly connected in middle; remaining segments medium to dark brown dorsally, with dark hairs; tergites 6–8 shiny. **Genitalia** (Fig. 3G–I). Ventral surface of abdominal segment 7 without sternal plate. Sternite 8 well sclerotized, bare medially, with 3–9 pale short setae submedially near posterior border, and with 13 or 14 dark long hairs laterally on each side; ovipositor valve triangular in shape, membranous, expanded ventrally, each covered with 18–28 short setae as well as numerous microsetae except narrow portion along inner margin and rather wide portion along posterior margin bare and transparent; inner borders not sclerotized, narrowly separated from each other. Genital fork of inverted-Y form, with well sclerotized stem; arms rather wide, each with strongly sclerotized distal ridge having a distinct projection directed anterodorsally. Paraproct in ventral view rounded posterolaterally, with anteromedial surface strongly sclerotized, having about 20 short spinous setae on it; paraproct slightly produced ventrally along medial margin, covered with numerous stout hairs laterally and ventrally. Cercus rounded posteriorly, about half as long as wide, covered with numerous stout hairs. Spermatheca globular, well sclerotized (except small area of its juncture with duct unsclerotized), with reticulate surface pattern at least near base, with minute internal setae; both accessory ducts subequal in width to main one.

**Male.** Body length 3.0–3.2 mm. **Head.** Slightly wider than thorax. Upper eye consisting of large facets in 22 or 23 horizontal and 22 vertical rows. Clypeus black, white pruinose, iridescent when illuminated, covered with dark-brown long hairs along lateral margins (median large portion nearly bare). Antenna composed of 2+9 segments, dark brown except base of 1st flagellar segment pale; 1st flagellar segment elongate, 1.8 times as long as 2nd one; flagellar segments 1–8 each with 1 or 2 small pits apically on each lateral surface, which are not so developed as compared to those of female. Maxillary palp composed of 5 segments, proportional lengths of 3rd, 4th, and 5th segments 1.0:1.3:3.2; 3rd segment (Fig. 4A) of normal size,

with a small, ellipsoidal sensory vesicle, 0.24–0.27 times length of 3rd segment, and with a small opening medially.

**Thorax.** Scutum brownish black (3 narrow longitudinal black vittae visible in alcoholic specimen), with silvery iridescent pattern differing with angles of light, as in male of *S. rudnicki*; scutum uniformly covered with yellow (or bright brassy in some males) recumbent short hairs interspersed with dark long upright hairs on prescutellar area. Scutellum brownish black, silvery iridescent when illuminated, with several upright dark hairs as well as yellow or bright-brassy short hairs. Postnotum brownish black, silvery iridescent when illuminated, and bare. Pleural membrane bare. Katepisternum longer than deep, and bare. **Legs.** Foreleg: coxa whitish yellow; trochanter and femur medium brown with apical cap of femur dark brown; tibia dark brown to brownish black except outer surface of basal 3/4 white, and with a large white sheen on most of outer surface when illuminated; tarsus brownish black; basitarsus somewhat dilated, 6.4 times as long as its greatest width. Midleg: coxa brownish black; trochanter and femur medium brown; tibia light to medium brown except posterior surface of basal 1/2 white (its margin obliquely defined when viewed laterally) and with a white sheen on posterior surface when illuminated; tarsus dark brown to brownish black except basal 3/5 whitish yellow (though its border not well defined). Hind leg: coxa dark brown; trochanter yellow; femur medium brown except extreme base yellow and apical cap dark brown; tibia dark brown except extreme base yellowish white, and with a whitish sheen basally on posterior surface when illuminated; tarsus dark brown except a little less than basal 1/2 of basitarsus and basal 1/3 of 2nd tarsal segment yellowish; basitarsus (Fig. 4B) somewhat enlarged, spindle-shaped, 4.8 times as wide as its greatest width, and 0.8 times as wide as the greatest width of hind tibia, which is nearly as wide as that of hind femur; calcipala small, 0.9 times as long as wide and 0.3 times as wide as the greatest width of hind basitarsus; pedisulcus distinct. **Wing.** Length 2.8–2.9 mm; other characters as in female except subcosta completely bare. **Abdomen.** As in male of *S. rudnicki*. **Genitalia** (Figs. 4C–K). Coxite in ventral view nearly quadrate. Style elongate, spatulate ventrodorsally, 2.2 times as long as coxite, gradually narrowed from base to apical 1/2, then widened to rounded apex (width at base about 1.2 times that near apex and about 1.7 times the narrowest width at middle), with a slender subterminal spine; style with a prominent basal protuberance pointed dorsally and furnished at and near apex with many conical spines on anterior and inside surfaces. Ventral plate in ventral view transverse, somewhat wider than its length, rounded posterolaterally, with posterior margin untoothed and somewhat concave medially, and covered with fine setae cen-

trally on ventral surface; basal arms long and stout, curved outwardly and forwardly. Parameres wide basally, each with numerous parameral hooks. Median sclerite narrow, moderately widened from base to basal 1/3, then nearly parallel-sided, with small median incision on apex. Aedeagal membrane densely covered with needle-like setae, with well-sclerotized narrow dorsal plate. Segment 10 without any distinct hair. Cercus rounded with 10–16 distinct hairs.

**Pupa.** Body length (excluding gill filaments) 3.0–3.5 mm. **Head.** Integument yellowish brown, bare, with 1 facial pair of long, simple or bifid trichomes and 2 frontal pairs of long, bifid or trifid trichomes; antennal sheath bare. **Thorax.** Integument yellowish brown, bare on anterior 1/2 except a small raised area at base of gill densely covered with tubercles of irregular shapes, moderately covered with small cone-shaped tubercles on posterior 1/2; thorax anteriorly with 3 dorsal and 2 dorsolateral pairs of long branched trichomes (split into 2–5), posteriorly with 1 lateral pair of branched trichomes (split into 2–4) and ventrolaterally with 3 pairs of long trichomes (simple, bifid or trifid). Gill (Fig. 5A) with 6 filaments arranged in sessile pairs, and with

medium-sized transparent protuberance at base; outer filaments of all pairs dark brown, subequal in thickness to one another but somewhat differing in length (1.5–2.0 mm), all gradually tapered from base to apex; inner filaments of all pairs medium brown, somewhat differing in length (1.0–1.5 mm), inner filaments of dorsal and middle pairs subequal in thickness to each other and gradually tapered toward apex after running with the same width or very slightly widened from base to basal 1/5 or 1/4 of their length, inner filament of lower pair apparently increasing its width from base to basal 1/5 or 1/4 of its length, then tapered toward apical tip; inner filament of each pair usually somewhat paler and shorter than its outer counter filament; all filaments with annular ridges and furrows throughout their length except near base, densely covered with minute tubercles. **Abdomen.** Dorsally, segment 1 light brown, with 1 simple long hair-like seta on each side; segment 2 light brown on anterior 1/2 or 1/3, with 1 simple long hair-like seta, 1 short spinous seta and 4 short simple hooked spines of equal size on each side; segments 3 and 4 each with 4 hooked spines along posterior margin on each side; segment 8 with a transverse row of

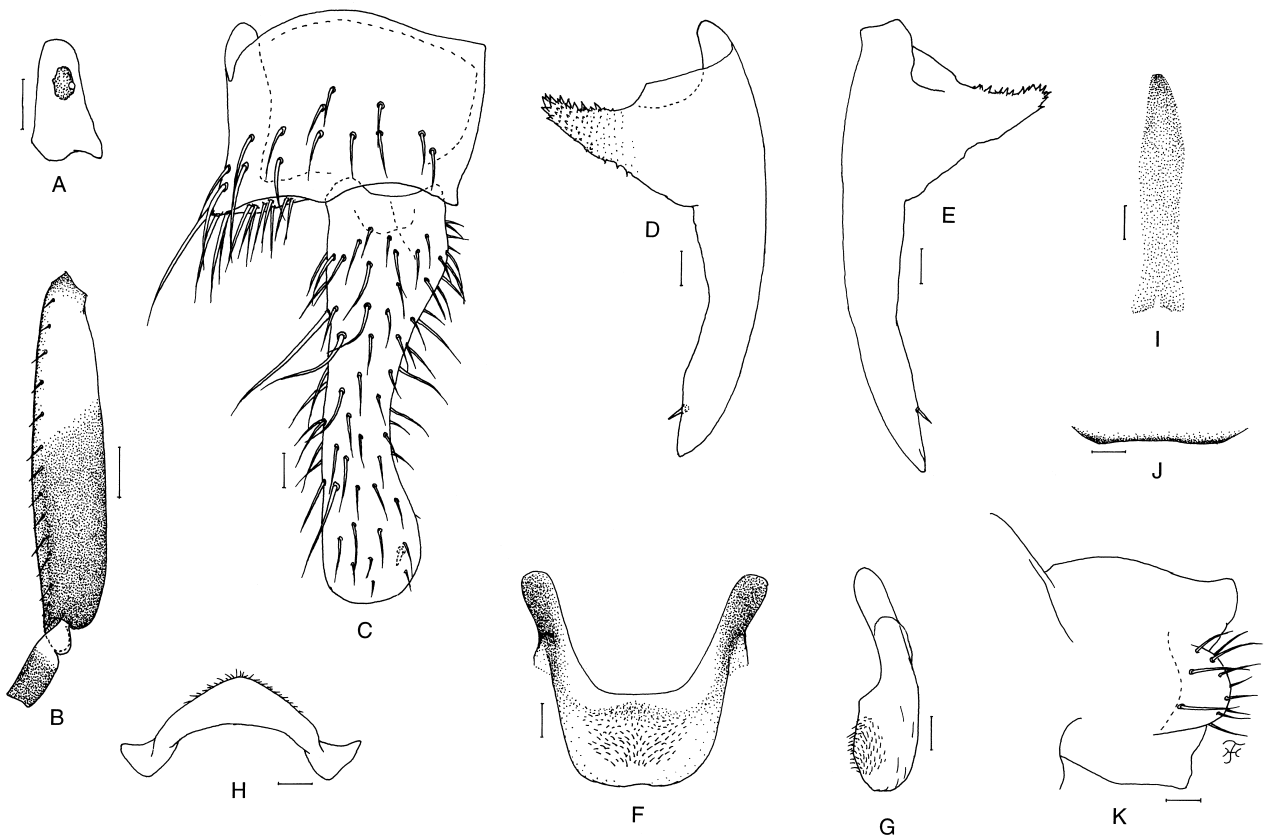


Fig. 4. Adult male of *Simulium* (*Simulium*) *mediocoloratum* sp. nov. A, 3rd segment of maxillary palp (right side, frontal view); B, hind basitarsus and 2nd tarsal segment (left side, outer view); C, coxite and style (right side, ventrolateral view); D and E, styles (both left side; D, inner view; E, outer view); F–H, ventral plates (F, ventral view; G, lateral view; H, end view); I, median sclerite; J, dorsal plate; K, abdominal tip showing cercus (lateral view). Scales. 0.02 mm for C–K; 0.05 mm for A; 0.1 mm for B.

spine-combs on each side; segment 5 bare; segments 6, 7 and 9 each lacking spine-combs, with a transverse row of comb-like groups of minute spines on each side; segment 9 lacking terminal hooks. Ventrally, segment 4 with 1 simple hook and a few short setae on each side; segments 5–7 each with a pair of simple or bifid inner and simple outer hooks on each side. Grapnel-like hooklets absent. **Cocoon.** Wall-pocket-shaped, pale yellow, thin, with anterior margin irregular in form, usually appearing to have a broad anterodorsal projection when viewed dorsally (Fig. 5B,C); some cocoons have a fragment of thread of various lengths directed downward from each side of the apex of the anterodorsal projection (Fig. 5D), suggesting that there may be a large anterolateral window on each side; cocoon usually somewhat extending ventrolaterally; 3.0–3.5 mm long by 2.0–2.2 mm wide.

**Mature larva.** Body length 7.0–8.0 mm. Body color usually dark greyish on thorax and light to dark brown or blackish brown on abdomen (darkened posteriorly). Abdomen gradually widened toward segment 7, then narrowed to posterior tip when viewed laterally; segments 6 and 7 appear to be equal in width to each other when viewed dorsally. Cephalic apotome (Plate 1B) pale yellow on anterior 1/2 or less, light to medium brown on the rest (except narrow portion along each lateral margin usually pale down to level of posterolateral spots), with a small dark area in middle along posterior border; anteromedial longitudinal spot faintly positive or negative, or sometimes merged into ground color, posteromedial spot usually positive or rarely merged into ground color; anterior 1/2 of mediolateral spot

on each side usually negative or merged into ground color, and posterior 1/2 usually positive; posterolateral spots usually merged into ground color, and rarely anterior one of these spots negative; lateral and ventral surfaces variable in color by populations; eg. in most larvae collected from Monthatharn Waterfall, nearly yellowish with spots merged into ground color, or in most larvae collected from Siribhume Waterfall, light to medium brown except eye-spot region yellowish and medial narrow area of postgenal bridge somewhat paler than ground color, with spots faintly or moderately negative (Plate 1F). Antenna composed of 3 segments and apical sensillum, much longer than stem of labral fan; length ratio of segments (from base to tip) 1.0:1.2:0.4–0.5; all segments pale white to yellow except 3rd segment entirely brownish black and apical small portion of 2nd segment somewhat darkened, as in *S. rudnicki*. Labral fan with about 52 main rays. Mandible (Fig. 5E) with usual mandibular serration of 1 medium-sized tooth and 1 small one; main tooth at an obtuse angle to mandible on apical side; supernumerary serrations absent; comb-teeth decreased in length from 1st to 3rd. Hypostomium (Fig. 5F) with 9 apical teeth, of which median tooth and each corner tooth subequal in length to each other, and longer than others; lateral margins moderately serrate apically; 8 or 9 hypostomal bristles diverging posteriorly from lateral border on each side. Postgenal cleft (Plate 1F) narrow, subtriangular or bullet-shaped, 1.6–2.3 times as long as postgenal bridge; lateral margins on posterior 1/2 nearly parallel-sided or slightly diverged at base, and pointed apically; subesophageal ganglion well pigmented, wine-glass-shaped. Thoracic

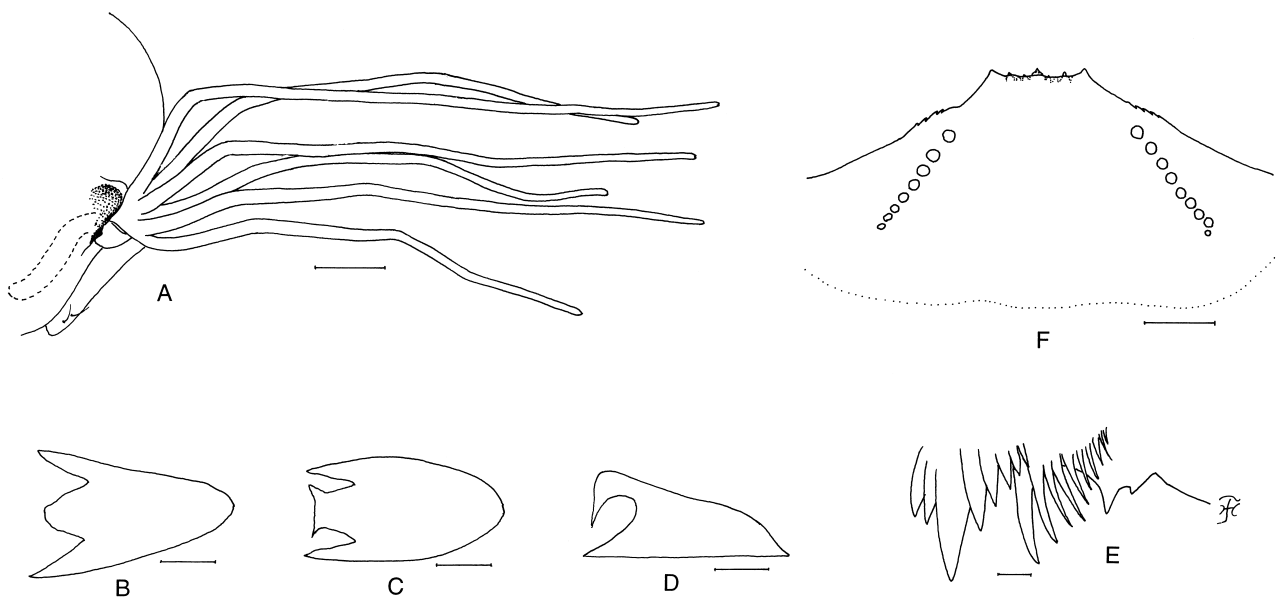


Fig. 5. Pupa and mature larva of *Simulium* (*Simulium*) *mediocoloratum* sp. nov. A, pupal gill filaments; B–D, cocoons (B and C, dorsal view; D, lateral view); E, larval mandible; F, larval hypostomium. Scales. 0.01 mm for E; 0.05 mm for F; 0.2 mm for A; 1.0 mm for B–D.



cuticle almost bare. Abdominal cuticle bare except last segment moderately covered with short colorless setae on each side of anal sclerite. Rectal scales present. Rectal organ of 3 lobes, each with 13–17 finger-like secondary lobules. Anal sclerite X-shaped, with broadened anterior arms about 0.7 times as long as posterior ones; 5–11 sensilla on basal area of anal sclerite, and 8–13 sensilla just posterior to posterior arms. Ventral papillae absent. Posterior cirlet with 146–150 rows of hooklets, with up to 20 hooklets per row.

**TYPE SPECIMENS.** Holotype female, reared from pupa collected from a cascading stream, Monthatharn Waterfall, Chiang Mai, Thailand, 31. XII. 2001, by W. Choochote. Paratypes: 8 females, 11 males, reared from pupae, 5 mature larvae, in alcohol, same data as holotype; 5 pupae and 20 mature larvae, collected from a small stream, Siribhume Waterfall, Doi Inthanon National Park, Chiang Mai, 15. II. 2004, by W. Choochote.

**ECOLOGICAL NOTES.** The pupae and larvae of *S. mediocoloratum* were found on the surface of the stream-bed rock in two streams: one in Monthatharn Waterfall (ca. 750 m in altitude) was a cascading stream, exposed to the sun or partially shaded, and water temperature was 17 °C, and the other in Siribhume Waterfall (ca. 1,500 m in altitude) was a small, moderately-flowing stream 0.5 m wide, exposed to the sun and its water temperature was 18.5 °C.

*Simulium mediocoloratum* was collected together with many other species in the two streams.

Mermithid and microsporidan infections were found in five and one of the 47 immature larvae of *S. mediocoloratum* collected from Monthatharn Waterfall, respectively.

**ETYMOLOGY.** The specific name *mediocoloratum* refers to the female of this species which is intermediate in the leg color between *S. rudnicki* and *S. yongi*.

**DISTRIBUTION.** Thailand.

**REMARKS.** *Simulium mediocoloratum* sp. nov. is assigned to the *griseifrons* species-group by the combination of the following characters: tarsal claws simple in the female; style with a prominent basal protuberance (Fig. 4D,E) and ventral plate transverse, without toothed margins (Fig. 4F) in the male; and gill with six filaments per side in the pupa (Fig. 5A).

The female of *S. mediocoloratum* resembles that of *S. rudnicki* in many characters including the antenna with pits and the ovipositor valve with transparent inner and posterior margins and is barely differentiated from the latter by the mid tibia yellowish white except its apical cap light to me-

dium brown (Fig. 3E) (cf. entirely yellow in *S. rudnicki*). On the other hand, this new species is readily distinguished from *S. rudnicki* in the male by the medium-brown mid femur and the style with the narrowest portion medially (Fig. 4C), in the pupa by the inner filament of the ventral pair narrowed basally as well as the small raised area near the gill base tuberculate (Fig. 5A), and in the larva by the cephalic apotome darkened only on the posterior 1/2 (Plate 1 B).

This new species is also very similar to *S. yongi* [5] but differs from the latter in that it has the more slender fore basitarsi in both sexes, the cibarium with about 90 conical processes (Fig. 3C), the mid femur entirely yellow (Fig. 3E) in the female, the ventral plate somewhat bent ventrally (Fig. 4G) in the male, the cocoon appearing to have an anterodorsal projection (Fig. 5B,C), and the larval cephalic apotome pale on the anterior 1/2 (Plate 1B).

The male genitalia suggest that this new species is closely related to *S. ufengense* Takaoka, described from Taiwan [6], and *S. fuzhouense* Zhang and Wang, from Fujian, south China [7]. However there are differences in the leg colors, the arrangement of the pupal gill filaments, and the cocoon. In the latter two species, the femora of the male legs are largely yellowish, four of six pupal gill filaments are distinctively more slender than the remaining two filaments, and the cocoon has a thick anterodorsal margin.

*Simulium taipokauense* Takaoka, Davies and Dudgeon (only the male adult is known) from Hong Kong [8] shows some similarities to *S. mediocoloratum* but differs in that it has the much longer basal protuberance of the style and the saddle-shaped ventral plate with a nipple-like median process.

#### *Simulium (Simulium) crocinum* sp. nov.

**DESCRIPTION. Female.** Body length 3.0 mm. **Head.** Nearly as in female of *S. mediocoloratum* except following characters. Frontal ratio 1.3:1.0:0.9; frons-head ratio 1.0:3.7. Fronto-ocular area (Fig. 6A) well developed, triangular. Clypeus moderately covered with dark long hairs except median portion largely bare. Labrum 0.56 times as long as clypeus. Maxillary palp brownish black, with 5 segments, proportional lengths of 3rd, 4th, and 5th segments 1.0:1.1:2.6; 3rd segment (Figs. 6B, C) not enlarged; sensory vesicle ellipsoidal or oblong, with rugged surface, 0.38–0.43 times length of 3rd segment, with a large opening. Maxillary lacinia with 12 or 13 inner and 15 or 16 outer teeth. Mandible with 28–30 inner and 15 outer teeth. Cibarium (Fig. 6D) with a cluster of about 56 conical processes medially. **Thorax.** Nearly as in female of *S. mediocoloratum* except scutum almost black and scutellum dark brown. **Legs.** Fore-

leg (Fig. 6E): coxa pale yellowish-white; trochanter pale yellowish-white with outer surfaces somewhat yellowish; femur yellow with extreme apex somewhat darkened; tibia pale yellowish-white except apical 1/5 brownish black, with a large white sheen on outer surface when illuminated; tarsus black; basitarsus dilated, 5.4 times as long as its greatest width. Midleg (Fig. 6F): coxa dark brown; trochanter yellow with apical 1/2 somewhat darkened; femur entirely yellow; tibia yellowish-white to yellow, with a large white sheen on posterior surface when illuminated; tarsus medium to dark brown except basal 2/3 of basitarsus and base of 2nd segment yellowish white. Hind leg (Fig. 6G): coxa dark brown; trochanter yellow; femur yellow with apex medium brown narrowly; tibia yellowish-white to yellow with apical cap dark brown on inner surface (Fig. 6H) but there is a broad light brown area extending forwardly from dark apical cap to a little less than basal 1/2 on outer surface (Fig. 6 G), and with a large white sheen on posterior surface when illuminated; tarsus brownish black except basal 3/5 of basi-

tarsus and basal 1/3 of 2nd tarsal segment yellowish white; basitarsus (Fig. 6I) nearly parallel-sided, 5.7 times as long as wide, and 0.7 and 0.6 times as wide as the greatest widths of hind tibia and femur, respectively; calcipala short, 0.8 times as long as its basal width and 0.4 times as wide as the greatest width of basitarsus; pedisulcus distinct at basal 1/3 of 2nd tarsal segment. Tarsal claws simple without any tooth. **Wing.** Length 2.8 mm; other characters as in female of *S. mediocoloratum*. **Abdomen.** Basal scale medium brown with a fringe of pale hairs; dorsal surface of abdomen dark brown to brownish black except anterior 1/2 medium brown and with a dorsolateral pair of shiny whitish spots broadly connected in middle, tergites 6-8 shiny, covered with dark short hairs. **Genitalia** (Fig. 6J-L). Ventral surface of abdominal segment 7 with a pair of weakly-developed sternal plates. Sternite 8 well sclerotized, bare medially, with 5-8 pale short setae submedially near posterior border, and with 24 or 25 dark long hairs laterally on each side; ovipositor valve triangular in shape, membranous,

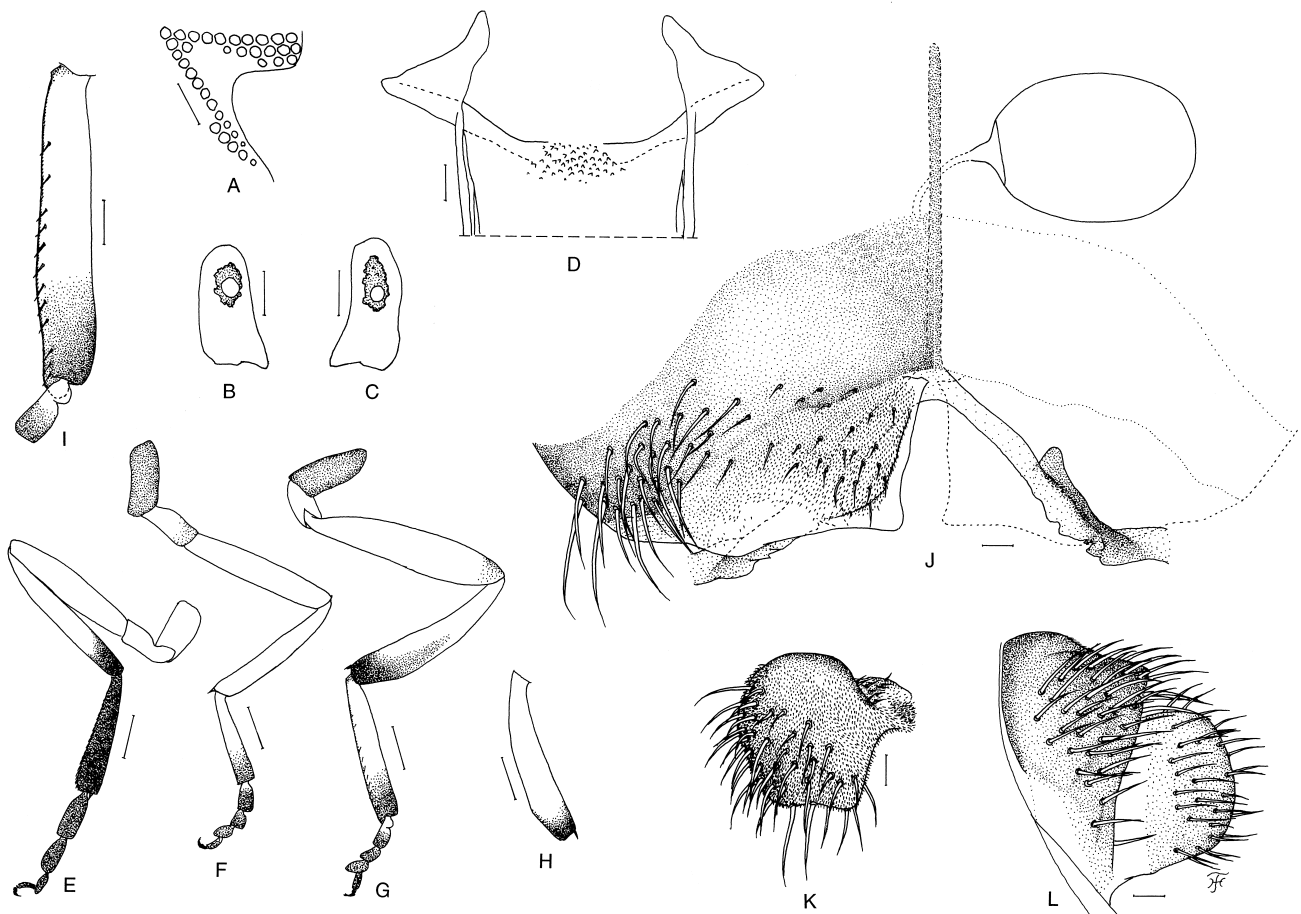


Fig. 6. Adult female of *Simulium* (*Simulium*) *crocinum* sp. nov. A, fronto-ocular area (right side, frontal view); B and C, 3rd segments of maxillary palp (B, right side; C, left side, both frontal view); D, cibarium; E-G, foreleg, midleg and hind leg, respectively (all left side); H, hind tibia (left side, inside view); I, hind basitarsus and 2nd tarsal segment (outer view); J, 8th sternite, ovipositor valves, genital fork and spermatheca (ventral view); K, paraproct (right side, ventral view); L, paraproct and cercus (right side, lateral view). Scales. 0.02 mm for D and J-L; 0.05 mm for A-C; 0.1 mm for I; 0.2 mm for E-H.

expanded ventrally, each covered with about 20 short setae as well as numerous microsetae except narrow portion along inner margin and rather wide portion along posterior margin bare and transparent; inner borders not sclerotized, moderately separated from each other. Genital fork of inverted-Y form, with well sclerotized stem; arms rather wide, each with strongly sclerotized distal ridge having a distinct projection directed anterodorsally. Paraproct in ventral view rounded posterolaterally, with anteromedial surface moderately sclerotized, having about 10 short spinous setae as well as numerous microsetae on it; paraproct slightly produced ventrally along medial margin, covered with numerous stout hairs laterally and ventrally. Cercus rounded posteriorly, about 0.6 times as long as wide, covered with numerous stout hairs. Spermatheca ellipsoidal, well sclerotized (except small area of its juncture with duct unsclerotized), with reticulate surface pattern at least near base, with minute internal setae; both accessory ducts subequal in width to main one.

**Male.** Body length 3.0–3.3 mm. **Head.** Slightly wider than thorax. Upper eye consisting of large facets in 20 horizontal and 22 vertical rows. Clypeus black, white pruinose, iridescent when illuminated, sparsely covered with dark brown hairs (median portion largely bare or with a few hairs). Antenna composed of 2+9 segments, dark yellow to light yellowish-brown on scape, pedicel, and a few basal flagellar segments, and the rest medium to dark brown; 1st flagellar segment elongate, 1.8 times as long as 2nd one. Maxillary palp composed of 5 segments, proportional lengths of 3rd, 4th, and 5th segments 1.0:1.1:2.3; 3rd segment (Fig. 7A) of normal size, with an ellipsoidal sensory vesicle having a small opening apically; sensory vesicle 0.25 times as long as 3rd segment. **Thorax.** Nearly as in male of *S. mediocoloratum*. **Legs.** Foreleg (Fig. 7B): coxa pale yellow; trochanter yellow with outer and posterior portions somewhat darkened; femur yellow on inside surface but dark yellow or light brown on outer surface; tibia medium brown to brownish black with basal 3/4 narrowly white on outer surface (white sheeny when illuminated); tarsus black, with moderate dorsal hair crest; basitarsus somewhat dilated, about 5.3 times as long as its greatest width. Midleg (Fig. 7C): coxa dark brown or blackish; trochanter medium brown with base yellow; femur entirely yellow; tibia entirely yellow, with a white sheen widely on posterior surface when illuminated; tarsus brownish black except basal 2/3 of basitarsus yellow (though its border not well defined) and extreme base of 2nd segment pale yellow. Hind leg (Fig. 7D): coxa dark brown; trochanter yellow; femur yellow except apical cap medium brown; tibia dark brown to brownish black with base whitish yellow (in another male, anterior surface of tibia pale more extensively

from base to near apical cap); tarsus brownish black except a little more than basal 1/2 of basitarsus whitish yellow and basal 1/3 of 2nd tarsal segment dark yellow; basitarsus (Fig. 7E) somewhat widened from base toward apical 3/4, then somewhat narrowed toward apex, 4.3 times as long as its greatest width, and 0.8 times as wide as the greatest width of hind tibia which is as wide as that of femur; calcipala of medium size, nearly as long as wide; pedisulcus distinct. **Wing.** Length 2.6 mm; other characters as in male of *S. rudnicki*. **Abdomen.** As in male of *S. rudnicki*. **Genitalia** (Fig. 7F–N). Coxite in ventral view nearly quadrate. Style elongate, spatulate ventrodorsally, 1.7 times as long as coxite, gradually narrowed from base to apical 1/3, then slightly widened to rounded apex, width near apex 0.75 times as wide as basal width, and about 1.4 times as wide as the narrowest width (in another male, style gradually narrowed from base to middle, then slightly widened toward apex, width near apex 0.85 times as wide as basal width, and about 1.3 times as wide as the narrowest width, as shown in Fig. 7G), with no subterminal spine (though right style of 1 male bears a slender hair-like spine in place of usual needle-like subterminal spine, as shown in Fig. 7G); style with a prominent basal protuberance pointed dorsally and furnished at and near apex with several conical spines mostly on anterior surface. Ventral plate in ventral view transverse, somewhat wider than its length, rounded posterolaterally, with posterior margin untoothed and slightly concave medially, and covered with fine setae on anterior 1/2 of ventral surface; basal arms long and stout, directed forwardly and somewhat outwardly. Parameres wide basally, each with numerous parameral hooks. Median sclerite in end view widened from base to basal 1/3, somewhat narrowed to apical 1/3, then widened toward apex, plate-like, and well sclerotized except apical portion. Aedeagal membrane densely covered with needle-like setae and with well-sclerotized narrow dorsal plate. Segment 10 with 2 distinct hairs on each lateral side (in another male, 1 distinct hair on right lateral side and no hair on left lateral side). Cercus rounded with 7–10 distinct hairs.

**Pupa.** Body length (excluding gill filaments) about 3.0 mm. **Head.** Integument medium to dark brown, bare; face with a pair of long simple or bifid trichomes; frons with 2 pairs of long bifid trichomes somewhat separated from each other; antennal sheath bare. **Thorax.** Integument medium to dark brown, bare on anterior 1/2 (except a few small raised areas at base of gill densely covered with tubercles), moderately covered with small cone-shaped tubercles dorsally on posterior 1/2; thorax anteriorly with 3 dorsal and 2 lateral pairs of long simple and/or branched trichomes (split into 2–4), posteriorly with 1 lateral pair of long bifid or trifid trichomes, and ventrolaterally with 3 pairs of long simple

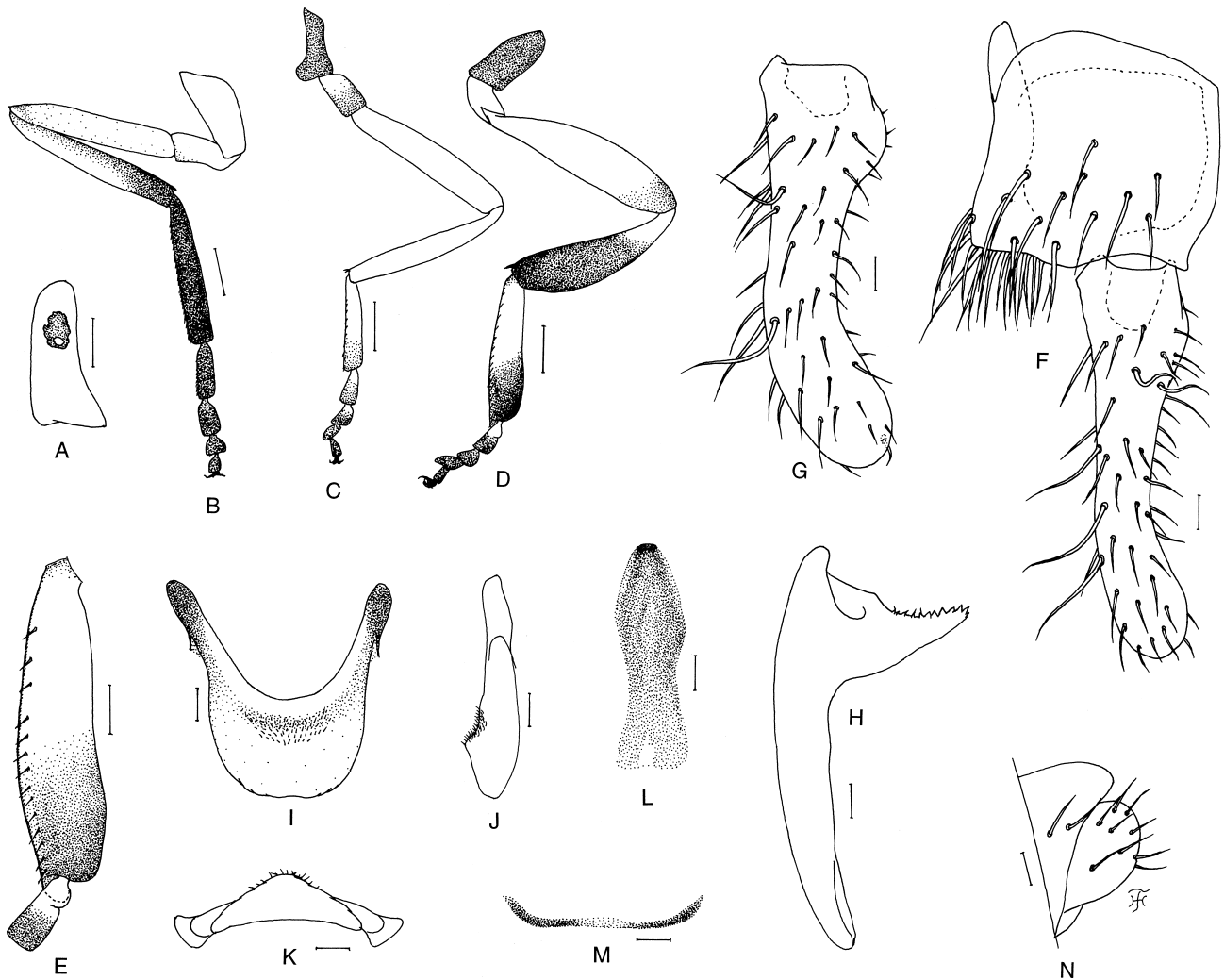


Fig. 7. Adult male of *Simulium* (*Simulium*) *crocinum* sp. nov. A, 3rd segment of maxillary palp (right side, frontal view); B–D, fore-leg, midleg and hind leg, respectively (all left side); E, hind basitarsus and 2nd tarsal segment (left side, outside view); F, coxite and style (right side, ventrolateral view); G and H, styles (G, right side, of different male, ventrolateral view; H, left side, outer view); I–K, ventral plates (I, ventral view; J, lateral view; K, end view); L, median sclerite; M, dorsal plate; N, abdominal tip showing cercus (lateral view). Scales. 0.02 mm for F–N; 0.05 mm for A; 0.1 mm for E; 0.2 mm for B–D.

and/or bifid trichomes. Gill (Fig. 8A) with 6 filaments arranged in sessile pairs, shortened in length from dorsal to ventral, outer filament of dorsal pair longest of all (1.0–1.5 mm long); usually outer filament of each pair somewhat longer than its counter inner filament; outer filament of dorsal pair slightly thicker than outer filament of middle pair, which is much thicker than the other filaments; inner filament of dorsal pair usually somewhat thicker than inner filament of middle pair and both inner and outer filaments of ventral pair; outer filaments of dorsal and middle pairs dark brown to brownish black at least basal 1/3, then gradually become paler toward apex, basal portions of these two filaments much darker than the other filaments which are uniformly light brown; outer filaments of dorsal and middle pairs gradually tapered toward apical tip, all inner filaments

and outer filament of ventral pair nearly parallel-sided along basal 1/3 or 1/4, then tapered toward apical tip; all filaments with annular ridges and furrows throughout their length, and densely covered with minute tubercles; gill with medium-sized transparent protuberance at base. **Abdomen.** Dorsally, segment 1 greyish light-brown, with 1 medium-long simple hair-like seta on each side; segment 2 grey on anterior 2/5, transparent on posterior 3/5, with 1 medium-long simple hair-like seta, 4 short simple hooklets of equal size (much smaller than those on segments 3 and 4) and 1 short spinous seta on each side; segments 3 and 4 each with 4 hooked spines and 1 short simple hooklet along posterior margin on each side; segments 5–9 each with a transverse row of comb-like groups of minute spines (though those on segment 5 very weakly developed) and lacking spine-combs on

each side except segment 8 with a transverse row of distinct spine-combs; segment 9 lacking terminal hooks. Ventrally, segment 4 with 1 simple hook, 1 simple hooklet and 2 short setae on each side; segment 5 with a pair of simple hooks submedially on each side; segments 6 and 7 each with a pair of simple (or bifid) inner and simple outer hooks somewhat separated from each other, on each side. Grapnel-like hooklets absent. **Cocoon** (Fig. 8B,C). Wall-pocket-shaped, with a medium to large anterolateral window on each side; thick, individual threads not visible; anterior margin well defined; cocoons attached on sticks and grass leaves thickly woven and well pigmented but those on rock surfaces usually thinly woven, less pigmented and sometimes nearly transparent; 3.2–3.6 mm long by 1.7–2.0 mm wide.

**Mature larva.** Body length 6.5–7.0 mm. Body color light to medium brown. Abdomen gradually widened toward segment 7, then narrowed to posterior tip when viewed laterally; segments 6 and 7 appear to be equal in width to each other when viewed dorsally. Cephalic apotome (Plate 1C) pale white on anterior 1/2 and pale to dark yellow on posterior 1/2 with a small dark area in middle along posterior border, with mediolateral spots and posteromedial longitudinal spot always distinctively positive (and rarely anteromedial longitudinal spot and posterolateral spots faintly positive); lateral surface yellowish brown to dark brown except eye-spot region and its dorsal area pale white to yellow; spots around eye-spot region faintly to distinctively negative; ventral surface (Plate 1G) light to dark brown with elongate spot on each side of postgenal cleft negative. Antenna composed of 3 segments and apical sensillum, much longer than stem of labral fan; length ratio of segments (from base to tip) 1.0:1.2:0.4; all segments pale white to yellow except 3rd segment entirely

brownish black and apical small portion of 2nd segment darkened to some extent. Labral fan with 40–44 main rays. Mandible (Fig. 8D) with usual mandibular serration of 1 medium-sized tooth and 1 small one, without supernumerary serrations; main mandibular tooth at an obtuse angle to the mandible on apical side; comb-teeth decreasing in length from 1st to 3rd. Hypostomium (Fig. 8E) with 9 apical teeth, of which median tooth and each corner tooth subequal in size, longer than others; lateral margins moderately serrate apically; 8–10 hypostomal bristles diverging posteriorly from lateral border on each side. Postgenal cleft (Plate 1G) bullet-shaped, somewhat pointed apically, 1.9–2.3 times as long as postgenal bridge; subesophageal ganglion well pigmented, wine-glass shaped. Cervical sclerite composed of a pair of small rod-like pieces, widely separated in middle from each other, not fused to occiput. Thoracic cuticle almost bare. Abdominal cuticle bare except last segment moderately covered with short colorless setae on each side of anal sclerite; rectal scales present (indistinct, then often overlooked). Rectal organ of 3 lobes, each with 19–22 finger-like secondary lobules. Anal sclerite X-shaped, with broadened anterior arms about 0.7 times as long as posterior ones; 16–18 sensilla just posterior to posterior arms. Ventral papillae absent. Posterior circle with about 136 rows of hooklets, with up to 18–22 hooklets per row.

**TYPE SPECIMENS.** Holotype female, with associated pupal exuvia and cocoon, collected from a small stream, Siribhume waterfall, Doi Inthanon National Park, Chiang Mai, Thailand, 28. II. 2004, by W. Choochote. Paratypes: 2 males (reared from pupae), and 13 pupae, same data and date as holotype; 11 pupae and 6 mature larvae, same data as holotype but date, 15. II. 2004.

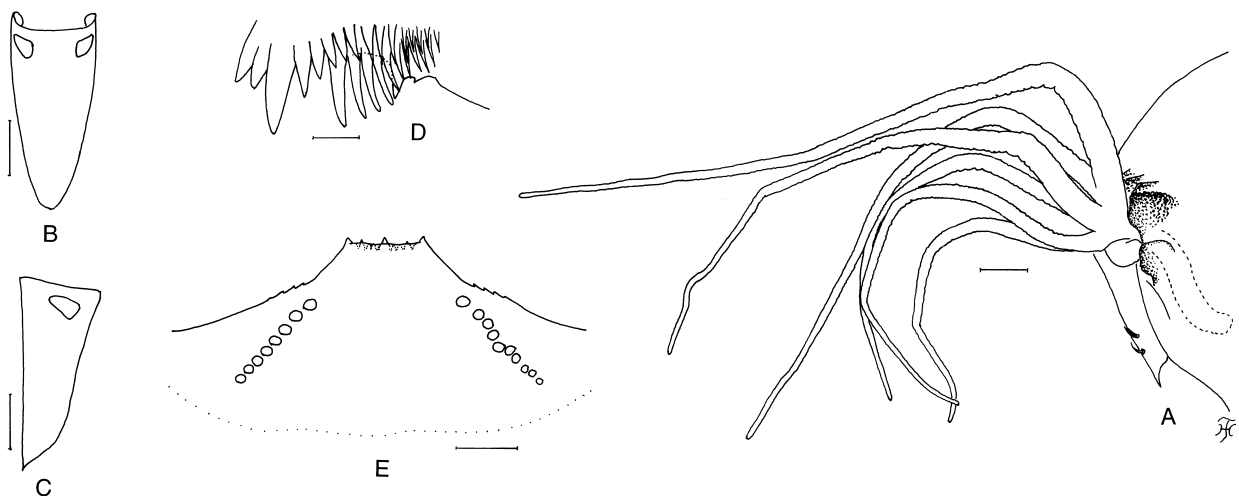


Fig. 8. Pupa and mature larva of *Simulium (Simulium) crocinum* sp. nov. A, pupal gill filaments; B and C, cocoons (B, dorsal view; C, lateral view); D, larval mandible; E, larval hypostomium. Scales. 0.02 mm for D; 0.05 mm for E; 0.1 mm for A; 1.0 mm for B and C.

ECOLOGICAL NOTES. The pupae and larvae of *S. crocinum* sp. nov. were found on the rock surface of a moderately flowing mountainous stream 0.5 m wide, exposed to the sun. A few pupae were also collected on trailing grasses and slender sticks in the fast flowing water. Water temperature was 18.5 °C. Altitude was ca. 1,500 m.

This species was collected together with *S. (S.) rufibasis* Brunetti, *S. (S.) mediocoloratum* sp. nov., *S. (Gomphostilbia) inthanonense* Takaoka and Suzuki, *S. (Nevermania) feuerborni* Edwards and *S. (Montisimulium)* sp.

ETYMOLOGY. The specific name *crocinum* refers to the yellowish legs of both sexes of this new species. The Latin word *crocinus* means yellow.

DISTRIBUTION. Thailand.

REMARKS. *Simulium crocinum* sp. nov. is assigned to the *griseifrons* species-group, as in the previous species.

The female of this new species resembles those of *S. rudnicki* and *S. mediocoloratum* in many characters including the antenna with pits and the ovipositor valve with transparent inner and posterior margins (Fig. 6J), but is differentiated from the latter two species by the dorsal surface of the anterior 1/2 of the second abdominal segment medium brown (cf. white or yellowish white in *S. rudnicki* and *S. mediocoloratum*), the fore tibia pale yellowish-white except apical 1/5 brownish black (cf. usually dark portion extending from the apical cap to basal 1/2 or more along the inside margin in *S. rudnicki* and *S. mediocoloratum*), the hind tibia yellowish-white to yellow except the apical cap dark brown at least on the inside surface though the outer surface with an excess light brown portion extending from the apical cap to a little less than basal 1/2 (Fig. 6G) (cf. hind tibia light to dark brown or brownish black except basal 1/3 and posterior surface of basal 2/3 white in *S. rudnicki* and *S. mediocoloratum*), and the ellipsoidal spermatheca (Fig. 6J) (cf. globular in the other two species). The female of this species is also distinguished from *S. mediocoloratum* by the entirely yellowish-white mid tibia.

The male of *S. crocinum* is very similar to that of *S. rudnicki*, but is barely distinguished by the hind tibia dark brown to brownish black with basal 1/4 or 1/5 whitish yellow (Fig. 7D) (cf. only the extreme base of hind tibia white in *S. rudnicki*) and the style without subterminal spine (Fig. 7F) (subterminal spine present in *S. rudnicki*). On the other hand, this new species is readily separated in the immature stages from *S. rudnicki* and *S. mediocoloratum*: in the pupa by the gill with two filaments much thicker than the other four filaments (Fig. 8A) and the light to medium brown, thickly-woven cocoon with an anterolateral window on

each side (Fig. 8B,C), and in the larva by the cephalic apotome with its ground color mostly pale (Plate 1C).

The male genitalia, leg colors and the pupal gill filaments of *S. crocinum* are very similar to those of *S. ufengense* Takaoka, described from Taiwan [6], and of *S. fuzhouense* Zhang and Wang, from Fujian, south China [7]. However, this new species is easily separated from these two species by the fenestrated cocoon (Fig. 8B,C) (cf. cocoons simple without lateral windows in *S. ufengense* and *S. fuzhouense* [6, 7]).

*Simulium taipokauense* from Hong Kong [8] shows some similarities to *S. crocinum* but differs in that it has the much longer basal protuberance of the style and the saddle-shaped ventral plate with a nipple-like median process.

#### *Simulium (Simulium) suchariti* Takaoka and Choochote, 2004

*Simulium (Simulium) suchariti* Takaoka and Choochote, 2004: 31–33 (female only).

DESCRIPTION. **Pupa.** Body length (excluding gill filaments) 3.5–4.0 mm. **Head.** Integument yellowish brown, densely and elaborately covered with tubercles of various sizes (Fig. 9A); all tubercles but small ones with several minute projections on their surface; antennal sheath also densely covered with tubercles; face with a pair of medium-long trifid or quadrifid trichomes (Fig. 9B); frons with 2 pairs of medium-long branched (split into 4–6) trichomes slightly shorter than facial ones (Fig. 9C); 2 frontal trichomes on each side arising close together. Thorax. Integument yellowish brown, moderately covered with tubercles of various sizes (Fig. 9D) (similar to those on head but most are much larger) on anterior 1/2 including areas near base of gill, and moderately covered with small cone-shaped tubercles dorsally on posterior 1/2; thorax anteriorly with 3 dorsal and 2 lateral pairs of very long fan-like trichomes each with 20–31 branches (Fig. 9E) (about twice as long as facial trichomes), posteriorly with 1 lateral pair of medium-long trichomes each with 7–10 branches (Fig. 9F), and ventrolaterally with 3 pairs of long and medium-long branched (split into 2–7) trichomes. Gill (Fig. 9G) with 6 filaments arranged in pairs; all pairs almost sessile except dorsal pair with very short stalk; all filaments usually pale, gradually decreasing in length and thickness from dorsal to ventral; outer filament of dorsal pair longest (1.8–2.0 mm) and thickest of all, and inner filament of lower pair shortest (0.5–0.8 mm) and thinnest (about half times as thick as the thickest dorsalmost filament); all filaments gradually tapered toward apical tip, with annular ridges and furrows throughout their length, and densely covered with minute tubercles. **Abdomen.** Dorsally, segment 1 light yellowish

low with narrow pale portion along posterior margin, with 1 bifid or trifold (or quadrifid) medium-long seta on each side; segment 2 almost pale, nearly transparent, with 1 simple or bifid medium-long seta, 1 short minute seta and 4 short simple spines of equal size on each side; segments 3 and 4 each with 4 hooked spines along posterior margin on each side; segment 5 bare; segments 6–9 each with a transverse row of comb-like groups of minute spines on each side; segment 8 with a transverse row of distinct spine-combs on each side; segment 7 sometimes with a transverse row of spine-combs, though much fewer in number and smaller in size than those on segment 8; segment 9 lacking terminal hooks. Ventrally, segment 4 with 1 simple hook (similar in size to those on segments 5–7) and a few simple or bifid short setae on each side; segment 5 with a pair of simple or bifid hooks submedially and a few simple or bifid hooklet-like setae on each side; segments 6 and 7 each with a pair of bifid inner and simple or bifid outer hooks somewhat separated from each other and a few simple or bifid setae on each side.

Grapnel-like hooklets absent. **Cocoon** (Fig. 9H–J). Wall-pocket-shaped, with a large anterolateral window (in some cocoons 1 of 2 windows is small, or even absent, though the window on the other side is large; in other cocoons, window is divided into 2 or 3 spaces of various sizes) on each side; ventrolateral tips of anterior margin approaching to each other anteroventrally, sometimes connected to each other; cocoon thin and usually pale; individual threads partially visible; 5.0–5.2 mm long by 1.8–2.0 mm wide.

**Mature larva.** Body length 7.5–8.0 mm. Body color greyish. Abdomen gradually widened toward posteriorly, with the widest portion on segment 7. Cephalic apotome (Plate 1D) almost entirely pale yellow except a small somewhat dark area in middle along posterior border (though mediolateral spots and anterior ones of posterolateral spots very faintly positive in 1 of 3 larvae examined); lateral surface entirely pale yellow without any dark spot; ventral surface (Plate 1H) somewhat darkened with elongate spot on each side of postgenal cleft usually faintly negative. An-

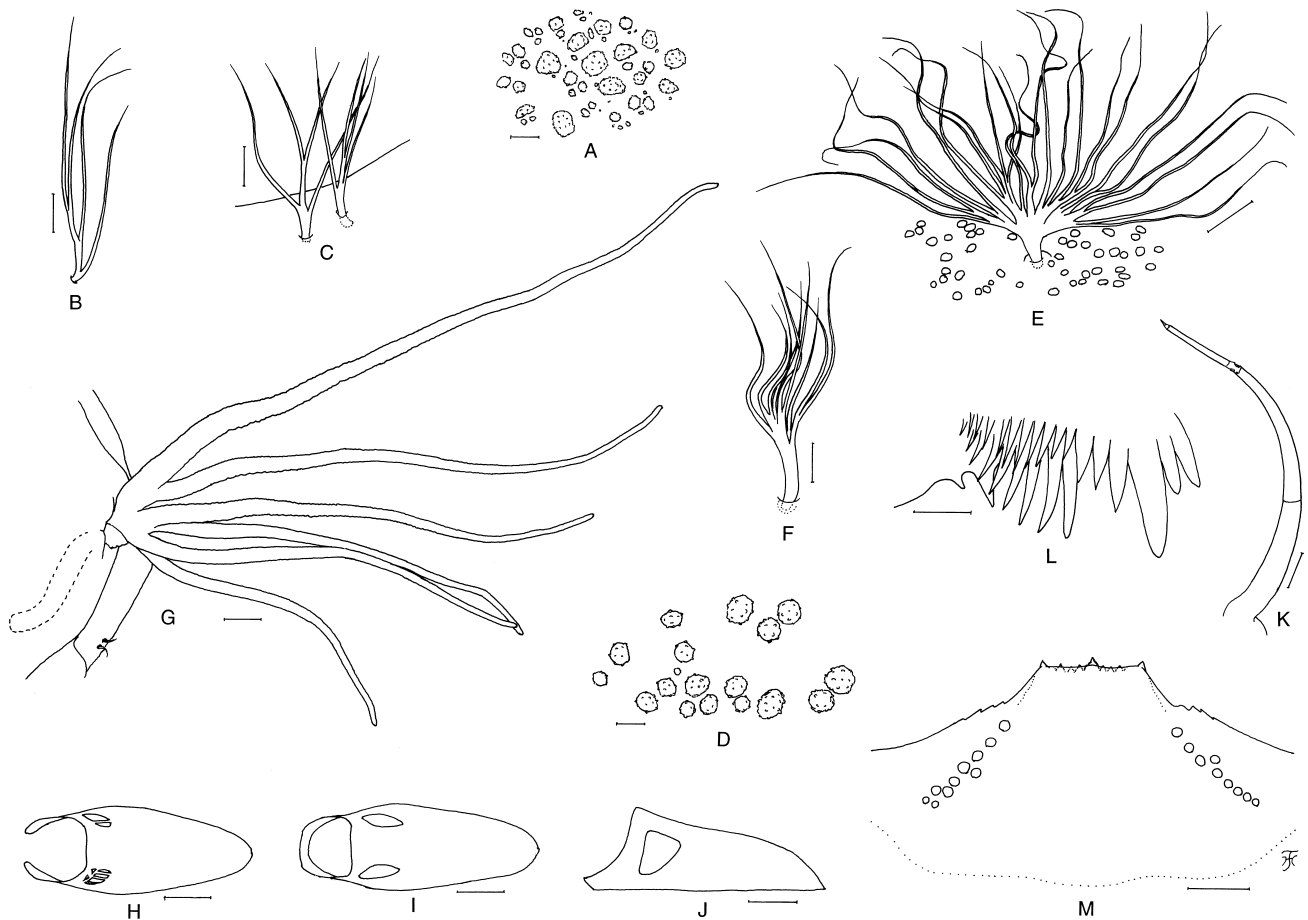


Fig. 9. Pupa and mature larva of *Simulium (Simulium) suchariti* Takaoka and Choochote. A–G, pupa; K–M, larva. A, tubercles on frons; B, trichome on face; C, 2 trichomes on frons (right side); D, tubercles on dorsal surface of thorax; E, trichome and tubercles near its base on dorsal surface of thorax; F, trichome on posterolateral surface of thorax; G, gill filaments; H–J, cocoons (H and I, dorsal view; J, lateral view); K, antenna (left side, dorsal view); L, mandible; M, hypostomium. Scales. 0.01 mm for A and D; 0.02 mm for B, C, F and L; 0.05 mm for E, K and M; 0.1 mm for G; 1.0 mm for H–J.

tenna (Fig. 9K) composed of 3 segments and apical sensillum, much longer than stem of labral fan; length ratio of segments (from base to tip) 1.0:1.6:0.7; all segments pale or yellow. Labral fan with about 40 main rays. Mandible (Fig. 9L) with usual mandibular serration of 1 medium-sized tooth and 1 small one, without supernumerary serrations (though left mandible of 2 larvae with 1 additional small tooth); main mandibular tooth at an obtuse angle to the mandible on apical side; 1st comb-tooth longest and thickest, followed by 2nd and 3rd teeth of similar size. Hypostomium (Fig. 9M) with 9 apical teeth, of which median tooth subequal in size to, or a little larger than, each corner tooth, and intermediate teeth small; lateral margins moderately serrate apically; 7–10 hypostomal bristles diverging posteriorly from lateral border on each side. Postgenal cleft (Plate 1H) bullet-shaped, rounded apically, 1.8–2.0 times as long as postgenal bridge; subesophageal ganglion not visible. Cervical sclerite composed of a pair of small rod-like pieces, widely separated in middle from each other, not fused to occiput. Thoracic cuticle almost bare. Abdominal cuticle bare except last segment moderately covered with short colorless setae on each side of anal sclerite; rectal scales present. Rectal organ of 3 lobes, each with about 17 finger-like secondary lobules. Anal sclerite X-shaped, with broadened anterior arms about 0.64 times as long as posterior ones; 10–20 sensilla just posterior to posterior arms. Ventral papillae absent. Posterior cirlet with about 120

rows of hooklets, with up to 18–20 hooklets per row.

**SPECIMENS EXAMINED.** 2 paratype females, 8 pupae, 1 pupal exuvia and 5 mature larvae, all collected from a small forest stream, Ang Ka, Doi Inthanon National Park, Chiang Mai, Thailand, 10. XII. 2003, by W. Choochote.

**ECOLOGICAL NOTES.** The pupae and larvae of *S. suchariti* were found on the surface of the rocky stream-bed of a shaded stream 0.3 m wide, slow-flowing in natural forest. Water temperature was 6.5 °C. Altitude was 2,565 m.

This species was collected together with *S. (S.) setsukoae* Takaoka and Choochote, *S. (Montisimulium) sp.* and *S. (Nevermannia) caudisclerum* Takaoka and Davies.

**DISTRIBUTION.** Thailand.

**REMARKS.** *Simulium suchariti* differs from the three related species treated above in the pupa by the head and thoracic integuments moderately or densely covered with tubercles as well as the arrangement of the gill filaments (Fig. 9A,G), and in the larva by the pale cephalic apotome (Plate 1D), the antenna with the third segment not darkened compared to the first and second segments (Fig. 9K) and the subesophageal ganglion not visible (Plate 1H).

The pupa and larva of *S. suchariti* are similar to those of *S. maenoi* Takaoka and Choochote, described from Thai-

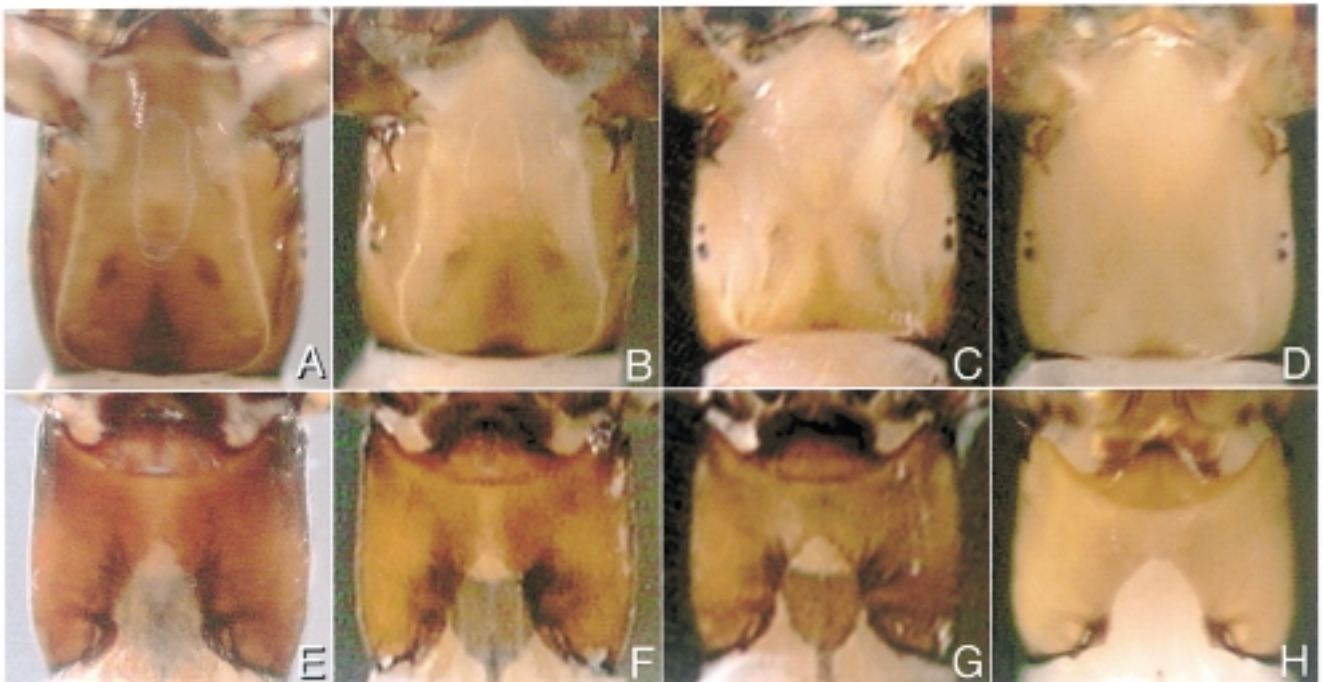


Plate 1. Larval head capsules of four *Simulium* (*Simulium*) species. A and E, *S. rudnicki* Takaoka and Davies; B and F, *S. medio-coloratum* sp. nov.; C and G, *S. crocinum* sp. nov.; D and H, *S. suchariti* Takaoka and Choochote. A–D, dorsal view; E–H, ventral view.



land [9] in the arrangement of the pupal gill filaments (Fig. 9G), and the pale larval cephalic apotome (Plate 1D) and the shape of the larval body. However *S. suchariti* is readily distinguished from *S. maenoi* in the pupa by the absence of the terminal hooks, head integument with tubercles of different sizes (Fig. 9A), and dorsal trichomes of the thorax with 20-31 branches (Fig. 9E), and the cocoon with a large anterolateral window on each side (Fig. 9J), and in the larva by the pale ventral surface of the head capsule (Plate 1H).

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