

## A NEW SPECIES OF *SIMULIUM* (*SIMULIUM*) FROM NORTHERN THAILAND (DIPTERA: SIMULIIDAE)

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**Abstract:** *Simulium* (*Simulium*) *phukaense* sp. nov. is described on the basis of the observation of females and males (both sexes of adults reared from pupae) and pupae collected in Nan Province, northern Thailand. This new species is assigned to the *griseifrons* species-group of the subgenus *Simulium* (*Simulium*) and is easily distinguished from other known species of this species-group by the simple shoe-shaped cocoon, as well as the arrangement of the six gill filaments.

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

During recent surveys on black flies in northern Thailand, we collected a new species which is assigned to the *griseifrons* species-group of the subgenus *Simulium* (*Simulium*) Latreille s. str., redefined by Takaoka and Davies [1]. This new species is very similar to *S.* (*S.*) *maenoi* Takaoka and Choochote, described from Thailand [2] but differs from the latter species and all the other species of the same species-group by its shoe-shaped cocoon.

The terms for morphological features used here follow those of Takaoka [3]. Holotype and paratype specimens of the new species are deposited at the Department of Infectious Disease Control, Faculty of Medicine, Oita University, Oita, Japan.

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

**DESCRIPTION. Female.** Body length 2.8–3.0 mm. **Head.** Narrower than thorax. Frons brownish black, shiny, thickly white pruinose, with several dark stout hairs along lateral margins; frontal ratio 1.3:1.0:0.9–1.0; frons-head ratio 1.0:3.4–3.8. Fronto-ocular area (Fig. 1A) well developed, rounded apically. Clypeus brownish black, thickly white pruinose, moderately covered with dark stout hairs except upper 1/2 narrowly bare medially. Labrum about 0.7 times as long as clypeus. Antenna (Fig. 1B) composed of 2+9 segments, medium to dark brown except scape, pedicel, and basal 1/3 (or up to 1/2) of 1st flagellar segment yellow; 1st flagellar segment slightly wider than long, and about 1.8 times as long as 2nd flagellar segment. Maxillary palp with 5 segments, light to dark brown, proportional lengths of 3rd,

4th, and 5th segments 1.0:1.1:2.3; 3rd segment (Fig. 1C) of normal size, with sensory vesicle oblong, 0.34 times as long as 3rd segment. Maxillary lacinia with 11–13 inner and 15 outer teeth. Mandible with about 34 inner and 15 or 16 outer teeth. Cibarium (Fig. 1D) with short blunt median projection directed dorsally at its dorsal margin, with many tubercles on its surface. **Thorax.** Scutum black, slightly shiny at certain angles of light, densely covered with yellow recumbent short hairs interspersed with dark brown short hairs on anterior surface, and also with dark long upright hairs on prescutellar area; when illuminated in front and viewed dorsally, scutum thickly whitish-grey pruinose, with 5 longitudinal unpruinose vittae, of which 1 median vitta is very narrow, 2 submedian and 2 lateral vittae rather wide, all vittae united with broad transverse band on prescutellar area; when illuminated from behind, scutum shows a reversed color pattern. Scutellum medium brown, covered with dark brown long upright hairs as well as yellow short hairs. Postnotum dark brown, shiny, whitish-grey pruinose, and bare. Pleural membrane bare. Katepisternum longer than deep, and bare. **Legs.** Foreleg: coxa whitish yellow; trochanter yellow with apical 1/3 or 1/2 dark yellow; femur yellow with apical tip light brown; tibia white except apical 1/4 brownish black; tarsus brownish black, with moderate dorsal hair crest; basitarsus greatly dilated, 6.1 times as long as its greatest width. Midleg: coxa brownish black; trochanter yellow except apical 1/2 dark yellow or light brown; femur yellow except apical tip light brown; tibia white to yellowish white except a little more than apical 1/4 blackish brown; tarsus dark brown to brownish black except basal

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1/5 (or up to 1/2) of basitarsus yellow. Hind leg: coxa blackish brown; trochanter yellow; femur yellow except apical cap light to medium brown; tibia white to yellowish white with a little less than apical 1/4 brownish black; tarsus blackish brown except a little less than basal 2/3 of basitarsus and basal 1/2 of 2nd segment yellowish white; basitarsus (Fig. 1E) nearly parallel-sided, about 6.6 times as long as wide, and 0.71 and 0.61 times as wide as greatest widths of hind tibia and femur, respectively; calcipala (Fig. 1E) moderately developed, nearly as long as wide; pedisulcus (Fig. 1E) well developed at basal 1/3 of 2nd tarsal segment. All tarsal claws simple. **Wing.** Length 2.6 mm. Costa with dark spinules and hairs; subcosta haired except apical 2/5 to 1/2 bare; basal section of radial vein bare, or with 2–4 hairs near apex;  $R_1$  with dark spinules and hairs;  $R_2$  with hairs; hair tuft on stem vein dark brown. **Abdomen.** Basal scale dark brown, with fringe of pale yellow hairs as well as dark brown hairs. Dorsal surface of abdomen dark brown to brownish black, with short dark hairs; tergite 2 shiny, silvery iridescent at certain angles of light, and tergites 6–8 shiny. Ventral surface of 7th segment with a pair of small submedian sternal plates. **Genitalia.** Sternite 8 (Fig. 1F) moderately sclerotized, with 16–20 long and medium-long stout hairs as well as a few short fine hairs on each lateral surface. Ovipositor valves (Fig. 1F) nearly triangular, membranous, covered with 11–15 short or medium-long hairs as well as numerous microsetae; narrow bare area along inner and posterior margins very thin and transparent (though very lightly darkened anteriorly along inner margin). Genital fork (Fig. 1G) of inverted-Y form, with narrow, well sclerotized stem; arms of moderate width, each with distinct projection directed anteriorly. Paraproct in ventral view (Fig. 1H) nearly as long as wide, with distinct concavity on anteroventral surface; paraproct in lateral view (Fig. 1I) about half as long as wide, moderately protruding ventrally beyond cercus forming round unpigmented apex, with numerous stout hairs on lateral and ventral surfaces. Cercus in lateral view (Fig. 1I) rounded posteriorly, about half as long as wide, with numerous stout hairs. Spermatheca (Fig. 1J) globular or somewhat ovoid, well sclerotized (except portion of junction to duct unsclerotized), polygonal surface patterns faintly visible, and with internal setae; accessory ducts subequal in thickness to major duct.

**Male.** Body length 3.0–3.2 mm. **Head.** Nearly as wide as thorax. Upper eye with large facets in 20 or 21 vertical columns and in 21 or 22 horizontal rows. Face and clypeus black, thickly white pruinose, sparsely covered with dark brown long hairs. Antenna (Fig. 2A) composed of 2+9 segments, medium to dark brown except base of 1st flagellar segment yellowish white; 1st flagellar segment elongate, twice as long as wide, and 2.5 times as long as 2nd flagellar

segment. Maxillary palp with 5 segments, medium to dark brown, proportional lengths of 3rd, 4th, and 5th segments 1.0:1.1:2.2; sensory vesicle (Fig. 2B) small, oblong, 0.2 times as long as 3rd segment. **Thorax.** Scutum black, densely covered with golden-yellow recumbent short hairs interspersed with brown similar hairs anteriorly, and with dark brown long upright hairs on prescutellar area; scutum at certain angles of light with whitish-grey pruinose spots, i. e., anterolateral pair of rectangular spots on shoulders which connect widely to posterior large spot on prescutellar area through spots along lateral margins; all these spots usually indistinct due to thick covering of golden-yellow short hairs. Scutellum brownish black or black, with golden-yellow short hairs as well as dark brown long upright hairs. Postnotum black, white pruinose, and bare. Pleural membrane and katepisternum as in female. **Legs.** Foreleg: coxa yellow; trochanter and femur medium to dark brown; tibia dark brown to brownish black with large median area on outer surface medium brown; tarsus brownish black, with moderate dorsal hair crest; basitarsus somewhat dilated, 7.0 times as long as its greatest width. Midleg: coxa brownish black; trochanter dark brown except base narrowly yellowish; femur medium brown; tibia medium to dark brown (though somewhat pale at extreme base); tarsus dark brown to blackish brown. Hind leg: coxa brownish black; trochanter dark yellow to yellowish brown; femur medium brown except base yellow, and apical cap dark brown to brownish black; tibia and tarsus dark brown to brownish black except minute base of tibia white; basitarsus (Fig. 2C) enlarged, spindle-shaped, 4.0 times as long as its greatest width, and very slightly narrower than greatest width of hind tibia, which is as wide as greatest width of hind femur; calcipala well developed, nearly as long as its width at base; pedisulcus well developed. **Wing.** Length 2.6 mm; other characters as in female except subcosta with 0–6 hairs on basal 1/2, and basal portion of radial vein bare or with 1 or 2 hairs near apical tip. **Abdomen.** Basal scale black, with fringe of dark brown long hairs. Dorsal surface of abdominal segments black, with dark short hairs; tergites 2, 6 and 7 each with a pair of dorsolateral whitish spots, those on tergite 2 connected broadly to each other medially. **Genitalia.** Coxite in ventral view (Fig. 2D) subquadrate, with stout hairs on posterior 1/2 of ventral surface. Style (Fig. 2D) elongate, much longer than coxite, gently curving inwards, moderately covered with stout hairs on ventral and lateral surfaces, and with single subterminal spine; style in ventrolateral view (Fig. 2E) very slightly narrowed from base to apical 1/3, then slightly widened near apex; style in medial view (Fig. 2F) with distinct basal protuberance directed dorsomedially, with several small cone-shaped spines at and near apex. Ventral plate in ventral view (Fig. 2D) with its

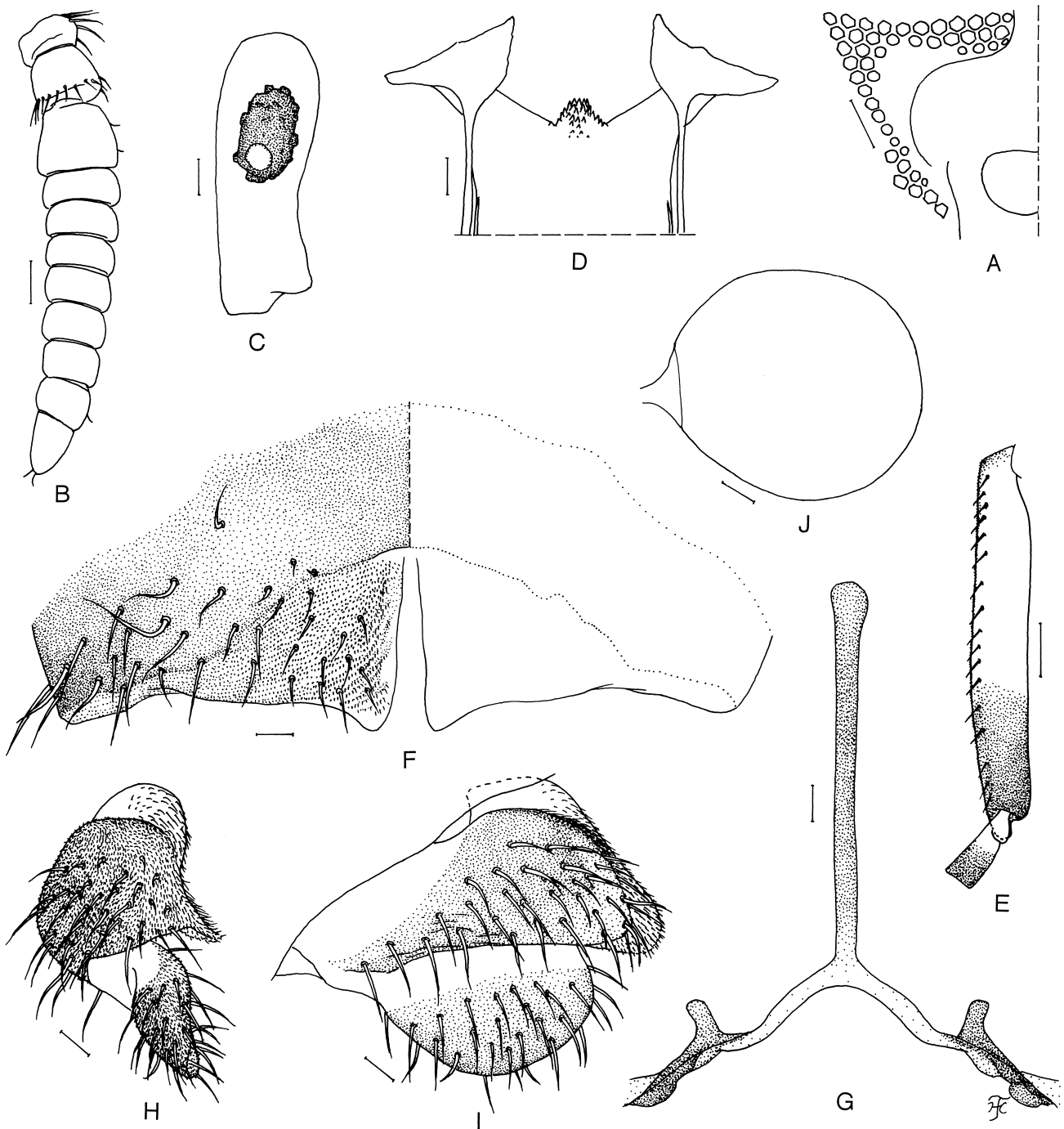


Fig. 1. Female of *Simulium* (*Simulium*) *phukaense* sp. nov. A, fronto-ocular area (right side); B, antenna (left, outer view); C, 3rd segment of maxillary palp with sensory vesicle (right side, front view); D, cibarium; E, basitarsus and second tarsal segment of hind leg showing calcipala and pedisulcus (left side, outer view); F, 8th sternite and ovipositor valves *in situ* (ventral view); G, genital fork (ventral view); H and I, paraprocts and cerci (right side; H, ventral view; I, outer view); J, spermatheca. Scale bars. 0.1 mm for E; 0.05 mm for A and B; 0.02 mm for C, D and F J.

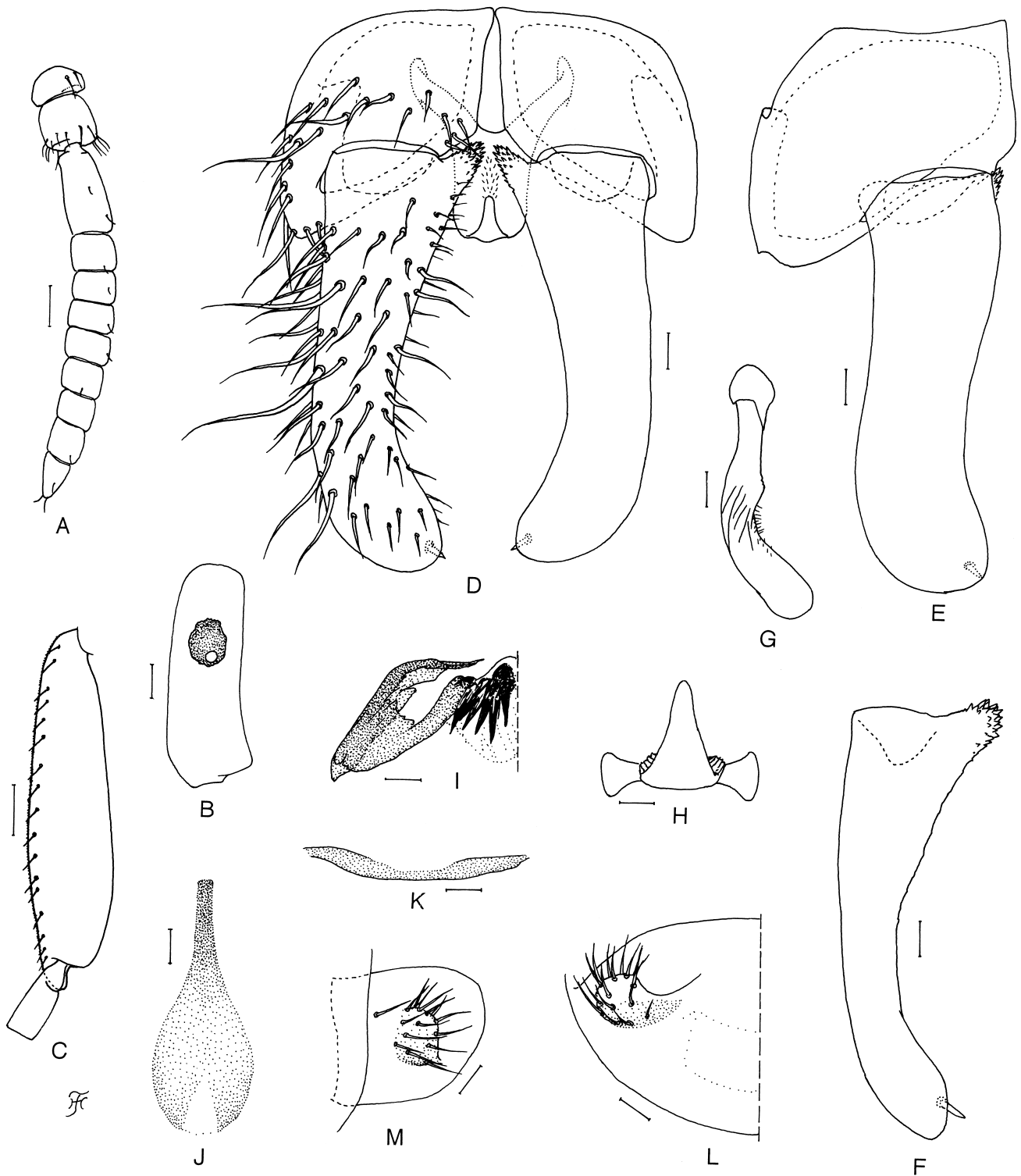


Fig. 2. Male of *Simulium* (*Simulium*) *phukaense* sp. nov. A, antenna (left side, inner view); B, 3rd segment of maxillary palp with sensory vesicle (right side, front view); C, basitarsus and second tarsal segment of hind leg showing calcipala and pedisulcus (left side, outer view); D, coxites, styles and ventral plate *in situ* (ventral view); E, coxite and style (right side, ventrolateral view); F, style showing basal protuberance (right side, medial view); G and H, ventral plates (G, lateral view; H, end view); I, paramere (right side, end view); J, median sclerite (posteroventral view); K, dorsal plate (ventral view); L and M, 10th abdominal segments and cerci (L, end view; M, outer view). Scale bars. 0.1 mm for C; 0.05 mm for A; 0.02 mm for B and D-M.

body rectangular (though the posterolateral corners are rounded), much longer than wide, and basal arms strongly sclerotized and divergent from each other; ventral plate in lateral and end views (Fig. 2G, H) with long narrow median process directed ventrally, nearly bare except anteroventral surface with several microsetae. Paramere (Fig. 2I) large basally, with several hooks. Median sclerite in ventroposterior view (Fig. 2J) narrow on basal 1/3, then widened toward apical 1/3, then somewhat narrowed apically with round apex, moderately sclerotized and brown except medial narrow portion near apex not sclerotized and transparent. Aedeagal membrane densely setose; dorsal plate (Fig. 2K) moderately sclerotized. Abdominal segment 10 (Fig. 2L, M) without any distinct hairs on each posterolateral corner. Cercus (Fig. 2L, M) small, short, rounded, with 8–16 hairs.

**Pupa.** Body length 3.0–3.5 mm. **Head.** Integument medium brown, moderately covered with rather large tubercles on frons each with minute secondary projections on its surface (Fig. 3A); antennal sheath with 9 ridges corresponding to 9 flagellar segments, each ridge covered densely or moderately with round tubercles, while interridge spaces bare; face with a pair of long fan-like trichomes each with 12–15 slender branches (Fig. 3B), frons with 2 pairs of long fan-like trichomes (upper one with 16–22 slender branches (Fig. 3C), lower one with 23–30 slender branches). **Thorax.** Integument medium brown, moderately covered with tubercles of various sizes, larger ones with secondary projections (similar to those on frons) on anterior 1/2, as well as smaller cone-shaped tubercles on posterior 1/2; thorax on each side with 5 long fan-like trichomes each with 13–22 branches anterodorsally and anterodorsolaterally (similar in shape to, but somewhat longer than, those on frons Fig. 3C), 1 medium-long stout trichome with 2–4 branches (Fig. 3D) posterolaterally, and 3 trichomes (2 medium-long, with 2–4 branches, 1 simple or bifid, long and stout) (Fig. 3E, F, G) ventrolaterally. Gill (Fig. 3H) with 6 slender thread-like filaments in 3 pairs (middle and lower pairs almost sessile, dorsal pair very short-stalked); outer filament of dorsal pair longest (1.8–2.0 mm) and thickest of all, followed by inner filament of dorsal pair, then by outer filament of middle pair, and 3 other filaments subequal to one another, and shortest (1.2–1.4 mm) and thinnest; all filaments dark brown, tapered toward apex, with distinct annular ridges and furrows, and densely covered with minute tubercles. **Abdomen.** Dorsally, segment 1 well sclerotized, medium brown, sparsely covered with small dark brown cone-shaped tubercles, and with 1 simple or bifid medium-long slender seta on each side; segment 2 transparent, with 1 simple or bifid medium-long slender seta and 5 short stout spines on each side; segments 3 and 4 transparent, each with 4 hooks and 1

short stout spine on each side; segments 5 and 6 transparent and bare; segment 7 with comb-like groups of minute spines on weakly sclerotized light brown narrow transverse band near anterior margin on each side; segment 8 with a transverse row of distinct spine-combs as well as comb-like groups of minute spines on weakly sclerotized light brown narrow transverse band near anterior margin on each side; segment 9 with or without comb-like groups of minute spines on weakly sclerotized light brown narrow transverse band near anterior margin on each side; posterior 1/2 of segment 9 very weakly to moderately sclerotized, yellowish to medium brown, and sparsely covered with small round tubercles, and lacking terminal hooks. Ventrally, all segments nearly transparent except segment 9 yellowish; segments 3–8 each with comb-like groups of minute spines; segment 4 with 1 simple stout hook (similar in shape and size to those on segments 5–7), 1 simple slender hooklet submedially and a few simple slender setae on each side; segment 5 with a pair of bifid and simple hooks submedially and a few simple slender setae on each side; segments 6 and 7 each with a pair of simple hooks and a few simple (or bifid) slender setae on each side. **Cocoon** (Fig. 3I, J). Shoe-shaped, tightly woven, not extending ventrolaterally; individual threads invisible; 3.5–4.0 mm long by 1.7–2.0 mm wide.

**Mature larva.** Unknown.

**TYPE SPECIMENS.** Holotype female with its associated pupal exuvia and cocoon, collected in Doi Phu Ka National Park, Nan Province, northern Thailand, 2.XII. 2004, by Wej Choochote. Paratypes: 3 females and 3 males, all with their associated pupal exuviae and cocoons, same data as holotype; 5 females and 11 males, all with their associated pupal exuviae and cocoons, same data as holotype except date, 23.XII. 2004.

**ECOLOGICAL NOTES.** The pupae of this new species were found attached to the surface of rocks in a fast flowing cascading stream (width ca. 1.5 m, depth ca. 15 cm, exposed to sun, water temperature 18°C, altitude 1,250 m above sea level) in a sparsely forested area. This species was found together with *Simulium* (*Daviesellum*) *courtneyi* Takaoka and Adler, *S.* (*Gomphostilbia*) *inthanonense* Takaoka and Suzuki and *S.* (*S.*) *fenestratum* Edwards.

**ETYMOLOGY.** The specific name *phukaense* refers to the name of the national park, Phu Ka, where this new species was collected.

**REMARKS.** *Simulium* (*Simulium*) *phukaense* sp. nov. is assigned to the *griseifrons* species-group of the subgenus *Simulium* (*Simulium*) by having the simple female claws,

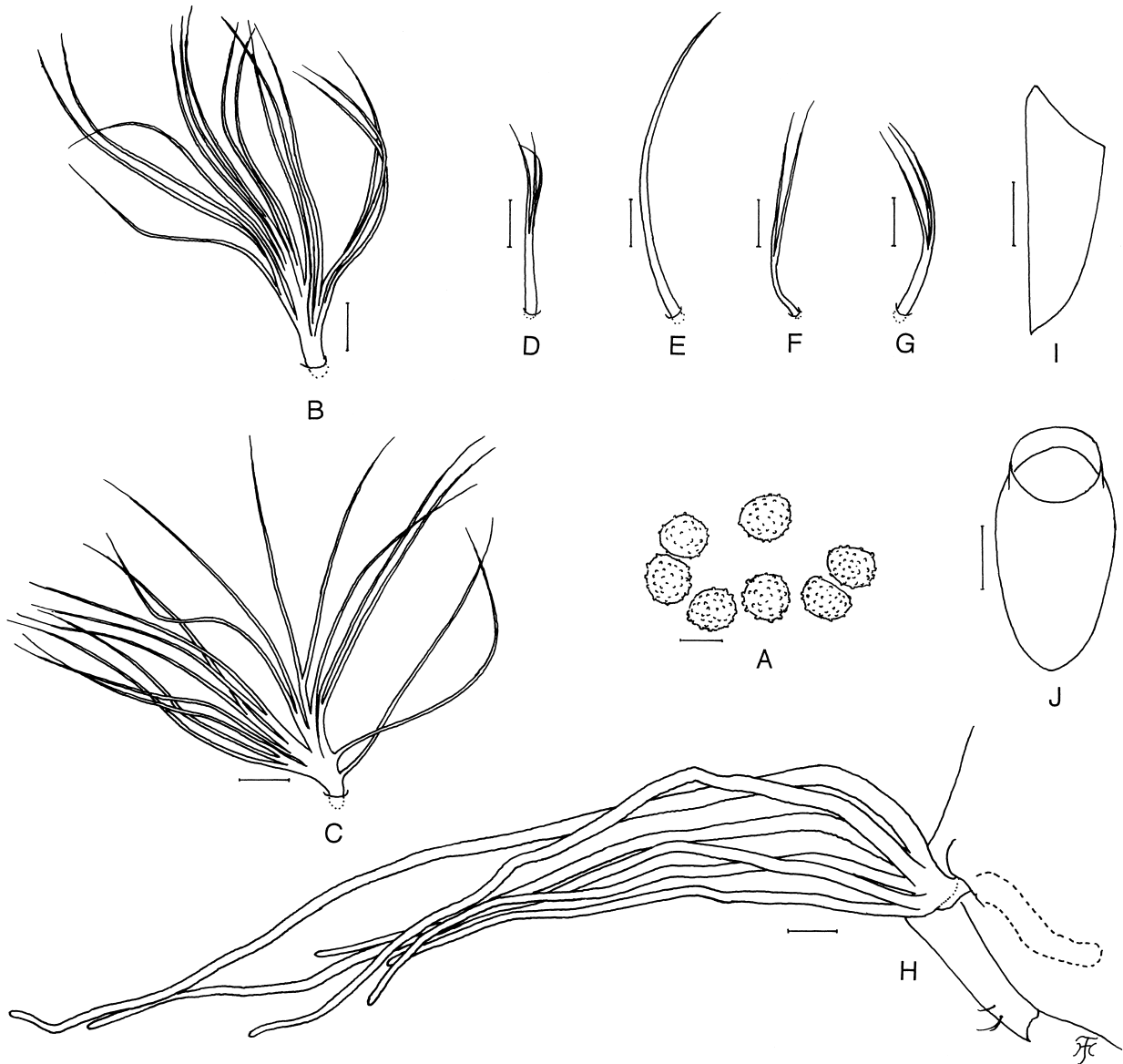


Fig. 3. Pupa of *Simulium* (*Simulium*) *phukaense* sp. nov. A, large tubercles on frons; B, facial trichome; C, frontal trichome; D-G, thoracic trichomes (D, posterolateral; E-G, ventrolateral); H, gill filaments (left side; outer view); I and J, cocoons (I, lateral view; J, dorsal view). Scale bars. 1.0 mm for I and J; 0.1 mm for H; 0.02 mm for B-G; 0.01 mm for A.

the male ventral plate without teeth (Fig. 2D), and the pupal gill with six filaments (Fig. 3H).

This new species appears to be closely related to *S. (S.) maenoi* described from Thailand [2] in that adults of both species have similarly shaped genitalia and a similar color pattern of the legs. However, *S. (S.) phukaense* sp. nov. is distinguished from the latter species as follows (characteristics of *S. (S.) maenoi* in parentheses): in the female by the median projection on the cibarium short (long), and the second abdominal segment entirely dark brown

(pale yellow on anterior 3/4), in the male by the hind basitarsus spindle-shaped (wedge-shaped), a pair of dorsolateral whitish spots present only on tergites 2, 6 and 7 (present also on tergite 5) and the body of the ventral plate in ventral view nearly parallel-sided (gradually narrowed toward posterior tip), in the pupa by the facial fan-like trichome with 12-15 slender branches (4 or 5 branches), the inner filament of the middle pair apparently thinner than the outer one of the same pair (both filaments subequal in thickness to each other), the terminal hooks absent (present), and the cocoon

shoe-shaped (wall-pocket-shaped with a small anterolateral window on each side).

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