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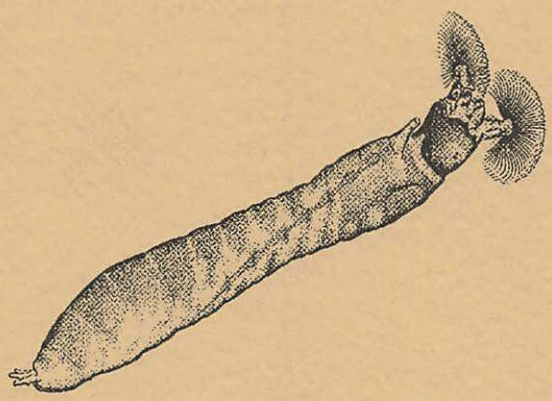
## The Black Flies (Diptera: Simuliidae) of Java, Indonesia

H. Takaoka and D.M. Davies



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# The Black Flies of Java

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# The Black Flies (Diptera: Simuliidae) of Java, Indonesia

H. Takaoka and D.M. Davies

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Larva of *Simulium vittatum* Zetterstedt,
courtesy of Dr. Douglas A. Craig

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## ABSTRACT

Twenty-two simuliid species from Java, Indonesia are treated, comprising four new species and 18 named species. All belong in the genus *Simulium* Latreille s.l. and three subgenera, *Nevermannia* Enderlein (4 spp.), *Gomphostilbia* Enderlein (8 spp.) and *Simulium* Latreille s. str. (10 spp.). Further groupings are made at species-group levels within the three subgenera, with new species-groups proposed within the subgenera *Gomphostilbia* and *Simulium*. Descriptions for all new species and redescriptions for most known species are given. Keys to the subgenera, most species-groups and species are provided for the adult female, male, pupa and mature larva.

# INTRODUCTION

The black flies (family Simuliidae) of the Sunda Archipelago, Indonesia have been little studied. De Meijere (1907, 1913) recorded *Simulium (Nevermannia) aureohirtum* Brunetti and described five new simuliid species from adult specimens collected from Java. Edwards (1925) described *S. (Gomphostilbia) varicorne* based on a single male from south Sumatra. Edwards (1934) also made thorough studies of black fly specimens including pupae and larvae collected from Java, Sumatra and Bali by various investigators. In that work, he redescribed most of the known species, described nine more new species and two new subspecies, and recorded two varieties (one of *S. (G.) metatarsale* Brunetti and the other of *S. (Simulium) iridescens* de Meijere). Crosskey (1973) raised the two subspecies, which Edwards (1934) reported, to species level. He also made lectotype designations for four Javanese species (Crosskey & Lowry, 1990). Recently, Takaoka and Hadi (1991) treated the variety of *S. (S.) iridescens* as a new species and named it *S. (S.) javaense*, and also described another new species, *S. (S.) sigiti*, from Java. Takaoka and Sigit (1992) described a new species, *S. (G.) parahiyangum*, from Java. In total, 22 black fly species were known from the Sunda Islands, of which 12 species were reported only from Java, four only from Sumatra, five from Java and Sumatra, and one from Java and Bali.

The present work contains the results of examination of the type specimens of most known species and other samples newly collected by ourselves from Java. We here revised all 18 known Javanese simuliid species, except *S. (G.) atratum* de Meijere, of which the type male specimen was not available. The variety of *S. (G.) metatarsale* is described as a new species. In addition, three new species are described, and *S. (G.) varicorne* is newly recorded, bringing to 22 the number of simuliid species from Java. These are placed into three subgenera of the genus *Simulium* Latreille s.l. and also, whenever possible, into several species-groups within subgenera. The *ceylonicum*-group of the subgenus *Gomphostilbia* Enderlein defined by Takaoka (1983) and the *multistriatum*-group of the subgenus *Simulium* Latreille s. str. used by Rubtsov (1956) and Crosskey (1987) are each further divided into three and four species-groups. Descriptions for all new species and redescriptions for most known species are presented. Keys to the subgenera, most species-groups and species are provided for all known stages; for each species, brief notes are included on the distribution, aquatic habitats and biting habits in a few, and on the taxonomic affinities with related species.

# MATERIALS AND METHODS

For the present revisionary work, type specimens of most Javanese black fly species which de Meijere (1913) and Edwards (1934) had studied were borrowed for examination from the Instituut voor Taxonomische Zoologie, Amsterdam, The Netherlands (hereafter abbreviated as ZMA) and The Natural History Museum, London, U.K. (BMNH). Some pinned specimens from the Zoological Museum, Bogor (ZMB), the Bishop Museum, Honolulu, Hawaii, USA (BISHOP), U.S. National Museum, Washington D.C. (USNM), Australian National Museum, Canberra, Australia (ANM), were also examined. Additional specimens examined consisted of larvae, pupae and reared adults of black flies collected from Java by the authors in 1975, 1990 and 1991.

Collecting and rearing methods, as well as dissection of anatomical parts for description follow Takaoka (1983) and Davies and Györkös (1987a). Morphological features and terms used follow those of Crosskey (1969).

The holotype, allotype and some paratype specimens of the new species will be deposited in BISHOP, and other paratypes, as well as new specimens of some known species, at the Department

**Table I.** Checklist of the Simuliidae of Java.

| | |
|---|---|
| FAMILY | Simuliidae Newmann, 1834 |
| SUBFAMILY | Simuliinae Newmann, 1834 |
| TRIBE | Simuliini Newmann, 1834 |
| GENUS | *Simulium* Latreille, 1802 |
| SUBGENUS | *Nevermannia* Enderlein, 1921 |
| GROUP | *ruficorne* species-group |
| 1. | *aureohirtum* Brunetti, 1911 |
| GROUP | *vernum* species-group |
| 2. | *tosariense* Edwards, 1934 |
| 3. | *tjibodense* Edwards, 1934 |
| GROUP | *feuerborni* species-group |
| 4. | *feuerborni* Edwards, 1934 |
| SUBGENUS | *Gomphostilbia* Enderlein, 1921 |
| GROUP | *batoense* species-group |
| 5. | *atratum* de Meijere, 1913 |
| 6. | *sundaicum* Edwards, 1934 |
| 7. | *batoense* Edwards, 1934 |
| 8. | *friederichsi* Edwards, 1934 |
| 9. | *parahiyangum* Takaoka and Sigit, 1992 |
| GROUP | *ceylonicum* species-group |
| 10. | *gyorkosae* sp. nov. |
| 11. | *atratoide* sp. nov. |
| GROUP | *varicorne* species-group |
| 12. | *varicorne* Edwards, 1925 |
| SUBGENUS | *Simulium* s. str. Latreille, 1802 |
| GROUP | *striatum* species-group |
| 13. | *argyrocinctum* de Meijere, 1913 |
| GROUP | *eximium* species-group |
| 14. | *eximium* de Meijere, 1913 |
| 15. | *upikae* sp. nov. |
| 16. | *thienemanni* Edwards, 1934 |
| GROUP | *tuberosum* species-group |
| 17. | *sigiti* Takaoka and Hadi, 1991 |
| GROUP | *nobile* species-group |
| 18. | *nobile* de Meijere, 1907 |
| GROUP | *melanopus* species-group |
| 19. | *iridescens* de Meijere, 1913 |
| 20. | *javaense* Takaoka and Hadi, 1991 |
| UNGROUPED SPECIES | |
| 21. | *nebulicola* Edwards, 1934 |
| 22. | *celsum* sp. nov. |

of Parasitology and Pathology, Faculty of Veterinary Medicine, Bogor Agricultural University, and at the Department of Entomology, ZMB, Indonesia, and other museums aforementioned.

# SYSTEMATICS

The present study follows the classification of Crosskey (1987), who recognized many subgenera within the largest genus *Simulium* Latreille s.l. and also species-groups in certain subgenera. All the 22 Javanese simuliid species herein treated are assigned to the genus *Simulium* by having the characters as defined below.

## Genus *Simulium* Latreille

*Simulium* Latreille, 1802: 426. Type species: *Rhagio columbaschensis* Fabricius, 1787 [= *Oestrus colombacensis* Scopoli, 1780], by monotypy.

The genus *Simulium* is distinguished by the following combination of characters (Davies & Györkös, 1987a).

Adult antenna with 8 or 9 flagellomeres; anterior wing veins with spinules as well as hairs, radial sector not forked; hind basitarsus with well-developed calcipala and 2nd segment of hind tarsus with distinct pedisulcus; pupa with cocoon wall-pocket-, shoe-, or boot-shaped. Larva with hypostomal teeth rather low, median tooth not trifid, anal sclerite with posterior arms subequal to or longer than anterior arms.

This is a large cosmopolitan genus consisting of 45 subgenera (Crosskey, 1987), and the only genus found in the Oriental Region.

Herein included are only three subgenera, i.e., *Nevermannia* Enderlein, *Gomphostilbia* Enderlein and *Simulium* Latreille s. str., to which four, eight and 10 Javanese species are assigned, respectively (Table 1). These three subgenera are common, being the major element of the simuliid fauna in the Oriental Region, although the subgenus *Gomphostilbia* is also commonly distributed in the Australasian Region, specially Papua New Guinea, and the other two, for the most part, in the Holarctic Region.

The other six rather minor subgenera so far reported from the Oriental Region are not represented in Java i.e., *Byssodon* Enderlein from Sri Lanka (only 1 sp.) (Davies & Györkös, 1988b), *Eusimulium* Roubaud from Taiwan (1 sp.) (Shiraki, 1935), *Himalayum* Lewis from Afghanistan to Thailand (2 spp.) (Lewis, 1973; Takaoka & Suzuki, 1984), *Montisimulium* Rubtsov from Taiwan (1 sp.) (Takaoka, 1979), India (2 spp.) (Datta, 1973, 1975b) and Myanmar (1 sp.) (Takaoka, 1989), *Morops* Enderlein from the Philippines (8 spp.) (Takaoka, 1983), Sulawesi (1 sp.) (Takaoka & Roberts, 1988) and Sri Lanka (1 sp.) (Davies & Györkös, 1988a), and *Wallacellum* Takaoka from the Philippines (8 spp.) (Takaoka, 1983), the Ryukyus and Lan-yu Is (1 sp.) (Takaoka, 1972; Chung, 1986).

### Key to Subgenera of Simuliidae of Java

**Adult females**

1. Katepisternum haired ..... ***Gomphostilbia***
–. Katepisternum bare ..... 2
2. Tarsal claw with large basal tooth ..... ***Nevermannia***
–. Tarsal claw simple or with small subbasal tooth. ..... ***Simulium*** s. str.

**Adult males**

1. Katepisternum haired ..... ***Gomphostilbia***
–. Katepisternum bare ..... **2**
2. Basal section of radius haired ..... ***Nevermannia***
–. Basal section of radius bare ..... ***Simulium*** s. str.

**Pupae**

1. Gill with 8 or 10 filaments arranged in 3+3+2 (rarely 2+4+2) or 3+3+2+2 from dorsal to ventral; grapnel-like hooklets present on last abdominal segment ..... ***Gomphostilbia***
–. Gill with 4, 6, 9 or 10 filaments arranged in pairs; grapnel-like hooklets absent on last abdominal segment ..... **2**
2 Cocoon with anterodorsal projection ..... ***Nevermannia***
–. Cocoon simple wall-pocket-shaped or shoe-shaped ..... ***Simulium*** s. str.

**Larvae**

1. Last abdominal segment lacks ventral papillae ..... ***Simulium*** s. str.
–. Last abdominal segment with ventral papillae ..... **2**
2. Postgenal cleft shorter than postgenal bridge; lateral serrations of hypostomium developed ..... ***Nevermannia***
–. Postgenal cleft longer than postgenal bridge; lateral serrations of hypostomium undeveloped ..... ***Gomphostilbia***

### (i) Subgenus *Nevermannia* Enderlein

*Nevermannia* Enderlein, 1921: 199. Type species: *Simulium annulipes* Becker, 1908 [= *Simulium ruficorne* Macquart, 1838], by original designation.

This subgenus consists of four species-groups, i.e., *loutetense*-group, *ruficorne*-group, *vernum*-group and *feuerborni*-group (Crosskey, 1987). The diagnostic characters of the first three species-groups were already given by Crosskey (1969) and that of the last, by Datta (1973). In Java, this subgenus is represented by 4 species which are placed in the last three species-groups.

#### Keys to Javanese Species of *Simulium (Nevermannia)*

**Adult females**

1. Antenna yellow with at least 1st flagellomere darkened; hind tibia yellow on basal 1/2, dark on distal 1/2, and with subbasal dark ring ..... ***aureohirtum***
–. Antenna almost all darkened except a few basal segments pale; hind tibia nearly all brown ..... **2**
2. Scutum reddish brown in ground color, with 3 longitudinal vittae ..... ***feuerborni***
–. Scutum brownish black in ground color, without longitudinal vittae ..... ***tosariense*** or ***tjibodense***

**Adult males**

1. Antenna yellow or yellowish brown with 1st flagellomere darkened; hind basitarsus slender, parallel-sided, much narrower than hind tibia. ..... ***aureohirtum***
–. Antenna almost all darkened; hind basitarsus inflated, spindle-shaped, at its

widest as wide as or slightly wider than that of hind tibia (Figs. 5, 27) ..... 2
2. Paramere with 3 or 4 parameral hooks (Fig. 25) ..... *feuerborni*
–. Paramere with a single parameral hook (Fig.11d) ..... *tosariense* and *tjibodense*

**Pupae**

1. Gill with 4 filaments ..... 2
–. Gill with 6 filaments ..... 3
2. Gill filaments with rather long stalks (Fig. 13) ..... *tjibodense*
–. Gill filaments with stalks of moderate length (Fig. 6) ..... *tosariense*
3. All filaments extending forwards close together; lower 2 filaments with rather long stalk (Fig. 31) ..... *feuerborni*
–. All filaments diverging widely from base; lower 2 filaments with short stalk ..... *aureohirtum*

**Larvae**

1. Abdomen with characteristic reddish brown markings dorsally (Fig. 35) ..... *feuerborni*
–. Abdomen without such markings dorsally ..... 2
2. Mandibular serrations composed of 2 well developed teeth and without supernumerary serrations on each side ..... *aureohirtum*
–. Mandibular serrations composed of 1 well developed and 1 small teeth and with supernumerary serrations on each side (Fig. 7) ... ..... *tosariense* (also probably *tjibodense*)

### (A) *ruficorne*-group

**1. *Simulium (Nevermannia) aureohirtum*** Brunetti, 1911

*Simulium aureohirtum* Brunetti 1911: 283–88 (male); Edwards, 1934: 134–37 (female, pupa and larva).
*Simulium (Nevermannia) aureohirtum*: Ogata, 1956: 61–62; Ogata, 1966: 129; Crosskey, 1987: 459; Takaoka and Roberts, 1988: 194–95.
*Simulium (Eusimulium) aureohirtum*: Puri, 1933: 1–7; Ogata and Sasa, 1954: 325; Ogata, Sasa and Suzuki, 1956: 73; Crosskey, 1973: 423; Takaoka, 1976: 170–71; Takaoka, 1979: 382–84; Datta, 1983: 225; Takaoka and Suzuki, 1984: 11–12.
*Eusimulium aureohirtum*: Orii, Uemoto and Onishi, 1969:1–13
*Simulium (Eusimulium) tuaranense* Smart and Clifford, 1969: 40–43. Syn. by Crosskey 1973.
*Simulium (Eusimulium) philippinense* Delfinado 1962: 47–62. Syn. by Takaoka 1983.

This species is widely distributed in the Oriental Region and parts of the Palaearctic Region, and has been assigned to the *ruficorne*-group by Crosskey (1969). The female, pupa and larva of this species were already reported from West Java and Sumatra by Edwards (1934). The morphology of the male specimens obtained in this study from Java agrees with the description of this species given by Takaoka (1979) and Takaoka and Roberts (1988) except that the scutellum of the Javanese specimens bears golden yellow long hairs instead of brown hairs. There is a slight difference in the shape of the style between the present specimens and the Indian type specimen. When viewed laterally and posteriorly, the style of the Javanese males is broad and appears to be boot-shaped with a subtriangular inner dorsal end, like those of Taiwan and Philippine specimens (Takaoka, 1979, 1983), whereas the type male has a broad and square-ended style, according to the description and illustration given by Edwards (1934).

**SPECIMENS EXAMINED.** WEST JAVA: 4 ♀, 4 ♂, all pinned with their pupal exuviae and cocoon, 5 pupae,

6 pupal exuviae and 8 mature larvae, Cibodas Botanic Garden, 18.XII.1975, D.M. Davies; 2 ♀, 4 ♂, all reared from pupae, and 4 mature larvae, Pengalengan, between Bandung and Santosa, 29.XII.1990, H. Takaoka; 1♂, pinned, Cilengsar, 16–19.VI.1937, J. Westernberg (ZMA).

**ECOLOGICAL NOTES.** In Cibodas Botanic Garden, pupae and larvae were collected from trailing grasses in a small stream 23–30 cm wide at outlet of small warm pond, and from another stream 3–5 m wide with moderate to fast flow, exposed to the sun. Water temperature was 21 °C and 19 °C respectively. They were also found on fallen leaves in small man-made channels (ca. 20 cm wide) irrigating rice paddies in the mountainous valley of Pengalengan.

This species was reported to be autogenous in several areas of Asian countries (Takaoka & Noda, 1979; Takaoka & Suzuki, 1984). However, no data were made available to confirm this phenomenon in the Javanese populations.

**DISTRIBUTION.** Borneo, China, India, Japan, Java, Philippines, Sri Lanka, Sulawesi, Sumatra, Thailand, Taiwan.

### (B) *vernum*-group

### 2. *Simulium (Nevermannia) tosariense* Edwards, 1934 Figs. 1–9

*Simulium latipes* Meigen var. *tosariense* Edwards, 1934: 132–34 (female, male, pupa and larva).
*Simulium (Eusimulium) tosariense*: Crosskey, 1973: 424; Datta, 1983: 228.
*Simulium (Nevermannia) tosariense*: Crosskey, 1987: 462; Crosskey and Lowry, 1990: 231.

This species was originally described from East Java (Edwards, 1934) and was assigned to the *vernum*-group (Crosskey, 1987). The female, male, pupae and mature larvae (paralectotype, BMNH) were examined and full descriptions are given here except the male genitalia, which were not made available in the loaned pinned specimen. Fortunately, male genitalia of this species were well illustrated in Edwards (1934).

**FEMALE.** ***Head.*** Narrower than thorax. Frons and clypeus brownish black, not shiny, whitish grey pruinose, moderately covered with yellow pubescence. Frontal ratio 1.8:1.0:2.3. Frons-head ratio 1.0:5.2. Antenna composed of 2+9 segments, brownish black except scape and pedicel reddish brown. Maxillary palp brownish black, composed of 5 segments, proportional lengths of 3rd, 4th and 5th segments 1.0:0.8:1.5; 3rd segment (Fig. 1) much enlarged, with elongated sensory vesicle (Fig. 1), 2.5–3.0 × as long as its width, 0.57 × length of 3rd segment. Maxilla with 15 inner teeth and 17 or 18 outer ones. Mandible with ca. 40 inner teeth and 17 outer ones. Cibarium without any denticles. ***Thorax.*** Scutum brownish black, thinly whitish grey pruinose, densely covered with yellow recumbent pubescence, intermixed with dark erect hairs on prescutellar area. Scutellum dark brown, whitish grey pruinose, with yellow pubescence and several erect dark hairs. Postscutellum dark brown, whitish grey pruinose, bare. Pleural membrane and katepisternum bare. ***Legs.*** All coxae dark brown. All trochanters pale brownish yellow with fore trochanter dark brown. All femora pale brownish yellow or pale brown with distal portion dark brown. Fore tibia brown, mid and hind tibiae pale brownish yellow with distal 1/3 of mid and distal 1/4 of hind tibiae dark brown. All tarsi dark brown to brownish black. Fore basitarsus slender, not dilated. Hind basitarsus parallel-sided. Calcipala and pedisulcus well developed. Claws each with large basal tooth. ***Wing.*** Costa with 2 parallel rows of short spines and hairs. Subcosta fully haired. Basal portion of radius fully haired. Hair tuft at stem vein dark brown. ***Abdomen.*** Basal scale pale brownish yellow with fringe of pale yellow hairs. Dorsal surface of abdomen brownish black, with dark short hairs. ***Genitalia*** (Figs. 3, 4). Sternal plate of 7th abdominal segment wide, uniformly covered with hairs except along middle longitudinal line widely bare. Sternite 8 bare medially but furnished with ca. 20 hairs on each side. Anterior gonapophyses thin, membraneous, triangular, with a few short setae; inner border narrowly sclerotized, posteromedian corner rounded and transparent. Genital fork with well sclerotized stem and wide arms; arms converge posteriorly with well sclerotized ridge, lack any prominent projection directed forward. Spermatheca ovoid, strongly sclerotized, with retic-

ulate pattern but no internal hairs. Paraproct in lateral view much shorter than wide, produced ventrally, with ca. 16 stout hairs on outer surface. Cercus subtriangular, though posterior margin gently rounded, ca. 0.6 × as long as its width, moderately setose.

**MALE.** ***Head.*** As wide as or slightly narrower than thorax. Holoptic, upper eye consisting of large facets in 19 vertical columns and 22 horizontal rows. Clypeus black, whitish grey pruinose, covered with numerous long brown hairs and several short yellow hairs. Antenna composed of 2+9 segments, brownish black with base of lst flagellar segment light brown; lst flagellomere elongated, ca. 2 × as long as 2nd flagellomere. Maxillary palp black, with 5 segments; proportional lengths of apical 3 segments 1.00:0.75:1.50; sensory vesicle (Fig. 2) oblong, ca. 2 × as long as wide, ca. 0.2 × length of 3rd segment. ***Thorax.*** Scutum black, not shiny, broadly whitish grey pruinose along anterior margin and on prescutellar area in certain angles of light, densely covered with yellow recumbent pubescence, intermixed with several concolored long hairs on prescutellar area. Scutellum brown, white pruinose, with several dark erect hairs as well as yellow pubescence. Postscutellum brownish black, white pruinose, bare. Pleural membrane and katepisternum bare. ***Legs.*** Brown to brownish black. Fore basitarsus cylindrical, ca. 9.1 × as long as its greatest width. Hind basitarsus (Fig. 5e) enlarged, spindle-shaped, L:W = 3.8:1.0, nearly as wide as width of hind tibia, but slightly narrower than width of hind femur. Calcipala and pedisulcus well developed. ***Wing.*** As in ♀. ***Abdomen.*** Basal scale brown with fringe of long, pale yellow and brown hairs. Dorsal surface of abdomen brownish black, not shiny, with short brown hairs.

**PUPA.** Body length (excluding gill filaments) ca. 4 mm. ***Head*** and ***thorax***. Integument dark yellow to yellowish brown, very sparsely covered with small tubercles. Head with 4 pairs of simple, long trichomes. Thoracic trichomes 5 pairs, all long and simple. Gill (Fig. 6) with 4 slender filaments, arranged in pairs, slightly longer than pupal body; all filaments subequal in thickness, tapered apically, with numerous transverse ridges, covered with minute tubercles; secondary stalks of moderate length but longer, to varying degrees, than common stalk, making angle of approximately 60° between them. ***Abdomen.*** Terga 1 and 2 yellow, weakly tuberculate; tergum 1 with slender seta on each side; tergum 2 with 1 long and a few short setae on each side. Terga 3 and 4 each with 4 hooked spines directed forward along posterior margin and 1 short seta on each side. Terga 5–8 each with transverse row of spine-combs sided by comb-like groups of very minute spines. Terga 5–7 each with short seta on each side. Tergum 9 with comb-like groups of very minute spines and pair of stout cone-like terminal hooks. Sterna 3–8 each with comb-like groups of very minute spines; sternum 5 with pair of bifid hooks situated close together, on each side; sterna 6 and 7 each with pair of inner bifid and outer simple hooks widely spaced, on each side. ***Cocoon.*** Wall-pocket-shaped, tightly woven, extending ventrolaterally, with very long anterodorsal projection, which is usually curved downward.

**MATURE LARVA.** Body length 7.2 mm. Body color greyish yellow. Cephalic apotome yellow with definite positive head spots. Antenna longer than labral fan stem, with 3 segments and apical sensillum; proportional lengths of 3 segments from base to tip 1.9:1.9:1.0. Labral fan with 35 main rays. Mandible with additional minute serration (Fig. 7c), as well as usual 2 mandibular serrations (Fig. 7b); comb-teeth (Fig. 7a) composed of 3 teeth, of which 1st tooth much longer and thicker than others. Hypostomium (Fig. 8a) with row of 9 apical teeth (Fig. 8b), of which each corner tooth and the median tooth are moderately developed; lateral serrations (Fig. 8c) well developed; 5 hypostomal setae (Fig. 8d) lying parallel to lateral margin on each side. Postgenal cleft (Fig. 8e) shallow, rounded anteriorly, ca. 0.7 × as long as postgenal bridge (Fig. 8f). Thoracic cuticle bare. Abdominal cuticle bare except dorsolateral surface of last segment with numerous colorless setae on each side of anal sclerite. Rectal papilla (Fig. 9) compound, each of 3 lobes with 5 or 6 lobules, most of which finger-like but distal 1 or 2 short, thumb-like. Anal sclerite of usual X-form, posterior arms ca. 1.5 × as long as anterior ones; basal portion of arms widely sclerotized. Accessory sclerite absent. Ventral papillae well developed. Posterior circlet with about 86 rows of up to 16 hooks each.

**SPECIMENS EXAMINED.** EAST JAVA: 1 ♀, 1♂ pinned (both paralectotype, BMNH 1931-554) (head and abdomen of both sexes and fore and hind legs of male were removed and mounted on slides; abdominal tip was not available in the male specimen), 4 pupae, 1 pupal exuvia and 2 mature larvae in alcohol (BMNH) (1 pupa and 1 larva were dissected and mounted on slides), all collected from Tosari, II. 1922, by D. Friederichs.

**DISTRIBUTION.** East Java.

**REMARKS.** The *vernum*-group is primarily distributed in the Holarctic Region and also extends into the Oriental Region. So far, six other species of this species-group have been recorded from Taiwan, Philippines, Myanmar and India. *Simulium (N.) tosariense* appears to be somewhat closely related to *S. (N.) yushangense* from Taiwan (Takaoka, 1979) and *S. (N.) purii* from India (Datta, 1973) by having the cocoon with a long anterodorsal projection, but is differentiated from the former by the arrangement of the pupal gill filaments and the absence of an accessary sclerite in the larva, and from the latter by the shape of the female genital fork and cercus.

*Simulium (N.) burmense* was recently described from female specimens from Myanmar (Takaoka, 1989). However, this species differs from *S. (N.) tosariense* by the presence of whitish pruinose spots on the scutum, the shape of genital fork and cercus.

The three other species, i.e., *S. (N.) taulingense* from Taiwan (Takaoka, 1979), *S. (N.) aberrans* from the Philippines (Takaoka, 1983), and *S. (N.) gracile* from India (Datta, 1973) differ from the present species by the arrangement of the pupal gill and the shape of the cocoon.

### 3. *Simulium (Nevermannia) tjibodense* Edwards, 1934 — Figs. 10–13

*Simulium latipes* Meigen var. *tjibodense* Edwards, 1934: 134 (female, male, pupa and larva).
*Simulium (Eusimulium) tjibodense*: Crosskey, 1973: 424
*Simulium (Nevermannia) tjibodense*: Crosskey,1987: 462; Crosskey and Lowry, 1990: 231

*Simulium (N.) tjibodense* was originally described from female, male, pupal and larval specimens collected in Mt. Gede, Cibodas, West Java (Edwards, 1934). The lectotype pharate adult male and associated pupal exuvia on slide (BMNH), which are the only material left, were examined.

**MALE.** ***Head.*** Holoptic, upper eye consisting of large facets in 17 vertical columns and 18 horizontal rows. Clypeus covered with dark hairs as well as yellowish ones. Antenna dark brown, 1st flagellar segment elongated, ca. 2 × length of 2nd flagellomere. Maxillary palp black, with 5 segments, proportional lengths of apical 3 segments 1.00:0.95:2.00; sensory vesicle small, elliptical (Fig. 10). ***Genitalia*** (Figs. 11, 12). Coxite longer than wide. Style slightly shorter than coxite, gently rounded apically, produced beyond level of apical spine. Ventral plate large, broad, setose posteromedially, without median keel. Parameres each with single hook. Median sclerite Y-shaped.

**PUPA.** Thoracic integument sparsely covered with small tubercles. Gill (Fig. 13) with 4 slender filaments, with long secondary stalks, 1.5–2.0 × length of common stalk; all filaments subequal in thickness, covered with numerous transverse ridges and with minute tubercles. ***Abdomen.*** As in *S. (N.) tosariense*.

**SPECIMENS EXAMINED.** WEST JAVA: Lectotype pharate adult ♂, associated with pupal exuvia on slide (lectotype designated by R. W. Crosskey, BMNH), Cibodas, Mt. Gede, Cilwong spring, 17.VII.1929, A. Thienemann.

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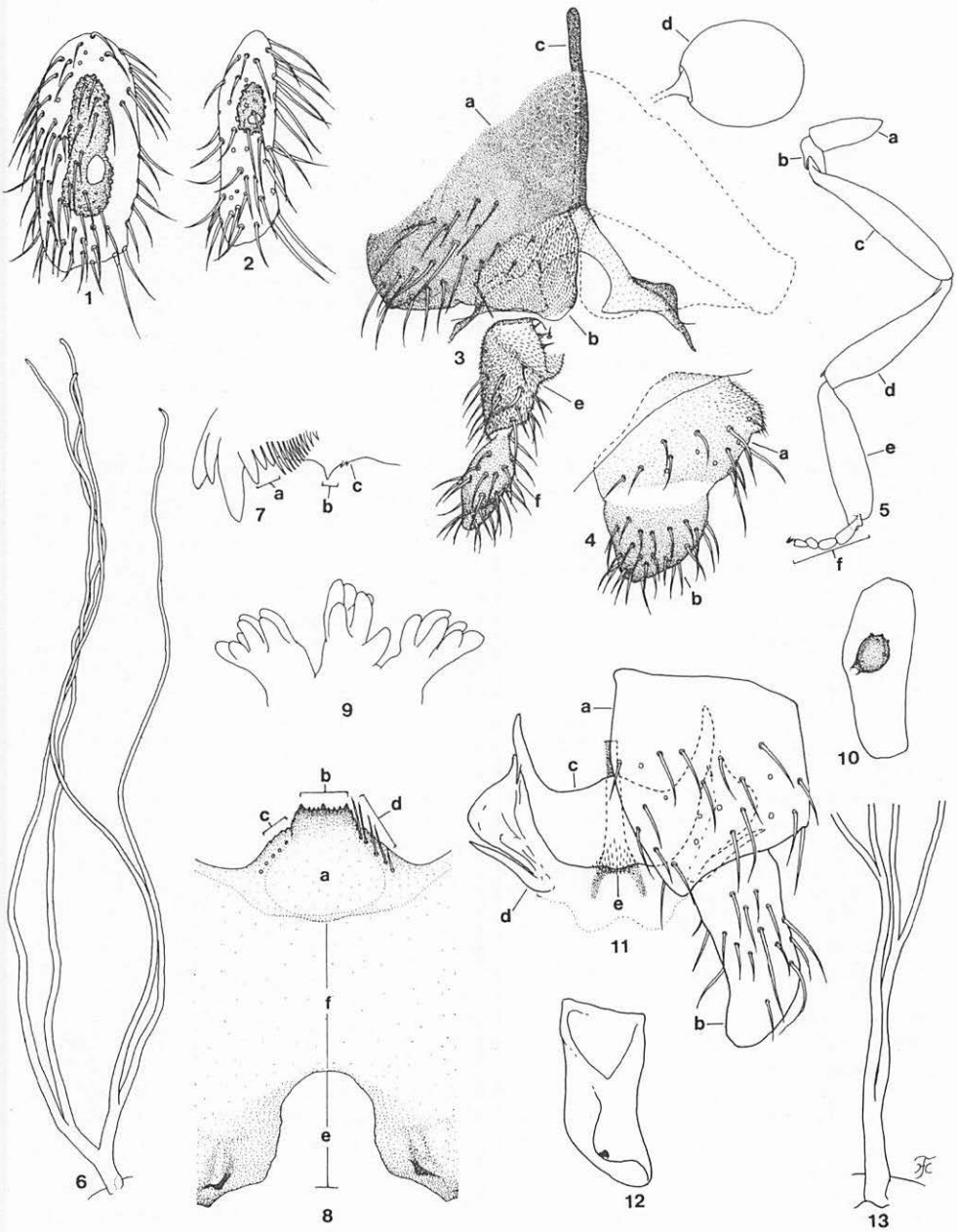
**Figs. 1–9.** *Simulium (Nevermannia) tosariense.* **1** and **2**, 3rd segments of maxillary palp with sensory vesicle (1, ♀; 2, ♂); **3**, ♀ genitalia *in situ* (ventral view), showing 8th sternite (a), anterior gonapophyses (b), genital fork (c), spermatheca (d), paraproct (e) and cercus (f); **4**, lateral view of paraproct (a) and cercus (b); **5**, ♂ hind leg showing coxa (a), trochanter (b), femur (c), tibia (d), basitarsus (e), and tarsal segments 2-5 (f); **6**, pupal gill filaments (from right side); **7**, tip of larval mandible showing comb-teeth (a), mandibular serration (b) and supernumerary serrations (c); **8**, larval head capsule (ventral view) showing hypostomium (a), apical teeth (b), lateral serrations (c), hypostomal setae (d), postgenal cleft (e) and postgenal bridge (f); **9**, larval rectal papilla of 3 lobes each with 6 or 7 secondary lobules.

**Figs. 10–13.** *S. (N.) tjibodense.* **10**, 3rd segment of ♂ maxillary palp with sensory vesicle (side view); **11**, ♂ genitalia (ventral view) showing coxite (a), style (b), ventral plate (c), paramere (d) and median sclerite (e); **12**, style (dorsal view); **13**, pupal gill filaments.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**DISTRIBUTION.** West Java.

**REMARKS.** This species was assigned to the *vernum*-group (Crosskey, 1987), and is distinguished from other related species among the group by having the very long secondary stalks on the pupal gill (Fig. 13).

## (C) *feuerborni*-group

### 4. *Simulium (Nevermannia) feuerborni* Edwards, 1934 Figs. 14–35

*Simulium feuerborni* Edwards, 1934: 129–32 (male, pupa and larva).
*Simulium (Eusimulium) feuerborni*: Crosskey, 1973: 424; Datta, 1973: 226.
*Simulium (Nevermannia) feuerborni*: Crosskey, 1987: 458.

This species was originally described based on the male, pupal and larval specimens from East Java and Bali (Edwards, 1934). The male, pupa and mature larva collected from West Java agree well with original descriptions. The female of this species is described for the first time. In addition, the male, pupa and mature larva are redescribed to supplement the original descriptions in which some important characters were not mentioned.

This is the type species of the *feuerborni*-group (Datta, 1973) and the only species in this species-group from Java.

**FEMALE.** Body length 2.8–3.0 mm. ***Head.*** Narrower than thorax. Frons and clypeus brownish black, thickly whitish grey pruinose, densely covered with whitish yellow pubescence, intermixed with sparse dark hairs. Frontal ratio 1.4:1.0:2.3. Fronto-ocular area (Fig. 16) well developed. Frons-head ratio 1.0:5.4. Antenna composed of 2+9 segments, dark brown except scape, pedicel and base of 1st flagellar segment yellow. Maxillary palp brownish black with 5 segments, proportional lengths of 3rd, 4th and 5th segments 1.0:0.8:1.6; 3rd segment (Fig. 14) somewhat enlarged, with elongated sensory vesicle, ca. 2.5 × as long as its width, 0.56 × length of 3rd segment. Maxilla with 10–11 inner teeth and 13 outer ones. Mandible with ca. 22 inner teeth and lacking outer teeth. Cibarium lacking denticles. ***Thorax.*** Scutum reddish brown, whitish grey pruinose, with 3 longitudinal dark vittae, densely covered with whitish yellow recumbent pubescence, intermixed with dark erect hairs on prescutellar area. Scutellum light brown, whitish grey pruinose, with whitish yellow pubescence and several erect dark hairs. Postscutellum brown, whitish grey pruinose, bare. Pleural membrane and katepisternum bare. ***Legs.*** All coxae and trochanters yellow except mid coxa dark brown. All femora yellow with apical tip brown, densely covered with whitish yellow hairs. All tibiae brown except middle having large portion dark yellow to light brown, densely covered with whitish yellow hairs. All tarsi dark brown except basal 2/3 of hind basitarsus greyish (though extreme base dark brown) and basal 1/2 of hind 2nd tarsal segment yellow. Fore basitarsus slender, cylindrical, ca. 7.3 × as long as its greatest width. Hind femur slightly wider than hind tibia (Fig. 26). Hind basitarsus (Fig. 26) parallel-sided. Calcipala and pedisulcus well developed (Fig. 28). Claws (Fig. 30) each with large basal tooth 0.42 × length of claw. ***Wing.*** Length 2.9–3.2 mm. Costa with 2 parallel rows of short spines as well as hairs. Subcosta fully haired. Basal portion of radius fully haired. Hair tuft at stem vein dark brown. ***Abdomen.*** Basal scale light brown with fringe of whitish yellow hairs. Dorsal surface of 2nd segment pale, somewhat pruinose in certain lights; rest of abdominal segments brown, with pale and dark short hairs; tergites 7–9 semishiny. ***Genitalia*** (Figs. 17–19). Sternal plate of 7th abdominal segment wide, uniformly covered with hairs except along middle longitudinal line widely bare. Sternite 8 bare medially, furnished with ca. 30 stout hairs on each side. Anterior gonapophysis thin, membraneous, triangular, with 5 short setae; inner border narrowly sclerotized, posteromedian corner rounded, transparent. Genital fork with well sclerotized stem and wide arms; arm with stout, distinct projection directed forward and rounded projection directed posteromedially. Spermatheca ovoid, strongly sclerotized, with reticulate pattern, but no internal hairs. Paraproct in lateral view slightly shorter than wide, not produced under cercus, with ca. 28 stout hairs. Cercus rounded, 0.5 × as long as wide, moderately setose.

**MALE.** Wing length 2.8–3.0 mm. ***Head.*** Wider than thorax. Holoptic, upper eye consisting of large facets in 16

vertical columns and 17 or 18 horizontal rows. Clypeus brownish black, whitish grey pruinose, with whitish yellow hairs and dark ones. Antenna composed of 2+9 segments; flagellar segments, when viewed from above, dark yellow or pale brown with base of 1st flagellomere pale yellow, but entirely yellow becoming somewhat darker toward tip when viewed from below; scape and pedicel always dark brown; lst flagellomere narrowed basally, elongate, ca. 2.5 × as long as wide, ca. 2.2 × as long as 2nd flagellomere. Maxillary palp with 5 segments; proportional lengths of apical 3 segments 1.0:1.0:1.5; sensory vesicle (Fig. 15) small, globular. ***Thorax***. Scutum reddish brown with 3 dark longitudinal vittae, not shiny, densely covered with yellow (or bright golden yellow in certain lights) recumbent pubescence, intermixed with several dark erect hairs on prescutellar area; scutum white pruinose, when viewed at certain angles. Scutellum reddish brown, white pruinose, with several dark erect hairs as well as yellow (or bright golden in lights) pubescence. Postscutellum dark brown, white pruinose, somewhat iridescent, bare. Pleural membrane and katepisternum bare. ***Legs***. All coxae and trochanters yellow with posterolateral surface of mid coxa dark brown. All femora yellow with apical 1/5 dark brown, covered almost entirely with yellow hairs. All tibiae dark brown with median large portion somewhat greyish, base of hind tibia yellow; all tibiae covered densely with yellow hairs on basal 1/2 or more. All tarsi brownish black with median large portion of hind basitarsus greyish brown, basal 1/2 of 2nd hind tarsal segment pale. Fore basitarsus cylindrical, ca. 8.6 × as long as its greatest width. Hind basitarsus (Fig. 27) spindle-shaped, nearly as wide as width of hind tibia, but slightly narrower than width of hind femur. Calcipala and pedisulcus well developed. ***Wing***. As in ♀; length 2.8–3.0 mm. ***Abdomen***. Basal scale brown with fringe of long yellow hairs. Dorsal surface of abdomen brownish black, not shiny, with short yellow and dark hairs; 2nd segment whitish pruinose, iridescent dorsolaterally when viewed at certain angles. ***Genitalia*** (Figs. 20–25). Coxite large, much longer than wide, ca. 1.4 × as long as style. Style short, curved inward, abruptly narrowed on apical 1/2 when viewed posteriorly, with stout apical spine. Ventral plate lamellate, ca. 0.5 × as long as wide, setose widely on ventral and posterior surface; posterior margin of ventral plate, when viewed ventrally, undulating as in Fig. 20 but widely concave (Fig. 22) when viewed in slightly oblique angle; arms short, converged. Paramere with 3 (or 4) distinct parameral hooks. Median sclerite simple, rod-shaped.

**PUPA**. Body length (excluding gill filaments) ca. 4 mm. ***Head*** and ***thorax***. Integument dark yellow to yellowish brown, moderately covered with small tubercles. Head with 3 pairs of simple, short trichomes; facial pair much longer than frontal pair which are very short and slender. Thoracic trichomes 6 pairs, all long and simple. Gill (Fig. 31) with 6 slender filaments, lying close together, slightly longer than pupal body (4.0–5.0 mm long); gill filaments composed of 4 filaments in dorsal and ventral pairs and 2 isolated middle filaments; ventral paired filaments with stalk of moderate size (0.6–1.0 mm long), dorsal paired filaments bearing very short stalk (occasionally almost sessile); 2 middle filaments arising individually from inside and outside surface of common stalk, usually lying very close to 2 dorsal paired filaments, then appearing as in Fig. 32 when viewed from above; lower 2 paired filaments slightly shorter and thinner than other 4 filaments, which are subequal in thickness; all filaments tapered apically, with numerous transverse ridges, covered with minute tubercles. ***Abdomen***. Terga 1 and 2 yellow, weakly tuberculate; tergum 1 with single slender seta on each side; tergum 2 with 6 short setae on each side. Terga 3 and 4 each with 4 hooked spines directed forward along posterior margin and 2 short setae (1 of 2 setae minute) on each side. Terga 5–8 each with comb-like groups of very minute spines and spine-combs, though number of spine-combs on tergum 5 varying from 0 to 2, on each side. Terga 5–7 each with short seta on each side. Tergum 9 with comb-like groups of very minute spines and pair of stout cone-like terminal hooks. Sterna 3–8 each with comb-like groups of very minute spines; sternum 5 with pair of bifid hooks situated close together on each side; sternum 6 with pair of inner bifid and outer simple hooks widely spaced on each side;sternum 7 as in sternum 6 except outer hook often replaced by slender seta. ***Cocoon***. Wall-pocket-shaped, thinly woven, extending ventrolaterally, with anterodorsal projection of moderate size.

**MATURE LARVA**. Body length 7.0–8.0 mm. Cephalic apotome pale with marked brownish head spots; lateral surface of head capsule pale, with 2 large dark spots behind eye spots and 4 isolated dark spots (1 in eye brow and other 3 below eye spots); ventral surface of head capsule largely darkened medially, with 2 pairs of dark spots posterolaterally. Antenna composed of 3 segments and apical sensillum, longer than stem of labral fan; proportional lengths of basal 3 segments 1.0:0.9:0.6. Labral fan with 22–26 main rays. Mandible (Fig. 33) with comb teeth decreasing in size from 1st to 3rd teeth; no mandibular serrations composed of a large and a small tooth and supernumerary serrations. Hypostomium (Fig. 34) with row of 9 apical teeth; median tooth as long as corner tooth on each side, much longer than 3 intermediate teeth on each side; lateral margin serrate apically;

hypostomal setae 7 or 8 lying parallel to lateral margins. Postgenal cleft (Fig. 34) small, of irregular form, 0.37–0.43 × as long as postgenal bridge. Body pale with characteristic markings dorsally (Fig. 35) and laterally as follows: thorax with light tawny transverse band just after head capsule; abdominal segments 1 and 2 each with pair of reddish brown small spots laterally; segments 3 and 4 each with pair of large reddish brown spots of rather irregular form dorsally, sometimes divided into anterior and posterior portions, also with pair of reddish brown spots laterally sometimes contiguous to dorsal spots; segment 5 dorsally with pair of large reddish brown spots close together near base and pair of large spots somewhat spaced posteriorly; segment 6 dorsally with 2 pairs of large spots, each anteriorly and posteriorly; segments 7 and 8 usually pale above, with faint sublateral longitudinal markings; all these markings of variable intensity, although those on abdominal segments 3 and 4 often stronger than others. Thoracic cuticle bare. Abdominal cuticle bare except sides on anal sclerite of last segment covered with numerous colorless setae. Rectal papilla compound, each of 3 lobes with 11–16 slender, finger-like secondary lobules. Anal sclerite of usual X-form, with anterior arms slightly shorter than posterior ones. Ventral papillae well developed. Posterior circlet with ca. 90 rows of up to 16 hooklets per row.

**SPECIMENS EXAMINED.** EAST JAVA: Holotype ♂, pinned, Tosari (BMNH). WEST JAVA: 8 ♀, 9 ♂, all pinned with associated pupal exuviae, 3 pupal skins and 2 mature larvae, Cibodas Botanic Garden, 17.XII.1975, D.M. Davies; 9 ♀, 3 ♂, all reared from pupae, 4 pupae, 8 pupal exuviae and 3 mature larvae, all in alcohol, Tugu, near Puncak Pass, 11.I.1991, H. Takaoka & U.K. Hadi; 4 ♀, 1 ♂, reared from pupae, 1 pupa, 2 pupal exuviae and 3 mature larvae, all in alcohol, Santosa, south of Bandung, 29.XII.1990, H. Takaoka. BALI: 2 pupae and 3 larvae in alcohol (paratypes, BMNH).

**ECOLOGICAL NOTES.** Pupae and larvae of this species were collected from small to medium-sized man-made streams (10–50 cm wide) shaded or exposed to the sun, in the open fields near the natural forests (900–1200 m in altitude).

**DISTRIBUTION.** West Java (new record), East Java and Bali.

**REMARKS.** The female of this species, which is here described for the first time, shows similarities to that of *S. (N.) praelargum* Datta, 1973 from India in many features including the 8th sternite with ca. 30 macrosetae on each side. However, there are differences in the shape of the genital fork and cercus. The arms of genital fork are wide in this species (Fig. 17) but narrow in *S. (N.) praelargum*. The cercus of *S. (N.) feuerborni* is rounded posteriorly (Fig. 19) but that of the latter species seems to be subtriangular in lateral view. A close examination of the male genitalia of *S. (N.) feuerborni* shows that the ventral surface of the ventral plate is widely covered with minute setae (Fig. 22) (not only in the middle as stated in the original description). It is also shown that the distinct parameral hooks are relatively few in number (i.e., 3 or 4), as compared with other related species (e.g., 6–9). In addition, the arrangement of the pupal respiratory filaments is shown to be very similar to that of *S. (N.) praelargum* described by Datta (1973) in that the dorsal pair of filaments are usually short stalked, and the 2 middle filaments arise individually from the common stem, as shown in Fig. 32.

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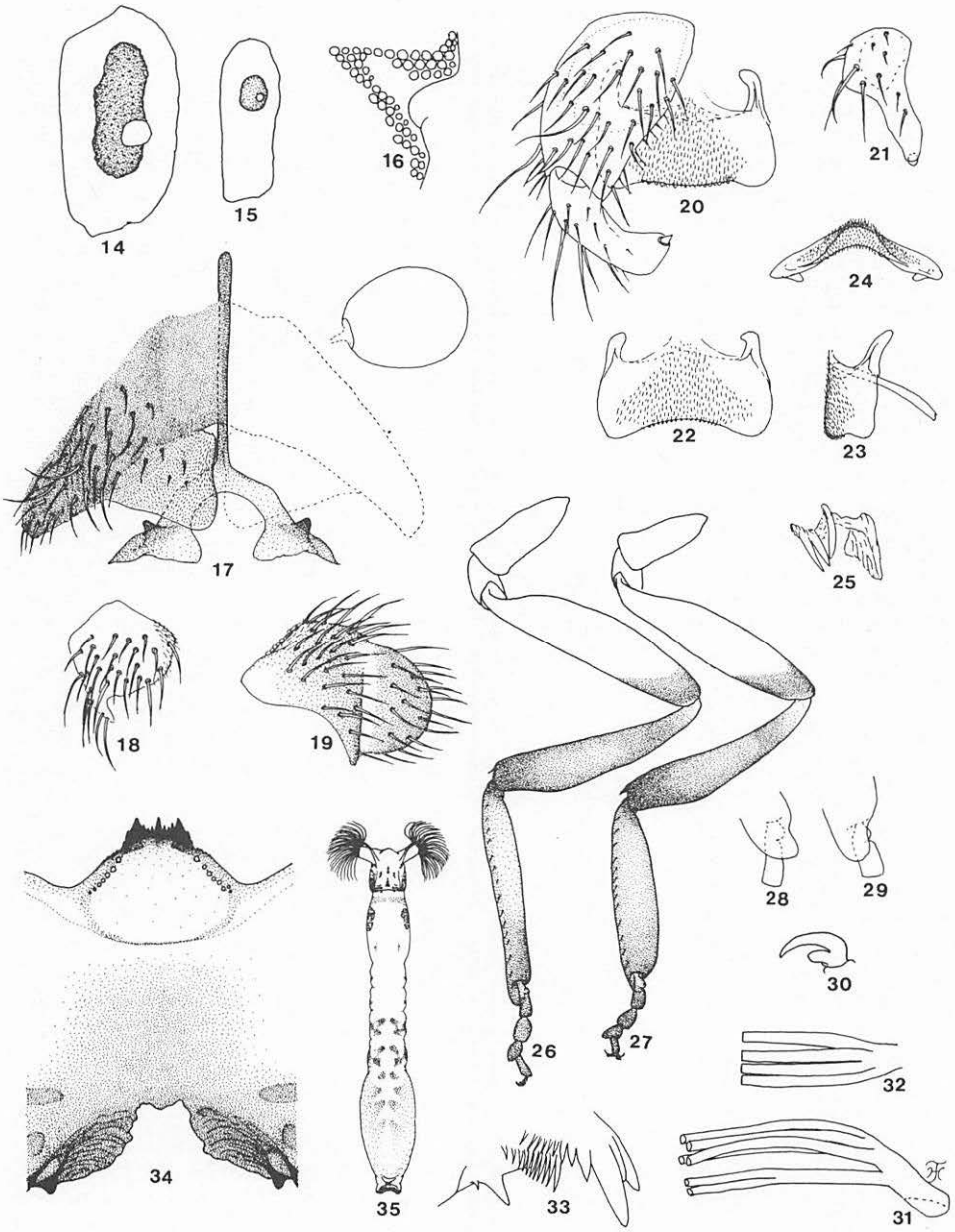
**Figs. 14–35.** *Simulium (Nevermannia) feuerborni*. **14** and **15**, 3rd segments of maxillary palp (14, ♀; 15, ♂); **16**, fronto-ocular area of ♀; **17**, ♀ genitalia except paraproct and cercus *in situ* (ventral view); **18**, ventral view of paraproct; **19**, lateral view of paraproct and cercus; **20**, ♂ genitalia (ventral view); **21**, style viewed posteriorly; **22–24**, ventral plate (22, ventral view; 23, lateral view, with median sclerite; 24, end view); **25**, paramere with 3 large parameral teeth; **26** and **27**, hind legs (26, ♀; 27, ♂); **28** and **29**, calcipala and pedisulcus (28, ♀; 29, ♂); **30**, ♀ claw with large basal tooth; **31**, basal portion of pupal gill filaments (from left side); **32**, upper and middle filaments in dorsal view; **33**, tip of larval mandible; **34**, larval head capsule (ventral view); **35**, dorsal view of mature larva showing a characteristic color pattern on the abdomen.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### (ii) Subgenus *Gomphostilbia* Enderlein

*Gomphostilbia* Enderlein, 1921: 199. Type species: *Gomphostilbia ceylonica* Enderlein, 1921, by original designation.

Diagnoses of the subgenus *Gomphostilbia*, which were first given by Crosskey (1967) and later by Datta (1973), were recently somewhat modified (Takaoka, 1983; Davies & Györkös, 1987a). Takaoka (1983), studying the Philippine black flies, proposed three species-groups in this subgenus on the basis of the shape of the female claws, the shape of the male genitalia, and the number of pupal gill filaments. The 1st species-group, *ceylonicum*-group, was to accommodate most of the *Gomphostilbia* species which have the female claws with medium-sized or large basal tooth, the male ventral plate of transverse form without median keel, and the pupal gill with 8 slender filaments arranged in 3+3+2, 2+4+2, or 6+2, dorsal to ventral. The 2nd species-group, *baisasae*-group, was created for *S. (G.) baisasae* Delfinado and two other related species all of which have the female claw simple, the male ventral plate of transverse form without median keel, and the pupal gill with 6, 8 (or 9) or 10 filaments. The last, *ambigens*-group, is represented by only one species, *S. (G.) ambigens* Delfinado, which has the female claw with a small subbasal tooth, the male ventral plate with a median keel, and the pupal gill with 6 filaments in pairs. The *baisasae*- and *ambigens*-groups are also unique among the subgenus in having a spermatheca with minute internal hairs. In *Gomphostilbia* species from Sri Lanka, Davies and Györkös (1987a) found that the male hind basitarsus was enlarged (not slender as in most *Gomphostilbia* species) in 3 species, i.e., *S. (G.) pattoni* Senior-White, *S. (G.) ceylonicum* (Enderlein) and *S. (G.) ela* Davies and Györkös, and also that the female fore basitarsus in all Sri Lankan species was much dilated as compared with those previously reported, (i.e., the length to width ratio was 4.5–5.7:1.0 versus 5.3–7.5:1.0 given by Takaoka (1983)). They also found that female *S. (G.) pattoni* has a small claw tooth, like *S. (G.) ambigens*. *Simulium (G.) pattoni*, however, shares most of its other characters with the *ceylonicum*-group.

In Java, eight species are placed in *Gomphostilbia* by having a combination of the haired katepisternum with the bare pleural membrane of both sexes of adults, a key character of this subgenus, and five of them appear to be assignable to the *ceylonicum*-group, defined by Takaoka (1983). On the other hand, the remaining three species, which are also, unless otherwise, assignable to the same species-group, show different characters which depart from the description of these three species-groups. *Simulium (G.) batoense* Edwards has a small female claw tooth, like *S. (G.) pattoni*, and *S. (G.) atratoides* sp. nov. has the pupal gill with 10 filaments, while *S. (G.) parahiyangum* has the dorsal protuberances on the larval abdomen, and the deep postgenal cleft with its apex widely reaching the hypostomium, all of which are atypical of *Gomphostilbia*.

In this study, considering these diversities in characters, as well as those found elsewhere, further groupings are attempted within *Gomphostilbia*. Two of the three species-groups mentioned above, *baisasae*-group and *ambigens*-group, which have not been represented outside the Philippines, are retained as before.

a). ***batoense*-group**. Adult antenna with 9 flagellomeres, female claw with a large basal tooth (except minute in *S. (G.) batoense* and *S. (G.) pattoni*), male hind basitarsus slender (or somewhat enlarged but much narrower at widest than hind tibia and nearly parallel-sided, as in the 2 above-mentioned species), male ventral plate of transverse form without median keel, pupal gill with 8 slender filaments, larval cleft deep but not reaching the hypostomal groove (except *S. (G.) parahiyangum*) and larval abdomen with or without dorsal protuberances.

The majority of the former *ceylonicum*-group species from various countries in Asia and Papua

New Guinea, except those which have the male hind basitarsus enlarged, are transferred to the *batoense*-group of Rubtsov (1959–1964), which is here redefined as one of the species-groups in the subgenus *Gomphostilbia*. In Rubtsov (1959–1964), nine species were assigned in this group within the genus *Eusimulium*, of which *S. (G.) batoense*, *S. (G.) ogatai* (Rubtsov) and *S. (G.) omutaense* Ogata and Sasa, and *S. (G.) shogakii* (Rubtsov) were later transferred to the subgenus *Gomphostilbia* by Crosskey (1967), and the other four species, *S. (N.) mie* Ogata and Sasa, *S. (N.) sasai* (Rubtsov), *S. (N.) yamayaense* Ogata and Sasa, and *S. (N.) inflatum* (Rubtsov), to the subgenus *Nevermannia* (Crosskey, 1987). The last, *S. (N.) lepnevae* (Rubtsov), appears to belong to *Nevermannia* (probably in *feuerborni*-group, like *S. (N.) mie* and *S. (N.) sasai*) although it was assigned to *Gomphostilbia* by Crosskey (1987).

The former species-group name, *ceylonicum*-group, is here used in a more restricted sense as noted below, because *S. (G.) ceylonicum* was shown to have the enlarged male hind basitarsus, as already mentioned by Davies and Györkös (1987a). Future studies may indicate that the *batoense*-group should be further divided into more than two groups since it consists of as many as 40 species of somewhat heterogenous elements.

Included species from Java in the *batoense*-group are *S. (G.) atratum*, *S. (G.) sundaicum* Edwards (possibly also from India [Datta, 1992]), *S. (G.) batoense*, *S. (G.) parahiyangum* and probably *S. (G.) friederichsi* Edwards (female, pupa and larva unknown). Three other Indonesian species: *S. (G.) zonatum* Edwards, *S. (G.) flavocinctum* Edwards from Sumatra (Edwards, 1934), and *S. (G.) torautense* Takaoka and Roberts from Sulawesi (Takaoka & Roberts, 1988), are also placed in this group. *Simulium (G.) pattoni* from India and Sri Lanka, *S. (G.) krombeini* Davies and Györkös and *S. (G.) dola* Davies and Györkös from Sri Lanka (Davies & Györkös, 1987a), *S. (G.) siamense* Takaoka and Suzuki from Thailand, *S. (G.) omutaense* and *S. (G.) yaeyamaense* Takaoka from Japan (Takaoka, 1991), and possibly *S. (G.) litoreum* Datta from India (Datta, 1975a) are also included in this group.

**b). *ceylonicum*-group.** Adult antenna with 9 flagellomeres, female claw with a large basal tooth, male hind basitarsus enlarged, nearly subequal to or wider than the hind tibia at widest, male ventral plate of transverse form without median keel, pupal gill with 6, 8 and 10 filaments, larval abdomen without dorsal protuberances, and larval cleft medium to large but not reaching the hypostomium.

The *ceylonicum*-group here redefined is thus restricted to the species which have the enlarged male hind basitarsus. This species-group is represented by three species from Indonesia: *S. (G.) gyorkosae* sp. nov. (= formerly *S. metatarsale* var. sensu Edwards, 1934), and *S. (G.) atratoides* sp. nov., both from Java, and *S. (G.) rosemaryae* Takaoka and Roberts from Sulawesi (Takaoka & Roberts, 1988). Included species from other countries are *S. (G.) ceylonicum* and *S. (G.) ela* from Sri Lanka (Davies & Györkös, 1987a); *S. (G.) metatarsale*, *S. (G.) tenuistylum* Datta and *S. (G.) darjeelingense* Datta from India (Datta, 1973); *S. (G.) nepalense* Lewis from Nepal (Lewis, 1964); *S. (G.) namense* Takaoka from Myanmar (Takaoka, 1989); *S. (G.) inthanonense* Takaoka and Suzuki from Thailand; "*S. (G.) metatarsale*" from Taiwan (Takaoka, 1979); *S. (G.) ogatai*, *S. (G.) tokarense* Takaoka and *S. (G.) okinawense* Takaoka from Japan (Rubtsov, 1959–1964; Takaoka, 1976). The pupal gill filaments are six in number in *S. (G.) rosemaryae* and 10 in *S. (G.) atratoides* while those of the other species are eight.

**c). *varicorne*-group.** Adult antenna with 8 flagellomeres, female claw with a large basal tooth, male hind basitarsus slender, male ventral plate of transverse form without median keel, pupal gill with 8 slender filaments, larval cleft not reaching the hypostomium, and larval abdomen without dorsal protuberances.

This new species-group is created for only two species, i.e., *S. (G.) varicorne* Edwards from Sumatra, West Malaysia and Mid Java (new record), and *S. (G.) shogakii* from Japan and China. The female, pupa and larva of the former species remain unknown from the type locality in Sumatra but the pupae of this species from West Malaysia (BMNH) were found to have the pupal gill with eight filaments arising from long stalks.

### KEY TO SPECIES-GROUPS IN *SIMULIUM (GOMPHOSTILBIA)* OF THE ORIENTAL REGION WEST OF WEBER'S LINE

**Adults**

**1.** Antenna composed of 10 segments ..... ***varicorne*-group**
**–.** Antenna composed of 11 segments ..... **2**
**2.** Female claw simple without subbasal tooth ..... ***baisasae*-group**
**–.** Female claw with subbasal tooth ..... **3**
**3.** Spermatheca with short sclerotized neck and minute internal hairs; male ventral plate with narrow median keel ..... ***ambigens*-group**
**–.** Spermatheca with unsclerotized neck and no internal hairs; male ventral plate without such a narrow median keel ..... **4**
**4.** Male hind basitarsus enlarged, nearly subequal to or wider than hind tibia ***ceylonicum*-group**
**–.** Male hind basitarsus slender, parallel-sided, or somewhat enlarged, much narrower than hind tibia ..... ***batoense*-group**

Note: In the pupa and larva no species-group is clearly separable from each other.

### KEYS TO JAVANESE SPECIES OF *SIMULIUM (GOMPHOSTILBIA)*

**Adult females**

**1.** Claw with small subbasal tooth ..... ***batoense***
**–.** Claw with large basal tooth ..... **2**
**2.** Hind coxa yellow; frons very narrow (frons-head ratio 1.0:6.9) (Fig. 130) ..... ***atratoides***
**–.** Hind coxa darkened; frons not so narrow (frons-head ratio 1.0:3.9–4.9) ..... **3**
**3.** Tuft of hairs at stem vein dark brown ..... ***parahiyangum***
**–.** Tuft of hairs at stem vein yellow ..... **4**
**4.** Hind tibia with dark subbasal ring (Fig. 50) ..... ***sundaicum***
**–.** Hind tibia without subbasal ring (Fig. 120) ..... ***gyorkosae***

**Adult males**

**1.** Antenna composed of 10 segments ..... ***varicorne***
**–.** Antenna composed of 11 segments ..... **2**
**2.** Hind basitarsus enlarged, nearly as wide as that of hind tibia ..... **3**
**–.** Hind basitarsus slender, much narrower than hind tibia ..... **4**
**3.** Hind coxa yellow; hind basitarsus almost all brownish except basal 1/3 somewhat paler (its border not well defined) (Fig. 143) ..... ***atratoides***
**–.** Hind coxa brown; hind basitarsus brownish black with basal 2/5 yellow (its border well defined) (Fig. 121) ..... ***gyorkosae***
**4.** Hind tibia yellow or dark yellow on basal 1/2, dark brown on the rest ..... **5**

–. Hind tibia almost dark brown except base pale ..... 6
5. Hind tibia with dark subbasal ring (Fig. 51) ..... *sundaicum*
–. Hind tibia without such a dark ring ..... *atratum*
6. Scutum silvery grey pruinose and with 3 broad black vittae consisting of 1 medial long vitta and 2 submedial oval ones ..... *friederichsi*
–. Scutum without such vittae ..... 7
7. Pair of dorsolateral whitish pruinose spots present on abdominal segments 2, 5, 6 and 7; style with apical spine (Fig. 66) ..... *batoense*
–. Pair of dorsolateral whitish pruinose spots present only on abdominal segments 2, 6 and 7; style without apical spine (Fig. 88a) ..... *parahiyangum*

**Pupae**

1. Gill with 10 filaments (Fig. 146) ..... *atratoides*
–. Gill with 8 filaments ..... 2
2. All filaments very short (ca. 0.7 mm), and very short-stalked (Fig. 99); antennal sheath with tuberculate projections (Fig. 98) ..... *parahiyangum*
–. At least 2 lower filaments long (over 2.0 mm) and with medium or long stalk; antennal sheath without such projections ..... 3
3. Lower 2 filaments slightly longer than other 6 filaments; upper and middle groups with common stalk of moderate length (Fig. 124) ..... *gyorkosae*
–. Lower 2 filaments about 2 × as long as other 6 filaments; upper and middle groups lacking common stalk or with very short one ..... 4
4. Lower 2 filaments with very long stalk; middle group composed of 2 paired filaments with stalk of moderate length and 2 individual ones directed inward near base (Fig. 76) ..... *batoense*
–. Lower 2 filaments with stalk of moderate length; middle group composed of 3 filaments (Fig. 55) ..... *sundaicum*

**Larvae**

1. Postgenal cleft deep, its apex widely reaching posterior border of hypostomal groove (Fig. 103); abdominal segments 1–5 with dorsolateral protuberances (Fig. 105) ..... *parahiyangum*
–. Postgenal cleft medium to deep (even when it is deep, its apex seldom reaching posterior border of hypostomal groove); abdominal segments 1–5 without such protuberances ..... 2
2. Postgenal cleft medium, 1.3–2.0 × as long as postgenal bridge ..... 3
–. Postgenal cleft deep, more than 5 × as long as postgenal bridge ..... 4
3. Postgenal cleft ca. 1.3 × as long as postgenal bridge (Fig. 150); abdomen pale pinkish grey on segments 1–5, pinkish or reddish brown on the remaining segments ..... *atratoides*
–. Postgenal cleft ca. 2.0 × as long as postgenal bridge (Fig. 129); abdomen pale with reddish brown transverse band on each segment ..... *gyorkosae*
4. Abdominal cuticle covered with minute dark spinules of various sizes (Fig. 80) .. *batoense*
–. Abdominal cuticle almost bare ..... *sundaicum*

### (A) *batoense*-group

#### 5. *Simulium (Gomphostilbia) atratum* de Meijere, 1913

*Simulium atratum* de Meijere, 1913: 331–32 (male and female).
*Simulium (Eusimulium) atratum*: Edwards, 1934: 121–22 (mature larva).
*Simulium (Gomphostilbia) atratum*: Crosskey, 1973: 424; Crosskey, 1987: 449.

This species was originally described from a male collected from Mt. Gede, West Java and two females from Nongkodjadjar, East Java (de Meijere, 1913). Edwards (1934) provisionally regarded a mature larva collected at Cibodas in Mt. Gede area by Feuerborn as *S. atratum*. This larva had the pupal gill histoblast of 10 filaments arising from the long common stalk on each side. At the same time, he mentioned that the male of *S. atratum* had a narrow hind basitarsus, based upon a sketch of the type sent by Prof. Enderlein.

In this study, two syntype females (ZMA) were examined, but the type male specimen was not available. We collected three *Gomphostilbia* species at Puncak in the Mt. Gede area, but none of these was reliably identified as *S. (G.) atratum* in the male. One of these three species (herein described as *S. (G.) atratoides* sp. nov.) has 10 pupal filaments on each side (Fig. 119) and probably is the same as what Edwards (1934) thought was *S. atratum*. However, the adult male specimens reared from the pupae with 10 filaments are different from that of *S. atratum* by the shape and coloration of the hind basitarsus. Their hind basitarsi are enlarged and almost dark except the basal 1/3 somewhat pale, as shown in Fig. 116. According to the original description given by de Meijere (1913), the hind basitarsus of *S. (G.) atratum* is yellow on the basal 1/2 and dark on the distal 1/2. It appears therefore that Edwards' tentative identification of the larva mentioned above is incorrect.

The other two *Gomphostilbia* species collected at Puncak were *S. (G.) sundaicum* and *S. (G.) gyorkosae* sp. nov.(= *S. (E.) metatarsale* var. by Edwards, 1934), the latter differing from *S. (G.) atratum* by having the enlarged male hind basitarsus (Fig. 94), as in *S. (G.) atratoides*. However, it should be mentioned that the females of *S. (G.) gyorkosae* are very similar to syntype females de Meijere regarded as *S. (G.) atratum*, although the latter females do not have distinctive vittae on the scutum, as seen in the former. On the other hand, *S. (G.) sundaicum* seems to be very similar to *S. (G.) atratum* because it has a narrow male hind basitarsus (Fig. 51), as well as similar coloration of the legs except a dark subbasal ring on each tibia. It should be however noted that in the pinned male specimens this tibial subbasal dark ring of *S. (G.) sundaicum* tends to be indistinct due to the thick covering of the whitish scale-like hairs. Similarly, the mid femur of *S. (G.) sundaicum* looks entirely yellowish like that of *S. (G.) atratum* in the pinned specimens although a median cluster of dark scale-like hairs are definitely observed in alcoholic specimens. It is therefore possible that *S. (G.) sundaicum* may be conspecific with *S. (G.) atratum* and tibial subbasal rings were overlooked in the latter species.

**SPECIMENS EXAMINED.** EAST JAVA: Syntype 2 ♀, pinned, Nongkodjadjar, Jacobson (ZMA).

**ECOLOGICAL NOTES.** Friederichs (1925) mentioned that this species was feeding on blood of domestic fowl.

**DISTRIBUTION.** West Java.

### 6. *Simulium (Gomphostilbia) sundaicum* Edwards, 1934 Figs. 36–58

*Simulium (Eusimulium) sundaicum* Edwards, 1934: 122–24 (female, male, pupa and larva).
*Simulium (Gomphostilbia) sundaicum*: Crosskey, 1973: 425.

This species was originally described from female, male, pupal and larval specimens collected from East Java (Edwards, 1934). The revised descriptions for all stages are given here.

**FEMALE.** Body length 2.0 mm. ***Head.*** Slightly narrower than width of thorax. Frons brownish, whitish grey pruinose, densely covered with whitish yellow recumbent pubescence interspersed with several dark hairs; frontal ratio 1.7:1.0:2.2. Frons-head ratio 1.0:4.4. Fronto-ocular area (Fig. 37) well developed. Clypeus brownish black, whitish grey pruinose, densely covered with whitish yellow pubescence interspersed with several dark hairs. Antenna composed of 2+9 segments, brown except scape, pedicel and basal 1/2 of lst flagellar segment yellowish. Maxillary palp composed of 5 segments, proportional lengths of 3rd, 4th and 5th segments 1.0:1.2:2.7; 3rd segment not so enlarged; sensory vesicle (Fig. 39) of moderate size, 0.33 × as long as 3rd segment, with its opening near distal end. Maxilla with 12 inner and 14 outer teeth. Mandible (Fig. 38) with 23 small inner teeth and 6 outer ones, the latter undeveloped near apex. Cibarium (Fig. 36) with dark longitudinal band medially with anterior tip heavily sclerotized on both sides, but lacking denticles. ***Thorax.*** Scutum brownish black in ground color, thinly whitish grey pruinose, with 3 dark longitudinal vittae distinct when viewed anterodorsally; scutum densely covered with whitish yellow recumbent pubescence. Scutellum brown with whitish yellow pubescence as well as long upstanding dark hairs along posterior margin. Postscutellum brownish black, whitish grey pruinose, bare. Pleural membrane bare. Katepisternum brownish black, whitish grey pruinose, with numerous pale and dark hairs, longer than deep; sulcus distinct. ***Legs.*** All coxae and trochanters yellow except mid and hind coxae brown. Fore femur dark yellow with distal tip brown. Mid and hind femora dark yellow to yellowish brown with distal cap brown. Fore and mid femora, on outer surface, each clustered with numerous dark scale-like hairs medially (more distinct on mid femur) in addition to yellowish and dark usual hairs, thus appearing as a dark broad band (Fig. 49), while hind femur rather uniformly covered with numerous dark scale-like hairs on outer surface except basal tip, so that hind femur appeared to be somewhat brownish throughout its shaft. Fore and hind tibiae yellowish white with distal 1/3 brown to brownish black. Mid tibia yellowish white on basal 1/3, brown on distal 2/3. All tibiae each with pale brownish subbasal ring. Fore tarsi brownish black. Mid tarsi brown with basal 1/3 of basitarsus yellow (its border not well defined). Hind tarsi brownish black except basal 3/5 of basitarsus and basal 1/2 of 2nd tarsal segment yellowish white. Fore basitarsus slightly dilated, ca. 5.7 × as long as its greatest width. Hind basitarsus (Fig. 50) slender, parallel-sided, ca. 5.8 × as long as wide. Calcipala (Fig. 52) moderately developed, ca. 1.33 × as long as wide, ca. 0.66 × as wide as width of basitarsal tip. Pedisulcus also distinct at basal 1/3 of 2nd tarsal segment. Claws (Fig. 54) each with large basal tooth, 0.5 × as long as claw. ***Wing.*** Length 1.9 mm. Costa with spinules as well as hairs. Subcosta haired. Tuft hairs of stem vein yellow. Basal portion of radius fully haired. ***Abdomen.*** Basal scale yellow with fringe of pale yellow hairs. Dorsal surface of abdomen brown to brownish black, with dark hairs; tergite of 2nd segment whitish pruinose, tergites of 6th, 7th and 8th segments wide, shiny. ***Genitalia*** (Figs. 41, 42). Sternite 8 bare medially, with ca. 18 dark macrosetae on each side. Anterior gonapophysis thin, membraneous, not rounded posteriorly, covered densely with microsetae except posterior margin narrowly bare, with a few short setae near anterior border; inner margin well sclerotized. Genital fork of usual inverted-Y form, with arms each produced inward to some extent but lacking any projection directed forward. Paraproct of usual form, with ca. 20 macrosetae ventrally and laterally. Cercus short, 0.4 × as long as wide, not rounded posteriorly when viewed laterally, covered with ca. 14 macrosetae on outside surface. Spermatheca ellipsoidal, sclerotized except small area near tubal juncture, without internal hairs.

**MALE.** Body length ca. 2.2 mm. ***Head.*** As wide as, or slightly wider than width of thorax. Upper eye consisting of 14 vertical columns and 16 horizontal rows of large facets. Clypeus brownish black, whitish pruinose, covered densely with yellow pubescence interspersed with dark hairs. Antenna composed of 2+9 segments, pale yellow on scape, pedicel and base of 1st flagellar segment, yellowish brown on the rest except apical 4 or 5 flagellar segments dark brown; 1st flagellar segment somewhat elongated, 1.5 × as long as 2nd flagellomere. Maxillary palp with 5 segments; proportional lengths of 3rd, 4th and 5th segment 1.0:1.3:3.2; sensory vesicle

(Fig. 40) small, ca. 0.26 × as long as 3rd segment, with small opening near distal tip. ***Thorax.*** Scutum brownish black, entirely whitish pruinose with 3 dark longitudinal vittae, densely covered with bright yellow recumbent pubescence. Scutellum brownish black, with bright yellow pubescence and several long marginal hairs. Postscutellum brownish black, whitish pruinose, bare. Pleural membrane and katepisternum as in female. ***Legs.*** All coxae brown except fore coxa yellow. All trochanters yellow except fore trochanter somewhat brownish on outer surface. Fore femur dark yellow or yellowish brown with distal tip brown. Mid femur yellow with distal cap brown. Hind femur yellowish brown with distal cap brown. Fore and mid femora each, on outer surface, clustered with numerous dark scale-like hairs medially (more prominent on mid femur), hind femur covered uniformly with dark scale-like hairs on outer surface except basal tip, as in female. Fore tibia dark yellow on basal 2/3, brown on distal 1/3. Mid tibia yellow to dark yellow on basal 1/3, brown on distal 2/3. Hind tibia yellow to dark yellow on basal 1/2, brown on distal 1/2. All tibiae each with dark subbasal ring. Fore basitarsus slender, ca. 7.1 × as long as its greatest width. Hind tibia (Fig. 51) subequal to hind femur in greatest width. Hind basitarsus (Fig. 51) slender, parallel-sided, ca. 5.6 × as long as wide. Calcipala (Fig. 53) well developed, 1.17 × as long as wide, 0.63 × as wide as basitarsal tip. Pedisulcus well developed. ***Wing.*** Length 1.9 mm. Other features as in female except subcosta bare. ***Abdomen.*** Basal scale dark brown, with hair fringe dark basally, pale distally. Dorsal surface of abdominal segments brownish black except that of 2nd segment brown, covered with short hairs; pair of dorsolateral whitish pruinose patches on segments 2, 5–8. ***Genitalia*** (Figs. 43–48). Coxite nearly rectangular in ventral view, ca. 1.3 × as long as wide. Style much shorter than coxite, gently curved inward, with apical spine. Ventral plate flat, subquadrate, slightly produced medially on posterior margin in ventral view; ventral plate also widely produced ventrally, with microsetae almost entirely on ventral and posterior surface; basal arms slightly diverging. Paramere with 3 long and 1 short parameral hooks and several small, indistinct ones. Median sclerite plate-like, with widened tip.

**PUPA.** Body length (excluding gill filaments) 2.2–2.5 mm. ***Head*** and ***thorax.*** Integument yellow, moderately covered with tubercles. Head trichomes 4 pairs, all long and simple. Thoracic trichomes 6 pairs (3 anterodorsally, 2 anterolaterally, 1 posterolaterally), all long and simple. Gill (Fig. 55) with 8 filaments, arranged in groups of 3, 3, 2 filaments from dorsal to ventral; lower pair of filaments (2.0–2.5 mm long) much longer and thicker than other 6 filaments of upper and middle groups, which are almost equal in length (1.0–1.5 mm long) and thickness; upper and middle groups each composed of 3 individual filaments arising from almost the same level of their short stalk or composed of 1 individual filament and paired 2 filaments with very short secondary stalk; middle triplet sharing very short basal stalk with upper triplet; stalk of lower pair much longer than combined length of primary and secondary stalks of middle triplet and common stalk of upper and middle triplets; all filaments with numerous transverse ridges, covered densely with minute tubercles. ***Abdomen.*** Terga 1 and 2 pale yellow, without tubercles; tergum 1 with single long seta on each side, and tergum 2 with 6 simple setae on each side, 1 of which much longer than others. Terga 3 and 4 each with 4 hooked spines directed forward along posterior margin on each side. Terga 6–9 each with transverse row of spine-combs directed caudad behind anterior margin on each side. Tergum 9 with pair of definite terminal hooks weakly serrated on outer margin (Fig. 56). Sternum 4 with 1 distinct simple hook and a few minute setae on each side; sternum 5 with pair of bifid hooks on each side; sterna 6 and 7 each with pair of inner bifid and outer simple hooks on each side; last segment with a few grapnel-like hooklets ventrolaterally on each side. ***Cocoon.*** Wall-pocket-shaped, moderately woven, extending ventrolaterally, anterior margin somewhat thickly woven but without dorsal projection.

**MATURE LARVA.** Body length 4.5–5.0 mm. Body greyish. Cephalic apotome pale or somewhat darkened, with faint brownish head spots. Antenna composed of 3 segments and apical sensillum, longer than stem of labral fan; proportional lengths of 3 segments from base to tip 1.00:0.78:0.76. Labral fan with ca. 33 main rays. Mandible (Fig. 57) with comb teeth decreasing in size from 1st to 3rd teeth; mandibular serrations composed of 1 large and 1 small teeth, without supernumerary serrations. Hypostomium (Fig. 58) with row of 9 apical teeth;

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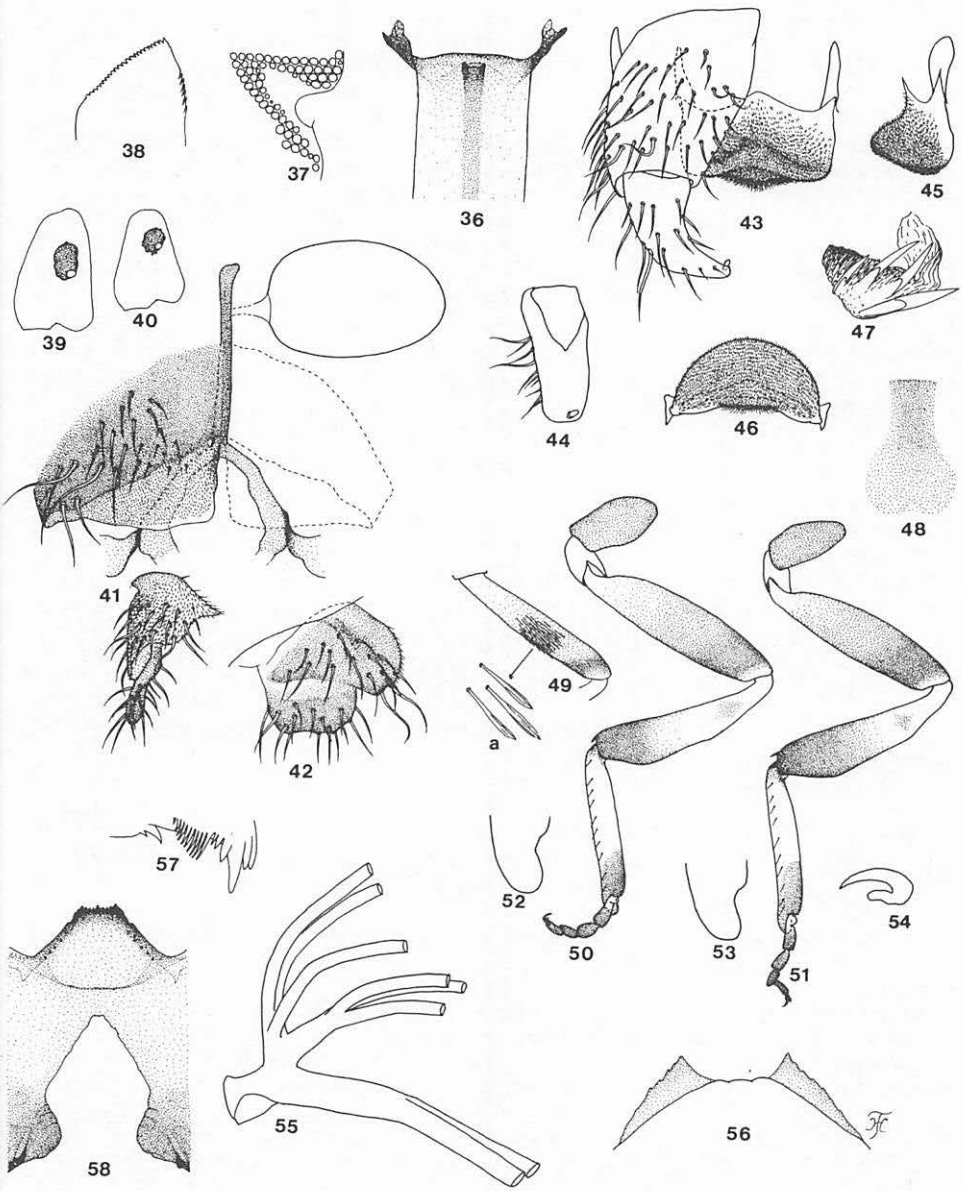
Figs. 36–58. *Simulium (Gomphostilbia) sundaicum.* **36**, cibarium of ♀; **37**, fronto-ocular area of ♀; **38**, ♀ mandible; **39** and **40**, 3rd segments of maxillary palp (**39**, ♀; **40**, ♂); **41**, ♀ genitalia *in situ* (ventral view); **42**, paraproct and cercus in lateral view; **43**, ♂ genitalia (ventral view); **44**, style in dorsal view; **45** and **46**, ventral plate (**45**, lateral view; **46**, end view); **47**, paramere; **48**, median sclerite; **49**, fore femur of ♀ leg showing dark scale-like hairs (a); **50** and **51**, hind legs (**50**, ♀; **51**, ♂); **52** and **53**, calcipala and pedisulcus (**52**, ♀; **53**, ♂); **54**, ♀ claw; **55**, basal portion of pupal gill filaments (from right side); **56**, terminal hooks on pupal abdomen; **57**, tip of larval mandible; **58**, larval head capsule (ventral view).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median tooth as long as corner tooth on each side, and longer than 3 intermediate teeth on each side; lateral margin smooth; hypostomal setae 4 or 5 in number lying subparallel to lateral margins. Postgenal cleft (Fig. 58) lanceolate, very deep, ca. 5 × as long as postgenal bridge (occasionally apex of cleft almost reaching posterior border of hypostomium). Thoracic cuticle bare. Abdominal cuticle bare except sides on anal sclerite of last segment covered with numerous colorless setae. Rectal papilla compound, each of 3 lobes with 5–7 finger-like secondary lobules. Anal sclerite of usual X-form, with anterior arms slightly shorter than posterior ones, broadly sclerotized at base. Ventral papillae well developed. Posterior circlet with ca. 76 rows of up to 12 hooklets per row.

**SPECIMENS EXAMINED.** EAST JAVA: 2 paratype mature larvae in alcohol, Karang Redjo (BMNH); 2 ♀ and 1 ♂, in alcohol, Kediri (BMNH). WEST JAVA: 1 ♀, pinned, Kebunraya, III.1975, D.E. Hardy (ZMB); 1 ♀, pinned, Cibodas, 1500 m, 20.IX.1958, J.L. Gressitt (BISHOP);1 pupa and 1 mature larva in alcohol, tributary of Ciliwung R., Jogjogan, 15.XII.1975, D.M. Davies; 8 ♀, 9 ♂, pinned together with their pupal exuviae, 1 pupae, 18 pupal exuviae and 8 mature larvae, all in alcohol, Cibodas Botanic Garden, 16–17.XII.1975, D.M. Davies; 2 ♂ pinned with their pupal exuviae, 2 pupae, 2 pupal exuviae and 7 mature larvae, all in alcohol, along the road between Cibodas Botanic Garden and Rarahan, 18.XII.1975, D.M. Davies.

**ECOLOGICAL NOTES.** The female of this species was observed to bite domestic fowl (Edwards, 1934). Pupae and larvae of this species were collected on trailing grasses, twigs, fine roots and fallen leaves in small streams (0.2–1.0 m wide) shaded or exposed to the sun. Collected together with *S. (G.) sundaicum* were *S. (N.) feuerborni*, *S.(G.) gyorkosae* sp. nov., *S. (S.) iridescens*, *S. (S.) argyrocinctum* de Meijere, *S. (S.) nebulicola* Edwards and *S. (S.) celsum* sp. nov.

**DISTRIBUTION.** Java and Sumatra.

**REMARKS.** The adults of both sexes of *S. (G.) sundaicum* are characterized by the presence of the subbasal dark ring on the integument of all the tibiae. It is also found that outer surface of fore and mid femora is medially furnished with a cluster of dark scale-like hairs in addition to yellowish and dark usual hairs, thus forming a medial dark patch, as shown in Fig. 49.

These tibial dark rings notwithstanding, the male of *S. (G.) sundaicum* is very similar to that of *S. (G.) atratum*, as already mentioned. Future studies may indicate that this species is a synonym of *S. (G.) atratum*.

### 7. *Simulium (Gomphostilbia) batoense* Edwards, 1934 Fig. 59–80

*Simulium (Eusimulium) batoense* Edwards, 1934: 124–25 (female, male and pupa).
*Simulium (Gomphostilbia) batoense*: Crosskey: 1973: 424.

This species was briefly described from female, male and pupal specimens collected from East Java (Edwards, 1934). The redescription for all stages are given below.

**FEMALE.** Body length 2.0 mm. ***Head.*** Slightly narrower than width of thorax. Frons brownish black, whitish grey pruinose, densely covered with whitish yellow recumbent pubescence interspersed with several dark hairs; frontal ratio 1.6:1.0:1.8. Frons-head ratio 1.0:4.2. Fronto-ocular area (Fig. 63) well developed. Clypeus brownish black, whitish grey pruinose, densely covered with whitish yellow pubescence interspersed with several dark hairs. Antenna composed of 2+9 segments, brownish black except scape, pedicel and base of lst flagellar segment yellowish. Maxillary palp with 5 segments; proportional lengths of 3rd, 4th and 5th segments 1.0:1.4:3.1; 3rd segment not so enlarged, sensory vesicle (Fig. 60) of moderate size, 0.38 × as long as 3rd segment, with large opening near distal end. Maxilla with 10 or 11 inner and 14–17 outer teeth. Mandible (Fig. 59) with 26–28 small inner teeth and 11 outer ones. Cibarium with heavily sclerotized arms and without denticles, although several minute teeth are faintly visible medially near posterior border as shown in Fig. 62. ***Thorax.*** Scutum brownish black in ground color, thinly whitish grey pruinose, with 3 dark longitudinal vittae distinct when viewed

anterodorsally; scutum densely covered with whitish yellow recumbent pubescence. Scutellum brown with whitish yellow pubescence and long erect dark hairs along posterior margin. Postscutellum brownish black, whitish grey pruinose, bare. Pleural membrane bare. Katepisternum brownish black, whitish grey pruinose, with numerous pale and dark hairs, longer than deep; sulcus distinct. ***Legs***. All coxae, trochanters and femora medium brown. Fore tibia brownish with large median portion pale brown; mid and hind tibiae brownish with base whitish yellow; in certain angles of light, outer surface of fore tibia and posterior surface of mid and hind tibiae largely white iridescent. Fore tarsi brownish black. Mid tarsi brown with base of basitarsus somewhat pale (its border not well defined). Hind tarsi brown except basal 3/5 of basitarsus and basal 1/3 of 2nd tarsal segment yellowish white. Fore basitarsus slightly dilated, ca. 5.7 × as long as its greatest width. Hind basitarsus (Fig. 71) slender, parallel-sided, ca. 6.2 × as long as wide. Calcipala (Fig. 73) moderately developed, nearly as long as wide, ca. 0.6 × as wide as width of basitarsal tip. Pedisulcus also distinct at basal 1/3 of 2nd tarsal segment. Claws (Fig. 75) each with small subbasal tooth. ***Wing***. Length 1.8 mm. Costa with spinules as well as hairs. Subcosta haired. Hair tuft of stem vein brownish. Basal portion of radius fully haired. ***Abdomen***. Basal scale brown with fringe of pale yellow hairs. Dorsal surface of abdomen brown to brownish black, with dark hairs; tergite of 2nd segment whitish pruinose, tergites of 6th, 7th and 8th segments wide, shiny. ***Genitalia*** (Figs. 64, 65). Sternite 8 bare medially, with 12–18 dark macrosetae on each side. Anterior gonapophysis thin, membraneous, rounded posteriorly, densely covered with microsetae except posterior margin narrowly bare, with a few short setae near anterior border; inner margin well sclerotized. Genital fork of usual inverted-Y form, with arms each produced inward to some extent but lacking any projection directed forward. Paraproct somewhat produced ventrally. Cercus short, ca. 0.45 × as long as wide, and rounded posteriorly when viewed laterally. Spermatheca ellipsoidal, sclerotized except small area near tubal juncture, without internal hairs.

**MALE**. Body length ca. 2.0 mm. ***Head***. Slightly wider than width of thorax. Upper eye consisting of 17 vertical columns and 17 horizontal rows of large facets. Clypeus brownish black, whitish pruinose, densely covered with yellow pubescence interspersed with dark hairs. Antenna composed of 2+9 segments, brownish black except base of 1st flagellar segment pale yellow, scape and pedicel brownish; 1st flagellar segment somewhat elongated, 1.8 × as long as 2nd flagellomere. Maxillary palp with 5 segments; proportional lengths of 3rd, 4th and 5th segments 1.0:1.3:3.0; sensory vesicle (Fig. 61) small, ca. 0.2 × as long as 3rd segment, with small opening medially. ***Thorax***. Scutum brownish black, whitish pruinose on shoulders, along lateral borders and on prescutellar area, densely covered with bright yellow recumbent pubescence. Scutellum brownish black, with bright yellow pubescence and several long marginal hairs. Postscutellum brownish black, whitish pruinose, bare. Pleural membrane and katepisternum as in female. ***Legs***. Coloration as in ♀ but somewhat darker. Fore basitarsus slender, ca. 7.1 × as long as its greatest width. Hind tibia (Fig. 72), at widest, slightly wider than hind femur. Hind basitarsus (Fig. 72) slender, almost parallel-sided, though slightly widened medially, then narrowed toward distal tip; hind basitarsus ca. 4.6 × as long as its greatest width, much narrower than hind tibia. Calcipala (Fig. 74) well developed, 0.8 × as long as wide. Pedisulcus well developed. ***Wing***. Length 1.8 mm. Other features as in female except subcosta bare. ***Abdomen***. Basal scale dark brown, hair fringe dark basally, pale distally. Dorsal surface of abdominal segments brownish black, covered with short hairs; pair of dorsolateral whitish pruinose patches on segments 2, 5–7. ***Genitalia*** (Figs. 66–70). Coxite nearly rectangular in ventral view. Style much shorter than coxite, gently curved inward, with apical spine. Ventral plate transverse, subquadrate, slightly depressed medially on posterior margin in ventral view; ventral plate widely produced ventrally, with microsetae almost entirely on ventral and posterior surface; basal arms parallel-sided or slightly converging. Paramere with 3 long parameral hooks and several small, indistinct ones. Median sclerite plate-like, slightly widened toward tip, with round tip.

**PUPA**. Body length (excluding gill filaments) 2.2–2.5 mm. ***Head*** and ***thorax***. Integument yellow, moderately covered with tubercles. Head trichomes 4 pairs, all long and simple. Thoracic trichomes 6 pairs (3 anterodorsally, 2 anterolaterally, 1 posterolaterally), all long and simple. Gill (Fig. 76) with 8 filaments, arranged in groups of 2, 4, 2 filaments from dorsal to ventral; in lower pair (2.2–2.6 mm long), of which stalk is longest, filaments much longer and thicker than other 6 filaments of upper and middle groups, which are subequal in length (1.0–1.4 mm long) and thickness; upper 2 filaments short-stalked, arising upward from base; middle group composed of 2 paired filaments moderately stalked, and 2 individual ones directed inward near base; latter 2 filaments usually arising close together from base of middle group's stalk and sometimes very short-stalked (it may be therefore reasonable not to include 1 of these 2 filaments in the upper group, although it is very close to upper

group and appears to belong to this group when viewed laterally); all filaments with numerous transverse ridges, densely covered with minute tubercles. ***Abdomen.*** Terga 1 and 2 almost transparent, without tubercles; tergum 1 with single long seta on each side, tergum 2 with 6 simple setae on each side, 1 seta much longer than others. Terga 3 and 4 each with 4 hooked spines directed forward along posterior margin on each side. Terga 6–9 each with transverse row of spine-combs directed caudad behind anterior margin on each side. Tergum 5 devoid of spine-comb or with 1 or 2 spines (not in form of spine-comb) on each side. Tergum 9 with pair of flat terminal hooks of irregular shape; outer margin undulate or weakly serrate (Fig. 77). Sternum 4 with 1 distinct simple hook and a few minute setae on each side; sternum 5 with pair of bifid hooks on each side; sterna 6 and 7 each with pair of inner bifid and outer simple hooks on each side; last segment with a few grapnel-like hooklets ventrolaterally on each side. ***Cocoon.*** Wall-pocket-shaped, moderately woven, extending ventrolaterally; anterior margin thickly woven, often with small bulge dorsomedially.

**MATURE LARVA.** Body length 4.5 mm. Body dark yellow to pale brown. Cephalic apotome somewhat darkened, with faint negative head spots, although median longitudinal spot and posterior 1 of 2 posterolateral spots on each side sometimes appearing blurredly positive. Antenna with 3 segments and apical sensillum, longer than stem of labral fan; proportional lengths of 3 segments from base to tip 1.0:0.9:0.9. Labral fan with 34–36 main rays. Mandible (Fig. 78) with comb-teeth decreasing in size from 1st to 3rd teeth; mandibular serrations composed of 1 large tooth and 1 small one, without supernumerary serrations. Hypostomium (Fig. 79) with row of 9 apical teeth; median tooth as long as each corner tooth, longer than 3 intermediate teeth on each side; lateral margin smooth; hypostomal setae 4 or 5 in number lying subparallel to lateral margins. Postgenal cleft (Fig. 79) lanceolate, very deep, 6.5–10 × as long as postgenal bridge, pointed anteriorly. Thoracic cuticle sparsely covered with minute dark branched spinules dorsally. Abdominal cuticle covered dorsally with minute dark spinules of various sizes, each with 4–9 apically transparent branches (Fig. 80), these spinules distributed sparsely on segments 1 and 2, moderately on segment 3, and densely on remaining posterior segments; sides on anal sclerite of last segment covered with numerous colorless setae. Rectal papilla compound, each of 3 lobes with 6–9 finger-like secondary lobules. Anal sclerite of usual X-form, with anterior arms slightly shorter than posterior ones, broadly sclerotized at base. Ventral papillae well developed. Posterior circlet with ca. 78 rows of up to 12 hooklets per row.

**SPECIMENS EXAMINED.** EAST JAVA: Lectotype ♂, 2 paralectotype ♀, 6 pupae and 3 larvae, collected at Batoe, near Malang, 18.IV.1924, Friederichs (all BMNH). WEST JAVA: 9 ♀, 11 ♂, all reared from pupae, 1 pupa, 3 pupal exuviae and 6 mature larvae collected at foot of Mt. Tangkubanperahu, 6 km north of Bandung, 30.XII.1990, H. Takaoka.

**ECOLOGICAL NOTES.** Pupae and larvae of *S. (G.) batoense* were found on banana leaves trailing in the water of a small shaded stream (ca. 1 m wide) running down through the sloped field cultivated for tea plantation. Collected together with this species were *S. (G.) sundaicum*, *S. (G.) parahiyangum*, *S. (S.) iridescens* and *S. (S.) sigiti.*

**DISTRIBUTION.** West Java (new record) and East Java.

**REMARKS.** Takaoka (1991) examined a series of type specimens of *S. (G.) batoense* in the BMNH and found that the female of this species had a small, subbasal claw tooth (Fig. 75), a character very rare in the subgenus *Gomphostilbia*, most of which have the large basal tooth on the female claw. In this respect, this species seems very close to *S. (G.) pattoni* from India and Sri

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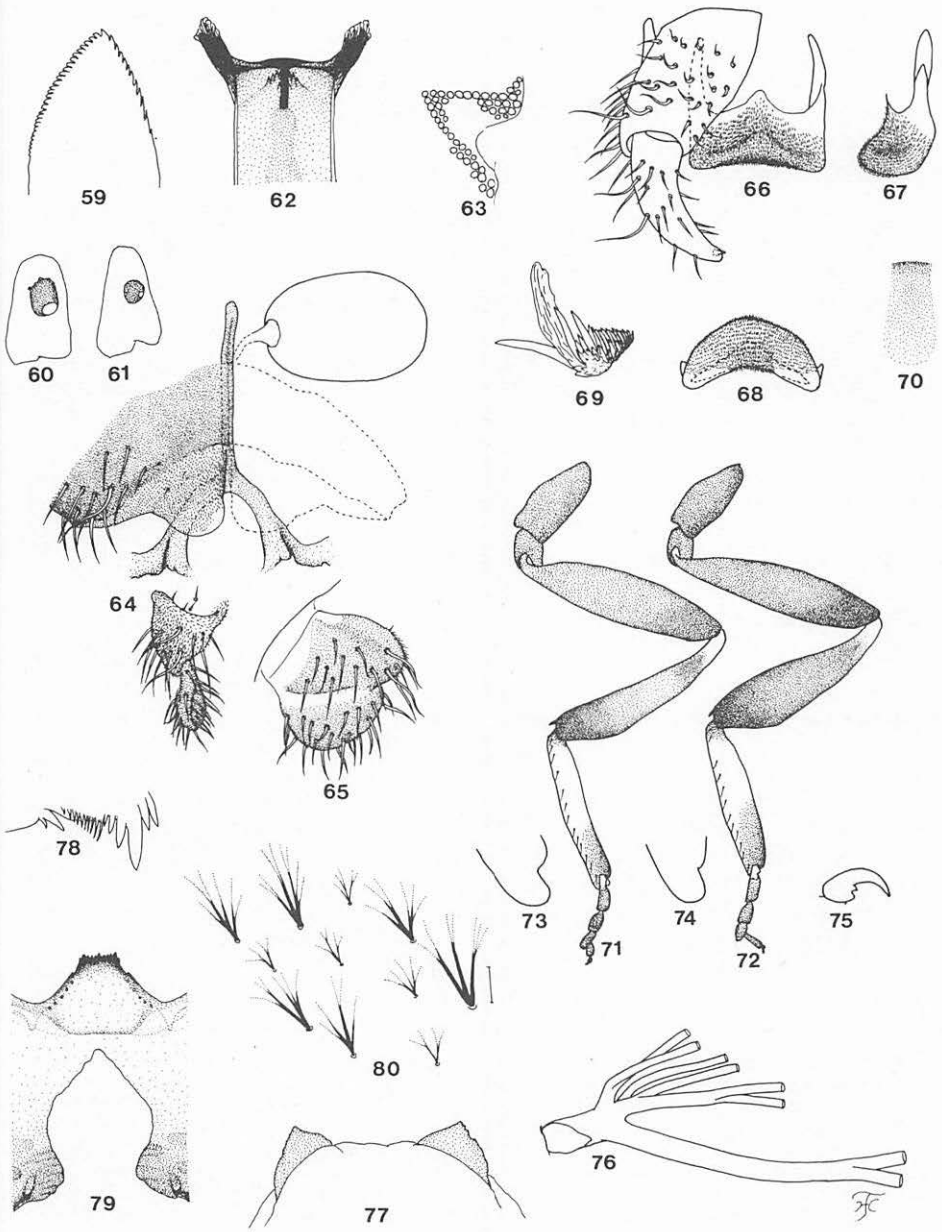
**Figs. 59-80.** *Simulium (Gomphostilbia) batoense.* **59,** tip of ♀ mandible; **60** and **61,** 3rd segments of maxillary palp (60, ♀; 61, ♂); **62,** ♀ cibarium; **63,** fronto-ocular area of ♀; **64,** ♀ genitalia *in situ* (ventral view); **65,** paraproct and cercus in lateral view; **66,** ♂ genitalia (ventral view); **67** and **68,** ventral plate (67, lateral view; 68, end view); **69,** paramere; **70,** median sclerite; **71** and **72,** hind legs (71, ♀; 72, ♂); **73** and **74,** calcipala (73, ♀; 74, ♂); **75,** ♀ claw showing small subbasal tooth; **76,** basal portion of pupal gill filaments (from right side); **77,** terminal hooks of pupal abdomen; **78,** tip of larval mandible; **79,** larval head capsule (ventral view); **80,** minute dark spinules on dorsal surface of larval abdomen (Scale bar 0.01 mm).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Lanka. However, the sensory vesicle is much larger and the coloration of legs is much lighter in *S. (G.) pattoni* (Davies & Györkös, 1987a). The pupal gill of the latter species is also different from that of *S. (G.) batoense*. Females of *S. (G.) ambigens* from the Philippines also have a small, subbasal claw tooth, but differ from this species by having the spermatheca with a sclerotized neck and lacking outer serrations on the mandible (Takaoka, 1983).

### 8. *Simulium (Gomphostilbia) friederichsi* Edwards, 1934

*Simulium (Eusimulium) friederichsi* Edwards, 1934: 118–19 (male).
*Simulium (Gomphostilbia) friederichsi*: Crosskey, 1973: 425; Crosskey, 1987: 450.

This species was originally described from the male by Edwards (1934). Its female, pupa and larva remain unknown. The male of this species was reported to have the characteristic ornamentation on the scutum (Edwards, 1934). Takaoka (1991) examined the type male and illustrated the scutal pattern, which is composed of a median longitudinal black vitta and a pair of submedian black spots on the greyish pruinose ground color.

Such a scutal pattern is very rare in *Gomphostilbia* species and has been so far reported in *S. (G.) yaeyamaense* (= formerly misidentified as *S. (G.) batoense*) from the Ryukyu Islands (Takaoka, 1991), and in *S. (G.) siamense* from Thailand (Takaoka & Suzuki, 1984). There are only slight differences in the pattern between the former species and *S. (G.) friederichsi.*
Apart from this scutal character, the male of *S. (G.) friederichsi* is very similar to *S. (G.) batoense* in dark leg coloration and the narrow hind basitarsus.

**SPECIMEN EXAMINED.** EAST JAVA: Holotype ♂, pinned, Pasirian, XI.1923, Friederichs (BMNH).

**DISTRIBUTION.** East Java.

### 9. *Simulium (Gomphostilbia) parahiyangum* Takaoka and Sigit, 1992 Figs. 81–107

*Simulium (Gomphostilbia) parahiyangum* Takaoka and Sigit, 1992: 135–42 (female, male, pupa and larva).

This species was recently described from female, male, pupal and larval specimens taken at the foothill of Mt. Tangkubanperahu, near Bandung, West Java (Takaoka & Sigit, 1992). The pupa and larva of *S. (G.) parahiyangum* had been provisionally associated with *S. (G.) varicorne*, which was so far known from the unique male specimen collected from South Sumatra (Edwards, 1934). However, Edwards' speculation was not correct since the reared adults of *S. (G.) parahiyangum* had a normal antenna consisting of nine flagellomeres (not eight as in *S. (G.) varicorne*).

As Edwards (1934) already noted, the larva of this species is most distinct among the known

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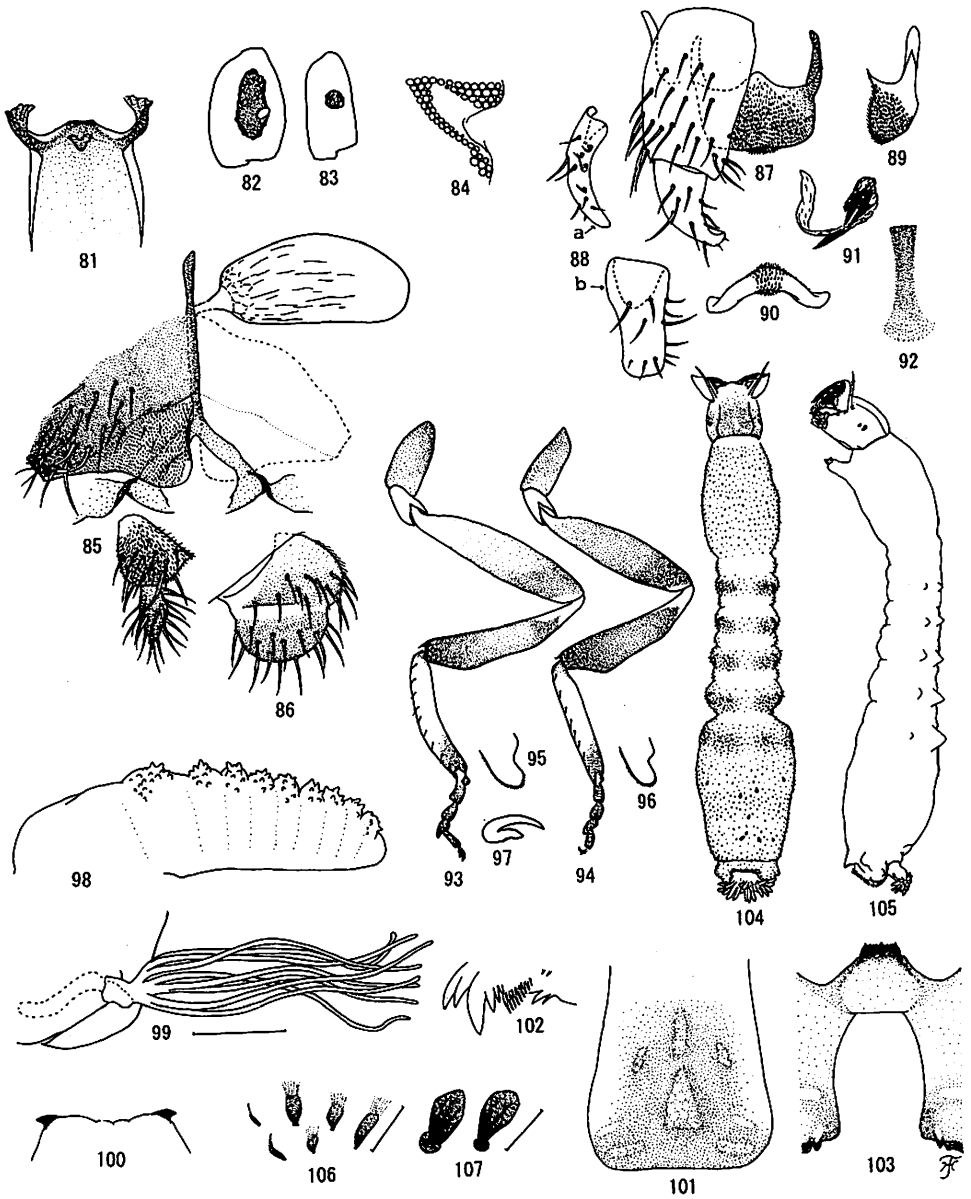
**Figs. 81–107.** *Simulium (Gomphostilbia) parahiyangum.* **81**, ♀ cibarium; **82** and **83**, 3rd segments of maxillary palp (82, ♀; 83, ♂); **84**, fronto-ocular area of ♀; **85**, ♀ genitalia *in situ* (ventral view); **86**, paraproct and cercus (lateral view); **87**, ♂ genitalia (ventral view); **88**, style viewed ventrointernally (a) and posterolaterally (b); **89** and **90**, ventral plate (89, lateral view; 90, end view); **91**, paramere; **92**; median sclerite; **93** and **94**, hind legs (93, ♀; 94, ♂); **95** and **96**, calcipala (95, ♀; 96, ♂); **97**, ♀ claw; **98**, antennal sheath of pupa (from left side) showing protuberances covered with spines; **99**, pupal gill filaments (from right side) (Scale bar 0.2 mm); **100**, terminal hooks of pupal abdomen; **101**, cephalic apotome of larva showing negative type of head spots; **102**, tip of larval mandible; **103**, larval head capsule (ventral view) showing deep postgenal cleft reaching widely the posterior border of hypostomium; **104**; mature larva (dorsal view) showing dense covering of spinules; **105**, mature larva (lateral view) showing dorsal and dorsolateral protuberances; **106**, flat spinules of larval thorax and abdomen (Scale bar 0.02 mm); **107**, black spines on larval abdominal segments 6–8 (Scale bar 0.02 mm).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species of the subgenus *Gomphostilbia* by the prominent dorsal protuberances on the abdomen (Fig. 105) and the deep postgenal cleft reaching the hypostomium (Fig. 103). The unique larva reported from Assam as *S. (G.)* nr. *varicorne* by Datta (1975a) is the only other example to show these unusual characters. In addition, *S. (G.) parahiyangum* is characterized by the enlarged sensory vesicle (length ratio to 3rd segment of maxillary palp is 0.6:1.0) (Fig. 82), the mandible serrated only on the inner margin and the oblong spermatheca (Fig 85) in the female, the style without an apical spine (Fig. 88a) in the male, the pupal antennal sheath with spines (Fig. 98) and the short pupal gill filaments (ca. 0.7 mm long) (Fig. 99).

**DISTRIBUTION.** West Java. Also probably East Java and South Sumatra where the pupa and larva were each collected according to Edwards (1934).

### (B) *ceylonicum*-group

**10. *Simulium (Gomphostilbia) gyorkosae*** Takaoka and Davies, **new species** Figs. 108–29

*Simulium (Eusimulium) metatarsale* var. Edwards, 1934: 119–21 (female, male and pupa).

This taxon was treated as an unnamed variety of *S. (G.) metatarsale* Brunetti, 1911 from India (Edwards, 1934). However, it is here raised to species level and given a new name because there are differences in the coloration of the legs of both species, as noted later.

**FEMALE.** Body length 2.2–2.5 mm. ***Head.*** Frons and clypeus brownish black, whitish grey pruinose, densely covered with whitish yellow pubescence, intermixed with sparse dark hairs. Frontal ratio 1.6–1.7:1.0:2.3–2.4. Frons head ratio 1.0:4.9. Fronto-ocular area (Fig. 112) well developed. Antenna composed of 2+9 segments, brown except scape, pedicel and basal 1/2 of 1st flagellar segment greyish yellow. Maxillary palp with 5 segments, proportional lengths of 3rd, 4th and 5th segments 1.0:1.2:2.9; 3rd segment normal, with small ovoid sensory vesicle (Fig. 109) 0.25–0.28 × as long as 3rd segment. Maxilla with 9 or 10 inner teeth and 12–14 outer ones. Mandible (Fig. 111) with ca. 22 inner teeth and 4 or 5 outer teeth. Cibarium (Fig. 108) with V-shaped ridge medially but lacking denticles. ***Thorax.*** Scutum brownish black, whitish grey pruinose, with 3 longitudinal dark vittae, densely covered with golden yellow recumbent pubescence. Scutellum brown with golden pubescence and several erect dark hairs posteriorly. Postscutellum brownish black, whitish grey pruinose, bare. Pleural membrane bare. Katepisternum with dark hairs. ***Legs.*** Fore coxa white. Mid coxa brownish black. Hind coxa brown. All trochanters whitish except mid one pale brown. All femora brownish with apical cap of hind one brownish black. Fore tibia whitish with apical 1/4 brownish black. Mid tibia whitish on basal 1/2, gradually darkened apically, brownish black on apical 1/3. Hind tibia whitish with apical 1/3 brownish black. Fore and mid tarsi brownish black with basal 1/3 or 2/5 of mid basitarsus pale yellow. Hind tarsi brownish black except basal 2/3 of basitarsus and basal 1/2 of 2nd segment whitish. Fore basitarsus somewhat dilated, ca. 4.6 × as long as its greatest width. Hind basitarsus (Fig. 120) parallel-sided, ca. 6.8 × as long as wide. Calcipala (Fig. 122) and pedisulcus well developed. Claws (Fig. 123) each with large basal tooth ca. 0.5 × length of claw. ***Wing.*** Length 1.9 mm. Costa with 2 parallel rows of short spines and hairs. Hair tuft at base of costa yellow. Subcosta fully haired. Basal portion of radius fully haired. Hair tuft of stem vein mostly yellow. ***Abdomen.*** Basal scale greyish yellow with yellow hair fringe. Dorsal surface of abdomen dark brown except basal 1/2 or 2/3 of 2nd segment pale, with dark hairs; when viewed in certain lights, tergite 2 somewhat grey pruinose and tergites 6–9 shiny. ***Genitalia*** (Figs. 113, 114). Sternal plate of 7th abdominal segment undeveloped. Sternite 8 bare medially, furnished with ca. 22 stout hairs on each side. Anterior gonapophysis thin, membraneous, triangular in shape, narrowly sclerotized on inner border, bare and transparent near rounded posteromedial border; a few short setae near anterior border. Genital fork with well sclerotized stem, lacking any projections on its arms. Spermatheca ellipsoidal, strongly sclerotized but without definite reticulate pattern and internal hairs. Paraproct short, not produced under cercus, moderately setose. Cercus short, ca. 0.38× as long as wide, moderately setose.

**MALE.** Body length 2.3–2.5 mm. ***Head.*** Slightly wider than thorax. Upper eye consisting of 13 or 14 horizon-

tal rows and 10 or 11 vertical columns of enlarged facets. Clypeus brownish black, whitish grey pruinose, densely covered with golden yellow pubescence interspersed with several dark hairs. Antenna composed of 2+9 segments, yellowish brown except scape, pedicel and base of 1st flagellomere pale yellow; 1st flagellomere somewhat elongated, ca. 1.6 × as long as 2nd flagellomere. Maxillary palp with 5 segments, proportional lengths of 3rd, 4th and 5th segments 1.0:1.3:3.0; sensory vesicle (Fig. 110) small, ca. 0.2 × as long as 3rd segment. ***Thorax.*** Scutum dark brown, whitish grey pruinose, with 3 faint dark longitudinal vittae, densely covered with golden yellow recumbent pubescence. Scutellum dark brown, whitish grey pruinose, with numerous golden yellow pubescence and marginal dark hairs. Postscutellum dark brown, whitish grey pruinose, bare. Pleural membrane bare. Katepisternum with dark hairs. ***Legs.*** All coxae dark brown except fore coxa whitish. All trochanters whitish or pale yellow. Fore and mid femora dark brown except fore femur becoming paler towards base. Hind femur dark brown with apical cap brownish black. Fore tibia white with distal 2/5 brownish black. Mid tibia white on basal 1/3, brownish black on apical 2/3. Hind tibia white on basal 2/5, brownish black on apical 3/5. Fore and mid tarsi brownish black to black except mid basitarsus pale yellow basally. Hind tarsi brownish black with basal 2/5 of hind basitarsus and basal 1/3 of 2nd segment white. Fore basitarsus slender, cylindrical, ca. 5.8 × as long as its greatest width. Hind basitarsus (Fig. 121) inflated distally, ca. 3.3 × as long as its greatest width; greatest width almost the same as or slightly narrower than that of hind tibia but slightly wider than hind femur. Calcipala and pedisulcus well developed. ***Wing.*** Length 2.0 mm. Costa with 2 parallel rows of short spines and dark hairs. Hair tuft at base of costa yellow. Subcosta bare. Basal portion of radius fully haired. Hair tuft of stem vein mostly yellow. ***Abdomen.*** Basal scale dark brown with brownish hair fringe. Dorsal surface of abdomen dark brown with dark hairs; tergites 2, 5–7 dorsolaterally grey pruinose, shiny. ***Genitalia*** (Figs. 115–19). Coxite enlarged, ca 1.7 × as long as wide. Style shorter than coxite, gently curved inward, with single spine. Ventral plate lamellate, well sclerotized, much wider than long, with posterior margin somewhat produced medially, covered ventrally, posteriorly and dorsally with minute setae; ventral surface raised ventrally along posterior margin; ventral plate in end view largely rounded ventrally. Paramere with 3 or 4 stout spines and several smaller ones. Median sclerite weakly sclerotized, broad, plate-like, with rounded apex.

**PUPA.** Body length (excluding gill filaments) ca. 3.0 mm. ***Head*** and ***thorax.*** Integument yellow, moderately covered with tubercles. Head trichomes 4 pairs, all long and simple. Thoracic trichomes 6 pairs (3 anterodorsally, 2 anterolaterally, 1 posterolaterally), all long and simple. Gill (Fig. 124) with 8 filaments, arranged in groups of 3, 3, 2 filaments from dorsal to ventral; lower pair of filaments slightly longer than pupal body; 3 filaments of middle group slightly shorter than lower filaments but slightly longer than upper triplet; 6 filaments of upper and middle groups subequal in thickness but slightly thinner than 2 filaments of lower pair; 3 upper filaments usually arising from almost same level of short primary stalk (at times 2 of them bearing very short secondary stalk); middle triplet sharing basal stalk with upper triplet, bearing primary stalk of moderate length but secondary stalk variable in length; stalk of lower pair as long as or slightly longer or shorter than combined length of primary and secondary stalks of middle triplet and common stalk of upper and middle triplets; all filaments with numerous transverse ridges, densely covered with minute tubercles. ***Abdomen.*** Terga 1 and 2 pale yellow, without tubercles; tergum 1 with single long seta on each side, tergum 2 with 6 simple setae on each side, 1 seta much longer than others. Terga 3 and 4 each with 4 hooked spines directed forward along posterior margin on each side. Terga 6–9 each with transverse row of spine-combs directed caudad and behind anterior margin on each side. Tergum 9 with pair of definite terminal hooks (Fig. 125) somewhat undulate on outer margin. Sternum 4 with 2 simple hair-like spines on each side; sternum 5 with pair of bifid hooks on each side; sterna 6 and 7 each with pair of inner bifid and outer simple hooks on each side; last segment with a few grapnel-like hooklets ventrolaterally on each side. ***Cocoon*** (Fig. 126). Wall-pocket-shaped, moderately woven, extending ventrolaterally, anterior margin somewhat thickly woven, with short but definite dorsal projection.

**MATURE LARVA.** Body length 4.6–5.5 mm. Body pale with greyish or russet transverse bands dorsally on abdominal segments. Cephalic apotome pale with faintly or moderately marked brownish head spots. Antenna with 3 segments and apical sensillum, longer than stem of labral fan; proportional lengths of 3 segments from base to tip 1.00:0.77:0.96. Labral fan with ca. 29 main rays. Mandible (Fig. 127) with comb-teeth decreasing in size from 1st to 3rd teeth; mandibular serrations composed of a large and a small tooth, without supernumerary serrations. Hypostomium (Fig. 128) with row of 9 apical teeth; median tooth as long as each corner tooth, longer than 3 intermediate teeth on each side; lateral margin smooth; hypostomal setae 4 or 5 in number lying subparallel to lateral margins. Postgenal cleft (Fig. 129) lanceolate, ca. 2 × as long as postgenal bridge. Thoracic cuti-

cle bare. Abdominal cuticle bare except sides on anal sclerite of last segment covered with numerous colorless setae. Rectal papilla compound, each of 3 lobes with 4 or 5 finger-like secondary lobules. Anal sclerite of usual X-form, anterior arms nearly as long as posterior ones, broadly sclerotized at base. Ventral papillae well developed. Posterior circlet with ca. 84 rows of up to 14 hooklets per row.

**TYPE SPECIMENS.** WEST JAVA: Holotype ♀ (BISHOP), slide-mounted with associated pupal exuvia, Cibitung, 12.XII.1990, H. Takaoka; allotype ♂, same data as holotype; paratypes: 1 ♀, 17 ♂, reared from pupae, 2 pupae and 15 mature larvae, all in alcohol, and 2 mature larvae on slide, same data as holotype; 1 ♀ reared from pupa, in alcohol, Tugu, Puncak, 11.I.1991, H. Takaoka; 2 ♂ pinned (associated pupal exuviae in alcohol) and 3 mature larvae in alcohol, Gunung Mas, Puncak, 19.VIII.1991, H. Takaoka & U.K. Hadi; 1 ♀ reared from pupa, in alcohol, Cigudek, 14.I.1991, H. Takaoka & U.K. Hadi; 4 ♀, pinned, Cibodas, 1400 m, 16.III.1975, D.E. Hardy (ZMB); 5 ♀, 1 ♂, reared from pupae, and 4 pupae in alcohol, Santosa, south of Bandung, 29.XII.1990, H. Takaoka; 3 ♀ (1 ♀ labelled *S. atratum*), pinned, Cibodas, 5000–6000 ft., 1913, Keringsberger (ZMA); 1 ♀ (labelled *S. atratum*), pinned, Mt. Teleman, 1917, Jacobson (ZMA). EAST JAVA: 1 ♀ reared from pupa and 1 mature larva, Tretes, 17.XII.1990, H. Takaoka; 1 ♀ reared from pupa, 6 pupae and 3 mature larvae, Batu, near Malang, 19.XII.1990, H. Takaoka.

**ECOLOGICAL NOTES.** Pupae and larvae of this species were collected on fine roots, twigs, leaves of grasses trailing in the water of small shaded streams (0.2–0.6 m wide) in forests and also in nearby open fields (altitude, 500–1400 m). Collected together with *S. (G.) gyorkosae* were *S. (N.) feuerborni*, *S. (G.) sundaicum*, *S. (G.) atratoides* sp. nov., *S. (S.) nebulicola*, *S. (S.) sigiti* and *S. (S.) argyrocinctum*.

**DISTRIBUTION.** West and East Java.

**REMARKS.** This new species was named after Helen Györkös, McMaster University, Ontario, Canada, in recognition of her contribution to black fly studies for over 25 years.

*Simulium (G.) gyorkosae* sp. nov. is characterized by the inflated wedge-shaped male hind basitarsus (Fig. 121). First noted in *S. (G.) metatarsale* from India, this character has been known in several *Gomphostilbia* species, most of which have been studied in detail by Davies and Györkös (1987a).

The female of *S. (G.) gyorkosae* has a relatively small sensory vesicle (0.25–0.28 × length of third maxillary palpal segment). In this aspect, this species is separated from most of other related species except *S. (G.) namense* from Myanmar, which in the female also has a small sensory vesicle (0.25 × length of third segment) (Takaoka, 1989). The female of the latter species shares many other characters with *S. (G.) gyorkosae* but there are differences in the color of mid femur (brown except basal 1/4 yellow, not entirely brown) and in the proportional length of 5th maxillary palpal segment to third one (2.4, not 2.9).

The male of *S. (G.) gyorkosae* most closely resembles that of *S. (G.)* sp. C from Thailand (Takaoka & Suzuki, 1984) in many characters including the coloration of the antenna, of the pubescence on the scutum and of the legs, in the number of rows of large facets and in the shape of the ventral plate. However, *S. (G.)* sp. C differs from the present species by the narrower fore basitarsus (length ratio to widest is 7.4:1.0 vs. 5.8:1.0). The ventral plate of *S. (G.) nepalense* from Nepal (Lewis, 1964) is also very similar to that of *S. (G.) gyorkosae* but the pubescence on the scutum of

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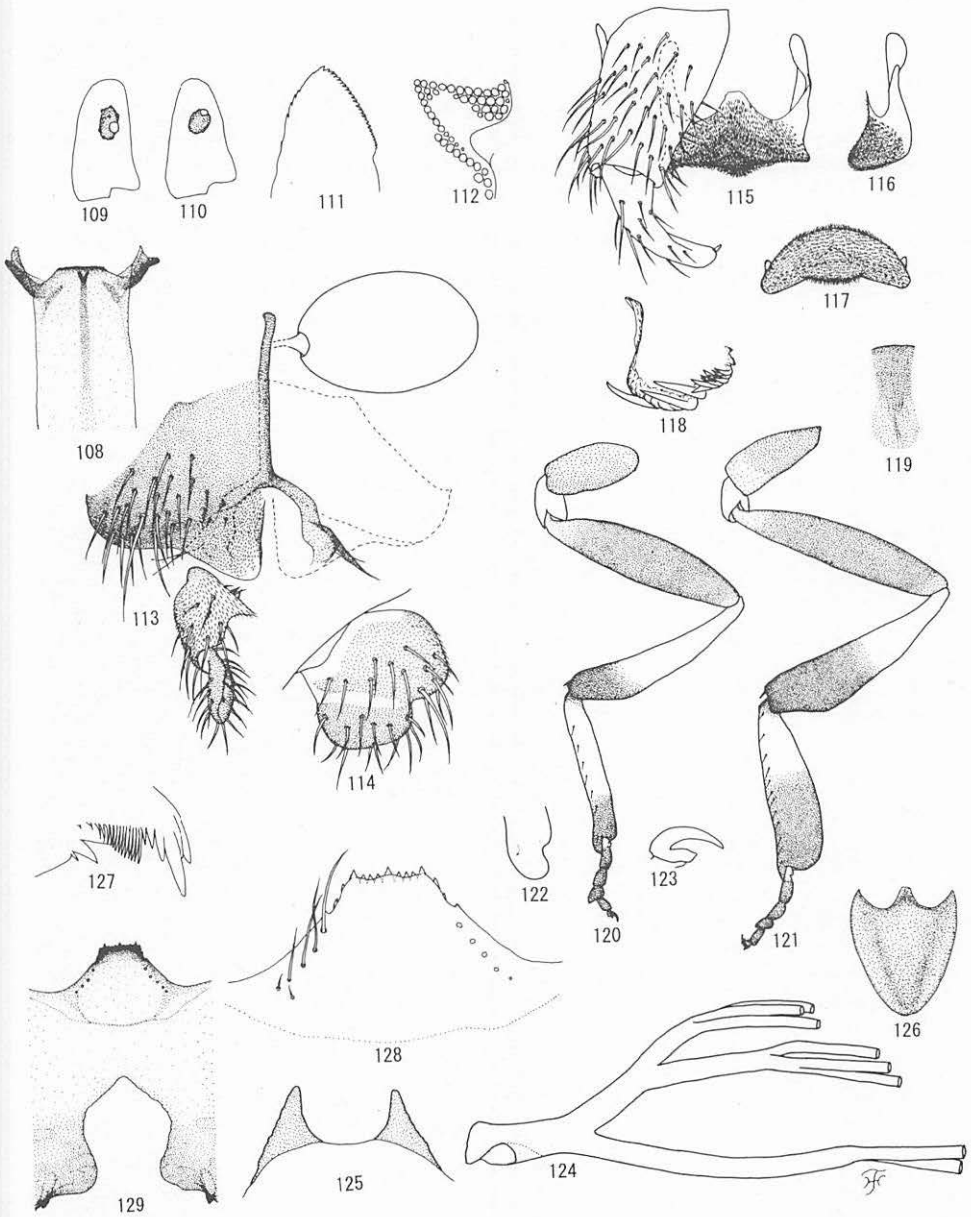
**Figs.108–29.** *Simulium (Gomphostilbia) gyorkosae*. **108**, ♀ cibarium; **109** and **110**, 3rd segments of maxillary palp (109, ♀; 110, ♂); **111**, tip of ♀ mandible; **112**, fronto-ocular area of ♀; **113**, ♀ genitalia *in situ* (ventral view); **114**, paraproct and cercus in lateral view; **115**, ♂ genitalia (ventral view); **116** and **117**, ventral plate (116, lateral view; 117, end view); **118**, paramere; **119**, median sclerite; **120** and **121**, hind legs (120, ♀; 121, ♂); **122**, ♀ calcipala; **123**, ♀ claw; **124**, basal portion of pupal gill filaments (from right side); **125**, terminal hooks of pupal abdomen; **126**, cocoon with short anterodorsal projection; **127**, tip of larval mandible; **128**, hypostomium; **129**, larval head capsule (ventral view).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the former species is brassy, not yellow as in this species.

The male of this species is easily separated from *S. (G.) metatarsale*, known only from the unique male collected from India (Brunetti, 1911). According to the original description given by Brunetti (1911), the fore femur is entirely dull yellow and mid tibia is yellow on the basal 1/2 and brown on the rest, while in *S. (G.) gyorkosae* the fore femur is brown although somewhat paler basally and the mid tibia is yellow on the basal 1/3 and brown on the rest.

The adults of "*S. (G.) metatarsale*" reported from Taiwan (Takaoka, 1979) are somewhat similar to this species but differ by the slender fore basitarsus (length ratio to widest 7.6:1.0) in the male and by the enlarged sensory vesicle (0.36 × length of 3rd segment) in the female.

**11. *Simulium (Gomphostilbia) atratoides*** Takaoka and Davies, **new species** Figs. 130–50

*Simulium (Eusimulium) atratum* (nec. de Meijere): Edwards, 1934: 121 (mature larva).

The larva of this new species was provisionally associated with the adults of *S. (G.) atratum* by Edwards (1934). The reared adult male of *S. (G.) atratoides* sp. nov. is quite different from that of *S. (G.) atratum*, as already mentioned under *S. (G.) atratum*.

**FEMALE.** Body length 2.4 mm. ***Head.*** Frons and clypeus brownish black, whitish grey pruinose, densely covered with whitish yellow pubescence, intermixed with sparse dark hairs. Frons (Fig. 130) very narrow, its narrowest width at lower 1/3; frontal ratio 1.5:1.0:3.7; frons-head ratio 1.0:6.9. Fronto-ocular area (Fig. 135) well developed. Antenna composed of 2+9 segments, pale brown except scape, pedicel and basal 1/2 of 1st flagellar segment greyish yellow. Maxillary palp with 5 segments, proportional lengths of 3rd, 4th and 5th segments 1.0:1.0:2.1; 3rd segment (Fig. 131) somewhat swollen, with large, elongate sensory vesicle 0.66 × as long as 3rd segment. Maxilla with 10 inner teeth and 12 outer ones. Mandible (Fig. 134) with ca. 26 inner teeth and devoid of outer teeth. Cibarium (Fig. 133) smooth, lacking denticles. ***Thorax.*** Scutum brown, whitish grey pruinose, with 3 faint longitudinal dark vittae, densely covered with golden yellow recumbent pubescence. Scutellum pale yellow with golden pubescence and several erect dark hairs posteriorly. Postscutellum brown, whitish grey pruinose, bare. Pleural membrane bare. Katepisternum with dark and pale hairs. ***Legs.*** All coxae whitish yellow except mid coxa brown. All trochanters whitish yellow. All femora yellow or dark yellow, somewhat darkened toward tip, brownish on apical cap. Fore tibia yellowish white with apical 1/4 brownish black. Mid tibia yellowish white on basal 1/3, gradually darkened apically, brownish black on apical 1/3. Hind tibia yellowish white with apical 1/3 brownish black. Fore and mid tarsi brownish black with base of mid basitarsus somewhat pale. Hind tarsi brownish black except basal 1/2 and little more of basitarsus and basal 1/2 of 2nd segment whitish. Fore basitarsus only slightly dilated, ca. 7.1 × as long as its greatest width. Hind basitarsus (Fig. 142) nearly parallel-sided. Calcipala (Fig. 144) and pedisulcus well developed. Claws (Fig. 145) each with large basal tooth ca. 0.5 × length of claw. ***Wing.*** Length 2.1 mm. Costa with 2 parallel rows of short spines and brown hairs. Hair tuft at base of costa yellow. Subcosta fully haired. Basal portion of radius fully haired. Hair tuft of stem vein mostly yellow. ***Abdomen.*** Basal scale yellow with yellow hair fringe. Dorsal surface of abdomen dark brown except 2nd segment whitish yellow, covered with dark and pale hairs; when viewed in certain lights, tergite 2 somewhat whitish pruinose, tergites 6–9 shiny. ***Genitalia*** (Figs.136,137). Sternal plate of 7th abdominal segment undeveloped. Sternite 8 bare medially, furnished with ca. 26 stout hairs on each side. Anterior gonapophysis thin, membraneous, triangular, narrowly sclerotized on inner border, bare and transparent near rounded posteromedial border; a few short setae near anterior border. Genital fork with well sclerotized stem, lacking any projections on its arms. Spermatheca elongate, strongly sclerotized, without definite reticulate pattern and internal hairs. Paraproct short, not produced under cercus, moderately setose. Cercus short, ca. 0.5 × as long as its width, moderately setose.

**MALE.** Body length 2.5 mm. ***Head.*** Slightly wider than thorax. Upper eye consisting of 14 horizontal rows and 11 vertical columns of enlarged facets. Clypeus brownish black, whitish grey pruinose, densely covered with golden yellow pubescence interspersed with several dark hairs. Antenna composed of 2+9 segments, entirely yellowish; 1st flagellomere elongate, ca. 2.0 × as long as 2nd flagellomere. Maxillary palp with 5 segments, pro-

portional lengths of 3rd, 4th and 5th segments 1.0:1.0:2.1; sensory vesicle (Fig.132) small, ca. 0.2 × as long as 3rd segment. ***Thorax***. Scutum brown, whitish grey pruinose, with 3 faint dark longitudinal vittae, densely covered with golden yellow recumbent pubescence. Scutellum dark yellow, with dense golden yellow pubescence and marginal dark hairs. Postscutellum brown, whitish grey pruinose, bare. Pleural membrane bare. Katepisternum with dark and pale hairs. ***Legs***. Colored as in female except that mid and hind tibiae yellowish white on basal 1/2 or little less and brownish on the remainder, and hind basitarsus (Fig.143) brownish entirely although basal 1/3 slightly paler. Fore basitarsus slender, cylindrical, ca. 7.6 × as long as its greatest width. Hind basitarsus (Fig.143) inflated, ca. 3.5 × as long as its greatest width at apical 1/3; greatest width slightly narrower than that of hind tibia. Calcipala and pedisulcus well developed. ***Wing***. Length 2.0 mm. Costa with 2 parallel rows of short spines and hairs. Hair tuft at base of costa yellow. Subcosta bare. Basal portion of radius fully haired. Hair tuft of stem vein at base of radius mostly yellow but brown near base. ***Abdomen***. Basal scale dark yellow with golden hair fringe. Dorsal surface of abdomen brownish black except 2nd segment yellow, with dark and pale hairs; tergites 2, 5–7 each with shiny, whitish pruinose patches dorsolaterally. ***Genitalia*** (Figs.138–41). Coxite enlarged, ca 1.9 × as long as wide. Style shorter than coxite, curved inward, with single spine. Ventral plate lamellate, well sclerotized, much wider than long, narrowed posteriorly, with posterior margin nearly straight, covered ventrally, posteriorly and dorsally with minute setae; ventral surface raised ventrally along posterior margin; ventral plate in end view largely rounded ventrally. Paramere with 3 stout spines and numerous smaller ones. Median sclerite weakly sclerotized, broad, plate-like, with rounded apex.

**PUPA**. Body length (excluding gill filaments) ca. 2.6 mm. ***Head*** and ***thorax***. Integument yellow, moderately covered with tubercles. Head trichomes 4 pairs, all long and simple. Thoracic trichomes 6 pairs (3 anterodorsally, 2 anterolaterally and 1 posterolaterally), all long and simple. Gill with 10 filaments on very long stalk (Fig.146), extending forward close together, slightly shorter than pupal body; filaments arranged principally in 2 groups (dorso-inner group and ventro-outer one), the former further divided into 2 triplets (Fig.147), of which branching varies individually, latter group usually divided into 2 short-stalked pairs; all filaments equal in length and thickness, with numerous transverse ridges, covered densely with minute tubercles. ***Abdomen***. Terga 1 and 2 pale yellow, without tubercles; tergum 1 with single long seta on each side, and tergum 2 with 6 simple setae on each side, 1 seta much longer than others. Terga 3 and 4 each with 4 hooked spines directed forward along posterior margin on each side. Terga 6–9 each with transverse row of spine-combs directed caudad behind anterior margin on each side. Tergum 9 with pair of definite terminal hooks serrulate on outer margin (Fig.148). Sternum 4 with 2 or 3 short, slender, simple setae on each side; sternum 5 with pair of bifid hooks on each side; sterna 6 and 7 each with pair of inner bifid and outer simple hooks on each side; last segment with a few grapnel-like hooklets ventrolaterally on each side. ***Cocoon***. Wall-pocket-shaped, moderately woven, extending ventrolaterally; anterior margin somewhat thickly woven but without dorsal projection.

**MATURE LARVA**. Body length 5.2 mm. Body pale pinkish grey almost entirely on thoracic segments and abdominal segments 1–5, pinkish or reddish brown dorsally on abdominal segments 6–8. Cephalic apotome yellowish with faint but positive head spots (although posterior spot of mediolateral spots and anterior spot of posterolateral spots are paler than apotome, then, appearing negative). Antenna composed of 3 segments and apical sensillum, longer than stem of labral fan; proportional lengths of 3 segments from base 1.0:0.7:0.8. Labral fan with 35 main rays. Mandible (Fig.149) with comb-teeth decreasing in size from 1st to 3rd teeth; mandibular serrations composed of a large and a small tooth, without supernumerary serrations. Hypostomium (Fig.150) with row of 9 apical teeth; median tooth as long as each corner tooth, longer than 3 intermediate teeth on each side; lateral margin smooth; hypostomal setae 4 or 5 in number, slightly diverging posteriorly from lateral margins. Postgenal cleft (Fig.150) medium in size, ca. 1.3 × as long as postgenal bridge, rounded anteriorly, constricted at base. Thoracic cuticle bare. Abdominal cuticle bare except last segment covered dorsally (both sides of anal sclerite) and laterally (down to base of ventral papillae) with numerous colorless setae. Rectal papilla compound, each of 3 lobes with 3 or 4 finger-like secondary lobules. Anal sclerite of usual X-form, with anterior arms nearly as long as posterior ones, broadly sclerotized at base. Ventral papillae well developed. Posterior circlet with ca. 92 rows of up to 14 hooklets per row.

**SPECIMENS EXAMINED**. WEST JAVA: Holotype ♀ (BISHOP), slide-mounted with associated pupal exuvia, Tugu, Puncak, 11.I.1991, H. Takaoka; allotype ♂, same data as holotype; paratypes: 4 ♀, 3 ♂, reared from pupae, 2 pupae, 1 pupal exuviae and 1 mature larva, all in alcohol, and 1 mature larva on slide, same data as

holotype; 2 ♂ pinned (associated pupal exuviae in alcohol), 1 ♂ and 1 pupa in alcohol, Gunung Mas, Puncak, 19.VIII.1991, H. Takaoka & U.K. Hadi; 1 ♀ pinned (its associated pupal exuvia in alcohol), Cibodas Botanic Garden, 16.XII.1975, D.M. Davies.

**ECOLOGICAL NOTES.** Pupae and larvae of this species were collected on fine roots, twigs, leaves of grasses trailing in the water of small shaded streams (0.2–0.4 m wide) in the forests and also in nearby open fields (altitude 1100–1400 m). Collected together with *S. (G.) atratoides* were *S. (N.) feuerborni*, *S. (G.) sundaicum*, *S. (G.) gyorkosae*, *S. (S.) nebulicola*, *S. (S.) sigiti* and *S. (S.) argyrocinctum*.

**DISTRIBUTION.** West Java.

**REMARKS.** The male of this new species has the enlarged hind basitarsus like *S. (G.) gyorkosae*. However, this species is easily distinguished from *S. (G.) gyorkosae* and other related species by many characters such as the yellowish coxae and femora of the hind leg in both sexes of adult, the narrow frons (frons-head ratio 1.0:6.9), the enlarged sensory vesicle (length ratio to third maxillary palpal segment 0.66:1.00), the mandible serrate only on the inner margin in the female, the almost dark hind basitarsus in the male, the 10-filamented gill in the pupa, and the medium-sized postgenal cleft subequal to bridge in the larva.

### (c) *varicorne*-group

### 12. *Simulium (Gomphostilbia) varicorne* Edwards, 1925

*Simulium varicorne* Edwards, 1925: 159–60 (male); Edwards, 1934: 126–29 (pupa and larva, nec. *varicorne* but of *parahiyangum*).
*Simulium (Gomphostilbia) varicorne*: Crosskey, 1973: 425; Crosskey and Lowry, 1990: 233.

This species was originally described from a male specimen collected from Wai Lima, South Sumatra (Edwards, 1925). The male genitalia were later illustrated by Edwards (1934). The larva and pupa collected from South Sumatra and East Java were thought to be *S. (G.) varicorne* by Edwards (1934) but recent survey showed that his tentative association was incorrect, as noted under *S. (G.) parahiyangum* (Takaoka & Sigit, 1992).

In this study, two pinned adult males collected at Pekalongan, Central Java (BISHOP) were identified as *S. (G.) varicorne*. As in the original description (Edwards, 1925), these males are readily distinguished by the 10-segmented antenna as well as its coloration (3rd and 5–8th flagellar segments darkened while others pale). The upper eye also consists of small numbers of facets (ca. 10 horizontal rows) as in the type specimen. As in the most other members of *Gomphostilbia*, the Javanese specimens have a pair of shiny, iridescent spots dorsolaterally each on the abdominal segments 2, 5, 6 and 7. The colorations of legs and thorax agree with the original description.

Crosskey (1973) recorded this species from West Malaysia, probably based on the male specimens reared from pupae collected by R. H. Wharton. These male and pupal specimens, as well as

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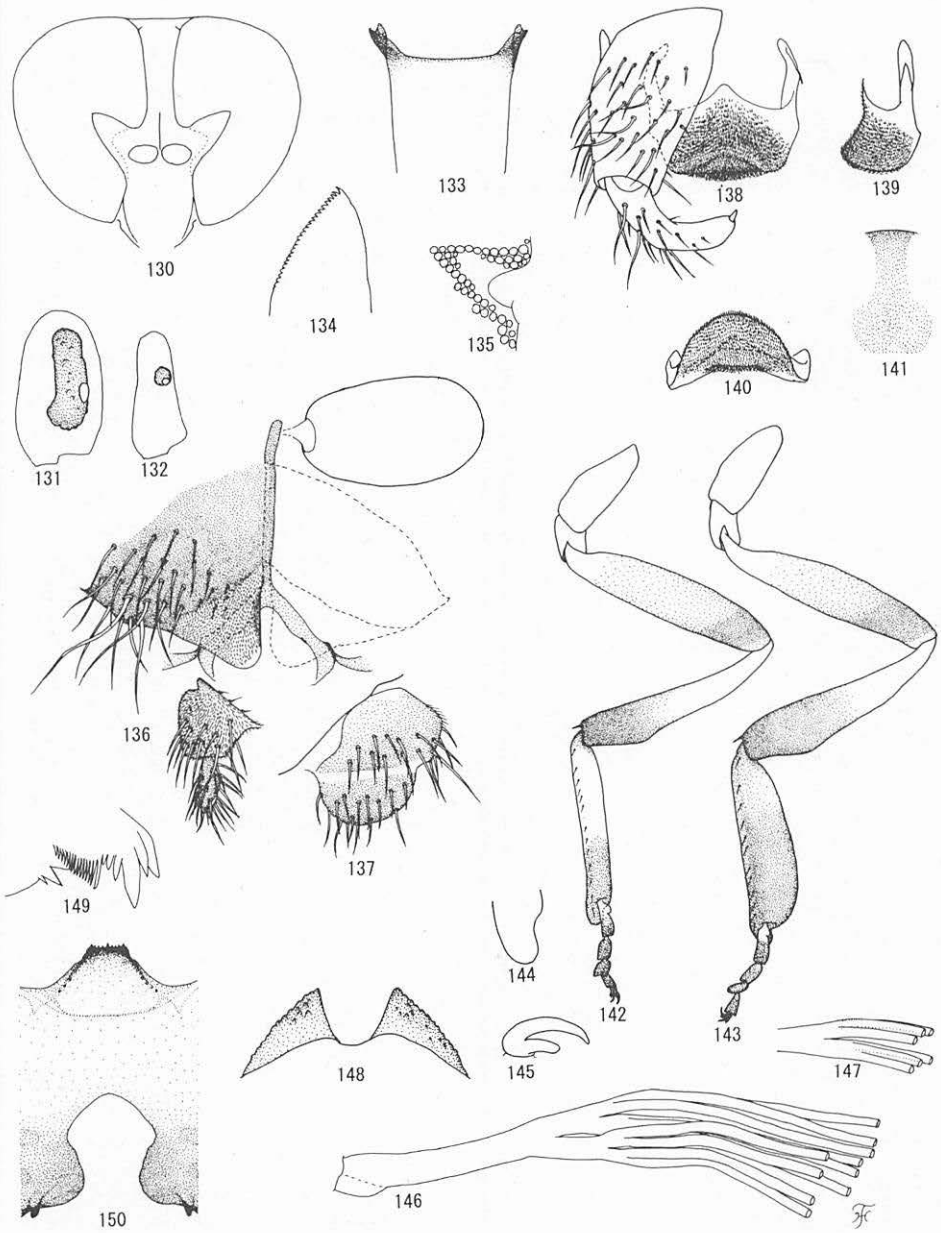
**Figs. 130–50.** *Simulium (Gomphostilbia) atratoide*. **130**, ♀ head (front view) showing narrow frons; **131** and **132**, 3rd segments of maxillary palp (131, ♀; 132, ♂); **133**, ♀ cibaricum; **134**, tip of ♀ mandible showing outer margin smooth; **135**, fronto-ocular area of ♀; **136**, ♀ genitalia *in situ* (ventral view); **137**, paraproct and cercus in lateral view; **138**, ♂ genitalia (ventral view); **139** and **140**, ventral plate (139, lateral view; 140, end view); **141**, median sclerite; **142** and **143**, hind legs (142, ♀; 143, ♂); **144**, ♀ calcipala; **145**, ♀ claw; **146**, basal portion of pupal gill consisting of 6 upper and 4 lower filaments (from right side); **147**, basal portion of upper group of 6 gill filaments (from right side) showing branching method; **148**, terminal hooks of pupal abdomen; **149**, tip of larval mandible; **150**, larval head capsule (ventral view).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the type male specimen (all in BMNH) were examined in this study. More detailed descriptions including the female, pupa and larva will be presented in a future paper on the West Malaysian Simuliidae.

**SPECIMENS EXAMINED.** MID JAVA: 2 ♂, pinned, Pekalongan, 7.IV and 7.V. (no data on year), F. Muir (BISHOP). SOUTH SUMATRA: Type ♂, slide mounted, Wai Lima, 7.XII.1921, H.H. Karny (BMNH 1923-247). WEST MALAYSIA: 1 ♂, pinned (head and genitalia slide mounted), and pupal exuvia in alcohol, Nori Valley, 24.II.1951, R.H. Wharton (BMNH 1952-410).

**DISTRIBUTION.** Mid Java (new record), Sumatra, West Malaysia.

### (iii) Subgenus *Simulium* Latreille s. str.

*Simulium* Latreille, 1802: 426. Type species: *Rhagio colombaschensis* Fabricius, 1787 [= *Oestrus columbacensis* Scopoli, 1780], by monotypy.

The subgenus *Simulium* s. str. was well defined by Crosskey (1969) and was recently divided into 19 species-groups (Crosskey, 1987), based on many of those established by Rubtsov (1956). Ten Javanese species are assignable to this subgenus (although their spermatheca has internal hairs, a character which departs from the definition by Crosskey (1969)).

Six known Javanese species were already placed in the two species-groups by Crosskey (1987), i.e., *S. (S.) argyrocinctum*, *S. (S.) eximium* de Meijere, and *S. (S.) thienemanni* Edwards to the *multistriatum*-group; *S. (S.) nobile* de Meijere, *S. (S.) iridescens* and *S. (S.) nebulicola* to the *nobile*-group. In this study, all these known species, as well as another four species, were examined in all stages. As a result, eight of 10 species are placed in five species-groups (including two of four species-groups redefined below), with the other two remaining unplaced.

The *multistriatum*-group of Rubtsov (1956) and Crosskey (1987) is a large aggregation that can be divided into at least four segregates. The first one is represented by *S. (S.) striatum* Brunetti, the second, by *S. (S.) eximium*, the third, by *S. (S.) multistriatum* Rubtsov (but here redefined) and the fourth, by *S. (S.) griseifrons* Brunetti. Rubtsov (1956) included the first three of these segregates in his *multistriatum*-group and the last one in his *subornatoide*-group, all of which were later included in the *multistriatum*-group (Crosskey, 1987). These four segregates appear to be closely related to, but easily separated from, one another as noted below in the key to the species-groups of subgenus *Simulium* in the Oriental Region and treated as such in the text.

**a). *striatum*-group.** This is characterized, as already noted by Takaoka (1979) and Takaoka and Suzuki (1984), by the striate scutum, ventrally-produced anterior gonapophyses (Fig. 155a) in the female; saddle-shaped ventral plate with no dentate margin (Fig. 156), style with short basal protuberance (Fig. 158) in the male; gill with 8 or 10 slender filaments, thoracic integument lacking rugose swellings in the pupa; cocoon microfenestrated anteriorly and shoe-shaped, with low or medium front wall; postgenal cleft large, miter-shaped (Fig. 169) and dorsal protuberances on the abdomen (Fig. 170; not confirmed in *S. (S.) consimile* Puri and *S. (S.) subpalmatum* Davies and Györkös) in the larva. The basal section of radius is bare in the male but bare or hairy in the female depending on the species.

*Simulium (S.) argyrocinctum* is the only species from Java in this species-group. Outside Indonesia, included species are *S. (S.) subpalmatum* from Sri Lanka (Davies & Györkös, 1992); *S. (S.) striatum*, *S. (S.) consimile* from India and Sri Lanka (Davies & Györkös, 1992); *S. (S.) griseiscens* Brunetti, *S. (S.) lineothorax* Puri, *S. (S.) pallidum* Puri, *S. (S.) palmatum* Puri, *S. (S.) kapuri* Datta, all from India (Puri, 1932e; Datta, 1975a); *S. (S.) bagmaticum* Maskey from Nepal (Maskey, 1985); *S. (S.) chiangmaiense* Takaoka and Suzuki, *S. (S.) nakhonense* Takaoka and Suzuki, *S. (S.)*

*thailandicum* Takaoka and Suzuki, all from Thailand (Takaoka & Suzuki, 1984); *S. (S.) quinquestriatum* (Shiraki) from Taiwan and Japan (Takaoka, 1979). Obviously *S. (S.) saccatum* (Rubtsov) from North China (Rubtsov, 1959-1964) also belongs to this species-group, although this species was placed in the *malyschevi*-group by Crosskey (1987).

**b). *eximium*-group.** This species-group is here newly formed for three Javanese species, i.e., *S. (S.) eximium*, *S. (S.) thienemanni*, and *S. (S.) upikae* sp. nov. One of the key characters of the *eximium*-group is female thorax without such definite vittae as seen in the *striatum*-group, which departs from the definition of the *multistriatum*-group by Crosskey (1987). Other main characters include anterior gonapophyses widely separated at base and angulated postero-internally (e.g., Fig. 183), paraproct of specialized form (e.g., Fig. 183) in the female; pear-shaped ventral plate with dentate margins (e.g., Fig. 191), the style with an elongated basal protuberance (e.g., Fig. 192) in the male; gill with 9 or 10 slender or inflated filaments, thoracic integument anteriorly with a pair of large rugose swellings (Fig. 207) in the pupa; cocoon boot-shaped with rather high front wall, and with or without windows anteriorly; larval postgenal cleft medium in size and dome-shaped (e.g., Fig. 211), and larval abdomen lacking dorsal projections. The basal section of radius is hairy in the female but bare in the male.

The following two related groups are noted here, though they are not represented by Javanese simuliid species.

**c). *multistriatum*-group.** This species-group name was used by Rubtsov (1956), but is here restricted to fewer species having the following characters: fore tibia silvery shining dorsally, striated scutum, anterior gonapophyses somewhat short and widely separated, paraproct of usual form in the female; ventral plate nearly quadrate in shape with or without dentate margin, style with an elongated basal protuberance in the male; pupal gill with 8 slender filaments; cocoon wall-pocket-shaped or shoe-shaped with low or incomplete front wall, with or without lateral windows anteriorly; larval postgenal cleft large, miter-shaped and larval abdomen without any dorsal protuberances (except *S. (S.) hirtinervis*). The basal section of radius is bare in the male and completely or partially hairy (or bare) in the female.

Out of 34 species of Crosskey's *multistriatum*-group, nine species are assignable to this species-group. In Indonesia, this species-group is represented only by *S. (S.) fenestratum* Edwards from Sumatra (Edwards, 1934). *Simulium (S.) hirtinervis* Edwards from Malay Peninsula was known only from the female but belong to this group according to the morphology of the female genitalia and male, pupa and larva recently collected (unpubl. data). Seven other species are *S. (S.) novolineatum* Puri, *S. (S.) barraudi* Puri, *S. (S.) dentatum* Puri, *S. (S.) digitatum* Puri, all from India (Puri, 1932c); *S. (S.) sakishimaense* Takaoka from Japan, Taiwan and Thailand (Takaoka, 1977, 1979; Takaoka & Suzuki, 1984); *S. (S.) multistriatum*, and *S. (S.) xanthogastrum* Rubtsov, both from the former USSR (Rubtsov, 1956).

**d). *griseifrons*-group.** This species-group is here newly created to accommodate the following five species: *S. (S.) griseifrons* from India (Puri, 1932c); *S. (S.) subornatoide* Rubtsov from the former USSR (Rubtsov, 1956); *S. (S.) japonicum* Matsumura, *S. (S.) kawamurae* Matsumura, and *S. (S.) horokaense* Ono, all from Japan (Rubtsov, 1959–1964; Ono, 1980). The first two species very closely resemble each other in all stages, as do also the other three species. This group is characterized by fore tibia silvery shining dorsally, scutum striated, anterior gonapophysis simple triangular in the female; ventral plate plate-like, narrow to medium in width and with no dentate margins, style with medium basal protuberance in the male; pupal gill with six slender filaments; cocoon shoe-shaped

or wall-pocket-shaped with or without lateral windows; larval postgenal cleft triangular, pointed anteriorly, larval abdomen without dorsal protuberances. The basal section of the radius is hairy or bare in both sexes of *S. (S.) griseifrons* and *S. (S.) subornatoide* but is always bare in the other species.

This group is almost the same as the *subornatoide*-group defined by Rubtsov (1959–1964) but is used in a more restricted sense, excluding *S. (S.) quinquestriatum* (a species of the *striatum*-group as mentioned above), which was placed in the latter group.

The two Indian species, *S. (S.) gravelyi* and *S. (S.) tenuitarsus*, both described by Puri (1933), which were ungrouped by Crosskey (1987), seem to be assigned in this species-group according to the original descriptions.

The remaining five species placed in the *multistriatum*-group by Crosskey (1987), i.e., *S. (S.) ufengense* Takaoka from Taiwan; *S. (S.) konakovi* Rubtsov, *S. (S.) kurilense* Rubtsov from the former USSR; *S. (S.) ambiguum* Shiraki and *S. (S.) katoi* Shiraki from Taiwan, are not reliably classified because of lack of information on the opposite sex of adults and/or immature stages, although the females of all these species except *S. (S.) ufengense* are similar to that of *S. (S.) japonicum*, suggesting their involvement in the *griseifrons*-group. The female of *S. (S.) ufengense* is not known (Takaoka, 1979). However, it is interesting to note that the male style of this species is very similar to that of the *multistriatum*-group but the ventral plate, as well as the 6-filamented pupal gill, is much like that of the *griseifrons*-group.

e). ***tuberosum*-group**. As defined by Rubtsov (1956), this species-group has the following main characters: frons shiny but clypeus dull, claw simple in the female; style with short spinous basal protuberance, ventral plate quadrate in shape with dentate margins in the male; pupal gill with 6 filaments; cocoon simple wall-pocket-shaped; larval abdomen with transverse, brownish band on each segment. Radius is bare in both sexes.

Included in this species-group is *S. (S.) sigiti* Takaoka and Hadi, which was recently described from Java, and represented the most southerly distribution of the *tuberosum*-group (Takaoka & Hadi, 1991). Also in this species-group are *S. (S.) puliense* Takaoka and *S. (S.) arisanum* Shiraki from Taiwan, *S. (S.) suzukii* Rubtsov from Taiwan, Japan and Korea, *S. (S.) rufibasis* Brunetti from India, Thailand, Taiwan, Japan and Korea (Takaoka, 1979), *S. (S.) quasifrenum* Delfinado from Philippines, *S. (S.) sabahense* Smart and Clifford, and *S. (S.) aeneifacies* Edwards, both from Sabah (Takaoka, 1983), and four species from India: *S. (S.) biforaminiferum* Datta, *S. (S.) nigrifacies* Datta, *S. (S.) nitidithorax* Puri and *S. (S.) ramosum* Puri (Puri, 1932b; Datta, 1974a,b).

f). ***nobile*-group**. This species-group is characterized by genitalia of both sexes of unique shape (Figs. 245, 247), slender hind basitarsus of both sexes, female 5th abdominal tergite dull, male scutum with the inverted V-shaped transverse dark band on grey ground, larval postgenal cleft widely reaching the posterior border of hypostomal groove (Fig. 258), as already defined by Takaoka (1983). Crosskey (1987) placed 3 Javanese species, *S. (S.) nobile*, *S. (S.) iridescens* and *S. (S.) nebulicola*, in this species-group. However, the assignment of the last 2 species is inappropriate because both of these species differ from all the *nobile*-group species in the above-mentioned key characters.

Also included in the *nobile*-group are *S. (S.) nodosum* Puri and *S. (S.) asishi* Datta from India (Datta, 1988), *S. (S.) shirakii* Kono and Takahasi from Taiwan (Shiraki, 1935), and six species from Philippines: *S. (S.) baltazarae* Delfinado, *S. (S.) cotabatoense* Takaoka, *S. (S.) benquetense* Takaoka, *S. (S.) leytense* Takaoka, *S. (S.) latistylum* Takaoka and *S. (S.) delfinadoae* Takaoka (Takaoka, 1983).

g). ***melanopus*-group.** This species-group was originally defined to accommodate 14 Philippine species and three North Bornean ones (Takaoka, 1983). Later, two more species from North Sulawesi were added (Takaoka & Roberts, 1988). The *melanopus*-group is easily distinguished from other species-groups within *Simulium* s. str. by the specialized paraproct with a well-sclerotized ventro-internal plate (Takaoka, 1983). Two Javanese species, *S. (S.) iridescens* and *S. (S.) javaense* are tentatively placed in the *melanopus*-group in having unstriated scutum, claw with a subbasal tooth, abdomen shiny on tergite 5 as well as tergites 6–8 in the female (though, in some species of the *melanopus*-group only tergites 6–8 are shiny); male style spatulate ventrodorsally and with no basal protuberance; pupal gill with six filaments, larval postgenal cleft not reaching the hypostomium, all of which are seen in the *melanopus*-group. However, it should be noted that the female paraproct of these two Javanese species lacks a ventro-internal sclerotized plate, one of the key characters of this group, although it takes an essentially similar shape in lateral view and has a flattened surface ventro-internally (Fig. 268). The male ventral plate of these species is also unique, differing from those of the *melanopus*-group. In addition, the cocoon is essentially wall-pocket-shaped (not shoe-shaped as in all the *melanopus*-group species) although it is very often connected anteroventrally by a narrow band (Fig. 279)

**h). Unplaced species.** The two species, *S. (S.) nebulicola* and *S. (S.) celsum* sp. nov., which are very closely related to each other, can not be satisfactorily placed in any of the known species-groups of the subgenus *Simulium* s. str., as will be discussed in the remarks under *S. (S.) nebulicola.*

i). ***variegatum*-group.** This species-group, which is characterized by the female anterior gonapophyses with inner margins widely concave medially, has not been found in Indonesia but is represented elsewhere in the Oriental Region, namely by *S. (S.) karenkoense* Shiraki, *S. (S.) taiwanicum* Takaoka, both from Taiwan (Takaoka, 1979), *S. (S.) chamlongi* Takaoka and Suzuki, *S. (S.) barnesi* Takaoka and Suzuki, both from Thailand, *S. (S.) hackeri* Edwards from Malay (Takaoka & Suzuki, 1984), *S. (S.) himalayense* Puri, *S. (S.) gurneyae* Puri, *S. (S.) nilgiricum* Puri, all from India (Puri, 1932a), and *S. (S.) bulla* Davies and Györkös, *S. (S.) nubis* Davies and Györkös, and possibly *S. (S.) cruszi* Davies and Györkös and *S. (S.) paranubis* Davies and Györkös, all from Sri Lanka (Davies & Györkös, 1987b, 1992). It is also well represented in the Palaearctic Region (ca. 14 spp.) (Crosskey, 1987).

j). ***subvariegatum*-group.** This species-group is characterized by the bluntly truncate anterior gonapophyses, the claw with small subbasal tooth in the female, the hind basitarsus much narrower than the hind tibia, the ventral plate Y-shaped with teeth posteriorly in the male, the gill with 6 filaments and cocoon simple, wall-pocket-shaped, with lateral windows in the pupa.

This group was first defined as one of the four species-groups in the genus *Gnus* by Rubtsov (1959–1964). Crosskey (1987) later subsumed all these species-groups into *malyschevi*-group in the subgenus *Simulium* s. str. As with the *multistriatum*-group already discussed, the *malyschevi*-group used by Crosskey (1987) includes several heterogenous segregates. For this reason we follow the treatment of Rubtsov (1959–1964) except for the assignment of these species-groups into the genus.

*Simulium (S.) hirtipannus* Puri in India (Puri, 1932d) is the only species in the *subvariegatum*-group in the Oriental Region. Included in this species-group elsewhere are *S. (S.) subvariegatum* Rubtsov from East Siberia and Mongolia, *S. (S.) jacuticum* Rubtsov from Siberia and North China, *S. (S.) remotum* Rubtsov from North China, *S. (S.) nacojapi* Smart from Siberia, Korea and Japan (Rubtsov, 1959–1964), and *S. (S.) kyushuense* Takaoka from Japan (Takaoka, 1978).

## KEYS TO SPECIES-GROUPS OF *SIMULIUM (SIMULIUM)* IN THE ORIENTAL REGION

**Adult females**

**1.** Scutum with 3 distinct dorsal vittae ..... 2
–. Scutum with no distinct dorsal vittae or with faint dorsal vittae ..... 4
**2.** Anterior gonapophyses with parallel inner margins, which extend ventrally in rounded flap; fore tibia without silvery white sheen dorsally ..... ***striatum***-group
–. Anterior gonapophyses short, spaced medially or with parallel inner margins, not extending ventrally; fore tibia with silvery sheen dorsally ..... 3
**3.** Anterior gonapophyses short, rather widely spaced medially ..... ***multistriatum***-group
–. Anterior gonapophyses short, more or less with parallel inner margins ..... ***griseifrons***-group
**4.** Scutum lacking distinct dorsal vittae or with faint dorsal vittae; basal section of radius haired ..... ***eximium***-group
–. Scutum lacking distinct dorsal vittae; basal section of radius bare ..... 5
**5.** Anterior gonapophyses with inner margins widely concave medially, with tips thin, bare, more or less pointed and approximate ..... ***variegatum***-group
–. Anterior gonapophyses otherwise ..... 6
**6.** Anterior gonapophyses bluntly truncate posteriorly ..... ***subvariegatum***-group
–. Anterior gonapophyses otherwise ..... 7
**7.** Fronto-ocular area undeveloped (Fig. 241); mid tarsi yellow except 4th and 5th segments darkened ..... ***nobile***-group
–. Fronto-ocular area well developed (eg., Fig. 264); mid tarsi brownish black with part of basitarsus yellowish ..... 8
**8.** Paraproct more or less modified, with well sclerotized ventro-internal plate, or pointed ventro-posteriorly with ventral surface furnished with long hairs; claw with small subbasal tooth (except *S. (S.) discrepans* Delfinado and *S. (S.) tumpaense* Takaoka and Roberts) ..... ***melanopus***-group
–. Paraproct normal in shape; claw simple ..... ***tuberosum***-group

**Adult males**

**1.** Scutum broadly silvery-pruinose with transverse, inverted-V-shaped, black band ... ..... ***nobile***-group
–. Scutum otherwise ..... 2
**2.** Ventral plate large, saddle-shaped and bare ..... ***striatum***-group
–. Ventral plate otherwise ..... 3
**3.** Ventral plate large, pear-shaped ..... ***eximium***-group
–. Ventral plate otherwise ..... 4
**4.** Style with basal protuberance with one or several spines ..... 5
–. Style with or without basal protuberance lacking spines ..... 8
**5.** Style with elongate basal protuberance, more than 1/4 style length .... ***multistriatum***-group
–. Style with short basal protuberance, less than 1/5 style length ..... 6
**6.** Scutum with silvery white spots on shoulders not connected submedially to posterior spot ..... 7
–. Scutum with silvery white spots on shoulders narrowly or widely connected submedially to posterior spot ..... ***tumpaense*** and ***dumogaense*** in ***melanopus***-group
**7.** Ventral plate lacking teeth posteriorly ..... ***griseifrons***-group
–. Ventral plate weakly serrated posteriorly ..... ***tuberosum***-group

**8.** Ventral plate Y-shaped, sharply serrated posteriorly, with narrow, ventral extension posteriorly ..... *variegatum*-group
–. Ventral plate Y-shaped or quadrate, weakly or strongly serrated, produced more or less ventrally but not in a narrow form ..... **9**
**9.** Hind basitarsus slender, much narrower than hind tibia ..... *subvariegatum*-group
–. Hind basitarsus more or less enlarged, nearly equal to, or wider than, hind tibia (except *S. (S.) discrepans*) ..... rest of *melanopus*-group

**Pupae**

**1.** Cocoon wall-pocket-shaped or slightly connected anteroventrally ..... **2**
–. Cocoon shoe- or boot-shaped, obviously connected anteriorly ..... **6**
**2.** Cocoon with lateral windows ..... **3**
–. Cocoon without lateral windows ..... **5**
**3.** Gill with 6 filaments per side ..... **4**
–. Gill with 8 filaments per side ..... *multistriatum*-group
**4.** Filaments subequal in length and thickness to one another ..... *subvariegatum*-group
–. Filaments decreasing in length and thickness from dorsal to ventral ... ..... *japonicum* in *griseifrons*-group
**5.** Gill with 3 inflated filaments per side ..... *nodosum*, *asishi* and *shirakii* in *nobile*-group
–. Gill with 6 filaments per side ..... *tuberosum*-group, *variegatum*-group, and *iridescens* and *javaense* in *melanopus*-group
**6.** Thorax with anterior ridges ..... *eximium*-group
–. Thorax without anterior ridges ..... **7**
**7.** Last abdominal segment with terminal hooks ..... **8**
–. Last abdominal segment without terminal hooks ..... rest of *melanopus*- and *nobile*-groups
**8.** Gill with 6 filaments per side ..... rest of *griseifrons*-group
–. Gill with 8 or 10 filaments per side ..... *striatum*-group

**Larvae**

There are few larval features that are available to separate the species-groups. Only the larvae of the *nobile*-group are distinct with the large postgenal cleft, apex of which approaches or completely reaches the hypostomal groove.

## Keys to Javanese Species of *Simulium (Simulium)*

**Adult females**

**1.** Basal section of radius haired ..... **2**
–. Basal section of radius bare ..... **5**
**2.** Scutum with 5 distinct longitudinal vittae; inner margins of anterior gonapophyses approximate, nearly parallel-sided ..... *argyrocinctum*
–. Scutum with no such distinct vittae or a trace of a few median vittae anteriorly, if any; inner margins of anterior gonapophyses widely separated at least medially ..... **3**
**3.** Hind tibia yellow on basal 1/2, dark on distal 1/2 ..... *thienemanni*
–. Hind tibia almost all dark except base yellow ..... **4**
**4** Cibarium with ca. 20 minute tubercles; ventral projection of paraproct with its apex directed ventrally (Fig. 185) ..... *eximium*
–. Cibarium with ca. 6 minute tubercles; ventral projection of paraproct with its apex directed posterolaterally (Fig. 187) ..... *upikae*

5. Claw simple ..... *sigiti*
–. Claw with small subbasal tooth ..... 6
6. Fronto-ocular area poorly developed and shallow (Fig. 241) ..... *nobile*
–. Fronto-ocular area moderately developed ..... 7
7. Tergites 5–8 shiny ..... *iridescens* and *javaense*
–. Tergites 6–8 shiny ..... 8
8. Hind femur dark with basal 1/4 yellow (Fig. 293) ..... *nebulicola*
–. Hind femur yellow with distal 1/5 dark (Fig. 309) ..... *celsum*

**Adult males**

1. Scutum covered with yellowish pubescence ..... 2
–. Scutum covered with dark pubescence ..... 5
2. Ventral plate saddle-shaped (Fig. 156) ..... *argyrocinctum*
–. Ventral plate pear-shaped (Fig. 191) ..... 3
3. Hind tibia yellow on basal 1/3 and dark on the rest ..... *thienemanni*
–. Hind tibia yellow on base and dark on the rest ..... 4
4. Hind basitarsus much enlarged, subequal at widest to hind tibia (Fig. 181) ..... *eximium*
–. Hind basitarsus moderately enlarged, at widest somewhat narrower than hind tibia (Fig. 182) ..... *upikae*
5. Scutum broadly silvery pruinose with transverse, inverted-V shaped, black band; hind basitarsus slender, much narrower than hind tibia ..... *nobile*
–. Scutum otherwise; hind basitarsus enlarged, subequal to hind tibia in greatest width ..... 6
6. Anterior silvery spots on scutum extending posteriorly along lateral border but disconnected to posterior spot just above the wing base (Fig. 221); style with basal round spinous protuberance (Fig. 226) ..... *sigiti*
–. Anterior silvery spots on scutum extending posteriorly along lateral borders and continued to posterior spot; style without basal protuberance ..... 7
7. Hind femur yellow with distal 1/5 darkened (Fig. 310); abdominal segments 2–7, each with dorsolateral silvery spots ..... *celsum*
–. Hind femur brownish black with basal 1/4 or less yellow; abdominal segments 2, 4–7, each with dorsolateral silvery spots ..... 8
8. Fore femur yellow on basal 1/2, gradually darkened up to distal 1/4 and brownish black on distal 1/4; ventral plate with parallel row of teeth on posterolateral margins (Fig. 292) ..... *nebulicola*
–. Fore femur dark yellow to brown at base, gradually darkened distally, brownish black on distal cap; ventral plate with transverse row of teeth on posteroventral margin (Fig. 269) ..... 9
9. Anterior silvery spots on scutum large, inner margins converging anteriorly (Fig. 266) ..... *iridescens*
–. Anterior silvery spots on scutum moderate in size, inner margins nearly parallel-sided ..... *javaense*

**Pupae**

1. Gill with 9 or 10 filaments ..... 2
–. Gill with 6 filaments ..... 5
2. Thoracic integument without any ridges anterodorsally; abdominal segment 8 with transverse row of spine-combs dorsally ..... *argyrocinctum*

–. Thoracic integument with anterodorsal pair of large rugose swellings (Fig. 207); abdominal segment 8 without spine-combs dorsally ..... 3
3. Gill filaments inflated (Fig. 206); cocoon boot-shaped with large ear-like lateral walls anteriorly (Fig. 210) ..... *thienemanni*
–. Gill filaments slender; cocoon boot-shaped without such walls ..... 4
4. Cocoon somewhat loosely woven, forming only a few very small open spaces near opening (Fig. 209); 9th and 10th filaments from dorsal shortened, 0.5–0.6 × as long as other 8 filaments (Fig. 205) ..... *upikae*
–. Cocoon loosely woven, and forming several large open spaces near opening (Fig. 208); gill filaments 9 or 10 and subequal in length (Figs. 202, 203), or 10 but 9th filament from dorsal shortened being 0.3–0.7 × as long as 10th filament (Fig. 204) ..... *eximium*
5. Cocoon shoe-shaped, with distinct front wall (Fig. 256) ..... *nobile*
–. Cocoon wall-pocket-shaped without such front wall ..... 6
6. Uppermost filament much longer than other 5 filaments (Figs. 296, 312) ..... 7
–. Uppermost filament as long as or slightly longer than other 5 filaments (Figs. 233, 278, 283) ..... 8
7. Uppermost filament ca. 2.8 mm in length (Fig. 312); last abdominal segment with pair of small but distinct terminal hooks ..... *celsum*
–. Uppermost filament ca. 1.8 mm in length (Fig 296); last abdominal segment without terminal hooks ..... *nebulicola*
8. Thoracic integument with pit-like cuticular organ at base of gill (Fig. 232a) ..... *sigiti*
–. Thoracic integument without such a cuticular organ ..... 9
9. Gill filaments inflated (Fig. 283) ..... *javaense*
–. Gill filaments slender (Fig. 278) ..... *iridescens*

**Larvae**

1. Abdominal segments 1–5 or 1–8 each with pair of dorsal protuberances (Figs. 170, 259) ..... 2
–. Abdominal segments lacking protuberances ..... 3
2. Postgenal cleft deep, its apex reaching posterior border of hypostomium (Fig. 258) ..... *nobile*
–. Postgenal cleft deep, its apex not reaching posterior border of hypostomium (Fig. 169) ..... *argyrocinctum*
3. Body length 7.4 mm or more; postgenal cleft rounded apically, ca. 2 × as long as postgenal bridge ..... 4
–. Body length less than 6.0 mm; postgenal cleft more or less pointed apically, over 2.3 × as long as postgenal bridge ..... 6
4. Histoblast of pupal gill with inflated filaments ..... *thienemanni*
–. Histoblast of pupal gill with slender filaments ..... 5
5. Posterior circlet with ca. 210 rows of up to 24 hooks per row ..... *eximium*
–. Posterior circlet with ca. 186 rows of up to 22 hooks per row ..... *upikae*
6. Rectal papilla of 3 lobes, each with 6 or more secondary lobules ..... 7
–. Rectal papilla of 3 lobes, each with 1–3 secondary lobules ..... 8
7. Cephalic apotome much darkened on both sides and behind posterior median spot (Fig. 297); lateral surface of head capsule widely darkened around eye-spot area, with negative spots near posterior border ..... *nebulicola*

–. Cephalic apotome somewhat darkened only behind posterior median spot (Fig. 313); lateral surface of head capsule widely pale with somewhat darkened areas above and behind eye-spot area ..... ***celsum***

**8.** Hypostomal setae lying subparallel to lateral borders (Fig. 237) ..... ***sigiti***

–. Hypostomal setae diverging posteriorly from lateral borders (Fig. 282) ..... **9**

**9.** Body color entirely greyish ..... ***iridescens***

–. Body color greyish with broad reddish brown band dorsally on each abdominal segment ..... ***javaense***

### (A) *striatum*-group

**13. *Simulium (Simulium) argyrocinctum*** de Meijere, 1913 Figs. 151–70

*Simulium argyrocinctum* de Meijere, 1913: 332–33 (male and female); Edwards, 1934: 108–10 (male, female, pupa and larva).

*Simulium (Simulium) argyrocinctum*: Crosskey, 1973: 426.

This species was described from both sexes of adult specimens by de Meijere (1913). Edwards (1934) described the pupa and larva of this species. In this study, revised descriptions for all stages are made and the female genitalia are described and illustrated for the first time.

**FEMALE.** Body length 2.5 mm. ***Head.*** Narrower than width of thorax. Frons black, shiny, thinly greyish pruinose, with several dark stout hairs along lateral margins; frontal ratio 1.4–1.5:1.0:1.6–1.7; frons-head ratio 1.0:4.4. Fronto-ocular area (Fig. 153) well developed. Clypeus black, shiny, greyish pruinose, with dark stout hairs; clypeus silvery iridescent when illuminated. Antenna composed of 2+9 segments, brownish black except scape, pedicel and base of lst flagellomere yellow (in some specimens antenna yellow or yellowish brown basally (including scape, pedicel and a few basal flagellar segments), becoming darker distally. Maxillary palp composed of 5 segments, proportional lengths of 3rd, 4th and 5th segments 1.0:1.2:2.3; 3rd segment not enlarged; sensory vesicle (Fig. 151) of medium size, oblong, with rugged surface, 0.3–0.4 × length of 3rd segment, with large round opening distally. Maxillary lacinia with 12 or 13 inner and 13 or 14 outer teeth. Mandible with ca. 24 inner and 11 outer teeth. Cibarium with ca. 20 very minute tubercles. ***Thorax.*** Scutum brownish black, shiny, covered densely with recumbent, yellow pubescence, interspersed with long, erect dark hairs on prescutellar area; when illuminated in front and viewed dorsally scutum thickly whitish grey pruinose with 5 rather broad longitudinal black vittae (1 medial, 2 submedial, 2 lateral), all vittae united with broad transverse band on prescutellar region; when illuminated from behind scutum having reversed color, with 4 broad longitudinal black vittae on a greyish ground; middle pair of vittae narrowed in front and rounded behind; outer pair of vittae emarginated externally near their anterior ends, reaching slightly farther back than middle pair; all vittae terminated before anterior and posterior margins. Scutellum brownish black, whitish grey pruinose, with recumbent yellow pubescence and long dark hairs. Postscutellum brownish black, whitish grey pruinose, iridescent when illuminated, without hairs. Pleural membrane bare. Katepisternum longer than deep, bare. ***Legs.*** Foreleg: coxa and trochanter pale yellow; femur yellow or yellowish brown basally, gradually darkened distally and with dark brown cap; tibia brownish black, with thin whitish grey pruinosity largely on outer surface when viewed from certain angles; basitarsus entirely black, somewhat dilated distally (W:L = 1.0:4.8); rest of tarsal segments black. Midleg: blackish except base of tibia and basal 3/4 or 4/5 of basitarsus pale whitish yellow; tibia with whitish sheen on posterior surface in certain lights. Hind leg (Fig. 163): blackish with trochanter, bases of femur and tibia, basal 5/8 of basitarsus and basal 1/3 of 2nd tarsal segment pale whitish yellow; on posterior surface tibia whitish yellow on basal 1/3 and with whitish sheen in certain lights, and at widest 0.9 × width of femur; basitarsus W:L = 1:6, calcipala short, width to that of basitarsal tip is 1.0:2.4, W:L ratio 1:1; pedisulcus distinct. All tarsal claws (Fig. 165) simple. ***Wing.*** Length 2.5 mm; costa with spinules and hairs; subcosta haired on basal 2/3 or 3/4; basal section of vein R haired on distal 2/3 or 3/4; hair tuft at base of stem vein blackish. ***Abdomen.*** Basal scale brownish black with fringe of dark hairs; 2nd segment dark brown with large, dorsolateral whitish iridescent spots broadly connected to each other medially; tergites 3–5 small, dark brown, not shiny; tergites 6–8 large, brownish black, shining, all tergites with dark hairs. ***Genitalia*** (Figs. 154, 155). Ventral surface of abdom-

inal segment 7 medially with very large sternal plate covered densely with numerous (ca. 80–120) short yellow and dark hairs. Sternite 8 well sclerotized, with deep quadrate medial notch posteriorly, each side with ca. 20 long hairs and ca. 10 short setae submedially near lateral border of notch; anterior gonapophysis for the most part thin, membraneous, covered with ca. 24 short setae and numerous microsetae; anterior gonapophysis narrowly sclerotized along inner margin, rounded posteriorly, with ventrally produced lobe along inner margin (Fig. 155a). Genital fork of inverted-Y form; stem slender, well sclerotized; arms slender, each with strongly sclerotized distal ridge and distinct projection directed anterodorsally. Paraproct in ventral view somewhat widened (L:W = 1:1) and in lateral view much produced ventrally (L:W = 1:2); paraproct well sclerotized basally, with numerous setae on outer surface. Cercus in lateral view rounded posteriorly, ca. 0.6 × as long as wide, covered with numerous setae. Spermatheca nearly ovoid, well sclerotized except tube and small area of tubal base, with indefinite reticulate pattern; minute internal setae present.

**MALE.** Body length 2.8–3.0 mm. ***Head.*** As wide as thorax. Upper eye consisting of 17 or 18 horizontal rows and 17 or 18 vertical columns of large facets. Clypeus black, whitish grey pruinose, iridescent when illuminated, covered marginally with long dark hairs. Antenna composed of 2+9 segments, dark brown to brownish black with scape, basal 1/2 of pedicel and base of 1st flagellar segment dark yellow; 1st flagellomere elongated (W:L = 1.0:1.8), ca. 1.8 × as long as 2nd flagellomere. Maxillary palp composed of 5 segments, proportional lengths of 3rd, 4th and 5th segments 1.0:1.3:2.9; 3rd segment of normal size, with oblong sensory vesicle (Fig. 152) 0.25 × length of 3rd segment. ***Thorax.*** Scutum brownish black, with white pruinose and iridescent pattern differing with angles of light: when illuminated anterodorsally and viewed dorsally scutum shows subanteriorly transverse pair of narrow subquadrate iridescent spots widely separated in middle; when illuminated laterally or dorsolaterally and viewed anteriorly these spots fused with each other, most of anterior region of scutum often widely iridescent; when illuminated posterodorsally and viewed dorsally, scutum shows anterior pair of narrow, subquadrate and somewhat posteromedially-arched iridescent spots on shoulders, which extend along lateral borders and connect to large transverse spot on posterior 1/3 including entire prescutellar area; when illuminated anterolaterally or dorsolaterally and viewed anterolaterally scutum on each shoulder has large anterior iridescent spot including anterior and subanterior narrow spots mentioned above; scutum uniformly covered with golden yellow recumbent pubescence (copper-colored pubescence in some specimens), interspersed with long dark erect hairs on prescutellar area. Scutellum dark brown, whitish pruinose, with several dark erect hairs and golden yellow (or copper-colored) pubescence. Postscutellum brownish black, whitish pruinose, iridescent under certain lights, bare. Pleural membrane and katepisternum as in female. ***Legs.*** Coloring as in female except fore trochanter somewhat darkened, hind tibia brownish black with base pale yellow and hind basitarsus whitish yellow on basal 1/2 or little less and brownish black on the rest. Fore basitarsus somewhat dilated (W:L ratio 1.0:6.5); hind basitarsus (Fig. 164) enlarged distally (W:L = 1.0:3.9), slightly narrower than hind tibia which is as wide as hind femur at widest; calcipala small, slightly shorter than wide; pedisulcus distinct at basal 1/3 of 2nd tarsomere. ***Wing.*** Length 2.4 mm; other features as in female except subcosta and basal portion of vein R entirely bare. Halter clear yellow. ***Abdomen.*** Basal scale blackish with long dark hairs. Dorsal surface of abdomen black, with dark hairs; segments 2, 5–7 each with pair of silvery iridescent areas dorsolaterally connected broadly (on segment 2) or narrowly (on other segments) to each other in middle. ***Genitalia*** (Figs. 156–62). Coxite in ventral view nearly quadrate, ca. 0.6 × length of style; style 3.1 × as long as its widest at base, nearly parallel-sided on distal 1/2; style spatulate ventrodorsally, with prominent basal protuberance pointed dorsally, apical margin appears rugged but bears no distinct spines, with subterminal spine. Ventral plate in ventral view broad, saddle-shaped, with rounded posterior margin, almost bare except several minute setae near center, with short basal arms directed forward; ventral plate with prominent median process sharply narrowed to more or less small rounded distal tip. Median sclerite thin, broad, shoehorn-shaped, widened on basal 1/2, nearly parallel-sided or slightly narrowed on distal 1/2. Paramere with several hooks, of which 3 apparently longer than others.

**PUPA.** Body length (excluding gill filaments) ca. 3.0 mm. ***Head.*** Integument yellow, covered densely and rather regularly with round tubercles and with 1 facial and 2 frontal pairs of simple trichomes (facial trichomes ca. 2 × as long as frontal ones). ***Thorax.*** Integument yellow, without any protruding ridges, covered densely and rather regularly with round tubercles similar to those on head, though somewhat smaller in size laterally and with cone-shaped processes on posterior surface; thorax anteriorly with 3 dorsal and 2 dorsolateral pairs of bifid trichomes (occasionally 1 or 2 of those simple or trifid) and also posteriorly with 1 lateral pair of bifid trichomes.

Gill (Fig. 166) with 10 slender filaments in pairs, much shorter than pupa, widely dispersed in almost flat vertical plane, short-stalked except 4th pair of filaments from above almost sessile; lower 3 pairs of filaments subequal in length to each other, slightly longer than upper 2 pairs of 4 filaments (uppermost filament is shortest, ca. 0.7 × length of lower 3 pairs); when compared basally, 3rd pair of filaments from dorsal thickest of all, 2 filaments of dorsalmost pair, upper filament of 2nd pair and lower filament of 4th pair slightly thinner than 3rd pair; lower filament of 2nd pair, upper filament of 4th pair and filaments of lower pair much thinner than others, lowermost pair thinnest, ca. 0.7 × as thick as 3rd pair of filaments; all filaments yellow or brownish yellow (as dark as or slightly darker than coloring of thoracic integument), slightly tapering toward tip, with distinct annular ridges and furrows throughout their length, forming reticulate pattern, covered with minute tubercles of different sizes, larger ones on ridges and smaller ones on inter-ridges. ***Abdomen.*** Tergum 1 with 1 simple slender hair on each side. Tergum 2 on each side with 1 long simple seta and 5 short simple spinous setae, 3 of which are very stout. Terga 3 and 4 each with 4 hooked spines along posterior margin on each side. Tergum 8 with transverse row of distinct spine-combs on each side. Terga 7 and 9 without distinct spine-combs although comb-like groups of minute spines present. Tergum 9 with pair of small but distinct terminal hooks. Sternum 4 with several minute simple setae submedially on each side. Sternum 5 with pair of bifid hooks submedially on each side. Sterna 6 and 7 each with pair of bifid inner and simple outer hooks widely spaced on each side. Grapnel-like hooklets absent. ***Cocoon*** (Fig. 167). Shoe-shaped, with rather low front wall, loosely woven with flat coarse fibers, forming several open interspaces or windows in webs anterolaterally and on upper 1/2 of front wall; 1/2 of ventral surface with floor posteriorly.

**MATURE LARVA.** Body length 5.0–6.2 mm. Body color dark grey on thorax and dark grey or greyish brown on abdomen. Cephalic apotome usually yellow to dark yellow, with peripheral areas much darkened along lateral margins and medially near posterior border, but sometimes partially (especially on posterior 1/2) or entirely dark brown; head spots generally indistinct, anterolateral and posterolateral spots usually faintly or markedly negative, medial longitudinal spots faintly positive, merged in ground color or negative depending upon the extent of darkness of the ground color. Antenna composed of 3 segments and apical sensillum, longer than stem of labral fan; length ratio of segments (from base to tip) 1.0:1.1:0.6. Labral fan with ca. 44 main rays. Mandible (Fig. 168) with mandibular serrations composed of a medium and a small tooth, without supernumerary serrations; 2nd and 3rd comb-teeth of equal size, shorter than 1st one. Hypostomal teeth 9, small, with median and each corner tooth longer than others; lateral margins weakly serrate apically; 4 or 5 hypostomal bristles diverging posteriorly from lateral border on each side. Postgenal cleft (Fig. 169) very deep, rounded, ca. 3 × as long as postgenal bridge. Thoracic cuticle almost bare, with 3 dorsolateral pairs of small protuberances (Fig. 170). Abdominal cuticle very sparsely covered with minute colorless setae on posterior segments and moderately with short, pale setae on each side of anal sclerite; segments 1–8 each with dorsolateral pair of conical protuberances (Fig. 170). Rectal papilla of 3 lobes, each with 7–10 finger–like secondary lobules. Anal sclerite X-shaped, with broadened anterior arms ca. 0.7 × as long as posterior ones. Last abdominal segment bulged laterally but lacking ventral papillae. Posterior circlet with ca. 112 rows of hooklets with up to 18 hooklets per row.

**SPECIMENS EXAMINED.** WEST JAVA: Lectotype ♂, pinned, Mt. Gede, Maart 1991, E. Jacobson (ZMA, lectotype designation by R.W. Crosskey 1968); 2♂, pinned, Cilengsar, 16–19.VI.1937, J. Westernberg (ZMA); 1♀, 1♂, pinned, Kebunraya, 25.II.1975 for ♂, III.1975 for ♀, D.E. Hardy (ZMB); 6♀, 6♂, reared from pupae, 10 pupae and 10 mature larvae, all in alcohol, Puncak, 4.I.1991, H. Takaoka; 10♀, 10♂, reared from pupae, 8 pupae, 10 mature larvae, Santosa, south of Bandung, 29.XII.1990, H. Takaoka; 3♀ pinned together with their pupal exuviae, and 1 mature larva in alcohol, Cisarus, near Bogor, 15.XII.1975, D.M. Davies; 19♀, 4♂, pinned together with their pupal exuviae, 1♂ reared from pupa, 29 pupae, 18 pupal exuviae, and 5 mature

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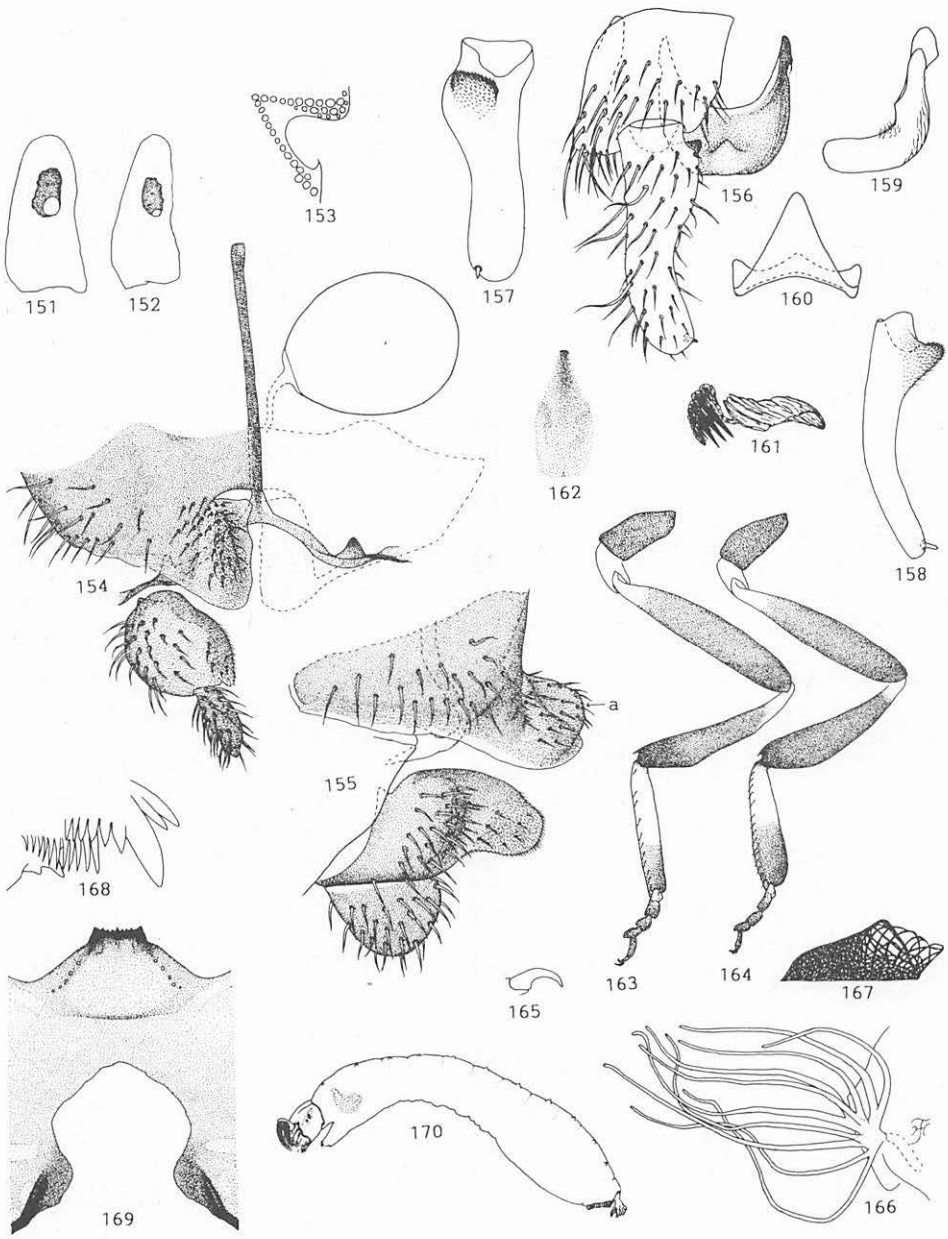
**Figs. 151–70.** *Simulium (Simulium) argyrocinctum.* **151** and **152**, 3rd segments of maxillary palp (151, ♀; 152, ♂); **153**, fronto-ocular area of ♀; **154**, ♀ genitalia *in situ* (ventral view); **155**, ♀ genitalia (lateral view) showing 8th sternite, anterior gonapophyses (a), paraproct and cercus; **156**, ♂ genitalia (ventral view); **157** and **158**, style (157, dorsal view; 158, inside view); **159** and **160**, ventral plate (159, lateral view; 160, end view); **161**, paramere; **162**, median sclerite; **163** and **164**, hind legs (163, ♀; 164, ♂); **165**, ♀ claw; **166**, pupal gill filaments (from left side); **167**, cocoon (lateral view); **168**, tip of larval mandible; **169**, ventral surface of larval head capsule; **170**, mature larva in lateral view showing dorsal protuberances on thoracic and abdominal segments.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larvae, all in alcohol, Ciliwung R. and its tributaries, Jogjogan; 20♀, 12♂, pinned together with their pupal exuviae, 1♂ reared from pupa, 6 pupae, 10 pupal exuviae and 16 mature larvae, all in alcohol, Cibodas Botanic Garden, 15.XII.1975, D.M. Davies; 8♀, 8♂, pinned together with their pupal exuviae, 13 pupae, 6 pupal exuviae and 14 mature larvae, between Cibodas Botanic Garden and Rarahan, 15.XII.1975, D.M. Davies; 2♀, 2♂, pinned together with their pupal exuviae, 2 pupae, 2 pupal exuviae and 11 mature larvae, all in alcohol, Cikundal R., just outside gate of Cibodas Botanic Garden, 18.XII.1975, D.M. Davies. EAST JAVA: 1♀, 1♂, pinned, Pasoetoean, VI.1923 (♂), VI.1924 (♀), K. Friederichs (USNM, labelled B.M. 1931-554).

**ECOLOGICAL NOTES.** Pupae and larvae of *S. (S.) argyrocinctum* were found attached to trailing grasses, leaves and stems in small to medium streams (0.2–4.0 m) and also in large streams (6–9 m wide) exposed to the sun or partially shaded. This species was collected together with *S. (S.) iridescens*, *S. (S.) nobile*, *S. (N.) feuerborni* and *S. (G.) sundaicum*. Friederichs (1925) found that this species was a pest of cattle, attacking mainly the ears of Bali cattle, cattle imported from Europe, water buffalos and horses. Edwards (1934) noted that females of this species were taken while swarming around a goat.

**DISTRIBUTION.** Java and Sumatra.

**REMARKS.** This species seems to be most closely related to *S. (S.) thailandicum* described from the male and pupal specimens collected from Thailand (Takaoka & Suzuki, 1984) by having the 10 slender pupal gill filaments arranged in five pairs rather than in two pairs plus two triplets, as in most of other *striatum*-group species. The male and pupa of both species are very similar to each other. However, there are subtle differences between both species. In *S. (S.) argyrocinctum*, the pupal gill filaments have sharply defined ridges on their surface while in *S. (S.) thailandicum* the surface of gill filaments lacks such sharply defined ridges though it has indefinite annulations. In addition, the shape of the male sensory vesicle is globular in this species but oblong in the latter species.

*Simulium (S.) nakhonense* from Thailand also has paired pupal gill filaments (Takaoka & Suzuki, 1984). However, the lower four or five filaments are always much thinner than the other upper filaments. The female and larva of *S. (S.) nakhonense* are very similar to those of *S. (S.) argyrocinctum* in having the haired basal section of the female radial vein and in lacking the dark spinous setae on the larval abdomen. On the other hand, the male of this species is easily separated from *S. (S.) argyrocinctum* by the globular sensory vesicle and the parallel-sided hind basitarsus.

Among the other *striatum*-group species, this species is similar, in the female, to *S. (S.) grisescens* from India (Puri, 1932e) and *S. (S.) quinquestriatum* from Taiwan and Japan (Takaoka, 1979) in having the haired basal section of the radius. However, the pupa and larva of these latter species are easily separated from *S. (S.) argyrocinctum* by the branching method of pupal gill filaments (10 filaments in two pairs plus two triplets) and by the presence of dark chisel-shaped spines on the larval abdomen.

### (B) *eximium*-group

**14. *Simulium (Simulium) eximium*** de Meijere, 1913 Figs.171, 172, 176, 177, 180, 181, 183–86, 191–94, 202–04, 207, 208, 211, 214

*Simulium eximium* de Meijere, 1913: 330 (male and female).
*Simulium (Simulium) eximium*: Edwards, 1934: 104–06 (male, female, pupa and larva); Crosskey, 1973: 426; Crosskey, 1987: 474.

This species was originally described from male and female specimens collected from East Java (de Meijere, 1913). Its pupa and larva were later described by Edwards (1934).

In this study we examined several reared adults, pupae and mature larvae from East and West Java, as well as the lectotype male and paralectotype female of *S. (S.) eximium* borrowed from ZMA. Revised descriptions of all stages are given below, chiefly based on the specimens from Cibodas Botanic Garden in West Java.

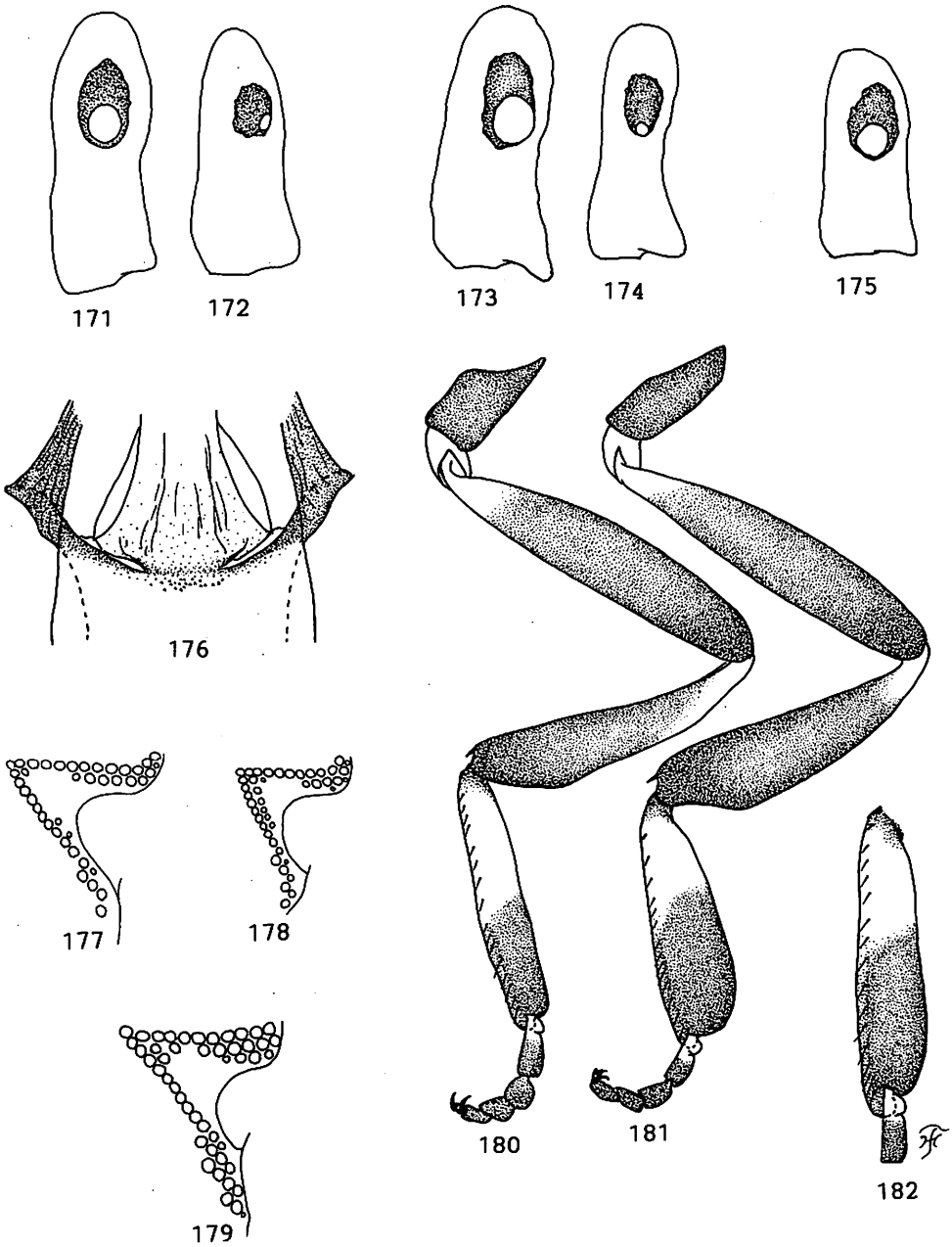
Apart from minor differences, there are variations in the key characters, such as the shape and number of the pupal gill filaments, the row number of the male large facets, and the presence or absence of the subapical spine on the male style depending on the three localities sampled, i.e., East Java and West Java (Cibodas Botanic Garden and Puncak, both in the Mt. Gede area).

**FEMALE.** A large species (body length ca. 3.2 mm). ***Head.*** Narrower than width of thorax. Frons black, shiny, thinly greyish pruinose, with several dark stout hairs along lateral margins; frontal ratio 1.3:1.0:1.1; frons-head ratio 1.0:4.4 (1.0:3.9 in the East Javanese specimen). Fronto-ocular area (Fig. 177) well developed. Clypeus black, shiny, greyish pruinose, with dark stout hairs; when illuminated, clypeus silvery iridescent. Antenna composed of 2+9 segments, dark brown except scape and pedicel pale. Maxillary palp composed of 5 segments, proportional lengths of 3rd, 4th and 5th segments 1.0:1.0:2.1; 3rd segment not enlarged; sensory vesicle (Fig. 171) of medium size, oblong, with rugged surface, 0.3 × length of 3rd segment, 1.9 × as long as wide, with large round opening distally (diameter 0.7 × width of sensory vesicle). Maxillary lacinia with 14–17 inner and 14 or 15 outer teeth. Mandible with ca. 26 inner and 11 outer teeth. Cibarium (Fig. 176) with ca. 20 minute tubercles. ***Thorax.*** Scutum brownish black without distinct vittae (paralectotype female), although in alcoholic specimens scutum dark brown with 3 faint longitudinal black vittae composed of 1 medial and 2 submedial vittae, the submedial 2 vittae arising from inner border of submedial black spots along anterior margin, running posteriorly to unite with large black spot on prescutellar area where medial vitta also terminates; when illuminated anteriorly and viewed dorsally, scutum with pair of whitish pruinose spots subanteriorly; when illuminated posterodorsally and viewed dorsally or laterally, scutum entirely whitish grey pruinose (more prominent peripherally, especially on shoulders and along lateral borders) or leaving pair of subanterior spots dark brown partially or entirely; scutum covered densely with recumbent, yellow pubescence and short less recumbent dark hairs, interspersed with long, erect dark hairs on prescutellar area. Scutellum dark brown with recumbent yellow pubescence and long dark hairs. Postscutellum dark brown, shiny, whitish grey pruinose, iridescent when illuminated, bare. Pleural membrane bare. Katepisternum longer than deep, bare. ***Legs.*** Almost blackish except fore coxa, base of fore trochanter, base of mid tibia, basal 1/2 of mid basitarsus (border not well defined), hind trochanter, base of hind femur and tibia, basal 1/2 of hind basitarsus, and basal 2/5 of hind 2nd tarsomere whitish yellow; when illuminated in certain angles of light all tibiae with whitish sheen on outer surface (fore tibia) or posterior one (mid and hind tibiae). Fore basitarsus somewhat dilated distally (W:L = 1.0:4.6). Hind tibia at widest 0.9 × width of femur; hind basitarsus (Fig. 180) parallel-sided, W:L = 1.0:5.6; calcipala short, width to that of basitarsal tip is 1.0:1.7, W:L ratio 1.0:0.8; pedisulcus distinct; all tarsal claws simple. ***Wing.*** Length 3.2 mm; costa with spinules and hairs; subcosta fully haired; basal section of vein R fully haired; hairs at base of stem vein dark brown; basal cell absent. ***Abdomen.*** Basal scale brownish black with fringe of dark hairs; 2nd segment pale on anterior 1/2 and brownish black on posterior 1/2, with large, dorsolateral whitish iridescent spots broadly connected to each other medially; tergites 3–5 small, brownish black, tergites 6–8 large, brownish black, shining, with dark hairs. ***Genitalia*** (Figs. 185, 186). Ventral surface of abdominal segment 7 with very large sternal plate medially, covered densely with long dark hairs except anterior 1/3 bare. Sternite 8 well sclerotized, with anterior expansion medially, bare medially but with 26–32 hairs on each side (smaller and shorter ones submedially, longer and stouter ones laterally); anterior gonapophyses triangular flap-shaped, protruding ventrally, then curved inward distally and meeting each other apically in middle, thin, membraneous, pale brownish, covered with a few short setae as well as numerous microsetae; each with inner border largely concave, rather widely folded back throughout its length, moderately covered with microsetae on this folded area as well as on the outer surface. Genital fork of inverted-Y form; stem slender and well sclerotized, tip somewhat flattened (only slightly so in the East Javanese specimen); arms slender, each with strongly sclerotized distal ridge and distinct projection directed anterodorsally. Paraproct in ventral view widened (L:W = 1.00:0.85), well sclerotized basally, having ventral projection medially, apex directed ventrally, not sclerotized, rounded, with a few short dark setae and numerous transparent setae; antero-internal surface of paraproct well sclerotized, gently sloped, with a few short setae; outside surface widely depressed, smooth, lacking microsetae except narrow area along posterior border where ca. 20 stout hairs and numerous microsetae are present. Cercus nearly subquadrate (semi-

circular in the East Javanese specimen), ca. 0.35 × as long as wide, covered with numerous stout hairs (ca. 40). Spermatheca nearly globular, well sclerotized except tube and small area of tubal base, with indefinite reticulate pattern; minute internal setae present.

**MALE.** Body length 3.2 mm. ***Head.*** As wide as thorax. Upper eye consisting of large facets in 21–23 horizontal and 18 or 19 vertical rows (n = 3) (18 or 19 horizontal and 16 vertical rows in the East Javanese specimens including lectotype, n = 5 and 16 or 17 horizontal and 14–16 vertical rows in the Puncak specimens, n = 4). Clypeus black, whitish grey pruinose, iridescent when illuminated, sparsely covered with dark brown hairs. Antenna composed of 2+9 segments, dark brown, scape, bases of pedicel and 1st flagellar segment pale; 1st flagellomere elongated (W:L = 1.0:2.1). Maxillary palp composed of 5 segments, proportional lengths of 3rd, 4th and 5th segments 1.0:1.1:2.2; 3rd segment of normal size, with small elliptical sensory vesicle (Fig. 172), 0.2 × length of 3rd segment. ***Thorax.*** Scutum brownish black (3 faint narrow black longitudinal vittae in alcoholic specimens), with white pruinose and iridescent pattern differing with angles of light: when illuminated anterodorsally and viewed dorsally, scutum shows transverse pair of narrow subquadrate spots subanteriorly (slightly widened apically) widely spaced in middle; when illuminated anteriorly, these spots fused, extending anteriorly in middle as broad medial spot connected with narrow pruinose spot along anterior margin; when illuminated posterodorsally and viewed dorsally, scutum shows anterior pair of narrow, subquadrate, somewhat arched spots on shoulders, directed posteromedially, and large transverse spot on posterior 2/5 including entire prescutellar area; when illuminated anterolaterally and viewed laterally, scutum on each side has large anterior spot including anterior and subanterior narrow spots mentioned above, which extends posteriorly along lateral border and continues to posterior large spot; scutum uniformly and densely covered with golden yellow recumbent pubescence, interspersed with short dark pubescence near anterior border and long erect hairs on prescutellar area. Scutellum brownish black, whitish pruinose, with several erect dark hairs and golden pubescence. Postscutellum brownish black, whitish pruinose, iridescent when illuminated, bare. Pleural membrane and katepisternum as in female. ***Legs.*** Almost blackish except fore coxa, base of mid tibia, basal 1/3 of mid basitarsus, hind trochanter, base of hind femur and tibia, basal 2/5 of hind basitarsus and basal 1/3 of hind 2nd tarsomere whitish yellow. Fore basitarsus somewhat dilated (W:L ratio 1:6); hind basitarsus (Fig. 181) enlarged (W:L = 1.0:3.3), as wide as hind tibia; calcipala small, as long as wide; pedisulcus distinct at basal 1/3 of 2nd tarsomere. ***Wing.*** Length 3.2 mm; other features as in female except subcosta and basal portion of vein R entirely bare. ***Abdomen.*** Basal scale blackish with long dark hairs. Dorsal surface of abdomen black, with dark hairs; segments 2, 5–7 each with pair of silvery iridescent areas dorsolaterally, connected broadly on segment 2 or connected narrowly on other segments to each other medially. ***Genitalia*** (Figs. 191–94). Coxite in ventral view 1.2 × as long as wide, ca. 0.67 × length of style; style length 3.8 × width at base, nearly parallel-sided on basal 1/3, abruptly narrowed toward distal 1/3, nearly parallel-sided on distal 1/3, inner side widely concave on distal 1/2 in ventral view; style spatulate ventrodorsally, with prominent subbasal protuberance pointed dorsally bearing many spines on tip and anterior surface, with subterminal spine (in Tretes of East Java as well as in Puncak of West Java, a subterminal spine is absent or present and, if present, is slender or stout depending on the individual specimens). Ventral plate: in ventral view body nearly pear-shaped, irregularly dentate posteriorly, almost bare except several minute setae near center, basal arms short, diverging; in lateral view, body slightly expanded posteriorly, with dentate posterior margin; in end view body equilaterally triangular in shape, bare, with weakly developed teeth on posterolateral margins. Median sclerite and paramere as in *S. (S.) upikae* sp. nov.

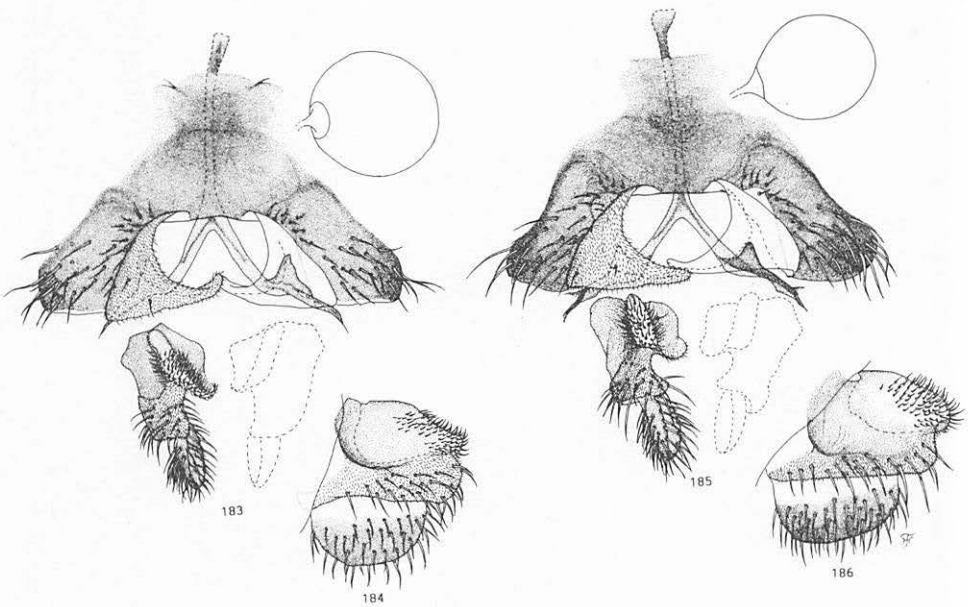
**PUPA.** Body length (excluding gill filaments) ca. 4.0 mm. ***Head.*** Integument yellow, densely covered with rather large yellow tubercles nearly rounded in shape bearing on their surface several minute tubercles (in West Javanese specimens tubercles are of usual size much smaller than those on the thoracic integument), with 1 facial pair of bifid or trifid long trichomes and 2 frontal pairs of simple, short trichomes. ***Thorax.*** Integument yellow, with anterior pair of rugose swellings (Fig. 207), moderately covered with rather large brown tubercles similar to those on head, though somewhat smaller in size laterally, with cone-shaped processes on posterior surface; thorax with 4 dorsal pairs of branched trichomes split into 6–8 as well as 1 lateral pair of trichomes with 5 branches. Gill (Fig. 203) with 9 slender filaments, arranged (dorsal to ventral) 2+2+2+2+1 in flat vertical plane, dorsal 4 filaments slightly shorter and thinner than ventral 5 (in East Java 8 pupae examined all had 10 filaments in pairs, all subequal in length and thickness (Fig. 202) as described by Edwards (1934); specimens collected from Puncak, West Java showed variations as follows: out of 27 pupae, 8 pupae had 10 filaments of




**Figs. 171–75.** 3rd segments of maxillary palp (171, ♀ *S. (S.) eximium*; **172**, ♂ *S. (S.) eximium*; **173**, ♀ *S. (S.) upikae*; **174**, ♂ *S. (S.) upikae*; **175**, ♀ *S. (S.) thienemanni*). **Fig. 176.** ♀ cibarium of *S. (S.) eximium*.

**Figs.177–79.** Fronto-ocular areas of ♀; **177**, *S. (S.) eximium*; **178**, *S. (S.) thienemanni*; **179**, *S. (S.) upikae*.

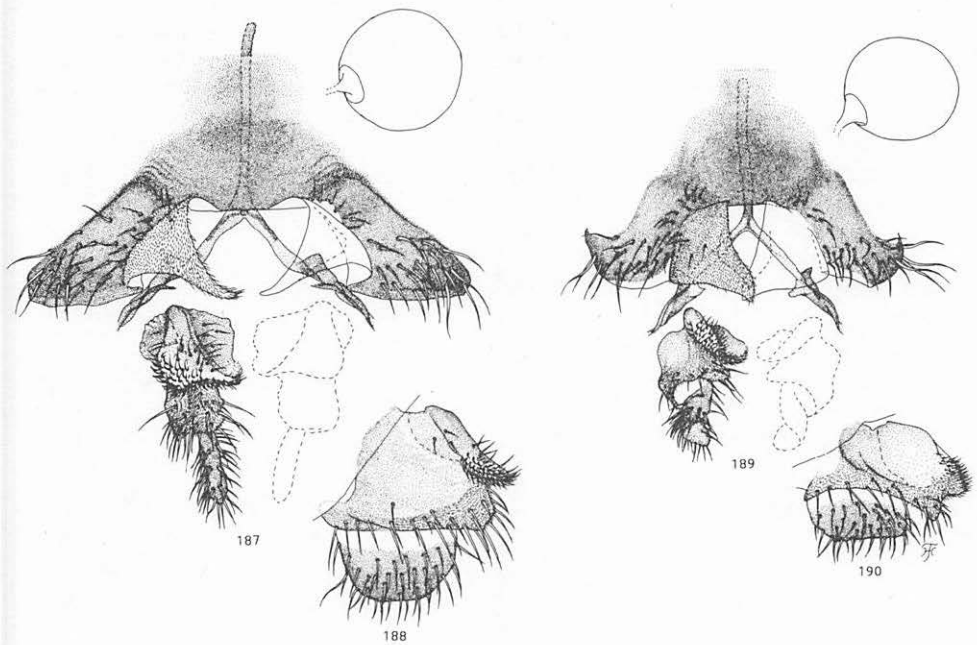
**Figs. 180–81.** Hind legs of *S. (S.) eximium* (180, ♀; 181, ♂). **Fig. 182.** Basitarsus and 2nd tarsal segment of ♂ hind leg of *S. (S.) upikae*.




**Figs. 183–86.** ♀ genitalia of *S. (S.) eximium* (183 and 184, East Javanese specimen from BMNH; 185 and 186, West Javanese specimen collected from Cibodas Botanic Garden). **183** and **185**, ventral view of genitalia; **184** and **186**, lateral view of paraproct and cercus.

subequal length as East Javanese specimens, 14 pupae had 10 filaments of which only the 9th filament from dorsal was shortened, 1/3 to 3/4 × as long as 10th filament (e.g., Fig. 204), 1 pupa had 10 filaments on one side and 9 filaments on the other, 4 pupae had 9 filaments lacking the 9th filament from dorsal, like those from Cibodas Botanic Garden); upper 3 pairs very short- stalked, 4th pair almost sessile; all filaments much shorter than pupa, not extending beyond opening of cocoon, gradually tapering, on their surface with very distinct annular ridges and furrows throughout their length, forming well defined reticulate pattern, covered with minute tubercles of different sizes, larger ones on ridges and smaller ones on inter-ridges; all filaments greyish brown, much darker than coloring of thoracic integument. ***Abdomen***. Tergum 1 with 1 simple slender hair on each side. Tergum 2 on each side with 1 long simple seta and 5 short simple, spinous setae of which 4 are stouter. Terga 3 and 4 each with 4 hooked spines along posterior margin on each side. Terga 7–9 without distinct spine-combs although comb-like groups of minute spines are present. Tergum 9 with pair of distinct terminal hooks. Sternum 4 with several minute simple setae submedially on each side. Sternum 5 with pair of bifid hooks submedially on each side. Sterna 6 and 7 each with pair of bifid inner and simple outer hooks widely spaced on each side. Grapnel-like hooklets absent. ***Cocoon*** (Fig. 208). Boot-shaped, with rather high front wall, somewhat loosely woven with flat coarse fibers, forming several large open spaces near opening; 1/2 of ventral surface with floor posteriorly.

**MATURE LARVA**. Body length 7.4–8.5 mm. Body color dark greyish. Cephalic apotome usually yellow or dark yellow on anterior 1/2, light brown to dark brown on posterior 1/2, with darkest narrowly along posterior border; anterior longitudinal median head spot usually positive in lighter ground color, posterior spot also positive but outline not well defined due to dark ground color; anterolateral spots usually as dark as or slightly paler than ground color, posterolateral spots usually paler than ground color (faintly or markedly negative depending upon extent of darkness of ground color). Antenna composed of 3 segments and apical sensillum, longer than stem of labral fan; length ratio of segments from base to tip 1.0:1.2:0.3. Labral fan with ca. 60 main rays. Mandible (Fig. 214) with mandibular serrations composed of a medium and a small tooth but no supernumer-




**Figs. 187–90.** ♀ genitalia (187 and 188, *S. (S.) upikae*; 189 and 190, *S. (S.) thienemanni* (BMNH)). **187** and **189**, ventral view of genitalia; **188** and **190**, paraproct and cercus in lateral view.

ary serrations; 2nd and 3rd comb-teeth of equal size, shorter than 1st. Hypostomal teeth 9, small, with median tooth longer than others; lateral margins weakly serrate apically; 9–11 hypostomal bristles (in East Javanese specimens only 7 bristles as shown in Fig. 211) diverging posteriorly from lateral border on each side. Postgenal cleft (Fig. 211) rounded apically, 1.5–2.0 × as long as postgenal bridge. Thoracic cuticle almost bare. Abdominal cuticle almost bare except each side of anal sclerite covered with short colorless setae. Rectal papilla of 3 lobes, each with 10–14 finger-like secondary lobules. Anal sclerite X-shaped, with broadened anterior arms ca. 0.66 × as long as posterior ones. Last abdominal segment bulged laterally, lacking ventral papillae. Posterior circlet with ca. 210 rows of hooklets with up to 24 hooklets per row.

**SPECIMENS EXAMINED**. EAST JAVA: Lectotype ♂ and paralectotype ♀, both pinned, Nongkodjadjar, I. 1911, E. Jacobson (ZMA, lectotype designation by R.W. Crosskey, 1968); 2 ♀, pinned, no data on locality and date, E. Jacobson (ZMA); 1 ♀, pinned (head and genitalia removed and mounted on slide), Pasoeroean, Poenten, VIII. D. Friederichs (BMNH-1931-554); 1 ♂ reared from pupa, 3 pharate ♂ and 6 mature larvae, all in alcohol, Tretes, 17.XII.1990, H. Takaoka; 2 pupae and 3 mature larvae, all in alcohol, Kali Rorura near Poenten, VIII. D. Friederichs (BMNH). WEST JAVA: 1 ♀, pinned, Cibodas, 4500 ft., 8.XII. F. Muir (BISHOP); 3 ♀, 2 ♂, 1 pharate ♂, 4 pupae and 3 mature larvae, Cibodas Botanic Garden, ca. 1200 m. above sea level, 5.I.1991, H. Takaoka and U.K. Hadi; 1 ♂, reared from pupa and pinned, Cibodas Botanic Garden, 17.XII.1975, D.M. Davies; 3 ♀, 5 ♂, 19 pupae and 10 mature larvae, Tugu, Puncak, 19.VIII.1991, H. Takaoka and U.K. Hadi.

**DISTRIBUTION**. East and West Java.

**ECOLOGICAL NOTES**. Pupae and larvae of this species were collected on trailing grasses and on the surface of stones in the rapids of fast-flowing shaded streams (ca. 0.5–1.0 m wide) running in the natural forests in Cibodas Botanic Garden and also in Puncak.

**REMARKS.** This species was assigned in the *multistriatum*-group by Crosskey (1987). However, it would be better to remove this species, together with its close ally, *S. (S.) thienemanni*, from this group because the females of both species have no (or a trace of) longitudinal vittae on the scutum, and because of the characteristic shape of the anterior gonapophyses and paraprocts.

As already mentioned, there are variations in the pupal gill filaments in the *S. (S.) eximium* population of Puncak in West Java. It may be interpreted that having originally nine or ten filaments of subequal length on each side, the pupae are in the process of attaining or losing the ninth filament. Both ends of this variation range seem to be well represented by the populations of East Java and Cibodas in West Java, respectively.

There are also variations in relation to the subterminal spine of the male style in both populations of Tretes in East Java and Puncak in West Java. Some males lack a subterminal spine as previously reported by Edwards (1934). Others have a slender or stout spine as observed in the males from Cibodas.

Although there are differences in the row number of male large eye facets, between individual specimens and also between populations, as well as minor ones as noted in the description, the genitalia of both sexes are essentially the same.

**15. *Simulium (Simulium) upikae*** Takaoka and Davies, **new species** Figs. 173, 174, 179, 182, 187, 188, 195–201, 205, 209, 212, 215

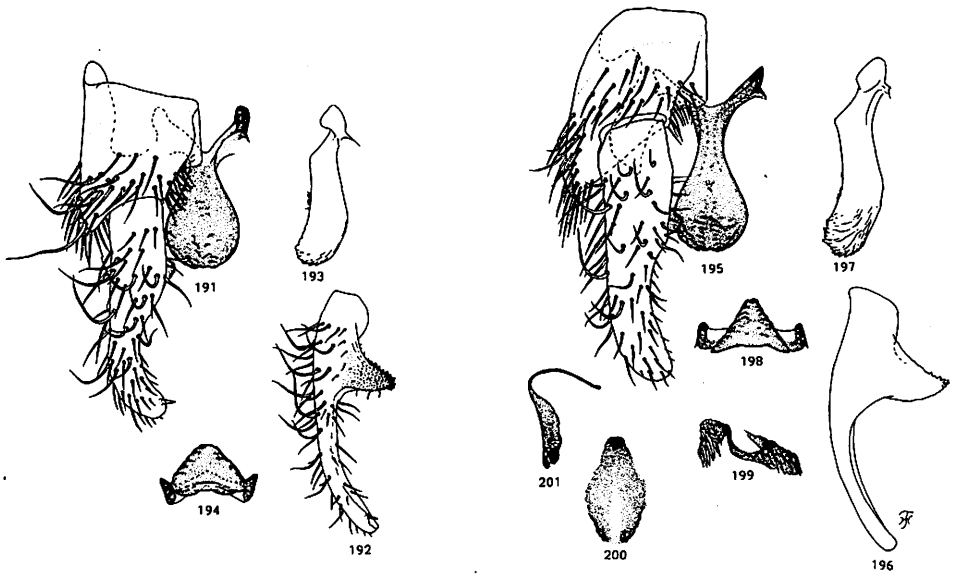
**FEMALE.** A large species (body length 3.3 mm). ***Head.*** Narrower than width of thorax. Frons black, shiny, whitish pruinose near antennal base, with several dark stout hairs along lateral margins; frontal ratio 1.30:1.00:1.12; frons-head ratio 1.0:4.0. Front-ocular area (Fig. 179) well developed. Clypeus black, shiny, whitish grey pruinose, with many dark stout hairs; when illuminated, clypeus iridescent. Antenna composed of 2+9 segments, dark brown, except scape, pedicel and base of 1st flagellomere yellowish (a few basal flagellar segments yellowish on anterior surface). Maxillary palp composed of 5 segments, proportional lengths of 3rd, 4th and 5th segments 1.0:1.1:2.2; 3rd segment not enlarged; sensory vesicle (Fig. 173) of medium size, with rugged surface, 0.4 × length of 3rd segment, 1.9 × as long as wide, with very large round opening (diameter nearly as wide as sensory vesicle) occupying almost entire distal 1/2. Maxillary lacinia with 14 inner and 14 outer teeth. Mandible with ca. 28 inner and 10 outer teeth. Cibarium with ca. 7 very minute tubercles. ***Thorax.*** As in female of *S. (S.) eximium*. ***Legs.*** Almost blackish except fore coxa, base of fore trochanter, base of mid tibia, basal 1/4 or 1/3 of mid basitarsus (border not well defined), hind trochanter, base of hind femur and tibia, basal 1/2 of hind basitarsus, and basal 2/5 of hind 2nd tarsomere whitish yellow; when illuminated in certain lights, all tibiae with iridescent sheen on outer surface (fore tibia) or posterior one (mid and hind tibiae). Fore basitarsus somewhat dilated distally (W:L = 1.0:5.3); hind basitarsus parallel-sided (W:L = 1.0:6.5); calcipala short, width to that of basitarsal tip is 1.0:1.7, W:L ratio 1:1; pedisulcus distinct. All tarsal claws simple. ***Wing.*** Length 3.1 mm; costa with spinules and hairs; subcosta fully haired; basal section of vein R fully haired; hairs at base of stem vein dark brown; basal cell absent. ***Abdomen.*** As in female of *S. (S.) eximium*. ***Genitalia*** (Figs. 187, 188). Ventral surface of segment 7 with very large sternal plate medially, densely covered with long dark hairs except entire anterior 1/3 and anterior 3/4 in the middle bare. Sternite 8 well sclerotized, with anterior expansion medially, bare medially but 28–30 hairs on each side (smaller and shorter ones submedially and longer and stouter ones laterally); anterior gonapophyses triangular flap-shaped, protruding ventrally, then curved inward distally and converging apically in middle; each thin, membraneous, brownish, covered with several minute setae and numerous microsetae; inner border largely concave, widely folded back throughout its length, moderately covered with microsetae on folded area and on outer surface. Genital fork of inverted-Y form; stem slender, well sclerotized, its tip not flattened; arms slender, each with strongly sclerotized distal ridge and distinct short projection directed anterodorsally. Paraproct in ventral view widened (L:W = 1.0:0.7), well sclerotized anteriorly, with ventral projection medially, its apex rounded, directed posterolaterally, covered with numerous transparent short setae; internal and ventral surface of median projection well sclerotized except near apex, somewhat plate-like, with ca. 17 short setae, without microsetae; when viewed from outside, paraproct shallowly depressed, with a few short setae anteriorly and with ca. 27 stout hairs along posterior border, but

largely smooth, lacking microsetae, except narrow area along posterior border. Cercus in lateral view rounded posteriorly, ca. 0.42 × as long as wide, covered with numerous stout hairs (ca. 30). Spermatheca nearly globular, well sclerotized, with definite reticulate pattern; tube and small area of spermatheca unsclerotized; minute internal setae present.

**MALE.** Body length 3.2 mm. ***Head.*** Slightly wider than thorax. Upper eye with 18–20 horizontal and 18 or 19 vertical rows of large facets. Clypeus black, whitish grey pruinose, iridescent when illuminated, covered sparsely with dark brown hairs. Antenna composed of 2+9 segments, dark brown, scape and base of pedicel and 1st flagellomere pale; 1st flagellomere elongated (W:L = 1:2), 1.7 × length of 2nd flagellomere. Maxillary palp composed of 5 segments, proportional lengths of 3rd, 4th and 5th segments 1.0:1.2:2.5; 3rd segment of normal size; sensory vesicle (Fig. 174) oblong, 0.27 × length of 3rd segment, with small opening distally. ***Thorax.*** As in male of *S. (S.) eximium*. ***Legs.*** Almost blackish except fore coxa, base of mid tibia, basal 1/3 of mid basitarsus, hind trochanter, base of hind femur and tibia, basal 2/5 of hind basitarsus and basal 1/3 of hind 2nd tarsomere whitish yellow. Fore basitarsus somewhat dilated (W:L = 1:6). Hind basitarsus (Fig. 182) enlarged, ca. 4 × as long as its widest at distal 1/4, ca. 0.8 × as wide as hind tibia which is subequal at widest to hind femur; calcipala small, as long as wide; pedisulcus distinct at basal 1/3 of 2nd tarsomere. ***Wing.*** Length 2.8 mm; other features as in female except subcosta and basal portion of vein R entirely bare. ***Abdomen.*** As in male of *S. (S.) eximium*. ***Genitalia*** (Figs. 195–201). Coxite nearly quadrate in ventral view, produced posterolaterally, much shorter than style; style length 3.7 × width at base, nearly parallel-sided on basal 1/3, abruptly narrowed toward distal 1/3, nearly parallel-sided on distal 1/3, inner side widely concave on distal 1/2 in ventral view; style spatulate ventrodorsally, prominent subbasal protuberance pointing dorsally bearing ca. 10 cone-like spines on tip and anterior surface, without terminal spine. Ventral plate: in ventral view body nearly pear-shaped, irregularly dentate posteriorly, almost bare except several minute setae near center, basal arms short, diverging; in lateral view body slightly curved ventrally near posterior end, with dentate posterior margin; in end view body equilaterally triangular in shape, with numerous, weakly-developed teeth, bare. Median sclerite of shoehorn shape, thin, gradually widened toward distal 1/4, slightly narrowed apically, ended roundly; lateral borders near apex strongly sclerotized, appear irregularly dentate. Paramere with numerous long and short hooks.

**PUPA.** Body length (excluding gill filaments) 3.6 mm. ***Head.*** Integument yellow, covered densely with rather large yellow tubercles nearly rounded in shape with several minute tubercles on their surface, with 1 facial and 2 frontal pairs of bifid or trifid trichomes (facial trichomes much longer than frontal ones). ***Thorax.*** Integument yellow, with anterior pair of prominently protruding sublateral ridges, moderately covered with rather large brown tubercles similar to those on head, though somewhat smaller in size laterally, with cone-shaped processes on posterior surface; thorax with 4 dorsal pairs of trichomes each with ca. 9 branches plus 1 lateral pair of trifid trichomes. Gill (Fig. 205) with 10 slender greyish brown filaments in pairs (much darker than coloring of thoracic integument), very short-stalked except 4th pair of filaments from dorsal almost sessile, slightly tapering apically, much shorter than pupa; all filaments widely dispersed in flat vertical plane, not extending beyond opening of cocoon, subequal in length and thickness to one another except lowermost pair of filaments ca. 0.5 or 0.6 × as long as other filaments; when thickness near tips are compared, lowermost paired filaments ca. 1.5 × as thick as other filaments; surface of filaments with very distinct annular ridges and furrows throughout their length, forming reticulate pattern, covered with minute tubercles of different sizes, larger ones on ridges and smaller ones on inter-ridges. ***Abdomen.*** Tergum 1 with 1 bifid slender hair on each side. Tergum 2 on each side with 1 long simple seta and 5 short simple spinous setae of which 4 are stouter than the rest. Terga 3 and 4 each with 4 hooked spines along posterior margin on each side. Terga 7–9 without distinct spine-combs although comb-like groups of minute spines are present. Tergum 9 with pair of distinct terminal hooks. Sternum 4 with several minute simple setae submedially on each side. Sternum 5 with pair of bifid hooks submedially on each side. Sterna 6 and 7 each with pair of bifid inner and simple outer hooks widely spaced on each side. Grapnel-like hooklets absent. ***Cocoon*** (Fig. 209). Boot-shaped, with rather high front wall, somewhat loosely woven with flat coarse fibers, forming only a few very small open spaces near opening; 1/2 of ventral surface with floor posteriorly.

**MATURE LARVA.** Body length 7.8–8.6 mm. Body color greyish or blackish brown. Cephalic apotome as in *S. (S.) eximium*. Antenna composed of 3 segments and apical sensillum, longer than stem of labral fan; length ratio of segments from base to tip 1.0:1.2:0.4. Labral fan with ca. 50 main rays. Mandible (Fig. 215) with




**Figs. 191-201.** ♂ genitalia (191-194, *S. (S.) eximium*; 195-201, *S. (S.) upikae*). **191** and **195**, ventral view of genitalia; **192** and **196**, styles viewed from inside; **193** and 197, ventral plates in lateral view; **194** and **198**, ventral plates in end view; **199**, paramere; **200** and **201**, median sclerite (200, ventral view; 201, side view).

mandibular serrations composed of a medium and a small tooth but no supernumerary serrations; 2nd and 3rd comb-teeth of equal size, shorter than 1st. Hypostomal teeth 9, small, with the median and each corner tooth longer than others; lateral margins weakly serrate apically; 7 or 8 hypostomal bristles diverging posteriorly from lateral border on each side. Postgenal cleft (Fig. 212) medium in size, rounded apically, parallel-sided or slightly widened towards base, ca. 2 × as long as postgenal bridge. Thoracic cuticle almost bare. Abdominal cuticle very sparsely covered with minute colorless setae on posterior segments, moderately with short, pale setae on each side of anal sclerite. Rectal papilla of 3 lobes, each with 10–17 finger-like secondary lobules. Anal sclerite X-shaped, with broadened anterior arms ca. 0.6 × as long as posterior ones. Last abdominal segment bulged laterally but lacking ventral papillae. Posterior circlet with ca. 186 rows of hooklets with up to 22 hooklets per row.

**SPECIMENS EXAMINED.** WEST JAVA: Holotype ♀ (BISHOP), slide mounted, reared from pupa, Puncak, 4.I.1991, H. Takaoka and U.K. Hadi; allotype ♂, same data as holotype except date, 26.VIII.1991; paratypes 1♀, 2♂, 2 pupae and 3 mature larvae same data as allotype.

**ECOLOGICAL NOTES.** The pupa of this new species was collected on trailing grasses in a stream (0.5–1.0 m wide) running down on mountain slope opened for tea cultivation (altitude ca. 1000 m), in January 1991. In the following survey made in August, no black fly larvae were collected from the same stream which was almost dried up, but several pupae and larvae of this new species were found, together with *S. (S.) eximium*, attached to the surface of stones in a rapid permanent stream (2–3 m wide; 1220 m in altitude) in the natural forest above the tea cultivation area mentioned above.

**DISTRIBUTION.** West Java.

**REMARKS.** This new species was named after Ms Upik K. Hadi, lecturer at Entomology Department, Faculty of Veterinary Medicine, Bogor Agricultural University, who helped us in various ways during the surveys.

This species is very similar to *S. (S.) eximium*. However, there are differences in the number of minute tubercles on the cibarium and the shape of paraprocts of the female, relative size of pupal gill filaments and the shape of the cocoon.

### 16. *Simulium (Simulium) thienemanni* Edwards, 1934

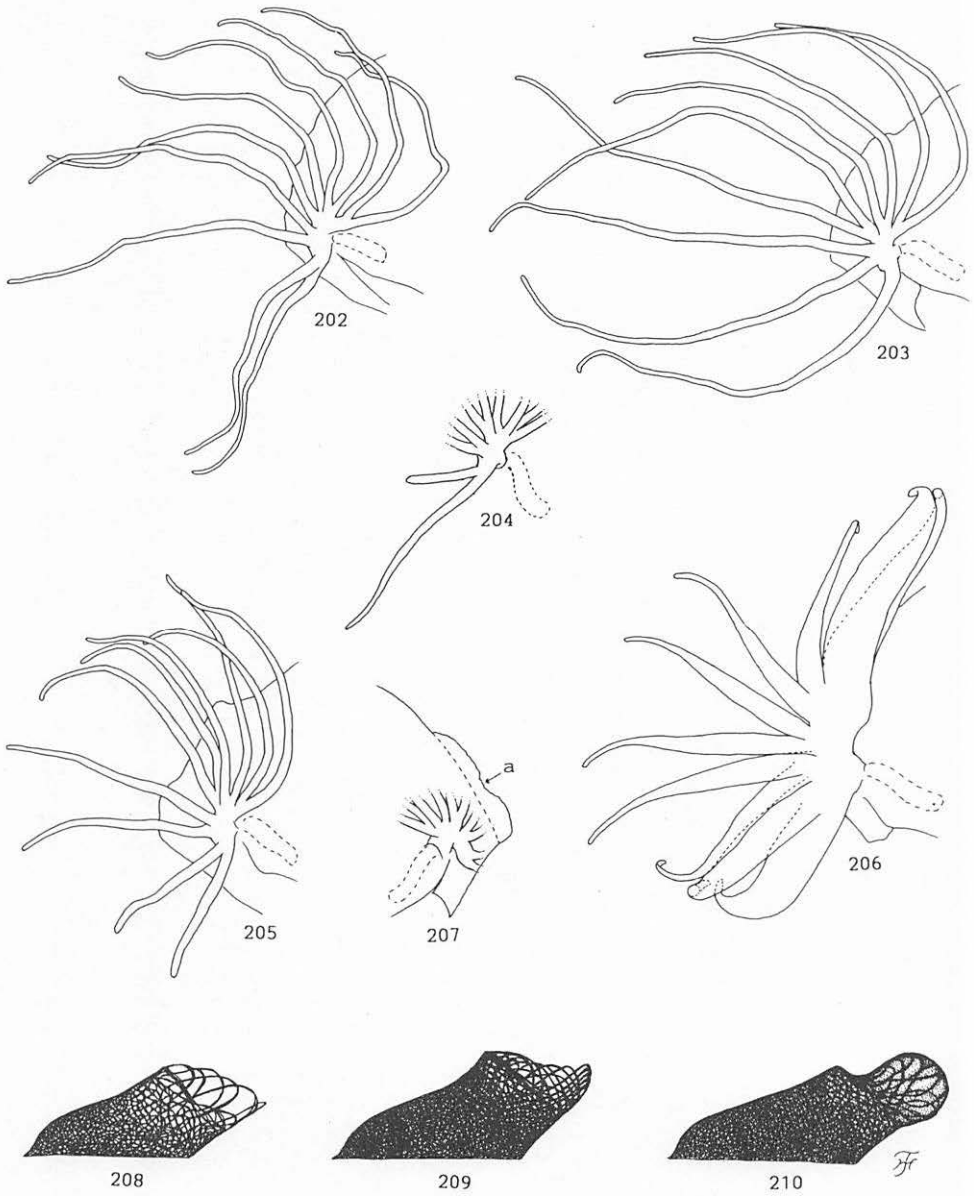
Figs. 175, 178, 189, 190, 206, 210, 213, 216

*Simulium (Simulium) thienemanni* Edwards, 1934: 106–08 (female, male, pupa and larva); Crosskey, 1973: 409; Crosskey,1987: 474.

According to the original description made by Edwards (1934), *S. (S.) thienemanni* closely resembles *S. (S.) eximium* but is distinguished by the following characters: the female of this species has thoracic markings less obvious, three dark vittae scarcely distinguishable, and yellow portions of legs more extensive (e.g., hind tibiae with almost the basal 1/2 yellow and hind basitarsus with rather more than the basal 1/2 yellow); the male also has the tibiae more extensively yellow at base (e.g., hind tibiae with almost the basal 1/3 yellow) and each style has a subterminal spine; the pupa bears the respiratory organ with 10 swollen filaments as well as its cocoon with ear-shaped anterior walls.

As in *S. (S.) eximium*, genitalia of the female were not previously studied, while those of the male were well illustrated showing a close similarity to that of *S.(S.) eximium*. The pinned female of *S. (S.) thienemanni* (paralectotype, BMNH) was examined in this study and the female genitalia, as well as some features on the head, are described for the first time. The pupa and larva also borrowed from BMNH were reexamined.

**FEMALE.** ***Head.*** Narrower than width of thorax. Frons black, shiny, whitish pruinose near antennal base, with several dark stout hairs along lateral margins; frontal ratio 1.53:1.00:1.15; frons-head ratio 1.0:3.5. Fronto-ocular area (Fig. 178) well developed. Clypeus black, shiny, whitish grey pruinose, with many dark stout hairs; when illuminated, clypeus iridescent. Antenna composed of 2 +9 segments, dark brown, scape, pedicel and basal tip of 1st flagellar segment yellowish (a few basal flagellar segments yellowish on anterior surface). Maxillary palp with 5 segments, proportional lengths of 3rd, 4th and 5th segments 1.0:1.1:1.9; 3rd segment not enlarged; sensory vesicle (Fig. 175) of medium size, elliptical, with rugged surface, 0.37 × length of 3rd segment, 1.53 × as long as wide, with large round opening distally (diameter 0.6 × widest part of sensory vesicle). Maxillary lacinia with 12 inner and 13 outer teeth. Mandible with ca. 24 inner and 10 outer teeth. Cibarium with ca. 30 minute tubercles. ***Thorax***, ***Wing***, ***Legs*** and ***Abdomen.*** Nearly as in original description. ***Genitalia*** (Figs. 189, 190). Ventral surface of segment 7 with very large sternal plate medially, covered densely with long dark hairs except entire anterior 1/3 bare. Sternite 8 well sclerotized, with anterior expansion medially, bare medially, 28–30 hairs (smaller and shorter ones submedially and longer and stouter ones laterally) on each side; anterior gonapophyses triangular flap-shaped, protruding ventrally at base, curved inward, meeting apically in middle, thin, membraneous, covered with several minute setae and numerous microsetae; inner border widely separated, nearly parallel-sided on anterior 3/5, converging posteriorly, finally crossing each other, each narrowly folded back throughout its length, moderately covered with microsetae on folded area and on outer surface. Genital fork of inverted-Y form; stem slender, well sclerotized, tip not flattened; arms slender, each with strongly sclerotized distal ridge and distinct short projection directed anterodorsally. Paraproct in ventral view widened (L:W = 1:1), well sclerotized basally, with ventral projection medially, apex directed ventrally, not sclerotized, rounded, with a few short setae and numerous transparent setae; internal surface of median projection well sclerotized, shallowly concave, with a few short setae; outside surface widely depressed, smooth, lacking microsetae, narrow area along posterior border with ca. 20 stout hairs and numerous microsetae. Cercus in lateral view nearly subquadrate, ca. 0.4 × as long as wide, covered with numerous stout hairs (ca. 30). Spermatheca nearly globular, well sclerotized except small area of tubal base, with weakly defined reticulate pattern and internal hairs.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**PUPA.** Body length (excluding gill filaments) 3.5–3.8 mm. ***Head.*** Integument yellow, moderately covered with rather large brown tubercles nearly rounded in shape and with several minute tubercles on their surface, with 1 facial and 2 frontal pairs of simple or bifid trichomes. ***Thorax.*** Integument pale yellow, with anterior pair of rugose swellings, moderately covered with rather large tubercles similar to those on head, though somewhat smaller in size laterally, with cone-shaped processes on posterior surface; thorax with 3 dorsal pairs of branched trichomes split into 4–6 plus 2 lateral pairs of branched trichomes split into 3–5. Gill (Fig. 206) with 10 inflated pale yellow filaments in pairs (almost the same coloring as thoracic integument), almost sessile, tapering apically, much shorter than pupa; uppermost and lowermost pairs of filaments much thicker and longer than filaments of intermediate pairs, curling round close to the body (i.e., head and thorax), partially overlapping those of opposite side; surface of filaments sparsely and irregularly roughened, forming small cone-shaped processes, densely covered with minute tubercles. ***Abdomen.*** Tergum 1 with 1 simple slender hair on each side. Tergum 2 on each side with 1 long simple seta and 5 short simple, spinous setae of which 4 are much stouter. Terga 3 and 4 each with 4 hooked spines along posterior margin on each side. Terga 7–9 without distinct spine-combs although comb-like groups of minute spines are present. Tergum 9 with pair of small but distinct terminal hooks. Sternum 4 with several minute simple setae submedially on each side. Sternum 5 with pair of bifid hooks submedially on each side. Sterna 6 and 7 each with pair of bifid inner and simple outer hooks widely spaced on each side. Grapnel-like hooklets absent. ***Cocoon*** (Fig. 210). Boot-shaped, with low or moderately high front wall, produced anteriorly and somewhat upwards on each side into large ear-shaped structure, loosely woven with flat coarse fibers, forming several open spaces on ear-shaped structure; 1/2 of ventral surface with floor posteriorly.

**MATURE LARVA.** Body length 7.4–8.3 mm. Body color greyish. Cephalic apotome dark yellow with dark area narrowly along posterior border; anterior and posterior longitudinal median head spots distinctively positive, anterolateral spots slightly darker than ground color, posterolateral spots indistinct. Lateral and ventral surface of head capsule dark brown except around eye spots. Antenna composed of 3 segments and apical sensillum, longer than stem of labral fan; length ratio of segments from base to tip 1.0:1.1:0.4. Labral fan with ca. 44 main rays. Mandible (Fig. 216) with mandibular serrations composed of a medium and a small tooth but no supernumerary serrations; 2nd and 3rd comb-teeth of equal size, shorter than 1st. Hypostomal teeth 9, median tooth longest, each corner tooth slightly longer than other intermediate teeth; lateral margins weakly serrate apically; 8 or 9 hypostomal bristles diverging posteriorly from lateral border on each side. Postgenal cleft (Fig. 213) medium in size, rounded apically, slightly widened towards base, ca. 2 × as long as postgenal bridge. Thoracic cuticle almost bare. Abdominal cuticle almost bare except each side of anal sclerite moderately covered with short colorless setae. Rectal papilla of 3 lobes, each with 10–11 finger-like secondary lobules. Anal sclerite X-shaped, with broadened anterior arms ca. 0.6 × as long as posterior ones. Last abdominal segment bulged laterally but lacking ventral papillae. Posterior circlet with ca. 200 rows of hooklets with up to 22 hooklets per row.

**SPECIMENS EXAMINED.** MID JAVA: Paralectotype ♀, pinned (head and genitalia mounted on slide), Sorangan, 6.XII.1925, A. Thienemann (BMNH-1931-244, paralectotype designation by R.W. Crosskey, 1987); 5 pupae, 2 mature and 3 immature larvae, Dieng Plateau, Parakbauring, VI.1929, A. Thienemann (BMNH, paralectotype). EAST JAVA: 1 mature larva, Coban, near Malang, 19.XII.1990, H. Takaoka.

**ECOLOGICAL NOTES.** In our survey, only one mature larva of *S. (S.) thienemanni* was collected on a trailing grass in the rapid of a forest stream (2–4 m wide). The majority of black flies collected from the same stream were *S. (S.) iridescens.*

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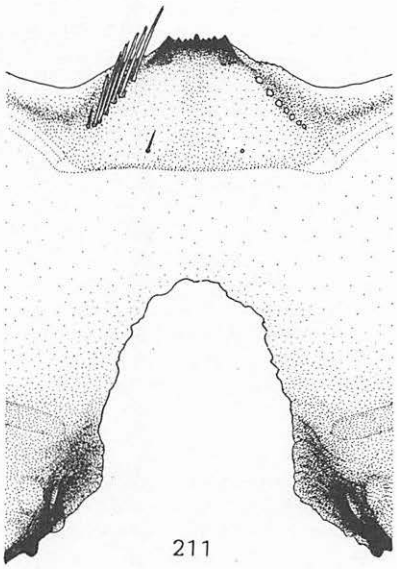
**Figs. 202-06.** Pupal gill filaments (from left side). 202–04, *S. (S.) eximium* (**202**, East Javanese specimen collected from Tretes, showing 10 filaments; **203**, West Javanese specimen of collected from Cibodas Botanic Garden, showing 9 filaments; **204**, West Javanese specimen collected from Puncak, with 10 filaments of which 9th filament is shortened, 1st to 8th filaments omitted); **205**, *S. (S.) upikae*, **206**, *S. (S.) thienemanni.*

**Fig. 207.** Anterior part of pupal thorax of *S. (S.) eximium* (from right view) showing a large rugose swelling on anterolateral surface (a).

**Figs. 208–10.** Lateral view of cocoons. **208**, *S. (S.) eximium* (East Java); **209**, *S. (S.) upikae*; **210**, *S. (S.) thienemanni.*



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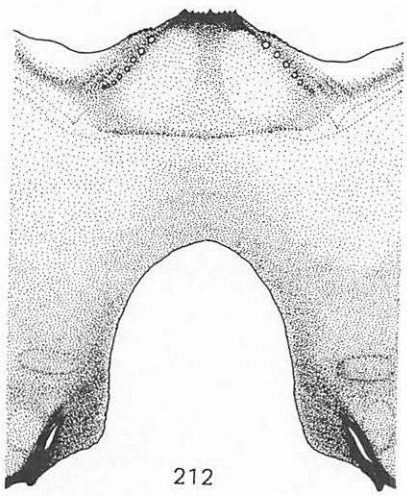

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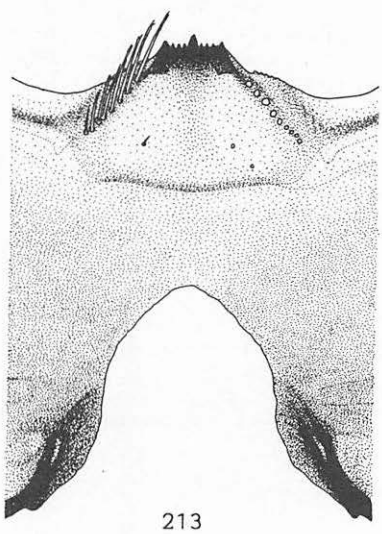

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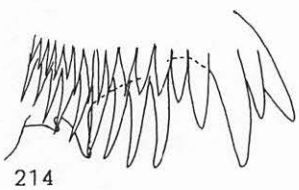

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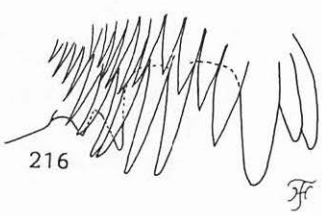

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**DISTRIBUTION.** Mid and East Java.

**REMARKS.** Edwards (1934) said that the cocoon of this species lacked a front wall, but all the five cocoons examined in this study had a low or moderately high front wall, thus boot-shaped as in *S. (S.) eximium*. Probably it was overlooked due to the large ear-shaped anterolateral structures.

Examination of the female genitalia revealed that anterior gonapophyses tapered toward the tip but not so narrowly as found in *S. (S.) eximium* and *S. (S.) upikae*.

### (C) *tuberosum*-group

**17. *Simulium (Simulium) sigiti*** Takaoka and Hadi, 1991 Figs. 217–38

*Simulium (S.) sigiti* Takaoka and Hadi, 1991:357–63. (female, male, pupa and larva).

*Simulium (S.) sigiti* was recently described from specimens collected from West Java (Takaoka & Hadi, 1991). This is the only species belonging to the *tuberosum*-group in Java, and is characterized by the presence of a pit-like cuticular organ at the base of the pupal gill (Fig. 232a), as well as shortened pupal gill filaments (Fig. 233).

**DISTRIBUTION.** West Java.

### (D) *nobile*-group

**18. *Simulium (Simulium) nobile*** de Meijere, 1907 Figs. 239–61

*Simulium nobile* de Meijere, 1907: 206. (male); Edwards, 1934: 115. (female, male, pupa and larva).
*Simulium (Simulium) nobile*: Crosskey, 1973: 428.
*Simulium kiuliense* Smart and Clifford, 1969: 26 (syn. by Crosskey in 1973).

This species was originally described from adult male specimens collected from Semarang, Central Java (De Meijere, 1907). The male, female, pupa and larva were briefly described by Edwards (1934) based on specimens collected from East and West Java and South Sumatra. Crosskey (1973) synonymized *S. kiuliense* from Sabah, and also added Malay Peninsula to the distribution of *S. nobile*. We reexamined the holotype male (ZMA) and most of the specimens examined by Edwards (BMNH), as well as other specimens collected by us. Revised descriptions of all stages are given below.

**FEMALE.** Body length 2.0 mm. ***Head.*** Narrower than width of thorax. Frons black, shiny, with several dark stout hairs along lateral margins; frontal ratio 1.2:1.0:1.3; frons-head ratio 1.0:4.7. Fronto-ocular area (Fig. 241) shallow, not deeply projecting laterally. Clypeus black, shiny, whitish pruinose, with scattered dark stout hairs; when illuminated, silvery iridescent. Antenna composed of 2+9 segments, yellow or tawny with apical 2 flagellar segments blackish; flagellar segments 1–7 often brownish dorsally, becoming darker apically with 2 or 3 apical segments blackish; in some females antenna dark brown to brownish black with scape, pedicel and base of 1st flagellar segment yellow. Maxillary palp brownish, composed of 5 segments, proportional lengths of 3rd, 4th and 5th segments 1.0:1.0:1.9; 3rd segment (Fig. 242) not enlarged; sensory vesicle small, elliptical, with rugged surface, 0.22 × length of 3rd segment, with small round opening distally. Maxillary lacinia with 10–13

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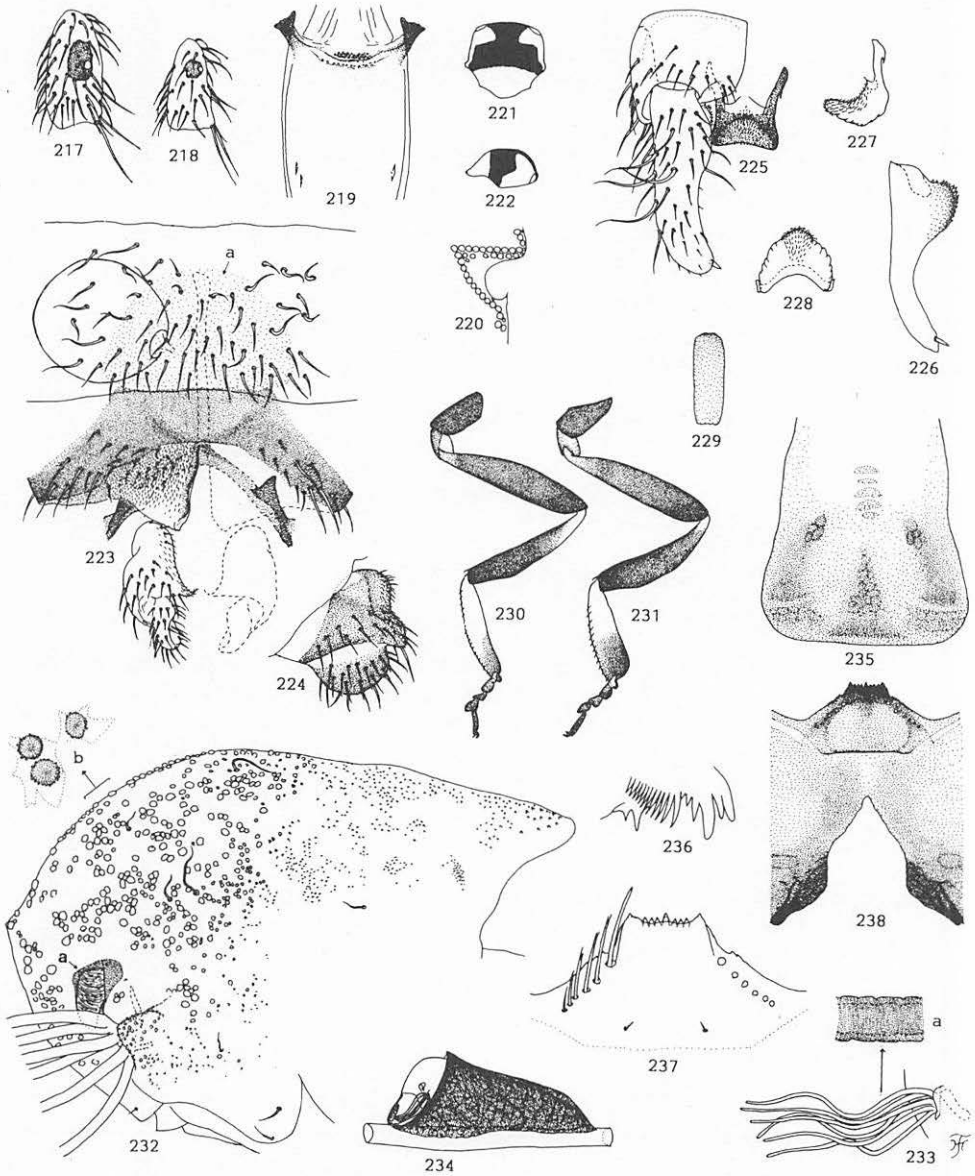
**Figs. 211–13.** Larval head capsules (ventral view). **211**, *S. (S.) eximium* (East Java); **212**, *S. (S.) upikae*; **213**, *S. (S.) thienemanni*.

**Figs. 214–16.** Tips of larval mandible. **214**, *S. (S.) eximium*; **215**, *S. (S.) upikae*; **216**; *S. (S.) thienemanni*.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inner and 10–13 outer teeth. Mandible (Fig. 240) with ca. 24 inner and 6 outer teeth. Cibarium (Fig. 244) with numerous well developed tubercles. ***Thorax.*** Scutum black, shiny, thinly grey-pruinose, not patterned, covered moderately with recumbent, dark brown pubescence. Scutellum brownish black, with long dark hairs. Postscutellum brownish black, shiny, silvery iridescent when viewed in lights, without hairs. Pleural membrane bare. Katepisternum longer than depth, bare. ***Legs.*** Fore coxa pale yellow, mid and hind coxae brownish black. Trochanters pale yellow except mid trochanter brownish black. Fore femur dark yellow or tawny, gradually darkened towards distal end, with pale scale-like hairs and usual simple hairs on outer surface; mid and hind femora brownish black except base of hind femur yellow, with brownish scale-like hairs (Fig. 252a) plus usual hairs on outer surface. All tibiae brownish black, with brown scale-like hairs on outer surface (Fig. 252b); fore tibia with large area of whitish sheen on outer surface, mid and hind tibiae each with large area of whitish sheen on posterior surface when illuminated. Fore tarsi brownish black. Mid tarsi almost whitish except 4th and 5th tarsal segments pale brown and brown respectively, and distal tip of basitarsus, 2nd and 3rd segments somewhat pale brown. Hind basitarsus whitish with distal 1/3 brown; remaining tarsal segments whitish with 4th and 5th segments brown and distal tip of 2nd and 3rd segments somewhat pale brown. Fore basitarsus dilated, ca. 4.1 × as long as greatest width. Hind basitarsus parallel-sided. Calcipala well developed, 0.9 × as long as wide, 0.44 × as wide as basitarsal tip. Pedisulcus distinct. Tarsal claws (Fig. 254) each with small, subbasal tooth. ***Wing.*** Length 1.6 mm; costa with spinules and hairs; subcosta bare; basal section of vein R bare; hair tuft of stem vein dark brown; basal cell absent. ***Abdomen.*** Basal scale black with fringe of dark hairs; 2nd segment dark brown with large, dorsolateral whitish iridescent spots broadly connected to each other in middle; dorsal surface of abdomen dark brown to brownish black, with sparse dark hairs; tergites 6–8 large, shining. ***Genitalia*** (Figs. 245, 246). Ventral surface of segment 7 lacking sternal plate. Sternite 8 well sclerotized, bare medially, with many long stout hairs laterally on each side; posterior margin produced backwardly, somewhat bent ventrally, forming submedian lobes (Fig. 246a), each covered with numerous long and short hairs, bluntly pointed posteroventrally; inner margins of lobes slightly concave, widely separated, each with nearly transparent projection sharply pointed backwardly (distinctively visible when genitalia viewed laterally Fig. 246b). Anterior gonapophyses not discernible. Genital fork of inverted-Y form, with long, well sclerotized stem; arms slender, each with strongly sclerotized distal ridge. Paraproct well sclerotized, much produced ventroposteriorly up to or slightly beyond level of anterior margin of cercus, with numerous long hairs ventrally and posteriorly; ventral surface narrow, not plate-like but rounded; paraproct subtriangular in lateral view, ca. 0.6 × as long as wide. Cercus rounded posteriorly, ca. 0.3 × as long as wide, covered with several short hairs. Spermatheca nearly globular, well sclerotized except small area near tubal juncture, with weakly defined reticulate pattern, with minute internal setae.

**MALE.** Body length 2.0 mm. ***Head.*** Much wider than thorax. Upper eye consisting of large facets in 13 or 14 horizontal rows and 13 or 14 vertical columns. Clypeus black, whitish pruinose, strongly iridescent when illuminated, sparsely covered with dark brown hairs. Antenna (Fig. 239) composed of 2+9 segments, yellow with apical 2 flagellar segments black; 1st flagellar segment elongate (W:L = 1.0:1.8 in dorsal view), ca. 1.3 × as long as 2nd flagellar segment. Maxillary palp composed of 5 segments, proportional lengths of 3rd, 4th and 5th segments 1.00:1.25:2.50; 3rd segment (Fig. 243) of normal size, with small, globular sensory vesicle 0.2 × length of 3rd segment. ***Thorax.*** Scutum broadly white pruinose (silvery iridescent when illuminated) with inverted V-shaped black band in certain angles of light disconnected anteriorly, leaving 2 broad black bands each slanting across scutum from anteromedial portion to wing base; scutum moderately covered with recumbent scale-like brown hairs. Scutellum brownish black with erect long dark hairs. Postscutellum brownish black, white pruinose, bare. Pleural membrane and katepisternum as in female. ***Legs.*** Coloration of legs and shape of scale-like

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**Figs. 217–38.** *Simulium (Simulium) sigiti.* **217** and **218**, 3rd segments of maxillary palp (217, ♀; 218, ♂); **219**, ♀ cibarium; **220**, fronto-ocular area of ♀; **221** and **222**, ♂ scutum (221, dorsal view; 222, side view); **223**, ♀ genitalia including also 7th sternite (a); 224, paraproct and cercus in lateral view; **225**, ♂ genitalia (ventral view); **226**, style in inside view showing spinous basal protuberance; **227** and **228**, ventral plate (227, lateral view; 228, end view); **229**, median sclerite; **230** and **231**, hind legs (230, ♀; 231, ♂); **232**, thoracic integument of pupa (from left side) showing pit-like organ (a) and enlarged round tubercles (b); **233**, pupal gill filaments (from left side) showing rather smooth surface of filament (a); **234**, pupa and cocoon attached to slender plant root; **235**, cephalic apotome of larval head; **236**, tip of larval mandible; **237**, hypostomium showing 6 hypostomal setae or bristles lying parallel to lateral margins; **238**, larval head capsule (ventral view).

hairs on outer surface of femora and tibiae as in female; fore basitarsus dilated, 4.6 × as long as its greatest width; hind basitarsus (Fig. 253) parallel-sided, ca. 6.1 × as long as wide, ca. 0.5 × as wide as greatest width of hind tibia. Calcipala well developed, nearly as long as wide, 0.5 × as wide as basitarsal tip. Pedisulcus well marked on 2nd tarsomere. ***Wing.*** Length 1.6 mm; other features as in female. ***Abdomen.*** Basal scale blackish with long dark hairs. Dorsal surface of abdomen black, with dark hairs; segments 2, 4–7 each with pair of silvery iridescent spots dorsolaterally, those on segment 2 connected broadly in middle. ***Genitalia*** (Figs. 247–51). Coxite nearly quadrate. Style elongate, slightly over 2 × as long as coxite, ca. 3 × as long as its greatest width at basal 1/3, broad on basal 1/2, gradually tapering toward apex, with subterminal spine (rarely 2 spines); style flattened ventrodorsally, without basal protuberance. Ventral plate with elongate base ca. 2 × as long as wide, rounded posteriorly, much raised ventrally, bearing parallel rows of sharp teeth posteriorly; median process thumb-like, hairy anteriorly, projecting ventrally beyond dentate portion; arms widely diverging. Median sclerite simple, narrow, plate-like, slightly widened apically. Parameres elongate, each with several small hooks.

**PUPA.** Body length (excluding gill filaments) 2.0–2.2 mm. ***Head.*** Integument dark yellow, sparsely or moderately covered with minute tubercles, with 3 pairs of simple trichomes. ***Thorax.*** Integument dark yellow, unevenly covered with minute tubercles (very sparsely on most of anterodorsal surface, moderately on peripheral areas and on posterodorsal 1/2), with simple trichomes in 5 pairs. Gill (Fig. 255) with 6 tawny short filaments in pairs, short-stalked (except middle pair sessile), somewhat inflated basally, tapering apically; all filaments subequal in length (ca. 1 mm), also subequal in thickness except inner filaments of lower and middle pairs slightly thicker than other 2 filaments basally; cuticle of filaments with numerous transverse ridges sharply edged for the most part but weakly edged basally, densely covered with minute tubercles. ***Abdomen.*** Tergum 2 with 1 long and 5 short simple setae on each side. Terga 3 and 4 each with 4 hooked spines along posterior margin on each side. Tergum 8 with transverse row of 3–5 spine-combs on each side. Tergum 9 with comb-like groups of minute spines, lacking spine-combs and terminal hooks. Sternum 5 with pair of bifid hooks close together submedially on each side. Sterna 6 and 7 each with pair of bifid or simple hooks widely spaced on each side. Grapnel-like hooklets absent. ***Cocoon*** (Fig. 256). Shoe-shaped, tightly woven, moderately extending ventrolaterally; opening directed upward and forward, with thick margin.

**MATURE LARVA.** Body length 3.6–4.4 mm. Body color dark grey, usually banded on abdominal segments 1–4, often with purplish markings on posterior abdominal segments. Cephalic apotome variable in markings: in some larvae entirely pale yellowish with indistinct head spots, in most of other larvae more or less darkened partially or entirely on posterior 2/5, darkest submedially (between anterolateral and posterolateral spots) and medially (along posterior border). Antenna composed of 3 segments and apical sensillum, longer than stem of labral fan; length ratio of segments (from base to tip) 1.0:0.9:0.7. Labral fan with ca. 38 main rays. Mandible (Fig. 257) with mandibular serrations composed of a large and a medium tooth but no supernumerary serrations. Hypostomal teeth 9, small with median and each corner tooth longer than others; lateral margins serrate apically; 4 or 5 hypostomal bristles slightly diverging posteriorly from lateral border on each side. Postgenal cleft (Fig. 258) very deep, apex reaching posterior border of hypostomium. Abdominal segments 1–5 each with dorsal pair of conical protuberances decreasing in size forwardly; another dorsal pair of small protuberances present on metathoracic segment (Fig. 259). Thoracic cuticle bare. Abdominal cuticle covered dorsally with spatulate setae (Fig. 260), moderately on segments 5–8, very sparsely on segments 2–4; segment 5 and adjacent segments covered with minute branched setae dorsally (Fig. 261); a few pale setae near each dorsal protuberance and numerous short, pale setae on sides of anal sclerite. Rectal papilla of 3 lobes, each with 2–7 finger-like secondary lob-

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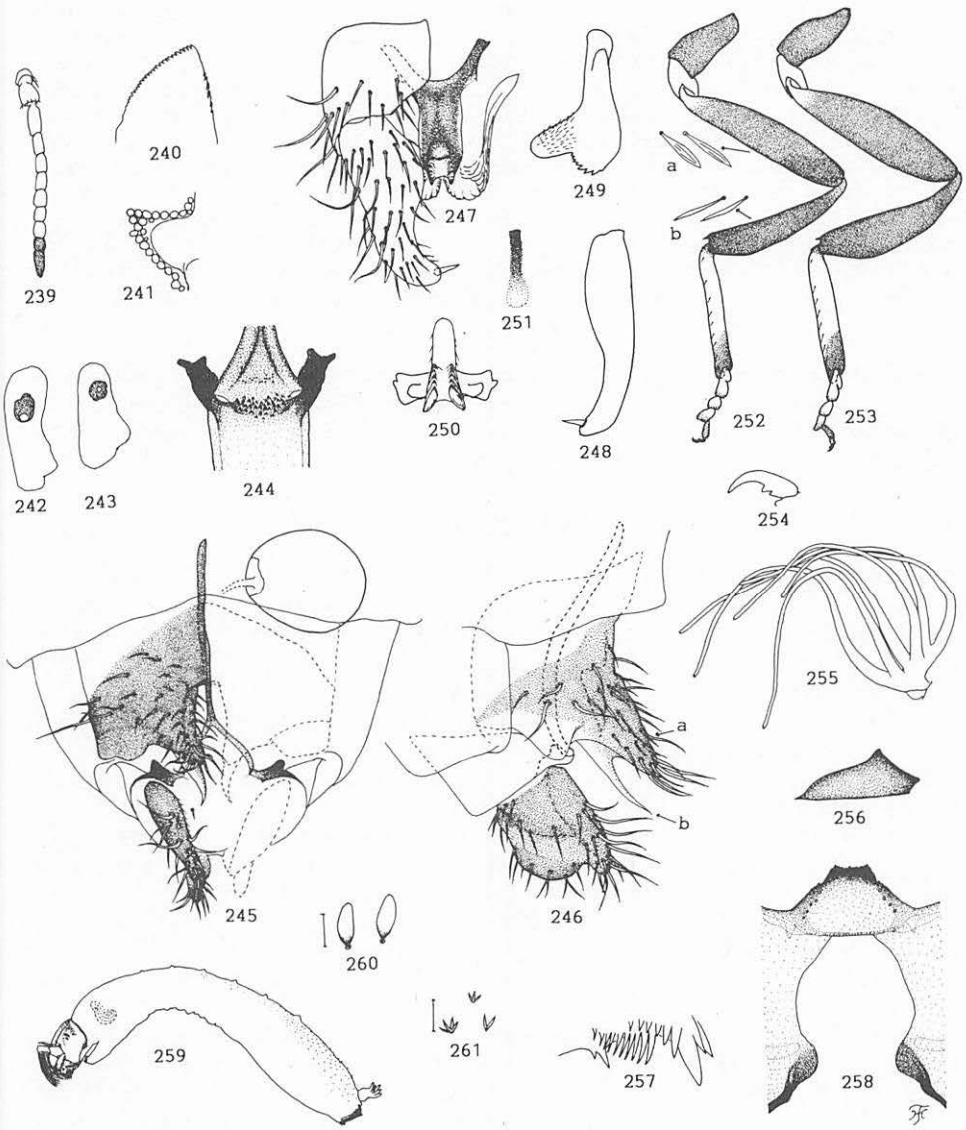
**Figs. 239–61.** *Simulium (Simulium) nobile.* **239,** ♂ antenna; **240,** tip of ♀ mandible; **241,** fronto-ocular area of ♀; **242** and **243,** 3rd segments of maxillary palp (242, ♀; 243, ♂); **244,** ♀ cibarium; **245,** ♀ genitalia *in situ* (ventral view) showing projection produced from inner margin of median lobe (anterior gonapophyses) of 8th sternite; **246,** ♀ genitalia (lateral view) showing median lobe (anterior gonapophyses) of 8th sternite (a), projection produced from median lobe (b), paraproct and cercus; **247,** ♂ genitalia (ventral view); **248,** style in lateral view; **249** and **250,** ventral plate (249, lateral view; 250, end view); **251,** median sclerite; **252,** hind leg of ♀ showing scale-like hairs on femur (a) and on tibia (b); **253,** hind leg of ♂; **254,** ♀ claw; **255,** pupal gill filaments (from left side); **256,** cocoon in lateral view; **257,** tip of larval mandible; **258,** larval head capsule (ventral view) showing a deep postgenal cleft; **259,** mature larva in lateral view showing dorsal protuberances on abdominal segments 1-5 and on metathoracic segment; **260,** spatulate spines on larval abdominal segments (Scale bar 0.01 mm); **261,** minute branched setae on abdominal segment 5 and adjacent segments of larva (Scale bar 0.01 mm).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ules. Anal sclerite X-shaped, with broadened anterior arms much shorter than posterior ones. Last abdominal segment bulged laterally, lacking ventral papillae. Posterior circlet with ca. 88 rows of hooklets with up to 16 hooklets per row.

**SPECIMENS EXAMINED.** MID JAVA: Holotype ♂, pinned, Semarang, II–III.1906, Jacobson (ZMA). EAST JAVA: 2 ♀ (1 ♀ pinned), 2 pupae and 2 mature larvae, Pasirian, 2.VI.1923, Friederichs (BMNH 1931-554). WEST JAVA: 1 ♀, pinned, Cilengsar, 16–19.VI.1937, Westernberg (ZMA); 4 ♀, 22 ♂, pinned, Bogor, Botanic Garden, 3–22.VIII.1964, M. Delfinado (BISHOP); 4 ♂, pinned, 7.III., F. Muir (BISHOP); 5 ♀, pinned, Bogor, 13–15.V.1929, I.M. Mackerras (ANM); 3 ♀, 3 ♂, reared from pupae, 8 pupae, 10 mature larvae, all in alcohol, Cigudek, 14.I.1991, H. Takaoka & U.K. Hadi; 8 ♀, 8 ♂, reared from pupae, 10 pupae, 6 mature larvae, all in alcohol, Pengalengan, south of Bandung, 29.XII.1990, H. Takaoka; 9 ♀, 9 ♂, pinned together with their pupal exuviae and cocoons, 10 ♀, 5 ♂, reared from pupae, 84 pupae, 50 pupal exuviae and 52 mature larvae, all in alcohol, Cisarus, near Bogor, 15.XII.1975, D.M. Davies; 13 ♀, pinned together with their pupal exuviae and cocoons, 2 ♀, 4 ♂ reared from pupae, 27 pupae, 27 pupal exuviae and 15 mature larvae, all in alcohol, Ciliwung River and its tributaries, Jogjogan, 15 km ENE of Bogor, 15.XII.1975, D.M. Davies. SOUTH SUMATRA: 10 ♀, 2 ♂, 2 pupae and 2 mature larvae, all in alcohol, Ranau, I–II,1929, A. Thienemann (BMNH 1931-244). MALAY PENINSULA: 10 ♀, 2 ♂, 5 pupae and 10 mature larvae, all in alcohol, R.H. Wharton (BMNH 1952-410)

**ECOLOGICAL NOTES.** Pupae and larvae of *S. nobile* were found on trailing grasses, fine roots, twigs and rocks in large streams (4–9 m wide) and also in small streams (0.1–1.0 m wide) draining rice fields, exposed to the sun or partially shaded. This species was collected together with *S. (S.) iridescens*, *S. (S.) argyrocinctum* and *S. (G.) sundaicum*.

**DISTRIBUTION.** Java, Sabah, Sumatra, and West Malaysia.

**REMARKS.** Edwards (1934) mentioned that *S. (S.) nobile* bore the simple, untoothed female claws. Two other species of the 10 *nobile*-group species, i.e., *S. (S.) nodosum* from India and *S. (S.) shiraki* from Taiwan, also have simple claws (Datta, 1988; Shiraki, 1935). However, this seems not to be true for *S. (S.) nobile* because all the female specimens examined in this study had a small subbasal tooth, like most other species of the *nobile*-group.

With this fact taken into account, it is now apparent that *S. (S.) nobile* is almost indistinguishable in both sexes of adult from *S. (S.) baltazarae* and *S. (S.) cotabatoense* from the Philippines (Takaoka, 1983), from which it differs in the pupal stage by the number of gill filaments (6 vs. 10 and 12) and also in the larval stage as mentioned later.

This species is also very similar in the female to *S. (S.) benquetense*, and in the male to *S. (S.) leytense*, both also from the Philippines (Takaoka, 1983), but is differentiated in the opposite sex of adult from the latter 2 species. The male of *S. (S.) benquetense* has a larger number of horizontal and vertical rows of large facets (17 rows). The female of *S. (S.) leytense* is separated from *S. (S.) nobile* by the different shape of the paraproct. The pupal gills of *S. (S.) benquetense*, *S. (S.) leytense* and *S. (S.) latistylum* (the last also from Philippines) are all 6-filamented, but not so inflated basally, as in *S. (S.) nobile*.

Contrary to the similarities in the adult stage, *S. (S.) nobile* is readily distinguished in the larval stage from all the 6 Philippine species (above-mentioned 5 species and *S. (S.) delfinadoae*) by the presence of a dorsal pair of conical protuberances each on the abdominal segments 1–5 and on the metathoracic segment (Fig. 259), as well as spatulate setae mainly on posterior abdominal segments (Fig. 260).

## (E) *melanopus*-group

### 19. *Simulium (Simulium) iridescens* de Meijere, 1913 Figs. 262–82

*Simulium iridescens* de Meijere, 1913: 333 (female and male); Edwards, 1934,13: 112–14 (female, male, pupa and larva).

*Simulium (Simulium) iridescens* de Meijere: Crosskey, 1973: 427; Crosskey, 1987: 475.

*Simulium (S.) iridescens* was originally described from both sexes of adult specimens collected from Nongkojajar, East Java (De Meijere, 1913). Edwards (1934) redescribed the male and female and described the pupa and larva of this species. The redescription of all stages of *S. (S.) iridescens* is here made based on specimens taken from East Java, and the female genitalia are described and illustrated for the first time.

**FEMALE.** Body length 2.2–2.5 mm. ***Head.*** Narrower than width of thorax. Frons black, shiny, thinly greyish pruinose, with several dark stout hairs along lateral margins; frontal ratio 1.2:1.0:1.2; frons-head ratio 1.0:4.4. Fronto-ocular area (Fig. 264) well developed. Clypeus black, shiny, greyish pruinose, with scattered dark stout hairs; when illuminated, silvery iridescent. Antenna composed of 2+9 segments, brownish black, scape, pedicel and base of lst flagellar segment dark yellow. Maxillary palp brownish black, with 5 segments, proportional lengths of 3rd, 4th and 5th segments 1.0:1.1:2.3; 3rd segment (Fig. 262) not enlarged; sensory vesicle of moderate size, elliptical, with rugged surface, 0.3 × length of 3rd segment; with small round opening distally. Maxillary lacinia with 11–13 inner and 15–17 outer teeth. Mandible with ca. 28 inner and 13 or 14 outer teeth. Cibarium (Fig. 265) with numerous (ca. 66) minute tubercles. ***Thorax.*** Scutum black, shiny, thinly grey pruinose, not patterned, moderately covered with recumbent, dark brown pubescence, interspersed with long, upstanding dark hairs on prescutellar area. Scutellum black, with long dark hairs. Postscutellum black, shiny, silvery iridescent when viewed in lights, without hairs. Pleural membrane bare. Katepisternum longer than deep, bare (occasionally with a few hairs). ***Legs.*** Foreleg: coxa yellow; trochanter dark yellow to brown with basal 1/3 or 1/2 yellow; femur dark yellow to brown at base, becoming dark distally, with distal cap brownish black; tibia brownish black with outer median portion largely white, iridescent in lights; basitarsus entirely black, dilated (W:L = 1.0:3.8), with thick dorsal hair crest; rest of tarsal segments black. Midleg: coxa brownish black; trochanter dark brown with base yellow; femur brown to brownish black with base yellow; tibia brownish black with base yellowish white, posterior surface of basal 2/5 whitish and iridescent in lights; tarsus brownish black with basal 4/5 of basitarsus and base of 2nd tarsomere yellowish white. Hind leg (Fig. 275): coxa brownish black; trochanter dark yellow; femur brownish black with base yellow; tibia as in mid-leg; tarsus brownish black with basal 2/3 of 1st tarsomere and basal 1/3 of 2nd tarsomere white; basitarsus W:L = 1.0:5.3, calcipala short, little shorter than its width; pedisulcus distinct. Tarsal claws (Fig. 277) each with small, subbasal tooth. Trochanter of mid-leg and femora and tibiae of all legs covered densely or moderately with scale-like hairs (Fig. 275a) as well as simple hairs on outer surface. ***Wing.*** Length 2.4 mm; costa with spinules and hairs; subcosta bare; basal section of vein R bare; hair tuft at base of stem vein dark brown; basal cell absent. ***Abdomen.*** Basal scale black with fringe of dark hairs; 2nd segment dark brown with large, dorsolateral whitish iridescent spots broadly connected in middle; tergites 3 and 4 small, dark brown, shining; tergites 5–9 large, dark brown, shining, with dark hairs. ***Genitalia*** (Figs. 267, 268). Ventral surface of abdominal segment 7 widely expanded posteriorly, covering sternite 8 almost entirely, moderately haired on anterior 2/3, bare on posterior 1/3 or 1/4; sternal plate undeveloped. Sternite 8 well sclerotized, bare medially and laterally but with ca. 14 long stout hairs submedially on each side; anterior gonapophysis triangular, rounded on postero-internal tip, membraneous, covered with a few minute setae and numerous microsetae except narrow bare portion along posterior margin; inner border nearly straight, narrowly sclerotized. Genital fork of inverted-Y form, with well sclerotized stem; arms slender, each with strongly sclerotized distal ridge and blunt projection directed anterodorsally (well discernible when viewed laterally). Paraproct narrowed ventroposteriorly in lateral view, uniformly covered with numerous short hairs on outer and ventral surfaces, narrowly on inner surface; when viewed from inside, paraproct widely transparent, with several minute setae medially, not forming wide, darkly sclerotized plate, although narrowly sclerotized along ventral margin near base. Cercus rounded posteriorly, ca. 0.7 × as long as wide, covered with numerous short hairs. Spermatheca nearly globular, well sclerotized with weakly defined reticulate pattern, with minute internal setae; tube and small area of spermatheca unsclerotized.

**MALE.** Body length 2.4–2.6 mm. ***Head.*** As wide as thorax. Upper eye consisting of large facets in 16 or 17 horizontal rows and 13 or 14 vertical columns. Clypeus black, whitish grey pruinose, strongly iridescent when illuminated, sparsely covered with dark brown hairs. Antenna composed of 2+9 segments, entirely brownish black with base of 1st flagellar segment yellow; 1st flagellomere somewhat elongated (W:L = 1.00:1.75), ca. 2 × as long as 2nd flagellomere. Maxillary palp composed of 5 segments, proportional lengths of 3rd, 4th and 5th segments 1.0:1.1:2.6; 3rd segment (Fig. 263) of normal size, with small, elliptical sensory vesicle 0.23 × length of 3rd segment. ***Thorax.*** Scutum black, with white pruinose pattern composed of anterior pair of large triangular spots, large transverse spot on prescutellar area contiguous to anterior spots by narrow band along lateral margins (Fig. 266) (these pruinose areas with silvery iridescence when illuminated); scutum uniformly covered with dark brown recumbent pubescence (in lights this pubescence appears bright coppery), with long upright hairs on prescutellar area. Scutellum, postscutellum, pleural membrane and katepisternum as in female. ***Legs.*** Colored as in female except mid and hind tibiae brownish black with base yellowish white, hind basitarsus whitish on basal 1/2, brownish black on distal 1/2. Scale-like hairs on outer surfaces of trochanters, femora and tibiae as in female. Fore basitarsus inflated (W:L = 1:5); hind basitarsus (Fig. 276) swollen (W:L = 1.0:3.0–3.4), slightly wider than greatest width of hind tibia; calcipala short, small, shorter than its width; pedisulcus well developed. ***Wing.*** Length ca. 2.4 mm; other features as in female. ***Abdomen.*** Basal scale blackish with long dark hairs. Dorsal surface of abdomen black with dark hairs; segments 2, 4–7 each with pair of silvery iridescent areas dorsolaterally, those on segment 2 connected broadly in middle. ***Genitalia*** (Figs. 269–74). Coxite in ventral view ca. 2.4 × as long as wide, ca. 0.7× length of style; style 2.5 × as long as its greatest width at basal 1/4, spatulate, somewhat curved inward, slightly tapering apically, with subterminal spine. Ventral plate: in ventral view nearly quadrate with short basal arms diverging; in lateral view, sharply increasing in thickness from anterior to posterior margins thus appearing triangular, with thumb-like projection directed ventrally in center, projection setose on anterior and lateral surfaces, bare on apex; in end view trapezoid, slightly constricted medially, with apical margin concave, irregularly and weakly dentate, posterior surface almost smooth, bare. Median sclerite of shoehorn shape, thin, slightly narrowed apically. Parameres each with numerous small hooks.

**PUPA.** Body length (excluding gill filaments) ca. 2.8 mm. ***Head.*** Integument dark yellow, covered with small rounded tubercles, moderately on lower 1/2, sparsely on upper 1/2, with 1 facial and 2 frontal pairs of simple trichomes. ***Thorax.*** Integument dark yellow, moderately covered with small rounded tubercles, with 2 dorsal and 3 lateral pairs of simple (very occasionally bifid) trichomes, all subequal in length. Gill (Fig. 278) with 6 dark brown, short, filaments in pairs, very short-stalked, tapering apically; all filaments subequal in length (1.5–1.8 mm) and thickness (though uppermost filament seems slightly thicker than others when compared basally); cuticle of filaments with numerous transverse ridges forming well-defined reticulate patterns (Fig. 278a), uniformly covered with minute tubercles. ***Abdomen.*** Tergum 1 entirely pale brown, without any tubercles, with single simple or bifid seta on each side. Tergum 2 pale brown on anterior 1/2, with 1 long and 5 short simple spinous setae, 3 of latter 5 stouter than other 2 setae. Terga 3 and 4, each narrowly pale brown along anterior margin, with 4 hooked spines along posterior margin on each side. Terga 7 and 8 each with transverse row of spine-combs together with comb-like groups of minute spines on each side. Tergum 9 with comb-like groups of minute spines in transverse rows, some of which somewhat enlarged but always much smaller than spine-combs on tergum 8; terminal hooks absent. Sternum 5 with pair of bifid hooks approximate submedially on each side. Sterna 6 and 7 each with pair of bifid hooks widely spaced on each side. Grapnel-like hooklets absent. ***Cocoon*** (Fig. 279). Simple, wall-pocket-shaped, thickly woven, with thick anterior rim; slender connecting band often present across front but not forming definite front wall as in *S. (S.) nobile.*

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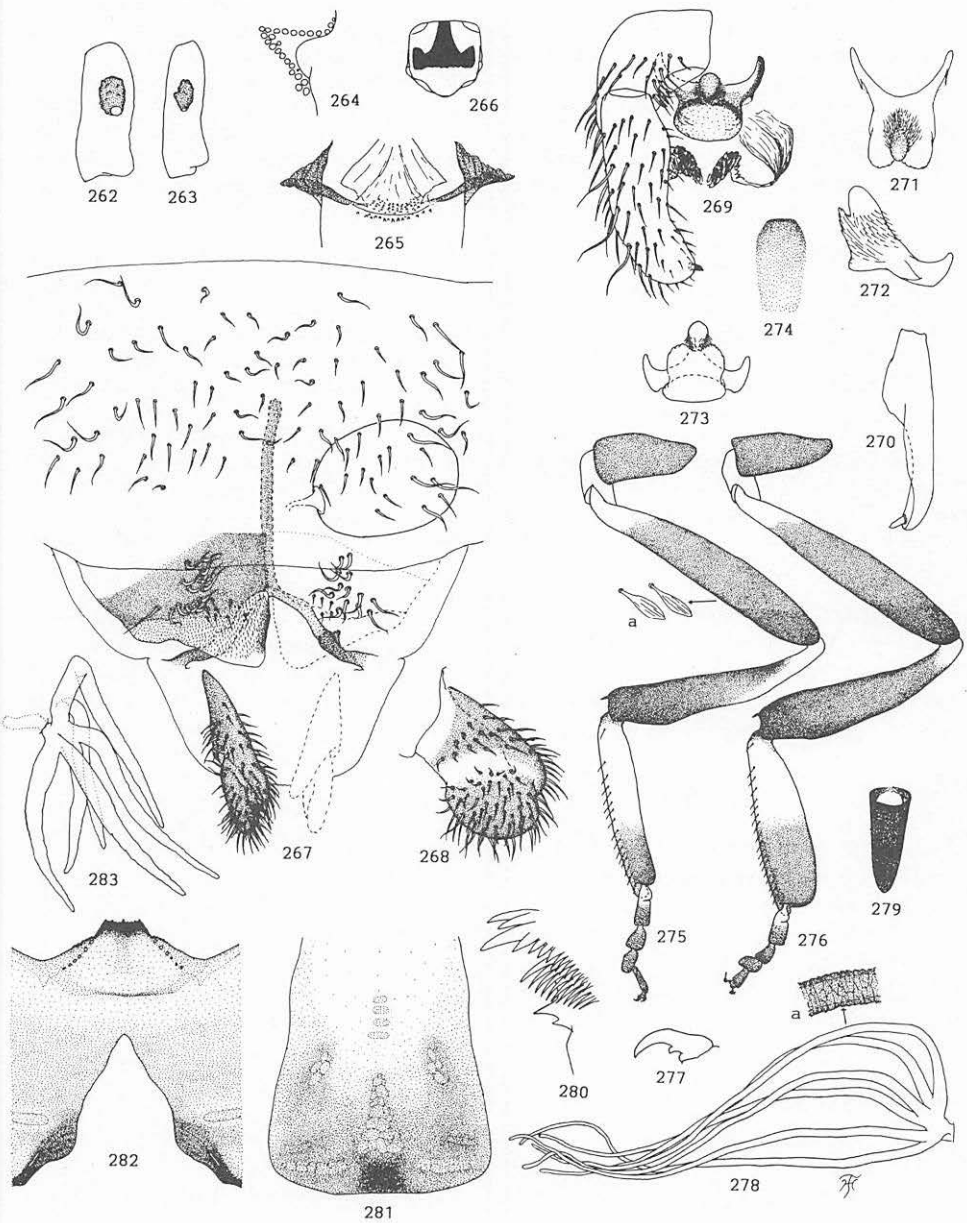
**Figs. 262–82.** *Simulium (Simulium) iridescens.* **262** and **263**, 3rd segments of maxillary palp (262, ♀; 263, ♂); **264**, frontoocular area of ♀; **265**, ♀ cibarium; **266**, ♂ scutum in dorsal view; **267**, ♀ genitalia *in situ* (ventral view) including 7th abdominal segment; **268**, paraproct and cercus in lateral view; **269**, ♂ genitalia (ventral view); **270**, style in lateral view; **271–73**, ventral plate (271, ventral view; 272, side view; 273, end view); **274**, median sclerite; **275**, hind leg of ♀ showing scale-like hairs (a); **276**, hind leg of ♂; **277**, ♀ claw; **278**, pupal gill filaments (from left side) showing reticulate pattern of filament (a); **279**, cocoon in dorsal view; **280**, tip of larval mandible; **281**, cephalic apotome of larval head; **282**, ventral surface of larval head capsule.

**Fig. 283.** Pupal gill filaments of *S. (S.) javaense* (from right side).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**MATURE LARVA.** Body length 5.6–6.2 mm. Body color entirely greyish. Cephalic apotome (Fig. 281) generally pale yellowish on anterior 1/2, light brown on posterior 1/2, with blackish part in middle just before posterior border; anterior longitudinal head spot usually somewhat darkened (positive spot), but most of other head spots paler than, or as dark as, surrounding dark background (negative or merged type). Antenna composed of 3 segments and apical sensillum, longer than stem of labral fan; length ratio of segments (from base to tip) 1.4:1.6:1.0. Labral fan with ca. 46 main rays. Mandible (Fig. 280) with mandibular serrations composed of a large and a medium tooth but no supernumerary serrations. Hypostomal teeth 9, small, with median and each corner tooth longer than others; 5 or 6 hypostomal bristles diverging posteriorly from lateral border on each side (Fig. 282). Postgenal cleft (Fig. 282) deltoid, widening posteriorly, 2.3–3.4 × length of postgenal bridge. Thoracic cuticle bare. Abdominal cuticle bare except dorsolateral areas on last segment moderately covered with short, discolored setae. Rectal papilla of 3 lobes, each with 1–3 (usually 2) small finger-like secondary lobules ventrally. Anal sclerite X-shaped, with broadened anterior arms ca. 0.7 × length of posterior ones. Posterior circlet with ca. 84 rows of hooklets with up to 14 hooklets per row. Ventral papillae absent.

**SPECIMENS EXAMINED.** EAST JAVA: Lectotype ♂ and paralectotype ♀, both pinned, Nongkodjadjar, I.1911, E. Jacobson (ZMA, lectotype designation by R.W. Crosskey, 1968); 1 ♀, pinned, Tosari, (no data on date), K. Friederichs (USNM, labelled B. M. 1931-554); 1 ♂, pinned, Pasoetoean, Batoe, IX.1923, K. Friederichs (USNM, labelled B. M. 1931-554); 10 ♀, 3 ♂, reared from pupae, 5 pupae, and 10 mature larvae, all in alcohol, Coban, near Malang, 19.XII.1990, H. Takaoka; 3 ♀ reared from pupae, 1 pupa, and 3 mature larvae, all in alcohol, Batu, 19.XII.1990, H. Takaoka. WEST JAVA: 2 ♂ reared from pupae and 1 pupa, all in alcohol, Curugluhur, Monsalak, 12.XII.1990, H. Takaoka & U.K. Hadi; 10 ♀, 10 ♂ reared from pupae, 5 pupae and 10 mature larvae, all in alcohol, Santosa, south of Bandung, 29.XII.1990, H. Takaoka; 2 pupae and 8 mature larvae in alcohol, Cisarus near Bogor, 15.XII.1975, D.M. Davies; 1 ♀, 1 ♂ reared from pupae, 25 pupae, 5 pupal exuviae and 7 mature larvae, all in alcohol, Ciliwung R. and its tributaries, Jogjogan, 15.XII.1975, D.M. Davies; 18 ♀, 20 ♂, pinned together with their pupal exuviae, 39 pupae, 83 pupal exuviae and 56 mature larvae, all in alcohol, streams in Cibodas Botanic Garden and Cibodas R. on south edge of Garden, 16–17.XII.1975, D.M. Davies.

**ECOLOGICAL NOTES.** Pupae and larvae were found attached to trailing grasses and twigs in open and shaded streams (width 0.2–3.0 m). This species was collected together with *S. (G.) sundaicum*, *S. (S.) argyrocinctum*, *S. (S.) nebulicola*, *S. (S.) celsum* sp. nov., *S. (S.) thienemanni*, *S. (S.) eximium* and *S. (S.) upikae*. Friederichs (1925) reported that females of this species in East Java attack cattle on the body but not the ears.

**DISTRIBUTION.** East and West Java.

**REMARKS.** *Simulium (S.) iridescens* is probably a species complex including two or more species. The adult male specimens of *S. (S.) iridescens* collected from West Java seem to be somewhat different from those collected from East Java (type locality) by the number of large facets (i.e., 17 or 18 vs. 13 or 14 vertical columns), and in the pattern of silvery pruinose spots on the scutum (i.e., anterior iridescent spots on shoulders are variable in shape depending on the direction of lights unlike those in the East Javanese males including lectotype). Further studies are needed to determine whether these differences are based on an interspecific or intraspecific variation.

**20. *Simulium (Simulium) javaense*** Takaoka and Hadi, 1991 Fig. 283

*Simulium (Simulium) javaense* Takaoka and Hadi, 1991: 363–68 (female, male, pupa and larva).
*Simulium iridescens* var.?: Edwards, 1934: 114 (male, pupa and larva).

Edwards (1934) reported this species as an unnamed variety of *S. (S.) iridescens* based on the male, pupal and larval specimens taken from East Java. Takaoka and Hadi (1991) elevated this species to species status and gave it the name, *S. (S.) javaense*.

In the female, it is very difficult to separate this species from *S. (S.) iridescens*. The male of this species is also very similar to *S. (S.) iridescens* in many features including the genitalia, as pointed out by Edwards (1934). There are nevertheless slight differences in the male as follows: (1) the size of the triangular pruinose scutal spots on the shoulders is smaller than that of *S. (S.) iridescens*, leaving wider median and submedian areas black, and (2) the number of large facets is greater than that of *S. (S.) iridescens* from East Java (i.e., 18 vs. 13 or 14 vertical columns).

On the other hand, the pupa of this species is readily distinguished from that of *S. (S.) iridescens* by the inflated gills (Fig. 283). Further, the cephalic integument is smooth in this species but is covered moderately with small tubercles in the latter species.

The larva of this species is also very similar to that of *S. (S.) iridescens* but differs from the latter by the presence of dorsal russet bands on the abdomen.

The male of *S. (S.) javaense* shows similarities to *S. (S.) nebulicola* described from a male taken at Tosari, East Java, but differs from the latter in the shape of the genitalia, as well as coloration of legs.

**DISTRIBUTION.** East Java.

### (E) ungrouped species

**21. *Simulium (Simulium) nebulicola*** Edwards, 1934 Figs. 284–99

*Simulium (Simulium) nebulicola* Edwards, 1934: 114–15 (male).

This species was described from a single male from East Java (Edwards, 1934). The female, pupa and larva of *S. (S.) nebulicola* are here described for the first time based on the specimens collected from West Java.

**FEMALE.** Body length 2.6 mm. ***Head.*** Narrower than width of thorax. Frons black, shiny, with several dark stout hairs along lateral margins; frontal ratio 1.4:1.0:1.5; frons-head ratio 1.0:4.4. Fronto-ocular area (Fig. 286) well developed. Clypeus black, shiny, thickly whitish grey pruinose, with scattered dark stout hairs; when illuminated, silvery iridescent. Antenna composed of 2+9 segments, dark brown, scape, pedicel and basal 1/3 of lst flagellar segment yellow. Maxillary palp composed of 5 segments, proportional lengths of 3rd, 4th and 5th segments 1.0:1.1:2.6; 3rd segment not enlarged; sensory vesicle (Fig. 284) of medium size, elliptical, with rugged surface, 0.34 × length of 3rd segment, with subterminal round opening of medium size (diameter ca. 0.5 × width of sensory vesicle). Maxillary lacinia with 14 inner and 15 outer teeth. Mandible with ca. 36 inner and 11 outer teeth. Cibarium with numerous minute tubercles. ***Thorax.*** Scutum black, shiny, moderately covered with recumbent, dark brown pubescence, interspersed with long, erect dark hairs on prescutellar area; scutum with bright iridescent spot on each shoulder extending posteriorly along lateral border to wing base in certain angles of lights. Scutellum black, with long dark hairs. Postscutellum black, shiny, silvery iridescent when viewed in lights, without hairs. Pleural membrane bare. Katepisternum longer than deep, bare. ***Legs.*** Foreleg: coxa and trochanter yellow; femur yellow with little more than distal 1/4 brownish black; tibia white with little more than distal 1/4 brownish black, outer median portion largely iridescent in lights; basitarsus entirely black, dilated (W:L = 1.0:4.2), with thick dorsal hair crest; rest of tarsal segments black. Midleg: coxa and trochanter black except basal 1/2 of trochanter yellow; femur brownish black with basal 1/4 yellow; tibia yellowish white except little less than distal 1/3 black, in certain lights with large area of whitish sheen on posterior surface; basitarsus whitish except distal tip brownish black; rest of tarsal segments brownish black except basal 1/3 of 2nd segment white. Hind leg (Fig. 293): coxa brownish black; trochanter yellow; femur brownish black except basal 1/4 pale yellow; tibia yellowish white except distal 2/5 brownish black, in certain lights with large area of whitish sheen on posterior surface; tibia nearly equal in greatest width to femur; tarsal segments brownish black except basal 2/3 of basitarsus and basal 1/3 of 2nd tarsomere whitish; basitarsus W:L = 1.0:4.7, calcipala short, width to that of basitarsal tip 1.0:1.8, W:L ratio 1:1; pedisulcus distinct. Tarsal claws (Fig. 295) each with small, subbasal tooth. ***Wing.*** Length 2.5 mm; costa with spinules and hairs; subcosta fully haired; basal section of vein R bare; hair tuft at base of stem vein dark brown; basal cell absent. ***Abdomen.*** Basal scale black with fringe of dark hairs;

2nd segment dark brown with large, dorsolateral whitish iridescent spots broadly connected in middle; tergites 3–5 small, dark brown, tergites 6–8 large, black, shining, with dark hairs. ***Genitalia*** (Figs. 287, 288). Ventral surface of abdominal segment 7 uniformly covered with long hairs; sternal plate undeveloped. Sternite 8 well sclerotized, bare medially, with ca. 20 long stout hairs laterally on each side; anterior gonapophysis inverted trapezoidal, not rounded on postero-internal tip, membraneous, covered with 14–16 short hairs and numerous microsetae except narrow portion along posterior margin bare; inner border nearly straight, narrowly sclerotized. Genital fork of inverted-Y form, with well sclerotized slender stem; arms slender, each with strongly sclerotized distal ridge and distinct projection directed anterodorsally. Paraproct in ventral view wider than long, with ca. 10 minute sensilla on anteromesal surface, covered with ca. 26 short and long hairs ventrally and laterally; in lateral view paraproct not produced ventroposteriorly below cercus. Cercus in lateral view subquadrate, ca. 0.5 × as long as wide, covered with numerous short hairs. Spermatheca nearly globular, well sclerotized except tube and small area of tubal base, with no definite reticulate pattern except near base, with minute internal setae.

**MALE.** Body length 2.8 mm. ***Head.*** Slightly wider than thorax. Upper eye consisting of large facets in 16 horizontal and 15 vertical rows. Clypeus black, whitish grey pruinose, strongly iridescent when illuminated, sparsely covered with dark brown hairs. Antenna composed of 2+9 segments, dark brown, scape, pedicel and base of 1st flagellar segment pale; 1st flagellomere somewhat elongated (W:L = 1:2). Maxillary palp composed of 5 segments, proportional lengths of 3rd, 4th and 5th segments 1.0:1.1:2.8; 3rd segment (Fig. 285) of normal size, with small, elliptical sensory vesicle 0.23 × length of 3rd segment. ***Thorax.*** Scutum black, with silvery iridescent pattern composed of anterior pair of spots on shoulders, large transverse spot on prescutellar area contiguous to anterior spots by narrow band along lateral margins; spot on each shoulder curved posteromedially, pointing posteriorly appearing like crescent band variable in size depending on direction of lights (e.g., in certain angles of light anterior 1/2 of anterior band disappears while posterior 1/2 disappears in another angle of light), in lateral view apical 1/2 of this band disappears; scutum uniformly covered with dark brown recumbent pubescence, interspersed with long upright hairs on prescutellar area. Scutellum, postscutellum, pleural membrane and katepisternum as in female. ***Legs.*** Foreleg: coxa and trochanter yellow; femur yellow on basal 1/2, darkened gradually to distal 1/4, then brownish black on distal 1/4; tibia white except distal tip on outer surface, basal 1/3 and distal 1/3 on inner surface brownish black, with large area of whitish sheen on outer surface; tarsi black; basitarsus somewhat dilated (W:L = 1:5). Midleg: coxa, trochanter and femur brownish black except basal 1/3 of trochanter and base of femur yellow; tibia yellowish white basally, gradually darkened toward distal 1/3, brownish black on distal 1/3 except median large portion on anterior surface and basal 1/2 on posterior surface white; basitarsus whitish except distal tip brownish black (its border not well defined); rest of tarsal segments brownish black except base of 2nd and 3rd segments pale. Hind leg (Fig. 294): coxa brownish black; trochanter yellow; femur brownish black except basal 1/4 or 1/5 yellow; tibia brownish black except base pale yellow, anterior surface somewhat pale submedially; tarsal segments brownish black except basal 1/2 of basitarsus and little less than basal 1/2 of 2nd tarsal segment whitish; hind basitarsus enlarged, wedge-shaped (W:L = 1.0:3.9), subequal in greatest width to hind tibia and femur; calcipala small, W:L ratio 1.0:0.8; pedisulcus distinct. ***Wing.*** Length 2.3 mm; other features as in female except subcosta bare. ***Abdomen.*** Basal scale blackish with long dark hairs. Dorsal surface abdomen black with dark hairs; segments 2, 4–7 each with pair of silvery iridescent areas dorsolaterally, those on segment 2 broadly connected in middle. ***Genitalia*** (Figs. 289–92). Coxite in ventral view 1.1 × as long as wide, ca. 0.53 × length of style; style length 3.7 × width at base, nearly parallel-sided throughout its length in ventral view; style spatulate ventrodorsally, with subterminal spine; no prominent subbasal protuberance present. Ventral plate and basal arms from ventral view forming Y-shape, having low ventral projection with toothed posterior margins (9 or 10 teeth on each side); plate with midventral ridge anterior to ventral projection, slightly wider than plate, covered with fine appressed setae anteriorly; basal arms long, curved outwardly and forwardly. Median sclerite of shoehorn shape, thin, gradually widened toward apex. Paramere with numerous medium-sized hooks.

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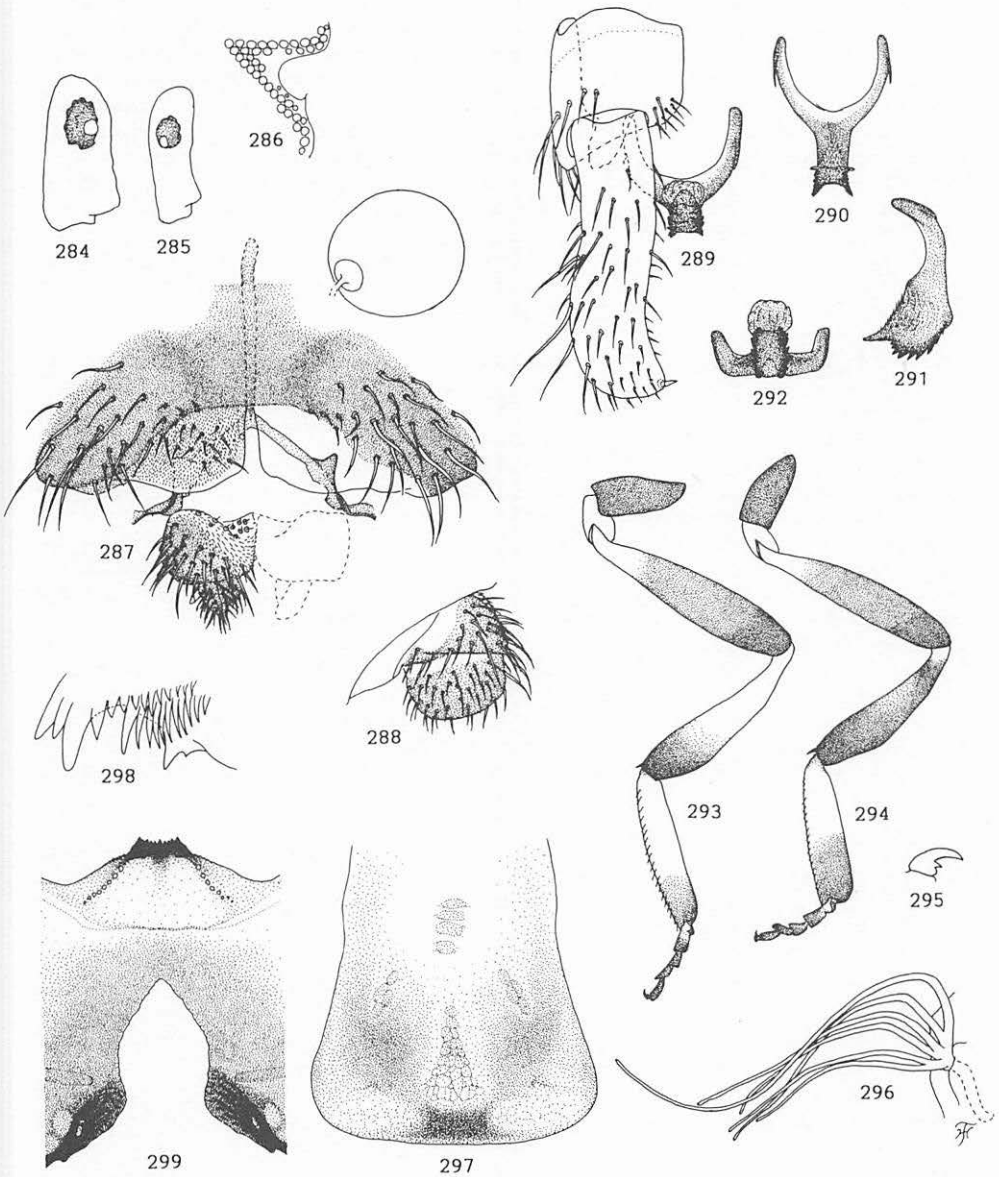
**Figs. 284–99.** *Simulium (Simulium) nebulicola.* **284** and **285**, 3rd segments of maxillary palp (284, ♀; 285, ♂); **286**, frontoocular area of ♀; **287**, ♀ genitalia *in situ* (ventral view); **288**, paraproct and cercus in lateral view; **289**, ♂ genitalia (ventral view); **290–92**, ventral plate (290, ventral view; 291, lateral view; **292**, end view); **293** and **294**, hind legs (293, ♀; 294, ♂); **295**, ♀ claw; **296**, pupal gill filaments (from left side); **297**, cephalic apotome of larval head; **298**, tip of larval mandible; **299**, larval head capsule (ventral view).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**PUPA.** Body length (excluding gill filaments) 2.8 mm. ***Head.*** Integument dark yellow, smooth without tubercles, with 1 facial and 2 frontal pairs of short, slender, simple trichomes, facial trichomes much longer than frontal ones. ***Thorax.*** Integument yellowish brown, sparsely covered with tubercles, with 2 dorsal and 2 lateral pairs of rather long simple trichomes on anterior 1/2 plus 1 lateral pair of trichomes on posterior 1/2, those trichomes are subequal in length to each other, but much longer than facial ones. Gill (Fig. 296) with 6 slender and dark brown filaments in pairs, almost sessile or very short-stalked, slightly tapering apically, much shorter than pupa; dorsal filament of upper pair longest (ca. 1.8 mm), ventral one of lower pair shortest (ca. 0.7 mm), other filaments intermediate in length (0.8–1.1 mm); thickness of filaments somewhat different by pair, decreasing from dorsal to ventral (ratio of thickness near base 1.0:0.8:0.6); cuticle of filaments with well-defined annular furrows and ridges forming reticulate pattern, uniformly covered with minute tubercles; annular ridges and minute tubercles becoming indistinct apically. ***Abdomen.*** Tergum 2 on each side with 1 long and 5 short simple setae. Terga 3 and 4 each with 4 hooked spines along posterior margin on each side. Terga 7 and 8 each with transverse row of spine-combs on each side. Tergum 9 lacking terminal hooks, although comb-like groups of minute spines present. Sternum 4 with several minute simple setae submedially on each side. Sternum 5 with pair of bifid hooks submedially on each side. Sterna 6 and 7 each with pair of bifid inner and simple outer hooks widely spaced on each side. Grapnel-like hooklets absent. ***Cocoon.*** Wall-pocket-shaped, thickly woven, with thick anterior rim; there is no ventrolateral extension.

**MATURE LARVA.** Body length 5.3–6.0 mm. Body color reddish brown on thorax and abdominal segments 5–8, dark greyish on abdominal segments 1–4. Cephalic apotome (Fig. 297) pale yellowish on anterior 1/2, with 3 distinct darkened areas on posterior 1/2 (1 medially just before posterior border, the other 2 submedially between head spots); anterior longitudinal head spot usually somewhat darkened, darker than surrounding area (positive type), other head spots except posterolateral spots also somewhat darkened but usually lighter than background (negative type), posterolateral spots just before posterior border completely pale (negative type); lateral surface of head capsule widely darkened around eye spot area, with negative spots near posterior border; ventral surface of head capsule (Fig. 299) dark except anterior narrow pale portion near posterior border of hypostomium. Antenna composed of 3 segments and apical sensillum, longer than stem of labral fan; length ratio of segments (from base to tip) 1.0:1.1:0.5. Labral fan with ca. 42 main rays. Mandible (Fig. 298) with mandibular serrations composed of a large and a minute tooth but no supernumerary serrations; 1st comb-tooth much longer than others. Hypostomal teeth 9, small, with median and each corner tooth longer than others; 8 hypostomal bristles diverging posteriorly from lateral border on each side. Postgenal cleft (Fig. 299) lanceolate, widest medially, slightly narrowed posteriorly, ca. 3 × length of postgenal bridge. Thoracic cuticle bare. Abdominal cuticle bare except dorsolateral areas on last segment moderately covered with short, discolored setae. Rectal papilla of 3 lobes, each with 7–9 slender, finger-like secondary lobules. Anal sclerite X-shaped, with broadened anterior arms ca. 0.7 × length of posterior ones. Posterior circlet with ca. 96 rows of hooklets with up to 15 hooklets per row. Ventral papillae absent.

**SPECIMENS EXAMINED.** EAST JAVA: Holotype ♂, pinned, with genitalia on slide, Tosari, Friederichs (BMNH). WEST JAVA: 3 ♂ reared from pupae, Puncak, 10.I.1991; 1 ♀ reared from pupa, Cibodas Botanic Garden, 4.I.1991; 2 ♀ reared from pupae, 1 pupa and 3 mature larvae, Gunung Mas, 19.VIII.1991, all collected by H. Takaoka & U.K. Hadi.

**ECOLOGICAL NOTES.** Pupae and larvae were found on fine roots of trees and on leaves trailing in the water of small shaded streams (less than 0.5 m wide; ca. 1300 m in altitude) running down through the sloped natural forest. This species was collected together with *S. (S.) iridescens*, *S. (S.) sigiti*, *S. (S.) celsum* sp. nov., *S. (G.) gyorkosae* and *S. (G.) atratoides*.

**DISTRIBUTION.** West Java (new record) and East Java.

**REMARKS.** This species was recently placed in the *nobile*-group by Crosskey (1987). However, *S. (S.) nebulicola* apparently differs, as does *S. (S.) iridescens*, from all the species of the *nobile*-group by lacking the inverted-V shaped band on the male scutum, the specialized paraprocts and

anterior gonapophyses in the female genitalia, the deep postgenal cleft reaching the hypostomium and the dorsal protuberances on the larval abdomen, all of which are characteristic of this species-group.

*Simulium (S.) nebulicola* appears to be related to the *malyschevi-* or *variegatum*-group by having the unstriated scutum, claws with a small subbasal tooth in the female, the usual iridescent scutal pattern, and the Y-formed ventral plate with serrate posterior borders in the male. However, this species can not be satisfactorily placed in either of these two groups. The anterior gonapophyses of these 2 species-groups are unique in shape, i.e, the inner borders being deeply concave internally in the *variegatum*-group or the posterior borders being strongly compressed and bluntly truncate in the *malyschevi*-group, while those of *S. (S.) nebulicola* are of usual form (see Fig. 287).

Two Indian black fly species, *S. (S.) christophersi* and *S. (S.) howletti*, both described by Puri (1932b,d), which were assigned to the *variegatum-* and the *malyschevi*-groups, respectively, by Crosskey (1987), have the usual anterior gonapophyses as in *S. (S.) nebulicola*. However, these two species are quite different from the present species by having the striated scutum in the female, a character also being unusual for the two species-groups.

The female of *S. (S.) argentipes* Edwards, 1928 from Malay (male, pupa and larva unknown) is similar to that of *S. (S.) nebulicola* by the unstriated scutum, the claws with a small subbasal tooth, and the anterior gonapophyses of usual form (unpub. data). However, there is a difference in the shape of the paraproct, which is much produced ventrally in *S. (S.) argentipes* but is not in *S. (S.) nebulicola*. It should be noted that *S. (S.) argentipes*, together with *S. (S.) fuscopilosum* Edwards, 1928 from Malay, was assigned to the *melanopus*-group (Crosskey, 1987). However, obviously this placement is incorrect because the female paraprocts of these two species do not have a well sclerotized plate anteromesally (unpub. data), one of the key characters of the *melanopus*-group (Takaoka, 1983). For the same reason, *S. (S.) nebulicola* also can not be placed in this species-group.

### 22. *Simulium (Simulium) celsum* Takaoka and Davies, **new species** Figs. 300–15

**FEMALE.** Body length 2.6 mm. ***Head.*** Narrower than width of thorax. Frons black, shiny, with several dark stout hairs along lateral margins; frontal ratio 1.2:1.0:1.1; frons-head ratio 1.0:3.8. Fronto-ocular area (Fig. 302) well developed. Clypeus black, shiny, thickly whitish grey pruinose, with scattered dark stout hairs; when illuminated, silvery iridescent. Antenna composed of 2+9 segments, brownish black, scape, pedicel and base of lst flagellar segment pale yellow. Maxillary palp composed of 5 segments, proportional lengths of 3rd, 4th and 5th segments 1.0:1.3:3.3; 3rd segment (Fig. 300) not enlarged; sensory vesicle of medium size, elliptical, with rugged surface, 0.35 × length of 3rd segment, with subterminal round opening of medium size (diameter ca. 0.3 × length of sensory vesicle). Maxillary lacinia with 11 inner and 15 or 16 outer teeth. Mandible with ca. 33 inner and 13 outer teeth. Cibarium with numerous minute tubercles. ***Thorax.*** Scutum black, shiny, thinly whitish pruinose (more prominent peripherally), moderately covered with recumbent, dark brown pubescence, interspersed with long, erect dark hairs on prescutellar area; scutum with bright iridescent spot on each shoulder extending posteriorly along lateral border to wing base when illuminated anterodorsally and seen laterally, with iridescence near posterior border when illuminated posterodorsally and seen anterodorsally. Scutellum black, whitish pruinose, with long dark hairs. Postscutellum black, shiny, silvery iridescent when viewed in certain lights, without hairs. Pleural membrane bare. Katepisternum longer than deep, bare. ***Legs.*** Foreleg: coxa and trochanter pale yellow; femur pale yellow with little less than distal 1/5 brownish black; tibia white with distal 1/4 brownish black, largely iridescent on outer median portion in certain lights; basitarsus entirely black, dilated (W:L = 1.0:4.8), with thick dorsal hair crest; rest of tarsal segments black. Midleg: coxa brownish black; trochanter pale yellow except distal 1/4 darkened; femur pale yellow except distal tip brownish black; tibia pale yellowish white except distal 1/4 brownish black, with large area of white sheen on posterior surface in certain lights; basitarsus yellowish white except distal tip brownish black; rest of tarsal segments brownish black except basal 1/2 of 2nd segment white. Hind leg (Fig. 309): coxa brownish black; trochanter pale yellow; femur pale yellow except dis-

tal 1/5 brownish black; tibia pale yellowish white except distal 1/5 brownish black, in certain lights with large area of whitish sheen on posterior surface; greatest width of tibia slightly narrower than femur; tarsal segments brownish black except basal 3/4 of basitarsus and basal 1/2 of 2nd tarsomere whitish; basitarsus W:L = 1.0:5.5, calcipala short, width to that of basitarsal tip 1:2, W:L ratio 1.0:0.7; pedisulcus distinct. Tarsal claws (Fig. 311) each with small, subbasal tooth. ***Wing.*** Length 2.6 mm; costa with spinules and hairs; subcosta haired; basal section of vein R bare; hair tuft at base of stem vein dark brown; basal cell absent. ***Abdomen.*** Basal scale black with fringe of dark hairs; 2nd segment brownish black with large, dorsolateral whitish iridescent spots broadly connected in middle; tergites 3–5 small, brownish black, tergites 6–8 large, black, shining, with dark hairs. ***Genitalia*** (Figs. 303, 304). Ventral surface of abdominal segment 7 uniformly covered with long hairs except narrow bare area in middle; sternal plate undeveloped. Sternite 8 well sclerotized, bare medially, with 18–20 long and short stout hairs laterally on each side; anterior gonapophysis tongue-like in shape, gently rounded postero-internally, membraneous, covered with ca. 14 short hairs and numerous microsetae except narrow bare portion along posterior margin; inner border, nearly straight, narrowly sclerotized. Genital fork of inverted-Y form, with well sclerotized slender stem bearing flattened anterior tip; arms slender, each with strongly sclerotized distal ridge and distinct projection directed anterodorsally. Paraproct in ventral view little wider than long, with ca. 7 minute sensilla on anteromesal surface, covered with ca. 32 short and long hairs ventrally and laterally; in lateral view paraproct not produced ventroposteriorly below cercus. Cercus in lateral view subquadrate, ca. 0.5 × as long as wide, covered with numerous short hairs. Spermatheca nearly globular, well sclerotized except tube and small area of tubal base, with no definite reticulate pattern except near base, with minute internal setae.

**MALE.** Body length 2.8 mm. ***Head.*** As wide as thorax. Upper eye consisting of large facets in 16 horizontal and 14 vertical rows. Clypeus black, whitish grey pruinose, strongly iridescent when illuminated, sparsely covered with dark brown hairs. Antenna composed of 2+9 segments, brownish black, scape, pedicel and base of 1st flagellar segment pale; 1st flagellomere somewhat elongated (W:L = 1.0:1.7). Maxillary palp composed of 5 segments, proportional lengths of 3rd, 4th and 5th segments 1.0:1.3:3.1; 3rd segment (Fig. 301) of normal size, with medium-sized elliptical sensory vesicle 0.31 × length of 3rd segment. ***Thorax.*** Scutum black, with silvery iridescent pattern composed of anterior pair of large spots on shoulders, large transverse spot on prescutellar area contiguous to anterior spots by broad band along lateral margins; spots on shoulders spaced widely in middle (width of median black vitta little more than 1/3 of width of thorax), somewhat curved posteromedially, bluntly ended posteriorly (shape and size of these spots not much modified by direction of lights); anterior border of posterior spot irregular, often double ridged, with small anterior projections submedially approaching at some distance to posterodorsal apices of anterior spots; scutum uniformly covered with dark brown recumbent pubescence, interspersed with long upright hairs on prescutellar area. Scutellum, postscutellum, pleural membrane and katepisternum as in female. ***Legs.*** Foreleg: coxa and trochanter yellow; femur yellow except distal tip brownish black; tibia white except little more than distal 1/4 black and basal 1/4 brown on inner surface, with large area of white sheen on outer surface in certain lights; tarsi black; basitarsus somewhat dilated (W:L = 1.0:5.5). Midleg: coxa brownish black; trochanter yellow except distal 1/3 dark yellowish brown; femur yellow except distal 1/4 brownish black; tibia yellow, becoming white basally, distal 1/5 brownish black, largely whitish iridescent on posterior surface; basitarsus whitish except distal tip brownish black; rest of tarsal segments brownish black except base of 2nd and 3rd segment pale yellow. Hind leg (Fig. 310): coxa brownish black; trochanter yellow; femur yellow except distal 1/5 brownish black; tibia on anterior surface yellow on basal 3/4, black on distal 1/4, on posterior surface brownish black to black except basal tip pale yellow, lateral surface yellow on little less than basal 1/2 with brownish subbasal spot, brownish black on rest of distal portion; tibia basally with narrow area of whitish sheen on posterior surface; greatest width of tibia 1.12 × as wide as femur; tarsal segments brownish black except basal 3/8 of basitarsus and basal 1/2 of 2nd tarsal segment whitish; hind basitarsus enlarged (W:L = 1.0:3.7), subequal in greatest width to hind femur; calcipala small, W:L ratio 1.0:0.9; pedisulcus distinct. ***Wing.*** Length 2.6 mm; other features as in female except subcosta bare. ***Abdomen.*** Basal scale blackish with long dark hairs. Dorsal surface of abdomen black, with dark hairs; segments 2–7 each with

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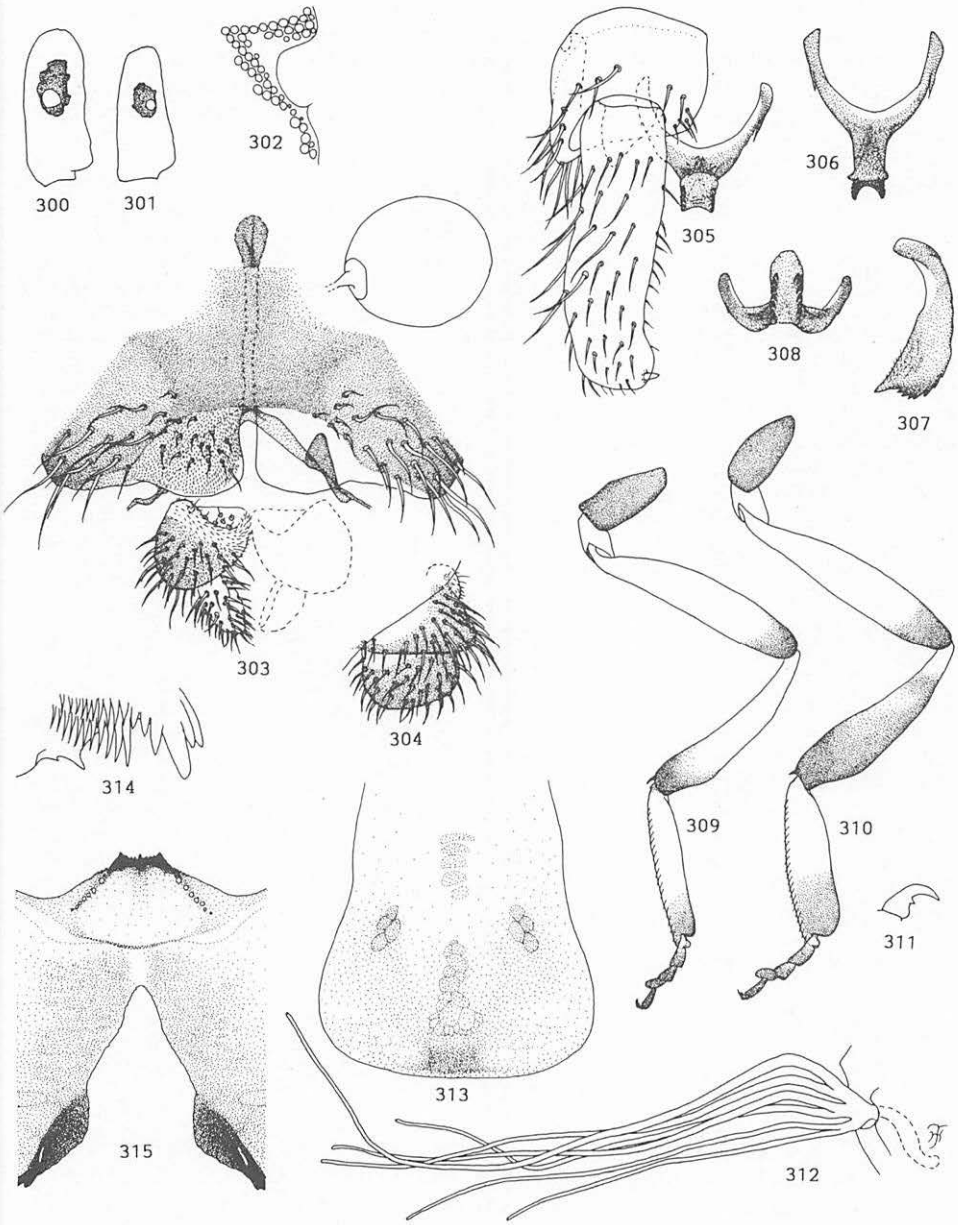
**Figs. 300–15.** *Simulium (Simulium) celsum.* **300** and **301**, 3rd segments of maxillary palp (300, ♀; 301, ♂); **302**, fronto-ocular area of ♀; **303**, ♀ genitalia *in situ* (ventral view); **304**, paraproct and cercus in lateral view; **305**, ♂ genitalia (ventral view); **306–08**, ventral plate (306, ventral view; 307, lateral view; 308, end view); **309** and **310**, hind legs (309, ♀; 310, ♂); **311**, ♀ claw; **312**, pupal gill filaments (from left side); **313**, cephalic apotome of larval head; **314**, tip of larval mandible; **315**, larval head capsule (ventral view).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pair of silvery iridescent spots dorsolaterally, those on segments 2–5 connected in middle. ***Genitalia*** (Figs. 305–08). Coxite in ventral view as long as wide, ca. 0.53 × length of style; style length 3.5 × width at base, nearly parallel-sided except distal 1/3 slightly narrowed in ventral view; style spatulate ventrodorsally, with subterminal spine; no prominent subbasal protuberance present. Ventral plate and basal arms in ventral view forming Y-shape, having low ventral projection with toothed posterior margins (7 teeth each side); plate with midventral ridge anterior to ventral projection, slightly wider than plate, covered with fine appressed setae anteriorly; basal arms long, curved outwardly and forwardly. Median sclerite of shoehorn shape, thin, gradually widened toward distal 1/4, then slightly narrowed, ended with rounded apical margin. Paramere with numerous medium-sized hooks.

**PUPA.** Body length (excluding gill filaments) 3.0 mm. ***Head.*** Integument dark yellow, smooth without tubercles, with 1 facial and 2 frontal pairs of short, slender, simple trichomes, facial trichomes much longer than frontal ones. ***Thorax.*** Integument dark yellowish brown, very sparsely covered with tubercles, with 2 dorsal and 2 lateral pairs of rather long, simple, somewhat stout trichomes on anterior 1/2 plus 1 lateral pair of trichomes on posterior 1/2 , those trichomes subequal in length, but much longer than facial ones. Gill (Fig. 312) with 6 slender, dark brown filaments in pairs, short-stalked, slightly tapering apically; dorsal filament of upper pair longest (ca. 2.8 mm), ventral one of lower pair shortest (ca. 1.4 mm), other filaments intermediate in length (1.8–2.1 mm); thickness of filaments differs decreasing from dorsal to ventral (ratio of thickness near base 1.0:0.8:0.8:0.6:0.5:0.5); cuticle of filaments with well-defined annular furrows and ridges forming reticulate pattern, uniformly covered with minute tubercles; annular ridges and minute tubercles becoming indistinct apically. ***Abdomen.*** Tergum 2 with 1 long and 5 very short simple setae on each side. Terga 3 and 4 each with 4 hooked spines along posterior margin on each side. Terga 7 and 8 each with transverse row of spine-combs on each side. Tergum 9 having pair of small but distinct terminal hooks, with comb-like groups of minute spines on each side. Sternum 4 with several minute simple setae submedially on each side. Sternum 5 with pair of bifid hooks submedially on each side. Sterna 6 and 7 each with pair of bifid inner and simple outer hooks widely spaced on each side. Grapnel-like hooklets absent. ***Cocoon.*** Wall-pocket-shaped, thickly woven, with thick anterior rim; there is no ventrolateral extension.

**MATURE LARVA.** Body length 5.2–6.0 mm. Body color dark greyish, somewhat reddish brown on abdominal segments 5–8. Cephalic apotome (Fig. 313) pale to dark yellow with faint or moderate positive head spots except posterolateral spots indistinct; lateral surface of head capsule widely pale with somewhat darkened area above and behind the eye spot area; ventral surface of head capsule (Fig. 315) somewhat dark except postgenal bridge pale medially. Antenna composed of 3 segments and apical sensillum, longer than stem of labral fan; length ratio of segments (from base to tip) 1.0:1.0:0.4. Labral fan with ca. 34 main rays. Mandible (Fig. 314) with mandibular serrations composed of a large and a minute tooth but no supernumerary serrations; 1st comb-tooth much longer than others. Hypostomal teeth 9, small, with median and each corner tooth longer than others; 7 or 8 hypostomal bristles diverging posteriorly from lateral border on each side. Postgenal cleft (Fig. 315) deep, ca. 4 × length of postgenal bridge, widest at basal 1/3, parallel-sided or slightly narrowed toward base, with pointed apex. Thoracic cuticle bare. Abdominal cuticle bare except dorsolateral areas on last segment moderately covered with short, discolored setae. Rectal papilla of 3 lobes, each with 6–10 slender, finger-like secondary lobules. Anal sclerite X-shaped, with broadened anterior arms ca. 0.5 × length of posterior ones. Posterior circlet with ca. 86 rows of hooklets with up to 14 hooklets per row. Ventral papillae absent.

**TYPE SPECIMENS.** WEST JAVA: Holotype ♀ (BISHOP), slide mounted, reared from pupa, Cibodas Botanic Garden, 4,I.1991, H. Takaoka. Allotype ♂, slide mounted, same data as holotype. Paratypes: 8 ♀, 3♂, all reared from pupae, 5 pupae and 6 mature larvae, in alcohol, same data as holotype; 4 ♀ and 4 ♂ reared from pupae, pinned together with their exuviae, Cibodas Botanic Garden, 16.XII.1975, D.M. Davies.

**ECOLOGICAL NOTES.** Pupae and larvae of this new species were collected on sticks and fine roots of grasses trailing in a shaded stream (0.3–0.5 m wide) near the edge of the natural forest, and also collected from an opened stream (0.6 m wide) running through the lawn behind the guest houses in the National Cibodas Botanic Garden. Associated with this species were *S. (S.) iridescens*, *S. (S.) nebulicola* and *S. (G.) gyorkosae*.

**DISTRIBUTION.** West Java.

**REMARKS.** This new species is most closely allied to *S. (S.) nebulicola*. The genitalia of both sexes of adults are almost identical in the two species. The lighter coloration of adult legs (Figs. 309 and 310) easily separates *S. (S.) celsum* from *S. (S.) nebulicola*. The pupa of this species resembles that of the latter species but is differentiated by the longer gill filaments and the presence of the terminal hooks. In the larval stage, there is a difference in the coloration of the head capsule.

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