

**A REDESCRIPTION OF THE FEMALE OF *SIMULIUM SANGUINEUM*
KNAB AND DESCRIPTIONS OF THE MALE, PUPA, AND
LARVA (DIPTERA: SIMULIIDAE)¹**

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Abstract.—The female of *Simulium sanguineum* Knab is redescribed and the male, pupa, and larva are described for the first time from specimens from the type-locality in Colombia. Illustrations and biological information are provided. *Simulium sanguineum* is differentiated from the closely related species *S. amazonicum* Goeldi.

The original description of *Simulium sanguineum* Knab was based on female specimens collected biting man on the Atrato River, Boca de Arquía, Colombia (Knab, 1915). Since that time specimens identified as *S. sanguineum* have been reported from Panama, Venezuela, Guyana, and Brazil. Considerable confusion exists in the literature concerning the identification of specimens of this species as well as those of *S. amazonicum* Goeldi and other closely related species. Currently, the designations *S. amazonicum* and *S. sanguineum* groups are being used by *Simulium* taxonomists to include at least six described species and an unknown number of undescribed species some of which have been confused with *S. sanguineum*. Superficially, the females of these groups are very similar and difficult to distinguish. Resolving the taxonomic confusion regarding these groups has been hampered by the lack of associated immature stages or in some cases by the incorrect association of immature stages with adults of another species.

The purpose of this paper is to redescribe the female of *S. sanguineum* and to provide the first descriptions of the male, larva, and pupa. The descriptions are based on material collected at the type-locality, and the females were compared with the holotype of *S. sanguineum* from the British Museum (Natural History), London, provided through the courtesy of R.

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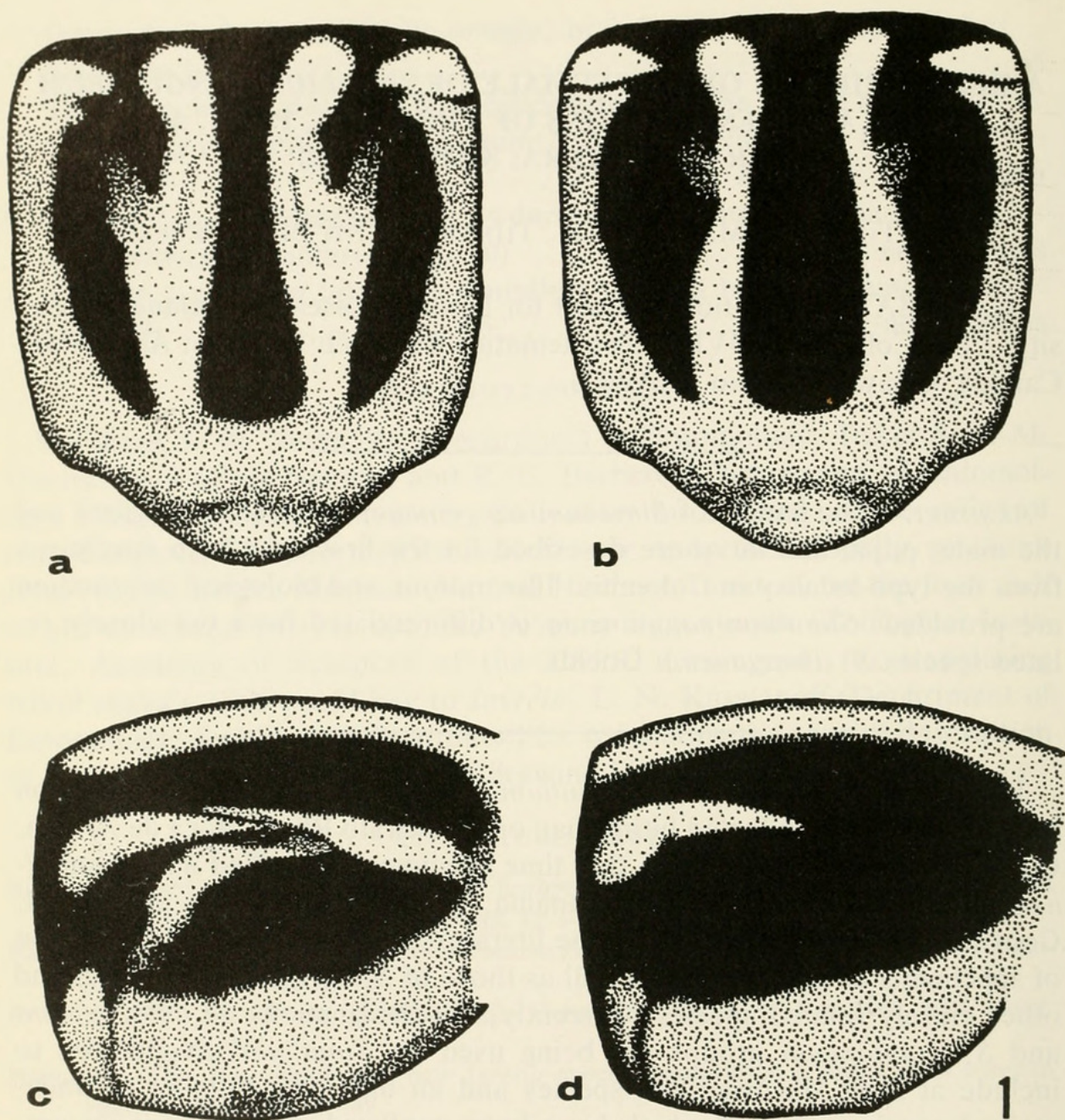


Fig. 1. *Simulium sanguineum*, female. a, Scutum, composite illustration with light sources from both sides. b, Scutum showing variation in pattern. c, Left lateral view of scutum with right submedian pruinose vitta at top, light sources anterior and posterior. d, Same position with posterior light source only.

Crosskey and A. J. Shelley. All colors are those of dry pinned specimens; measurements were made from slide mounted or alcohol preserved material. Figures 1a and b are composite drawings; with specimens in this position the lateral pruinosity is not normally observed to the extent that it has been illustrated. Figures 4a–c were drawn from cleared specimens in temporary gel mounts, and Figure 4d was made from a permanent slide mounted specimen.

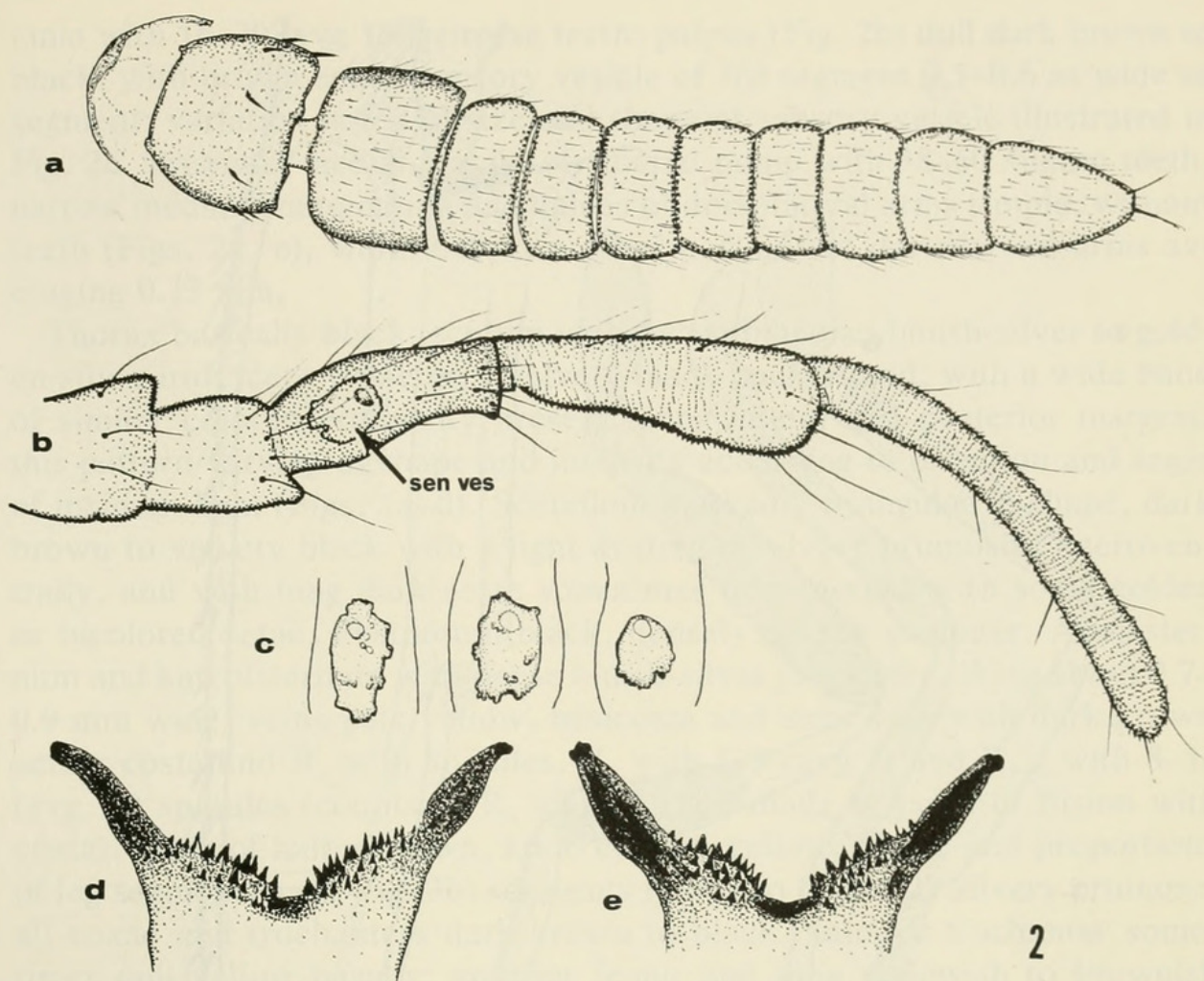


Fig. 2. *Simulium sanguineum*, female. a, Antenna. b, Palpus. c, Variation in form of sensory vesicle. d, Proximal margin of cibarial pump. e, Variation in margin of cibarial pump. Abbreviation: sen ves = sensory vesicle.

Simulium sanguineum Knab

Simulium sanguineum Knab, 1915: 279 (♀).

Female.—General body color black. Length: Body, 1.2–2.0 mm (dry pinned specimens), 1.6–2.1 mm (alcohol preserved specimens); wing, 1.3–1.5 mm.

Head black with a bluish-silver pruinosity. Frons pruinose, moderately broad, at vertex about 0.18 mm wide and approximately $1\frac{1}{3}\times$ as wide as at narrowest point. Ocular triangle greatly reduced, short but broad, at tallest point less than width of an ommatidium. Clypeus slightly wider than frons at narrowest point, concolorous with it except more densely pruinose, with sparse yellow to pale brownish setae. Antenna about 0.3 mm long, shape and proportions of segments as in Fig. 2a; scape, pedicel and base of 1st flagellomere yellow to brownish yellow, remaining flagellomeres dark brown to black. Proboscis yellowish brown to dark brown; mandible with about 6 or more serrations on outer lateral margin and 25–27 on inner margin. La-

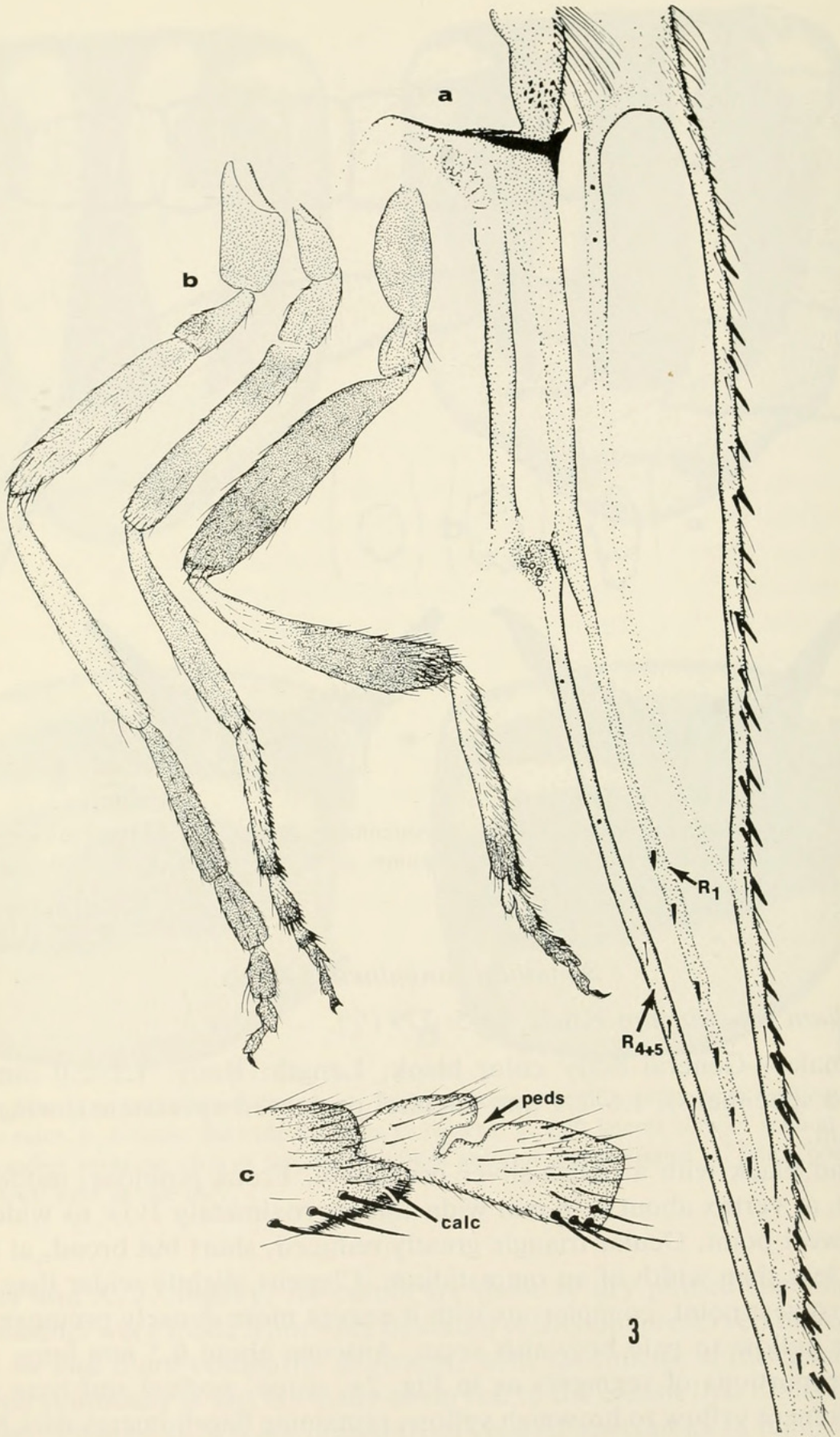


Fig. 3. *Simulium sanguineum*, female. a, Anterior wing venation showing detail. b, Legs. c, Portion of hindtarsus showing calcipala and pedisulcus. Abbreviations: calc = calcipala; peds = pedisulcus.

cinia with 16–20 (avg 18) retrorse teeth; palpus (Fig. 2b) dull dark brown to black, with brown setae; sensory vesicle of 3rd segment 0.5–0.6 as wide as segment; variation noted in size and shape of sensory vesicle illustrated in Fig. 2c. Proximal medial margin of cibarial pump with 38–60 minute teeth, narrow medial emargination and apices of dorsolateral arms simple, without teeth (Figs. 2d, e), width between distal portions of dorsolateral arms averaging 0.13 mm.

Thorax basically black; scutum with two submedian bluish-silver to golden-silver iridescent vittae on a velvety black background, with a wide band of similar colored pruinosity present along lateral and posterior margins, this pattern varying in shape and intensity according to direction and angle of incident light (Figs. 1a–d). Scutellum markedly triangular in shape, dark brown to velvety black with a light dusting of silvery pruinosity lateroven-trally, and with long dark setae sometimes interspersed with some golden or bicolored setae. Postnotum black, densely silvery pruinose. Anepisternum and katepisternum with dense bluish-silver pruinosity. Wing about 0.7–0.9 mm wide; veins pale yellow, basicosta and stem vein with dark brown setae; costa and R_1 with spinules, R_1 with 5–9 (avg 7) and R_{4+5} with 8–14 (avg 10) spinules (counts of R_1 and R_{4+5} are made to point of fusion with costa). Stem of halter brown, knob creamy yellow. Shape and proportions of leg segments as in Fig. 3b; segments faintly to distinctly silvery pruinose; all coxae and trochanters dark brown to black, anterior trochanter sometimes dull yellow basally; anterior femur and tibia yellowish to brownish yellow, midfemur and hindfemur dark brown to black, midtibia with pale ring basally, hindtibia with basal $\frac{1}{3}$ to $\frac{1}{2}$ creamy white, remainder black; anterior tarsus slender, black, basitarsus of middle leg dirty yellow with small dark area distally, 2nd and 3rd tarsomeres pale basally and apical 2 tarsomeres dark brown to black; hindbasitarsus mostly creamy white with about apical $\frac{1}{6}$ black, 2nd and 3rd tarsomeres pale basally and apical 2 tarsomeres dark brown to black; legs generally with pale setae on yellow areas and dark setae on dark areas; all femora and tibiae with some flattened scales, more numerous on outer surfaces of midleg and hindleg; calcipala about as wide as long, pedisulcus deep (Fig. 3c); claw simple.

Abdomen black, with terga 1–5 dull velvety black, terga 6–9 subshining and with faint silvery pruinosity, terga 1 and 3–5 with a faint silvery prui-nosity along posterior margins, tergum 2 more widely covered with distinct silvery pruinosity; fringe of tergum 1 of long brown setae, remaining terga with sparse brown setae. Sterna 2–7 not sclerotized, all sterna dull black with faint silvery pruinosity. Terminalia as in Fig. 4; hypogynial valves (ovipositor lobes) short, their hind margins slightly curved, medial margins slightly concave on about posterior $\frac{1}{2}$, and faintly sclerotized on about anterior $\frac{1}{2}$, with fine irregular rows of microtrichia on greater portion of ventral surface. Anal lobe, in lateral view, somewhat ovate, ventral margin

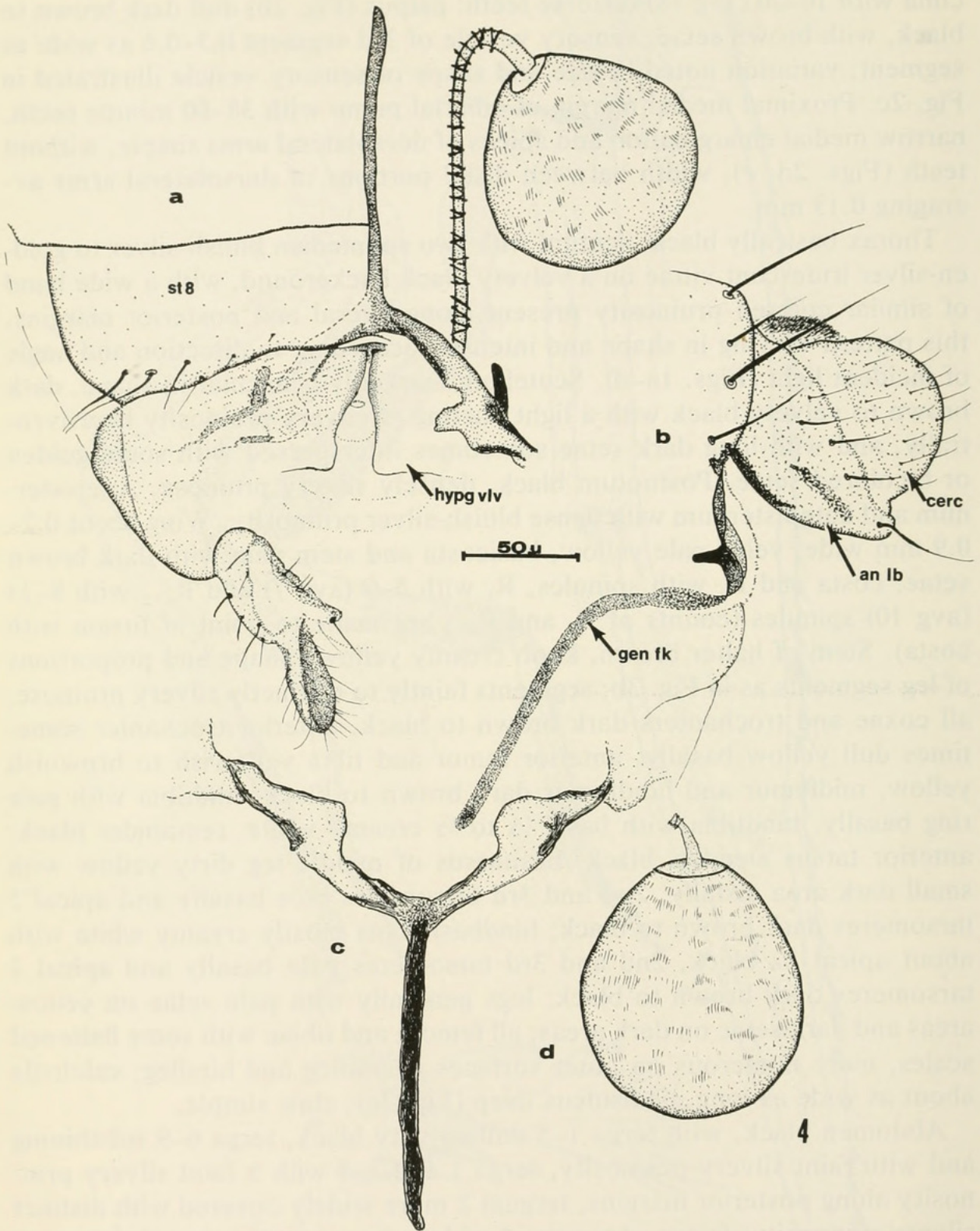
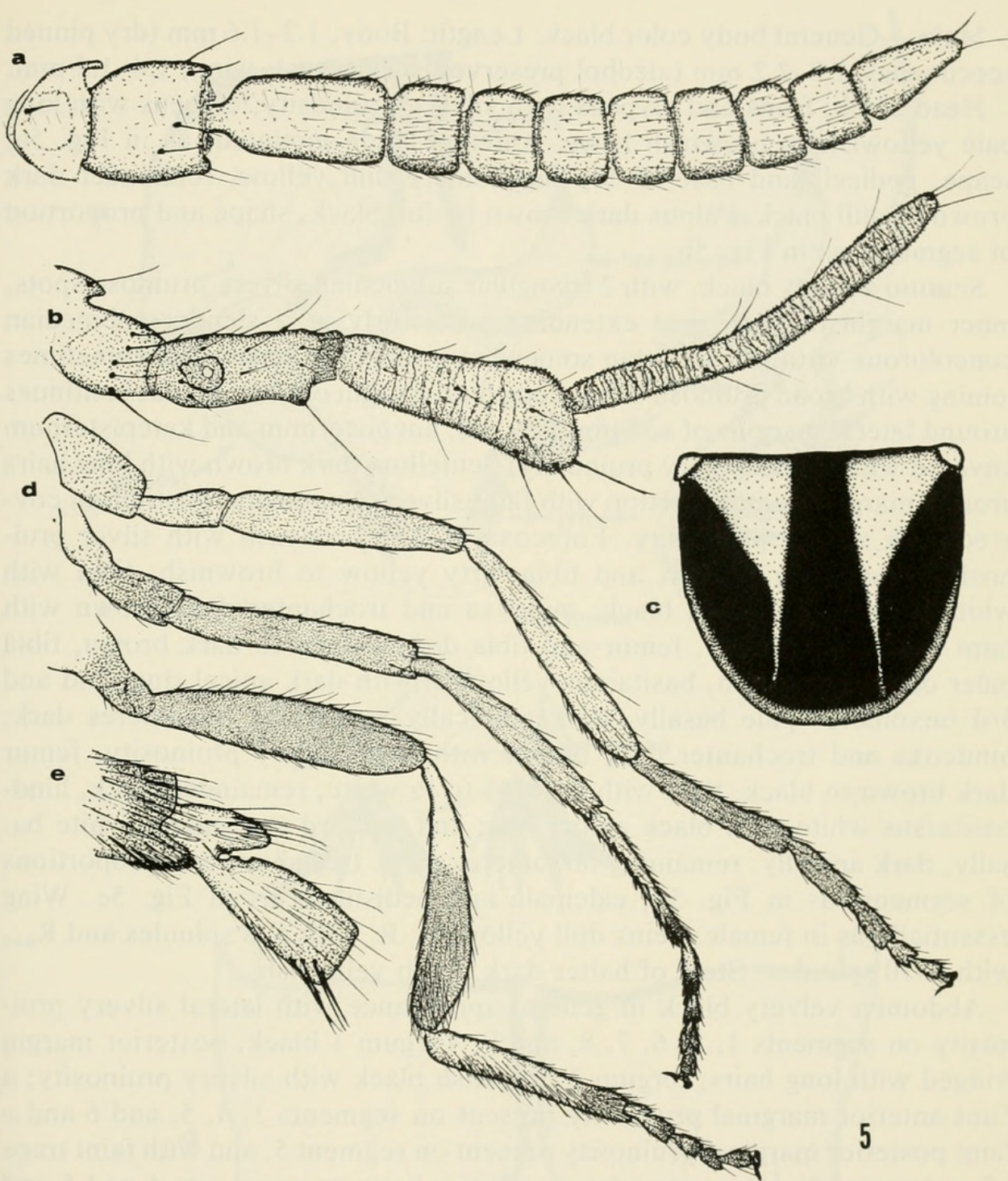


Fig. 4. *Simulium sanguineum*, female terminalia. a, Ventral view with portions of left side removed. b, Left lateral view including genital fork. c, Variation in genital fork. d, Variation in shape of spermatheca. Abbreviations: an lb = anal lobe; cerc = cercus; gen fk = genital fork; hypg vlv = hypogynial valve; st 8 = sternum 8.



5

Fig. 5. *Simulium sanguineum*, male. a, Antenna. b, Palpus. c, Composite illustration of scutal pattern. d, Legs. e, Portion of hindtarsus showing calcipala and pedisulcus.

gently curving posteriorly but not produced beyond hindmargin of cercus. Cercus broadly rounded posteriorly. Genital fork with stem and base of arms heavily sclerotized, arms distally subrectangular to subtriangular, moderately sclerotized, each with a moderately long slender sclerotized anteriorly directed process. Spermatheca globular to slightly elongate, heavily sclerotized, with small differentiated circular area at junction with spermathecal duct.

Male.—General body color black. Length: Body, 1.3–1.6 mm (dry pinned specimens), 1.8–2.2 mm (alcohol preserved specimens); wing, 1.4–1.5 mm.

Head black; frons and clypeus with silvery pruinosity; clypeus with long pale yellowish to brownish hairs. Antenna (slide mounted) as in Fig. 5a; scape, pedicel, and base of 1st flagellomere dull yellow, remainder dark brown to dull black. Palpus dark brown to dull black, shape and proportion of segments as in Fig. 5b.

Scutum velvety black, with 2 triangular submedian silvery pruinose spots, inner margin of each spot extending posteriorly as a slender submedian concolorous vitta, these vittae somewhat variable in length but sometimes joining with broad pruinose band along hind margin of scutum that continues around lateral margins of scutum (Fig. 5c); anepisternum and katepisternum covered with dense silvery pruinosity. Scutellum dark brown with long hairs around margin, ventral portion with faint silvery pruinosity; postnotum covered with silvery pruinosity. Forecoxa of legs brownish with silver pruinosity, trochanter, femur, and tibia dirty yellow to brownish, tibia with whitish pruinosity, tarsi black; midcoxa and trochanter dark brown with faint silvery pruinosity, femur and tibia dirty yellow to dark brown, tibia paler on basal portion, basitarsus yellowish with dark apical ring, 2nd and 3rd tarsomeres pale basally, darker apically, remaining tarsomeres dark; hindcoxa and trochanter dark brown with faint silvery pruinosity, femur dark brown to black, tibia with basal $\frac{1}{3}$ to $\frac{1}{2}$ white, remainder black, hind-basitarsus white with black apical ring; 2nd and 3rd tarsomeres white basally, dark apically; remaining tarsomeres dark. Leg shape and proportions of segments as in Fig. 5d; calcipala and pedisulcus as in Fig. 5e. Wing essentially as in female, veins dull yellowish; R_1 with 5–8 spinules and R_{4+5} with 6–10 spinules. Stem of halter dark, knob yellowish.

Abdomen velvety black in general appearance with lateral silvery pruinosity on segments 1, 2, 6, 7, 8, and 9. Tergum 1 black, posterior margin fringed with long hairs; tergum 2 brownish black with silvery pruinosity; a faint anterior marginal pruinosity present on segments 3, 4, 5, and 6 and a faint posterior marginal pruinosity present on segment 5, and with faint trace of pruinosity on intersegmental membrane between segments 4 and 5 and segments 5 and 6; terga 6–8 with silvery pruinosity that is absent medially, thus forming a posteriorly expanded elongate black triangle. Male terminalia as in Fig. 6; gonocoxite subquadrate, with prominent setae on distal $\frac{1}{2}$; gonostylus approximately $\frac{3}{4}$ length of gonocoxite at longest point; basal width of gonostylus varying from $\frac{1}{2}$ to $\frac{3}{4}$ its length, tapering to apex, with a single apical spine. Ventral plate somewhat U-shaped in ventral view, and strongly depressed dorsoventrally, its greatest width occurring approximately midway between basal arms to decurved distal margin; basal extremities of arms strongly sclerotized. Paramere with numerous small and large spines.

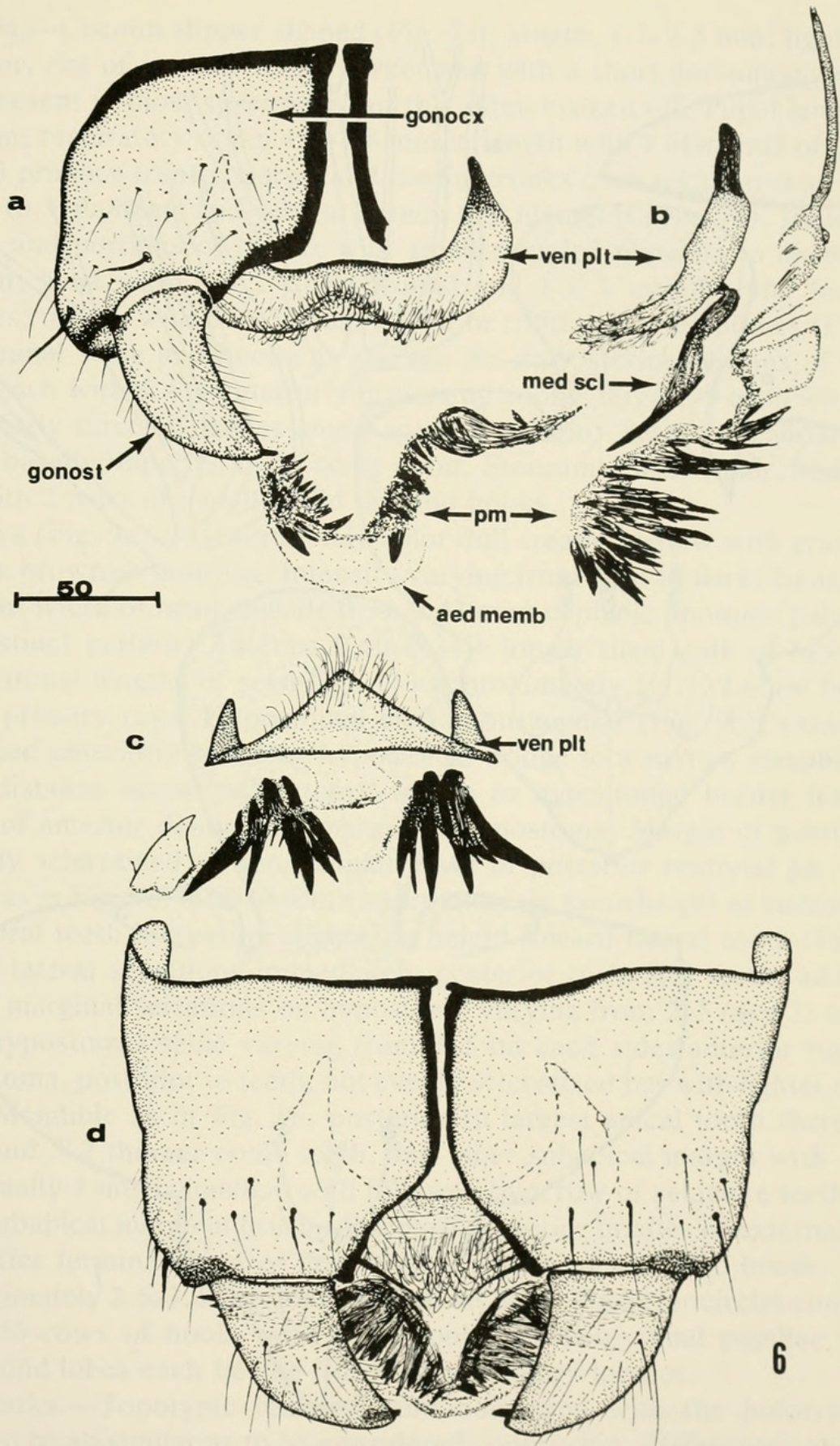


Fig. 6. *Simulium sanguineum*, male terminalia. a, Ventral view with portions of left side removed. b, Left lateral view of ventral plate and paramere. c, Terminal (end) view of same structures. d, Terminalia of separate specimen from permanent slide mount. Abbreviations: aed memb = aedeagal membrane; gonocx = gonocoxite; gonost = gonostylus; med scl = median sclerite of aedeagus; pm = paramere; ven plt = ventral plate of aedeagus.

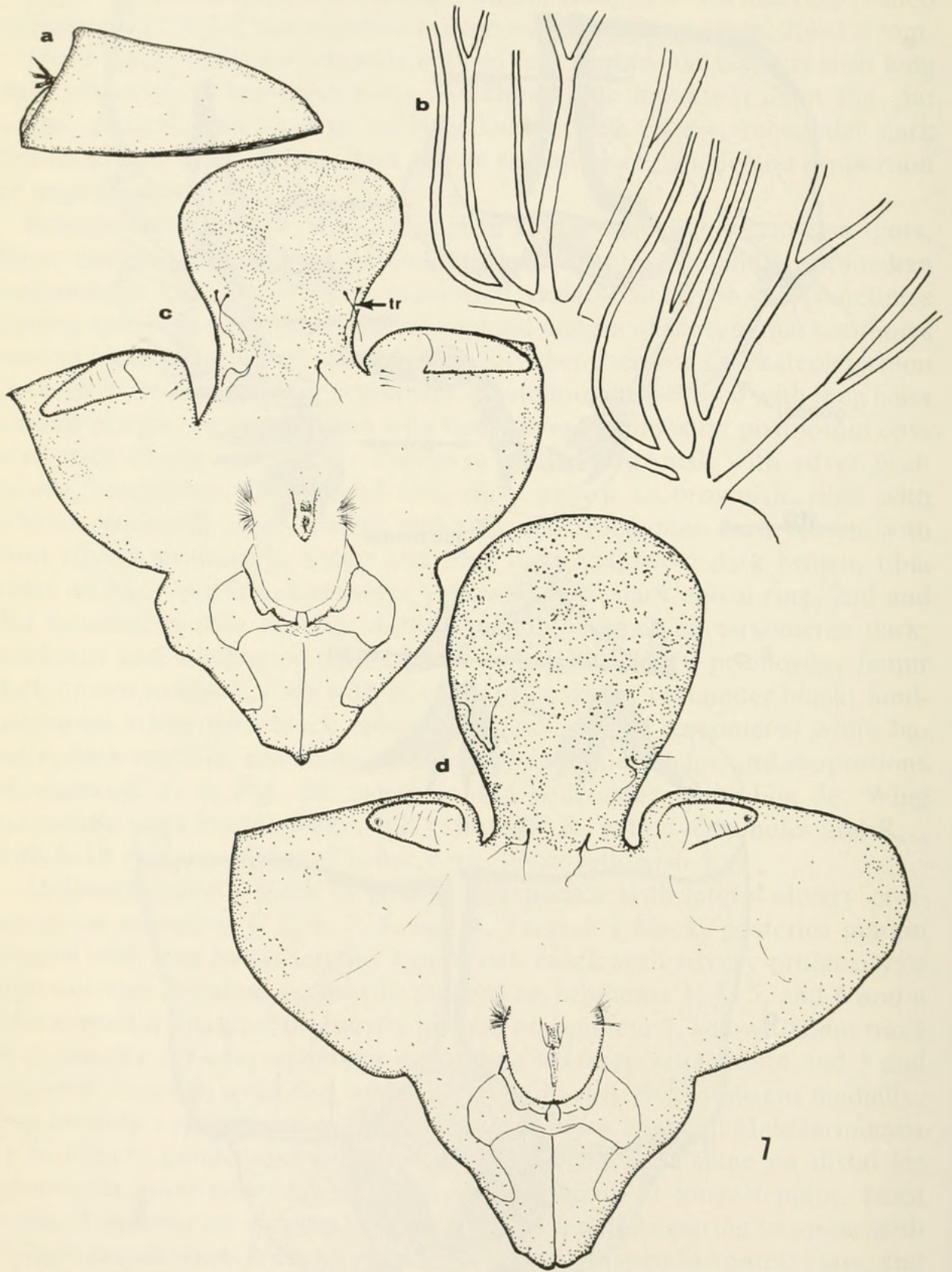


Fig. 7. *Simulium sanguineum*, pupa. a, Cocoon. b, Respiratory organ showing variation in level of branching. c, Head, female, d, Head, male. Abbreviation: tr = trichomes.

Pupa.—Cocoon slipper shaped (Fig. 7a); length, 1.7–2.5 mm; light brown in color, rim of anterior collar darker and with a short dorsomedial projection present in most specimens but this often broken off. Pupal length 1.6–2.2 mm; respiratory organ 1.4–1.8 mm in length with 8 filaments originating from 3 primary trunks, dorsal and medial trunks each giving rise at varying levels to 3 filaments and ventral branch to 2 filaments (Fig. 7b). Head (Figs. 7c, d) and portions of thorax with small rounded platelets in an irregular pattern; head with 2 + 2 single frontal and 1 + 1 usually bifid facial trichomes; thorax with 5 + 5 usually bifid or trifid dorsal trichomes (Fig. 8a). Abdominal setae and hooks as in Figs. 8b–d; posterior margins of terga 3 and 4 each with 4 + 4 anteriorly projecting hooks; terga 7–9 each with small posteriorly directed spines along anterior margin. Terminal caudal spines broad basally, tapering to an acute point. Sternum 4 with 1 pair, and sterna 5–7 with 2 pairs of usually bifid or trifid hooks.

Larva (Fig. 9a).—General body color dull creamy yellow with gray-green to dark brownish mottling, intensity varying from faint to dark. Length 3.8–4.5 mm; width of head capsule 0.39–0.43 mm; cephalic apotome pale, without distinct pattern. Antenna 0.10–0.34× longer than stalk of labral fan; proportional lengths of segments 1–3 approximately 1:1:1. Labral fan with 20–22 primary rays. Hypostomal cleft subtriangular (Fig. 9b), extensively produced anteriorly reducing hypostomal bridge to a narrow straplike process, distance across hypostomal bridge to hypostomal border less than width of anterior denticulate margin of hypostoma. Margin of postocciput strongly sclerotized to approximate level of posterior tentorial pit. Hypostoma as in Fig. 9c; median tooth approximately same height as lateral teeth; sublateral teeth increasing slightly in height toward lateral tooth (Fig. 9d); 1 or 2 lateral serrations immediately posterior to lateral teeth; additional lateral marginal serrations on hypostoma varying from 2–5 (avg 3) on each side; hypostomal setae varying from 3–5 on each side; anterior region of hypostoma, posterior to teeth, not evenly sclerotized but with lighter median area. Mandible as in Fig. 9e; posterior to largest apical tooth there are 3 stout and 5–7 thinner comb teeth, and inner subapical margin with 1 large and usually 1 much smaller tooth followed by a row of setaelike teeth forming a subapical marginal brush. Apices of posterior bristles of external brush of bristles terminating at or near base of subapical marginal brush. Palpus approximately 2.6–3.4× as long as width at base. Posterior circlet composed of 52–55 rows of hooks with 8–12 hooks per row. Anal papillae with 3 compound lobes each having from 3–5 secondary lobules.

Remarks.—Topotypic females were compared with the holotype and found to be so similar as to be considered conspecific. Differences observed in the intensity of coloration were probably due to fading with age of the holotype. It was difficult to discern the extent of silvery pruinosity on some of the legs and the abdomen of the holotype and accurate comparisons could

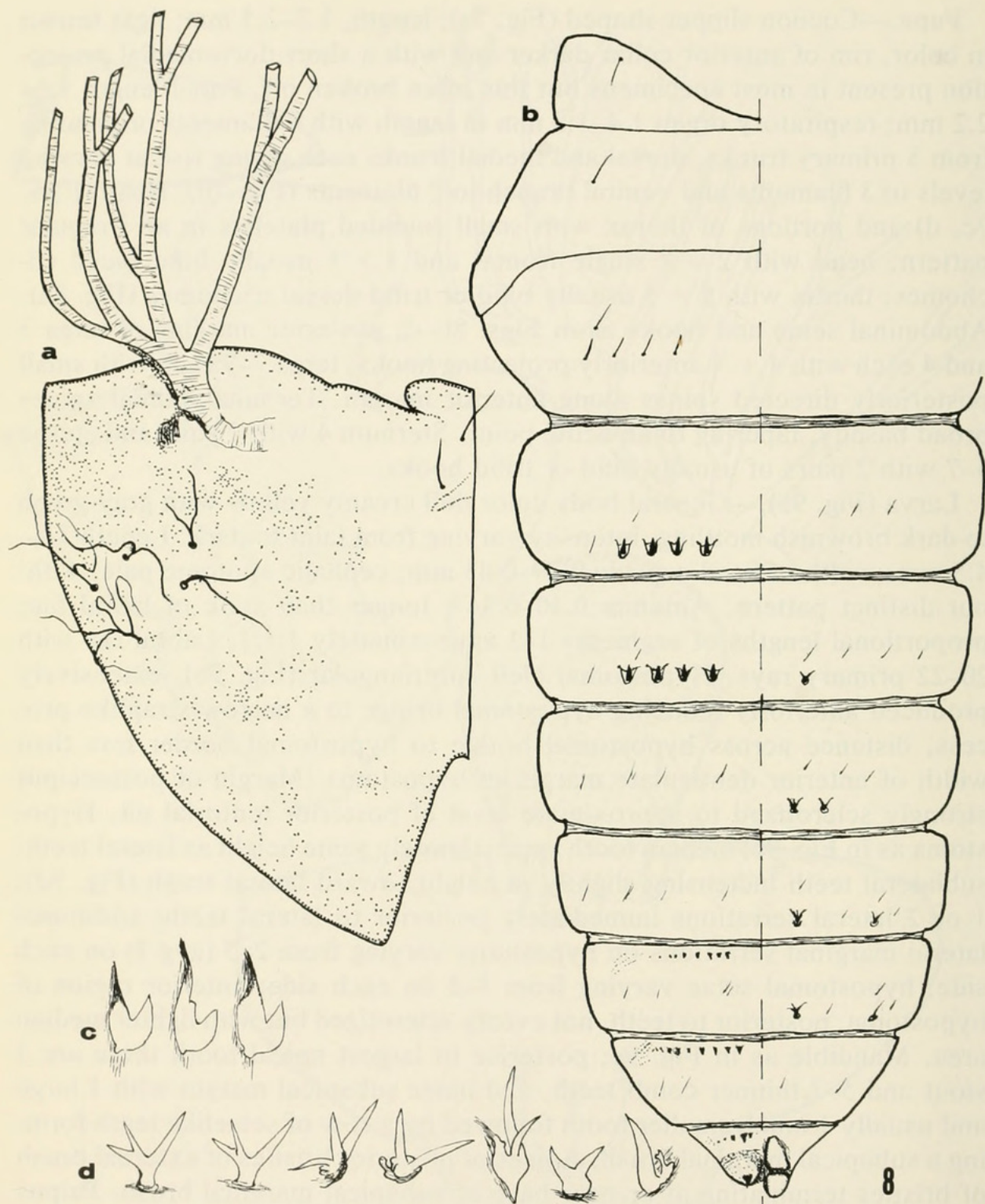
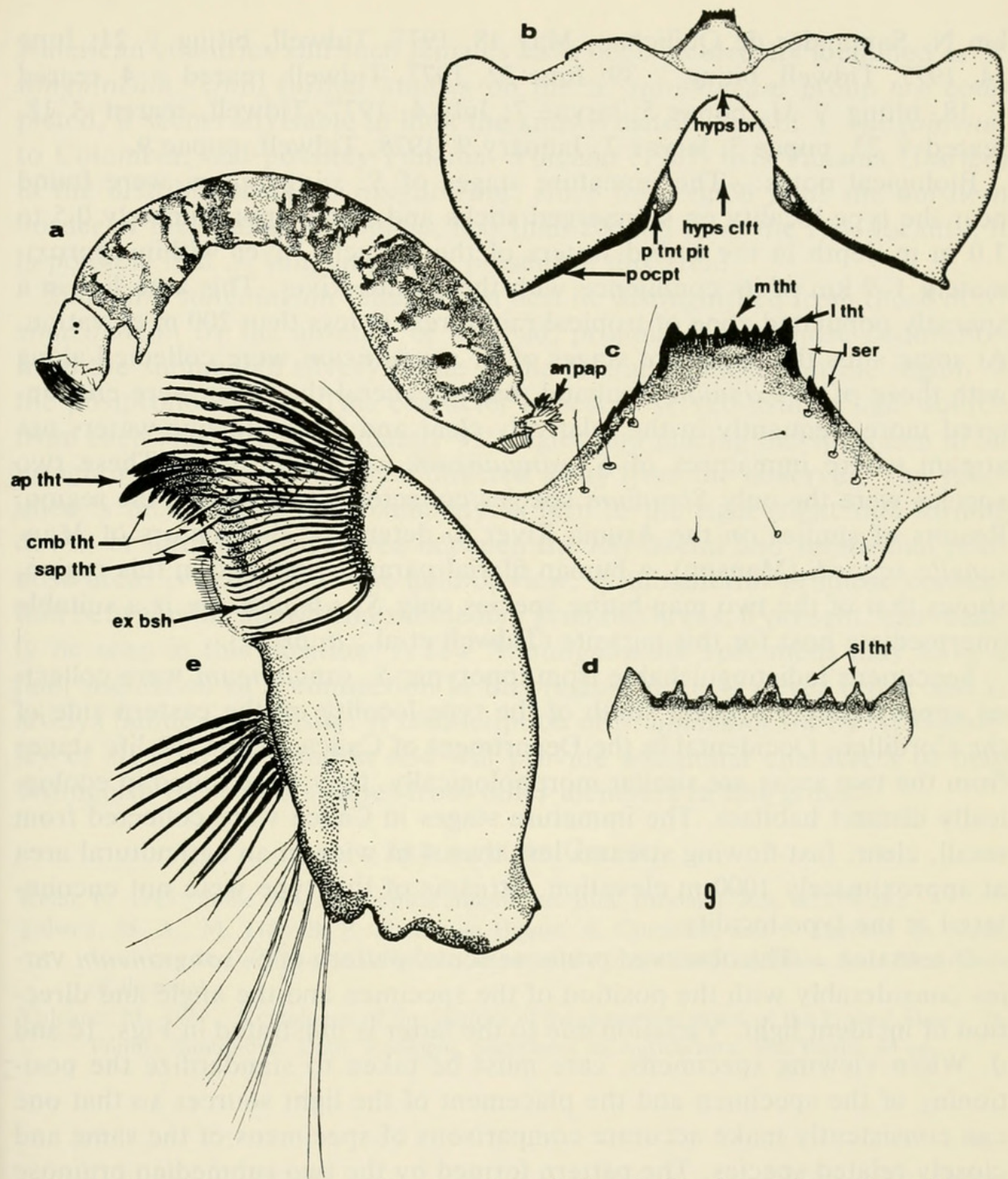


Fig. 8. *Simulium sanguineum*, pupa. a, Portion of thorax showing trichomes and respiratory organ. b, Abdomen, dorsal surface on left. c, Dorsal hooks. d, Variation in ventral hooks.

not be made. Knab apparently miscounted the abdominal segments in his description of *S. sanguineum* when he listed segments 5–8 as shining black.

Specimens examined.—COLOMBIA: Dept. of Chocó, Río Tagachí, 1–9 km from mouth of river, September 12, 1978, Tidwell, reared ♂ 41, reared



9

Fig. 9. *Simulium sanguineum*, larva. a, Lateral view. b, Head capsule, undersurface. c, Hypostoma. d, Hypostomal teeth. e, Mandible. Abbreviations: an pap = anal papillae; ap tht = apical teeth; cmb tht = comb teeth; ex bsh = external brush; hyps br = hypostomal bridge; hyps clft = hypostomal cleft; l tht = lateral tooth; l ser = lateral serrations; m tht = median tooth; p ocpt = postocciput; p tnt pit = posterior tentorial pit; sap tht = subapical teeth; sl tht = sublateral teeth.

♀ 51, pupae 29, larvae 14; August 23, 1979, Tidwell, biting ♀ 10, pupae 4, larvae 10. Río Atrato near Boca Arquía, August 23, 1979, Tidwell, biting ♀ 31. Río Arquía, Pt. Palacio, September 9, 1977, Tidwell, biting ♀ 2; February 14, 1978, Tidwell, biting ♀ 5. Dept. of Cauca, approximately 11

km N. Santander de Quilichao, May 18, 1977, Tidwell, biting ♀ 21; June 14, 1977, Tidwell, biting ♀ 39; June 22, 1977, Tidwell, reared ♂ 4, reared ♀ 18, biting ♀ 31, pupae 5, larvae 7; July 4, 1977, Tidwell, reared ♂ 12, reared ♀ 23, pupae 3, larvae 7; January 9, 1978, Tidwell, pupae 9.

Biological notes.—The immature stages of *S. sanguineum* were found near the type-locality on submerged sticks and stems approximately 0.5 to 3.0 m in depth in the turbid waters of the Tagachí River within approximately 1–9 km of its confluence with the Atrato River. This area lies in a sparsely populated zone of tropical rain forest at less than 200 m elevation. At some sites the immature stages of *S. sanguineum* were collected along with those of *S. exiguum* Roubaud, but in general the latter were encountered more frequently in the relatively clear and faster flowing waters upstream where immatures of *S. sanguineum* were not found. These two species were the only *Simulium* species collected biting man in the region. Results of studies on the Arquía River to determine the vectors of *Mansonella ozzardi* (Manson), a human filarial parasite endemic in this region, shows that of the two man-biting species only *S. sanguineum* is a suitable intermediate host for this parasite (Tidwell et al., *in press*).

Specimens indistinguishable from topotypic *S. sanguineum* were collected approximately 330 km south of the type-locality on the eastern side of the Cordillera Occidental in the Department of Cauca. While the life stages from the two areas are similar morphologically, they were found in ecologically distinct habitats. The immature stages in Cauca were collected from small, clear, fast-flowing streams less than 4 m wide in an agricultural area at approximately 1000 m elevation. Streams of this type were not encountered at the type-locality.

Discussion.—The observed pruinose scutal pattern of *S. sanguineum* varies considerably with the position of the specimen and the angle and direction of incident light. Variation due to the latter is illustrated in Figs. 1c and d. When viewing specimens, care must be taken to standardize the positioning of the specimen and the placement of the light sources so that one can consistently make accurate comparisons of specimens of the same and closely related species. The pattern formed by the two submedian pruinose vittae as seen in dorsal view (Figs. 1a, b) may vary and this character should be used with caution when separating closely related species. The pruinose patterns seen in a standardized lateral view with the light source from the anterior and/or posterior aspects generally tend to be less variable and may be used to aid in a more accurate separation of some members of this group.

Characters for the separation of females of some species of the *S. amazonicum-sanguineum* groups have not yet been completely worked out and characters of the males and/or immature stages must be used for separating these species. Females indistinguishable from those of *S. sanguineum* but emerging from six filamented pupae have been reported from several South

American countries and such females have been incorrectly identified as *S. sanguineum*. Until further studies on the *S. sanguineum* group are completed, it seems advisable to limit the known distribution of *S. sanguineum* to Colombia, and possibly Panama. Vulcano (1967) lists Panama (Darién) in the distribution of *S. sanguineum*; since this region joins the northern border of the Chocó, Colombia, less than 200 km from the type-locality, it is possible that *S. sanguineum* is present in this area.

Simulium sanguineum females can best be distinguished from those of *S. amazonicum* by the absence of a broad, pronounced pruinose connection from the submedian silvery vittae to the lateral pruinosity in the region of the postpronotal lobe. This character is best observed using a light source from each side at approximately 45° angles and placing the specimen in an upright position with the head directed away from the observer. The specimen is then rotated approximately 1/8 turn to the right (right side turning down) or until the black area between the left lateral and submedian pruinose areas is centered in the field of view. A subanterior pruinose connection between the lateral and submedian pruinose areas, if present, can readily be seen in this position. A few *S. sanguineum* specimens may have a faint indication of a connection in this region but it is never broad and is always fading in intensity. A redescription of *S. amazonicum* by A. J. Shelley et al. is in preparation and will provide additional characters to help distinguish these two species from other members in this group.

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