

NOTES ON THE SIMULIIDAE OF PANAMA

(Dipt., Nematocera)

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This paper is the result of attempts to identify Simuliidae collected from time to time during the past year in the Republic of Panama and the Panama Canal Zone. No claims as to its completeness can be made, as I have seen no material from the mountainous region of Chiriqui Province, and very little from Darien Province or the Atlantic coast of the Isthmus. Practically all the material, in fact, was taken in the Canal Zone or along the Pacific side of Panama west of the Canal Zone.

The literature records but two species of *Simulium* from Panama, while in the material before me I have been able to identify with fair certainty seven previously described forms, and three which appear to be new. In addition to these, I have seen material of two other species, but in one case the specimens are not sufficiently well preserved for description, and in the other, the single specimen was destroyed by ants before it could be studied. Furthermore, I insert here brief notes upon two other described species which are quite likely to occur within the boundaries of the Republic, but which I have not yet encountered.

Simulium sanguineum Knab (Bull. Ent. Res., VI, pp. 279-280. 1915-16), from the Rio Atrato, Colombia. This locality is near the eastern border of Panama. Knab mentions only the female, and gives no figures. It is described as a small black species with iridescent blue thoracic stripes and unarmed tarsal claws.

Simulium exiguum Roubaud (Bull. Mus. Hist. Nat., Paris. XII, No. 12, pp. 108-109). Described from Venezuela, and recorded by Bequaert from Guatemala (Onchocerciasis, pp. 212-214. 1934). It is said to be a small black species with yellowish legs, unarmed tarsal claws and bare stem vein. The male and early stages are unknown.

It is interesting to note that most of the described species reported herein have been recorded previously only from Central America north of Panama. *S. ochraceum* Wlk. has been recorded from South America, but I question the identification (see below under *ochraceum*). *S. metallicum* Bell. is recorded

from Trinidad, but as noted below under that species, there appear to be at least two forms going under this name. *S. mexicanum* Bell. apparently occurs in Venezuela, if my interpretation of *S. lugubra* Lutz and Tovar is correct.

From the point of view of possible public health significance, it might be well to point out that two of our species, *S. ochraceum* and *S. metallicum*, have been incriminated as vectors of *Onchocerca caecutiens* in Mexico and Guatemala. In North America, several species of *Simulium* are known to transmit *Leucocytozoon* infections of domestic birds.

For the purposes of the present paper, all the species are placed in the genus *Simulium*, as a discussion of generic and subgeneric problems would necessitate a far wider acquaintance with the group than I possess. The characters used in the keys are based entirely on external structures of the female and pupa, as I believe that where such characters exist, they are far more practical than those of the male genitalia. The pupal respiratory filaments, at least in the species I have studied, show admirable characters in their number and arrangement, and although there is some variation, there has never been any difficulty in separating the species on this basis. It is hoped, however, to discuss the male genitalia and larvae in a later paper.

All figures were drawn from material mounted in balsam, which, in the case of the legs, obscures the colors of the vestiture. The figures thus indicate only the color of the underlying chitin. The female genital fork is quite thin and tenuous in many cases, and is apt to become folded and twisted during dissection and mounting. Although there is considerable individual variation, this structure offers good specific characters if used with care.

KEY TO FEMALES

1. Basal section of radius (R_1) between the stem vein and insertion of R_{2+3} with at least a single row of macrotrichia.....2
- Basal section of radius bare.....6
2. At least the mesonotum rich golden yellow or orange in ground color.....3
- Mesonotum blackish or brownish with various ornamentation.....5
3. Tarsal claws entirely toothless. Mesonotum with a pair of dorsal and a pair of lateral silvery stripes. Abdomen yellowish with 3 or 5 rows of black tergal spots.....*samboni* Jennings
- Tarsal claws toothed. Abdomen not spotted.....4
4. Tarsal claws with a strong double basal tooth. Mesonotum yellow with 4 silvery stripes. Abdomen dusky, lighter basally. Legs mostly yellowish, *panamense* sp. nov.
- Mesonotum orange with 2 incomplete dorsal silvery stripes. Abdomen clear yellow on first three segments, black on remainder. Legs mostly blackish, *ochraceum* Wlk.

5. Large blackish species, over 2 mm. long. Tarsal claws with strong tooth. Legs largely blackish. **mexicanum** Bell.
 Small greyish species, less than 1.5 mm. long. Tarsal claws with very minute basal tooth. Legs largely yellowish. **clarki** sp. nov.
6. Mesonotum with brilliant iridescent bluish-green scales, especially on sides. Frons shining black. Legs mostly dark, with some silvery pollinosity. **metallicum** Bell.
 Mesonotum with or without silvery nacreous stripes, but without iridescent scales. 7
7. Mesonotum with 4 prominent silvery or greyish stripes on a deep black ground, 8 Mesonotum without prominent stripes, grey or reddish brown. 9
8. Stripes of mesonotum narrow, nacreous silvery, the lateral pair broken up into two short streaks or spots. Legs extensively blackish. Tarsal claws with a strong tooth. **haematopotum** Mall.
 Stripes of mesonotum broad, equal to or broader than the median black interval. Lateral stripes continuous. Legs, except tarsi, all yellowish. Tooth of tarsal claws very minute. **marathrumi** sp. nov.
9. Mesonotum blackish, with indistinct greyish stripes, and long silvery hairs. Hind tibiae with a prominent dark ring on basal half. Small species, less than 2 mm. long. **pulverulentum** Knab.
 Mesonotum dull mahogany brown, thinly grey pollinose. Hind tibiae without dark ring. Large species, over 2.5 mm. long. **virgatum** Coq.

KEY TO PUPAE

1. Respiratory filaments 6-branched. 2
 Respiratory filaments with 8 or more branches. 3
2. The three main stems each fork close to and equidistant from the base. Cocoon lightly woven, a simple wall-pocket type without flaring sides, **metallicum**
 Two of the main stems fork a short distance from the base, the third practically at the base. Cocoon of wall-pocket type, but with flaring sides. **clarki**
3. Filaments 8-branched. 4
 Filaments with more than 8 branches. 8
4. All forks rather close to the base. 5
 At least one fork quite far from base. 6
5. Three main stems, bearing 4, 1, and 3 branches. Cocoon slipper-shaped, the margin produced into long finger-like projections. **virgatum**
 Four main stems, with 2, 3, 1, and 2 branches. Cocoon of wall-pocket type, with very wide flaring sides. **ochraceum**
6. Three main stems, with 4, 2, and 2 branches, the terminal fork on the four-branched stem quite far from base. Cocoon as in *clarki*. **haematopotum**
 Two main stems. 7
7. Main stems unusually stout, branches quite tapered. Main stems with 2 and 6 branches, the forks of the most basal branch of the 6-branched stem dividing it approximately into thirds. Cocoon a simple wall-pocket with irregular upper margin. **marathrumi**
 Main stems normal, branches slender throughout. Main stems branched as above, but basal branch of 6 branched stem with the forks close together, dividing the branch approximately in halves. Cocoon of wall-pocket type, but with flaring sides. **samboni**
8. Filaments of 10 short stout branches. Cocoon slipper-shaped, the lower lip margin irregular. **pulverulentum**
 Filaments more than 10 branched. 9
9. Filaments of 12 medium branches, all arising practically at the base. Cocoon slipper-shaped, the lower lip margin deeply dentate. **mexicanum**
 Filaments of 20 branches, arising from 3 main stems, one bearing 4 branches, the other two, 8 each. All forks fairly near base. Cocoon of simple wall-pocket type, the upper lip margin produced in the middle. **panamense**

***Simulium samboni* Jennings**

1915. Proc. Ent. Soc. Washington, XVII, p. 199-200 (♂ ♀; Empire, C. Z.).
Pinto, 1931, 7th Reun. Soc. Arg. Pat. Reg. Norte, p. 740.

Length of mesonotum and scutellum 1.0 mm., of wing 2.0 mm.¹

Female.—Prons and clypeus with silvery pubescence and golden hairs. Antennae yellow. Front tarsi somewhat inflated. Legs without silvery scale-like hairs. Fore and mid femora and tibiae yellow, fore tarsi blackish, mid tarsi mostly yellowish. Hind legs as figured (Fig. 9). Thorax with mesonotum orange yellow, sparsely golden haired, and with four silvery stripes, a dorsal and a lateral pair. Pleura yellow with some dusky areas. Scutellum yellow, with long dark hairs. Abdomen poorly chitinized, yellow on first two tergites, 3rd to 6th tergites with small black median dorsal plates, and 1 or 2 series of dorsolateral dark spots. The terminal tergites are whitish and shiny. Laterally and beneath the abdomen is dusky and apparently without patches of silvery pubescence. Post-scutellum with some silvery pubescence. Tarsal claws simple, without tooth or strong basal heel (Fig. 8). Pupal filaments 8 (Fig. 31). Cocoon of wall-pocket type with widely flaring sides. Genital rod as figured (Fig. 24). Stem vein setose.

Male.—Similar to ♀, except that silver stripes of mesonotum reduced to short anterior patches, some silver pollinosity on fore tibiae, and large lateral patch of silver on 2nd tergite. Abdomen lighter, only the terminal segments dusky.

The adult is very similar to *S. panamense*, except that the abdomen is yellowish with longitudinal rows of rounded dark spots, and the midtarsal claws are entirely without teeth. The *pupa* is, however, very distinct, having 8-branched filaments about 1.6 mm. long.

Cocoon subconical, margin slightly thickened, irregular dorsally. No floor; texture thin. Length about 1.8 mm.

Panama records: Empire, C. Z. (♂ ♀ Types). Cerro Sta. Rita, Colon Prov., R. P. February 2, 1940. Rio Paloma, near Juan Diaz, Panama Prov., R. P. January 14, 1940. Quebrada Mañanita, near Pedregal, Panama Prov., R. P. January 14, 1940. El Valle, Coclè Prov., R. P. December 10, 17, 1939. Rio Puente, Panama Prov., R. P. April 27, 1940. Rio Callabaco, C. Z. Forest Reserve January 21, 1940. All bred from pupa on vegetation or detritus.

Of the three small yellow species of *Simulium* taken in Panama, the present one seems best to fit Jennings' description. It is the only species with the abdomen with conspicuous discrete dark spots. Jennings apparently did not preserve the

¹The length of the whole insect is not given, as the abdomen is subject to much shrinkage.

pupae from which he bred his material, at least Dr. Alan Stone was unable to find them when he kindly undertook a comparison with my material, so that complete certainty in the identification is impossible at present. *Samboni* seems quite close to *callidum* D. & S., but differs in lacking the small black mesonotal spots, in the pupal filaments, which branch very much farther from the base, and in the cocoon, which has prominent lateral extensions on the substratum, said by Bequaert (1934, p. 212) to be lacking in *callidum*.

S. samboni is one of the most abundant species about the Canal Zone, the pupae being found on dead leaves and twigs in nearly every little stream I have examined, but it apparently does not attack man.

Simulium panamense n. sp.

Female.—Length of mesonotum and scutellum, 1.1 mm., of wing, 2.4 mm. Frons medium, much widened at vertex, grey pollinose with a few dark hairs. Antennae of 11 visible segments, yellow basally, darkening to brownish at apex, moderately pubescent. Palpi blackish, pubescent and moderately hairy. Proboscis yellowish brown.

Mesonotum (from above) rich orange yellow, rather translucent, with two parallel stripes of silver pollinosity reaching from the anterior margin, where they are widened slightly, to near the base of the scutellum. The stripes are narrow, less than half as wide as the median space between them. The mesonotum is covered rather evenly with mixed brassy and dark hairs. Viewed from the side, the pleuron and a stripe along the lateral margin of the mesonotum from its anterior angle to just above the wing base is silvery grey pollinose. Scutellum pale straw color, sparsely grey pollinose and with rather sparse erect brassy and dark hairs.

Legs: Fore coxae and femora yellow, tibiae yellowish white, dusky at apex, tarsi black, somewhat inflated. Mid legs entirely yellow, except extreme apices of tarsal segments, which are dusky. Hind coxae yellow, femora yellow, dusky at apex, tibiae black on apical third; apical half of 1st hind tarsal black (fig. 12). 2nd hind tarsal yellowish at base, black at apex, as are rest of tarsal joints. Calcipala well developed, pedisulcus broad and deep. Mid tarsal claws (fig. 20) with blunt double basal tooth.

Wings with stem vein setose, no branch on R_2 . Halteres yellow. Abdomen poorly chitinized, dusky with a light spot on third tergite. pollinose, and with scattered hairs.

Pupa with twenty branchial filaments about 1.5 mm. long. All forks are quite close to the base (Fig. 39).

Cocoon 3.0 mm. long, subconic, the opening about 90 degrees to the long axis, but the cocoon is completely floored, the floor extending out in front a considerable distance. There is also a dorsal projection of irregular extent. The texture is moderately dense, but there are numer-

ous openings, particularly in the anterior part. The margins of the aperture may be slightly thickened.

This species seems nearest to *S. simplicicolor* Lutz, which also has 20-branched respiratory filaments, but it differs from that species in having a pair of silvery dorsal stripes on the mesonotum.

Holotype ♀, Allotype ♂, 4 ♀ Paratypes. El Valle, Coclé Prov., R. P. December 17, 1939. 5 ♀, 1 ♂ Paratypes. El Valle, March 17, 1940. 1 ♂ Paratype, Rio Puente, Panama Prov., R. P. April 21, 1940.

Simulium ochraceum Walker

1861. Trans. Ent. Soc. London, (N. S.) V, pt. 8, p. 332 (♀ Mexico). Kertész, 1902, Cat. Dipt., I, p. 289. Johannsen, 1903, New York State Mus., Bull. 68, p. 370 (♀). Aldrich, 1905, Cat. N. Amer. Dipt., p. 170. Bequaert, 1934, Onchocerciasis, pt. III, p. 210.

Odegnis ochracea Enderlein, 1925, Zool. Anz., LXII, p. 208.

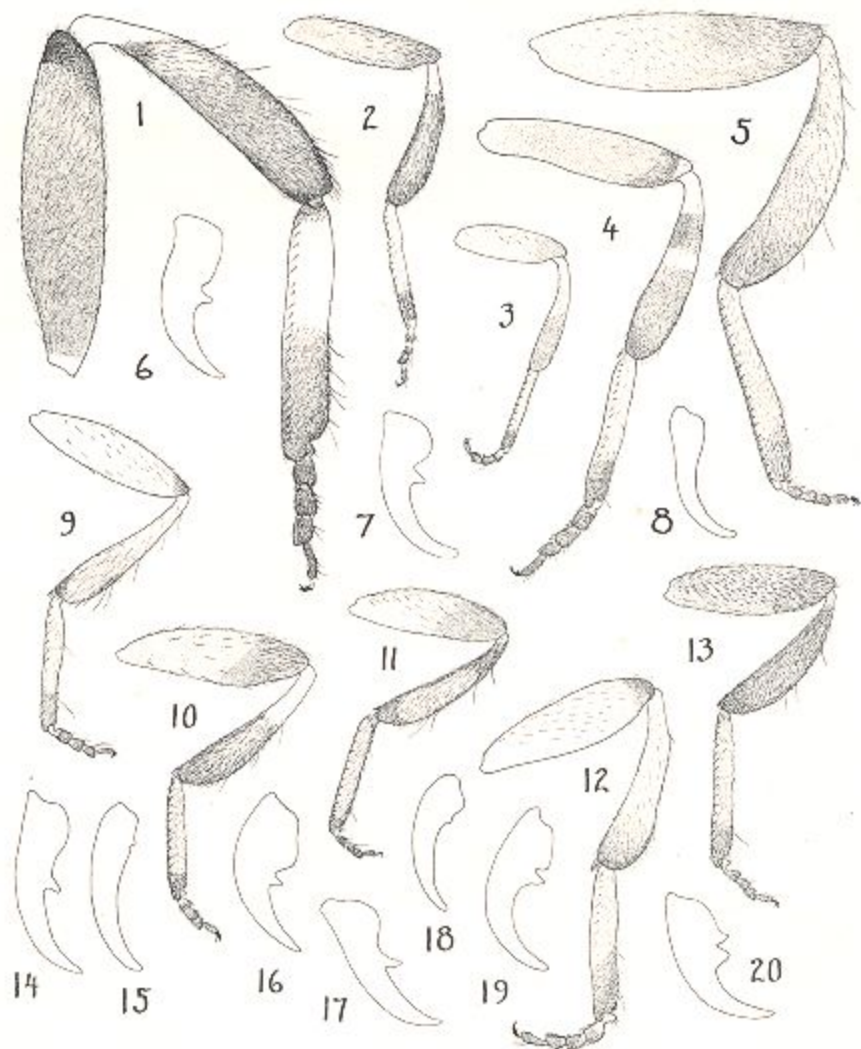
Eusimulium ochraceum Dyar and Shannon, 1927, Proc. U. S. Nat. Mus., LXIX, Art. 10, p. 16 (♀; Chiapas, Mexico). Dampf, 1931, Medicina, Revista Mexicana, XI, pp. 756, 757, 758, fig. 3, (♀ Chiapas) C. C. Hoffmann, 1930, Arch. Schiffs- u. Tropenhyg., XXXIV, p. 470; 1930, An. Inst. Biologia, Mexico, I, 4, p. 298, fig. 4 (♀); 1931, op. cit., II, 3, p. 217, figs. 3, 4, 5, 12, 14, 15 (larva and pupa).

Length of mesonotum and scutellum 0.71 mm., of wing 2.0 mm.

Female.—Frons pearly pollinose. Antennae reddish basally, the rest black. Legs without prominent silvery scales, the femora basally yellow, the tibiae and tarsi largely blackish (fig. 11). Front tarsi somewhat inflated. Mesonotum orange yellow, with two anterior dorso-lateral patches of silver pollinosity. Sides of mesonotum without silver. Pleura brownish with some silver pollinosity. Abdomen poorly chitinized, the first 3 segments clear yellow, the remaining black; tip of abdomen chitinized and shiny. Stem vein setose. Mid tarsal claws strongly toothed (fig. 6).

Male.—As in female, but no silver on mesonotum, and abdomen with pearly patches. *Pupa* with 8-branched filaments (fig. 35), *cocoon* of wall pocket type, the upper margin of the aperture somewhat thickened, the rear half floored over, and with widely flaring sides.

My material agrees well with Bequaert's and Hoffman's descriptions and figures, except that the pupal filaments branch somewhat more basally than shown in Hoffman's figure. *S. ochraceum* of Lutz and Tovàr [1928 Est. Zool. Parasit. Venezolanas, p. 45, Pl. 4, Fig. 4, (♀) Pl. 6, Fig. 3 (respiratory filament)], and of Pinto (1931, 7th Reun. Soc. Argentina Pat. Reg. Norte, pp. 739, 752, Fig. 10), seems to be different, as the arrangement of the pupal filaments is not the same, the size is larger, the abdomen entirely dark, and the legs extensively light colored. Recently, J. Lane and C. E. Porto (Bol. Biol. Sao



The figures of legs and genital forks are drawn to the same scale, the figures of the respiratory filaments are accompanied by a scale line, which in each case represents 0.5 mm., while the figures of the claws are not drawn to scale.

- Fig. 1. Hind leg of *S. mexicanum*
 Fig. 2. Hind leg of *S. haematopotum*
 Fig. 3. Hind leg of *S. marathrumi*
 Fig. 4. Hind leg of *S. pulverulentum*
 Fig. 5. Hind leg of *S. virgatum*
 Fig. 6. Mid tarsal claw of *S. ochraceum*
 Fig. 7. Mid tarsal claw of *S. virgatum*
 Fig. 8. Mid tarsal claw of *S. samboni*
 Fig. 9. Hind leg of *S. samboni*
 Fig. 10. Hind leg of *S. clarki*
 Fig. 11. Hind leg of *S. ochraceum*
 Fig. 12. Hind leg of *S. panamense*
 Fig. 13. Hind leg of *S. metallicum*
 Fig. 14. Mid tarsal claw of *S. mexicanum*
 Fig. 15. Mid tarsal claw of *S. marathrumi*
 Fig. 16. Mid tarsal claw of *S. haematopotum*
 Fig. 17. Mid tarsal claw of *S. metallicum*
 Fig. 18. Mid tarsal claw of *S. darki*
 Fig. 19. Mid tarsal claw of *S. pulverulentum*
 Fig. 20. Mid tarsal claw of *S. panamense*

Paulo, (N. S.) IV, 2, p. 171, 1939) mention specimens (as *Eusimulium ochraceum*) from Bolivia, but they give no description.

The species has been bred from pupae on dead leaves in a small stream on the Atlantic side of the Isthmus, and a single pupa secured at El Valle on the Pacific side. It has not been seen to bite man.

Distribution: Mexico, Guatemala, Panama.

Panama records: El Valle, Coclè Prov., December 10, 1939 (pupa only). Cerro Sta. Rita, Colon Prov., February 2, 1940. Rio Puente, R. P. April 27, 1940.

Simulium mexicanum Bellardi

1862, Sagg. Ditt. Messicana, Appendice, p. 6 (♂; Tuxpango, near Orizaba, Mexico). Kertész, 1902, Cat. Dipt., I, p. 288. Johannsen, 1903, New York State Mus., Bull. 68, p. 369 (♂). Aldrich, 1905, Cat. N. Amer. Dipt., p. 170. Malloch, 1914, U. S. Dept., Agric., Bur. Ent., Techn. Ser., Bull. 26, p. 35 (♂ ♀). Bequaert, 1934, Onchocerciasis, pt. III, pp. 216-217, fig. 99 (♂ ♀, pupa, cocoon; Guatemala).

Odagmia mexicana Enderlein, 1925, Zool. Anz., LXII, p. 208.

Eusimulium mexicanum Dyar and Shannon, 1927, Proc. U. S. Nat. Mus., LXIX, Art. 10, p. 15; pl. IV, fig. 46 (♀; Cordoba, Mexico). Dampf, 1927, Rev. Mex. de Biología, VII, p. 129. Pinto, 1931, 7th Reun. Soc. Arg. Pat. Reg. Norte, p. 738.

Simulium aureopunctatum Malloch, 1914, l. c., p. 27 (♀; Guatemala). Pinto, 1931, l. c., p. 732.

Odagmia aureopunctata Enderlein, 1925, l. c., p. 208.

Eusimulium turgidum C. C. Hoffman, 1930, An. Inst. Biol., Mexico, I, 4, p. 298, figs. 6 and 13 (♀; Chiapas, Mexico). Pinto, 1931, l. c., p. 740.

Simulium lugubre Lutz and Tovar, 1928, Est. Zool., Parasit. Venezolanas, p. 46, pl. 4, fig. 2 (♀), pl. 6, fig. 6 (respiratory filaments of pupa; Venezuela). Pinto, 1931, l. c., p. 748, fig. 10 (respiratory filaments).

Female.—Length of mesonotum and scutellum, 2.0 mm., of wing, 3.5 mm. Frons about two and one-half times as high as wide, wider at vertex, grey pollinose with a row of black hairs along each eye margin and scattered hairs on vertex. Excision of eye border opposite antennal base broad and rather shallow. Clypeus about twice as long as broad, grey pollinose with sparse, long hairs. Antennae yellowish brown, 11-segmented, the third segment noticeably broader than the others, brownish pubescent. Palpi and proboscis blackish.

Mesonotum (from above) uniform dark grey pollinose with scattered golden or brassy hairs. Scutellum concolorous, with sparse long erect hairs along the margins. Pleura a little lighter than mesonotum.

EXPLANATION OF PLATE II

Fig. 21. Genital fork of *S. marathrumi*

Fig. 22. Genital fork of *S. mexicanum*

Fig. 23. Genital fork of *S. ochraceum*

Fig. 24. Genital fork of *S. samboni*

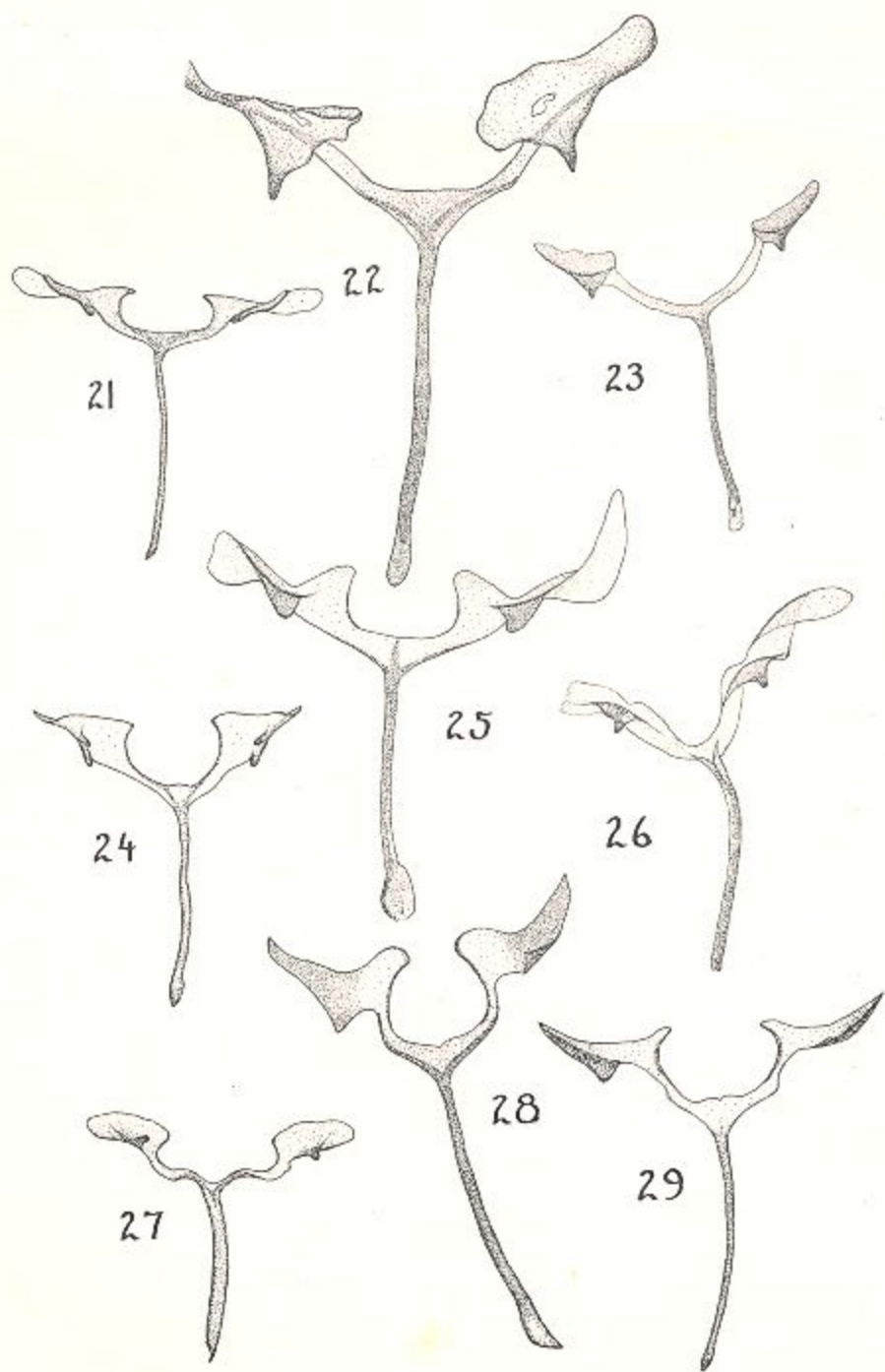
Fig. 25. Genital fork of *S. clarki*

Fig. 26. Genital fork of *S. metallicum*

Fig. 27. Genital fork of *S. haematopotum*

Fig. 28. Genital fork of *S. pulverulentum*

Fig. 29. Genital fork of *S. panamense*



Legs: Fore coxae and femora yellow with mixed yellow and black pubescence. Tibiae silvery pubescent on proximal two-thirds, black distally; tarsi all black, rather inflated. Mid coxae and femora dark, apex of latter yellowish; tibiae dark on apical half and on inside edge, proximal half yellowish and silvery haired on the outside; first tarsal white, black at apex, second basally white, others all brown to black. Hind legs as figured (fig. 1). Calcipala well developed, pedisulcus rather narrow. Mid tarsal claw toothed (fig. 14).

Wing with stem vein hairy; R_2 simple. Halteres yellow. Abdomen dark grey, the terminal segments well chitinized and shiny.

Cocoon slipper-shaped, the margins of the aperture lacelike. *Pupa* with 12 moderately short filaments, all of which arise close to the base (fig. 37).

My material agrees quite well with Bequaert's description. Lutz and Tovâr's descriptions and figures of the adult and the pupal filaments seem to fit the present species closely, though they do not mention the hairy base of the radius. In the text the length is given as 3-4 mm., which would be about right for this species, but the figure indicates a species considerably less than 2 mm. in length. However, the part of this work dealing with *Simuliidae* apparently was not checked, and the text and figures do not agree in many instances.

The species has been taken only at El Valle, R. P., at elevations above 2000 ft., and has not been seen to attack man.

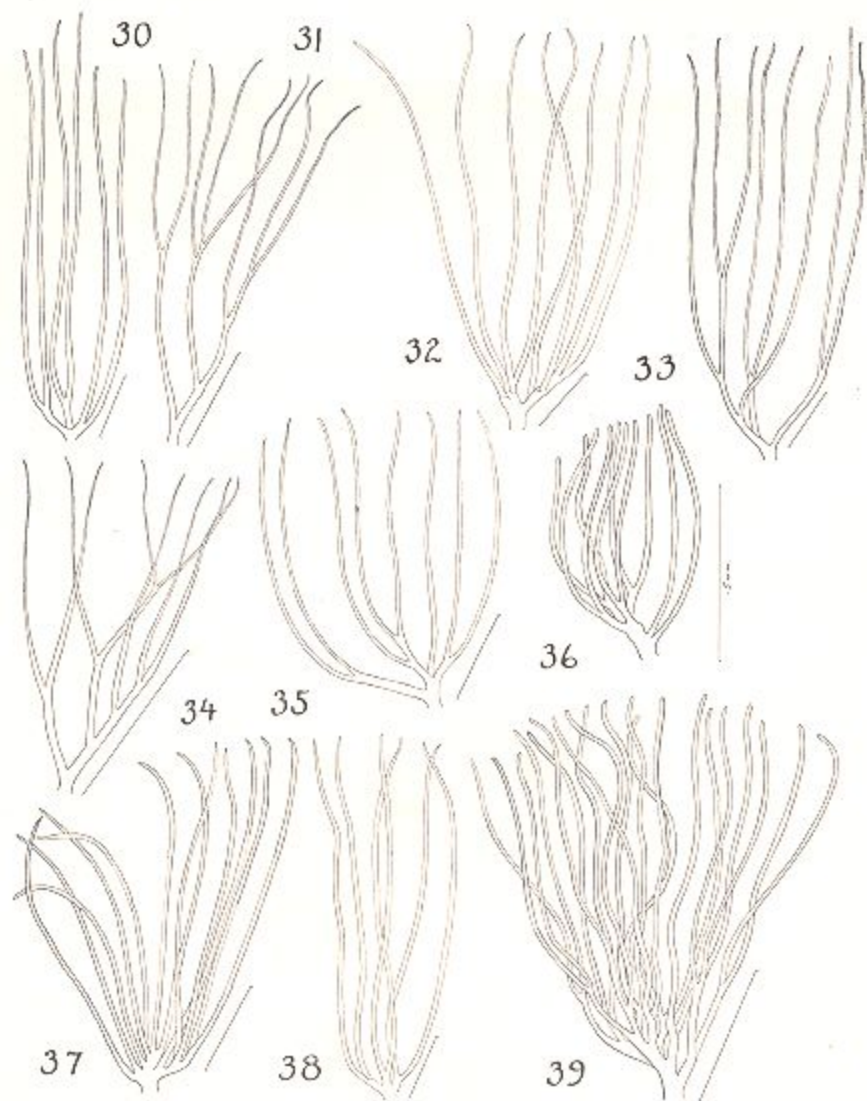
Distribution: Mexico, Guatemala, Panama, Venezuela.

Panama records: El Valle, Coelè Prov., December 10, 1939, (in car); March 17, 1940 (bred from pupae on roots and dead leaves in a mountain stream).

Simulium clarki n. sp.

Female.—Length of mesonotum and scutellum, 0.9 mm., of wing, 1.9 mm. Frons subtriangular, narrow at antennae, broad at vertex, excision of eye margin opposite antennal base as deep or deeper than wide. Clypeus longer than broad, broadest at apex, narrow at antennal insertion. Frons and clypeus pale silvery grey pollinose, the former with a few, the latter with many silvery hairs. Antennae subcylindrical, of 11 segments, yellowish at base, darkening to a black apex, grey pollinose and pubescent. Palpi and proboscis dusky.

Mesonotum (viewed from above) uniformly silvery grey pollinose, rather evenly beset with well spaced silvery to pale brassy hairs, which are longer and denser on the margins than on the disc. On the posterior fourth and posterior lateral margin to as far forward as the level of the wing bases, these hairs point towards the anterior end of the insect, while those on the rest of the mesonotum point backward, and a ridge of upstanding hairs is formed where the two types join. Scutellum silvery grey with dense, long, curved, silvery hairs. Pleura and sides of mesonotum silvery grey pollinose.



- Fig. 30. Pupal respiratory filaments of *S. clarki*
Fig. 31. Pupal respiratory filaments of *S. samboni*
Fig. 32. Pupal respiratory filaments of *S. virgatum*
Fig. 33. Pupal respiratory filaments of *S. haematopotum*
Fig. 34. Pupal respiratory filaments of *S. marathrumi*
Fig. 35. Pupal respiratory filaments of *S. ochraceum*
Fig. 36. Pupal respiratory filaments of *S. pulverulentum*
Fig. 37. Pupal respiratory filaments of *S. mexicanum*
Fig. 38. Pupal respiratory filaments of *S. metallicum*
Fig. 39. Pupal respiratory filaments of *S. panamense*

Legs: Fore coxae and femora yellow with yellow pubescence, the latter very slightly dusky at apex. Tibiae yellow, with dense silvery pollinosity on the outer side and yellow pubescence on the inner; apex dusky. Tarsi black, slightly inflated, black pubescent. Mid coxae dusky, femora yellow, dusky at apex and with yellow pubescence. Basal third of tibiae white, silvery pubescent, apical two thirds black, with mixed yellow and black pubescence. Basitarsis basally two-thirds white, rest and remaining tarsal segments black. Hind legs as figured (fig. 10). Calcipala and pedisulcus well developed. Claws of mid tarsi with a minute tooth (fig. 18).

Wings with stem vein hairy, R_2 simple. Halteres white.

Abdomen dusky with scattered pale hairs, the last five segments rather well chitinized, shiny.

Male.—Essentially like the female but mesonotum (from above) deep velvety black, more densely covered with rich golden hairs. With light of suitable incidence, a broad continuous marginal band of silvery pollinosity encircling the mesonotum can be made out. The scutellum is much less hairy, the abdomen, less highly chitinized, is velvety black, with patches of bright silvery pollinosity on the sides of tergites two and five.

Pupa with six-branched filaments 3.3 mm. long (fig. 30). *Cocoon* 2.8 mm. long, subconic. The aperture at about 90° to the long axis, the aperture sides flaring and produced beyond the aperture on the substratum. About half floored. Margin of aperture thickened. Texture quite loose and open, net-like laterally.

Holotype ♀, Allotype ♂, 1 ♀ 3 ♂ Paratypes bred from pupae on grass blades in a small stream feeding lily ponds at Summit Experiment Gardens, Summit, C. Z., January 9, 1940. 5 ♀ 4 ♂ Paratypes bred from water weeds in a small stream at El Valle, Coclé Prov., R. P. December 10, 1939.

Simulium metallicum Bellardi

- 1859, Sagg. Ditt. Mess., I, p. 14 (♂; Mexico). Kertész, 1902, Cat. Dpit., I, p. 288. Johannsen, 1903, New York State Mus., Bull. 68, p. 365 (♂). Aldrich, 1905, Cat. N. A. Dipt., p. 170. Roubaud, 1906, Bull. Mus. Hist. Nat. Paris, XII, p. 518 (♀). Malloch, 1914, U. S. Dept. Agric., Bur. Ent., Techn. Ser., Bull. 26, p. 48 (♀; larva, pupa) (? nec. Bell.) Dyar and Shannon, 1927, Proc. U. S. Nat. Mus., LXIX, Art. 10, p. 41, pl. V, figs. 72a, 73. (♀; Guatemala). Dampf, 1931, Medicina, Revista Mexicana, XI, pp. 754, 759, fig. 1 (♀; Chiapas, Mexico). Pinto, 1931, 7th Reun. Soc. Arg. Pat. Reg. Norte, pp. 676, 731, 732, 735, 746.
- Odagnia metallica* Enderlein, 1925, Zool. Anz., LXII, p. 208.
- Simulium avidum* C. C. Hoffman, 1930, An. Inst. Biol., Mexico, I, 1, p. 52, figs. 1-4 (♀; Chiapas, Mexico); 1930, Op. cit., I, 4, p. 295, figs. 1, 7, 8 (♂ ♀); 1931, Arch. Schiffs- u. Tropenhyg., XXXIV, p. 470; 1931, An. Inst. Biol., Mexico, II, 3, p. 212, figs. 2a, 10, 13, 17 (larva and pupa). Pinto, 1931, 7th Reun. Soc. Arg. Pat. Reg. Norte, p. 734.

Female.—Length of mesonotum and scutellum, 0.8 mm., of wing, 1.8 mm. Frons moderately broad, only slightly widened at vertex, shiny dark grey to blackish. Clypeus hardly twice as long as broad, covered

with flat, shiny nacreous scales. Excision of eye border opposite antennae broad and rounded. Antennae of 11 visible segments, cylindrical, pubescent, yellow at base, dusky greyish toward apex. Palpi and proboscis dusky.

Mesonotum (from above) black with four large grey patches. The two median grey patches are in the form of stripes, reaching from near the anterior margin to about three-fourths of the distance to the scutellum, narrow anteriorly, broadening into drop-shaped marks posteriorly. They are separated from each other by a narrower median black line, and from the large oval sublateral grey patches by somewhat wider black stripes. Under light of proper incidence, the dark areas are brilliantly pearly iridescent. There are scattered black hairs, especially around the margins of the mesonotum. Scutellum black with grey pollinosity and black hairs. Pleura with pearly grey pollinosity, sides of mesonotum brilliantly bluish-green iridescent.

Legs: Fore coxae black on basal half, yellow apically, rather densely yellow haired, femora yellow, dusky at apex, and with silvery scales and whitish hairs. Tibiae dirty yellowish, with dense yellowish pubescence and silvery pollinosity, nearly black at apex, and with black hairs. Tarsi black and black haired, somewhat inflated. Mid legs with coxae dark, femora dark, both with some silvery pollinosity and rather dense, dark hairs. Tibiae dusky, yellow at base, pollinose and pubescent. First tarsal joint white with silver pubescence and pollinosity, dusky and dark haired at apex. Other tarsals yellowish with dusky hairs. Hind legs as figured (fig. 13). Calcipala and pediculus normally developed. Tarsal claws toothed (fig. 17).

Wings with stem vein bare, R_2 simple. Halteres yellow.

Abdomen with a pearly patch on dorsum of first segment and sides of second segment. 3rd to 5th segments velvety black pollinose, terminal segments more heavily chitinized, shiny, dark brown.

Male.—Differs from female mainly in color. Mesonotum (from above) deep velvety black with two small anterior triangles and a patch anterior to the scutellum pearly iridescent. The pleural, lateral mesonotal, and abdominal pollinosity is more brilliantly iridescent than in the female. The mesonotal hairs are sparser and shorter while those on the scutellum are very long.

Pupa with six-branched respiratory filaments, the filaments long and the branches close to the base (fig. 38). *Cocoon* conical, of rather open weave, and with flaring sides.

I follow Bequaert (1934, p. 208) in the application of this name. *S. metallicum* of Malloch (1914, p. 28) at least in part, and of Pinto (1931, p. 676) seems to be a different species, as the pupa is said to have eight-branched respiratory filaments.

Distribution: Mexico, Guatemala, Costa Rica, Panama.

Panama records: El Valle, Coclè Prov., R. P. December 10, 1939 (bred from pupae on water weeds in mountain stream).

Simulium haematopotum Malloch

1914, U. S. Dept. Agric., Bur. Ent., Techn. Ser. No. 26, p. 62 (♀; Vera Cruz, Mexico). Dyar and Shannon, 1927, Proc. U. S. Nat. Mus., LXIX, Art. 10, p. 38, figs. 86, 87. (Mexico, Guatemala, Cuba, Puerto Rico). Dampf, 1927, Rev. Mex. de Biología, VII, p. 129. Pinto, 1931, 7th Reun. Soc. Argentina Pat. Reg. Norte, p. 734. Bradt, S., 1932 Puerto Rico Journ. Public Health Trop. Med., VIII, 1, p. 77.

Female.—Length of mesonotum and scutellum, 0.8 mm., of wing 1.7 mm. Frons about twice as high as wide, silvery nacreous pollinose, the excisions of the eye border opposite the antennal bases broad and rather shallow. Clypeus longer than broad, concolorous with frons, and with sparse long hairs. Antennae 11 segmented, yellow, silvery pubescent. Palpi and proboscis brownish.

Mesonotum (from above) velvety black with a pair of rather narrow brilliantly nacreous dorsolateral stripes, broadest at the anterior margin and reaching posteriorly to the level of the wing insertions. The whole mesonotum is beset with golden hairs, sparse on the disc, more numerous around the edges. Scutellum brown, with a very few black erect hairs. Pleura brownish, silvery pollinose. The side of the mesonotum is velvety black, with a narrow arched nacreous streak extending from the posterior pronotum to just anterior to the wing base. Below this on the most ventral part of the mesonotum is an oval nacreous patch. With suitable illumination, a large nacreous patch may be seen upon the posterior aspect of the mesonotum anterior to the scutellum.

Legs: Fore legs all dark brown, except femora-tibial, and tibio-tarsal joints, which are narrowly yellowish. Fore coxae silvery pollinose, rest of legs dark pubescent. Mid coxae and femora black. Extreme base of tibiae yellowish, tarsi all yellowish white, the apices of the segments somewhat dusky. Hind legs (fig. 2) same as mid pair, the tarsi a little more extensively darkened. Calcipala and pedisulcus present. Tarsal claws (fig. 16) with strong sub-basal tooth.

Wing with stem vein bare, R_2 simple. Halteres yellow.

Abdomen velvety black with silvery pollinose lateral patches on the anterior segments, the terminal three segments brownish, shiny and well chitinized.

Male.—Differs in having the dorsal mesonotal stripes reduced to two anterior patches, the lateral mesonotal markings in the form of three rounded spots arranged in a triangle, and the abdomen being less chitinized posteriorly.

Pupa with 8 long branchial filaments (fig. 33). *Cocoon* about 2 mm. long, subconical, loosely woven with spaces, the aperture with a slightly projecting roof and flaring sides; margin not thickened, slightly irregular. Floor on posterior half only.

My material does not agree in certain respects with Dyar and Shannon's figures of this species (I was unable to consult Malloch's original description), as a comparison of our figures of the ♀ genital fork will show. *S. pseudohaematopotum* of C. C. Hoffman seems close also, but the genital fork is still different

and the tarsal claws are unarmed. *S. quadrivittatum* of Loew seems to be the name under which Dunn (1934, Psyche, XLI, 3, pp. 177-178) listed the present species, but no description of Loew's species is available to me here. It was described from Cuba, where *haematopotum* is stated to occur also. Bradt (l. c.) lists both species from Puerto Rico, but gives no description. It is probable that there are a number of similarly marked species in this group, but their elucidation will have to wait until further material accumulates.

This is the only species which seems to bite man at all readily at lower elevations on the Isthmus. During the latter part of the rainy season it becomes quite annoying at the Laboratory's station at Juan Mina on the Chagres River above Gamboa. The early stages have been taken on grass and dead leaves in a small stream which feeds the lily ponds at Summit Gardens, Canal Zone.

Distribution: Mexico, Guatemala, Cuba, Puerto Rico, Panama. I have recently received specimens from British Honduras which appear to be this species, though they are somewhat larger than my Panama material.

Panama records: Summit, C. Z., January 9, 1940. Juan Mina Station, Rio Chagres, C. Z., November 8, 1939. Canal Zone Forest Reserve October 11, 1939. Las Guacas, R. P., January 4, 1940. Guayabalito, R. P., October 20, 1938 (at light). Chilibre, R. P., November 23, 1939.

Simulium marathrumi n. sp.

Female.—Length of mesonotum and scutellum, 0.7 mm., length of wing, 1.5 mm. Frons broad, widened at vertex, eye border broadly excised around antennal base, greyish nacreous pollinose. Antennae of 10 visible segments, the first two apparently fused, broadest at the 3rd or 4th segment, dirty yellowish brown and quite hairy. Clypeus concolorous with frons. Palpi and proboscis dirty yellowish brown.

Mesonotum, (viewed from above and with the light from directly in front) deep velvety black with two very broad greyish nacreous dorso-lateral bands reaching from the anterior margin to the scutellum, joining to form a transverse band before the scutellum. The median black interval is narrower than the bands, and there is a fine median light line upon it. The light bands are somewhat narrower posteriorly. The whole dorsum of the thorax is clothed with long, curved, brilliantly golden hairs. Viewed from the side, the pleura are greyish, and the sides of the mesonotum bear a greyish, nacreous band, reaching from the anterior angles of the mesonotum to above the wing bases. The scutellum appears to be greyish, densely covered with long, golden hairs. All legs clear yellow except front tarsi, apical half of hind tibiae, and

inner margin and apex of basitarsus (fig. 3). The last four tarsal segments of mid and hind legs are somewhat dusky. All legs have more or less of a vestiture of pale scale-like hairs. Fore tarsi cylindrical. Hind tarsus with well developed calcpala and pedisulcus. Mid tarsal claws with a very minute tooth (fig. 15). Wings with stem vein bare, R_2 not forked, halteres pale yellow.

Abdomen blackish, with a nacreous patch beneath the scutellum and probably on sides of some other segments, but so poorly is it chitinized, except for the apical segments, that little can be seen.

Male.—Differs from female in having the broad grey nacreous stripes of the mesonotum reduced to two triangular areas on the anterior fourth of the mesonotum. They are more iridescent than in the female, and are only visible when observed from the front. The golden hairs are more sparse, being absent from the disc of the mesonotum, and the scutellum is dark. The legs are as in the female except that the hind femora are more extensively dark.

Pupa with 8 branchial filaments (fig. 34). *Cocoon* roughly conical, the opening at 90° to the long axis, dorsally with a blunt angle. Closely woven, no spaces, and no marginal thickening.

This species bears certain resemblances to *S. paraguayense* Schrottky as interpreted by Lutz (1928) and Pinto (1931), but the smaller size, absence of a strong tooth on the tarsal claws, and the prominent grey mesonotal stripes should serve to distinguish it. The pupal filaments are somewhat like those of *S. lutzianus* Pinto 1931, a species described from a pupal shell from Venezuela, but the present species has shorter, more tapered filaments and the branching is somewhat different.

Holotype ♀, Allotype ♂, 2 ♀ 2 ♂ Paratypes, bred from pupae on *Marathrum schiedeianum* Cham., Rio Las Lajas, Panama Prov., R. P. November 20, 1939. 1 ♀ Paratype, Chorrera Falls, near Chorrera, R. P., March 31, 1940 (biting).

Simulium pulverulentum Knab.

1914, *Ins. Ins. Mens.*, II, No. 12, pp. 177-178. (♀; Punta Gorda, British Honduras). Pinto, 1931, 7th Reun. Soc. Arg. Pat. Reg. Norte, p. 734.

Female.—Length mesonotum and scutellum, 1.0 mm., of wing, 2.1 mm. Frons broad, broadest at vertex, greyish pollinose with scattered silvery hairs. Excavation of eye border opposite antennae quite deep. Clypeus concolorous with frons, rather hirsute. Antennae of 11 visible segments, reddish brown and quite hairy, the segments, except the narrower terminal, of about equal width, palpi and proboscis brownish, grey pubescent.

Mesonotum (from above) pale grey, with a narrow median and a pair of wider dorsolateral dark grey stripes, which do not reach the anterior border, and which widen and fuse on the posterior fourth of the mesonotum. Whole mesonotum with long, silvery hairs, sparse on the

disc, rather dense near the margins. Anterior lateral areas indistinctly mottled with dark grey. From the side, the mesonotum has a dark area between the shoulder and wing base, and the dorsolateral dark stripe appears to reach the anterior margin. Pleura grey. Scutellum grey, with dense silvery hairs pointing upwards and anteriorly.

Legs: Fore coxae yellow, femora dirty yellowish with dusky patches at base, middle and near apex; tibiae dirty yellowish, with a dark patch just beyond base and the apical third dusky; tarsi dark, slender. Mid coxae dusky, femora yellow, tibiae yellow at base, then a dark ring, then yellow again, and the apical half dusky; first tarsal segment with basal half yellow, the rest and the terminal tarsal segments dark. Hind coxae dark, basal third and extreme apices of femora yellow, rest dark; tibiae and tarsi same as mid legs (fig. 4). Basitarsis with a well developed calipala, pedisulcus of second tarsal segment rather shallow. Mid tarsal claws with strong basal tooth (fig. 19).

Wings with stem vein bare. Halteres yellowish white.

Abdomen feebly chitinized, dark greyish pubescent, the terminal segments with scattered silvery hairs.

Male.—Essentially the same as female, but mesonotum with stripes obsolescent, either entirely black with a few grey patches anteriorly (viewed from above), or entirely grey with small black streaks anteriorly (viewed from the side). Shiny hairs much sparser than in female and brassy instead of silvery.

Pupa.—Branchial filaments 10, about $\frac{1}{2}$ mm. long. All branches quite close together and to the base (fig. 36). *Cocoon* subconical, about 2 mm. long, slipper shaped, the aperture at about 60° to the long axis. Margin not thickened, but continuous all the way around opening. Close woven, no visible openings.

The only other described Neotropical species known to me with 10 respiratory filaments is *S. hirtipupa* Lutz, described from a single pupal skin from Minas Geraes, Brazil. *Pulverulentum* differs in having much longer filaments which are strongly annulated, and in lacking the numerous trichomes of *hirtipupa*. The immature stages of this species fairly swarm in some of the swifter and clearer streams of the Pacific slope, being partial to those with a heavy growth of *Marathrum schiedeianum* Cham., on whose finely divided leaves the pupae are often massed in incredible numbers. I have not observed this species biting.

Distribution: Hitherto only recorded from the type locality, Punta Gorda, British Honduras.

Panama records: Rio Las Lajas, Panama Prov., R. P., November 20, 1939. Chorrera Falls, Chorrera, R. P., March 31, 1940. Quebreda Mañanita, near Pedregal, Panama Prov., R. P., January 14, 1940. Rio Paloma, near Juan Diaz, Panama Prov., R. P., January 14, 1940.

Simulium virgatum Coquillett

1902, Proc. U. S. Nat. Mus., XXV, p. 97 (♂ ♀; Las Vegas, New Mexico). Johannsen, 1903, New York State Mus., Bull. 68, p. 383 (♂ ♀). Aldrich, 1905, Cat. N. A. Dipt., p. 170. Malloch, 1914, U. S. Dept. Agric., Bur. Ent., Techn. Ser., Bull. 26, p. 57 (♂ ♀; New Mexico, California). Dyar and Shannon, 1927, Proc. U. S. Nat. Mus., LXIX, Art. 10, p. 39, pl. VI, figs. 82-83, pl. VII, figs. 126-128 (♂ ♀). Pinto, 1931, 7th Reun. Soc. Arg. Pat. Reg. Norte, p. 737. Bequaert, 1934, Onchocerciasis, Part III, pp. 214-216 (♀, cocoon, pupa; Guatemala. Treated as var. *rubicundulum* of Knab.).

Odoznia virgata Enderlein, 1925, Zool. Anz. LXII, p. 208.

Simulium hippovorum Malloch, 1914, l. c., p. 28 (♀; Sierra Madre, Mexico).

Wilhelmia hippovora Enderlein, 1925, l. c., p. 207.

Simulium rubicundulum Knab., 1914, Ins. Ins. Mens., II, p. 178 (♀; Vera Cruz, Mexico; New Mexico).

Simulium virgatum chiapanense C. C. Hoffman, 1930, An. Inst. Biol., Mexico, I, 4, p. 295, figs. 2, 9. (♀ Chiapas, Mexico). Pinto, 1931, l. c., p. 737.

Female.—Length of thorax and scutellum, 2.0 mm., of wing 3.0 mm. Frons and clypeus grey pollinose. Antennae dusky. Mesonotum mahogany brown, with ill-defined stripes of thin grey pollinosity and sparse silvery hairs. All femora largely whitish, fore tarsi somewhat inflated. Tibiae black and white, the fore pair with some silvery hair. Mid and hind tarsi black and white (fig. 5). Abdomen blackish, the tergites fairly well chitinized, especially the terminal ones. Stem vein bare. Tarsal claws strongly toothed (fig. 7). Calcipala quite short, pedisulcus deep and wide.

Pupa with 8 rather long and stout filaments (fig. 32) branching close to the base. *Cocoon* slipper-shaped, with long finger like projections around the aperture. I have not taken the male.

My single bred ♀ agrees well with Bequaert's (1934) conception of the species, and the pupal filaments are like those figured for *S. chiapanense* by Hoffmann (1931).

Distribution: Mexico, Guatemala, Panama.

Panama records: Chorrera Falls, Chorrera, R. P., March 31, 1940 (bred from pupa).

REFERENCES

It seems unnecessary to give here an extended bibliography, as the papers by Jobbins-Pomeroy and Bequaert (1934) may be consulted for the older references. I have included a few of the more useful papers on taxonomy and those published subsequent to Bequaert's paper which were available to me.

1916. Jobbins-Pomeroy, A. W. Notes on five North American Buffalo gnats of the genus *Simulium*. U. S. Dept. of Agriculture, Bull. No. 329. Professional paper (contains 14 pages of references).
1927. Dyar, H. G., and Shannon, R. C. The North American two-winged flies of the family Simuliidae. Proceedings U. S. National Museum, LXIX, Art. 10, pp. 1-54, Plates 1-7.
1931. Pinto, C. Simuliidae da America Central e do Sul. Sèptima Reunião de la Sociedad Argentina de Patologia Regional del Norte, Tucuman. (Contains keys and illustrations of a number of species, and a complete list of the described Neotropical forms).

1934. **Strong, Sandground, J. Bequaert and Ochoa.** Onchocerciasis, with special reference to the Central American form of the disease. Contributions from the Department of Tropical Medicine and the Institute for Tropical Biology and Medicine, No. VI, Harvard University Press, Cambridge, Mass. (Part III, by Bequaert, refers to the Simuliidae, and contains an extensive bibliography).
1939. **Lane, John, and Porto, Carlos E.** Simulideos da regio Neotropica. O Genero Eusimulium. Boletim Biologico, Sao Paulo, (N. S.) IV, 2, pp. 168-176, 7 text figures. (Contains key to genera, key to species, and discusses 8 species.)
1939. **Porto, Carlos E.** Simulideos da Regiao Neotropica (II-Genero Simulium) Boletim Biologico, Sao Paulo, (N. S.) IV, 3, pp. 369-373, 3 text figures. (Discusses 3 Brazilian species.)
1939. **Orfila, R. N.** Simuliidae (Dipt) de la Republica Argentina. 9th Reunion de la Sociedad Argentina de Patologia Regional, Mendoza, Oct., 1935, III, pp. 1525-1534. 1939. (Contains keys to subgenera and species, and lists 30 species with synonymies.)