

Simulium (Simulium) metallicum Bellardi (complex)

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This is one of the most common man-biting species in Central and northern South America and is medically important as a vector of human onchocerciasis. It has been recently recorded in Brazil by Hamada & Grillet (2001) and Pepinelli *et al.* (2006)

Simulium metallicum Bellardi, 1859: 14. HOLOTYPE f#, MEXICO, 1856 (*Sallé*). (MNHN [as Museo zoologico di Parigi]). [Examined.]

Simulium riveti Roubaud, 1906a: 108. HOLOTYPE f#, ECUADOR: Napo Province, 1902 (*Dr G.Rivet*) (MNHN). [Synonymy with *S. metallicum* Bellardi by Wygodzinsky, 1971: 12.] [Examined.]

Simulium nitidum Malloch, 1912: 652. HOLOTYPE f#, PERU: Huancabamba, 6.ix.1911 (*C.H.T.Townsend*) (USNM, cat.no. 15307). [Synonymy with *S. metallicum* by Shelley *et al.*, 1982: 28.] [Examined.]

Simulium versicolor Lutz & Nuñez Továr, in Lutz 1928: 47. SYNTYPES f##, VENEZUELA: Caracas, Maracay, Turmero, El Limón, Ocumare de la Costa, 1925 (*Lutz, A. & Nuñez Továr*) (IOC). [Synonymy with *S. metallicum* by Ramírez Pérez, 1983: 2.]

Simulium avidum Hoffmann, 1930a: 51. SYNTYPES f##, MEXICO: Chiapas, Soconusco District, Finca "La Granja", ix.- x.1929 (*C.C.Hoffmann*) ([No depositary cited] type number 18103). [Synonymy with *S. metallicum* by Dampf, 1931: 760.]

Simulium violacescens Enderlein, 1934: 285. HOLOTYPE f#. Mexico, (*Deppe*) (ZMHU, cat no. 7074). [Synonymy with *S. metallicum* by Coscarón *et al.*, 1999: 568. These authors cite the original description date as 1933 as printed on journal, actually distributed in February 1934.]

FEMALE. General body colour black. Body length (specimens preserved in alcohol): man-biting 2.0-3.1 mm (mean=2.5 mm, s.d.=0.24, n=30) reared 2.0-2.4mm (mean=2.2 mm, s.d.=0.13, n=30), wing length: man-biting 1.6-2.0 mm (mean=1.8 mm, s.d.=0.09, n=29) reared 1.7-1.9 mm (mean=1.8 mm, s.d.=0.06, n=4), wing width: man-biting 0.8-0.9mm (mean=0.9, s.d.=0.07, n=30) reared 0.9-1.0 mm (mean=0.9, s.d.=0.02, n=4).

Head — dichoptic with red eyes; nudiocular area well developed (Fig. X). Frons, clypeus and occiput black with silver pruinosity, frons and occiput with several, long black hairs on lateral margins and on basal margin of frons. Mouthparts and maxillary palps dark brown. Antennae brown with scape, pedicel and basal third of first flagellomere yellow. Cibarium with well developed and highly sclerotised cornuae, poorly sclerotised in central region and lacking teeth in central trough (Fig. X).

Thorax — scutum black with numerous recumbent hairs, which appear black, brown or golden depending on light direction. Scutal pattern varying in appearance with illumination. With anterior illumination, thorax black with following areas silvery grey: 1+1 median vittae extending from anterior margin of scutum for three quarters length of scutum, vittae widening towards posterior of scutum; 1+1 drop-shaped, wide, sub-median vittae beginning in anterior third of scutum and

extending posteriorly to terminate at same level as median vittae; 1+1 sub-median, highly iridescent, circular patches on anterior margin; silver humeri (Fig.X). With posterior illumination scutal pattern reverses with black areas becoming silver pruinose and silver pruinose areas becoming black, humeri remain silver (Fig. X). Variation in scutal pattern occurs but is slight with most specimens conforming to the pattern described. Vittae may be wider, as in one specimen median vittae join posteriorly (Figs. X) (also seen in specimens from Ecuador, Panama and Venezuela) and may be almost completely merged (Fig. X) (also seen in a specimen from the Caripe onchocerciasis focus in Venezuela and the South Chiapas onchocerciasis focus of Mexico). Scutellum dark brown with several black bristles. Pleura silver pruinose. Postnotum black with silver pruinosity. Costa of wing with relatively sparse distribution of spines and fine hairs. Subcosta with no setae, basal section of Radius without setae; basal tuft of dark hairs. Legs dark brown to black with lighter banding as follows: fore-leg coxae, trochanters and femora and external median surface of tibiae light brown, external face of tibiae appears white with some light incidences; mid legs with all tarsal segments cream with distal tips light brown; hind legs with basal two-thirds of basitarsi cream (Fig. X). Femora and tibiae of all legs with elongate scales. Claws of legs curved, each with basal tooth, well developed on hind leg. Halteres lemon yellow.

Abdomen — tergites I-V velvet black with silver pruinosity on lateral face of tergite II and on postero-lateral margins of segments II-V (only seen in specimens with distended abdomens); tergites VI-IX shiny, brownish black. Tergal plates well developed. Sternites and genitalia greyish black. Eighth sternite lightly sclerotised with even distribution of short setae except in central area, gonopophyses small membranous and setose with 2-5 larger setae on internal margins (Fig. X). Sternite VII with no median sternal plate. Cerci hemispherical, paraprocts conical with curved dorsal surface (Fig. X). Genital fork thin and lightly sclerotised, terminations of lateral arms convoluted with poorly developed anterior processes (Fig. X). Spermatheca oval with no obvious external sculpturing and small groups of setae on internal surface; area of insertion of spermathecal duct membranous and about quarter maximum width of spermatheca.

MALE. General body colour black. Body length (specimens preserved in alcohol) 2.5-3.0 mm (mean=2.7 mm, s.d.=0.18, n=7), wing length 1.7-1.9 mm (mean=1.8 mm, s.d.=0.07, n=6), wing width 0.7-1.0 mm (mean=0.9, s.d.=0.11, n=5).

Head — holoptic with eye facets dark red. Rest of head coloration as in female, except antennae dark brown.

Thorax – scutum velvet black with recumbent, dark brown hairs. Scutal pattern varies with light incidence: with anterior light source 1+1 silver pruinose triangles beginning on anterior scutal border and extending for half length of abdomen (Fig. X). With light source posterior to specimen pruinose marks absent (Fig. X). Humeri, lateral and posterior margins of scutum silver pruinose. Scutellum velvet black with long, dark brown setae; postnotum black with silver pruinosity. Wing as in female. Leg coloration as in female except hind legs with basal half of basitarsi cream (Fig. X).

Abdomen — tergites velvet black, basal fringe with long black hairs. Silver pruinose ornamentation as follows: tergite II completely silver, tergites V, VI and VII with most of lateral margins silver. Genitalia black, sternites black; sternal plates poorly developed. Gonocoxite broadly rectangular; gonostyle conical, elongate terminating in single large spine (Fig. X). Ventral plate well sclerotised with well developed basal arms and keel well developed with recumbent long hairs (Fig. X). Median sclerite pyriform about twice as long as width at widest part (Fig. X). Paramere with few (up to six) well developed spines (Fig. X).

PUPA. Cocoon length dorsally 2.7-3.5 mm (mean=3.1 mm, s.d.=0.32, n=11), ventrally 3.0-3.7 mm (mean=3.3 mm, s.d.=0.26, n=13), pupa length 3.0-3.5 mm (mean=3.4 mm, s.d.=0.19, n=13), gill length 3.9-5.2 mm (mean=4.5 mm, s.d.=0.47, n=13).

Cocoon — light brown, slipper-shaped (as in Fig. X), composed of lightly woven threads and with reinforced anterior margin. Gill light brown with six forwardly directed branches.

Gill — filament branching very basal and configuration variable, sometimes with one gill differing from other in same pupa. Variations in configuration are as follows: more commonly main trunk giving rise to a dorsal and two ventral primary branches (both on same horizontal plane), dorsal arising more basally than the inner and outer ventral branches. Each primary branch gives rise almost immediately to two filaments with bifurcation in dorsal primary branch being more basal than two ventral primary branch bifurcations, which are at same level (Fig. X). A variation occurs where main trunk gives rise to a dorsal and ventral primary branches, the dorsal then dividing again to form a ventral and dorsal secondary branch each of which gives rises to two filaments – collectively the two secondary and ventral primary branches are in the vertical plane (Fig. X). Filaments fine, slightly tapering distally with spicules on surface, edges crenate and ends rounded; primary and secondary branches slightly wider.

Head — with 2+2 frontal and 1+1 facial trichomes well developed and bifid (frontal sometimes trifid); surface of head covered with rounded tubercles, which are large on frontal region and smaller on sclerites covering eyes.

Thorax — with 5+5 well developed bifid to quadrid trichomes; surface of thorax covered with rounded tubercles, larger in anterior half.

Abdominal — tergite I with 1+1 simple hairs laterally; tergite II with 3+3 sub-median simple setae and 3 simple setae in a longitudinal row on lateral margin; tergites III-IV with 4+4 simple spines and III with 1+1 sub-median simple setae on anterior border; tergites V-VI with poorly developed spine combs on anterior margin, more obviously laterally; tergites VII-VIII with single row of backwardly directed stout spines on median anterior margin and 1+1 lateral groups of fine spine combs on anterior margins; tergite IX with 1+1 strong, unbranched terminal spines and several rows of fine spine combs on anterior margin. Abdominal sternite III with median band of small spine combs in central area of segment, sternite IV with 4+4 sub-median simple (sometimes bifid) spines of which the second most median is better developed, spine combs covering anterior two thirds of segment; sternite V with 2+2 strong spines, outer simple or bifid and inner with 4 branches with 1+1 patches of spine combs anterior to them, 1+1 lateral simple hairs in central part of segment; sternites VI-VII with 2+2 well developed bifid spines (sometimes outer ones simple) and 1+1 patches of spine combs anterior to them; sternite VIII with 1+1 patches of sub-median spine combs on anterior border.

TAXONOMIC DISCUSSION.

This species has been comprehensively reviewed by Shelley *et al.* (2002) based on numerous specimens collected in Belize and the examination of type material for the majority of its synonyms and other related species. *Simulium metallicum* was first found in Brazil by Hamada & Grillet (2001) in northern of the country. More recently, *S. metallicum* was recorded from

the State of São Paulo and briefly re-described by Pepinelli *et al* (2006). The latter authors did not give reference on their paper to the reviewed of Shelley *et al.* (2002), who provided a morphological description for the adults and pupal life stages.

The female of *S. metallicum* are easily recognised by the 1+1 median and 1+1 sub-median silver pruinose vittae and 1+1 sub-median, highly iridescent, circular patches on anterior margin [with light source anterior to the specimen] (Fig. X). The males can be identified by the 1+1 silver pruinose triangles beginning on the anterior border of the scutum extending for half length of abdomen [light source anterior] (Fig. X). The pupa of *S. metallicum* can be readily identified by the long, six-filamented pupal all dividing at the base of the gill. A similar gill configuration pattern occurs in *S. inaequale* and *S. cerradense*, but both species are distinguished by a different structure of the female and male genitalia.

DISTRIBUTION.

Simulium metallicum has been recorded from the following countries (cytotaxa where known in brackets) Belize, Brazil, Colombia (CL), Costa Rica (G), El Salvador, French Guiana, Guatemala (ABHI), Ecuador, Jamaica, Mexico (ABHIX), Nicaragua, Panama (FHJK), Peru, Trinidad, Venezuela (DE) (Arteaga & Muñoz de Hoyos, 1996; Crosskey, 2002; Crosskey & Howard, 1996; Hamada & Grillet, 2001; Muñoz de Hoyos, 1994; Pepinelli *et al.*, 2006; **Material Examined**).

BIOLOGY AND MEDICAL IMPORTANCE.

In Brazil the immature stages of *Simulium metallicum s.l.* were found on deciduous and submerged leaves on the trailing vegetation (Pepinelli *et al.*, 2006). The female of *S. metallicum s.l.* is commonly found biting man voraciously in Mountain Pine Ridge (Belize), sympatrically with *S. quadrivittatum* between 400-700 m in altitude. Pupae and larvae were collected in small, sometimes shaded, slow to fast running streams varying from 1m wide and 10cm deep to 10 m wide and 50cm deep always attached to fallen leaves, grasses and beds of submerged vegetation (Shelley *et al.*, 2002).

There have been numerous publications concerning the biology and medical importance of *S. metallicum s.l.* in Latin America. The following give reviews and/or access to the literature: Ramírez Pérez, (1971, 1977), Shelley (1988a, 1988b, 1991). *Simulium metallicum s.l.* typically breeds in small shaded streams but can occur in larger rivers, bites man voraciously even in areas where it is largely zoophilic, but where population numbers are high. In Guatemala Dalmat (1955) recorded this species biting the following animals: horses, mules, donkeys, cattle, sheep, goats, deer, pigs, dogs, foxes, cats, ocelots, tayras (weasels), chickens, turkeys, ducks. Little information is available on the biology of the cytotypes of the *S. metallicum* complex. Grillet & Barrera (1997) and Grillet *et al.* (1995) studied the biology of *S. metallicum* cytotype E larvae in an area of northern Venezuela where onchocerciasis occurs and where this cytotype is probably a vector of the disease (Takaoka *et al.*, 1984). Distribution was recorded in relation to physical and chemical characteristics of streams and highest populations were recorded at the end of the wet season. Takaoka (1982) studied the bionomics of *S. horacioi* in relation to *S. metallicum s.l.*; although the latter species was found naturally infected with *O. volvulus* L3 larvae none was found in *S. horacioi*, though sample size was small. Takaoka (in Tada, 1983) collected no *S. racenisi* biting man or animals in northern Venezuela. Lewis (1963) and Ramírez Pérez, (1971, 1977) made no mention of this species biting man.

Simulium metallicum s.l. is a primary vector of human onchocerciasis in northern Venezuela, but only a secondary vector in the Central American foci because of its largely zoophilic habits. Its lack of cibarial teeth in the female facilitates its role as an effective host to *O. volvulus* in areas where it is anthropophilic. *Simulium metallicum s.l.* is a poor host to the virus causing Venezuelan Equine Encephalitis in Colombia and if involved in cyclical or mechanical transmission of the virus is not considered as an important vector (Homan *et al.*, 1985). In Ecuador León & Wygodzinsky (1953) cite *S. metallicum s.l.* (as *S. riveti*) and *S. exiguum s.l.* as vectors of “Mal de Pinto” or “Carate” (a skin condition, now uncommon, also referred to as “pinta” and caused by a spirochaete *Treponema carateum* (similar to *T. pallidum*, which causes syphilis) based on the presence of these species where the condition occurs.