

***Simulium (Psaroniocompsa) oyapockense* Floch and Abonnenc (complex)**

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This is a common, mainly anthropophilic species with a broad distribution within Brazil, but mainly around the northern tributaries of the R. Amazon. It is one of the better studied species because of its role as a primary vector of onchocerciasis in lowland areas of the Amazonia focus of the disease.

Simulium oyapockense Floch & Abonnenc, 1946c: 4. LECTOTYPE f # [By designation of Shelley *et al.*, 1984:147], FRENCH GUIANA: Maripá, R. Oyapock, near Cafésoca Falls (no collection date, collector probably E. Abonnenc) (IP)

Simulium pseudosanguineum Ramírez Pérez & Peterson, 1981a: 154. HOLOTYPE f#, VENEZUELA: Bolivar State, Piar District, Canaima (no collection date or collector) (IND). [Synonymy by Ramírez Pérez, 1983:8.]

Simulium sanchezi Ramírez Pérez, Yarzabal & Peterson, 1982: 71. HOLOTYPE f#, VENEZUELA: Amazonas State, Departamento Rio Negro, San Carlos de Rio Negro, Raudal Mabajate, 100m (no collection date or collector) (IND) [Synonymy by Shelley *et al.*, 1984: 147.]

Simulium cuasisanguineum Ramírez Pérez, Yarzabal & Peterson, 1982: 36. HOLOTYPE f#, VENEZUELA: Tamatama, junction between Orinoco river and the Casiquiare canal, 150m, 2°01'N 67°07'W (no collection date or collector) (IND) [Synonymy by Shelley *et al.*, 1987a: 462.]

Simulium pseudoamazonicum Ramírez Pérez & Peterson, 1981a: 151. HOLOTYPE f#, VENEZUELA: Aragua State, Urdaneta District, Barbacoas (no collection date or collector)(IND). [Synonymy by Shelley *et al.*, 1997.]

The following descriptions are based on topotypes and are largely the same as those given in Shelley *et al.* (1997) from specimens collected at Cachoeira Bem Querer (the Bem Querer form of *S. oyapockense*). Morphological differences in adults and pupae from different populations of *S. oyapockense s.l.* are discussed and figured in Shelley *et al.* (2006).

FEMALE. General body colour black with silver pruinosity. Bem Querer form: body length 1.4-2.6 mm (mean=2.1mm, s.d.=0.3, n=43); wing length 1.2-1.9mm (mean=1.5mm, s.d.=0.1, n=42), wing width 0.5-1.0mm (mean=0.7mm, s.d.=0.1, n=32).

Head — dichoptic with dark red eyes (appearing black in dried specimens); nudiocular area minute or absent (Fig. X). Frons, clypeus and occiput black with feint silver pruinosity. Mouthparts brown with maxillary palps dark brown. Antennae dark brown with scape, pedicel and basal third of

first flagellomere yellow/orange. Cibarium with 1+1 groups of large, pointed teeth (21-28) either side of deep, narrow, sclerotised central trough and extending on to heavily sclerotised cornua (Fig. X).

Thorax — scutum black with silver pruinosity and numerous recumbent, slender gold hairs. Scutal pattern variable in relation to illumination. With anterior lighting black areas of scutum on silver pruinose background as follows: wide median black vitta extending from anterior border for about three quarters of scutum, rounded and twice as wide posteriorly as on anterior scutal border; pair of disc-shaped areas between median vitta and lateral margin of scutum, beginning in second quarter of scutum and extending to same posterior limit as median vitta; pair of comma-shaped marks extending from anterior scutal border to mid point of scutum in silver pruinose area between median vitta and disc-shaped areas (Figs. X). With posterior lighting median black vitta remains the same while the pair of disc-shaped areas extend to anterior margin of scutum to form bands running nearly parallel to median vitta; pair of comma-shaped marks appear narrower and bright silvery-white pruinose (Figs. X). Humeri silver pruinose regardless of light direction. Scutellum velvet brown with long, dark and short, recumbent, golden setae at posterior margin. Postnotum silver pruinose; paranotal folds with silver pruinosity. Pleural region uniformly dark brown with light pruinosity. Subcostal wing vein and basal section of Radius bare; basal tuft of dark hairs. Legs with dark and pale bands (Fig. X). Fore leg with coxa mid brown, often slightly darker on upper inner edge; trochanter, femur and tibia yellow to pale brown; tarsi dark brown. Mid leg with coxa dark brown; trochanter, femur and tibia pale to mid-brown (femur and tibia often mid brown in central half/three-quarters); distal two tarsomeres brown; remaining tarsi yellow, occasionally darker at posterior margin. Hind leg with coxa dark brown; trochanter pale brown; femur becoming progressively darker distally with a maximum of basal sixth pale brown and minimum of distal quarter dark brown; distal half of tibia, distal fifth/quarter of basitarsus dark brown, distal third of second tarsomere mid brown, third tarsomere often as second or completely mid brown as remaining tarsi; remaining areas white. Fore tarsi narrow as in *S. exiguum* (Fig.X). All femora and tibiae with scales as in *S. exiguum* (Fig. X). Claws slender, slightly curved and lacking basal tooth (Fig. X). Halteres pale white/yellow with only basal area of stem dark.

Abdomen — tergites all dark brown; tergite I velvety with basal fringe of few, brown, medium-length hairs; tergite II with silver pruinosity; tergites III-V velvety with both anterior and posterior margins pruinose; tergites VI-IX shiny. Tergal plates well developed as in *S. exiguum* (general Fig.X). Sternites and genitalia pale brown. Eighth sternite usually lightly sclerotised with 10-17 (4-7 weak, 6-10 strong) setae on each side (Fig. X); gonapophysis with postero-median corner square and not extending posteriorly, margin with lightly sclerotised inner sub-parallel sides, covered in fine setae. Cerci hemispherical; paraprocts small to medium sized, sub rectangular, only extending

slightly beyond ventral margin of cercus (Fig. X). Genital fork (Fig. X) with heavily sclerotised spatulate stem, with ends of lateral arms arranged obliquely to transverse axis of abdomen, anterior processes to lateral arms poorly developed and posterior processes partially developed.

Spermatheca oval, sclerotised, with feint surface sculpture and transverse rows of spicules in groups; area of insertion of spermathecal duct membranous and about one third as wide as maximum width of spermatheca.

MALE. General body colour black with silver pruinosity. Topotypes from R. Oyapock: Bem Querer form: Body length 1.7-2.4 mm (mean=2.1mm, s.d.=0.2, n=15); wing length 1.2-1.6mm (mean=1.4mm, s.d.=0.1, n=13); wing width 0.4-1.0mm (mean=0.7mm, s.d.=0.1, n=9).

Head — holoptic with upper eye facets red/brown and lower eye facets dark red (appearing black in dried specimens). Rest of head coloration as in female.

Thorax — scutum velvet-black with pair of sub-median silver cunae extending for 1/2 to 2/3 length of scutum from anterior scutal border (Figs. X) (only visible with light source anterior to specimen). Posterior and lateral borders with wide band of silver pruinosity. Scutum with recumbent golden hairs. Humeri black. Coloration of rest of thorax as in female. Wing setation as in female. Leg and haltere coloration as in female.

Abdomen — tergites dark, velvet brown with scattered golden setae, basal fringe of long and short, fine, dark hairs. Tergite II silver pruinose except for small central area of tergal plate; tergite VI with large, sub-median, silver pruinose spots which are separated only in centre by narrow dark sclerotised plate; tergites VII-VIII with progressively smaller sub-median silver pruinose spots; tergite IX silver pruinose. Tergal plates well developed as in *S. exiguum* (General Fig.) and dark brown. Sternites dark brown; genitalia dark brown with light silver pruinosity. Gonocoxite almost rectangular, slightly wider than long; gonostyle stout and sub-rectangular, about two-thirds length of gonocoxite; sub-terminal spine large, stout and club-shaped (Fig. X.). Ventral plate crescent-shaped with numerous setae and spines, apex rounded, basal arms broad; median sclerite with small lateral processes (Fig. X). Paramere with several, large, well-developed spines occurring in two groups interspersed with smaller spines (Fig. X).

PUPA. The following dimensions are recorded by Shelley *et al.* (1997). Topotypes from R. Oyapock. Cocoon length dorsally 1.6-2.8mm (X=2.1mm; s.d. = 0.3; n = 25); ventrally 1.5-2.6mm (X = 2.0mm; s.d. = 0.2; n = 26); pupa length 1.7-1.8mm (n = 2); gill length 0.7-1.5mm (X = 1.0mm, s.d. = 0.2, n = 20). All other localities. Cocoon length dorsally 1.6-2.3 mm (X = 2.0mm, s.d. = 0.2, n = 10); ventrally 1.7-2.4mm (X = 2.1mm, s.d. = 0.2, n = 10); pupa length 1.5-2.1mm (X = 1.9mm, s.d. = 0.2, n = 10); gill length (longest intact filaments) 0.8-1.5mm (x = 1.0mm, s.d. = 0.2, n = 10).

Extra data from Shelley *et al.* (2006) [see this publication for statistical analysis] - topotypes 1.6-2.1mm($X=1.8$ mm, s.d. = 0.2, $n=5$); – other localities - gill length 0.8-1.9mm. Summary of gill length ranges: topotypes – 0.7-2.1mm; all other localities: 0.8-1.9mm.

Cocoon — slipper-shaped, mid to dark brown; rim dark, thickened, with slight median protuberance (as in general Fig. X). Cocoon of closely woven threads, sides not flared.

Gill — light brown with six forwardly directed tubular filaments orientated in vertical plane. The gill trunk initially divides basally into three primary branches. In topotypes the dorsal bifurcation is most basal and the median and ventral bifurcations, at the same level, slightly more distal to it (Fig. P 410). Variations found are with the ventral bifurcation slightly more distal to the median in the Bem Querer form or with both median and ventral branches at the same level, but significantly more distal from the base than the dorsal branch at the R. Ituxi (See Shelley *et al.*, 2006). Exceptionally, the ventral bifurcation in *S. oyapockense s.l.* can be significantly more distal. Gill filaments rounded distally, margins crenated and with spicules. Spicules in trunk region larger and grouped together in short longitudinal rows.

Head — (frontoclypeus) with 2 + 2 short, simple, frontal and 1 + 1 simple or bifid facial trichomes. Trichomes are occasionally long in other populations of *S. oyapockense s.l.* (see Shelley *et al.*, 2006). Numerous rounded tubercles are present in topotypes, but *S. cuasisanguineum* (a synonym of *S. oyapockense s.l.*) is devoid of tubercles and pointed tubercles are also present in another synonym *S. sanchezi* and several populations of *S. oyapockense s.l.* in other parts of Brazil (see Shelley *et al.*, 2006).

Thorax — with 5 + 5 simple, bifid or rarely with one trifid antero-dorsal trichomes; 1 + 1 simple trichomes directly beneath spiracular trunk; 2 + 2 simple, fine trichomes at ventral margin below gill base; 1 + 1 small, simple trichomes in central region of thorax. Numerous, rounded and pointed tubercles over anterior and median parts [only on median part in *S. cuasisanguineum*, a synonym of *S. oyapockense*].

Abdomen — tergite I with 1 + 1 simple, sub-median hairs towards anterior margin; tergite II with 4 + 4 simple hairs in row centrally with 1 + 1 simple hairs anterior to outer two hairs of each row, and 1 + 1 patches of spine combs towards antero-lateral margin; tergite III with 4 + 4 simple hooks on posterior border of segment, 1 + 1 simple hairs anterior to outer two hooks of each group and 1 + 1 patches of spine combs towards antero-lateral border [spine combs are absent on one or both of tergites II and III in some populations of *S. oyapockense s.l.* (see Shelley *et al.*, 2006)]; tergite IV with 4 + 4 simple hooks towards posterior border and 1 + 1 simple hairs anterior to outer two of each group; tergite V with 4 + 4 fine hairs centrally; tergite VI with 2 + 2 fine hairs centrally and 1 + 1 areas of poorly developed spine combs at antero-lateral border; tergite VII with 1 + 1 rows of spines on anterior margin of segment, 1 + 1 areas of poorly developed spine combs on antero-lateral

border and 1 + 1 fine, sub median hairs centrally; tergite VIII with row of well developed spines across anterior region of segment and 1+1 areas of spine combs at lateral margin and 1 + 1 fine hairs centrally; tergite IX with 1 + 1 small rounded apical spines, 1 + 1 groups of anterior spines becoming spine combs at lateral margins. Sternite III with 1 + 1 areas of spine combs towards anterior margin; sternite IV with 1 + 1 bifid or trifid hooks and 1+1 groups of spine antero-laterally; sternite V with 2 + 2 hooks, the inner pair 3-4 pronged and outer pair trifid or bifid, and 1+1 areas of spine combs anterior to outer two hooks; sternites VI-VII with 4 evenly spaced hooks, inner pair trifid or bifid, outer pair bifid or simple, and with spine combs anterior to outer two hooks; sternite VIII with continuous band of spine combs on anterior margin.

TAXONOMIC DISCUSSION.

The initial work on species of the *amazonicum* group before its review in Shelley (1988) resulted in various misidentifications and synonyms. These are given in Shelley *et al.* (1987, 1997). The morphology of the two closely related onchocerciasis vector species, *S. oyapockense s.l.*; and *S. roraimense s.s.* was reviewed in detail by Shelley *et al.* (1997) who then proposed *S. pseudoamazonicum* Ramírez Pérez & Peterson as a synonym of *S. oyapockense*. Their later work (Shelley *et al.*, 2006) provided further taxonomic data on the two species and a modern definition of the *amazonicum* group and its constituent species.

Preliminary chromosomal studies on larvae of members of the *amazonicum* group were made by Procunier who proposed a species complex for *S. oyapockense* containing two cytotypes, the Manabi form from Ecuador and the Bem Querer form from Brazil. Shelley *et al.* (2006) discussed this in detail and based on morphological criteria grouped the Manabi form with *S. roraimense s.s.* as *S. roraimense s.l.* They suggested the presence of a species complex in *S. oyapockense* consisting of at least the zoophilic *S. oyapockense s.s.* and the anthropophilic *S. oyapockense* Bem Querer form. More recent chromosomal studies by Pereira *et al.* (2001) challenged the synonymy of *S. sanchezi* Ramírez Pérez, Yarzabal & Peterson with *S. oyapockense* by Shelley *et al.* (1984) based only on an ideogram showing a chromosomal inversion in the larva of a Brazilian population of simuliid that they identified as *S. sanchezi*. The inversion is absent in the Bem Querer form of *S. oyapockense*. However, Luz *et al.* (In press) also showed the presence of the same inversion in *S. roraimense s.s.* and pointed out morphological differences in pupae of true *S. sanchezi* from Venezuela and the Brazilian population of Pereira *et al.* (2001). Luz *et al.* (In press) maintained the synonymy until more comprehensive studies integrating various taxonomic techniques can be made.

DISTRIBUTION.

Simulium oyapockense s.l. has a wide distribution within Brazil from northern Roraima to the south of the country (Map 1). It is more commonly found breeding in northern Amazon tributaries and is widespread here. It appears to occur more infrequently in southern Amazon tributaries, but more prospection is needed in this vast area to establish its true distribution. It also occurs, but less frequently, in southern Brazil where simuliid prospection has been more concentrated and in western Brazil, but more prospection is needed to get a clearer picture of its distribution here. It is also recorded (Map 2) from Colombia (Tidwell *et al.* 1981b), French Guiana (Floch & Abonnenc 1946c; Hamada & Fouque 2001), Guyana (Material Examined; Shelley *et al.* 2004) and is almost certainly present in Surinam. In Venezuela it occurs in the Orinoco headwaters and to the north and east of the country (Ramírez Pérez 1983; Ramírez Pérez *et al.* 1982) [we have included the synonyms *S. cuasisanguineum*, *S. pseudoamazonicum*, *S. pseudosanguineum* and *S. sanchezi* in the map under *S. oyapockense s.l.*]. Man-biting females collected in Bolivia (Material Examined) are also probably of this species, and it undoubtedly occurs in Peru in the lowland rain forest region adjacent to Amazonas and Rondônia states of Brazil.

BIOLOGY AND MEDICAL IMPORTANCE.

Considerable variability has been recorded for the biting habits of *S. oyapockense s.l.* [reviewed in Shelley *et al.*, 1997, 2006]. This species appears to be zoophilic at its type locality on the Brazil-French Guiana border near the eastern seaboard of the continent. Further inland in Brazilian Amazonia most populations are probably largely anthropophilic, often biting man in very high numbers throughout the day that often precludes agricultural development of the fertile strands of large rivers. Although biting in open areas and not in dense forest this species will enter houses to feed when populations are very high and all regions of the body are bitten. These large populations occur at the end of the rainy season when the larger rivers are beginning to diminish in volume. Breeding typically occurs on submerged vegetation particularly where rapids are present and these are the main source for populating other parts of rivers as the rains begin and flooding of riverside vegetation occurs and forms new breeding grounds.

Simulium oyapockense s.l. is the primary vector of human onchocerciasis in lowland areas of the Amazonia focus of the disease that is located on the border of northern Brazil and southern Venezuela [see Shelley, 1991; 1994; 2002]. Although not an efficient host to *O. volvulus* because

when feeding on human blood many ingested microfilariae are damaged by the fly's cibarial teeth , the large biting populations of the fly make significant parasite transmission possible. It is also responsible for the transmission of *M. ozzardi* in Brazil and Colombia