Description of *Simulium damascenoi* (Diptera: Simuliidae) Male and the Black-Fly Species from the State of Amapá, Brazil

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Five species are included in the Simulium siolii *group, which is placed in the subgenus* Psaroniocompsa *(Diptera: Simuliidae). Of these five species, only two* (Simulium siolii *Py-Daniel and* Simulium tergospinosum *Hamada) have been described in all their life stages, except eggs. Knowledge of the taxonomic characters of all life stages of a species is important in order to clarify interspecific and higher-level taxonomic relationships. The objectives of the present study are to describe the male of* Simulium damascenoi *Py-Daniel, to provide a list of black-fly species their bionomics and distributions in the state of Amapá, Brazil, and to provide an identification key for larvae and pupae for these species.*

Key words: aquatic insects - *Simulium damascenoi* - taxonomy - species distribution - Amapá - Brazil

The group *siolii* is placed in the subgenus *Psaroniocompsa* (Diptera: Simuliidae) and has been composed, until now, of five species: *Simulium siolii* Py-Daniel, 1988, *Simulium lourencoi* Py-Daniel, 1988, *Simulium damascenoi* Py-Daniel, 1988, *Simulium guaporense* Py-Daniel, 1989 and *Simulium tergospinosum* Hamada, 2000 (Py-Daniel 1988, 1989, Hamada 2000). Of these five species, only two have been described in all their life stages, except eggs: *S. siolii* and *S. tergospinosum*. Knowledge of the characters of all life stages is important to clarify taxonomic problems, especially in black flies where there are many species complexes.

The following species have already been reported from the state of Amapá: *Simulium cauchense* Floch & Abonnenc, *S. damascenoi* Py-Daniel, *S. goeldii* Cerqueira & Nunes de Mello, *Simulium guianense* Wise, *Simulium inaequale* Paterson & Shannon, *S. incrustatum* Lutz (as *Simulium aequifurcatum* Lutz), *Simulium iracouboense* Floch & Abonnenc, *Simulium maroniense* Floch & Abonnenc, *Simulium oyapockense* Floch & Abonnenc, *Simulium perflavum* Roubaud, *Simulium quadrifidum* Lutz, *Simulium rorotaense* Floch & Abonnenc and *Simulium trombetense* Hamada, Py-Daniel & Adler (Py-Daniel 1988, Coscarón et al. 1992, 1996, Charalambous et al. 1996, Hamada & Adler 1998, 1999). Aside from the work of Coscarón et al. (1992), no information on the distribution and bionomics of the black-fly fauna from Amapá has been provided before.

The objectives of this study are to provide: (1) the first description of *S. damascenoi* male; (2) identification keys for larvae and pupae; (3) bionomics and (4) distribution information on the black-fly fauna in the study area.

MATERIALS AND METHODS

Sampling was done in four periods, September 1993, July 1996, July 2000 and June 2001, in the state of Amapá, located in the North region of Brazil. The choice for the sampling sites was based mainly on accessibility by road, and in some cases by boat. The sampled sites lie on a transect from south to north, around the federal road (BR 156) that connects Laranjal do Jari and Oiapoque counties (Fig. 1).

Electrical conductivity (Cole-Parmer conductivimeter), pH (Cole-Parmer pH meter), temperature (alcohol thermometer), geographic position (Garmin GPS) and stream width also were estimated, whenever possible, at each sampled site.

Larvae and pupae were hand collected directly from the substrate – deciduous tree leaves, green leaves and roots of the streamside vegetation, leaves of Podostemaceae (an aquatic plant) and rocks under the water.

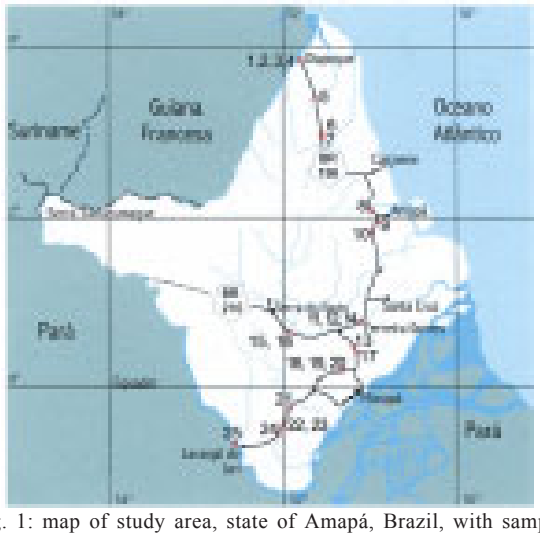

Fig. 1: map of study area, state of Amapá, Brazil, with sampled sites. Note: complete site information can be found in Table I.

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Larvae were preserved in Carnoy solution (3 parts absolute ethanol: 1 part glacial acetic acid); pupae were preserved in absolute ethanol. Some pupae were maintained alive in a glass vial with a piece of wet filter paper to obtain adults. After emergence, the adults were preserved in 80% ethanol; pharate adults that did not emerge were also preserved in 80% ethanol. All specimens were preserved on ice in the field; in the laboratory they were maintained refrigerated at 4ºC. In the laboratory, adults in 80% ethanol were dehydrated according to the technique of Sabrosky (1966) and pinned. Permanent slides were mounted using Euparal® as the mounting medium after being clarified in hot 95% lactic acid.

All specimens used in this study are deposited in the Invertebrate Collection of the Instituto Nacional de Pesquisas da Amazônia (Inpa), Manaus, AM , Brazil.

RESULTS AND DISCUSSION

Taxonomy

Simulium (*Psaroniocompsa*) *damascenoi* Py-Daniel (Figs 2-17)

Simulium (*Psaroniocompsa*) *damascenoi* Py-Daniel, 1988:304, Figs 69-97.

Male description

Body length, 1.65 mm (n = 4). Wing length, 1.42 mm (n = 4). Lateral thorax length 0.4 mm (n = 4). Antenna 0.4 mm (n = 5) long, dark brown, except the scape, pedicel and half distal region of the first flagellomere, yellow (Fig. 3). Maxillary palpus brown (Fig. 2), sensory vesicle almost one-third of the size of palpomere that holds it. Scutum black, with two antero-lateral quadrangular spots, with irregular posterior region (Figs 16, 17). Anepisternum and katepisternum brown with silver pruinosity; scutellum dark brown with brown hairs that have golden highlights, postnotum brown with silver pubescence. Femur and tibiae with scale-like setae distributed with filiform setae ones. Abdominal sclerites brown; membranous areas brown; basal fringe hair brown. Tergites dark brown; gonocoxite and gonostylus brown (Figs 7, 8), gonostylus bearing one apical tooth and one longitudinal ridge; ventral plate as in Fig. 4; median sclerite oval (Fig. 5); paramere with spines (Fig. 6).

Simulium damascenoi female – Additional taxonomic information

Body length, 1.83 mm (n = 2). Wing length, 1.65 mm (n = 1). Lateral thorax length 0.43 mm (n = 2). Female was described from a specimen dissected from its pupal skin (Py Daniel 1988); therefore, no information on scutum pattern was provided. Scutum with paired thick silver stripes (Figs 14, 15). Distal abdominal tergites (VI-IX) striking distinct from the others, pale, greenish in color, with a varnish-like appearance (Fig. 13), tergites III-V brown, with median plate varnish-like in appearance, tergites 1-2 brown with silver pruinosity. Cibarium (Fig. 11) has typical *Psaroniocompsa* subgenus configuration; sensory vesicle of maxillary palpus about a half of basal article length as shown in Fig. 9; antenna color pattern as in Fig. 10. Spermatheca subspherical, with cuticular microspines, spermatheca duct and area of attachment not pigmented (Fig. 12).

S. damascenoi specimens examined

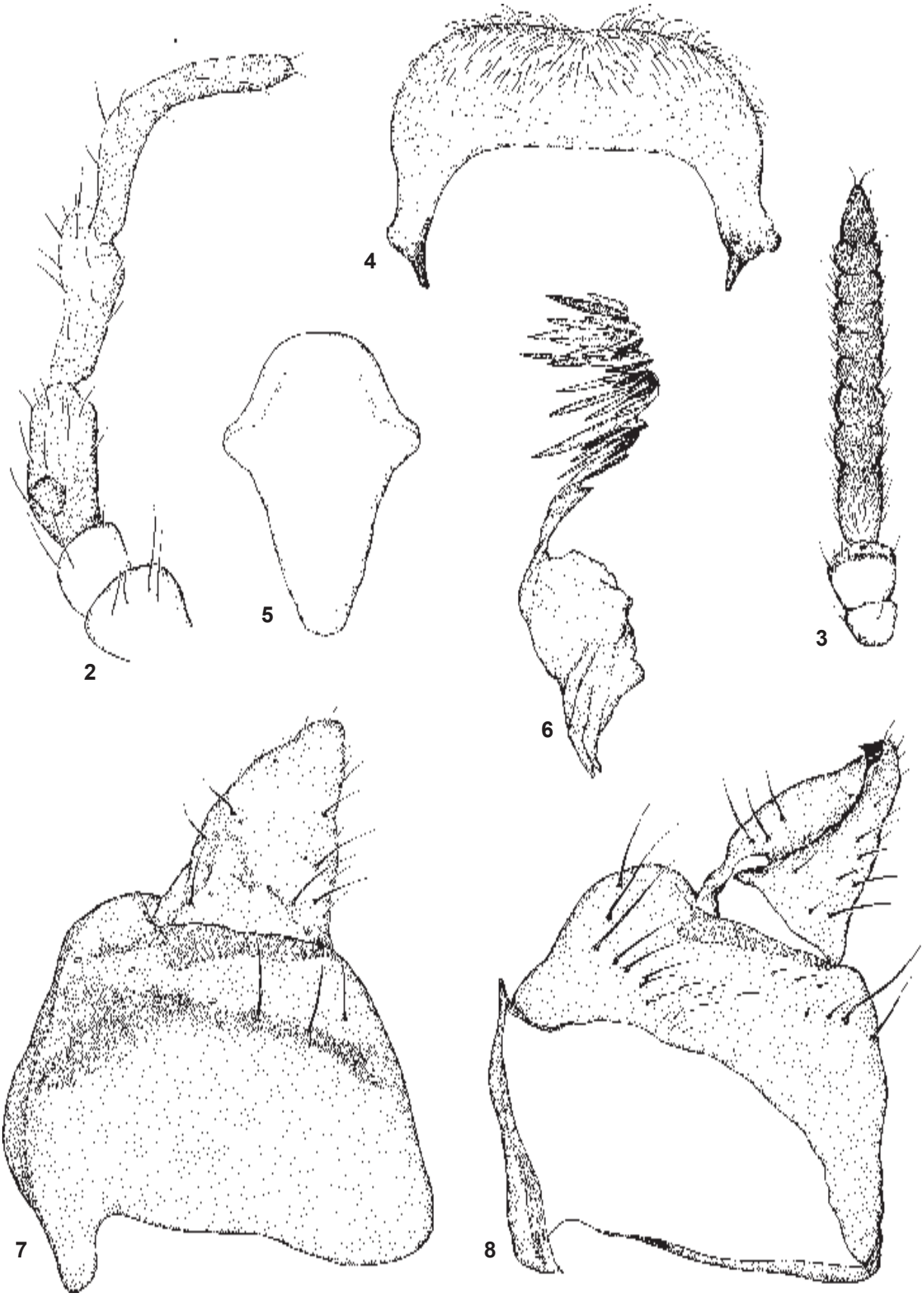
Brazil, state of Amapá: Igarapé Davi Grande, Amapá county, 24/vii/2000, Hamada N, Barbosa UC, Cavalcante A, Freire R (Inpa), 1 pharate male (thorax and part of abdomen pinned, head and genitalia in slide mount), 1 pharate female in slide mount; 18/vi/2001, Hamada N, Ale-Rocha R, Freire R (Inpa), 4 pinned male, 2 pinned female, 1 pharate male (thorax pinned, head and abdomen in slide mount); Igarapé Água Branca, near Carnot Village, 25/vii/2000, Hamada N, Barbosa UC, Cavalcante A, Freire R (Inpa), 1 pinned male, 1 pinned female; 19/vi/2001, Hamada N, Ale-Rocha R, Freire R (Inpa), 1 pharate female in slide mount; Igarapé do Henrique, 18/vi/2001, Hamada N, Ale-Rocha R, Freire R (Inpa), 1 pharate male (head and thorax pinned, abdomen in slide mount), 1 pharate male in slide mount.

Remarks

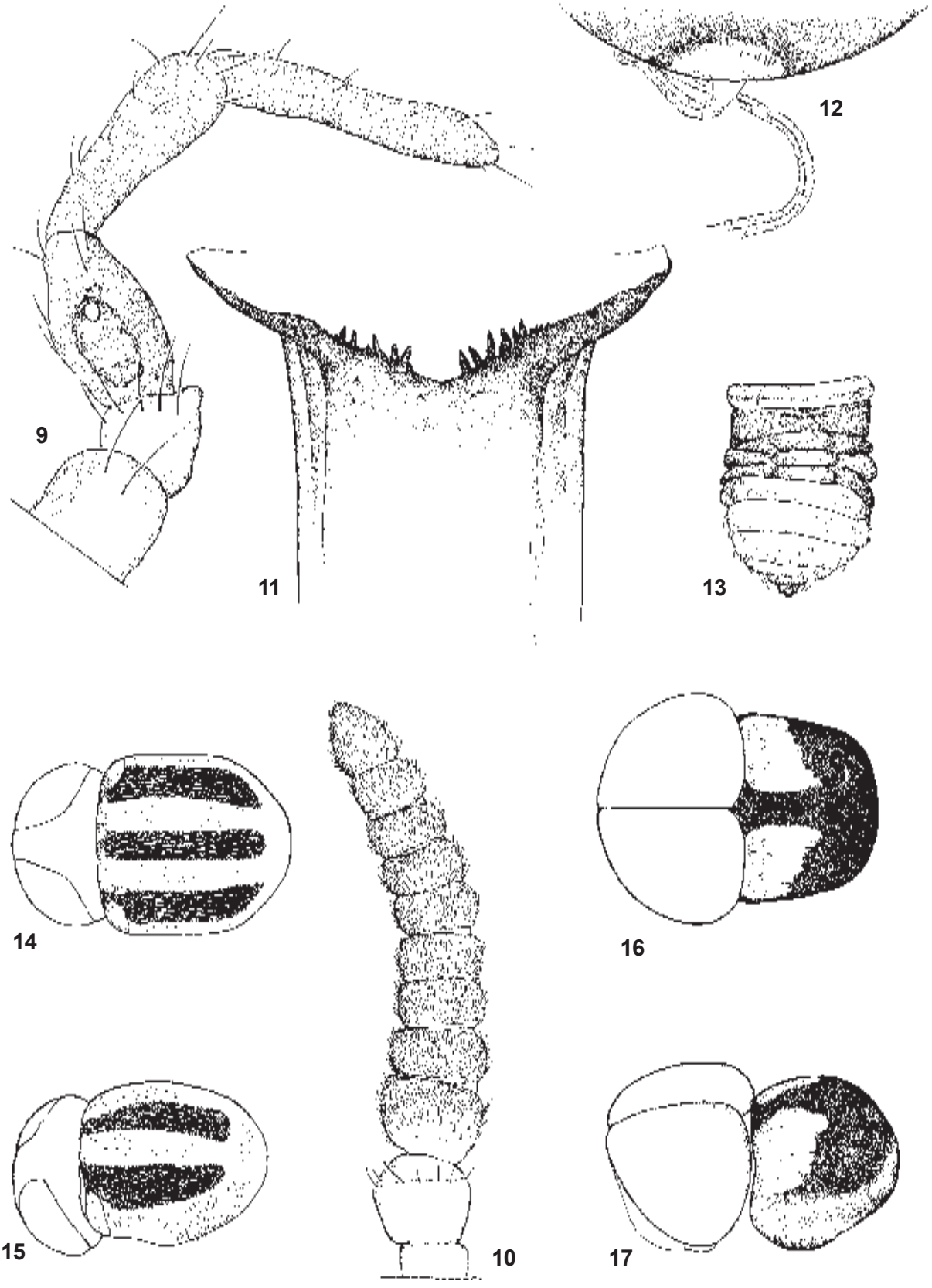
At the male stage, *S. damascenoi* can be distinguished from *S. siolii* and *S. tergospinosum* (the only species for which the males are known in the siolii group) by the presence of the paired quadrangular spot in the antero-lateral region of the scutum. Females of this species can be distinguished from the other known females in the siolii group (*S. siolii* and *S. tergospinosum*) by the pale, greenish color of the distal abdominal tergites (VI-IX), which is strikingly distinct from the dark brown color of these structures in the other species. Another difference is that the thick-paired bands on the *S. damascenoi* female scutum are of similar width, while in *S. tergospinosum* and *S. siolii* female scutum, the thick-paired bands turn narrower in the distal region.

Identification key for *Simulium* spp. (Diptera: Simuliidae) larvae in The State of Amapá, Brazil

1. Larva without ventral posterior papillae 2
1'. Larva with ventral posterior papillae .....…..…..... 10
2. Subesophageal ganglion pigmented .....… 3
2'. Subesophageal ganglion not pigmented .....….. 6
3. Body with dorsal subtriangular protuberances, which increase in length in the antero-posterior direction in the first five abdominal segments, dissected gill histoblast with 4 filaments …….....……..... *S. damascenoi*
3'. Body without dorsal subtriagular protuberances, dissected gill histoblast with 8 or more filaments …..... 4
4. Dissected gill histoblast with 8 filaments, dorsal side of terminal region of abdomen without racket-like shape setae …….....…..…..…..…..….. *S. subpallidum*
4'. Dissected gill histoblast with 12 filaments, dorsal side of terminal region of abdomen with racket-like shape setae ….……..…..... 5
5. Larvae of median size (length 4 - 6 mm); terminal region of abdomen not truncated ..…….... *S. guianense s.l.*
5'. Larvae large (length 7.3 - 8.8 mm); terminal region of abdomen truncated .....…... *S. hirtipupa*
6. Larvae small to medium size (< 5.5 mm); cephalic capsule, dorsally, with dark pattern in the form of a circle with crenate outer border; dissected histoblast with 8 filaments ……..……... *S. iracouboense*
6'. Larvae larger (> 6 mm); cephalic capsule, dorsally, without defined pattern; dissected histoblast with 8 or more filaments .....….....…... 7
7. Gill histoblast *in situ* large (> 1.5 mm) 8



Male of *Simulium damascenoi* (Diptera: Simuliidae). Fig. 2: maxillary palpus. Fig. 3: antenna. Fig. 4: ventral plate. Fig. 5: median sclerite. Fig. 6: paramere. Gonocoxite and gonostylus. Fig. 7: ventral view. Fig. 8: dorsal view



Simulium damascenoi (Diptera: Simuliidae). Female. Fig. 9: maxillary palpus. Fig. 10: antenna. Fig. 11: cibarium. Fig. 12: spermatheca. Fig. 13: abdomen. Fig. 14: scutum, dorsal view. Fig. 15: scutum, dorso-lateral view. Male. Fig. 16: scutum, dorsal view. Fig. 17: scutum, dorso-lateral view

7'. Gill histoblast *in situ* not large (< 1.5 mm) 9
8. Larvae with coloration dark green; gill histoblast *in situ* with numerous thin filaments coming out from thick trunk; dissected gill histoblast with more than 100 filaments ..... *S. trombetense*
8'. Larvae with coloration pale green; gill histoblast *in situ* with thick filaments visible; dissected gill histoblast with 8 filaments ..... *S. perflavum*
9. Dissected gill histoblast with 18-21 thick, dark filaments branching near base, with dorsal filaments shorter than ventral ones; in anterior view, filaments forming open rosette basally ..... *S. maroniense*
9'. Dissected gill histoblast with 18-21 thinner, lightly pigmented filaments, varying in size and branching pattern; in anterior view filaments projected forward, not forming open rosette basally ..... *S. rorotaense*
10. Subesophageal ganglion pigmented; dissected gill histoblast with 6 filaments 11
10'. Subesophageal ganglion not pigmented; dissected gill histoblast with number of filaments variable 12
11. Postgenal cleft longer than wide, constricted at base, so that maximum width is about one-third of length; postgenal bridge between one-half and one-third as long as hypostomium ..... *S. incrustatum*
11'. Postgenal cleft approximately as long as wide at the broadest point, narrowed at base; postgenal bridge half as long as hypostomium ..... *S. oyapockense s.l.*
12. Distal portion of postgenal cleft pointed; dissected gill histoblast with 6 filaments ..... *S. inaequale*
12'. Distal portion of postgenal cleft rounded; dissected gill histoblast with 4 or 8 filaments 13
13. Postgenal cleft not wide at the distal portion; lateral mandibular process bifid or trifid; second antenal article larger than the first; dissected gill histoblast with 8 filaments ..... *S. goeldii*
13'. Postgenal cleft wide at the distal portion; lateral mandibular process simple; second antenal article smaller than the first, dissected gill histoblast with 4 filaments 14
14. Dorsal abdominal region with multiramous setae, with irregular branching pattern (Fig. 18); dissected gill histoblast with filaments branching far away from the base ..... *S. cauchense*
14'. Dorsal abdominal region with multiramous setae, branching near the base (Fig.19); dissected gill histoblast branching near the base ..... *S. quadrifidum*

Identification key for *Simulium* spp. (Diptera: Simuliidae) pupae in the state of Amapá, Brazil

1. Gill with more than 17 filaments 13
1'. Gill with 4-12 filaments 2
2. Gill with 4 filaments, cocoon slipper-shaped 3
2'.Gill with 6-12 filaments, cocoon variable 5
3. Cephalic plate with pointed tubercles; pattern of gill filaments variable, cocoon with proeminent dorsal projection 4
3'. Cephalic plate without tubercles; base of gill filaments very short, with 2 principal trunks, cocoon without proeminent dorsal projection ..... *S. damascenoi*
4. Primary branch of gill filaments branching at more than half of total length of filament ..... *S. cauchense*
4'. Primary branch of gill filaments branching near base ..... *S. quadrifidum*
5. Gill with 6 filaments 6
5'.Gill with 8-12 filaments 8
6. Gill filaments short, approximately the length of pupae ..... *S. oyapockense s.l.*
6'. Gill filaments long, at least 1.5 x the length of pupa 7
7. Gill filaments branching near base (primary and secondary branches very short) ..... *S. inaequale*
7'. Gill filaments branching at variable distances from base ..... *S. incrustatum*
8. Gill with 12 filaments; gill filaments very short, shorter than body length, cocoon shoe-shaped 9
8'. Gill with 8 filaments, as long as the length of the body, cocoon slipper-shaped 10
9. Cephlalic plate and exposed portion of the thorax without long setae ..... *S. guianense s.l.*
9'. Cephalic plate and exposed portion of the thorax with numerous long setae ..... *S. hirtipupa*
10. Cocoon with dorsal median projection; gill filaments 1.5 x or more the body length; gill filaments branching at different distances from base ..... *S. goeldii*
10'. Cocoon without dorsal median projection; gill filaments shorter than 1.5 x the body length; gill filaments branching near base; if not, gill filaments shorter than cocoon; gill filaments branching at same or different heights 11
11. Gill filaments branching from one common trunk, near base and usually at same heights ..... *S. perflavum*
11'. Gill filaments branching at different heights; near base, main trunk branching in three primary branches 12
12. Cephalic trichomes short and simple ... *S. iracouboense*
12'. Cephalic trichomes with 2-5 branches .. *S. subpallidum*
13. Gill with more than 100 filaments ..... *S. trombetense*
13'. Gill with 17-23 filaments 14
14. Gill with thin, lightly pigmented filaments, varying in size and branching pattern; in anterior view, filaments projected forward, not forming rosette ..... *S. rorotaense*
14'. Gill with thick, darkly pigmented filaments; dorsal filaments shorter than ventral ones; in anterior view, filaments forming open rosette basally ..... *S. maroniense*

Bionomics and distribution

Sampling was done in 25 streams or rivers (Table I, Fig. 1) including areas with savanna and forest type of vegetation. Streams and rivers sampled in the study area had width varying from 2 to 500 m, pH varying from 4.7 to 7.6, electrical conductivity varying from below 10 to 20 µS/cm and temperature ranging from 24 to 28ºC. Of the 25 streams sampled, 19 had bedrock, boulders or small stones while only six had sandy/clayey streambeds. Many of the streams with rocks (n = 14) had plants belonging to the family Podostemaceae, which are frequently used as substrates by many different aquatic insects, including black-fly larvae and pupae.

Fifteen black-fly species were collected during the sampling period (Tables I, II). This is the first record of the species *Simulium hirtipupa* Lutz and *Simulium subpallidum* Lutz in Amapá.

The mean number of species per collection was 2.5 (± 1.19) (n = 39, range = 1 to 5 spp.). This is similar to the mean number of black-fly species found in streams in

TABLE I

Simulium spp. (Diptera: Simuliidae) collection data in the state of Amapá, Brazil

Collection number	Collection location	Date	Collectors	Collected species
1	Oiapoque river, 03º48'N 51º53'W	26.07.2000	NH, UCB, AC, RF	1, 2, 3, 9
		20.06.2001	NH, RAR, RF	1, 2
2	Pantanary stream, Oiapoque county, 03º47'N 51º48'W	20.06.2001	NH, RAR, RF	1, 8
3	Stream near airport, Oiapoque county, 03º52'N 51º47'W	25.07.1996	NH, LA	6, 8
		28.07.2000	NH, UCB, AC, RF	6, 8
4	Stream near entrance of Oiapoque city, (owner - Mr Edmilson)BR 156	27.07.1996	NH, LA	8, 9
5	Stream near Primeiro do Caciporé, BR 156, ~ 90 km from Oiapoque city, 03º11'N 51º32'W	27.07.2000	NH, UCB, AC, RF	5, 8, 9, 12
6	Água Branca stream, near Carnot village, BR 156 Macapá-Oiapoque, 02º40'N 51º21'W	25.07.1996	NH, LA	5, 8, 9, 12, 14
		28.07.2000	NH, UCB, AC, RF	5, 8, 9, 12, 14
		19.06.2001	NH, RAR, RF	1, 5, 8, 9, 12
7	Torrão stream, near Água Branca stream, BR 156 Macapá-Oiapoque, 02º27'N 51º13'W	25.07.1996	NH, LA	5, 8, 9
		28.07.2000	NH, UCB, AC, RF	8, 9
		19.06.2001	NH, RAR, RF	8, 9
8	Cachoeira Grande river, Amapá county, BR 156 Macapá-Oiapoque, 02º09'N 50º55'W	28.09.1993	NH	1, 3, 12
		27.07.2000	NH, UCB, AC, RF	1, 2, 12
9	Davi Grande stream, Amapá county, BR 156 Macapá-Oiapoque, 01º55'N 50º51'W	08.1993	NH	12
		25.07.1996	NH, LA	8
		24.07.2000	NH, UCB, AC, RF	8, 9, 12
		18.06.2001	NH, RAR, RF	8, 12
10	Henrique stream, Amapá County, BR 156 Macapá-Oiapoque, 01º45'N 50º52'W	25.07.1996	NH, LA	8
		28.07.2000	NH, UCB, AC, RF	9, 12
		18.06.2001	NH, RAR, RF	8, 12
11	Araguari river, BR 156 Macapá-Oiapoque, Ferreira Pena bridge, 00º51'N 51º11'W	28.09.1993	NH	1
12	Stream tributary of Araguari river, above Ferreira Pena bridge, 00º51'N 51º11'W	28.09.1993	NH	7, 10
		18.06.2001	NH, RAR, RF	7, 10
13	Flexal stream, Araguari tributary, Monte Taboa, BR 156 Macapá-Oiapoque, 00º29'N 51º07'W	24.07.2000	NH, UCB, AC, RF	7, 8, 11
14	Stream near Ferreira Gomes village, road to UHE Paredão, 00º50'N 51º11'W	30.07.1996	NH, LA	7, 8, 9, 14
15	Água Fria river, Macapá-Serra no Navio road, large bridge, 00º48'N 51º58'W	29.07.1996	NH, LA	1, 2, 9
16	Stream near Serra do Navio village, Cachaço stream tributary, ~ 00º48'N 51º58'W	29.07.1996	NH, LA	5, 7, 8, 9
17	Stream near EMBRAPA, BR 156 Macapá-Oiapoque, 00º28'N 51º06'W6)	30.07.1996	NH, LA	8, 11
18	Stream Cachoeirinha (balneário), Macapá county, BR 156 Macapá-Jari, 00º12'N 51º28'W	24.07.1996	NH, LA	7, 9
19	Stream ~ 19 km after stream Cachoeirinha, Macapá county, BR 156 Macapá-Jari, 00º12'N 51º28'W	24.07.1996	NH, LA	7, 9, 13
20	Stream ~ 24 km after stream Cachoeirinha, Macapá county, BR 156 Macapá-Jari, 00º12'N 51º28'W	24.07.1996	NH, LA	7, 11
21	Stream on BR 156, Macapá-Jari, 00º05'S 51º43'W	31.07.1996	NH, LA	7
22	Stream on BR 156, Macapá-Jari, 00º27'S 52º05'W	31.07.1996	NH, LA	4, 7, 8, 14
		23.06.2001	NH, RAR, RF	8, 14
23	Stream on BR 156, Macapá-Jari, 00º27'S 52º07'W	31.07.1996	NH, LA	4/5, 7, 14
24	Stream at Marinho village. On the road to Laranjal do Jari	31.07.1996	NH, LA	8
25	Jari river, Santo Antônio waterfall, Laranjal do Jari county, 00º39'S 52º30'W	24.06.2001	NH, RAR, RF	15

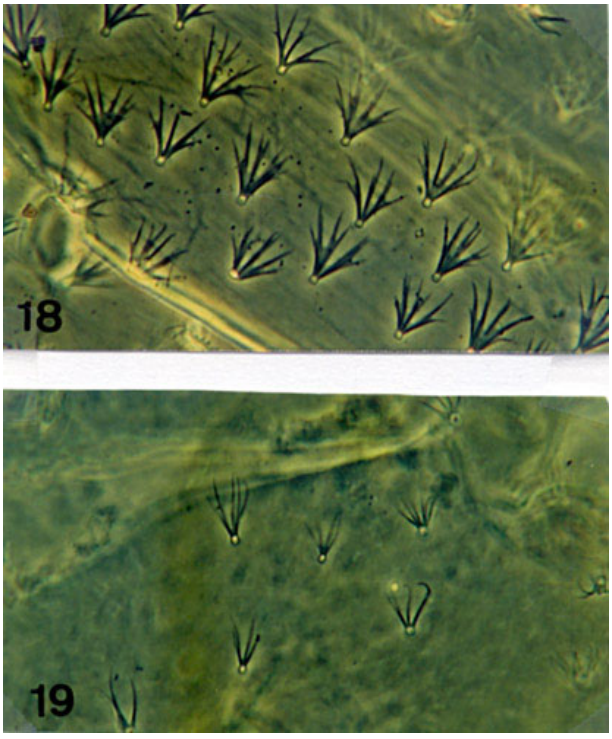
Date: day,month, year; BR: Federal road; UHE: hydroelectric dam; LA: Luís Aquino; NH: Neusa Hamada; UCB: Ulysses C Barbosa; RF: Raimundo Freire; AC: Aracy Cavalcante; RAR: Rosaly Ale-Rocha; Species - 1: *S. iracouboense*; 2: *S. guianense* (*s.l.*); 3: *S. oyapockense* (*s.l.*); 4: *S. rorotaense*; 5: *S. maroniense*, 6: *S. trombetense*, 7: *S. perflavum*; 8: *S. quadrifidum*; 9: *S. cauchense*; 10: *S. inaequale*; 11: *S. incrustatum*; 12: *S. damascenoi*; 13: *S. goeldii*; 14: *S. subpallidum;* 15: *S. hirtipupa*

TABLE II

Habitat characterization of *Simulium* spp. (Diptera: Simuliidae) collected in the state of Amapá, Brazil

Species	Occurrence per site	Habitat width (m)	Electrical conductivity (mS/cm)	Temperature (°C)	pH	Streambed	Vegetation type (number of sites)	Substrate
S. cauchense	12	5 - 500	< 20	24 - 28	4.7 - 6.9	Rock	Forest (6) / Savanna (6)	D, G, R, P
S. damascenoi	5	8 - 100	< 10	25 - 27	5.5 - 6.4	Rock	Forest (2) / Savanna (3)	D, G, R, P
S. goeldii	1	5	< 10	27	4.7	Stones	Savanna	D
S. guianense	3	95 - 500	< 20	24 - 28	5.9 - 6.9	Rock	Forest (1) / Savanna (2)	P
S. hirtipupa	1	150	< 20	26	7.6	Rock	Forest	P
S. inaequale	1	10	< 10	26	5.7	Sand	Savanna	D
S. incrustatum	3	2 - 8.5	< 10	25 - 28	4.7 - 4.9	Sand/clay	Savanna	D, G
S. iracouboense	6	40 - 500	< 10	24 - 28	5.9 - 6.9	Rock	Forest (3) / Savanna (3	D, G, R., P
S. maroniense	4	8 - 17	< 10	25	5.3 - 6.4	Rock	Forest	D, G, P
S. oyapockense	2	100 - 200	< 10	27 - 28	6.4 - 6.9	Rock	Forest (1) / Savanna (1)	D, P
S. perflavum	10	3 - 10	< 20	25 - 28	4.7 - 5.7	Sand	Forest (1) / Savanna (9)	D, G, R
S. quadrifidum	14	2 - 40	< 20	24 - 26	4.9 - 6.4	Rock	Forest (8) / Savanna (6)	D, G, R, P
S. rorotaense	1	10	< 10	27	4.7	Rock	Savanna	D, P
S. subpallidum	4	2 - 10	< 20	25 - 28	5.0 - 5.7	Rock	Forest (1) / Savanna (3)	D, G, P
S. trombetense	1	4	a	25	5.6	Rock	Forest	D, G, R, Rk

a: not measured; Rock: rock bottom/boulder; Stones: small stones; D: deciduous leaves; G: green leaves of streamside vegetation; R: roots of streamside vegetation; P: Podostemacea leaves; Rk: rock



Larval abdominal dorsal setae. Fig. 18: *Simulium cauchense*. Fig. 19: *Simulium quadrifidum*

Central Amazonia by Hamada et al. (2002).

Species with high frequency, occurring in 40 to 56% of the collections, were *S. quadrifidum*, *S. cauchense* and *S. perflavum* (Table I). *S. iracouboense*, *S. damascenoi*, *S. maroniense* and *S. subpallidum* occurred in 16-24% of the sites and *S. guianense*, *S. incrustatum*, *S. oyapockense* s.l., *S. rorotaense*, *S. trombetense*, *S. inaequale, S. goeldii* and *S. hirtipupa* occurred in 4-12% of the sites (Table I).

Some physical-chemical characteristics of the habitat of each species sampled during this study are shown in Table II. Co-occurrences of species can be observed in Table I.

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