

Forest Culicinae Mosquitoes in the Environs of Samuel Hydroelectric Plant, State of Rondônia, Brazil

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Data on frequency and seasonal distribution of culicinae were recorded in the forest near a recently constructed hydroelectric plant - Samuel, in the State of Rondônia, Brazilian Amazon. Collections were performed almost daily from August 1990 to July 1991, between 6 and 9 p.m., using human bait. A total of 3,769 mosquitoes was collected, representing 21 species, including seven new records for the State of Rondônia. The most frequently collected species were Aedes fulvus (25%) and Ae. pennisai (12.3%). The highest density for the majority of mosquito species coincided with the rainy season.

Key words: Diptera: Culicidae - Culicinae mosquitoes - seasonal frequency - hydroelectric plant

The major objectives of the entomological surveys carried out during the last decades in the Brazilian Amazon, mainly in the State of Rondônia, were to investigate the biology of local anophelines and determine the vectors of human malaria parasites. Few data on the Amazonian Culicinae have been obtained during these malaria surveys.

Surveys of Culicinae mosquitoes in the State of Rondônia were first performed by Degallier and Travassos-da-Rosa (1989) to assess the risk of arbovirus transmission near the Samuel hydroelectric plant and by Xavier and Mattos (1989) on the geographical distribution of mosquitoes at Porto Velho and Guajará-Mirim. The biology of culicines was studied in both rural and urban areas in Costa Marques, southwestern Rondônia (Klein et al. 1992) and in rural settlements in the municipality of Porto Velho (Tubaki & Barata 1993). Culicinae mosquitoes are important vectors of human and animal diseases such as Bancroftian filariasis, dengue and yellow fever as well as more than 150 arboviruses. These diseases represent a problem to rural development, particularly in the Amazon Region of Brazil. An entomological survey was conducted in primary forest near the Samuel hydroelectric plant in order to assess the frequency of mosquito species and their seasonal distribution.

MATERIALS AND METHODS

Description of the study area - The studies were performed from August 1990 to July 1991 at the Ecological Station of Samuel, in the municipality of Candeias do Jamari, State of Rondônia, Brazil (8° 50' S 9° 04' S and 63° 08' W 63° 19' W), nearly one year after the construction of the Samuel Hydroelectric plant, when the reservoir had already been filled up. The study site is bounded to the west by the Jamari River and the reservoir of the Samuel Hydroelectric plant, and is contiguous with the Jamari National Forest. The Ecological Station of Samuel comprises an area of primary forest. The vegetation is peculiar, with predominance of the dense "terra firme" (dry land) forest, interspersed "varzea" (seasonally flooded) forest, as well as flooded forest along the streams. The forest is uninhabited, and the nearest human settlement is the village of Itapoã do Oeste, about 20 km from the centre of the Ecological Station of Samuel.

The local climate is tropical, with the dry season from June to August, and the wet season from December to March. The local temperature oscillates between 21°C and 32°C, with an annual average of 25.5°C. The relative humidity varies from 74% to 90.8%, with an annual average of 82% (Lisboa 1990). Other data on the Samuel Ecological Station, such as details about climate, vegetation and fauna, were published elsewhere (ELETRONORTE 1988, Lourenço-de-Oliveira & Deane 1995) and the sites where mosquitoes have been surveyed were spotted on a map presented in Lourenço-de-Oliveira and Deane (1995: 333).

Mosquito collections and identification - Mosquito collections were performed at three sites 1 km apart in the Ecological Station of Samuel, nearly 50 km from the dam. Collections were carried out at each site on alternate days.

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Mosquitoes were collected on a human bait (on his own legs) at least three times a week, from 6 to 9 p.m, using an aspirator tube, and preserved in numbered plastic vials, containing superimposed layers of naphthalene, cotton and filter paper.

Most of the Culicines were identified by the keys of Lane and Cerqueira (1942), Lane (1953) and Forattini (1965a,b). Some of the less common species were identified by the comparison of caught female specimens with those deposited in collections at the Department of Entomology, Oswaldo Cruz Institute, Rio de Janeiro and the Department of Epidemiology, Faculty of Public Health, University of São Paulo. The identifications were also confirmed after examining genitalia of eventually wild-caught males. The taxonomic organization and nomenclature followed that of Knight and Stone (1977) and the abbreviations of genera and subgenera are those of Reinert (1975).

RESULTS

Frequency of Culicinae mosquito species - The frequency of each mosquito species at the Ecological Station of Samuel is shown in Table I. A total of 3,769 mosquitoes was collected, in which 9 genera and 21 species of Culicinae were recognized. Seven species accounted for 84% of the total collected: *Ae. fulvus* (25%), *Ae. pennai* (12.3%),

Psorophora dimidiata (12.3%), *Coquillettidia lynchi* (9.7%), *Ae. serratus* (9.6%), *Culex bastagarius* (9%) and *Cx. chrysonotum* (6.5%). The other species were less frequent or rare, each one accounting for less than 5% of the total (Table I).

Ae. fulvus was the most frequent culicine mosquito collected at the Ecological Station of Samuel, with a total of 932 specimens, approximately double the number of the second and third most abundant species: *Ae. pennai* (475 specimens) and *Ps. dimidiata* (463). These three species together accounted for 50% of the total mosquitoes collected in the area.

Monthly frequency - Mosquito frequency was highest in April, with 154.3 specimens/man-10hr and lowest in August, with 26.2 mosq./man-10 hr (Table III).

The highest numbers of culicines were recorded during the period of February, March and April (Tables II, III). This period of high mosquito density occurred after the second peak of rain (January - February) and terminated at the beginning of the dry season in May (Fig.).

Most mosquito species (e.g. *Ae. fulvus*, *Ae. serratus* and *Ae. pennai*) showed highest biting densities during the rainy season (February - April). However, *Cq. lynchi* and *Cx. bastagarius* were less abundant during the rainy period (Fig.). *Ps.*

TABLE I

Culicinae mosquito species in decreasing order of frequency, collected from human bait in the forest of the Ecological Station of Samuel, State of Rondônia, western Amazon region of Brazil, from August 1990 to July 1991

Species	Number	%
<i>Aedes (Ochlerotatus) fulvus</i> (Wiedmann, 1828)	932	25.0
<i>Aedes (Ochlerotatus) pennai</i> Antunes and Lane, 1938	475	12.3
<i>Psorophora (Grabhamia) dimidiata</i> Cerqueira, 1943	463	12.3
<i>Coquillettidia (Rhynchotaenia) lynchi</i> (Shannon, 1931)	365	9.7
<i>Aedes (Ochlerotatus) serratus</i> (Theobald, 1901)	361	9.6
<i>Culex (Melanoconion) bastagarius</i> Dyar & Knab, 1906	340	9.0
<i>Culex (Melanoconion) chrysonotum</i> Dyar & Knab, 1908	245	6.5
<i>Culex (Melanoconion) spp.^a</i>	181	4.8
<i>Psorophora (Janthinosoma) albipes</i> (Theobald, 1907)	145	3.8
<i>Psorophora (Janthinosoma) ferox</i> (Von Humboldt, 1819)	83	2.2
<i>Culex (Melanoconion) pedroi</i> Sirivanakarn & Belkin, 1980	76	2.0
<i>Culex (Culex) coronator</i> Dyar & Knab, 1906	65	1.7
<i>Psorophora (Janthinosoma) spp.^a</i>	12	0.3
<i>Culex (Culex) mollis</i> Dyar & Knab, 1906	10	0.3
<i>Culex (Culex) spp.^a</i>	6	0.2
<i>Mansonia (Mansonia) titillans</i> (Walker, 1848)	3	0.1
<i>Psorophora (Psorophora) cilipes</i> (Fabricius, 1805)	2	0.0
<i>Trichoprosopon (Trichoprosopon) digitatum</i> (Rondani, 1848)	2	0.0
<i>Orthopomyia fascipes</i> (Coquillett, 1905)	1	0.0
<i>Sabethes (Sabethoides) chloropterus</i> (Von Humbolt, 1819)	1	0.0
<i>Uranotaenia sp.^a</i>	1	0.0
Total	3,769	100

a: non identifiable specimens

TABLE II

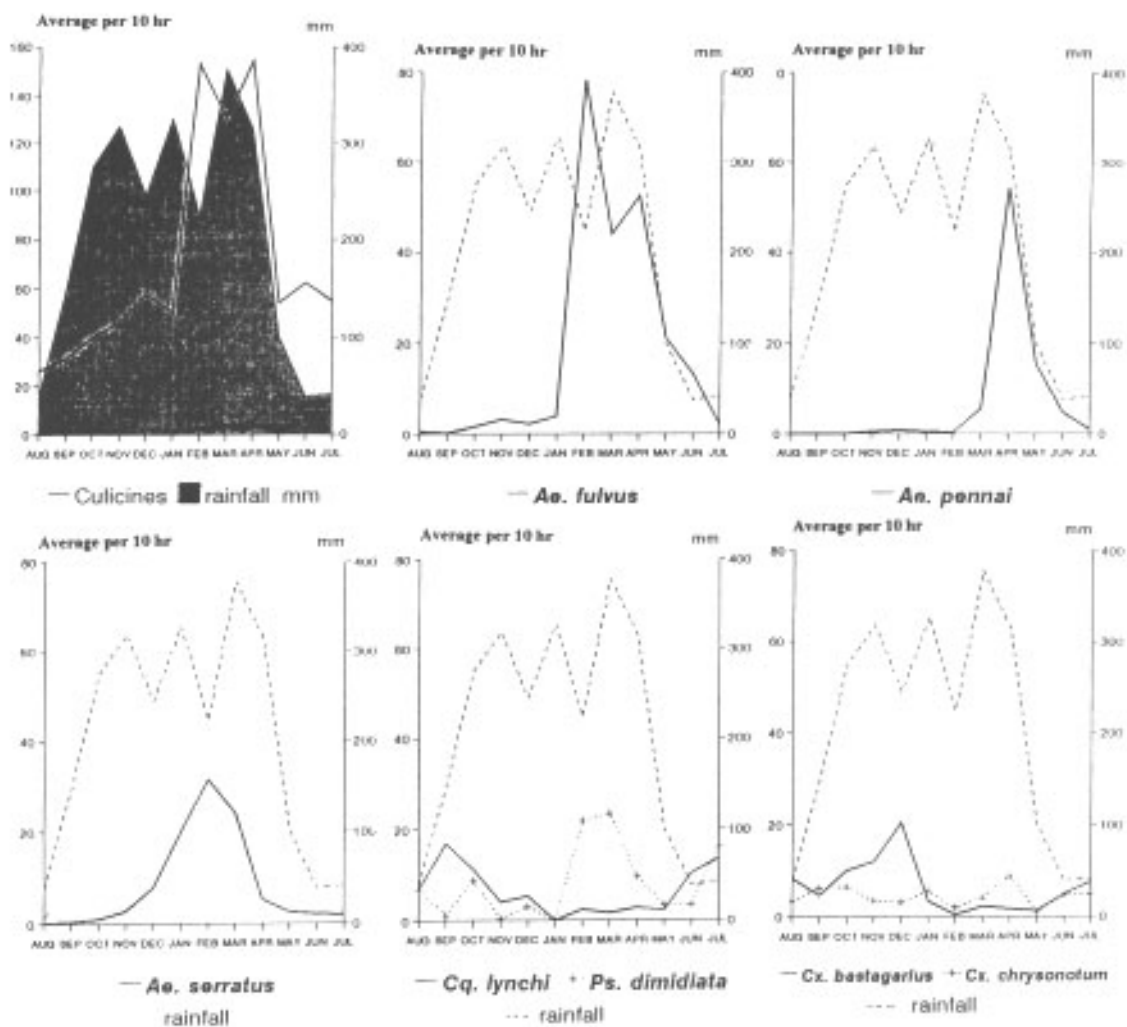
Number of Culicinae mosquitoes collected monthly on human bait in the forest of the Ecological Station of Samuel, State of Rondônia, western Amazon region of Brazil, from August 1990 to July 1991

Species	1990					1991						
	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.
<i>Aedes fulvus</i>	3	1	6	14	9	16	219	140	314	127	75	8
<i>Aedes pennai</i>	-	-	-	2	3	2	1	18	325	93	27	4
<i>Aedes serratus</i>	1	2	3	12	31	80	88	77	32	15	12	8
<i>Coquillettidia lynchi</i>	41	85	43	18	21	-	7	5	17	13	58	57
<i>Culex coronator</i>	-	-	-	8	8	8	4	10	16	6	4	1
<i>Culex mollis</i>	1	1	-	-	-	1	1	1	22	1	1	1
<i>Culex (Culex) spp.</i>	-	1	1	-	-	-	1	2	-	1	-	-
<i>Culex bastagarius</i>	49	23	38	53	81	13	1	7	10	7	27	31
<i>Culex chrysonotum</i>	20	31	24	15	12	22	5	13	52	6	25	20
<i>Culex pedroi</i>	-	1	-	8	10	12	2	6	16	2	8	11
<i>Culex (Melanoconion) spp.</i>	-	3	2	50	37	47	2	12	-	5	10	13
<i>Mansonia titillans</i>	-	-	-	1	1	-	-	1	-	-	-	-
<i>Orthopodomyia fasciipes</i>	-	-	-	1	-	-	-	-	-	-	-	-
<i>Psorophora albipes</i>	-	1	1	2	4	-	20	28	60	14	12	3
<i>Psorophora cilipes</i>	-	-	-	-	-	-	-	1	1	-	-	-
<i>Psorophora dimidiata</i>	41	6	33	17	12	-	61	75	57	20	73	68
<i>Psorophora ferox</i>	-	-	1	-	-	-	8	17	23	15	15	4
<i>Psorophora (Janthinosoma) spp.</i>	-	-	-	-	-	-	8	4	-	-	-	-
<i>Sabethes chloropterus</i>	-	-	-	-	1	-	-	-	-	-	-	-
<i>Trichoprosopon digitatum</i>	-	-	-	-	-	-	-	1	1	-	-	-
<i>Uranotaenia sp.</i>	1	-	-	-	-	-	-	-	-	-	-	-
Total	157	155	152	201	230	201	428	418	926	325	347	229
Hours spent in captures	60	50	38	44	40	40	28	32	60	60	56	42

TABLE III

Number of mosquitoes/man-10 hours monthly collected in the forest of the Ecological Station of Samuel, State of Rondônia, western Amazon region of Brazil, from August 1990 to July 1991

Species	1990					1991						
	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.
<i>Aedes fulvus</i>	0.5	0.2	1.6	3.2	2.3	4.0	78.2	43.8	52.3	21.2	13.4	2.0
<i>Aedes pennai</i>	-	-	-	0.5	0.8	0.5	0.4	5.6	54.2	15.5	4.8	1.0
<i>Aedes serratus</i>	0.2	0.4	1.0	2.8	7.8	20.0	31.4	24.0	5.3	2.5	2.1	2.0
<i>Coquillettidia lynchi</i>	6.8	17.0	11.3	4.1	5.3	-	2.5	1.6	2.8	2.2	10.3	13.6
<i>Culex coronator</i>	-	-	-	1.8	2.0	2.0	1.4	3.1	2.7	1.0	0.7	0.2
<i>Culex mollis</i>	0.2	0.2	-	-	-	0.3	0.4	0.3	0.3	0.2	0.2	0.2
<i>Culex (Culex) spp.</i>	-	0.2	0.3	-	-	-	0.4	0.6	-	0.2	-	-
<i>Culex bastagarius</i>	8.2	4.6	10.0	12.0	20.3	3.3	0.4	2.2	1.7	1.2	4.8	7.4
<i>Culex chrysonotum</i>	3.3	6.2	6.3	3.4	3.0	5.5	1.8	4.0	8.7	1.0	4.5	4.8
<i>Culex pedroi</i>	-	0.2	-	1.8	2.5	3.0	0.7	1.9	2.7	0.3	1.4	2.6
<i>Culex (Melanoconion) spp.</i>	-	0.6	0.5	1.4	9.3	11.8	0.7	3.8	-	0.8	2.0	3.1
<i>Mansonia titillans</i>	-	-	-	0.2	0.3	-	-	0.3	-	-	-	-
<i>Orthopodomyia fasciipes</i>	-	-	-	0.2	-	-	-	-	-	-	-	-
<i>Psorophora albipes</i>	-	0.3	0.3	0.5	1.0	-	7.1	8.8	10.0	2.3	2.3	0.7
<i>Psorophora cilipes</i>	-	-	-	-	-	-	-	0.3	0.2	-	-	-
<i>Psorophora dimidiata</i>	6.8	1.2	8.7	0.4	3.0	-	21.8	23.4	9.5	3.3	3.3	16.2
<i>Psorophora ferox</i>	-	-	0.3	-	-	-	3.0	5.3	3.8	2.5	2.5	1.0
<i>Psorophora (Janthinosoma) spp.</i>	-	-	-	-	-	-	3.0	1.3	-	-	-	-
<i>Sabethes chloropterus</i>	-	-	-	-	0.3	-	-	-	-	-	-	-
<i>Trichoprosopon digitatum</i>	-	-	-	-	-	-	-	0.3	0.2	-	-	-
<i>Uranotaenia sp.</i>	0.2	-	-	-	-	-	-	-	-	-	-	-
Total	26.2	31.0	40.0	46.0	57.5	50.3	153.0	130.6	154.3	54.2	62.0	54.5



Monthly rainfall (mm) and average number of particular taxa collected on human bait (mosquitoes/ man-10hr) in the forest of the Ecological Station of Samuel, State of Rondônia from August 1990 to July 1991.

dimidiata was collected throughout the year, except in January, but its density increased in February, in association with increasing rainfall. In contrast the annual distribution of *Cx. chrysonotum* did not seem to be related to the rainfall (Tables II, III, Fig.).

DISCUSSION

Culicinae of Samuel - Seven species are here recorded for the first time from the State of Rondônia: *Ae. pennai*, *Cq. lynchi*, *Cx. mollis*, *Cx. bastagarius*, *Cx. chrysonotum*, *Cx. pedroi* and *Ps. dimidiata*.

Members of the genus *Aedes* were the most common culicine at Samuel. *Ae. fulvus* has been found elsewhere in the State of Rondônia, such as Guajará-Mirim (Xavier & Mattos 1989) on human bait, and using the CDC light-traps near the Samuel

dam (Degallier & Travassos-da-Rosa 1989). During the studies on malaria in rural and urban areas in Costa Marques, this species was more frequent in rural and extra-domiciliary environments close to the forest (Klein et al. 1992). *Ae. serratus* has a similar distribution in the state and has been found by Klein et al. (1992) to be more frequent outdoors in rural areas. In southern and southeast Brazil, Forattini et al. (1968, 1981, 1986a,b) collected these two *Aedes* species in higher numbers on human bait than by CDC light-traps. Forattini et al. (1978) and Guimarães et al. (1989) observed the increased abundance of *Ae. fulvus* and *Ae. serratus* in the extra-domiciliary environment.

Ps. ferox has been found in the municipalities of Guajará-Mirim, Abunã, Porto Velho (Xavier & Mattos 1989), Costa Marques (Klein et al. 1992) and Candeias do Jamari-Samuel (Degallier &

Travassos-da-Rosa 1989) in the State of Rondônia. *Ps. albipes* was recorded from Candeias do Jamari-Samuel (Degallier & Travassos-da-Rosa 1989) and Costa Marques (Klein et al. 1992). Both species occur predominantly in the forest, in rural areas and feed on humans outdoors (Forattini et al. 1968, 1978, 1981, Guimarães et al. 1989).

Monthly frequency - In tropical regions the seasonal distribution of mosquitoes is controlled by the dry and rainy periods (Bates 1949). These two periods are very evident at Samuel (Fig). The rainy/dry seasons determine the water volume in the Jamari River basin thereby influencing the abundance of breeding places. The sites of mosquito collections at the Ecological Station of Samuel are located near the Japiim stream, a tributary of the Jamari River. During the rainy season, when the water level is high in the Jamari basin, the Japiim stream floods the marginal terrain and forms small lakes and swamps. In the dry period, when the water level is low only small pools with muddy ground remain at the stream margins.

Ae. fulvus females were collected throughout the year, but with a reduced frequency between July and January. On the other hand, collection frequency quickly increased in February and then gradually diminished until June (Table II, Fig.). The abundance of *Ae. fulvus* closely coincided with the beginning of the rainy season in October. One may presume that the larval breeding-places of *Ae. fulvus* at Samuel should be abundant when the lowland terrains at the river margins are flooded. At this time the river water reaches eggs that have been laid on the ground during the dryer times of the year, and consequently the adult population increases rapidly. The heavy rains in March may interfere with larval and pupal development. In April when heavy rains were rare another peak of density was observed (Fig.). The frequency of *Ae. fulvus* decreased as rainfall (after April) suggesting the eggs laid by females emerging from February to April would hatch during the next rainy season.

Ae. pennai was also more frequent during the rainy season, but its highest density was observed in April. The species was absent during the collections made from August to October. The only peak observed in April coincided with the end of the heavy rains, when most of the river margins were flooded. This suggests that the breeding-sites of *Ae. pennai* were sufficiently flooded when the river's level was high. According to Belkin et al. (1971) the larval habitats of *Ae. pennai* are forest rain pools. It may also be speculated that eggs of this species need several or intermittent contacts with water to hatch, as already verified for other Aedini mosquitoes.

Ae. serratus was collected throughout the year with a peak in February, after the two peaks of high rainfall (November and January). Its frequency diminished during March when heavy rains were more common.

Cq. lynchi was more frequently collected in September, at the beginning of the rainy season but was rare during the rainiest months, disappearing in January. The abundance of *Cq. lynchi* was highest during the drier periods in the year (Fig.). The breeding sites of Mansonini mosquitoes may be disturbed by torrents. *Mansonia titillans*, a species belonging to this tribe, has been more abundant during the dry season (Lourenço-de-Oliveira 1984).

Studies on the culicine fauna associated with hydroelectric plants must be performed before, during and after their construction. The anthropic changes brought by new settlements should also be studied. Besides biting nuisance, these changes in the environment may favour the development and abundance of mosquito vectors of disease. Some mosquito species may be very numerous around hydroelectric plants, like near Tucuruí, State of Pará, Brazil, where a mean of 500 mosquito/man-hr was recorded (ELETRONORTE 1989).

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