Entomological investigation of a sylvatic yellow fever area in São Paulo State, Brazil

Investigação entomológica em área de ocorrência de febre amarela silvestre no Estado de São Paulo, Brasil

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Abstract

Following reports of two autochthonous cases of sylvatic yellow fever in the State of São Paulo, Brazil, in 2000, entomological surveys were conducted with the objective of verifying the occurrence of vector species in forest environments close to or associated with riparian areas located in the western and northwestern regions of the State. Culicidae were captured in 39 sites distributed in four regions. Haemagogus leucocelaenus *and* Aedes albopictus *were the most abundant species and were captured in all the regions studied.* H. leucocelaenus *was the most abundant species in the municipalities of Santa Albertina and Ouroeste, where the two cases of sylvatic yellow fever had been reported. Mosquitoes from the* janthinomys/capricornii *group were only found at eight sites in the São José do Rio Preto region, while* Sabethes chloropterus *was found at one site in Ribeirão Preto.* H. leucocelaenus *showed its capacity to adapt to a secondary and degraded environment. Our results indicate a wide receptive area for yellow fever transmission in the State of São Paulo, with particular emphasis on the possibility of* H. leucocelaenus *being involved in the maintenance of this sylvatic focus of the disease.*

Yellow Fever; Culicidae; Insect Vectors; Entomology

Introduction

Mosquitoes from the Culicidae family have provided the means both for circulation of the yellow fever virus among animals and its extension to the human population. With the discovery of the occurrence of yellow fever without participation by *Aedes aegypti*, species from the genera *Haemagogus* and *Sabethes* were incriminated as playing a vector role between primates and humans in the sylvatic environment [1].

In South America, epizootic events followed by cases of human infection occur according to what are still insufficiently studied cycles. Nearly two-thirds of Brazil's territory is considered an enzootic area for the virus, distributed in the North, Northeast, Central-West, Southeast, and South [2]. Public health interest has been awakened by the reporting of epizootic activity in areas that were silent for several decades, as in the case of areas located in the South of the country, as well as epizootics and human cases in the Southeast [3,4].

Enzootic activity of the yellow fever virus in municipalities (counties) infested with *A. aegypti* leads to questions concerning the probably of this virus urbanizing, supported by the oral susceptibility of *A. aegypti* samples from different regions of Brazil [5]. This possibility reopens the discussion concerning yellow fever vaccine coverage, especially in riparian areas close to urban areas infested with the vector, which are a priority for vaccination campaigns as a strategy to avoid introduction of the yellow fever virus into urban areas in the State of São Paulo.

Beginning in 1999, when human cases of sylvatic yellow fever were detected in the State of Goiás along with an epizootic in 54 municipalities, a shift of the virus to the South and East of Brazil was documented. The same events occurred in States such as Minas Gerais, Pará, Tocantins, Mato Grosso do Sul, and Rondônia. However, the most worrisome fact occurred in 2000, when human cases occurred outside what were considered the classical endemic areas with intact forest cover [3,6]. Epizootics now occur in transformed areas and remnants of the Atlantic Forest, as in the cases reported in the States of Bahia and São Paulo [7,8].

In the State of São Paulo, sylvatic yellow fever had not been reported since 1953 [9], until the year 2000 when two autochthonous cases were diagnosed in the municipalities of Santa Albertina and Ouroeste [7]. These two municipalities are located in the northwestern region of the State, bordering on municipalities in the State of Minas Gerais, with the most frequent outbreaks in the Southeast of the country from 2000 to 2002. Epidemiological investigation of the two cases in São Paulo characterized the situation as one of natural foci with a high degree of deforestation and rural areas where the native vegetation was distributed in sparse remnants, sometimes as riparian forest and other times farther away from the rivers, surrounded by pasture. Degradation of the forest areas thus results from invasion by domestic animals and humans themselves.

In the epidemiological field, the region had already recorded the main vector species for sylvatic yellow fever [7]. However, studies were still lacking to monitor the effects of deforestation and alteration of the natural environment by the above-mentioned populations. *Haemagogus janthinomys* is known to be a sylvatic species, and it is necessary to evaluate its capacity to survive in degraded areas as well as the potential for *Haemagogus leucocelaenus* and other species from this genus to develop in such new environments [10]. Corroborating this is the genus' long history of natural competence for yellow fever transmission in the Americas [4,11]. Dégalier et al. [12] emphasized the need for research on the frequency and abundance of mosquitoes from this group in different epizootic, enzootic, and endemic areas for sylvatic yellow fever in Brazil. The present study approaches the vector issue and analyzes the distribution of species involved in the enzootic cycles of sylvatic yellow fever in secondary forests in the State of São Paulo.

Material and methods

The research areas included 39 sites belonging to 25 municipalities along the banks of the Rio Grande and Rio Paraná. These municipalities belong to the administrative regions (regional health divisions) of Ribeirão Preto, São José do Rio Preto, Araçatuba, and Presidente Prudente.

Site selection took into account the presence of secondary forest formations close to hydroelectric dams with a mean distance of 20km between them, with the following sites being investigated: eight in the Ribeirão Preto region; 13 in the São José do Rio Preto region; eight in the Araçatuba region; and ten in the Presidente Prudente region, thus broadly representing the western and northwestern regions of the State of São Paulo (Figure 1).

The forest environments investigated represented riparian forests or fragments of mesophilic forests (semi-deciduous seasonal forests) in various stages of alteration, displaying both cultivated fields and pastures in adjacent areas. In the sites in the Ribeirão Preto region, the tree height varied from 8 to 20 meters, with an average of 16 meters, and fragments of forest ranged from 2.5 to 75 hectares, with a mean of 40 hectares. All the fragments were riparian forests, extending up to 50 meters away from the riverbanks. In the sites in São José do Rio Preto, the mean tree height was 12 meters, and the wooded areas ranged from 2 to 31 hectares (mean: 11 hectares). All the fragments were mesophilic forests, ten of which located less than 50 meters from the Rio Grande and three between 50 and 250 meters from the banks. In the sites located in the Araçatuba region, the trees ranged from 10 to 25 meters high, with an average of 15 meters, while the areas varied from 2 to 497 hectares (mean: 83 hectares). All the fragments were mesophilic forest and located less than 50 meters from the Rio Grande, except for one, located between 50 and 250 meters from this river. In the sites in the Presidente Prudente region, the trees ranged from 6 to 15 meters high (mean: 11 meters) and the areas ranged from 10 to 600 hectares (mean: 220 hectares). The riparian forests predominat-

Figure 1

Distribution of municipalities with entomological capture sites along the banks of Rio Grande (1) and Rio Paraná (2), State of São Paulo, Brazil.

ed, five of which located within 50 meters from the river, two between 50 and 250 meters, and two between 250 and 1000 meters, with one fragment of mesophilic forest located more than one kilometer from the river.

The captures were performed quarterly over the course of one year, from July 2000 to July 2001 in São José de Rio Preto, Araçatuba, and Presidente Prudente and from July 2001 to July 2002 in Ribeirão Preto. For each site, the captures were performed on three consecutive days by a pair of technicians, one of whom crossed through the forest and the other of whom remained at a fixed point. The capture technicians switched positions every 20 minutes. The capture period was from 9:00 AM to 3:00 PM. The hand net (*puçá*) technique was used to collect adult specimens during flight and electric aspirators or Castro traps to collect winged specimens at their landing sites.

Captured specimens were killed with chloroform vapor and stored in previously prepared entomological cases, with the time and place of capture and the technician's name recorded. Identification of the mosquitoes used the key proposed by Consoli & Oliveira [13] and was conducted by technicians from the Entomology Laboratories of the Regional Services in Presidente Prudente, Araçatuba, and São José do Rio Preto belonging to the Superintendency for the Control of Endemics (SUCEN). Due to the lack of morphological elements to distinguish between *Haemagogus janthinomys* and *H. capricornii*, the two were tabulated jointly as the *janthinomys/capricornii* group. The result of this identification was recorded on a specific form and consolidated in a program prepared for this purpose (SUCEN, 2000).

In order to represent the abundance of genera and species, we calculated the Williams mean as proposed by Forattini [10]. The data analysis used Epi Info v. 6.04.

Results

From 2000 to 2002, 39 sites were studied, resulting in the capture of 389 mosquitoes from genus *Haemagogus* (Table 1). The São José do Rio Preto region showed the greatest abundance and broadest distribution of mosquitoes from genera *Sabethes* and *Haemagogus* (Tables 1 and 2). There was an important presence of *Aedes albopictus* in 30 sites, including all the regions studied and particularly that of São José do Rio Preto (Table 1).

In relation to the species captured, *H. leucocelaenus* accounted for 88.4%, *H. janthinomys/capricornii* 10.8%, and *Haemagogus spegazzinii* 0.8% (Table 1). Specimens from the *janthinomys/capricornii* group, as sylvatic yellow fever vectors, were captured in eight sites, located in the regions of São José do Rio Preto (5), Araçatuba (2), and Ribeirão Preto (1); meanwhile *H. leucocelaenus* was captured in all the regions studied, with a total of 21 sites. In the Presidente Prudente region, genus *Haemagogus* was represented only by *H. leucocelaenus*, limited to two sites. Only 24 specimens were identified as far as genus *Haemagogus*, captured in eight sites in São José do Rio Preto, while for six specimens in Presidente Prudente, identification only reached genus *Sabethes*.

Genus *Sabethes* was represented by five species, of which *Sabethes chloropterus* (recognized as a yellow fever vector) was found only in one site in the Araçatuba region (Table 2). As for the other species from genus *Sabethes*, the species *Sabethes glaucodaemon* was found in the majority of the sites in the regions studied, except for that of Araçatuba. This species accounted for 43.1% of the sabethines captured, with a Williams mean of 14.8 specimens month/man. *S. chloropterus* was captured almost exclusively in the municipality of Cardoso, while *S. glaucodaemon* was widely distributed in the sites in the four regions. The other species appeared only sporadically on the capture days.

Another important finding was that of 416 specimens of *A. albopictus*, sufficiently to demonstrate its wide distribution in rural areas of the State of São Paulo. The 13 municipalities in the São José do Rio Preto region were infested with this species, which totaled 146 specimens or 35.1% of all the total captures in the four regions. In the Presidente Prudente region, this mosquito corresponded to 49.5% of the specimens captured, but concentrated in the municipality of Panorama.

Discussion

The recent reporting of autochthonous human cases of sylvatic yellow fever in the northwestern and western regions of São Paulo State 50 years after the most recent previous report emphasized the need to review receptive factors that could explain the return of sylvatic transmission of this disease. The vector issue is among the factors that most prominently related to the occurrence and frequency of *Haemagogus* populations in relation to ecological changes that substantially affect their natural habitats. In order to address this issue, the current study evaluated elements related to vector capacity.

Different horizontal and vertical dimensions in the forest fragments were studied based on the hypothesis that sylvatic yellow fever vectors might be responding differently to deforestation and ecological instability in the forest remnants. The wooded areas in São José do Rio Preto, which were smaller and had more open tree crowns and a predominant height of 12 meters, and the fragments in Ribeirão Preto and Araçatuba, with maximum heights of 25 meters, showed differential results in the presence and abundance of *Haemagogus* and *Sabethes* mosquitoes.

Sabethines were the most frequently captured mosquitoes, especially *S. glaucodaemon* (Table 2). Despite the supposed involvement of this group in the enzootic maintenance of the yellow fever virus, these are the least studied species in this regard. *S. chloropterus*, considered an important vector for sylvatic yellow fever, occurred with low abundance ($X_w = 0.096$) and in only one site, in the Araçatuba region, where the forest was more preserved as compared to the other areas studied (Table 2), thus appearing not to explain the transmission of the yellow fever virus to humans. In fact, this finding did not coincide with the municipalities where the two cases were reported. This low abundance and the absence of this species in the other areas suggest its lack of adaptation to secondary forests, and although the captures were conducted at the ground level, the species may also have been affected in terms of its acrodendrophilic habits [14,15].

In the São José do Rio Preto region, the *janthinomys/capricornii* group was found in five out of eight sites studied, including those where there was human transmission of sylvatic yellow fever. The group's reduced presence, with a density ranging from 0.03 to 0.24 (Table 1), suggests a response by the group to different degrees of alterations in the habitats. Note that Forattini [16] reported the occurrence of *H. capricornii* in domain *cerrado* (savannah) areas in the State of São Paulo, which supports the suspicion that this species is occurring in this region. Concerning its abundance, our re-

Table 1

Frequency of mosquitoes from the genera *Haemagogus* and *Aedes albopictus* by site, municipality, and administrative region in the State of São Paulo, Brazil, 2000/2002.

Municipality	**Site**	**Species**									
		H. janthynomis /capricornii		*H. leucocelaenus*		*H. spegazzinii*		Total from genus *Haemagogus*		*Aedes albopictus*	
		n	Xw	n	Xw	n	Xw	n	Xw	n	Xw
Ribeirão Preto region		3	0.08	2	0.07	1	0.03	6	0.18	20	0.76
Igarapava	1	0	0.00	0	0.00	0	0.00	0	0.00	7	0.31
Miguelópolis	2	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
	3	0	0.00	0	0.00	0	0.00	0	0.00	2	0.08
	4	0	0.00	1	0.03	0	0.00	1	0.03	3	0.14
Guaíra	5	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Colombia	6	0	0.00	1	0.03	0	0.00	1	0.03	0	0.00
	7	3	0.08	0	0.00	0	0.00	3	0.08	0	0.00
Guaraci	8	0	0.00	0	0.00	1	0.03	1	0.03	8	0.26
São José do Rio Preto region		39	0.84	324	3.71	2	0.07	365	4.33	146	5.89
Icem	9	0	0.00	7	0.20	0	0.00	7	0.20	36	1.13
Orindiúva	10	1	0.10	67	0.80	0	0.00	68	0.83	4	0.65
Paulo de Faria	11	0	0.00	54	0.64	0	0.00	54	0.64	23	0.91
Riolândia	12	14	0.25	52	0.54	1	0.03	67	0.72	3	0.12
Cardoso	13	0	0.00	16	0.24	0	0.00	16	0.24	3	0.11
Mira Estrela	14	11	0.24	3	0.10	0	0.00	14	0.33	1	0.04
Indiaporã	15	0	0.00	3	0.10	0	0.00	3	0.10	20	0.68
Ouroeste	16	3	0.10	27	0.41	0	0.00	30	0.45	2	0.11
Populina	17	0	0.00	2	0.06	0	0.00	2	0.06	3	0.12
Santa Albertina	18	0	0.00	89	0.50	0	0.00	89	0.50	4	0.18
Santa Rita d'Oeste	19	10	0.16	1	0.03	1	0.03	12	0.18	14	0.58
Santa Clara d'Oeste	20	0	0.00	0	0.00	0	0.00	0	0.00	28	1.07
Rubinéia	21	0	0.00	3	0.10	0	0.00	3	0.10	5	0.20
Araçatuba region		3	0.09	14	0.41	0	0.00	17	0.51	44	1.84
Ilha Solteira	22	0	0.00	4	0.12	0	0.00	4	0.12	19	0.75
	23	0	0.00	1	0.03	0	0.00	1	0.03	6	0.29
	24	0	0.00	4	0.10	0	0.00	4	0.10	2	0.07
	25	0	0.00	1	0.03	0	0.00	1	0.03	0	0.00
	26	0	0.00	0	0.00	0	0.00	0	0.00	2	0.07
Castilho	27	1	0.03	4	0.12	0	0.00	5	0.16	10	0.47
	28	2	0.06	0	0.00	0	0.00	2	0.06	0	0.00
	29	0	0.00	0	0.00	0	0.00	0	0.00	5	0.19
Presidente Prudente region		0	0.00	4	0.12	0	0.00	4	0.12	206	2.23
Paulicéia	30	0	0.00	2	0.06	0	0.00	2	0.06	3	0.12
Panorama	31	0	0.00	2	0.06	0	0.00	2	0.06	192	1.73
Presidente Epitácio	32	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
	33	0	0.00	0	0.00	0	0.00	0	0.00	6	0.19
Marabá Paulista	34	0	0.00	0	0.00	0	0.00	0	0.00	1	0.04
Rosana	35	0	0.00	0	0.00	0	0.00	0	0.00	1	0.04
	36	0	0.00	0	0.00	0	0.00	0	0.00	2	0.07
	37	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
	38	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
	39	0	0.00	0	0.00	0	0.00	0	0.00	1	0.04
Total		42	1.01	344	4.31	3	0.10	389	5.14	416	10.74

Table 2

Frequency of mosquitoes from genus *Sabethes* by site, municipality, and administrative region in the State of São Paulo. Brazil, 2000/2002.

Municipality	Site	Species											
		S. chloropterus		*S. glaucodaemon*		*S. albipprivus*		*S. tarsopus*		*S. tridentatus*		Total from genus *Sabethes*	
		n	Xw	n	Xw	n	Xw	n	Xw	n	Xw	n	Xw
Ribeirão Preto region		0	0.00	101	2.34	0	0.00	0	0.00	0	0.00	101	2.34
Igarapava	1	0	0.00	25	0.54	0	0.00	0	0.00	0	0.00	25	0.54
Miguelópolis	2	0	0.00	10	0.24	0	0.00	0	0.00	0	0.00	10	0.24
	3	0	0.00	18	0.38	0	0.00	0	0.00	0	0.00	18	0.38
	4	0	0.00	15	0.37	0	0.00	0	0.00	0	0.00	15	0.37
Guaíra	5	0	0.00	7	0.21	0	0.00	0	0.00	0	0.00	7	0.21
Colombia	6	0	0.00	11	0.25	0	0.00	0	0.00	0	0.00	11	0.25
	7	0	0.00	15	0.35	0	0.00	0	0.00	0	0.00	15	0.35
Guaraci	8	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
São José do Rio Preto region		0	0.00	784	10.26	0	0.00	1.111	2.93	20	0.64	1.915	12.92
Icem	9	0	0.00	31	0.55	0	0.00	0	0.00	1	0.03	32	0.56
Orindiúva	10	0	0.00	38	0.81	0	0.00	1	0.03	1	0.07	40	0.83
Paulo de Faria	11	0	0.00	20	0.48	0	0.00	0	0.00	1	0.03	21	0.51
Riolândia	12	0	0.00	9	0.24	0	0.00	0	0.00	0	0.00	9	0.24
Cardoso	13	0	0.00	37	0.73	0	0.00	1.108	2.83	4	0.13	1.149	3.20
Mira Estrela	14	0	0.00	29	0.62	0	0.00	0	0.00	0	0.00	29	0.62
Indiaporã	15	0	0.00	32	0.60	0	0.00	0	0.00	4	0.10	36	0.66
Ouroeste	16	0	0.00	79	0.99	0	0.00	1	0.03	0	0.00	80	0.99
Populina	17	0	0.00	65	0.81	0	0.00	0	0.00	0	0.00	65	0.81
Santa Albertina	18	0	0.00	140	1.23	0	0.00	0	0.00	1	0.03	141	1.24
Santa Rita d'Oeste	19	0	0.00	169	1.42	0	0.00	0	0.00	3	0.08	172	1.43
Santa Clara d'Oeste	20	0	0.00	29	0.46	0	0.00	1	0.03	3	0.10	33	0.50
Rubinéia	21	0	0.00	106	10.26	0	0.00	0	0.00	2	0.06	108	1.32
Araçatuba region		4	0.10	0	0.00	3	0.08	0	0.00	1	0.03	8	0.21
Ilha Solteira	22	4	0.10	0	0.00	0	0.00	0	0.00	0	0.00	4	0.10
	23	0	0.00	0	0.00	0	0.00	0	0.00	1	0.03	1	0.03
	24	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
	25	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
	26	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Castilho	27	0	0.00	0	0.00	3	0.08	0	0.00	0	0.00	3	0.08
	28	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
	29	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Presidente Prudente region		0	0.00	130	2.25	178	2.95	0	0.00	24	0.29	332	4.82
Paulicéia	30	0	0.00	7	0.18	0	0.00	0	0.00	0	0.00	7	0.18
Panorama	31	0	0.00	28	0.41	46	0.84	0	0.00	2	0.06	76	1.11
Presidente Epitácio	32	0	0.00	1	0.03	9	0.15	0	0.00	0	0.00	10	0.16
	33	0	0.00	16	0.30	0	0.00	0	0.00	0	0.00	16	0.30
Marabá Paulista	34	0	0.00	50	0.63	32	0.62	0	0.00	0	0.00	82	0.99
Rosana	35	0	0.00	0	0.00	6	0.12	0	0.00	0	0.00	6	0.12
	36	0	0.00	6	0.18	84	1.18	0	0.00	0	0.00	90	1.24
	37	0	0.00	11	0.24	0	0.00	0	0.00	0	0.00	11	0.24
	38	0	0.00	8	0.17	1	0.03	0	0.00	0	0.00	9	0.20
	39	0	0.00	3	0.10	0	0.00	0	0.00	22	0.23	25	0.28
Total		4	0.10	1.900	14.84	184	3.03	2.221	2.93	64	0.96	4.373	20.29

sults were similar to findings in Bolivia [17], where *H. janthinomys* was found in low deciduous gallery forests with penetration of sunlight. Fé et al. [18], studying five rural areas in municipalities in the State of Amazonas, found *H. janthinomys* in only two areas and with few specimens. However, despite the low abundance in the areas studied, this species merits attention due to the fact that it has been found under natural conditions with the yellow fever virus and conducting a vertical transmission cycle [19]. In addition, its vector role is emphasized more by its anthropophilic nature than by its abundance [20,21].

Considering the levels of environmental alterations and the remnants of native forest, the data suggest greater capacity by *H. leucocelaenus* to survive the environmental transition phase, as observed in the area studied. This species was found in all the administrative regions that were studied, representing 53.9% of the sites (21/39), with particular emphasis on its presence in the São José do Rio Preto region, that is, in twelve of the thirteen sites with a median abundance ranging from 0.03 to 0.80 (Table 1). It was the most abundant species in the municipalities of Ouroeste ($X_w = 0.41$) and Santa Albertina ($X_w = 0.50$), where the cases of sylvatic yellow fever were reported. In addition, it showed higher frequency as compared to the other species from genus *Haemagogus*. As in the State of São Paulo, reports from the State of Rio Grande do Sul [4] have shown that this species is present in small semi-deciduous forest areas with low tree height surrounded naturally by clearings. *H. leucocelaenus* has a long history of vector competence, having participated in various yellow fever epizootics, which corroborates the hypothesis of its possible involvement in transmission of the sylvatic virus in the State of São Paulo [1,4,11,20]. The report of *H. leucocelaenus* in a yellow fever transmission area in Bolivia [17], located in more open gallery forests, reaffirms that its proliferation occurs in degraded environments and those where humans circulate. All these reports indicate that this species may potentially predominate in forests with various degrees of degradation. In northwestern and western São Paulo State, *H. leucocelaenus* proved to be more capable of occupying the niches created by the degradation of natural environments and may thus indicate a significant potential for the species' adaptability. Under these circumstances and in some locations, this species could play an important vector role.

The wide distribution of *A. albopictus* in the regions studied, with a high abundance in various locations in all the regions, including an overlap with the epizootic yellow fever area, poses the possibility of contact between this mosquito and the yellow fever virus in its natural cycle, allowing transfer of the sylvatic agent to periurban and urban areas. In studies on the infectivity of *A. albopictus* in various Brazilian regions, Lourenço-de-Oliviera et al. [22] showed that in laboratory this species presented high yellow fever virus infection rates. Confirmation of its vector competence, added to its capacity for dispersion and higher densities in transition areas for sylvatic yellow fever, combine to recommend further studies to evaluate the vector role of *A. albopictus* in order to subsequently measure the odds of transferring the yellow fever virus to urban areas. This is corroborated by reports by Chiaravalloti et al. [7] in São José do Rio Preto and Gomes et al. [23] in Bataguassu, Mato Grosso do Sul.

Finally, it appears evident that the ecological succession resulting from changes in the forest environment has favored *H. leucocelaenus*. Thus, the maintenance of natural yellow fever foci in the region includes participation by this species and the *janthinomys/capricornii* group, especially in the São José do Rio Preto region. Consequently, these species are suspected of being involved in the transmission of the two recent cases of sylvatic yellow fever. In addition, the epizootics recorded in the South of Brazil, with isolation of the virus in *H. leucocelaenus* [4], supports the reasoning that such epizootics reflect these changes in the disease's ecology. Furthermore, the results of the current study allow expanding the classification of risk areas for yellow fever transmission in the State of São Paulo and should also be useful for defining a more adequate strategy to protect the resident communities in these areas.

Resumo

O registro de dois casos autóctones de febre amarela silvestre no Estado de São Paulo, Brasil, em 2000, desencadeou investigações entomológicas com o objetivo de verificar a ocorrência das espécies vetoras em ambientes florestais próximos ou associados às zonas ribeirinhas, situados nas regiões oeste e noroeste do Estado. As capturas foram realizadas em 39 localidades distribuídas por quatro regiões do Estado. Haemagogus leucocelaenus *e* Aedes albopictus *foram as espécies mais abundantes e capturadas em todas as regiões.* H. leucocelaenus *foi a espécie mais abundante nos municípios de Santa Albertina e Ouroeste, onde os casos de febre amarela silvestre foram registrados. Mosquitos do grupo janthinomys/capricornii foram encontrados em oito localidades de São José do Rio Preto, enquanto* Sabethes chloropterus *uma única vez em localidade de Ribeirão Preto. Ficou evidenciada a aptidão de* H. leucocelaenus *para adaptar-se a ambiente secundário e degradado. Nossos resultados apontam para uma ampla área receptiva para a transmissão de febre amarela, com destaque para a possibilidade de* H. leucocelaenus *estar envolvido na manutenção deste foco silvestre da doença.*

Febre Amarela; Culicidae; Insetos Vetores; Entomologia

Collaborators

V. L. F. de Camargo-Neves participated in all the stages of the study, including its original conceptualization, design, overall coordination, interpretation and analysis of the results, and final drafting of the article. D. W. Poletto, L. A. C. Rodas, and M. L. Pachioli participated in the design and were responsible for the entomological captures in the Araçatuba region, identification of the insects from Araçatuba and Ribeirão Preto, and data compilation from the region. R. P. Cardoso and S. A. S. Scandar participated in the design and were responsible for the entomological captures in the São José do Rio Preto region, identification of the insects, and data compilation from the region. S. M. P. Sampaio and P. H. Koyanagui participated in the design and were responsible for the entomological captures in the Presidente Prudente region, identification of the insects, and data compilation from the region. M. V. Botti coordinated the captures in Ribeirão Preto. L. F. Mucci was responsible for combining the databases, and interpretation and discussion of the results. A. C. Gomes participated in the design, interpretation, and discussion of the results and drafting and final revision of the article.

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