Anthropophilic activity of *Aedes aegypti* and of *Aedes albopictus* in area under control and surveillance

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Abstract

Objective
To describe the hematophagous activity of *Ae. aegypti* and *Ae. albopictus* in an area under control and surveillance.
Methods
The study was conducted during 18 months, from April, 1993 to October, 1994, in Cosmópolis, São Paulo state, Brazil. Human baits were used to collect mosquitoes. The number of females captured is presented monthly by area of the city and local in the household. The rainfall was measured and indices are presented without model adjustment.
Results
The presence of females of both species was observed in 83% (*Ae. albopictus*) and 61% (*Ae. aegypti*) of the period studied. The months of January, February and March presented the highest rates of activity for females of both species, with *Ae. albopictus* being more frequently captured than *Ae. aegypti*. Both species were captured in central and peripheral areas of the city, during the day from 9 to 12 am and from 4 to 7 pm. By a Poisson regression, it was observed that *Ae. albopictus* females were more frequently captured in the peri-housed area, in an independent way considering the area of the city.
Conclusions
It has been identified difference on the hematophagous activity only for *Ae. albopictus*, being of importance the outside area of the house.

INTRODUCTION

In populations of Culicidae mosquitoes, the activities related to feeding on blood involve a complex interaction of physical, chemical and biological factors that are connected to the life cycles of the species.[2] The anthropophilia of *Aedes aegypti* is well known[13] but the spatial distribution pattern of its hematophagous activity is not uniform across the different localities infested, since it is modulated by the characteristics of the various natural and artificial environmental factors.

The females of *Aedes albopictus* utilize a wide spectrum of animals as hosts, including man. However, studies for identifying what its main food source is stumble against the variability of possible situations that, together with its eclectic feeding habits, characterize it as an opportunistic species.[9,13,14]

In addition to the natural factors, there are aspects related to chemical, environmental and educational interventions, which are important in altering behavior, as already described for *Anopheles darlingi* when subjected to control by organochlorine insecticides.[6]

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In Brazil, studies on the feeding activity of *Ae. aegypti* and *Ae. albopictus* have been infrequent and even absent in the geographical areas subjected to chemical and environmental control.

Among the characteristics of mosquito species, it is known that their abundance and reproduction are favored by the period of the year corresponding to the hot and rainy seasons.[10,13]

Chadee & Cobert[5] described the influence of the home microenvironment on the species *Ae. aegypti*. For *Ae. albopictus*, the home does not appear to have importance, since this mosquito predominantly seeks shelters and reproduction locations that are preferentially situated in outdoor sites with protection and shade.[9]

With regard to controlling these species in the State of São Paulo, the measures developed through the official programs for mosquito combat utilize chemical substances of various molecular structures to kill larva and adults.[12] In the municipality of Cosmópolis, mosquito breeding sites were removed, or insecticide was applied to them. This specific interference in the urban domestic environment had the objective of eliminating *Ae. aegypti*, as a preventive measure against the transmission of the arbovirus of dengue fever and yellow fever.

Ae. aegypti and *Ae. albopictus* are exotic and sympatric species that have hematophagous activity within the environment of human habitation. Hence, the objective of the present study was to describe their behavioral characteristics in the light of the changes imposed by the control activities.

METHODS

The study was performed over an 18-month period, from April 1993 to September 1994, within the urban zone of the municipality of Cosmópolis (23º38' south; 47º10' west), in the State of São Paulo. The city has 10,200 premises, which are predominantly residential, according to information from the Brazilian Institute for Geography and Statistics (*Instituto Brasileiro de Geografia e Estatística* - IBGE) for the year 1991. The city lies on flat terrain and contains many potential natural resting sites (trees) for the species studied.

To describe the behavior of *Ae. aegypti* and *Ae. albopictus*, the city of Cosmópolis was divided into two areas, central and peripheral, with similar numbers of houses. For each month of the study, mosquitoes were captured at two houses, one in the peripheral area and one in the central area, thus totaling 18 houses in each area studied and 36 overall.

The observation of the blood feeding process was done once a week, with the collection of females by using two people as human bait, during the morning, from 9:00 a.m. to 12:00 noon, and in the late afternoon, from 4:00 p.m. to 7:00 p.m. It was established that one technician would always be positioned inside the home and the other outside. This scheme was followed throughout the study. For the statistical analysis, the specimens captured each week were summed, month by month.

The technique using human bait was utilized at that time because there had not yet been any record of the transmission of the dengue fever to humans. The method consisted of catching all the mosquitoes that landed on the collectors' clothes, using an electric suction device. Every hour, the specimens collected were killed using chloroform vapor and were packed in entomological boxes for transportation to the laboratory for identification.

While this study was being performed, the municipal health department of Cosmópolis was undertaking a health program. This included the collection of debris throughout the city and focal treatment of receptacles using temephos-based larvicide.[12] In addition to this, "trawls" were taking place to remove any objects that could accumulate water and serve as breeding sites for these two vectors. These measures were supplemented with educational activities for the community, by means of talks for the community and school students and distribution of informative materials.

A rain gauge was installed at the city's water supply station, to record the daily quantities of rainfall. The data are presented graphically, in millimeters of rainfall per month.

For the statistical analysis, the numbers of specimens captured during the month was considered according to the area of the city and whether caught inside or outside the home. The analysis consisted of time series graphs of the numbers of females of *Ae. aegypti* and *Ae. albopictus* captured and the rainfall index, per month. The importance of the area of the city, the location in relation to the home and the period of the day, with regard to the numbers of females caught, was investigated by means of Poisson regression, in univariate and multivariate analysis.

RESULTS

Females of *Ae. albopictus* and *Ae. aegypti* were collected in 83% (15/18) and 61% (11/18) of the months studied, respectively. No females of *Ae. aegypti* were caught during the months of April,

September, October and November 1993 and June, July and August 1994. During another nine months, females were captured in quantities ranging from one to six specimens per month, and there were peaks of 14 and 15 specimens in the months of January and March 1994. With regard to females of *Ae. albopictus*, none were caught in the three months of September 1993 and August and September 1994. During another 11 months, there was a maximum capture of eight specimens per month, with greater abundance during the months of April 1993 and January, February and March 1994. The maximum number of specimens caught was 61, during January 1994 (Figure).

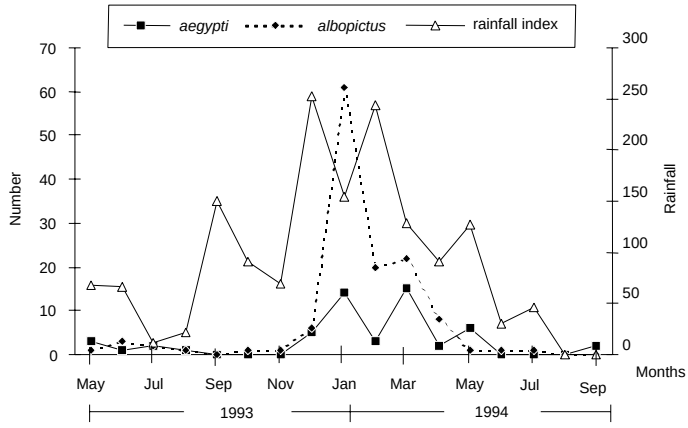

Figure - Monthly distribution of females of *Aedes aegypti* and *Ae. albopictus* captured and average rainfall. Municipality of Cosmópolis, April 1993 to September 1994.

It was only during the months of September 1993 and August 1994 that no females of either species were captured. In all other months, there was the presence of at least one of them. Even though the number of females of *Ae. albopictus* captured was greater, there was a simultaneous rise in the capture rate for the two species in January and March 1994 (Figure).

Rainfall occurred in all months of the study period, with the single exception of September 1994. The rainfall tended to be greater between May 1993 and February 1994, with fluctuations. The greatest rainfall occurred in December 1993 and February 1994. After February 1994, there was a declining trend in the rainfall, culminating with zero rainfall in September 1994 (Figure).

As shown in the results presented in Table 1, a total of 54 females of *Ae. aegypti* and 177 of *Ae. albopictus* were caught in the central and peripheral areas, inside and outside the homes, during the two periods of the day.

Greater presence of females of *Ae. albopictus* than of *Ae. aegypti* was observed both in the central and peripheral areas of the city. The females of *Ae. albopictus* were found in greater numbers outside the homes, thus differing from the females of *Ae. aegypti*, which were found in similar numbers inside and outside the homes. The data on the capture distribution according to the period of the day are presented in Table 1. The data from univariate analysis of capture distribution suggested greater presence of the vectors during the afternoons. However, after multivariate analysis, it was seen that there was no difference between the periods of the day in relation to the presence of females of the species (Table 2).

DISCUSSION

Control measures for diseases transmitted by arthropods have the objective of reducing the vector density for consequent reduction of the incidence of dengue fever. In practice, performing such control aims to ensure the interruption of disease transmission, without harming man and the environment. However, their success runs up against difficulties of an ecological nature and relating to the organization of urban spaces. This is because the same action applied to different localities may present results of differing impact.

The control performed in the city of Cosmópolis was shown to be insufficient for eliminating either of

Table 1 - Distribution of the numbers of females captured, according to species, area of the city, location in relation to the home and period of the day. Cosmópolis, April 1993 to September 1994.

Area/location	*Aedes aegypti*						*Aedes albopictus*					
	Morning		Afternoon		Total		Morning		Afternoon		Total	
	N	%	N	%	N	%	N	%	N	%	N	%
Central area												
Inside home	6	43	8	57	14	100	0	-	6	100	6	100
Outside home	12	36	21	64	33	100	19	25	58	75	77	100
Subtotal	18	38	29	62	47	100	19	23	64	77	83	100
Periférica												
Inside home	1	25	3	75	4	100	1	11	8	89	9	100
Outside home	0	-	3	100	3	100	25	29	60	71	85	100
Subtotal	1	14	6	86	7	100	26	28	68	72	94	100

Table 2 - Prevalence ratios (adjusted and non-adjusted) for females captured, according to species, location in relation to home, area and period of the day.

Variable	*Ae. aegypti*			*Ae. albopictus*		
	Non-adjusted	Adjusted	Prevalence ratio p value	Non-adjusted	Adjusted	p value
Area						
Central	1	1	0.351	1	1	
Peripheral	0.72	0.69		1.04	1.08	0.615
Location						
Inside home	1	1	0.125	1	1	
Outside home	1.57	1.55		1.84	1.88	0.012
Period						
Morning	1	1		1	1	
Afternoon	1.3	1.42	0.224	0.98	1.05	0.800

the two species. From the small numbers of females of *Ae. aegypti* captured, it can be inferred that there had been greater interference in the abundance of females of this species than of *Ae. albopictus*, probably because of the hemisynanthropic nature of the latter. At this point, it is emphasized that the present study did not allow verification that a reduction in the population of *Ae. aegypti* had occurred, although this is a plausible explanation.

The difficulty in controlling the proliferation of *Ae. albopictus* has already been described by Franco-Estrada & Craig Jr[8] who explained this as a consequence of the widespread distribution of its natural and artificial breeding sites. Forattini et al[7] proved that this survival characteristic of the species may be an adaptation response in cities, particularly when these cities have a lot of trees and present a diverse range of microhabitats. These characteristics are applicable to the city of Cosmópolis, regardless of whether considering the center or periphery.

The present study corroborates the theory put forward by Chiaravalloti et al[6] in an evaluation of the spatial distribution of *Ae. albopictus*. They drew attention to the non-uniform occupation of urban areas, and emphasized that the peripheral areas were more frequented by this species. They also pointed to the presence of vegetation as a possible factor favoring infestation by *Ae. albopictus*. Gomes et al,[10] in a study carried out on the urban periphery of the municipality of Tremembé, also reported the influence of vegetation, with the presence of larvae in tree hollows. According to Braks et al,[3] in a study using oviposition traps, the abundance of the two species was similar in suburban areas of Rio de Janeiro and Florida. The present study also revealed a similarity in the capturing of females in the central and peripheral areas of the city, with a difference for *Ae. albopictus*, if the location in relation to the home was considered.

Barata et al,[1] utilizing a manual suction device for catching *Ae aegypti*, described greater abundance of this species inside the home. In the present work, no difference was found between inside and outside the home, although there may have been an influence from the small numbers of specimens captured, with regard to the power of the statistical tests utilized. As expected, the greatest capture of A*e. albopictus* occurred outside the home, thus suggesting greater hematophagous activity preferentially outdoors, even though the homes were not free of its presence indoors.

In the present study, the capture was not differentiated between the morning and afternoon periods, and this does not agree with the findings of Chadee,[4] who described greater peaks of activity among the females in the morning and at the end of the afternoon.

A relationship between rainfall and the reproduction of *Aedes* mosquitoes is known and described in the scientific literature.[10-12] Chiaravalloti[6] observed in a municipality in the western part of the State of São Paulo that the rainy season from November to April was considered to be important for the reproduction of *Ae. albopictus*. In the city of Cosmópolis, no association was indicated between rainfall and the numbers of females captured, which may perhaps be explained by the constancy of rainfall throughout the study period or by the environmental control activities of reducing outdoor container availability.

The present study has revealed the co-occurrence of the two species and has also suggested a difference in the hematophagous activity of *Ae. albopictus*, if the location in relation to the home is considered as an indication of synanthropic characteristic.

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