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MOSQUITO ASSEMBLAGE DIVERSITY IN URBAN PARKS, SÃO PAULO, BRAZIL

[1]ANTÔNIO R. MEDEIROS-DE-SOUSA, [2]DANIEL P. VENDRAMI, [1]ANDRÉ B. B. WILKE, [1]PAULO R. URBINATTI, [1]WALTER CERETTI-JÚNIOR, AND [1,2]MAURO T. MARRELLI

[1]Faculdade de Saúde Pública, Universidade de São Paulo, [2]Instituto de Medicina Tropical de São Paulo, USP, Brazil

Abstract Due to the scarcity of information about the fauna of mosquitoes in the city of São Paulo, Brazil, an investigation was done with the aim of describing the diversity of species present in green areas of municipal parks in the city. Between March 2011 and February 2012, adult and immature mosquitoes were collected in seven parks in the municipality. The collections were once a month, in each park. The species richness was analyzed, Simpson's diversity index (1 - D), abundance of the species of epidemiological interest and similarity of assemblages by Sorensen's qualitative similarity index. Richness ranged between 11-36 species per park. Simpson index ranged between 0.014-0.833. *Culex quinquefasciatus*, *Cx nigripalpus*, *Aedes fluviatilis*, *Ae. scapularis* and *Ae. albopictus* were collected in parks showing relatively high abundance in some. *Ae. aegypti* were scarce or absent in these areas. The similarity between sessions ranged from 0.32 (Anhanguera - Ibirapuera) to 0.8 (Chico Mendes - Ibirapuera).
Key words *Culicidae*, green areas, biodiversity.

INTRODUCTION

Brazil has a considerable richness of *Culicidae* (about 486 described species (WRBU, 2013). Many species, especially those of the genera *Aedes*, *Anopheles* and *Culex*, are important vectors of pathogens in different regions of Brazilian (Forattini, 2002). Currently, there is a great concern among public health agencies such as the emergence or re-emergence of diseases transmitted by culicids and their dispersal in an urban environment (Weissenböck et al., 2010; Weaver, 2013).

In the city of São Paulo, located in southeastern Brazil, there are several fragments of green areas to conserve native or introduced populations of species of flora and fauna, besides conserving springs, streams, lakes and water reservoirs. Much of these fragments are in the urban parks, constantly visited by the population as leisure environments. Some of these parks have vestiges of the Atlantic Forest in the secondary stage of development the remaining parks have gardens area and groves with native or exotic flora species, reflecting different historical interventions (São Paulo - SVMA, 2012).

Studies have indicated relatively high richness and abundance of mosquitoes in urban parks showing that many native and exotic species are able to dwell in these "green islands" as shelter and maintenance of their populations (Taipe-Lagos and Natal, 2003; Montes, 2005; Medeiros-Sousa et al., 2013). Despite these contributions, there are now over a hundred public parks and protected areas scattered throughout São Paulo's city, of which nothing is known about its culicid fauna, either from an ecological or epidemiological perspective.

Due to the scarcity of information about the fauna of mosquitoes in urban parks of the city of São Paulo, and its importance in the dissemination of pathogens to humans, it was developed an investigation with the aim of describing the diversity of species present in urban parks in the city.

MATERIAL AND METHODS

Characterization of the Study Areas

Collections were performed in the urban parks of the city of São Paulo (23.54° W 46.63° S) inserted in the Atlantic forest of southeastern Brazil. Currently, the city has 100 municipal parks, two Areas of Environmental Protection and a Private Reserve of Natural Heritage administered by the municipal government (São Paulo, 2012). Besides these, ten other protected areas lie within the city, administered by the state. For this study selected seven municipal parks: Alfredo Volpi, Anhanguera, Carmo, Chico Mendes, Ibirapuera, Santo Dias and Shangrilá (Figure 1).

Collection and identification of specimens

The Collection has performed in each park during the period March 2011 to February 2012. Adult mosquitoes were captured in the parks using an electric aspirator 12 volt battery (Natal and Marucci 1984), CDC and Shannon traps (Bustamante and Pires, 1951, Gomes et al. 1985). Aspirations were performed at three predetermined areas of the park each lasting about 20 minutes. CDC traps were installed at two points in each park, one in an open area, preferably near the administrative offices or recreational areas, and another in the forest. At each point two traps were placed, one at about 1 meter above the ground and one at 5 meters or more in height. These traps were triggered at the beginning of the twilight and maintained for about three hours. Shannon trap with light gas lamp were installed inside the forest, for two hours after dusk, mosquitoes that landed on the surface of the tent were collected by manual electric aspirator batteries (6 volts battery).

Immature forms were collected using entomological shells (400 ml) in natural or artificial breeding sites as puddles, ponds and water tanks. Removable breeding sites had their content poured into plastic trays and the specimens were collected with pipettes. In the case of vegetable breedings, such as bromeliads, tree holes and bamboo nodes contents were extracted by using a suction pump. All samples obtained at immature stage were maintained in the laboratory until adult emergence.

Morphological identification of specimens was performed at the Laboratory of Entomology of Public Health, School of Public Health, University of São Paulo (LESP/FSP/USP).

Data analysis

We have compared observed and estimated richness (Jackknife 1), Simpson's diversity index (1 - D), abundance of the main species of epidemiological interest and similarity of assemblages by qualitative index of Sorensen. Adults and immature were considered for analysis of total richness and qualitative index of Sorensen, but for the analysis of Simpson's diversity index and abundance of the main species only adults were considered, since the aggregate distribution of immature of many species of culicids could cause biases in this type of analysis.

RESULTS AND DISCUSSION

Based on samples taken at each park culicid richness observed ranged from 11 species in the Ibirapuera park to 36 species in the park Anhanguera. The estimate of the total richness, based on Jackknife 1, showed that only in Anhanguera and Shangrilá parks not get an approximation of the asymptote, unlike other parks surveyed (Figure 2). The park Anhanguera has a much larger area than other parks, with 9.5 million square meters, with different types of forest formations like Atlantic forest remnants, dry fields,

Figure 1. Map of the city of São Paulo (23.54° W - 46.63° S) indicating the location of the seven urban parks where the culicid collections were performed.

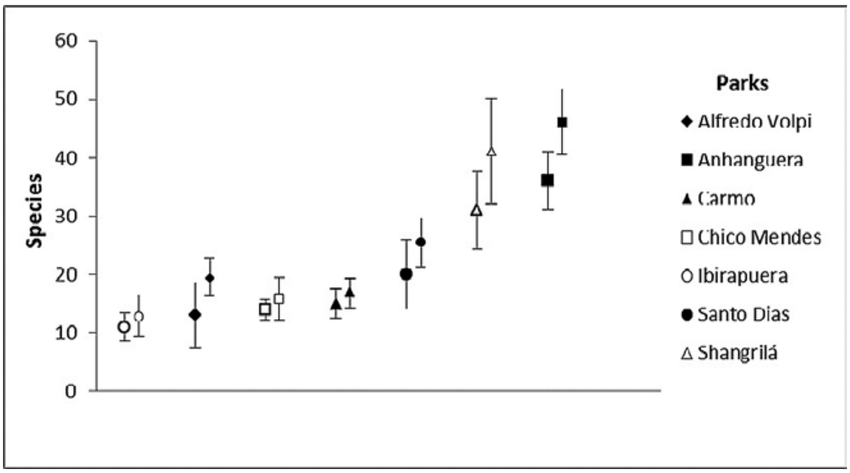

Figure 2. Observed richness (larger symbols) and estimated richness by Jackknife 1 (smaller symbols), with a confidence interval of 95%, to culicids of seven urban parks of the city of São Paulo, in sampling from March 2011 to February 2012.

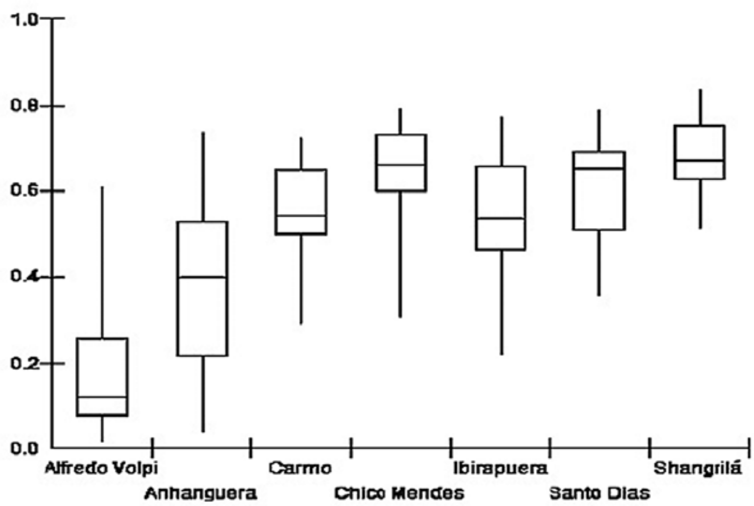

Figure 3. Box plot containing the median, first and third quartiles and variation (whisker) on values of the Simpson's diversity index (1-D) from culicid adults in seven urban parks of the city of São Paulo in samples taken from March 2011 to February 2012.

swamps, forests of *Eucalyptus* sp. and garden areas, this heterogeneity can provide various breeding sites and allow a greater number of species occur in this park. In turn, the Shangrilá Park, although smaller in extent, with 75,000 square meters, is located on the edge of the water reservoir Billings, within an area of environmental protection with over 90 million square meters. These characteristics may be responsible for greater culicids richness in these two parks. Taipe- Lagos and Natal (2003) and Montes (2005) had already demonstrated high mosquito richness in peripheral green areas of the city.

The Simpson's diversity index showed values ranging from 0.014 to 0.833 in the Alfredo Volpi and Shangrila parks respectively, these two values were obtained in December 2011. Shangrilá park showed the highest diversity and lower variation values over the year of collection (0.511-0.833). The most significant differences were observed in the Anhanguera park (0.035-0.733), low values of Simpson's index in this park are due to a high abundance of *Culex nigripalpus* compared to other species, mainly between the months September to December 2011. Alfredo Volpi showed low values of diversity because of the presence of few species per collection and because the high abundance of *Aedes fluviatilis* (87.4% of total samples in the park). Other parks showed intermediate values with a relative influence of the dominant species (Figure 3). Regarding the Sorensen's qualitative similarity index, the values ranged from 0.32 (Anhanguera - Ibirapuera) to 0.8 (Chico Mendes - Ibirapuera) (Figure 4). The Anhanguera and Shangrilá parks showed lower similarity to other parks possibly due to the already mentioned features on these two areas. The other parks are more inserted into in the urban area and probably this characteristic influences the greater similarity in composition and lower species richness.

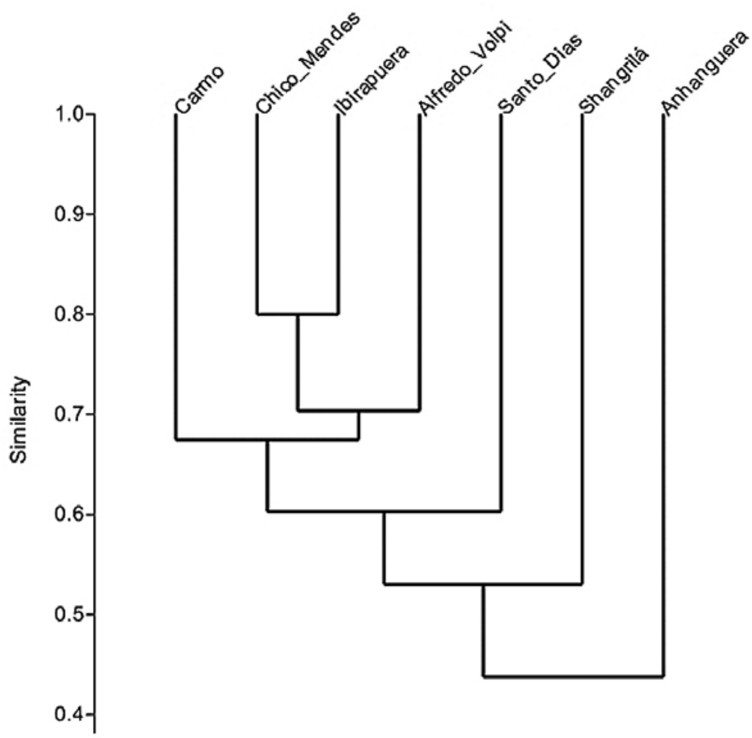

Figure 4. Dendrogram showing the similarity (Sorensen's qualitative similarity index) between the species composition of culicids from seven urban parks in the city of São Paulo in samplings from March 2011 to February 2012.

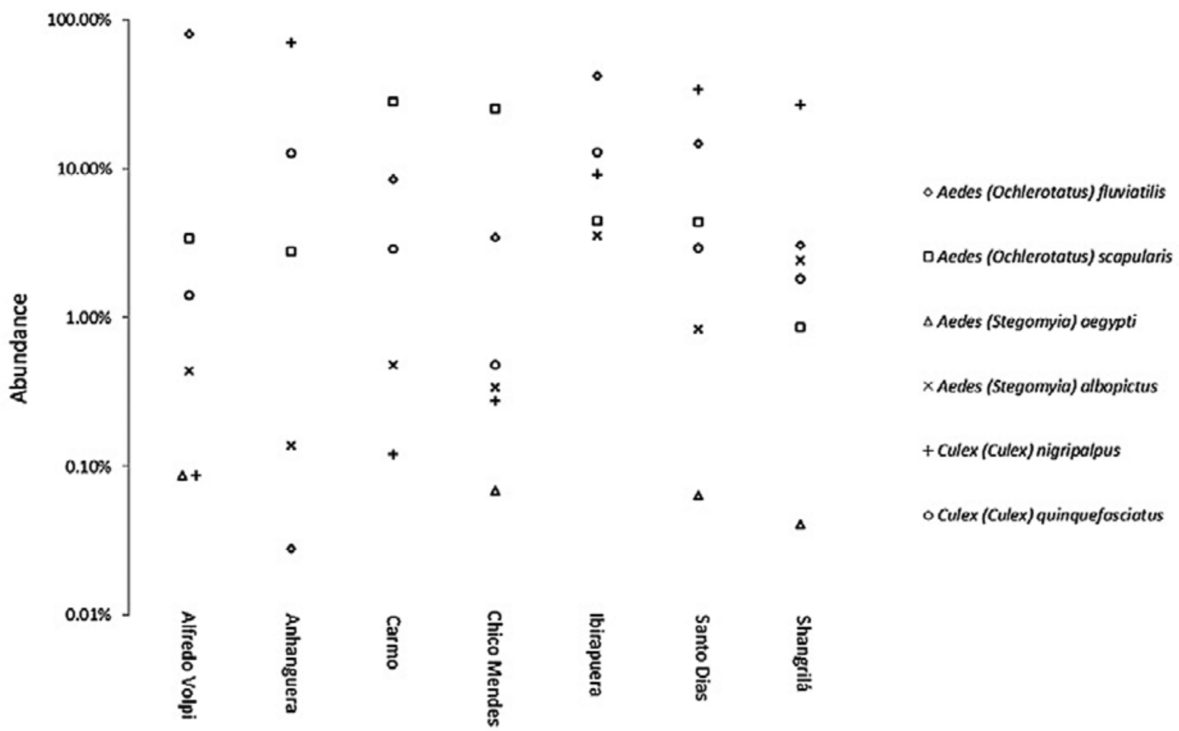

Figure 5. Relative abundance of culicids adults from six species of epidemiological interest collected in seven parks in the city of São Paulo from March 2011 to February 2012.

Some of the species of the epidemiological interest collected in these parks also shown to be quite abundant and frequent, like *Aedes fluviatilis*, *Ae. scapularis*, *Ae. albopictus*, *Cx nigripalpus*, *Cx quinquefasciatus* (Figure 5). These species, besides causing nuisance to people due to their bites, are recognized vectors competent for the transmission of many pathogens, mainly arboviruses (Forattini, 2002; Weissenböck et al., 2010; Fontes et al., 2012; Weaver, 2013). *Ae. Aegypti* presented low abundance or absent in these areas, possibly because this species is highly anthropophilic, preferring the domestic environment of the surroundings (Forattini, 2002).

There is a permanent risk that visitors, employees and the people who live or work in the surrounding of the parks come into contact with emerging or reemerging pathogens circulating in these environments. The knowledge of the Culicidae fauna and its diversity in urban parks can contribute to the effectiveness of monitoring and control methods, preventing transmission cycles of pathogens established in this environment. Future analyzes based on these data will help to understand the role that urban fragments of green areas have much to preserve biodiversity on the one hand and host species of epidemiological interest on the other side.

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