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Biodiversity of culicidae in a fragment of Atlantic forest, Sao Paulo State, Brazil

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Abstract
A mosquito faunal survey was conducted from April/2016 to October/2016 in the Butantan Institute park of Sao Paulo City, Brazil. A total of 12 species grouped into seven genera were collected (*Aedes*, *Culex*, *Limatus*, *Ochlerotatus*, *Psorophora*, *Toxorhynchites*, and *Wyeomyia*). The artificial larval habitats found here were colonized by a great diversity of species, thus human artifacts left by the public in the area that collect water may promote an increase in mosquito populations. Among the species collected, some are known or suspected vectors of pathogens to humans and/or veterinary relevance, and it deserves attention for future studies.

Keywords: Mosquito, urban park, immature, diversity

1. Introduction
Members of the Culicidae family, popularly known as mosquitoes, have a global distribution and have recently attracted a lot of attention in the field of public health, as they are involved in the transmission of various pathogens in humans and other animals [1]. Currently, approximately 3,500 species have been described [2], most of which are endemic to the Neotropical region [3]. Knowledge of the distribution and abundance of mosquitoes in primary Atlantic Forest remnants typical of Brazil is of great importance for understanding the eco-epidemiology of mosquito-borne diseases [4]. Despite this fact, most entomological studies have mainly focused on species such as *Aedes aegypti* (Linnaeus 1762) and *Aedes albopictus* (Skuse 1895), which are exotic in Brazil. Research on the diversity of mosquitoes in their natural environment may reveal unknown habits of these vectors [5].
The Butantan Institute (Instituto Butantan) is a research center in Sao Paulo, Brazil, surrounded by a park comprising 80 ha with more than 62% of green area. The park is situated in a large fragment of the Atlantic Forest surrounded by urban areas. Although the mosquito fauna of Sao Paulo is scarcely known, some local surveys indicate high mosquito frequency in specific areas [6, 7, 8]. To increase the knowledge of the biodiversity and identify larval habitats used by immature mosquitoes in this place, we conducted an entomological survey in multiple areas within the park of the Butantan Institute. Such knowledge is important, because it enables an evaluation of the impact of anthropogenic activities in this region. The main objective of this study was to identify the immature and adult Culicidae specimens in different collection sites inside the park and describe the population in terms of species richness and composition.

2. Materials and Methods
The Culicidae fauna were sampled from April/2016 to October/2016. We collected immature mosquitoes using traps such as small plastic pots or bamboos containers distributed in approximately 40 sites within the green area (Figure 1). Besides, ten natural and artificial breeding sites found around the Institute park were also sampled. Adults were collected using suction tubes (mouth aspirators) and Shannon traps. All collections were made during the daytime. The specimens were transported to the laboratory; to improve the identification accuracy, immature forms were allowed to develop into adults. Specimens were identified at the Entomology Laboratory of the Faculty of Public Health – University of Sao Paulo (USP) and morphological identification was based on Forattini [1].

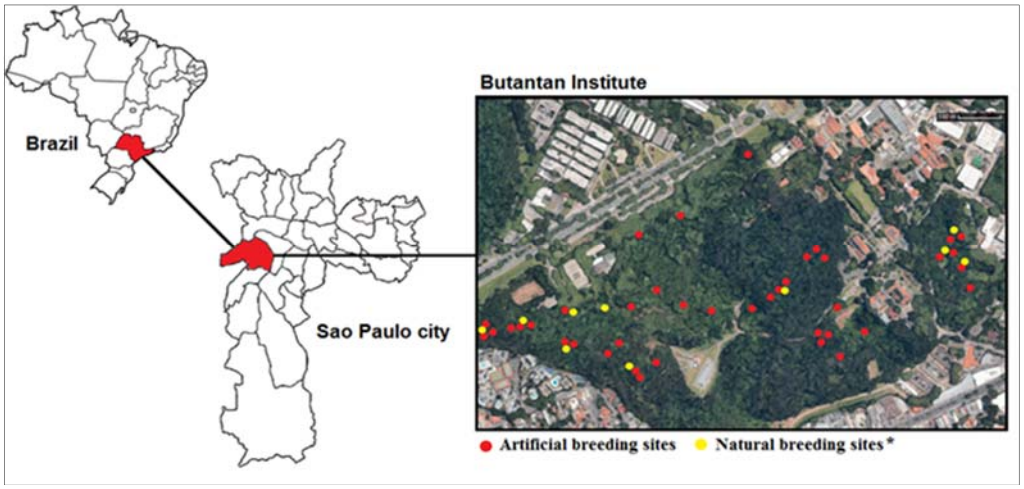

Fig 1: Location of study area and sampling sites in the Butantan Institute, Sao Paulo Brazil. *Natural breeding sites: temporary ground water and phytotelmata bromeliads.

3. Results & Discussion

Over the sampling period, 12 different species belonging to seven genera were collected (Table 1). Some of these species are recognized vectors of human disease, e.g., *Ae. aegypti* and *Ae. albopictus*. *Culex dolosus* (L. Arribálzaga 1891) was the dominant species (43.2%) and colonized the highest number of larval habitats, followed by *Ae. albopictus* (15%). Other species with low abundance (<1%) included *Ae. serratus*, *Ae. crinifer*, *Culex pleuristriatus*, and *Toxorhynchites* sp. When we compared these results with the results of other studies conducted in parks in Sao Paulo, we noticed that the species richness of the Butantan Institute park was relatively low. According to Medeiros-Souza *et al.* [8], other state parks yielded more than 25 species, in contrast to just 12 species found in our study. Keesing *et al.* [9] have stated that biodiversity loss could affect the transmission dynamics of infectious diseases. From this eco-epidemiological viewpoint, studies that seek to explain the role of urban green fragments in the incidence of vector-borne disease are of great relevance [8].

Table 1: Total numbers of immature and adult mosquito specimens collected in Butantan Institute (Brazil) from April/2016 to October/2016.

Species	Collection site*	Adults	Immatures	Total (%)
Culex dolosus	A/N	15	103	43.2
Aedes albopictus	A	6	35	15.0
Culex coronator	A/N	10	29	14.3
Limatus durhami	A/N	13	18	11.4
Psorophora ferox	N	2	13	5.5
Ochlerotatus scapularis	A/N	2	8	3.7
Aedes aegypti	A	8	3	4.0
Aedes serratus	N	-	2	0.72
Aedes crinifer	N	-	1	0.36
Culex pleuristriatus	N	-	1	0.36
Wyeomyia theobaldi	N	2	1	1.1
Toxorhynchites sp.	N	-	1	0.36
Total		58	215	100

* A = Artificial breeding sites; N = Natural breeding sites

The larval mosquito community was found in artificial habitats, temporary ground water, and phytotelmata bromeliads. Some mosquito species that develop quickly, such as *Ochlerotatus scapularis* (Rondani 1848) and some *Culex* and *Psorophora* mosquitoes as those found in this study can exploit habitats like temporary rain pools that, depending on temperature conditions, may only last for a few days. Regarding Sabethini mosquitoes, some studies showed that *Limatus durhamii* (Theobald 1901) was the species best adapted to the urban environment, with a high potential for domiciliation and adaptation to different types of artificial larval habitats [4]. Lourenço-de-Oliveira *et al.* [10] have found immature *Li. durhamii* exclusively in artificial containers in peri-urban areas of the city of Rio de Janeiro. Consistently, in Instituto Butantan 80% of *Li. durhamii* larvae were collected from artificial containers.

In the present study, *Psorophora ferox* (Von Humboldt 1819) were collected exclusively in ground water, and mostly in temporary waters. This species lay eggs that can tolerate drought conditions and may remain viable for several years or until the next flood event [11], a strategy that would allow them to colonize recently formed ground pools and that is common to all species of Psorophora in general [1].

4. Conclusions

In general, the artificial larval habitats found in Instituto Butantan were colonized by a great diversity of species, thus human artifacts left by the public in the area that collect water may promote an increase in mosquito populations. Among the species collected, some are known or suspected vectors of pathogens to humans and/or veterinary relevance, and it deserves attention for future studies.

5. Acknowledgments

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