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Does Native Bromeliads Represent Important Breeding Sites for *Aedes aegypti* (L.) (Diptera: Culicidae) in Urbanized Areas?

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Abstract

This study evaluates the importance of native bromeliads growing on rocky outcrops interspersed with urbanized areas as breeding sites for the *Aedes aegypti* (L.) in Vitória, state of Espírito Santo, Brazil. Oviposition traps were installed in backyards of houses in two separate zones. In the first zone houses were up to 50 m away from the rocky outcrops, while in the second zone they were at least at 200 m from the rocky outcrops. *Aedes aegypti* was significantly more abundant in the latter zone. The finding was that rocky outcrops with native bromeliads, even with the greater availability of potential breeding sites, do not play an important role as breeding sites for *A. aegypti*. This conclusion supports the hypothesis that the macrobiota of native bromeliads plays an important role in the natural control of *A. aegypti*. Besides, the interspecific competition between species of mosquitoes and the attractiveness of bromeliads could also be important factors.

Introduction

The African mosquito *Aedes aegypti* (L.) became adapted to artificial breeding habitats, accompanying human migrations throughout the tropics and subtropics (Barrett & Higgs 2007). Its preferred breeding sites include artificial containers that allow rainwater to accumulate, particularly in areas of high human population density (Mazine *et al* 1996). In Brazil, *A. aegypti* acted as the vector of urban yellow fever in recent decades, and has also been responsible for dengue fever epidemics (Vasconcelos 2002, Braga 2007). Various researchers have reported finding immatures of this species in bromeliads used for urban ornamentation, leading public health authorities to discourage maintenance of these plants in residential areas (e.g. Forattini & Marques 2000, Cunha *et al* 2002). *Aedes aegypti* were also reported in native bromeliads growing on rocky outcrops interspersed with urbanized areas in Vitória, state of Espírito Santo, Brazil (Varejão *et al* 2005). Therefore, the objective of the present study was to evaluate whether native bromeliads in their natural habitat represent important breeding sites for *A. aegypti*. Bromeliads and the human-produced breeding sites in residences close to rocky outcrops would be readily available and more exposed to infestation by *A. aegypti* than those situated at greater distances from these rocky outcrops, if bromeliads prove to be playing an important role as breeding sites for this species.

Material and Methods

The study was carried out in the Vitória neighborhoods of Santa Lúcia and Bela Vista (Fig 1), where *A. aegypti* had already been reported breeding in native bromeliads *Billbergia amoena*, *Billbergia tweedieana*, and *Vriesea extensa* (Varejão *et al* 2005). The climate of the region is defined by the Köppen-Geiger classification as tropical monsoon (Peel *et al* 2007), with a mean annual temperature of 25ºC and an annual precipitation of 1100

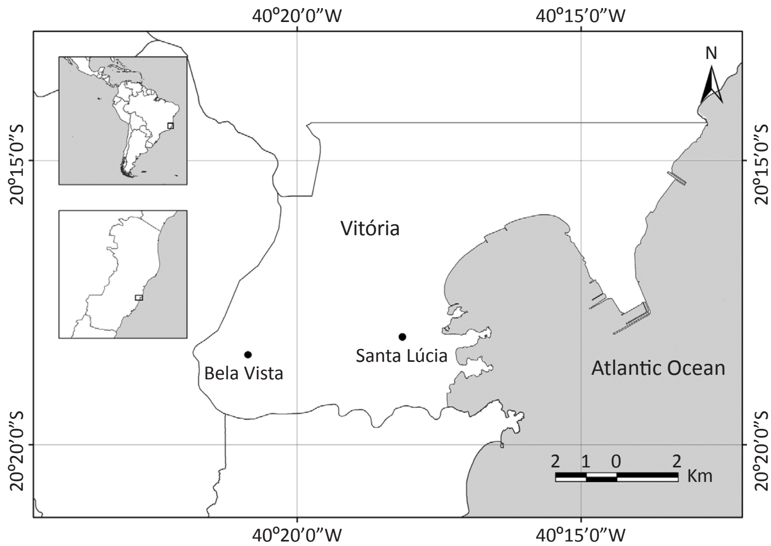

Fig 1 Sampled neighborhoods Santa Lúcia and Bela Vista, located in Vitória, state of Espírito Santo, Brazil.

mm (Hijmans *et al* 2005). The urbanized part of each neighborhood was situated on a plane area, so the density of the residences and their artificial breeding sites close to the outcrops was similar to those in areas that were more distant. During the study, the house infestation index of Santa Lúcia was 1.1 and that of Bela Vista 2.2 (SESA 2008).

Ten houses situated at distances up to 50 m from rocky outcrops (≤ 50 m) with native bromeliads and 10 others at distances beyond at least 200 m from the rocks (≥ 200 m) were randomly selected in each neighborhood. The distance the ovitraps were placed from the rocky outcrops was based on the flight capacity reported for *A. aegypti* (Liew & Curtis 2004, Russel *et al* 2005, Maciel-De-Freitas *et al* 2007). A sample comprising 40 units was included in each survey, and an oviposition trap (ovitrap) was installed in the backyard of each house (Fay & Eliason 1966), as ovitraps are reported to be the most efficient sampling and detection technique for *A. aegypti* (Braga *et al* 2000). Five surveys were conducted between 2007 and 2008, when ovitraps were simultaneously installed in the selected houses every three months. These traps remained exposed for five days each time, after which they were retrieved and transported to the laboratory to allow eggs to be counted, and larvae to hatch for species identification (Consoli & Lourenço-de-Oliveira 1994).

Mosquito samples were distributed among groups, according to species and distances between the rocky outcrops and the traps in which they were captured. Paired-samples *t*-test was applied to the data. This test helps to avoid the influences of the seasons and neighborhood characteristics on the comparisons. The assumption of normality of the data was tested with the Shapiro-Wilk test. If the data contradicted this assumption, a logarithmic transformation was used to correct for normality (Zar 1999).

Results

Of the 200 ovitraps installed during the experiment, 106 were positive, collecting 3,357 eggs. Of these, 979 were collected in ovitraps installed at distances of up to 50 m away from the rocky outcrops and 2,378 in ovitraps at distances of at least 200 m. Of the viable eggs, 723 came from ovitraps at 50 m or closer and 1,739 from ovitraps at 200 m or further away. *Aedes aegypti* and *Aedes albopictus* (Skuse) were collected, and their abundance were similar in ovitraps located up to 50 m from the rocky outcrops (≤ 50 m). Most of the specimens collected at ovitraps located at least at 200 m away (≥ 200 m) were represented by *A. aegypti* (Table 1).

Table 1 Total number (N) and relative abundance (%) of the collected and hatched eggs, and of the *Aedes aegypti* and *A. albopictus* larvae. The eggs were sampled using ovitraps installed at distances up to 50 m and at least 200 m from rocky outcrops in Santa Lúcia and Bela Vista neighborhoods, located in Vitória, state of Espírito Santo, Brazil, 2007 to 2008.

Distance to rocks	Eggs collected N (%)	Eggs hatched N (%)	*A. aegypti* N (%)	*A. albopictus* N (%)
≤ 50 m	979 (29%)	723 (29%)	362 (20%)	361 (59%)
≥ 200 m	2378 (71%)	1739 (71%)	1490 (80%)	249 (41%)
Total	3357 (100%)	2462 (100%)	1852 (100%)	610 (100%)

Data was log transformed, and the paired-samples *t*-test showed a significant difference between the *A. aegypti* groups, indicating their population in areas ≥ 200 m away from the rocky outcrops to be higher than those in areas ≤ 50 m (t = 4.117, P = 0.003; Fig 2). The population of *A. aegypti* in areas ≥ 200 m away was also higher than that of *A. albopictus* either at ≤ 50 m (t = 3.485, P = 0.007) or at ≥ 200 m (t = 4.236, P = 0.002) from the rocky outcrops.

Discussion

Peryassú (1908) first reported the presence of *A. aegypti* in bromeliads used as ornamental plants in urban areas of Rio de Janeiro. Since then, various researchers found the presence of this species in bromeliads cultivated in households, drawing attention to the risk that these plants could pose as additional breeding sites for this and other mosquito species (e.g. Forattini & Marques 2000, Cunha *et al* 2002). In French Guiana, *A. aegypti* was found in bromeliads in the rainforests at distances of about 30 km from the nearest human settlement (Fouque *et al* 2004), and in Brazil it was reported in native bromeliads growing on rocky outcrops in the urbanized areas of Vitória (Varejão *et al* 2005). However, the importance of native bromeliads in their natural habitat as breeding sites for *A. aegypti* was unknown.

Our monitoring of ovitraps distributed nearby and far away from rocky outcrops revealed *A. aegypti* is less abundant in residences situated at distances up to 50 m, as compared with those situated at least at 200 m away from these rocky outcrops. This contradicted the initial expectation that the greater availability of potential breeding sites provided by native bromeliads in the rocky outcrops would facilitate proliferation of this species, raising infestation rates in nearby houses. This finding indicates that rocky outcrops with native bromeliads do not play an important role in providing additional breeding sites for *A. aegypti*. This was also observed in south Florida, USA, and in southern Brazil (O'meara *et al* 2003, Varejão *et al* 2005).

Varejão *et al* (2005) noted a clear predominance of *A. albopictus* in native bromeliads in Vitória municipality, as this species is probably better adapted to preserved habitats. Several authors have studied larval competition between *A. aegypti* and *A. albopictus* , and *A. albopictus* is known to have a greater dispersal capability to more undisturbed habitats. Therefore, *A. albopictus* is able to reach forest margins, while *A. aegypti* is restricted to urban areas (Ho *et al* 1989, Rai 1991, Lima-Camara *et al* 2006).

The high color value (i.e. lightness) of natural bromeliad leaves is likely to deter oviposition by adult *A. aegypti* in favor of competing oviposition sites of lower color value (Frank 1985). Besides, native bromeliads have a rich macrobiota, including natural predators of mosquitoes (Richardson 1999, Armbruster *et al* 2002), including the native bromeliads growing on the same rocky outcrops analyzed in this study (Varejão e*t al* 2005), which may probably play an important role in the natural control of *A. aegypti*.

Despite the abundance of native bromeliads in the rocky outcrops of the study area, it appears that they do not play an important role as breeding sites for *A. aegypti*. On the contrary, significantly lower infestation rates in houses closest to the rocks suggest that plants might act as traps for these insects. The interspecific competition between species and the attractiveness of bromeliads to this species could also be important factors discouraging their presence.

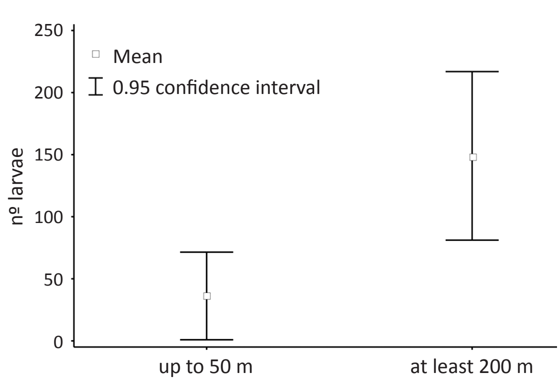

Fig 2 Mean ± 0.95 confidence interval of *Aedes aegypti* larvae hatched from eggs collected using ovitraps installed at distances up to 50 m and at least 200 m from rocky outcrops in Santa Lúcia and Bela Vista neighborhoods, located in Vitória, state of Espírito Santo, Brazil, 2007 to 2008. A paired-samples *t*-test revealed the *A. aegypti* population in areas ≥ 200 m to be higher than those in areas ≤ 50 m (t = 4.117, P = 0.003).

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