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Saúde Pública

Infestation of Palm Trees by Triatomines (Hemiptera: Reduviidae) in the State of Bahia, Brazil

Rodrigo Gurgel-Gonçalves[1]✉, Gilmar Ribeiro Júnior[2] & Eraldo Medeiros da Costa Neto[3]

1. Laboratório de Parasitologia Médica e Biologia de Vetores, Faculdade de Medicina, Universidade de Brasília, e-mail: rgurgel@unb.br (Autor para correspondência✉). 2. Centro de Pesquisas Gonçalo Moniz (CPqGM), FIOCRUZ, Salvador, Bahia, e-mail: gilmarribeirojr@gmail.com. 3. Universidade Estadual de Feira de Santana, Bahia, e-mail: eraldont@hotmail.com.

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Abstract. Palm trees play important roles as breeding and foraging habitats for sylvatic triatomines, vectors of Chagas disease. The occurrence of triatomines in peridomestic palm trees may increase the risk of invasion in households and should therefore be considered to develop prevention strategies. In order to investigate the infestation of palm trees by triatomines in the state of Bahia and to determine their natural infection with *Trypanosoma* spp., we sampled 183 palms in 12 municipalities between 2006 and 2011 using manual capture and/or mouse-baited adhesive traps. Triatomines were detected in 79 palms (43%) such as *Copernicia prunifera*, (Mart.) Becc., *Mauritia flexuosa* L. and *Attalea* spp. (*Attalea burretiana* Bondar or *Attalea salvadorensis* Glassman). In other palm species (*Syagrus coronata* (Mill) H.E. Moore, *Attalea funifera* Mart ex. Spreng, and *Elaeis guineensis* Jacq) triatomines were not detected. *Rhodnius neglectus* Lent, *Triatoma sordida* (Stål), and *Triatoma pseudomaculata* Corrêa & Espínola occurred in *C. prunifera* along the São Francisco River. In western Bahia, *R. neglectus* and *Psammolestes tertius* Lent & Jurberg were detected in *M. flexuosa*, while *Triatoma tibiamaculata* (Pinto) occurred in *Attalea* sp. in urban areas of Salvador on the coast of Bahia. Overall, 180 triatomines were captured, mainly *R. neglectus*. *T. tibiamaculata* had the highest rate of natural infection (61%). The results indicate that at least three species of palms are suitable habitats for triatomines in the state of Bahia and occur in peridomestic environment, what may enhance the probability of triatomine invasion into houses.

Keywords: Arecaceae; Chagas disease; Entomological surveillance; Triatominae.

Infestação de Palmeiras por Triatomíneos (Hemiptera: Reduviidae) no Estado da Bahia, Brasil

Resumo. As palmeiras desempenham papéis importantes como habitats de reprodução e alimentação para triatomíneos silvestres, vetores da doença de Chagas. A ocorrência de triatomíneos em palmeiras peridomiciliares pode aumentar o risco de invasão desses insetos em domicílios e deve ser considerada para desenvolver estratégias de prevenção. Com objetivo de investigar a infestação de palmeiras por triatomíneos no Estado da Bahia e determinar a infecção natural desses insetos por *Trypanosoma* spp., foram amostradas 183 palmeiras em 12 municípios entre 2006 e 2011 utilizando captura manual e/ou armadilhas adesivas iscadas com camundongos. Os triatomíneos foram detectados em 79 palmeiras (43%) das espécies *Copernicia prunifera* (Mart.) Becc., *Mauritia flexuosa* L. e *Attalea* spp. (*Attalea burretiana* Bondar ou *Attalea salvadorensis* Glassman). Em outras espécies de palmeiras (*Syagrus coronata* (Mill) H.E. Moore, *Attalea funifera* Mart ex. Spreng e *Elaeis guineensis* Jacq) não foram detectados triatomíneos. *Rhodnius neglectus* Lent, *Triatoma sordida* (Stål), e *Triatoma pseudomaculata* Corrêa & Espínola ocorreram em *C. prunifera* ao longo do rio São Francisco. No extremo oeste da Bahia, *R. neglectus* e *Psammolestes tertius* Lent & Jurberg foram detectados em *M. flexuosa*, enquanto *Triatoma tibiamaculata* (Pinto) ocorreu em *Attalea* sp. em áreas urbanas de Salvador. No total, 180 triatomíneos foram capturados, principalmente *R. neglectus*. A maior taxa de infecção natural (61%) foi observada em *T. tibiamaculata*. Os resultados indicam que pelo menos três espécies de palmeiras são habitats favoráveis para triatomíneos no estado da Bahia e ocorrem no ambiente peridomiciliar, o que pode aumentar a probabilidade de invasão de triatomíneos nas casas.

Palavras-Chave: Arecaceae; Doença de Chagas; Triatominae; Vigilância entomológica.

Palm trees play important roles as breeding and foraging habitats for sylvatic triatomines, vectors of Chagas disease, especially for *Rhodnius* Stål species (Lent & Wygodzinsky 1979). The distribution of these triatomines in Latin America coincides with the distribution of palms (Gaunt & Miles 2000; Abad-Franch *et al.* 2009; Gurgel-Gonçalves & Cuba 2009).

In Brazil, high rates of palm infestation by triatomines have been reported (Barretto *et al.* 1969; Miles *et al.* 1983; Diotaiuti & Dias 1984; Pinto & Bento 1986; Bento *et al.* 1992; Teixeira *et al.* 2001; Gurgel-Gonçalves *et al.* 2004a; Sarquis *et al.* 2004; Dias *et al.* 2008; Abad-Franch *et al.* 2009; Dias *et al.* 2010). Moreover, palm trees provide shelter and food for several vertebrates; some of them often sleep and nest in the crown, which favors the maintenance of a steady blood supply for triatomines in this environment (Teixeira *et al.* 2001; Gurgel-Gonçalves & Cuba 2007; Dias *et al.* 2010). Thus, palms have been considered as an ecological indicator of areas where enzootic *Trypanosoma cruzi* Chagas transmission cycles probably occur (Romaña *et al.* 1999; Abad-Franch *et al.* 2010; Gurgel-Gonçalves *et al.* 2012a).

The state of Bahia has the highest triatomine species richness in Brazil (Gurgel-Gonçalves *et al.* 2012b). Additionally, at least 59 native palm tree species occur in Bahia (Lorenzi *et al.* 2004). Some triatomine species recorded in domiciles in Bahia, such as *Triatoma sordida* (Stål) (Carcavallo *et al.* 1998) and *Rhodnius neglectus* Lent (Gurgel-Gonçalves & Cuba 2009), have been also detected in palms from other Brazilian regions suggesting that the origin of some specimens collected inside houses in Bahia is related to the presence of palm trees. In addition, triatomines infected with *T. cruzi*, particularly *Triatoma tibiamaculata* (Pinto), have been frequently found near urban forest remnants

where palm trees are present in the capital city, Salvador (Dias-Lima & Sherlock 2000; Santana *et al.* 2011). The occurrence of triatomines in peridomestic palm trees may increase the risk of invasion in households and should therefore be considered to develop prevention strategies. This study aims to investigate the infestation of palm trees by triatomines in the state of Bahia and to determine their natural infection with *Trypanosoma* spp. These data expand the knowledge of triatomine bugs from Bahia, thus contributing to the design of improved strategies for Chagas disease vector surveillance.

MATERIAL AND METHODS

We sampled 183 palms in 12 municipalities in State of Bahia, Brazil, between 2006 and 2011. The sample covered almost all the mesoregions of the state, and prioritized palm genera with wide geographical distribution (*Attalea*, *Copernicia*, *Elaeis*, *Mauritia*, *Syagrus*) (Figure 1). The identification of palm species was based on Lorenzi *et al.* (2004). Palm trees were distributed between 10 and 500 m away from houses. Sampling was carried out along linear transects (40 to 500 m) with equally spaced points (10 m). At each point, the nearest palm tree was sampled.

Two sampling methods of triatomines were used: manual capture and mouse-baited adhesive traps, similar to those described by Noireau *et al.* (2002). The collection of insects was done with prior licensing from Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio). Ladders and ropes were used to reach the palm tree crowns, from where organic matter, vegetation and abandoned nests were collected and placed into plastic bags. This material was then brought down to the ground and placed over a white cloth to facilitate triatomine search (Gurgel-Gonçalves *et al.* 2003). Additionally, we performed an active search of bugs between the bases of the leaves with a tweezer. This method was used for sampling *Mauritia flexuosa* L., *Copernicia prunifera* (Mill) H.E. Moore, and *Syagrus coronata* (Mart.) Becc. In the case of *Attalea funifera* Mart ex. Spreng we did only active search of bugs between the bases of the leaves and fibers.

Research was approved by the ethics committee on animal use at the State University of Feira de Santana. One to six traps were placed at the base of the leaves on opposite sides of palms. Traps were operated for approximately 16 hours, from sunset until the following morning. *Elaeis guineensis* Jacq. (114 trap-nights), *Attalea* palms (*Attalea burretiana* Bondar and *Attalea salvadorensis* Glassman) (120 trap-nights), *C. prunifera* (45 trap-nights), and *S. coronata* (50 trap-nights) were sampled using this method. Additionally, 16 bromeliads located on the palms or trees near the palms were sampled using the traps (20 trap-nights).

Triatomines were identified to the species level according to Lent & Wygodzinsky (1979). *Trypanosoma* spp. infection was determined by examination of fresh feces obtained by abdominal compression of the triatomine bugs. Parasites were morphologically identified by observation under a light microscope of Giemsa-stained insect feces (Cuba Cuba 1998).

RESULTS

Triatomines were detected in *C. prunifera*, *M. flexuosa* and *A. burretiana*/*A. salvadorensis* (Table 1). Among the 183 palms sampled, 79 (43%) were infested; 180 triatomines were collected (average of 2.3 triatomines per palm). *R. neglectus*, *T. sordida*, and *Triatoma pseudomaculata* Corrêa & Espínola occurred in *C. prunifera* along the São Francisco river. In western Bahia, *R. neglectus* and *Psammolestes tertius* Lent & Jurberg were detected in *M. flexuosa*, while *T. tibiamaculata* occurred in *Attalea* spp. in urban areas of Salvador on the coast of Bahia (Table 1). *R. neglectus* was the most common species in palm trees, representing 66% of the triatomines captured. In the municipality of Ibotirama, where two methods were applied simultaneously to collect triatomines in *C. prunifera*, the efficacy of manual capture (palm infestation = 65% and number of insects/infested palm = 3.3) was higher than that obtained using mouse-baited adhesive traps (27% and 1.25, respectively). No bugs were detected in 16 bromeliads sampled.

Thirteen of the 93 triatomines examined were infected with *Trypanosoma* spp. in *C. prunifera*, *M. flexuosa* and *Attalea* spp. (Table 1). *T. tibiamaculata* had the highest rate of natural infection (61%). The phenotypic identification of the parasites revealed flagellates morphologically similar to *T. cruzi* in palms from Ibotirama and Salvador, but in São Desidério we identified parasites morphologically similar to *T. rangeli* Tejera.

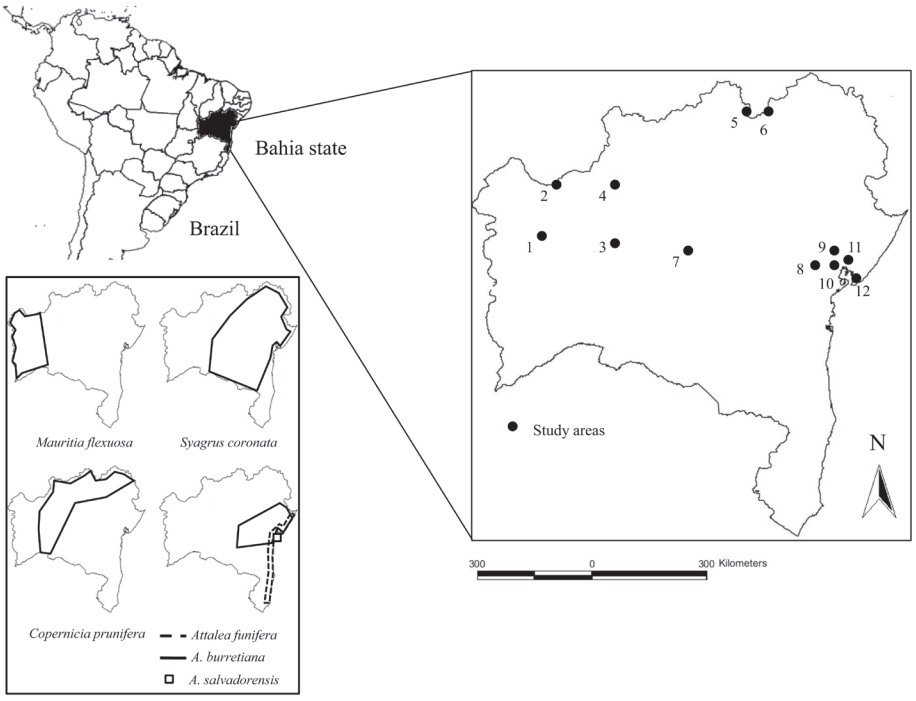

Figure 1. Study areas in the state of Bahia. The geographical distribution of palm species sampled in the study is also presented (modified from Lorenzi *et al.* 2004). Municipalities according to mesoregions of the state: Western Bahia: (1) São Desidério and (2) Santa Rita de Cássia; São Francisco Valley: (3) Ibotirama, (4) Xique-Xique, (5) Juazeiro and (6) Curaçá; Central South Bahia: (7) Seabra; Central North Bahia: (8) Santa Terezinha and (9) Conceição do Jacuípe; Metropolitan Salvador: (10) São Félix, (11) Cachoeira and (12) Salvador. The geographical distribution of the African palm *Elaeis guineensis* was not presented in Bahia, despite being common in the Recôncavo baiano region.

Table 1. Entomological indices of triatomines in palm tree species sampled in 12 municipalities, Bahia, Brazil.

Palm species	Municipality	N palms sampled	Distance to the nearest domicile (m)	Triatomine species	Infested palms (%)	Insects colected	Insects/ infested palm	Insects examined (%)	Insects infected (%)
Mauritia flexuosa	São Desidério	4[1]	200	*Rhodnius neglectus*	3 (75)	15	5	9 (60)	1 (11)[3]
				Psammolestes tertius	2 (50)	32	16	-	-
	Santa Rita de Cássia	11[1]	20	*R. neglectus*	4 (36)	16	4	2 (12.5)	0 (0)
Copernicia prunifera	Ibotirama	23[1,2]	250	*R. neglectus*	13 (56)	50	4	35 (70)	1 (3)[4]
				Triatoma sordida	7 (30)	10	1.4	7 (70)	0 (0)
	Xique Xique	10[1]	300	*R. neglectus*	6 (60)	17	2.8	8 (47)	0 (0)
	Juazeiro	5[1]	30	*R. neglectus*	4 (80)	17	4.2	12 (70.6)	0 (0)
	Curaçá	10[1]	50	*R. neglectus*	2 (20)	4	2	2 (50)	0 (0)
				Triatoma pseudomaculata	1 (10)	1	1	-	-
Syagrus coronata	Seabra	10[1]	500	-	0 (0)	0	-	-	-
	Santa Terezinha	50[2]	10	-	0 (0)	0	-	-	-
Elaeis guineensis	Conceição do Jacuípe	16[2]	250	-	0 (0)	0	-	-	-
	São Félix	14[2]	30	-	0 (0)	0	-	-	-
Attalea funifera	Cachoeira	10[1]	500	-	0 (0)	0	-	-	-
A. burretiana/ A. salvadorensis	Salvador	20[2]	50	*Triatoma tibiamaculata*	2 (10)	18	9	18 (100)	11 (61)[4]
Total		183	200		79 (43)	180	2.3	93 (51.7)	13 (14)

[1]Manual capture, [2]Mouse-baited adhesive traps, [3]*Trypanosoma rangeli,* [4] *Trypanosoma cruzi.*

DISCUSSION

This paper lists the palm tree species associated with triatomines in the state of Bahia, Brazil. The results indicate that at least three widely distributed species of palms are favorable habitats for the maintenance of *R. neglectus*, *T. sordida* and *T. pseudomaculata* populations in western Bahia and the São Francisco valley, and *T. tibiamaculata* populations in the metropolitan region of Salvador. Specimens infected with parasites morphologically similar to *T. cruzi* were detected in palm trees from Salvador and Ibotirama; their proximity to houses may maintain the risk for vector-borne transmission of Chagas disease, as suggested in other regions of Brazil (Miles *et al.* 1983; Sarquis *et al.* 2004; Abad-Franch *et al.* 2009).

The occurrence of *R. neglectus* in *M. flexuosa* and *C. prunifera* palms in the state of Bahia was expected, as the species had been recorded in these palms in other regions of Brazil (Bento *et al.* 1992; Carcavallo *et al.* 1998; Gurgel-Gonçalves *et al.* 2003, 2004a; Abad-Franch *et al.* 2009). The results show that *R. neglectus* is more common in palms of western Bahia and the São Francisco valley. The geographical distribution of this species in these areas had already been predicted based on ecological niche modeling (Batista & Gurgel-Gonçalves 2009), and data from the present study confirm these predictions. Additionally, specimens of *R. neglectus* have been collected in domiciles of northwestern Bahia (Silveira *et al.* 1984). Adult specimens may invade houses by flying from infested peridomestic palms (Castro *et al.* 2010, Gurgel-Gonçalves *et al.* 2012a) or due to passive transport of insects from palm material used in building peridomestic structures.

In addition to *R. neglectus*, *T. pseudomaculata* and *T. sordida* were also recorded in *C. prunifera*, and *P. tertius* in *M. flexuosa*. The presence of these triatomine species in palm trees may be associated with the occurrence of bird nests (Barretto & Carvalheiro 1968; Barretto *et al.* 1969; Gurgel-Gonçalves & Cuba 2007). Although *T. pseudomaculata* and *T. sordida* preferably live under bark, they have also been caught in bird nests (Carcavallo *et al.* 1998). In this study, we show for the first time the co-occurrence of *R. neglectus* and *T. sordida* in the palm *C. prunifera*. In the municipality of Ibotirama, 5 out 13 infested palms were occupied by both species.

The results also show that *Attalea* palms (*A. burretiana* and/or *A. salvadorensis*) are infested by *T. tibiamaculata* in urban areas of Salvador. This species is predominantly sylvatic, occurring naturally in shelters of marsupials and rodents, including bromeliads and palms (Carcavallo *et al.* 1998). However, its presence in domestic environment has been reported in state of Bahia (Dias-Lima & Sherlock 2000; Santana *et al.* 2011).

In the present study, triatomines were not detected in *S. coronata* palms. However, this palm has been described as habitat of *T. sordida* and *Rhodnius nasutus* Stål in Iraquara, state of Bahia (Venâncio 2010). Considering the wide geographical distribution of *S. coronata* in Bahia, there is a need to study a more representative sample of this species to determine its role in the maintenance of triatomine bugs. We did not observe nesting birds or mammals in *E. guineensis*, which might reduce infestation probabilities. In the case of *A. funifera*, the few specimens sampled were young and they also had no evidence of vertebrates in its crowns.

The natural infection rate of *R. neglectus* with flagellates morphologically similar to *T. cruzi* or *T. rangeli* in palm trees obtained in this study (3%) was low compared to other regions of Brazil (Barretto *et al.* 1969; Diotaiuti & Dias 1984; Gurgel-Gonçalves *et al.* 2004b; Abad-Franch *et al.* 2009). However, about half of the specimens captured were not examined because they arrived dead and dried in the laboratory. Recent studies of trypanosomatid detection using molecular tools (Gurgel-Gonçalves *et al.* 2012a) confirmed the infection of *R. neglectus* specimens from São Desidério with *T. rangeli*. Unlike *R. neglectus*, *T. tibiamaculata* presented a high rate of natural infection with flagellates morphologically similar to *T. cruzi*. Molecular characterization of parasites from these triatomines confirmed the phenotypic identification. This high natural infection rate

could be due to the frequent occurrence of many mammals in the crown of *Attalea* palms (Miles *et al.* 1983), including species of *Didelphis* known as natural reservoirs of *T. cruzi* (Ramirez *et al.* 2002; Steindel *et al.* 2008).

In Salvador, human population growth coupled with urbanization has caused the deforestation of the Atlantic forest remnants or a closer contact of the houses with forested areas, where palm trees naturally occur. This may facilitate the invasion of houses by triatomines, which may increase the risk of Chagas disease transmission (Dias-Lima & Sherlock 2000). In Salvador, the Chagas disease Control Program (PCDCh) asks residents to collect and send suspect specimens to triatomine information posts, where insects are identified and infection by *Trypanosoma cruzi* ascertained. According to Santana *et al.* (2011), *T. tibiamaculata* was the species most frequently collected in Salvador between 2006 and 2009; 54% of all triatomines were collected inside houses and 48.6% were infected with *T. cruzi*, indicating the risk of vector-borne or oral transmission (Dias *et al.* 2006).

In conclusion, our data reinforce the idea that the occurrence of peridomestic palms (as in the case of *Attalea* spp. in Salvador and *C. prunifera* in Ibotirama) could help define risk situations at the local level (Abad-Franch *et al.* 2010). Since palms with large amounts of decaying vegetable debris are frequently infested, it has been suggested that cutting down dead leaves and removing epiphytes from palm crowns might help reduce infestation risk (Abad-Franch *et al.* 2005, 2010).

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