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Major Article

Occurrence of *Triatoma costalimai* (Hemiptera: Reduviidae) in different environments and climatic seasons: a field study in the Brazilian savanna

Fernanda Machiner[1], Rebecca Martins Cardoso[1], Cleudson Castro[1] and Rodrigo Gurgel-Gonçalves[1],[2]

[1]. Núcleo de Medicina Tropical, Faculdade de Medicina, Universidade de Brasília, Brasília, DF. [2]. Laboratório de Parasitologia Médica e Biologia de Vetores, Faculdade de Medicina, Universidade de Brasília, Brasília, DF.

ABSTRACT

Introduction: *Trypanosoma cruzi*-infected specimens of *Triatoma costalimai* have been detected in domiciliary units of Central Brazil, thereby maintaining the potential risk of vectorial transmission of Chagas disease. The aim of this study was to determine the occurrence and natural infection of *T. costalimai* in different environments (gallery forest, dry forest and peridomicile) and climatic seasons (wet and dry), in the municipality of Mambaí, State of Goiás, Brazil. **Methods**: Triatomines were captured in October 2010 and in June 2011, employing two different methods (manual capture and mouse-baited adhesive traps). The insects were later separated by sex and nymphal stage, counted and examined parasitologically by abdominal compression and microscopic analysis of feces. **Results**: *Triatoma costalimai* was found in three environments and in the two seasons studied. Overall, capture success of 900 traps and 60 blocks of rocks inspected was 5.8% and 11.7%, respectively. The occurrence of *T. costalimai* was higher among rocks in the peridomicile, where 97% of the 131 specimens were captured. The proportion of nymphs (98%) was much higher than that of adults, which were only detected in peridomicile. Most (95%) insects were captured during the wet season, with predominance of early-stage nymphs. None of the 43 specimens examined were infected by trypanosomatids. **Conclusions**: The results indicate a greater occurrence of *T. costalimai* in peridomiciliary environments and during the wet season in Mambaí, Goiás, highlighting the synanthropic behavior of this triatomine species in one area of the Brazilian savanna and the importance of entomological surveillance.

Keywords: Triatominae. Rocky habitats. *Triatoma costalimai.* Brazilian savanna. Brazil.

INTRODUCTION

After Brazil was declared free from Chagas disease transmission by the domestic vector *Triatoma infestans* (Klug, 1834), the difficulty in consolidating vector control has been the generalized occurrence of wild triatomine species that invade human dwellings sporadically[1,2]. Ecological aspects of these species must be studied for a better understanding and monitoring of the process of domiciliation, which are fundamental for strengthening entomological surveillance.

Among the species of wild triatomines that invade houses in Brazil is *Triatoma costalimai* Verano & Galvão, 1959, the biology of which is poorly understood. This species was described from specimens captured in limestone in peridomiciliary environments in the municipality of Taguatinga, State of Tocantins[3]. *Triatoma costalimai* specimens are still being captured in domiciliary units in municipalities in the southeast of Tocantins[4] and northeast of Goiás[5,6] with significant rates of infection by *Trypanosoma cruzi* Chagas, 1909[7,8], thereby maintaining the potential risk of vectorial transmission of Chagas disease.

In a pioneer study on the ecology of *T. costalimai*, Mello[9] noted the occurrence of this species in rocky habitats adjacent to gallery forests of the Brazilian savanna and also indicated associations of *T. costalimai* with lizards, rodents (*Calomys callosus* Rengger, 1830 and *Trichomys aperoides* Lund, 1839), and marsupials (*Didelphis albiventris* Lund, 1840) in this environment. However, there has been no detailed information regarding the occurrence of *T. costalimai* in other environments (such as dry forests) and in different seasons. Such information may clarify the synanthropic potential of *T. costalimai* and consequently support strategies for the surveillance of Chagas disease vectors in Central Brazil. In this context, the objective of this study was to determine the occurrence and natural infection of *T. costalimai* in rock habitats in different environments (gallery forest, dry forest, and peridomicile) and climatic seasons (wet and dry) in the municipality of Mambaí, State of Goiás, Brazil.

METHODS

Study area

The municipality of Mambaí is located in northeast of Goiás (46º06'36''W, 14º21'48''S) about 320km from Brasília, Federal District, Brazil. It has an estimated population of 6,883 people[10], in an area of 859,555km^2. The municipality is inserted in the speleological district of São Domingos, a karstic region with caves, canyons, cliffs and ruiniform landscapes produced by the geological action of groundwater on soluble rocks[11]. This region has an annual average rainfall of 1,500mm and an average temperature of 23°C. The municipality is inserted in the Brazilian savanna biome, with two distinct seasons: a dry season from May to September, and a wet season from October to April. The latter presents the highest temperature

Address to: Dr. Rodrigo Gurgel Gonçalves. Lab Parasitologia Médica e Biologia de Vetores/Área de Patologia/FM/UnB. Campus Universitário Darcy Ribeiro, Caixa Postal 4569, Asa Norte, 70904-970 Brasília, DF, Brasil.
Phone: 55 61 3107-1786
e-mail: rgurgel@unb.br
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and precipitation values[12]. Savannas, gallery forests and dry forests are found within the municipality[13]. In Mambaí, the entomological surveillance maintains a community participation strategy with a network of triatomines information posts (PITs) in schools and health care units.

Sampling was conducted in three environments: a) dry forests – forests that have no association with watercourses and are characterized by different levels of falling leaves during the dry season; b) gallery forests – forests that follow small rivers and streams, forming narrow corridors over the watercourse and showing no significant falling leaves during the dry season[14]; and c) peridomicile – considered the environment within a radius of 100 meters around a human domicile. All these environments had limestone rock formations, where insects were collected.

Triatomine collection and parasite detection

The insects were collected in October 2010 (wet season) and in June 2011 (dry season). Limestone rock formations present in each environment were georeferenced and blocks of rocks were sampled using two sampling methods for triatomines: manual capture and mouse-baited adhesive traps[15]. Manual capture was carried out in 60 blocks of rocks set in 20 blocks per environment, 10 in each climatic season. The blocks were raised with the support of iron levers, and insects found in crevices and holes between fragments of rock were collected with tweezers. Traps were placed in openings between blocks of rocks late in the afternoon and retrieved early the next morning; they were left in the rocks for approximately 12 hours. A total of 300 traps were set in each environment (150 traps in each season), for a total capture effort of 900 traps (450 traps in each season). We spent three days to capture triatomines in each environment. All insects collected were placed in plastic recipients, properly identified with the place and date of capture. Triatomines were grouped by sex and nymphal stage and identified morphologically with the Lent and Wygodzinsky.[16] key. The parasitological research was conducted through abdominal compression of triatomines and subsequent examination of fresh feces under a light microscope to detect natural infection by trypanosomatids.

Data analysis

In each environment the following entomological data were analyzed: percentage of infested rocks using manual capture; percentage of positive trap-nights; number of triatomines captured; number of triatomines per infested rock; number of triatomines per positive trap; percentage of nymphs captured; percentage of triatomines engorged; number of triatomines examined and infected. Differences between the proportions of insects collected in the different environments and climatic seasons were evaluated using the chi-square test, considering $p<0.05$ as statistically significant.

Ethical considerations

The study followed the Ethical Principles in Animal Experimentation developed by the Brazilian College of Animal Experimentation (COBEA), which were approved by the Ethics Committee on Animal Use at the Faculty of Medicine, University of Brasília (UnB).

RESULTS

The overall capture success of the 900 traps and 60 blocks of rocks surveyed was 5.8% and 11.7%, respectively. *T. costalimai* was the only triatomine species detected. The occurrence of *T. costalimai* differed among the environments sampled; the proportion of positive traps was greater in a peridomiciliary environment compared to gallery forest ($\chi^2=49.0$; $p<0.01$) and dry forest ($\chi^2=43.3$; $p<0.01$). The number of specimens of *T. costalimai* was also greater in rocks in peridomiciliary environments associated to pigpens and henhouses, where 97% of the 131 specimens were captured **(Table 1)**. The proportion of nymphs was much greater than that of adults, which were all males and which were only detected in a peridomiciliary environment. Engorged insects were only detected in peridomicile **(Table 1)**, especially using the manual capture method. None of the 43 specimens examined were infected by trypanosomatids **(Table 1)**.

The occurrence of *T. costalimai* varied by climatic season, as found by both the trapping method ($\chi^2=33.8$; $p<0.01$) and

TABLE 1 - Entomological data of *Triatoma costalimai* in different environments (gallery forest, dry forest and peridomicile) and climatic seasons (dry and wet) in Mambaí, State of Goiás, Brazil, 2010-2011.

	Gallery forest		Dry forest		Peridomicile	
Entomological data	**dry**	**wet**	**dry**	**wet**	**dry**	**wet**
Infestation (%)*	0.0	0.0	0.0	0.0	10.0	60.0
Trap-nights positive (%)**	0.0	1.0	0.0	2.0	3.0	30.0
Bugs captured by trapping (n)	0	1	0	3	5	92
Bugs captured manually (n)	0	0	0	0	1	29
Bugs/infested rock	0	0	0	0	1	5
Bugs/positive trap	0	1	0	1	1	2
Nymphs (%)	***	100.0	***	100.0	66.0	99.0
Engorged bugs (%)	***	0.0	***	0.0	0.0	20.0
Examined bugs (n)	0	0	0	0	6	37
Infected bugs (n)	0	0	0	0	0	0

*number of rocks infested/sampled; 10 blocks of rocks were sampled in each climatic season. **150 trap-nights were used in each climatic season using the manual capture method.***no bugs captured.

the manual capture method (χ^2=4.0; p=0.04). The percentages of positive traps and of blocks of rocks infested by *T. costalimai* were higher in the wet season **(Table 1)**. Moreover, most (95%) insects were captured in the wet season, with a predominance of nymphs I **(Figure 1)**.

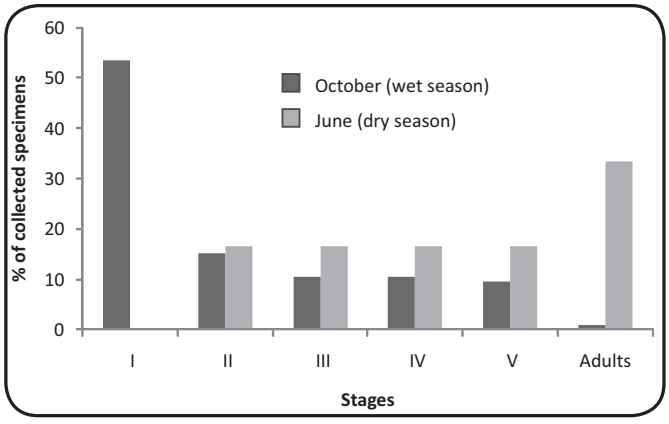

FIGURE 1 - Percentage of specimens of *Triatoma costalimai* collected in Mambaí, State of Goiás in October (wet season) and June (dry season), by stage of development.

DISCUSSION

Limestone rocks had already been reported as habitats for *T. costalimai* in areas of gallery forests in Mambaí, Goiás[9]. Our study confirms the occurrence of *T. costalimai* in this environment and also indicates that the species occurs in blocks of rocks in dry forests and, especially, in peridomiciliary environments. The results also suggest, for the first time, a difference in the occurrence of *T. costalimai* in different climatic seasons in one area of the Brazilian savanna.

Between 1979 and 1981, Mello[9] sampled 22 blocks of rocks by manual collection, obtaining 43 nymphs in 10 of them (insect/infested rock = 4.3). We detected 30 insects in 7 blocks of rocks (insect/infested rock = 4.3), using the same sampling method. The higher occurrence of *T. costalimai* in peridomicile relative to the wild environment (gallery forest and dry forest) is an indicator of the synanthropic potential of this species. In the peridomicile studied, many engorged specimens were found in rocks next to pigpens and henhouses, indicating that *T. costalimai* can feed on domesticated animals such as poultry and pigs. The occurrence of *T. costalimai* inside domiciles was already detected by Oliveira & Silva[6], but there is little evidence of colonies inside human dwellings[17].

According to Lorosa et al.[8], the feeding habits of this species are varied. A number of food sources have been found in the intestinal contents among specimens sampled in northern Goiás, including rodents, opossums, lizards, horses, armadillos and birds. The abundant and continuous food source present in the peridomicile could explain the higher occurrence of *T. costalimai* in this environment. According to Forattini et al.[18], environments with dense vegetation are not favorable for population growth of other species common to the Brazilian savanna, such as *Triatoma sordida* Stål, 1859. The presence of predators and the lower occurrence of continuous food sources (and, therefore, greater competition for food) could limit the development of *T. costalimai* colonies in the wild environment. On the other hand, open areas, changed by human intervention and with the presence of animal breeding, may offer greater opportunities for feeding and development of this triatomine species. Similar studies in other areas of the Brazilian savanna may confirm the differences in the spatial occurrence of *T. costalimai* detected in this study.

Our results showed that most specimens of *T. costalimai* were captured in October, with predominance of nymphs I, indicating the occurrence of reproductive processes and oviposition in the beginning of the wet season. According to Schofield et al.[17], the life cycle of *T. costalimai*, maintained at 27 ± 3º C with 40-80% Rh conditions and fed fortnightly, is over one year. Thus we would expect the emergence of adults in the second semester of the following year. The detection of nymphs II in June does not necessarily imply reproductive events during the dry season, since *T. costalimai* may remain in this nymphal stage for up to 145 days. In the case of other triatomine species such as *Panstrongylus megistus* (Burmeister, 1834), studies in different regions of Brazil indicate that the invasion of specimens in domiciles occurs more in the wet season, especially during the last quarter of the year[19-21]. The increase of temperature seen in areas of the Brazilian savanna during this period[22] could stimulate the reproduction, dispersal and development of *T. costalimai* colonies, as already observed for other triatomine species[23,24]. Future studies on temporal occurrence of *T. costalimai* in other areas and with greater capture effort in each climatic season may confirm the results obtained in this study. These studies are essential to clarify the population dynamics of triatomines and may support entomological surveillance strategies, such as the determination of best periods for control practices or application of measures to prevent infestation or reinfestation of areas already controlled[25].

In this study, specimens of *T. costalimai* infected by trypanosomatids were not detected. However, only 33% of the insects captured were examined, as the others were dry or dead at the moment of examination, making the removal of the intestinal contents unfeasible. Moreover, more than half of the specimens captured were nymphs I, which decreases the probability of detection of infected triatomines. The occurrence of natural infection of *T. costalimai* by *T. cruzi* in Mambaí has been evidenced by Mello and Borges[7]. *Trypanosoma cruzi* infection rates of *T. costalimai* detected in other municipalities of northern Goiás and southeast Tocantins were 13.5% and 75%, respectively[4,8], indicating that *T. costalimai* maintains a potential risk of vectorial transmission of Chagas disease. Future studies using molecular tools for detection of *T. cruzi*[26] may determine more accurately the infection rate of *T. costalimai* in rock habitats at Central Brazil.

The results of this study indicate that limestones present in the peridomicile are favorable environments for the development of *T. costalimai* colonies in Mambaí, State of Goiás, highlighting the synanthropic behavior of this triatomine species. Therefore, we recommend that residents of these areas avoid building houses next to rocks, as well as keeping domesticated animals near these rocks. We also suggest the improvement of the PIT network in the municipality, and community encouragement, based on educational actions, for active participation of inhabitants in entomological surveillance. These preventive measures may decrease the risk of domiciliary infestation by *T. costalimai* and, consequently, decrease the probability of transmission of *T. cruzi* to humans in these areas.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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ABSTRACT IN PORTUGUESE

Ocorrência de *Triatoma costalimai* (Hemiptera: Reduviidae) em diferentes ambientes e estações climáticas: um estudo de campo em área de Cerrado

Introdução: Espécimes de *Triatoma costalimai* infectados por *Trypanosoma cruzi* têm sido detectados em unidades domiciliares no Brasil Central, mantendo o risco potencial de transmissão vetorial da doença de Chagas. Objetivou-se determinar a ocorrência e infecção natural de *T. costalimai* em habitats rochosos em diferentes ambientes (mata de galeria, mata seca e peridomicílio) e estações climáticas (chuvosa e seca), no município de Mambaí, Estado de Goiás, Brasil. **Métodos**: Os triatomíneos foram capturados em outubro de 2010 e junho de 2011 usando dois métodos (coleta manual e armadilhas adesivas com isca animal) e posteriormente foram separados por estádio e sexo, contabilizados e examinados parasitologicamente por compressão abdominal e análise microscópica das fezes. **Resultados:** *Triatoma costalimai* foi detectado nos três ambientes e nas duas estações amostradas. O sucesso total de captura das 900 armadilhas e 60 blocos de rochas inspecionados foi de 5,8% e 11,7%, respectivamente. A ocorrência de *T. costalimai* foi maior em rochas do peridomicílio, onde 97% dos 131 espécimes foram capturados. A proporção de ninfas (98%) foi muito superior à de adultos, os quais só foram detectados no peridomicílio. A maioria (95%) dos insetos foi capturada na estação chuvosa, com predominância de ninfas I. Nenhum dos 43 espécimes examinados estava infectado por tripanosomatídeos. **Conclusões**: Os resultados indicam maior ocorrência de *T. costalimai* em ambiente peridomiciliar e na estação chuvosa em Mambaí, Goiás, salientando o comportamento sinantrópico dessa espécie de triatomíneo em uma área do cerrado Brasileiro e a importância da vigilância entomológica.

Palavras-chaves: Triatominae. Habitats rochosos. *Triatoma costalimai.* Cerrado. Brasil.

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