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Major Article

Spatial distribution of triatomine bugs in a Chagas disease endemic region in Brazil

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Abstract

Introduction: *Trypanosoma cruzi* is the etiological agent of Chagas disease (CD), a zoonotic infection transmitted by triatomine bug vectors to human beings. Although the story of this parasitic infection was born in Brazil and here this has made major step forward information, the same cannot be said about the actual distribution of the triatomine vector in several areas of this country. The aim of this study was to assess the occurrence of triatomine species in an endemic region for CD in Northeastern Brazil. **Methods:** A retrospective study was performed using data obtained from 2008 to 2017. All information was provided by the *V Gerência Regional de Saúde* of the state of Pernambuco. The spatial distribution of triatomine species was analyzed by drawing a map using the Quantum geographic information system. **Results:** A total of 4,694 triatomine specimens (469.4 ± 221.2 per year) were collected during the period 2008-2017, with 94.5% (4,434/4,694) at the intradomicile and 5.5% (260/4,694) at peridomicile environment. Of all arthropods collected, 92.5% (4,340/4,694) and 7.5% (354/4,694) were adults and nymphs, respectively. The species most frequently detected were *Panstrongylus lutzi* (30.36%), *Triatoma brasiliensis* (26.12%), *Triatoma pseudomaculata* (22.43%), and *Panstrongylus megistus* (20.54%). **Conclusions:** These data contribute to a better understanding of the distribution of *T. cruzi* infection in the Northeastern region of Brazil. Preventive measures based on vector control should be implemented in the study area in order to reduce the burden this neglected tropical disease.

Keywords: Vector. American trypanosomiasis. Epidemiology. Brazil.

INTRODUCTION

Trypanosoma cruzi (Kinetoplastida: Trypanosomatidae) is acknowledged as the etiological agent of Chagas disease (CD). This parasitic infection is currently considered as one of the most important neglected tropical diseases and is a major threat to public health, with an annual incidence of 28,000 cases and up to 12,000 deaths in the Americas alone[1]. The transmission of the CD relies on occurrence of triatomine vectors (e.g., *Triatoma infestans*, *Panstrongylus megistus* and *Rhodnius robustus*) that carry the infecting form of the protozoon (i.e., metacyclic trypomastigotes) in their fecal fluids, which are detected near the site of the bite wound after a blood meal. Alternatively, *T. cruzi* comes into contact with vertebrate hosts through intact mucosal membranes, such as the conjunctiva[2]. Furthermore, in recent years additional routes of transmission such as blood transfusion, organ transplantation, and transplacental and oral transmission have acquired importance[3].

The vectors of *T. cruzi* are hematophagous insects (Reduviidae: Triatominae) belonging to a group of 148 species, 65 of which occur in Brazil[2]. Approximately ten species are epidemiologically important for the transmission of CD[4]. In Brazil, the presence of these reduvids has been

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reported in different regions, since they are adapted to distinct ecotypes[5,6]. These specimens may live in intradomiciliary and peridomiciliary environments[7,8]. Peridomiciliary ecotypes, including animal facilities and building remains, play an important role as a bridge between the domestic and wild cycles of the disease[8,9].

Only a few epidemiological surveys have been conducted in distinct Brazilian regions so far. For instance, in the Southeast region, *P. megistus* has been retrieved in urban areas[10], while in the South Brazil, *Triatoma circummaculata* and *Triatoma rubrovaria*[11] have been reported as the most commonly detected species. In the Northeastern region species such as *Triatoma brasiliensis*, *Panstrongylus lutzi* and *Triatoma pseudomaculata* are frequently reported[7,9,12]. It is important to note that several natural environments in this region (e.g., xerophilous trees and rocks) are inhabited by triatomines[13].

Data on the distribution of these vectors is needed to better understand the epidemiological aspects related to the transmission of CD and to drive preventive interventions[7]. Therefore, the aim of this study was to assess the occurrence and distribution of triatomine species in an endemic region for CD in Northeastern Brazil.

METHODS

Study area

The study was conducted in the microregion of Garanhuns (Latitude 8°53′27″ South and Longitude 36°29′48″ West), state of Pernambuco, Northeastern Brazil (**Figure 1**). The area includes 21 municipalities, and it is featured by a semi-arid climate with a mean annual temperature of 22°C (17 - 30°C), mean annual rainfall of 147 mm (25 - 295 mm), and relative air humidity of 90%.

From 2007 to 2015, 773 cases of CD were recorded in the study area, with an annual average of 85.8 cases per year[14].

Study design and data analysis

A retrospective study was performed using data obtained from 2008 to 2017. All data were provided by the *V Gerência Regional de Saúde* of the state of Pernambuco, and were taken from the National Chagas Disease Control Program.

Information about vector species, life stage, area of capture, and municipality were obtained, and the absolute and relative frequencies were calculated. In addition, the Chi-square test ($\chi 2$) with Yates correction (5% significance level) was used to compare the positivity between species and area of capture (intradomicile or peridomicile), and between stages and area of capture. The BioEstat software (version 5.3) was used for these analyses[15].

The spatial distribution of triatomine species were analyzed by drawing a map using the Quantum geographic information system (QGIS 3.2 BONN). The Jenks optimization method was used to organize the data, and subsequently construct a histogram of frequencies to identify clustering[16].

RESULTS

A total of 4,694 triatomine specimens (469.4 ± 221.2 per year) were collected during the study period, with 94.5% (4,434/4,694) and 5.5% (260/4,694) from the intradomiciliary- and peridomiciliary- environments, respectively. A highly significant difference was observed between the most common species and area of capture ($\chi 2 = 50.363$; $p = 0.0000$), and between life stages and area of capture ($\chi 2 = 112.496$; $p = 0.0000$). The largest number of specimens collected in a single year (17.3%; 870/4,694) was obtained during 2008. Of all invertebrates collected 92.5% (4,340/4,694) and 7.5% (354/4,694) were adults and nymphs, respectively (**Table 1**). The reduviid species most frequently reported were *P. lutzi* (30.36%), *T. brasiliensis* (26.12%), *T. pseudomaculata* (22.43%), and *P. megistus* (20.54%) (**Table 1**).

Figure 2 illustrates the spatial distribution of triatomine collected in the study area.

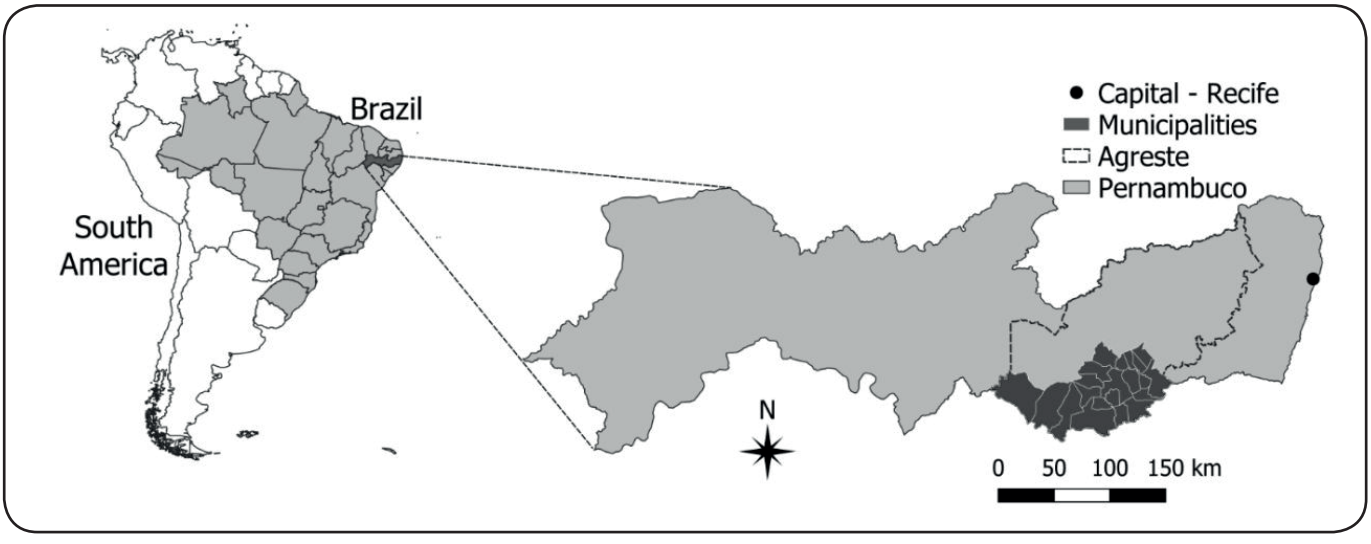

FIGURE 1: Study area located at the microregion of Garanhuns, state of Pernambuco, Northeastern Brazil.

TABLE 1: Triatomine species collected in intra- and peridomicile areas from 2008 to 2017.

Species	Intradomicile			Peridomicile			Total	Relative frequency (%)
	adults	nymphs	total	adults	nymphs	total		
Panstrongylus lutzi	1375	14	1389	36	0	36	1425	30.36
Triatoma brasiliensis	968	194	1162	44	20	64	1226	26.12
Triatoma pseudomaculata	943	39	982	42	29	71	1053	22.43
Panstrongylus megistus	834	43	877	72	15	87	964	20.54
Triatoma spp.	12	0	12	0	0	0	12	0.09
Triatoma melanocephala	8	0	8	0	0	0	8	0.25
Rhodnius spp.	4	0	4	0	0	0	4	0.09
Panstrongylus sp.	0	0	0	1	0	1	1	0.02
Triatoma infestans	0	0	0	1	0	1	1	0.02
Total	**4,144**	**290**	**4,434**	**196**	**64**	**260**	**4,694**	**100**

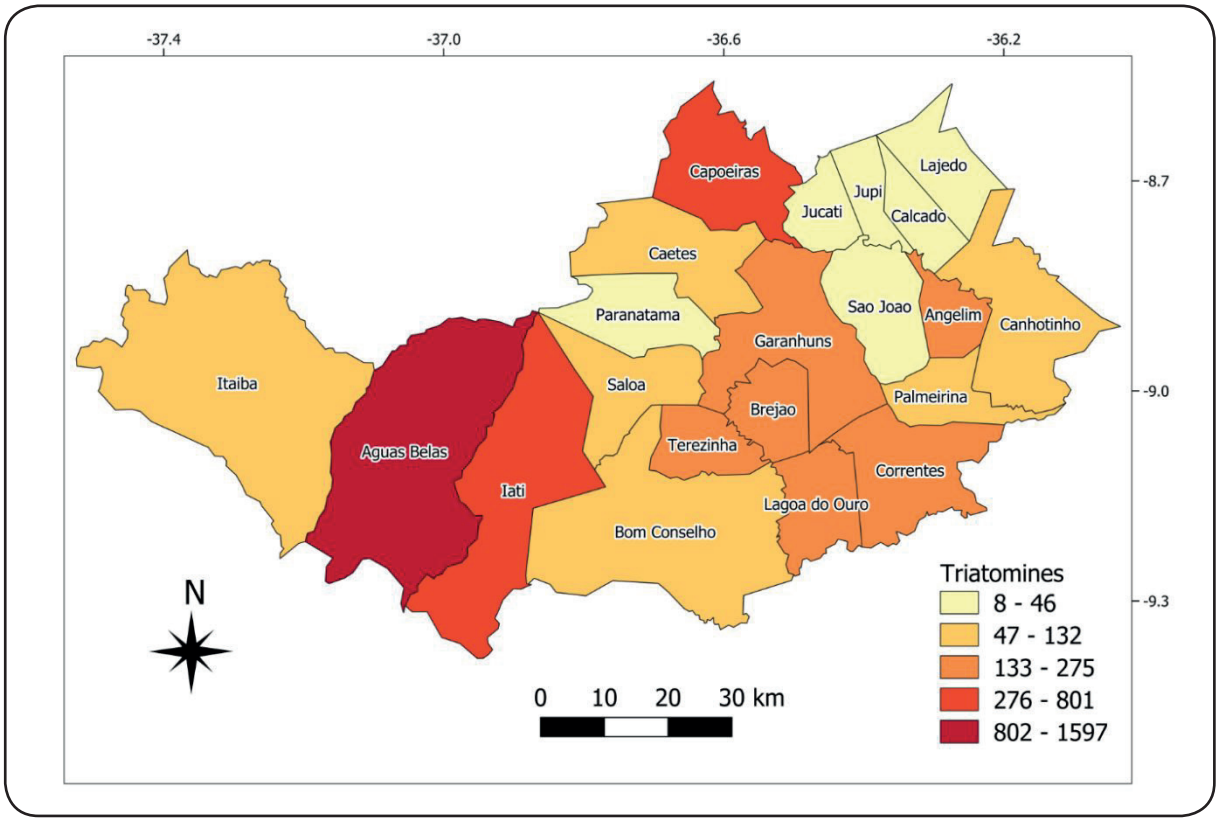

FIGURE 2: Distribution of triatomines collected at the study area from 2008 to 2017.

DISCUSSION

This study reports the occurrence of vectors of CD in intradomiciliary and peridomiciliary areas of an endemic region of Northeastern Brazil. The percentage of specimens collected from intradomiciliary areas is similar to a previous study conducted in the same area, where 92.4% of triatomines were collected indoors[17]. These invertebrates usually live in wild environments, however due to the degradation of their natural habitats, synanthropic triatomines are frequently reported[18]. These arthropods are attracted by light sources in intradomicile areas[19] or may be passively transported by accumulated wood or unused furniture near the houses (outdoors) inhabited by them and other synanthropic animals such as marsupials and rodents[9,20].

In the study area, the vigilance of these vectors occurs both actively and passively. During the study period (2008 to 2017) a gradual reduction in the number of specimens was observed,

which may be related to an improvement in the sanitary conditions of the population. Nonetheless, the risk of vector proliferation increases with a decrease in vigilance.

Both nymphs and adults were retrieved from intradomiciliary and peridomiciliary areas. The dispersion of triatomines in different environments may be related to mating or a search for food[19]. In this study, the presence of nymphs intradomicile indicates the formation of colonies in these environments represented by the phenomenon of domiciliation, and consequently high risk for human infection[7,12].

Various species were captured during the study (i.e., *P. lutzi*, *T. brasiliensis*, *T. pseudomaculata* and *P. megistus*), with *P. lutzi* being the most frequent (30.36%). This species had been already detected in other Brazilian regions[12,17], and is relevant for the persistence of CD in endemic areas[21]. From an epidemiological perspective, *P. lutzi* plays a crucial role in the dynamic of *T. cruzi* infection in Northeastern Brazil, since it feeds on a wide plethora of hosts (e.g., birds, rodents, marsupials, dogs, goats, and humans), many of which are commonly found within the study area[9]. On the other hand, *T. brasiliensis,* apparently associated with rodents has been considered one of the most important vectors of *T. cruzi* in Brazil, using as a shelter the cactus specie *Pilosocereus gounellei* commonly found in the Northeastern region[22].

Similarly, *T. pseudomaculata* and *P. megistus* share a similar natural habitat and hosts. Interestingly, *T. pseudomaculata* has been captured in wild ecotypes of *Mimosa tenuiflora* (commonly known as *jurema-preta*), a native vegetation found in the study area[20]. Although less frequently, species of genus *Rhodnius* have been detected in the area of the present study[17].

Findings contribute to a better understanding of the dynamics of CD in the Northeastern region of Brazil. The poor quality of housing materials and homes, especially in rural areas, provides a favorable environment for the proliferation of triatomine vectors. Unfortunately, vector transmission of CD in Brazil still occurs, and the domiciliation of the vectors observed in this study is a risk factor for the occurrence of the disease. Therefore, preventive measures based on vector control should be implemented in the study area in order to reduce the incidence of CD.

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Conflict of Interest

The authors declare that there is no conflict of interest.

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