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Combining geospatial analysis and exploratory study of triatomine ecology to evaluate the risk of Chagas disease in a rural locality

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ABSTRACT

The use of geo-spatial analysis to anticipate transmission risk for Chagas disease was tested in a rural area of northeast Brazil in an approach that combined geo-referencing and exploratory study of triatomine infestation, including related elements such as the environment and hosts. A total of 617 triatomine specimens, mainly *Triatoma brasiliensis*, were captured, exhibiting an overall *T. cruzi* positivity of 44.4%. Layer analysis indicated that the greatest transmission risk to man was associated with woodpiles. The buffer area generated contained uninhabited dwellings teeming with bats and positive bugs. Other locations outside the buffer, near uninhabited dwellings housing cattle, contained colonies of triatomines harboring *T. cruzi*. The results indicate that local residents' activities themselves favor the development of risk areas for Chagas disease.

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1. Introduction

Chagas disease, a neglected disease of poor, forgotten, rural populations, is endemic in Latin American countries (Coura, 2007; Coura and Viñas, 2010). Until recently, *Triatoma infestans*, a species of triatomine native to the Bolivian Andes, was considered the main vector of the disease in Southern Cone countries, including Brazil, where the species had been introduced, and was perfectly adapted, to domiciles. Following a very well-structured program, this triatomine has been controlled in Brazil (Pan American Health Organization, 2006). However, autochthonous vectors, mainly peridomestic and sylvatic species, have increasingly acquired the ability to invade and colonize domiciles, due to poor-quality housing in endemic regions and human interference in the environment (Pan American Health Organization, 2006). In Brazil, native insects, among them *Triatoma brasiliensis* and *T. pseudomaculata*, have been reported in and around dwellings in several regions, especially in the northeast (Alencar et al., 1977; Costa et al., 2003; Sarquis et al., 2006; Almeida et al., 2008). In this study, we investigate triatomine infestation and infection rates in a rural locality of an endemic area for Chagas disease in northeastern Brazil.

The study was conducted in a rural locality of the municipality of Russas, Ceará State, at coordinates 56°4′25″S and 37°58′33″W, in the Jaguaribe River Valley in northeast Brazil. In order to ascertain the current triatomine distribution in the municipality, an exploratory study was conducted in a rural locality, Miguel Pereira, on the floodplain 17 km from the town center. The locality comprises 471 dwellings, housing approximately 1000 residents, distributed along the main thoroughfare, a 7 km long street, and its secondary intersections.

The study was carried out during five consecutive days in December 2007, at the invitation of the Russas Municipal Health Department, because many residents frequently complained of household triatomine infestation. A convenience sample of 76 residences was investigated in which we actively sought triatomines in intra- and peridomiciles, including animal shelters, woodpiles, brick and tile piles, as potential risk of emerging micro-epidemiological foci. Triatomine capture was performed by exhaustion. In the laboratory, all specimens collected were classified according to species and developmental stage (Lent and Wygodzinsky, 1979).

Subsequently, the feces were examined for natural *Trypanosoma cruzi* infection. For purposes of spatial analysis, we considered a buffer zone of 200 m, which is the flight range described for *T. infestans* attracted by light (Cecere et al., 2004) (as no reference is available in this respect for *T. brasiliensis* and *T. pseudomaculata*). Accordingly, using a geographic information system, this buffer zone was marked around the geographical coordinates of woodpiles on the main street of the locality. Also a kernel

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Table 1
Place of capture, number of triatomines and rate of *Trypanosoma cruzi* infection, according to species, in Miguel Pereira, Municipality of Russas, Ceará State, Brazil, 2007.

Local of capture	Captured triatomines intra* (*Tb*/*Tp*/*Pm*)**	Captured triatomines peri* (*Tb*/*Tp*/*Pm*)	Examined triatomines (*Tb*/*Tp*/*Pm*)	Positive triatomines (*Tb*/*Tp*/*Pm*)	Natural infection rates (%) (*Tb*/*Tp*/*Pm*)
Inhabited houses	02/00/00	33/14/05	32/13/04	09/02/00	28.13/15.38/–
Non-inhabited houses	78/00/00	29/09/00	86/09/–	52/03/–	60.47/33.33/–
Piles of wood located in the circulation via of the locality	–	496/05/00	446/00/–	196/00/–	43.95/–/–
Total	80	591	590	262	44.41

* Intradomicile/peridomicile (structures found around dwellings like animal shelters and piles of wood and tile).
** *T. brasiliensis*/*T. pseudomaculata*/*P. megistus*.

density-estimation map was generated (Lagrotta et al., 2008), with an adaptive radius and a quartic function algorithm, in relation to the dwellings infested by infected triatomines.

Of the 76 dwellings surveyed, 12 exhibited triatomine infestation in the peridomiciles only, and three uninhabited dwellings used as animal shelters were infested only indoors. Two woodpiles located on the main street of the locality presented high rates of both *T. brasiliensis* ($n = 496$) *and T. pseudomaculata* ($n = 5$) infestation ($n = 501$) and *T. cruzi* natural infection (~43.95%). The wood was of the same kind used for buildings, fences, corrals, pigsties and hen-houses.

1.1. Triatomines captured and infection rates

Considering all the intradomiciles, peridomiciles and woodpiles investigated, 671 triatomine specimens were captured (638 *T. brasiliensis*, 28 *T. pseudomaculata* and 5 *Panstrongylus megistus*), of which 590 (92.5%) were examined to detect *T. cruzi*. For this

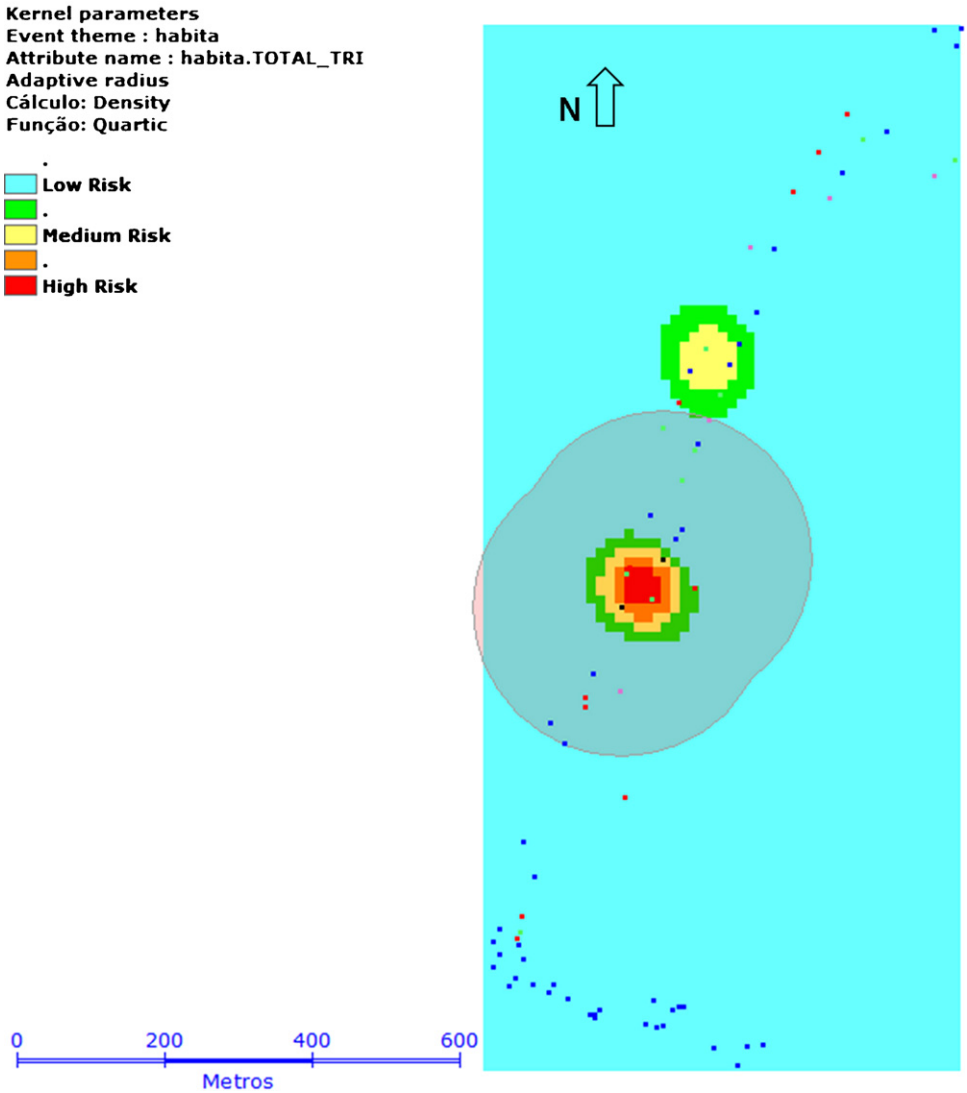

Fig. 1. Buffer around woodpiles on the main road and kernel of uninhabited dwellings infested by *Trypanossoma cruzi* infected triatomines, in Miguel Pereira, Municipality of Russas, Ceará State, Brazil.

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