Aspects of peridomiciliary ecotopes in rural areas of Northeastern Brazil associated to triatomine (Hemiptera, Reduviidae) infestation, vectors of Chagas disease

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Artificial ecotopes of 121 peridomiciliary environments in four rural localities in the state of Ceará, Brazil, were studied and the type of material of the ecotopes was identified as triatomine infestation. Two thousand two hundred and four Triatoma brasiliensis *Neiva, 340* Triatoma pseudomaculata *Corrêa and Espínola, 121* Rhodnius nasutus *Stall, and 5* Panstrongylus lutzi *(Neiva and Pinto) were captured. Out of the 323 ecotopes found ($\bar{x}$ =2.0 ± 1.8 per dwelling) – such as pigpens, henhouses, corrals, perches, dovecotes, piles of roofing tiles, bricks, wood, and straw – 30.3% were infested by triatomines in all different developmental stages, including eggs. A substantial number of triatomines were found in perches, however the largest infestation took place in roofing materials used in the construction of goat/sheep corrals, henhouses, and pigpens, where 98% of them were captured: 1372 triatomines were located in the roofing tile covers, 285 in the straw, 187 in the perches, 77 in the coverings of roofing tiles and straw, and 13 in the straw and wood. Among all the different pile of materials, roofing tiles were the most infested (50%) followed by bricks (38.9%) and woods (36.1%).* T. brasiliensis *colonized mainly brick piles (χ^2=16.539; p < 0.05) and roofing tiles (χ^2=5,090.58; p < 0.05);* T. pseudomaculata *preferred wood perches (χ^2= 472.39; p < 0.05) and woodpiles (χ^2 =126.0 p < 0.05), and* R. nasutus *was principally found in roofing straw (χ^2=384.43; p < 0.05). These findings suggest that triatomines tend to colonize peridomiciliary ecotopes similar to their original habitats.*

Key words: triatomines - ecotopes - peridomicile - Chagas disease - Northeastern Brazil

Triatoma infestans (Klug) has been chemically controlled in an effective manner by a joint program involving the Southern Cone countries (Silveira 2002). However, a new endemic epidemiological picture of Chagas disease may arise caused by the growing rate of the wild or peridomiciliated species domiciliation (Silveira et al. 2001). Within this context, *T. brasiliensis* and *T. pseudomaculata* have become particularly important, mainly because they have been frequently and persistently found infesting dwellings, principally in the Brazilian Northeast region, in addition to the high natural infection rate by *Trypanosoma cruzi* Chagas (Costa et al. 2003). *Rhodnius nasutus* Stall is another triatomine present in that region that can take part in the transmission of *T. cruzi* in the domestic cycle. This species is predominantly wild, nevertheless, it has been frequently found colonizing artificial peridomiciliary ecotopes, often presenting high indices of *T. cruzi* infection (Silveira & Vinhaes 1998, Sarquis et al. 2004).

The municipality of Jaguaruana, located in the state of Ceará, has been considered by the Chagas Disease Control Program (PCDCh/FNS) as one of the highest endemic regions for American tripanosomiasis (Bezerra et al. 2004). The Brazilian National Health Foundation and the State Health Department of Ceará have been trying to maintain a periodical control system spraying all domiciliary units where the presence of bugs is confirmed; however, these vectors are still frequently found mainly in the peridomicilium of rural areas (Sarquis 2003, Lima et al. 2004, Sarquis et al. 2004).

The aim of this paper is to analyze the characteristics of peridomiciliary artificial ecotopes found in rural areas of Jaguaruana, associating them with infestation and colonization by triatomines and also to determine which of those ecotopes are the best suited for installation and development of the Chagas disease vectors.

MATERIALS AND METHODS

Jaguaruana municipality is located in a hot and dry region in the eastern of the state of Ceará , about 180 km from Fortaleza; the average annual temperature ranges from 23ºC to 33°C, and rainfall is approximately 850 mm per year; the vegetation coverage is compound of spinous caducifolius forest and dense arbustive caatinga, presenting some areas in accentuated degradation. The municipality contains 156 localities in the rural area. Peridomiciles of four of these localities – Currais do Felipe, Coberto, Figueiredo, and Figueiredo do Bruno – were investigated. Coberto has 3 km^2, 15 domiciles, and 61 inhabitants; Currais do Felipe has 3,5 km^2, 19 domiciles, and 76 inhabitants; Figueiredo do Bruno has 4 km^2, 41 domiciles, and 146 inhabitants; Figueiredo has 8 km^2, 83 domiciles, and 348 inhabitants; the four localities totalize 158 dwellings, and approximately 630 people living there.

Peridomicilium was considered to be the area situated within 100 m proximity the dwellings. Henhouses, pig-

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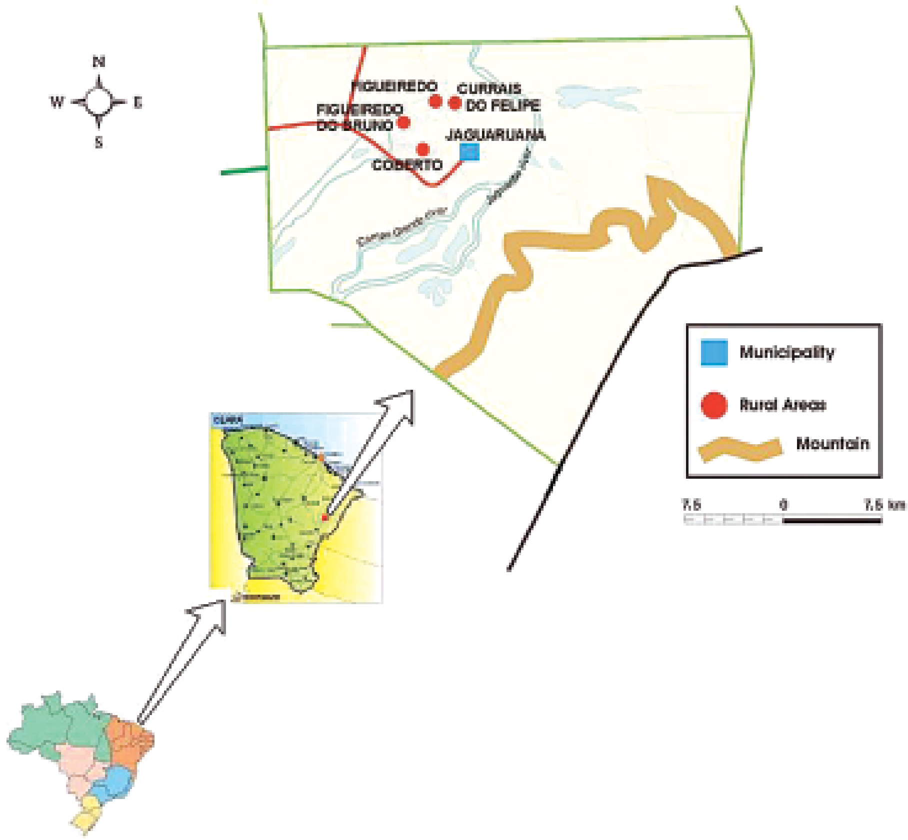

Map of the municipality of Jaguaruana, state of Ceará, Brasil, showing the geographic location of the surveyed ares.

pens, corrals, perches, piles of tiles, bricks, wood, and straw were analyzed regarding quantity, distance to the dwelling, presence or absence of roofing, type of construction, material, and infestation by triatomines. Domestic animals present in each peridomicilium were quantified by ecotope.

In each of the peridomiciles, two men per ecotope, with the aid of tweezers, exhaustively performed five manual triatomine captures within the period between November 2000 and April 2002; no dislodging substances were used. All annexes were carefully checked. The captured triatomines were stored in labeled plastic containers and forwarded to the laboratory for identification, according to the criteria proposed by Lent and Wygodzinsky (1979).

The Chi-square test was carried out to estimate the preference of the different triatomine species for each ecotope. The Spearman test correlated the density of the triatomine population of each ecotope with the number of animals present.

RESULTS

Among the 158 domiciliary units studied, 121 peridomiciles displayed ecotopes, on a mean of 2.0 ± 1.8 (median and mode = 2) per domiciliary unit, including animal shelters and piles, all of them having been there for a long time. Domestic animals were found in 91.1% of the dwellings; most were fowl, followed by goat/sheep, cows, pigs, dogs, cats, and horses; residents reported that they frequently encounter mice inside and opossums and crab-eating foxes (*Cerdocyom thous*) in proximity to the houses.

Triatomines in different developmental stages and eggs were found in 30% of the ecotopes, 68.7% being shelters for domestic animals, and 32.3% piles of bricks, roofing tiles or wood. Most shelters contained walls composed of carnauba wax palm (*Copernicia prunifera*) or black quince trees (*Croton sonderianus*) trunks and were roofed with tile, straw or wood. Out of the infested ecotopes, 7.4% were directly linked to the house walls and 66.3% were located within 10 m vicinity of the houses.

The largest infestation rate occurred in goat/sheep corrals (40.4%), followed by perches (34.4%), henhouses (26.2%), and pigpens (21.1%). In piles of roofing tiles, bricks, and wood the average percentages of infestation were 50.5, 38.9 and 36.1%, respectively. Cattle corrals, dovecotes and piles of straw were not infested. Triatomines ehxibited clear preference for roofs, where 98% were captured. A total of 2670 triatomine specimens were captured: 2204 *T. brasiliensis*, 340 *T. pseudomaculata*, 121 *R. nasutus*, and 5 *Panstrongylus lutzi*.

T. brasiliensis displayed a significantly higher preference for wood animal shelters with roofing tiles (χ^2 = 5,090.58; $p < 0.05$). *T. pseudomaculata* and *R. nasutus* preferred perches (χ^2 = 472.39; $p < 0.05$) and wood shelters with straw roofs (χ^2 = 384,43; p < 0.05), respectively (Table I).

T. brasiliensis and *T. pseudomaculata* were found in all infested piles, nevertheless, the former showed significant preference for brick piles (χ^2 = 16.39; p < 0.05) and the latter for wood piles (χ^2 = 126.0; p < 0.05). *R. nasutus* was exclusively found in wood piles and *P. lutzi* was captured only in piles of roofing tile (Table I).

Colonies of *T. brasiliensis* of all sizes were recorded, some of them with more than 100 specimens. This species was found colonizing all types of infested ecotopes, mainly wood shelters with tile roofing and brick piles. *T. pseudomaculata* was also capable of colonizing certain peridomiciliary ecotopes and of forming colonies of up to 50 specimens, with preference for perches and woodpiles. Although *R. nasutus* was found in smaller amounts, it colonized mainly wood shelters with straw roofing, where it formed at least one 50-specimen colony. This species was also capable of colonizing perches and woodpiles, with one colony each (Tables II, III).

R. nasutus was not found isolated in any of the six colonies; in four of them it cohabitated with *T. pseudomaculata* and in two others with *T. brasiliensis* and *T. pseudomaculata*. These last two species formed isolated colonies; when they cohabitated with *T. brasiliensis*, this species prevailed.

The correlation analysis between the density of triatomines and the number of domestic animals present in each ecotope did not present a significant value (Table IV). Nevertheless, the correlation between the number of pigs and captured triatomine (r = 0.6849) presented a borderline value with 5% significance.

DISCUSSION

In this research work, the most lightly infected ecotopes were goat and sheep corrals, followed by perches and finally henhouses. Diotaiuti et al. (2000), in a study that took place in the municipality of Independência, also located in the state of Ceará, obtained similar results, except for the recorded order of infestation: perches were

TABLE I

Type of peridomiciliary ecotopes found in the studied areas of the rural region of the municipality of Jaguaruana, Ceará, Brazil, regarding the characteristics, infestation, and captured species of triatomines

Characteristics of the ecotopes	Existing N	Infestation (%)	Captured species and percentage of infested ecotopes: *Triatoma brasiliensis* / % of ecotopes	*Triatoma pseudomaculata* / % of ecotopes	*Rhodnius nasutus* / % of ecotopes	*Panstrongylus lutzi* / % of ecotopes
Shelters						
Wood wall with roofing tile	124	36.3	1.319 / 33	51 / 8	2 / 1.6	0
Wood wall with roofing tile and straw cover	4	50	74 / 16.1	0	3 / 50	0
Wood wall with straw cover	51	9.8	165 / 3.9	33 / 7.8	87 / 5.8	0
Wood wall with straw and wood cover	9	44.4	11 / 22.2	2 / 22.2	0	0
Wood fence	26	0	0	0	0	0
Wood perch	29	34.5	23 / 10.3	161 /27.5	3 /3.4	0
Piles						
Woods	36	36.1	191 / 16.6	82 / 16.6	26 / 2.8	0
Bricks	18	38.9	250 / 27.8	7 / 5.6	0	1 / 5.6
Roofing tiles	24	50	171 / 41.7	4 / 4.2	0	4 / 4.2
Straws	2	0	0	0	0	0
Total	323	30.3	2.204 / 22	340 / 9.9	121 / 2.8	5 / 0.6

TABLE II

Number of colonies per species of triatomines distributed per colony size, present in shelters of domestic animals

Specimen of triatomines per colony	Number of colonies per species: *Triatoma brasiliensis*	*Triastoma pseudomaculata*	*Rhodnius nasutus*
1 to 10	26	17	1
11 to 20	10	2	3
21 to 30	3	1	0
31 to 40	5	2	0
41 to 50	5	2	1
> 50	6	0	0
Total	55	24	5

TABLE III

Number of colonies per species of triatomines distributed per colony size present in piles

Specimen of triatomines per colony	Number of colonies per species: *Triatoma brasiliensis*	*Triastoma pseudomaculata*	*Rhodnius nasutus*
1 to 10	13	7	0
11 to 20	5	3	0
21 to 30	1	0	1
31 to 40	2	1	0
41 to 50	0	0	0
> 50	3	0	0
Total	24	11	1

TABLE IV

Spearman correlation (r_s) between the number of captured triatomines and the amount of domestic animals present in each ecotope

Ecotope	N	r_s	p
Henhouse	15	0.3829	0.1589
Pigpen	8	0.6849	0.0609
Goat/sheep corral	12	0.0573	0.8597

the most infested ecotopes, followed by henhouses and then goat/sheep corrals.

In successive captures we observed that *T. brasiliensis* tended to infest and colonize shelters or piles containing roofing tiles or bricks, thus making the species population stability evident in these ecotopes in comparison with other ecotopes. Roofing tiles were usually overlapping, either covering a shelter or forming piles; this arrangement offers excellent refuge. A similar situation occurs with bricks, which when parallelly arranged or in piles create microenvironments where triatomines may harbour themselves. Bricks and roofing tiles are made of wet clay and have a porous texture, which may be a thermal insulator and creates microclimatic environments (temperature and humidity) that are favorable to colony formation (Lorenzo et al. 2000).

In the wild, *T. brasiliensis* inhabits cracks and spaces among rocks (Alencar 1987). The fact that roofing tiles and bricks are made of clay, notably with some constitution characteristics similar to those found in the natural habitat, may explain the preference of this species for these artificial ecotopes. Reparaz and Bar (1984) performed laboratory studies concerning the preference of *T. infestans* for different types of construction materials and they found that this species demonstrates a preference for dry clay rather than other materials.

In this study, *T. pseudomaculata* displayed preference for wood ecotopes, specially perches made of carnauba wax palm or black quince tree trunks, which provide hiding places in their core or beneath the bark. *T. pseudomaculata* is an arboreal species that naturally inhabits tree crannies and hollows or bird nests (Alencar 1987, Carcavallo et al. 1999).

R. nasutus is also an arboreal species, exclusively of palm trees, which inhabits on the crowns of the trees and bird nests found there (Alencar 1987, Carcavallo et al. 1999). In our area of study this species has only been captured in carnauba wax palms (Sarquis 2003), hence it has proven to be the only species living in the crowns of palm trees. According to Lent and Wygodzinsky (1979) and Romaña et al. (1999), palm trees are natural ecotopes for the species of genus *Rhodnius*, and they can be considered as ecological indicators of a risk area for Chagas disease. In the peridomicilium, *R. nasutus* was captured in other ecotopes containing perches and woodpiles, nevertheless their preferred material was palm tree straw used as roofing for henhouses.

In the present assay, we could not find *R. nasutus* cohabitating with any other species of triatomine in the wild. Nevertheless it was not encountered isolated in the peridomiciliary environment. These data lead us to believe that there is an adaptation of the species, probably resulting from the change in habit due to the scarcity of food and reduction of vegetation, which forced it to cohabitate with other species.

T. infestans domiciliation has made control easier, however species with wild or semi-domestic habits, such as *T. brasiliensis*, *T. pseudomaculata*, and *R. Nasutus*, are extremely difficult to control. The Chagas Disease Control Program of the state of Ceará has been spending a great effort to maintain a regular control in and around the houses of the Jaguaruana municipality; even so, these triatomines tend to reinvade dwellings soon after chemical insecticides have been applied. The natural habitat for these species, represented by caatinga, has ecological characteristics that facilitate their development, therefore they are almost always found in large densities. On the other hand, deforestation together with other human interference in this environment has caused displacement of these insects to peridomiciles. Large populations of domestic animals can be found in these environments and their shelters can also host insects. The frequent presence of sinantropic animals, in conjunction with the accumulation of materials in the shelters, provides all the conditions for triatomine colonization. Furthermore, these artificial ecotopes usually offer innumerable hiding places, some of them totally inaccessible to spraying, thus facilitating development and recolonization of the remaining specimens. As stated by Rabinovich (1985), insect vector population in domiciliary conditions associated to *T. cruzi* infection contitutes an essencial risk factor for human infection. Hence, with the reference to a previous paper (Sarquis et al. 2004), the high natural infection index of these hematofages which are frequently found colonizing intradomiciles in Jaguaruana suggests that epidemiological surveillance must be constant in order to insure that these species do not become a severe public health problem.

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