Human Trypanosomiasis in the Eastern Plains of Colombia: New Transmission Scenario

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Abstract. Characteristics of *Trypanosoma cruzi* infection were studied in a rural area of the eastern plains of Colombia. Using enzyme-linked immunosorbent assay and indirect fluorescent-antibody tests, the infection was determined in 11.6% of the inhabitants of 142 dwellings. During 6 months of community surveillance, in 42.3% dwellings, 609 triatomines were collected (597 *Rhodnius prolixus* and seven, three, one, and one of *Panstrongylus geniculatus*, *Psammolestes arturi*, *Eratyrus mucronatus*, and *Triatoma maculata*, respectively). *Rhodnius prolixus* was found in 80% peridomestic *Attalea butyracea* palms examined with baited traps, and its infection with *T. cruzi* was 30% and 38.5% in dwellings and palms, respectively. *Trypanosoma cruzi* was isolated in five of 35 triatomines and in one of 24 dogs. The blood of domestic and wild animals was identified in triatomines collected in the intradomicile and in palms. These results support the extension of the wild cycle of *T. cruzi* to human dwellings and the characterization of a new scenario for transmission in Colombia.

Trypanosoma cruzi infection continues to affect nearly 6 million people in 21 countries of the Americas¹ despite the success of control programs against domestic triatomines.² There are zones where dwellings are infested by other species of Triatominae with peridomestic and wild ecotopes. In the Amazon, some of the more than 27 wild species described, principally of the genus *Rhodnius*, have made incursions into dwellings, with the risk of infecting human populations.³

In Colombia, the Andean region in the eastern zone below 2,000 m above sea level has been considered endemic for Chagas disease because of the high degree of domiciliary infestation, wide dispersion, and the high densities of *Rhodnius prolixus*.^{4,5} A decade after the adoption of a government program to control domiciliary triatomines, in our observation, this species has been controlled. However, another transmission scenario has begun to be known with checking of the wild cycle in peridomestic palms as a transmission risk factor in the departments of the eastern plains⁶ and the reporting of high prevalence rates of human infection with *T. cruzi*.⁷ This study was conducted for the purpose of clarifying the epidemiological characteristics of this scenario in this region.

In December 2008, the prevalence of *T. cruzi* infection was evaluated in the inhabitants of 142 dwellings in the department of Casanare, dispersed in rural areas of the municipalities of Maní (04°49'02"N/72°17'19"W) and Aguazul (05°10'23"N/72°33'17"W), which were fumigated by the program of Vector-Transmitted Diseases (Enfermedades Transmitidas por Vectores [ETV], in Spanish) in that department. This territory corresponds to the alluvial and eolic plains of the Orinoquía, composed of flooded savannas with herbaceous and graminaceous vegetation in the humid warm thermal floor, with an average temperature of 25–27°C and an annual rainfall of 2,400–2,600 mm (Figure 1).

The dwellings are constructed with brick walls, cement, tile or earth floors, and zinc tile roofs, with open spaces between the roof and the walls and no protection against the entrance of insects or other animals. Their peridomestic surroundings

are not clearly demarcated and have rustic constructions for the shelter of domestic animals, small areas of subsistence crops, pastures with scattered palms, and also pockets of forests, mainly “Royal Palm” (*Attalea butyracea*), where domesticated and wild animals roam freely.

In visits to their homes, information about Chagas disease, as well as the purpose of the study, was offered to raise awareness for their participation. Those who agreed to participate were asked to provide written informed consent.

Of 492 inhabitants, 50% were women and 50% were men, with a mean age of 28.5 years and a range from 0 to 88 years. A blood sample was taken from adults, or minors authorized by their parents, on Whatman No. 3 filter paper (Sigma-Aldrich, St. Louis, MO) to determine *T. cruzi* infection by means of the tests enzyme-linked immunosorbent assay (ELISA) and immunofluorescent-assay (IFA), using the filter paper technique.⁸

During 6 months in the dry season, the inhabitants, ETV program technicians, and researchers conducted entomological surveillance of domiciliary infestation by triatomines using three methods: community surveillance, actively searching (hours/man) without vacating, and “Maria” biosensors.⁹ In dwellings with palms located within 100 m of the peridomicile, individuals of *A. butyracea* and *Cocus nucifera* were examined using live bait traps^{6,9}; the degree of infestation and colonization and the clustering (number of collected triatomines/number of palms or dwellings infested) and density (number of collected triatomines/number of palms or dwellings examined) in the two habitats (dwellings and palms) were established.¹⁰ The intestinal content of the triatomines collected alive was used for identifying their food sources by ELISA technique¹¹ and determining the natural infection by direct examination and polymerase chain reaction (PCR). Using primers S35 and S36,⁶ a 330-bp fragment corresponding to the kinetoplast minicircle DNA sequence specific to *T. cruzi* was amplified. *Trypanosoma cruzi* in triatomines and domestic mammals was isolated and classified as *T. cruzi*, *T. cruzi* I, or *T. cruzi* II using the TC/TC1/TC2 primers for the intergenic spacer of minicircle genes.¹²

The study was conducted within the framework of a research project approved by the ethics committee of the Industrial University of Santander.

Serological tests revealed infection in 57 of 492 (11.6%) inhabitants, 33 men and 24 women, and a range between 7 and

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FIGURE 1. Geographical distribution and location of the municipalities and dwellings in study area (Aguazul and Maní, Casanare, Colombia).

76 years, including four children under 15 years of age. In 60 of 142 dwellings, 609 triatomines (597 specimens of *R. prolixus* and seven, three, one, and one adult *Panstrongylus geniculatus*, *Psammolestes arturi*, *Eratyrus mucronatus*, and *Triatoma maculata*, respectively) were collected by community surveillance, resulting in a degree of infestation of 42.3%, a degree of colonization of 1.7%, a clustering of 10.9 triatomines per infested dwelling, and a density of 4.3 triatomines per dwelling.

In 24 of 28 *A. butyracea* examined, 336 specimens of *R. prolixus* were collected, and there were none in two

C. nucifera individuals examined, resulting in a degree of infestation of 80% and colonization of 75% and a density of 11.2 and a clustering of 14.

The presence of flagellates was observed by the direct examination of feces in 20 of 85 triatomines collected in dwellings (23.5%), in 56 of 170 collected in palms (33%), and in two of 24 (8.3%) triatomines used for xenodiagnosis in dogs. Infection with *T. cruzi* was determined by PCR in nine of 30 triatomines collected from dwellings (30%) and in 10 of 26 triatomines collected in palms (38.5%).

TABLE 1
Number of individuals according to place of collection, natural infection, and food sources of *Rhodnius prolixus*

Place of collection	Adults		Nymphs					Total	% Infection (PCR)	Food source identified (no. of triatomines) (n = 224)
	Females	Males	I	II	III	IV	V			
Dwellings	402	194	0	0	0	0	1	597	30.0	Chicken (1) Sheep (1) Iguana (3) Primate (1)
Peridomiliary palms (<i>Attalea butyracea</i>)	57	38	15	46	56	62	62	336	38.5	Chicken (11) Sheep (6) Equine (5) Iguana (3) Bat (4) Rat (1) Iguana and chicken (1)

PCR polymerase chain reaction.

Trypanosoma cruzi was isolated in five of 35 triatomines, three collected in dwellings and two in palms, and in one of 24 dogs. All were determined to be *T. cruzi* I. None were isolated in any of 11 cats, three pigs, one horse, and one cow on which xenodiagnoses was performed. Domestic animals and wild animals were identified as the blood food source in six of 34 triatomines collected in the intradomicile and in 31 of 224 triatomines collected in *A. butyracea* (Table 1).

The presence of residents infected with *T. cruzi*, which included children, indicates the active transmission of the parasite to the human population in the Colombian Orinoquía, where no intradomiciliary triatomine colonies were found. The elevated domiciliary infestation by adult *R. prolixus* insects in recently fumigated dwellings, a large proportion of which were infected with *T. cruzi*, can explain this transmission and reveal the ineffectiveness of fumigation for controlling intrusions by wild triatomines. The low physical protection of the dwelling and the discovery of infestation by large colonies of *R. prolixus* in the majority of the peridomiliary *A. butyracea* examined suggest that these colonies are the source of the domiciliary infestation.

The identification of the blood of domestic animals in the intestinal contents of the triatomines collected in palms and the blood of wild animals in the adult insects collected in the intradomicile indicates a constant flow of the populations of these insects from the palms toward the domiciles and the return of these to their wild habitats. This pattern may signify the extension of the wild transmission cycle to the human environment, a situation that highlights the contact risk of its inhabitants with these populations of infected triatomines, as was suggested earlier for this region.⁶ This flow of triatomines from wild ecotopes to dwellings has been previously documented in Colombia (K. P. Luna, Thesis Dissertation, Universidad Industrial de Santander, 2009) and Venezuela.^{13,14}

The infection of the human inhabitants with *T. cruzi* in this study agrees with that found in school-age children, in pregnant women, and in the general population in rural areas of this region,^{7,15} and it is similar to that found in the state of Barinas in Venezuela's Orinoquía.¹⁶

The observation of *T. cruzi* in 8.3% of the dogs examined, although much lower than the prevalence found in Venezuela and Panama,^{17,18} is similar to that found in dogs inhabiting dwellings with domiciliary triatomines in endemic areas of the Andes zone in Colombia.^{19,20} *Trypanosoma cruzi* I isolated in triatomines and mammals in this study is the discrete

typing unit most frequently found in Colombia and in *R. prolixus* in this region and is associated with severe cardiopathy in Colombia and Argentina.²¹

The presence of infected people, the high domiciliary infestation by permanent intrusion of infected adult specimens of *R. prolixus* from highly infested peridomiliary palms, and the identification of domestic and wild hosts as a common food source in palm and intradomiciliary triatomines and in infected dogs in the dwellings support the extension of the wild cycle of *T. cruzi* to human domiciles.

These findings are characterizing a new scenario of *T. cruzi* transmission to the residents in this region that is unlike what traditionally has been known in the Colombian Andes zone, where there are high densities and wide dispersion of mainly domestic *R. prolixus*.

The increasing emergence of human settlements by population migration to a territory recently incorporated into petroleum exploitation and the agroindustrial production of African palms as well as the inefficiency of traditional chemical measures for controlling the infestation by *R. prolixus* from palm species that are part of the natural landscape of the region require the implementation of a monitoring program for the detection and prompt treatment of acute infections.

Similarly, it is necessary to implement actions for health education and monitoring of the infestation and testing of new alternatives for the control of the permanent intrusion of triatomines and wild mammals to avoid the risk of vectorial transmission and oral transmission by food contamination.

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