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Morphometric evidence for a possible role of *Rhodnius prolixus* from palm trees in house re-infestation in the State of Barinas (Venezuela)

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Abstract

The main vector of Chagas disease in Venezuela is *Rhodnius prolixus.* Specimens of *Rhodnius* sp., identified elsewhere as *R. prolixus* by molecular tools, were collected in Barinas State (Venezuela) before insecticide application, and compared by morphometric techniques with post-spraying, re-infesting insects after control. Geometric morphometry was applied, allowing separate analyses of shape and size. The idea of a single species sharing silvatic and domestic/peri-domestic ecotopes was supported, suggesting new evolutionary scenarios for the controversial *R. prolixus* origins. The same data allowed to understand the possible mechanisms of villages re-infestation after a control campaign, either recolonization by local recovery of survivors or re-infestation by external migrants. Both mechanisms were apparent. Although shape properties could distinguish very close subpopulations such as insects from houses and insects from peri-domestic shelters, they were unable to identify the insects from palm trees as a distinct subpopulation. This strongly suggested that human environment could receive immigrants from palm trees. The pattern of size variation supported the hypothesis of a one-way exchange from silvatic to human environments, but did not support the reverse movement. Thus, morphometric data indicated that a silvatic population of the local vector is probably responsible for re-infesting villages after insecticide application, and they also pointed to the existence of re-infestation by local recovery of survivors. According to this interpretation, new epidemiological scenarios must be considered to improve Chagas disease control in Venezuela.

Keywords: *Rhodnius prolixus*; Chagas disease; Morphometrics; Vector control; Venezuela

1. Introduction

Chagas disease is a serious public health problem. It is endemic in 21 countries in Latin America. In 2002, it was estimated that 92,895,000 individuals were at risk of contracting the infection by *Trypanosoma cruzi* (WHO, 2002), while recent prevalence estimations varied between 17 (WHO, 2002) and 12 millions (Dujardin and Schofield, 2004).

The parasite is transmitted by “kissing bugs” (Hemiptera: Reduviidae: Triatominae). It is sustained in nature by a multitude of mammal reservoirs, leading to complex silvatic, peri-domestic, and domestic cycles (Miles et al., 2003). In certain areas, the maintenance

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of the domestic cycle by silvatic Triatominae makes the control of the vectorial transmission a difficult task. Since the 1960s, one of the longest control campaigns against Chagas disease was conducted in Venezuela with satisfactory results: the endemic area reduced from 750,000 km^2 to 365,000 km^2, the seroprevalence from 44.5% to 9.2% and the house "triatomine" infestation index from 60–80% to 8–11% (Aché and Matos, 2001). This programme also led to the reduction of the annual incidence in the susceptible population of endemic areas from approximately ten per 1000 people in the 1950s to one per 1000 in the 1980s (Feliciangeli et al., 2003). However, during the last decade the control program has weakened, and the vectorial transmission – which had not been completely interrupted – has increased (Feliciangeli et al., 2003). Moreover, recent observations of acute cases in absence of intradomestic vector populations in Barinas State (Añez et al., 1999) and Mérida State (Feliciangeli et al., 2002) suggested new epidemiological scenarios. In this regard, the study of the origin of domestic subpopulations of Triatominae after insecticide intervention is one track to be followed for which the usefulness of morphometry has been demonstrated in Triatominae (Dujardin et al., 1997; Dujardin and Schofield, 2004; Dujardin et al., 2007).

In Venezuela the situation is more complicated because of the presence of *Rhodnius robustus* and *R. prolixus*, two closely related and almost morphologically indistinguishable species. Although recent molecular studies could suggest more complex scenarios (Monteiro et al., 2003), the current theory presents *R. prolixus* as a domestic derivative of the silvatic *R. robustus*. Thus, *R. robustus* is thought to be the sylvatic source from which *R. prolixus* would have evolved by adapting to domestic structures (Schofield and Dujardin, 1999). The separation of these taxa would have subsequently occurred, leaving *R. robustus* confined to the sylvatic ecotope, while *R. prolixus* would have passively dispersed with humans throughout the northern part of South America (Venezuela, Colombia) as well as to Central America (Dujardin et al., 1998). In these latter territories, *R. prolixus* would have become an exclusively "domestic" species (Dujardin, 1998). On this base in 1997, the Venezuelan Government joined Colombia, Ecuador and Peru in signing the Andean Pact Initiative (WHO, 1997), committing these countries to the elimination of vectorial transmission of Chagas disease by 2010. Large-scale investment in mass interventions would greatly reduce Chagas disease burdens in the Andean region as it has in the Southern Cone (Guhl et al., 2005).

In the present study morphometric variation of shape and size of *R. prolixus* was explored at various spatial and ecotopic levels in the State of Barinas (Venezuela). Metric properties of the wings were used to disclose similarities or differences among domestic and silvatic subpopulations of the bugs. Our objective was to identify the possible source of village re-infestation by the vector of Chagas disease, with special emphasis on the possible role of palm tree subpopulations.

2. Materials and methods

2.1. The insects

2.1.1. Field collections and laboratory identification

Domestic and peri-domestic insects were collected indoors by trained personnel (active search or flushing out deltamethrin 0.2%) or by inhabitants that were previously asked to catch and keep insects (that they would see inside the houses) in carton boxes which had been previously left in the houses. In peri-domestic habitats only active search by trained personnel was carried out.

Collections of Triatominae from palm trees were performed by palm dissections (Gamboa, 1970) and by using live baited adhesive traps develop by Noireau et al. (2002) in palm trees situated in the proximity of houses also included in the study.

All Triatominae were kept in carton boxes with a code indicating the village, name of the householder and date of collection.

In the laboratory bugs were classified into species, sex and developmental stage. All specimens which did not fit the morphological properties of either *R. prolixus* or *R. robustus* (Lent and Wygodzinsky, 1979) were kept separately and were not included in this analysis. Moreover, the specimens used in this study were also submitted elsewhere to molecular analyzes, based on mt*cytB* sequences and microsatellites: all of them fitted the *prolixus* diagnostic of species (Fitzpatrick, 2006).

2.1.2. Geographic origin of the specimens

Thus, the entomological sample for this study was *R. prolixus* from 3 villages of Barinas State (Venezuela): Gallegos, Rio Bravo and Laguna Hermosa (Fig. 1). According to the Holdridge life zones classification by Ewel and Madriz (1968), these villages are located in a subtropical wet forest with an average temperature of 26.4 °C and annual rainfall ranging from 1300 mm to 1500 mm. The main economic activities of the area are cattle farming and the cultivation of maize, sorghum, yucca, and bananas. The most important house building materials of the study area are wooden or cement walls with palm or metal roof (Sanchez-Martin et al., 2007).