Presence of *Rhodnius ecuadoriensis* in Sylvatic Habitats in the Southern Highlands (Loja Province) of Ecuador

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ABSTRACT The main vectors of Chagas disease in Ecuador are *Triatoma dimidiata* and *Rhodnius ecuadoriensis*. The latter species occupies domestic and peridomestic habitats, as well as sylvatic ecotopes—particularly associated with *Phytelephas aequatorialis* palm trees—in the western coastal region of Ecuador. In the southern highlands, however, such palm tree habitats are uncommon, and sylvatic populations of *R. ecuadoriensis* have not previously been reported to date. This study was carried out in five rural communities in Loja Province in southern Ecuador, where manual triatomine searches were conducted in various sylvatic habitats. A total of 81 squirrel nests (*Sciurus stramineus*) and >200 bird nests and other habitats were searched. One hundred three *R. ecuadoriensis* individuals were found in 11 squirrel nests (infestation index = 13.6%, density = 2 bugs per nest searched, crowding = 9.5 bugs per infested nest, colonization index = 72.7% of infested nests with nymphs). No triatomines were found in bird nests or other sylvatic habitats. The presence of sylvatic *R. ecuadoriensis* in the southern highlands of Ecuador has important implications for the long-term control of Chagas disease in the region because of the possibility of reinfestation of dwellings after insecticide-based control interventions.

KEY WORDS Chagas disease, Ecuador, *Rhodnius ecuadoriensis*, *Sciurus stramineus*.

Triatominae are the vectors of Chagas disease (ChD). ChD is caused by the protozoan parasite *Trypanosoma cruzi* and is one of the most important parasitic diseases in Latin America, including Ecuador (Aguilar et al. 1999, WHO 2002). Fifteen different species of Triatominae (Reduviidae) have been reported in 18 of 24 Ecuadorian provinces (Abad-Franch et al. 2001; Grijalva et al. 2003, 2005). At least 13 of these species are potential vectors of ChD (Lent and Wygodzinsky 1979, Abad-Franch et al. 2000). The main vectors in Ecuador are *Triatoma dimidiata* and *Rhodnius ecuadoriensis*. *R. ecuadoriensis*, like other *Rhodnius* species, is mainly recorded from palmtree habitats (Gaunt and Miles 2000, 2002; Abad-Franch et al. 2001, 2002, 2005; Abad-Franch and Monteiro 2005). Reports indicate that *R. ecuadoriensis* is native to the coastal region in western Ecuador and occupies diverse ecotopes, including domestic, peridomestic, and sylvatic habitats; sylvatic populations have hitherto been recorded mainly from *Phytelephas aequatorialis* palm trees (Lent and Wygodzinsky 1979; Barrett 1991; Schofield 1994; Abad-Franch et al. 2000, 2001). In the southern highlands, particularly in Loja province, *R. ecuadoriensis* has been found to colonize domestic and peridomestic environments (Grijalva et al. 2005) and can establish large colonies associated with poultry, guinea pigs, and other domestic animals (Abad-Franch et al. 2002, Grijalva et al. 2005). The strong synanthropic behavior of *R. ecuadoriensis* and the absence of palm trees in southern Ecuador and northern Peru suggest that this species may have spread to the region through association with humans (Herrer et al. 1972, Abad-Franch et al. 2001, Vargas et al. 2007). Here we report the presence of sylvatic populations of *R. ecuadoriensis* in the southern highlands of Ecuador and discuss the implications of this finding for the long-term control of ChD in this region.

Materials and Methods

Study Area. This study was carried out in five rural communities of Loja Province, Ecuador: Amarillos (3.8633° S, 79.6853° W; 948–1,265 m above sea level [masl]) in Chaguarpamba county, La Ciénega (4.1960° S, 80.104° W; 580–870 masl) in Celica county, Galápagos (4.3556° S, 79.730° W; 1,200–1,400 masl) in Quilanga county, and Naranjo Dulce (4.0590° S, 79.6945° W; 1,200–1,650 masl) and Ashimingo (4.030° S, 79.730° W; 870–1,150 masl) in Paltas county (Fig. 1). This region has an average annual rainfall of 400 mm

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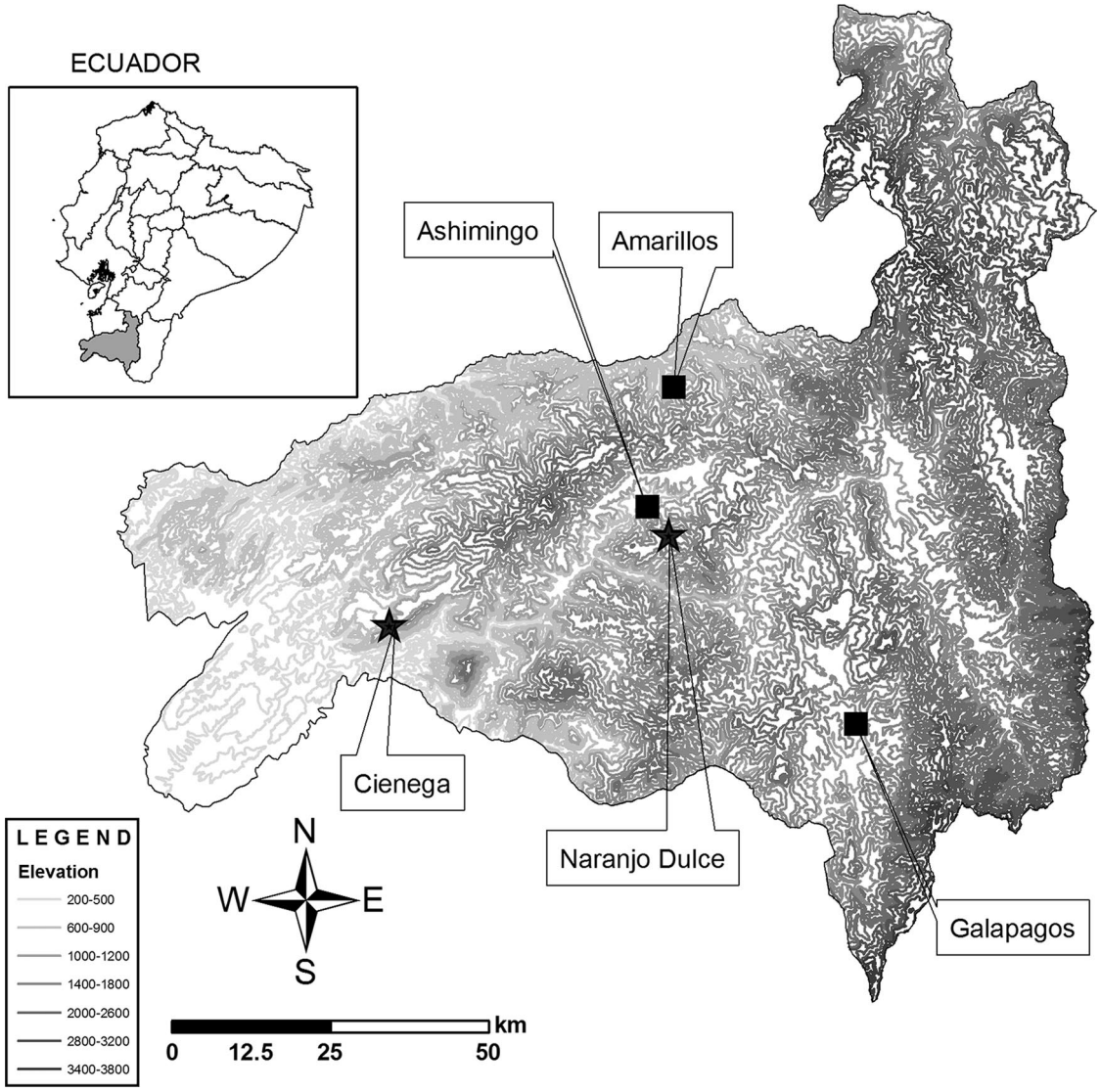

Fig. 1. Map of Loja province, Ecuador, showing the location of the studied communities. *Localities with presence of sylvatic *R. ecuadoriensis* (La Ciénega and Naranjo Dulce).

and two rainy seasons: February to May and October to November. There are also two dry seasons: June to September and a milder one in December to January (Grijalva et al. 2005).

Light Trapping. For one night, a light trap, constructed of a vertically stretched 2 by 2-m white sheet and illuminated by two 600-W mercury lamps, was placed in an open field near a wooded area located 600 m away from the nearest house in La Ciénega community. No light from the village could be seen from the wooded area or from the location of the light trap. All insects attracted to the light were collected by field entomologists and released if not identified as Triatominae.

Triatominae Collection in Sylvatic Habitats. Collections were made in wooded or open areas within a radius of ≈2 km around each village. Searches in potential triatomine habitats were conducted manually, including mammal and bird nests located in trees, bushes, piles of rocks, etc. Triatomines were collected and placed in labeled plastic containers, counted, and identified according to species and instar. The coordinates of each collection point and the identification of the vertebrate inhabitants of each nest were recorded.

Entomological Indexes. Infestation rate (no. of nest infested/no. of nests searched × 100), density (no. of triatomines captured/no. of nests searched), crowding (no. of triatomines captured/no. of nests infested), and colonization index (nests with nymphs/nests infested × 100) were calculated (WHO 2002, Grijalva et al. 2005).

Table 1. Entomological indices in squirrel nests near five rural communities at Loja Province in Ecuador

County	Community	Total *N* nests	Infested nests	All stages								Total no. Triatomines	Infestation index (%)	Density	Crowding	Colonization index (%)
				Eggs	NI	NII	NIII	NIV	NV	Adults						
										Females	Males					
Chaguarpamba	Amarillos	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Celica	La Ciénega	32	7	0	7	18	11	0	1	13	13	63	21.9	2.0	9.0	57.1
Quilanga	Galápagos	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paltas	Naranjo Dulce	20	4	0	0	11	16	10	0	2	1	40	20.0	2.0	10.0	100.0
	Ashimingo	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	81	11	0	7	29	27	10	1	15	14	103	13.6	1.3	9.5	72.7

Results

One male *R. ecuadoriensis* adult was collected using the light trap. The bug did not land on the illuminated white sheet but on the exposed leg of a person sitting ≈6 m away from the sheet.

Sylvatic *R. ecuadoriensis* were present in two of the five locations searched. A total of 81 squirrel nests (*Sciurus stramineus* Eydoux and Souleyet, 1841) were searched. Eleven of the nests were infested, defined as the presence of triatomines of any instar, with a total infestation index (IIn) of 13.6% in these habitats. One hundred three individuals of *R. ecuadoriensis* were found in squirrel nests (Table 1). None of the ≈200 birdnests and other sylvatic habitats searched were found to be infested with triatomines.

Discussion

High household infestation rates by infected vectors of ChD and human anti-*T. cruzi* seropositivity have been previously reported in southern Ecuador (Grijalva et al. 2005). Of the species found in this region, *R. ecuadoriensis* and *Triatoma carrioni* were found to colonize intra- and peridomestic habitats, with a few adult *Panstrongylus rufotuberculatus* and *P. chinai* found in the intradomicile. None of the searches conducted in sylvatic areas had previously yielded positive results, suggesting that elimination of *R. ecuadoriensis* and *T. carrioni* could be achieved in this region by indoor insecticide spraying. To evaluate the potential efficacy of this control strategy, we sought to increase our knowledge of triatomine ecology in the southern Ecuadorian highlands.

Populations of *R. ecuadoriensis* are widely distributed in the central coastal region of Ecuador and are usually associated with *Phytelephas aequatorialis* palm trees, a species endemic to humid areas of western Ecuador (Borchsenius et al. 1998; Abad-Franch et al. 2000, 2001; Cuba Cuba et al. 2002). Recently, colonization by *R. ecuadoriensis* of bird nests (*Campylorhynchus fasciatus* Passeriformes, Troglodytidae, and other unidentified species) not associated with *P. aequatorialis* was found in western Ecuador (M.J.G., unpublished results). In addition, this species is found in domestic and peridomestic habitats in this region. Conversely, in the southern highlands of Ecuador and northern Peru, *R. ecuadoriensis* had previously only been found in domestic and peridomestic habitats (Lent and Wygodzinsky 1979, Schofield 1994, Aguilar et al. 1999, Abad-Franch et al. 2001, Cuba Cuba et al. 2002, Grijalva et al. 2005, Vargas et al. 2007).

We found sylvatic *R. ecuadoriensis* in the southern highlands of Ecuador associated with nests of the squirrel *Sciurus stramineus*, known in English as Guayaquil squirrel. This species is widely distributed from Manabí Province in the central western coastal region of Ecuador to the western slope of the Andean region of northern Peru (Tirira 2007). The question remains as to whether these sylvatic populations were the precursors of the synanthropic populations of *R. ecuadoriensis* or if they represent a secondary adaptation of synanthropic populations to a suitable sylvatic habitat in the region. Morphological and molecular studies are being carried out to determine the relationship of sylvatic, peridomestic, and domestic populations of this species found in southern and western Ecuador.

Cuba Cuba et al. (2002) stated that, in Peru, the only report of *R. ecuadoriensis* in an uninhabited area is of a single nymph collected from a hollow tree (*Schinus molle*), suggesting that there is probably no true sylvatic ecotope in northern Peru and that its presence in the region is probably related to passive transportation in association with humans. The extent of triatomine infestation and colonization found in this study indicates a successful adaptation of *R. ecuadoriensis* to a sylvatic habitat in southern Ecuador. Despite considerable efforts, we could not find *T. carrioni*, an endemic species of epidemiological importance, *P. rufotuberculatus*, or *P. chinai* in sylvatic habitats.

The presence of *R. ecuadoriensis* in sylvatic habitats in southern Ecuador has profound implications for the long-term control of Chagas disease in this region. Even if the current high household infestation is eliminated through insecticide spraying, recolonization of domestic habitats by sylvatic populations may pose a major challenge for the vector control program and will require sustained surveillance and rapid intervention to prevent the reestablishment of vectorial transmission of *T. cruzi* in the region.

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