BRIEF COMMUNICATION

CHICKEN COOPS, *Triatoma dimidiata* INFESTATION AND ITS INFECTION WITH *Trypanosoma cruzi* IN A RURAL VILLAGE OF YUCATAN, MEXICO

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SUMMARY

This study longitudinally investigated the association between *Triatoma dimidiata* infestation, triatomine infection with *Trypanosoma cruzi* and household/backyard environmental characteristics in 101 homesteads in Molas and Yucatan, Mexico, between November 2009 (rainy season) and May 2010 (dry season). Logistic regression models tested the associations between insect infestation/infection and potential household-level risk factors. A total of 200 *T. dimidiata* were collected from 35.6% of the homesteads, mostly (73%) from the peridomicile. Of all the insects collected, 48% were infected with *T. cruzi*. Infected insects were collected in 31.6% of the homesteads (54.1% and 45.9% intra- and peridomiciliary, respectively). Approximately 30% of all triatomines collected were found in chicken coops. The presence of a chicken coop in the backyard of a homestead was significantly associated with both the odds of finding *T. dimidiata* (OR = 4.10, CI 95% = 1.61-10.43, p = 0.003) and the presence of triatomines infected with *T. cruzi* (OR = 3.37, CI 95% = 1.36-8.33, p = 0.006). The results of this study emphasize the relevance of chicken coops as a putative source of *T. dimidiata* populations and a potential risk for *T. cruzi* transmission.

KEYWORDS: Peridomicile; *Triatoma dimidiata*; *Trypanosoma cruzi*; Chagas disease.

In the Mexican state of Yucatan, Chagas disease is an endemic zoonosis transmitted domestically by *Triatoma dimidiata* Latreille 1811 (Hemiptera: Reduviidae), the only locally proven vector. *T. dimidiata* can be collected in domestic, peridomestic and sylvatic habitats of Yucatan. House infestation is described as seasonal, occurring mainly due to the dispersal of adult insects from peridomestic and sylvatic habitats during the late dry season with non-apparent or limited colonization. Few studies in Yucatan have examined the importance of household and backyard characteristics in the prevalence of triatome infestations and their infection rates with *T. cruzi* in and around houses. GUZMÁN-MARÍN *et al.* reported that household triatome infestation in rural communities was associated with the type/quality of housing, e.g., construction with natural materials, thatched roofs, unplastered walls or walls with adobe plastering and the lack of cemented floors. However, other studies have reported that the location of a house within a community (especially if located on the periphery) is a significant risk factor for infestation and the invasion of dispersing adult insects. REYES-NOVELO *et al.* showed that *T. dimidiata* did colonize animal shelters (e.g., chicken and dove coops, dog houses and opossum nests). More recently, DUMONTEIL *et al.* quantified that the number of dogs in a house and keeping chickens in a corral were strong determinants for house infestation in rural communities. Such findings from Yucatan agree with reports of house infestation and colonization by *T. dimidiata* in Guatemala. This study confirms the significance of the peridomicile environment, and particularly of chicken coops, as a source of *T. dimidiata* populations and a potential risk factor for *T. cruzi* transmission in a rural village in Yucatan, Mexico.

Fieldwork was carried out between November 2009 and May 2010 in a sample of 101 homesteads (each homestead including the house and all peridomestic structures found in the front and backyard) from Molas, a rural village located in the Southeast of Mexico (20° 48’58” N and 089° 37’54” W). The community has a population of 2,014 inhabitants, living in 553 houses and surrounded by a subtropical deciduous forest within the Cuxtal ecological reserve. Altitude is 10 m, a.s.l. Climate is characterized by an average annual temperature of 25.9 °C, with an annual rainfall of 800-1000 mm, occurring mainly between June and November. Molas is located within the highest risk area for Chagas disease in the state of Yucatan.

Homestead infestation with triatomines was evaluated through: i) active collections both intra- and peridomiciarily and; ii) householders’...
participatory collections within the houses. Two cross-sectional timed manual active searches for triatomines (described by Gürtler et al. 1999) were performed, one during the 2009 rainy season (November) and the other one during the 2010 dry season (May).

Collections were performed inside houses (interdomiciliary) and in front/backyards (peridomiciliary) by teams of two trained research personnel (30 min in each ecotope to complete one man/hour/homestead between 8:00 a.m. and 1:00 p.m.). Intradomiciliary searches included inside walls, the base of the roof and furniture. Peridomiciliary searches focused on animal housing, rock and woodpiles, tree trunks, and any other potential triatoma refuges. In addition, householders were invited to take part in a six-month participatory vector surveillance strategy between December and March, 2010.

Trypanosoma cruzi DNA extraction from individual triatomines and PCR amplification of T. cruzi kinetoplast DNA were performed as described by REYES-NOVELO et al. and EDWARDS et al. and MOSER et al. protocols. The primers used were TcZ1: 5'-CGAGCTTTGCCCACCGGGTGCT-3' and TcZ2 5'-CCCTCAAGCAGCGGATAGTTCAGG-3'. Amplification was performed in a Techne TC132 (Barloworld Scientific LTD, Staffordshire, UK) thermal cycler. A 188bp fragment identified the presence of T. cruzi DNA following the electrophoresis of a percentage of PCR product in a 2% agarose-TBE stained with ethidium bromide (10 µg/mL) and further documentation in an EDAS 290 gel documentation system (Kodak, Rochester, USA). Local strains of T. cruzi were used as positive controls, whereas the whole mixture minus DNA was used as a negative control.

A household survey was performed to investigate a range of household/backyard characteristics previously reported as significant in the infestation of T. dimidiata and other triatomines - type/material of the house (roof, walls, floor); use of window screening; presence of rubbish, rock/wood piles, stone walls, abandoned lots on the sides; the presence of domestic animals e. g. dogs, cats, poultry, horses, sheep, cattle, and the presence of animal housing structures (organized by species) e. g. chicken coops, pig corrals, house stables and kennels.

Using a Fisher’s exact test, statistical analyses compared the sex and stage of development of T. dimidiata between locations (intra- and peridomnicile). Comparisons of infection by sex between seasons were not performed because of the low number of insects collected. Tests were carried out to study the association between triatoma infestation (positive homesteads) and T. cruzi infection with household-level potential risk factors. Variables of interest were analyzed using χ² to reduce the model, by comparing percentages in contingency tables. Those with p < 0.25 were included in a logistic regression analysis. Adjusted Odds Ratio and Confidence Intervals (α = 0.05) were calculated with SPSS® (v17.0).

A total of 200 T. dimidiata specimens were collected from 35.6% (36/101) homesteads throughout the study period (Table 1). Overall, a greater number of adults were collected than nymphs (p < 0.05), with a higher male:female abundance ratio (p < 0.05) between ecotopes (Table 1). The majority of specimens (73%) - both adults and nymphs - were collected in the peridomnicile environment; nevertheless, 22.5% of the adults and 4.5% of the nymphs collected were reported to have been found intradomiciliary.

Collection methods were complementary. Active collections yielded more specimens (65%) than participatory collections. 130 T. dimidiata specimens were captured by active collection, mostly peridomniciliary (97.7%), with a sample composed by adults and nymphs in a similar ratio. 70 specimens of T. dimidiata were captured through householders’ collections, mostly reported as intradomiciliary (74.3%) and consisting mostly of adult triatomines (77%).

Overall, 48% (96/200) of the T. dimidiata specimens collected tested positive for T. cruzi (Table 1) and were found in 31.6% (32/101) of homesteads. The infected specimens were mostly adults (p < 0.05); but the proportion of nymphs infected was high (37.5%). Slightly more infected T. dimidiata were found intradomiciliary (54.1%) than in the peridomnicile environment (45.9%). Infection prevalence detection was higher in participatory collections (59/70) than in active collections (37/130) (p < 0.05).

Table 1

|                  | Total (%) | Nymphs (%) |Adults (%) |♀ (%) |♂ (%)|
|------------------|-----------|------------|-----------|------|------|
| Infestation      |           |            |           |      |      |
| Intradomiciliary | 54 (27.0) | 9 (16.7)   | 45 (83.3) | 19   | 26   |
| Peridomiciliary  | 146 (73.0)| 79 (54.1)  | 67 (45.9) | 42   | 25   |
| Total            | 200 (100) | 88 (44.0)  | 112 (56.0)*| 61   | 51   |
| Infection        |           |            |           |      |      |
| Intradomiciliary | 52 (54.1) | 9 (17.3)   | 43 (82.7) | 18   | 25   |
| Peridomiciliary  | 44 (45.9) | 27 (61.4)  | 17 (38.6) | 8    | 9    |
| Total            | 96 (100)  | 36 (37.5)  | 60 (62.5)*| 26   | 34   |

* Significant statistical difference in the frequencies of developmental stage and sex between locations, as given by Fisher’s exact test (p < 0.05). Statistical tests regarding infestation and infection were performed separately.
This study shows that chicken coops are a risk factor for insect infestation and parasite infection. Nonetheless these findings should be re-evaluated in other communities infested by *T. dimidiata*.

**RESUMEN**

Gallineros, la infestación por *Triatoma dimidiata* y su infección con *Trypanosoma cruzi* en una localidad rural de Yucatán, México

Investigamos longitudinalmente la asociación entre la infestación por *Triatoma dimidiata*, su infección con *Trypanosoma cruzi* y las características ambientales de los domicilios/peridomicilios en 101 viviendas de Molas, Yucatán, México entre Noviembre de 2009 (temporada lluviosa) y Mayo de 2010 (temporada seca). Mediante modelos de regresión logística se probaron asociaciones entre la infestación/infección de *T. dimidiata* y factores de riesgo potenciales a nivel de las viviendas. Se colectó un total de 200 individuos de *T. dimidiata* en el 35.6% de las viviendas, mayormente del peridomicilio (73%). De todos los triatominos colectados el 48% se encontraron infectados con *T. cruzi*. Los triatominos infectados fueron colectados en el 31.6% de las viviendas (54.1% y 45.9% en intra y peridomicilio).
respective). Aproximadamente el 30% de todos los triatominos colectados, fueron encontrados en gallineros. La presencia de un gallinero en el peridomicilio de una vivienda se asoció significativamente tanto con las posibilidades de encontrar *T. dimidiata* (OR = 4.10, CI 95% = 1.61-10.43, p = 0.003) como con la presencia de triatominos infectados con *T. cruzi* (OR = 3.37, CI 95% = 1.36-8.33, p = 0.006). Los resultados de este estudio enfatizan la relevancia de los gallineros como fuente putativa de poblaciones de *T. dimidiata* y como una fuente potencial de riesgo de transmisión de *T. cruzi*.

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**REFERENCES**

1. Cohen JM, Wilson ML, Cruz-Celis A, Ordoñez R, Ramsey JM. Infestation by *Triatoma pallidipennis* (Hemiptera: Reduviidae: Triatominae) is associated with housing characteristics in rural Mexico. J Med Entomol. 2006;43:1252-60.

2. Dumonteil E, Gourbière S, Barrera-Pérez M, Rodríguez-Félix E, Ruiz-Piña H, Baños-López O, et al. Geographic distribution of *Triatoma dimidiata* and transmission dynamics of *Trypanosoma cruzi* in the Yucatan peninsula of Mexico. Am J Trop Med Hyg. 2002;67:176-83.

3. Dumonteil E, Gourbière S. Predicting *Triatoma dimidiata* abundance and infection rate: a risk map for natural transmission of Chagas disease in the Yucatan peninsula of Mexico. Am J Trop Med Hyg. 2004;70:514-9.

4. Dumonteil E, Ramírez-Sierra MJ, Ferral J, Enán-García M, Chavez-Nuñez L. Usefulness of community participation for the fine temporal monitoring of house infestation by non-domiciliated triatomines. J Parasitol. 2009;95:469-71.

5. Dumonteil E, Nouvellet P, Rosecrans K, Ramírez-Sierra MJ, Gamboa-León MR, Cruz-Chan JV, et al. Eco-Bio-Social determinants for house infestation by non-domiciliated *Triatoma dimidiata* in the Yucatan peninsula, Mexico. PLOS Negl Trop Dis. 2013;7:e2466.

6. Edwards K, Johnstone C, Thompson C. A simple and rapid method for the preparation of plant genomic DNA for PCR analysis. Nucleic Acid Res. 1991;19:1349.

7. Gourbière S, Dumonteil E, Rabinovich JE, Minkoue R, Menu F. Demographic and dispersal constraints for domestic infestation by non-domiciliated Chagas disease vectors in the Yucatan Peninsula, Mexico. Am J Trop Med Hyg. 2008;78:133-9.

8. Guzmán-Marín E, Barrera-Perez M, Rodríguez-Félix ME, Escobedo-Ortegon F, Zavala-Velázquez J. Índices entomológicos de *Triatoma dimidiata* en el estado de Yucatán. Rev Biomed. 1991;2:20-9.

9. Guzmán-Marín E, Barrera-Perez M, Rodríguez-Félix ME, Zavala-Velázquez J. Hábitos biológicos de *Triatoma dimidiata* en Yucatán, México. Rev Biomed. 1992;3:125-31.

10. Guzmán-Tapia Y, Ramírez-Sierra M, Dumonteil E. Urban infestation of *Triatoma dimidiata* in the city of Mérida, Yucatán, México. Vector Borne Zoonotic Dis. 2007;7:597-606.

11. Monroy CM, Bustamante DM, Rodas A, Enriquez ME, Rosales R. Habitats, dispersion and invasion of sylvatic *Triatoma dimidiata* (Hemiptera: Reduviidae: Triatominae) in Peten, Guatemala. J Med Entomol. 2003;40:800-6.

12. Moser D, Kirchoff LV, Donelson JE. Detection of *Trypanosoma cruzi* by DNA amplification using the polymerase chain reaction. J Clin Microbiol. 1989;27:1477-82.

13. Ramírez-Sierra MJ, Herrera-Aguilar M, Gourbière S, Dumonteil E. Patterns of house infestation dynamics by non-domiciliated *Triatoma dimidiata* reveal a spatial gradient of infestation in rural villages and potential insect manipulation by *Trypanosoma cruzi*. Trop Med Int Health. 2010;15:77-86.

14. Reyes-Novelo E, Ruiz-Piña HA, Escobedo-Ortegon J, Barrera-Perez M, Manrique-Saide P, Rodríguez-Vivas RJ. *Triatoma dimidiata* (Latreille) abundance and infection with *Trypanosoma cruzi* in a rural community of Yucatan, Mexico. Nottrop Entomol. 2013;42:317-24.

15. Starr MD, Rojas JC, Zeldeón R, Hirú DW, Carpenter TE. Chagas’ disease: risk factors for house infestation by *Triatoma dimidiata*, the major vector of *Trypanosoma cruzi* in Costa Rica. Am J Epidemiol. 1991;133:740-7.

16. Zeldeón R, Montenegro VM, Zeldeón O. Evidence of colonization of man-made ecotopes by *Triatoma dimidiata* (Latreille, 1811) in Costa Rica. Mem Inst Oswaldo Cruz. 2001;96:659-60.

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