

Short communication

Seasonal variation in the home range and host availability of the blood-sucking insect *Mepraia Spinolai* in wild environment

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Abstract

In this study, we quantify the home range of *Mepraia spinolai*, a wild vector of *Trypanosoma cruzi*, and the abundance of wild mammals during summer and winter seasons in a protected area of north-central Chile. Results revealed significant differences between seasons for home range size and host availability. *M. spinolai* presented larger home range sizes, and mammal hosts were more abundant in summer, indicating that *T. cruzi* would have a higher probability of being transmitted during warmer months.

Keywords: Triatominae; Reduviidae; Protozoa; Parasite; Vector; Chagas disease

In vector-borne parasites, transmission depends on the frequency of effective contacts between definitive hosts and vectors. Therefore, the probability of a host being infected will increase with the number of times the host is bitten (Dobson and Hudson, 1995; Canals et al., 1999a,b). Within this context, life history characteristics of vectors, such as longevity and mobility, are crucial for transmission (Dye and Williams, 1995).

Mobility can be thought as neighborhood dispersal, i.e., the process by which individuals migrate into adjacent areas. Mobility in animals depends on their home range size that is the area over which individuals search for food, mates, and shelters. Many blood-sucking insects are vectors of disease, and the assessment of their home range, in an individual or colonial base, is valuable in the study of disease transmission.

Mepraia spinolai Porter, 1934, is a blood-sucking insect restricted to semiarid and arid zones of north-central Chile. This insect is the only conspicuously

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polymorphic triatomine species, presenting macropterous, brachypterous or micropterous males, and micropterous females (Lent and Wygodzinsky, 1979). This endemic species has been reported as naturally infected by *Trypanosoma cruzi*, the causative agent of Chagas disease (Lent and Wygodzinsky, 1979; Ordenes et al., 1996). DNA evidence of *T. cruzi* in *M. spinolai* populations from northern Chile indicates that 46.2% of the insects are infected (Botto-Mahan et al., 2005). Recently, Canals et al. (2001) reported a human blood index for this species of 4.6%, which is almost 2-fold higher than the one previously reported. Even though, *M. spinolai* individuals are often found in stony hills, rock crevices, nest of birds and mammals, and corrals of domestic animals, they can occasionally be collected in human dwellings (Lent and Wygodzinsky, 1979; Frías et al., 1995; Canals et al., 1999a,b). Therefore, *M. spinolai* is a potentially dangerous species due to the high level of *T. cruzi* infection and increasing house colonization in country areas specially after the domestic vector, *Triatoma infestans*, has been technically eradicated (Valdés et al., 2001; Cattan et al., 2002).

Unlike other triatomines, *M. spinolai* is a diurnal insect with a peak of activity at noon (Canals et al., 1997). This long-lived species is relatively sedentary in the absence of potential hosts, showing a general sit-and-wait strategy for host finding. However, a high locomotory capability is shown as soon as a potential host comes close to their refuges, being able to detect and actively follow mammals over several meters (P. Cattan, unpublished data). In this sense, the home range of *M. spinolai*, quantified as a colony, will depend on the insect mobility and availability of potential hosts in the area, and this in turn will impact on the probability of transmission and dispersal of *T. cruzi*. In this study, we assess the transmission potential of *T. cruzi* during summer and winter seasons, by quantifying the home range of wild populations of *M. spinolai* and the availability of host mammals in a protected area of northern Chile.

This study was conducted in a protected area, Las Chinchillas National Reserve, located approximately 300 km north from Santiago (31°30'S, 71°06'W; Chile). In this area, the climate corresponds to a semi-arid Mediterranean type with scarce rainfall concentrated in the winter season (di Castri and Hajek, 1976). Fieldwork was carried out in January and July 1999

(austral summer and winter, respectively) in stony sites with scarce human activity and traffic of cattle yard animals.

Home range size was estimated by using capture, marking and recapture procedures in nine and six sites for summer and winter, respectively. Capturing areas presented similar microtopographic features, therefore, nymphs could equally disperse in all directions. Estimation trials were carried out at midday in consecutive days. In each trial, fifty nymphs (IV and V instars) were captured by hand, painted with non-toxic red powder on the connexivum, and released at the center of a 2 m radius capturing area. Two hours later, in a trial of 1 h, two observers distant 2 m from the releasing point recorded the location of painted nymphs in the capturing area or beyond it. In order to avoid any influence of observers in the locomotion behavior of *M. spinolai*, the observers moved randomly every 10 min keeping constant the distance to the releasing point. The home range size was estimated through the minimum-area method (Southwood and Henderson, 2000). In addition, the maximum distance traveled by insects was recorded. Data were log-transformed for normality and analyzed by one-way ANOVAs with season as single factor (Sokal and Rohlf, 1995).

We estimated the abundance of natural hosts of *M. spinolai* including native rodents *Phyllotis darwini* (Muridae), *Octodon degus* (Octodontidae), *Abrothrix olivaceus* (Muridae), *Olygorizomys longicaudatus* (Muridae) and *Abrocoma benetti* (Abrocomidae), and the native marsupial *Thylamys elegans* (Didelphidae) (Canals et al., 2001). Host abundance was estimated in January and July 1999 using trapping lines. Each 20 × 1 trapping line had stations separated by 10 m, covering an area of 10 m × 200 m including a boundary strip of 5 m. Trapping lines were equipped with Sherman traps activated during 14 and 7 consecutive nights for summer and winter seasons, respectively. Traps were baited with oat flakes and checked every morning. The captured animals were hair marked and released at the trapping place. Host abundance was estimated as the average number of mammals captured during consecutive nights in the trapping area. As before, data were log-transformed for normality and contrasted by one-way ANOVA with season as single factor (Sokal and Rohlf, 1995).

The home range of *M. spinolai* differed significantly between seasons (one-way ANOVA: $F_{1,13} = 7.03$;

Table 1

Home range size and maximum distance traveled by insects from wild populations of *M. spinolai* during summer and winter seasons at Las Chinchillas National Reserve (IV Region, Chile)

Trial number	Summer season			Winter season		
	Home range (m ²)	Maximum distance (m)	Maximum temperature (°C)	Home range (m ²)	Maximum distance (m)	Maximum temperature (°C)
1	83.3	27.60	19.8	1.20	1.80	12.4
2	10.59	5.20	23.0	2.30	3.70	19.4
3	78.20	16.80	26.3	10.73	6.70	13.0
4	5.57	6.20	22.5	2.00	2.00	14.6
5	1.48	2.10	26.5	18.70	10.70	11.0
6	26.10	4.80	28.0	2.00	3.50	12.0
7	160.70	21.50	19.6	–	–	–
8	28.14	12.00	21.0	–	–	–
9	30.80	13.00	24.0	–	–	–
Mean ± S.E.	47.21 ± 17.23	12.13 ± 2.86	23.41 ± 1.01	6.16 ± 2.90	4.73 ± 1.39	13.73 ± 1.23

Maximum temperatures for experimental days are indicated for both seasons.

$P = 0.019$), being 7.7-fold larger in summer than in winter season (Table 1). The maximum distance traveled by insects differed marginally between seasons, being 2.6-fold higher in summer than in winter season (one-way ANOVA: $F_{1,13} = 4.51$; $P = 0.054$; Table 1).

Overall, our results suggest that the higher locomotion shown by *M. spinolai* in warm summer months may favour *T. cruzi* transmission to native mammals inhabiting wild areas. Probably, the same high risk of infection is affecting local people living in dwellings associated to stony places. Unfortunately, to our knowledge no information about home range of other wild triatomine species has been reported to compare with our results. Cattán et al. (2002) showed that the maximum overall densities of *M. spinolai* in wild and domestic habitats occurs in austral summer months, from February to March, which supports the idea of a higher *T. cruzi* transmission risk during warmer months. In addition, our suggestion about higher transmission during summer is consistent with the results reported by Schilman and Lazzari (2004). These authors measured the rate of weight loss for *Rhodnius prolixus* at different environmental temperatures, and proposed an increase in the probability of Chagas disease transmission with increasing temperature due to a higher meal consumption rate with it consequent increase in biting rate. In our study site, we found strong differences between maximum temperatures for summer and winter days. Maximum temperatures in experimental summer days were almost 10°C higher than

experimental winter days (Table 1). This difference in environmental temperature is likely to be the mechanistic explanation of the significant difference in the home range detected between summer and winter due to an increase of locomotory activity with higher temperature.

Regarding the abundance of potential hosts, results indicate that host availability significantly differed between seasons (one-way ANOVA: $F_{1,19} = 5.04$; $P = 0.037$), being 2-fold higher in summer than in winter season (Table 2). This result indicates that more native mammals are available as potential blood-donors and parasite-recipients during warm months.

Table 2

Total number of native mammals captured during 14 and 7 consecutive nights of summer and winter seasons, respectively, at Las Chinchillas National Reserve (IV Region, Chile)

Species	Total number of individuals captured	
	Summer season	Winter season
<i>P. darwini</i>	48	18
<i>O. degus</i>	9	26
<i>A. olivaceus</i>	40	14
<i>O. longicaudatus</i>	1	11
<i>A. benetti</i>	5	4
<i>T. elegans</i>	7	8
Mean number of mammals per hectare ± S.E.	7.54 ± 1.12	3.94 ± 0.99

In summary, our results suggest that transmission of *T. cruzi* to native mammals, and probably to local people and pasturing cattle using wild environments, may be contingent to the time of the year on which it is measured. We suggest that risk of transmission would be higher in warmer than colder months as a result of differential vector mobility. Even though many other factors may influence vectorial transmission (e.g., seasonal changes in infectivity and vector population structure), home range and host availability assessments may help to understand vectorial competence in wild cycles of Chagas disease.

Acknowledgements

We thank the following students for collaboration during the fieldwork: M. Ehrenfeld and C. Garín. We thank R. Medel for useful comments on the manuscript. CONAF IV Region authorized this study at LCNR. This study was supported by FONDECYT 1980768 to PEC, and FONDECYT 2010022 to CBM. Additionally, FONDECYT 3050033 to CBM supported final writing of this article. CBM thanks CONICYT-fellowship for graduate studies.

References

- Botto-Mahan, C., Ortiz, S., Rozas, M., Cattán, P.E., Solari, A., 2005. DNA evidence of *Trypanosoma cruzi* in the Chilean wild vector *Mepraia spinolai* (Hemiptera: Reduviidae). Mem. Inst. Oswaldo Cruz 100, 000–000 (in press).
- Canals, M., Solis, R., Valderas, J., Ehrenfeld, M., Cattán, P.E., 1997. Preliminary studies on temperature selection and activity cycles *Triatoma infestans* and *T. spinolai* (Heteroptera: Reduviidae) Chilean vectors of Chagas disease. J. Med. Entomol. 34, 11–17.
- Canals, M., Bustamante, R.O., Ehrenfeld, M., Cattán, P.E., 1999a. Assessing the impact of disease vectors on annual populations. Acta Biotheor. 46, 337–345.
- Canals, M., Solis, R., Tapia, C., Ehrenfeld, M., Cattán, P.E., 1934. Comparison of some behavioral and physiological feeding parameters of *Triatoma infestans* Klug, 1834 and *Mepraia spinolai* Porter vectors of Chagas disease in Chile. Mem. Inst. Oswaldo Cruz 94, 687–692.
- Canals, M., Cruzat, L., Molina, M.C., Ferreira, A., Cattán, P.E., 2001. Blood host sources of *Mepraia spinolai* (Heteroptera; Reduviidae), wild vector of Chagas disease in Chile. J. Med. Entomol. 38, 303–307.
- Cattán, P.E., Pinochet, A., Botto-Mahan, C., Acuña, M.I., Canals, M., 2002. Abundance of *Mepraia spinolai* in a Periurban zone of Chile. Mem. Inst. Oswaldo Cruz 97, 285–287.
- di Castri, F., Hajek, E.R., 1976. Bioclimatología de Chile. Ediciones de la Universidad Católica de Chile, Santiago Chile.
- Dobson, A.P., Hudson, P.J., 1995. Microparasites: observed patterns in wild animal populations. In: Grenfell, B.T., Dobson, A.P. (Eds.), Ecology of Infectious Diseases in Natural Populations. Cambridge University Press, Cambridge, pp. 52–89.
- Dye, C., Williams, B.G., 1995. Non-linearities in the dynamics of indirectly-transmitted infections (or, Does having a vector make a difference?). In: Grenfell, B.T., Dobson, A.P. (Eds.), Ecology of Infectious Diseases in Natural Populations. Cambridge University Press, Cambridge, pp. 260–279.
- Friás, D., Solari, A., González, C., Henry, A., Alviña, A., 1995. Indices de infección de *Mepraia spinolai* con *Trypanosoma cruzi*, su invasión a ambientes domésticos e interacción con *Triatoma infestans*. Parasitol. al Día 19, 195.
- Lent, H., Wygodzinsky, P., 1979. Revision of the triatominae (Hemiptera: Reduviidae) and their significance as vectors of Chagas disease. Bull. Am. Mus. Nat. Hist. 163, 130–138.
- Ordóñez, H., Ehrenfeld, M., Cattán, P.E., Canals, M., 1996. Infección tripano-triatomina de *Triatoma spinolai* en una zona de riesgo epidemiológico. Rev. Med. Chile 124, 1053–1057.
- Schilman, P.E., Lazzari, C.R., 2004. Temperature preference in *Rhodnius prolixus*, effects and possible consequences. Acta Tropica 90, 115–122.
- Sokal, R.R., Rohlf, F.J., 1995. Biometry. The Principles and Practice of Statistics in Biological Research. WH Freeman and Company, New York, NY.
- Southwood, T.R.E., Henderson, P.A., 2000. Ecological Methods. Blackwell Science, Cambridge.
- Valdés, J., Correa, V., Melendez, F., Mejías, G., Parra, A., Segura, J.A., Lorca, M., 2001. Criterios Técnicos para la eliminación de *Triatoma infestans* en Chile. Publicaciones Minsal, Ministerio de Salud. Gobierno de Chile.