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EPIDEMIOLOGICAL ROLE OF HUMANS, DOGS AND CATS IN THE TRANSMISSION OF TRYPANOSOMA CRUZI IN A CENTRAL AREA OF ARGENTINA (*)

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SUMMARY

Trypanosoma cruzi prevalence rates of human, dog and cat populations from 47 households of 3 rural localities of the phytogeographical Chaqueña area of Argentina were determined both by serological and xenodiagnostic procedures. Human prevalence rates were uniform and ranged from 49.6 to 58.7%. Overall prevalence rate in dogs (75.6%) was significantly higher than in humans (51.0%). The overall proportion of parasitemic individuals assessed by xenodiagnosis was significantly higher in either dog (64.2%) or cat (63.6%) populations than among humans (12.5%). Although both the average number of resident as well as infected individuals per household was higher for people than for dogs (6.5 vs. 3.3, and 3.4 vs. 2.4, respectively), the reverse was recorded when parasitemic individuals were considered (1.0 vs. 2.1). Results are discussed in relation to dog between dogs and people, and dogs and bugs. In the light of present data, dogs must be considered as the major donors of parasites to vector bugs and thus, principal contributors to transmission in this region of Argentina.

INTRODUCTION

High **T. cruzi** prevalence rates in dogs (over 50%) and in human populations have been reported from rural areas of Argentina [23], Venezuela [20] and Bolivia [28]. Lower infection rates in dogs (relying upon diagnostic methods of different sensitivity) ranging from 10 to 30 per cent, have been found in other countries of Central and South America [1,2,4,5,9,12-14,17-19,21,22,27,31], suggesting the existence of different epidemiological circumstances in the area.

The epidemiological importance of domestic reservoirs has been clearly stated in Brazil by MOTT et al. [17], who found a clear-cut association between seroreactivity in children below age 10 and the presence of at least one **T. cruzi**-infected dog or cat in their houses. On the other hand, extensive field data from FREITAS [9] in Brazil show a significantly higher proportion of parasitemic individuals among either dogs or cats than in the human population, suggesting that these hosts are differently involved in transmission.

The present work was undertaken to compare the prevalence of **T. cruzi** infection among dog, cat and human populations of different rural villages of the phytogeographical Chaqueña area of Argentina to establish and epidemiological pattern of the region.

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MATERIALS AND METHODS

The study was carried out in the Province of Santiago del Estero, localities of La Invernada and Amamá, and in the Province of Córdoba, locality of Guanaco Muerto, between 1979 and 1982, all of them belonging to the phytogeographical Chaqueña area [3] (Fig. 1). The area is semiarid, with a mean annual rainfall of 500-750 mm, mainly in summer, and a mean annual temperature between 20 and 23°C. Vegetation is mainly xerophytic, varying from a dense, thorn forest of "quebracho" (**Schinopsis lorentzii**) in Amamá, to deforested areas destined to agriculture or livestock raising in La Invernada and Guanaco Muerto.

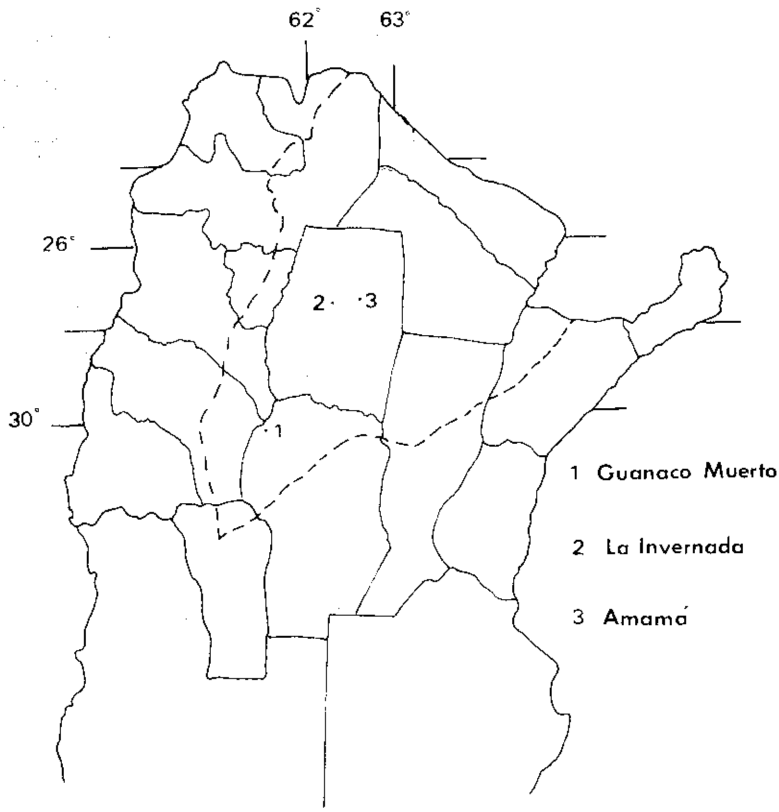

Fig. 1 — Map of central and north of Argentina showing the phytogeographical Chaqueña area (in dashed lines) and the localities surveyed

Access to settlements was usually through long-extending narrow pathways in the forest, inaccesible after heavy rains. La Invernada was the only locality placed along a paved road and with an incipient socio-economic development. Houses were usally isolated in the forest forming small groups and followed similar construction patterns: 2 contiguous rooms with mud-brick or mud-stick walls, either plastered or unplastered with mud, and a roof of longitudinaly piled shrubs covered with mud. The roof extended to the front in a porch [29]. Only 6 households from La Invernada with improved building structures departed from this scheme. Peridomiciliary structures, storerooms and kitchens, were located 20-30 m from the main house, and were built in a way similar to them. Goatpens were placed 50-100 m from bedrooms.

Sporadical burning of BHC tablets by local inhabitants was the only means of domestic bug control applied in all areas; insecticide spraying of households by the official executer of the vector control campaign was undertaken several times in La Invernada and only twice in Guanaco Muerto between 1963 and 1972. Houses around Amamá were never sprayed.

All house-dwellers and domestic animals were censused, and information on cultural and economic activities as well as habits was required from them. Blood samples for serologic studies were obtained from every member of the household and dogs and cats. When necessary, animals were anaesthetized by intramuscular injection of 10 mg/kg Ketalar^R (Parke-Dávis, Argentina). Blood for serologic studies was conserved as already described[23], with the exception of human sera from Amamá which were mixed with an equal volume of buffered (Sörensen pH 7.2, u=0.005) glycerine (Merck^R) and kept at room temperature for one week. Serological studies performed to human and domestic animals sera included: a) Direct agglutination test; b) Indirect hemagglutination test; c) Complement fixation test; d) Indirect immunofluorescence antibody test (only for human sera); using the techniques previously described[23]. Six sera from laboratory infected dogs[11] and an equal number from dogs of non endemic areas were used as positive and negative controls in serological tests of domestic animals.

Two xenodiagnosis boxes containing 10 third or fourth instar **T. infestans** nymphs each, were applied to children up to 12 years old and on dogs and cats. Four boxes were applied on human individuals older than 12 years old. Human population from Guanaco Muerto and adult people from Amamá were not examined by xenodiagnosis.

The rectal contents of bugs mixed with physiological saline solution were searched for trypanosomes 30 and 60 days after feeding[6]. Two wet preparations were made from each box and microscopically examined at 400 X.

Bug collections were carried out in each household after spraying walls and roofs with a synthetic pyrethrin solution (neopynamin 0.2%). Search for trypanosomes and blood meal identification studies were performed later at the laboratory as already described[29].

RESULTS

A total number of 47 households from the 3 localities were visited. The survey included 17 households from 400 in La Invernada, 9 from 17 in Guanaco Muerto and 20 from 40 in Amamá. The overall human population examined in each locality ranged from 68.9% to 92.7%. Eighty per cent of resident dogs as well as 14 from 30 cats (46.7%) were examined.

Table I shows the comparison of prevalence rates of **T. cruzi** infection in dog, human and cat populations in each locality. Statistical significance was analyzed by the G-test[26]. Overall prevalence rate in dogs (75.6%) as well as in cats (78.6%) was significantly higher than in humans (51.0%) ($p < 0.001$), but no differences were detected between dogs and cats ($p > 0.05$). The overall proportion of parasitemic individuals (=parasite rate) was significantly higher in either dog (64,2%) or cat (63.6%) populations than among humans (12.5%) ($p < 0.001$).

While prevalence rates of **T. cruzi** in dogs from Guanaco Muerto, Amamá and La Invernada were very similar, the parasite rate was significantly higher in Amamá (75.0%) than in La Invernada (46.2%) ($p < 0.005$).

Prevalence of **T. cruzi** in human populations did not differ significantly and ranged from 49.6 to 58.7% ($p > 0.05$).

Although the proportion of infected cats was high in La Invernada and Moreno, the low number of examined animals reflects the cat population size from each site.

Table II shows the comparative distribution of resident, infected and parasitemic dogs and human individuals per household in each area. The proportion of infected individuals per household was calculated as the product of the prevalence rate of infection in the area and the average number of resident people and animals per house. A similar method was followed when considering parasitemia. As in Amamá xenodiagnosis was only performed on humans below age 14 and the outcome agreed with previous results from La Invernada the parasite rate among seropositive individuals older than this age from both areas was assumed to be the same, since overall prevalence in both populations was similar.

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TABLE I

Distribution of infection by **T. cruzi** among human and domestic animals in three localities of the central area of Argentina (1979-1982)

Locality (No. of households)	Dogs		Humans		Cats	
	Infection rate * (%)	Parasite rate ** (%)	Infection rate (%)	Parasite rate (%)	Infection rate (%)	Parasite rate (%)
Guanaco Muerto (9)	20/28 (71.4)	17/25 (68.0)	27/46 (58.7)	ND ****	ND	ND
La Invernada (17)	26/39 (66.7)	18/39 (46.2)	42/84 (50.0)	12/82 (14.6)	5/8 (62.5)	3/5 (60.0)
Amamá (20)	47/56 (83.9)	42/56 (75.0)	57/115 (49.6)	7/70 *** (10.0)	6/6 (100)	4/6 (66.7)
Total (46)	93/123 (75.6)	77/120 (64.2)	125/245 (51.0)	19/152 (12.5)	11/14 (78.6)	7/11 (63.6)

* Infection rate: no. infected/no. examined. Infection by **T. cruzi** determined by serology and/or xenodiagnosis
** Parasite rate: no. individuals with a positive xenodiagnosis/no. examined
*** Performed only to children below age 14
**** ND = not done

TABLE II

Comparison of the average number of resident, infected and parasitemic individuals per household among human and dog population of 3 different rural localities of the central area of Argentina

Locality	Average No. of individuals per household		Expected No. of individuals/household: infected *		Expected No. of individuals/household: Parasitemic *	
	humans	dogs	humans	dogs	humans	dogs
Guanaco Muerto	6.3	3.4	3.7	2.4	ND	2.1
La Invernada	7.0	2.9	3.5	1.9	1.0	1.3
Amamá	6.2	3.6	3.1	3.0	1.0 **	2.8
Mean No. of individuals	6.5	3.3	3.4	2.4	1.0	2.1

* Estimated as the product of the prevalence rate (or parasite rate) and the average number of resident individuals per household
** As the parasite rates of seroreactive individuals below age 14 as well as the overall prevalence rate in La Invernada and Amamá agreed, the overall proportion of parasitemic individuals in both areas was assumed to be the same
ND: Not done

While the mean number of human individuals per household was very uniform in the 3 localities, there was some variation among dog populations (range= 2.8-3.6). Although both the average number of resident as well as infected individuals per household favored humans (6.5 vs. 3.3 and 3.4 vs. 2.4, respectively). the reverse was appreciated when parasitemia was considered (1.0 vs. 2.1).

DISCUSSION

Trypanosoma cruzi infection rates in dogs reported here are the highest for Argentina and Latin America, exceeding that of the entire human population recorded by us (52.1%) and other researchers[7,25] as the highest figure for the country.

Attempts to explain the differences among dog infection rates in different geographical áreas of Latin America have been tried on the basis of host-preference of local vector species[15]. Such point of view assumes than in areas where **Rhodnius prolixus** and **Panstrongylus megistus** are the main domiciliary vectors, dogs are not an important blood source for bugs and, implicitly, reservoirs of parasites. The reverse should be expected where **Triatoma infestans** is the local vector. This approach has proved to be insufficient at least with **P. megistus** in Minas Gerais, Ceará and Bahia, Brazil[1,12,17] and **R. prolixus** in Yaracuy and Cojedes, Venezuela [20,21,27], where significant infection rates in dogs have been found. This suggests that different epidemiological circumstances (e.g.: rural or suburban areas 1; different human-dog contact; level of transmission; existence of sylvatic cycle, etc.) may interact with the "intrinsec" host preference of a certain vector species giving a certain infection pattern in domestic hosts. Although it has been claimed that proximity and availability of blood sources should be more determinant than bug preference itself [16], the bulk of the problem has been laid on the side of the vector and little attention been paid to the behavior patterns of susceptible hosts. It has been suggested (R. Zeledón, pers. com.) that the fact that dogs do not sleep inside houses in other countries of Latin America, as they do in rural areas of central and north of Argentina, could determine different host-selection patterns of triatomine bugs in different areas. This, in turn, could explain the occurrence of different **T. cruzi** infection rates in dogs from those countries. Moreover, in rural zones of Argentina dogs sleep very frequently under or beside beds, either inside the house or in the porch (where house-dwellers sleep the major part of the year), thus increasing the probability of coming into contact with the vector. This hypotheses finds support on the high frequency of blood meals on dog detected in bug populations of different areas of Argentina [29,30].

Cats were not only few compared with dog and human populations, but also differently related to the household: their owners frequently reported that they usually disappeared in the forest for weeks. This situation reflects on the low frequency of blood meals on cats usually detected in **T. infestans** from our country [29,30]. The opposite situation is claimed by DEANE [8] for Brazil.

Although household levels of bug infestation vary significantly from locality to locality, final prevalence rates in human populations are very uniform, especially in La Invernada and Amamá, despite differences in socio-economic activities and landscape. It is noteworthy too that the parasite rate among individuals below 14 years from La Invernada and Amamá was the same (10%).

The lower number of resident as well as infected dogs per household in La Invernada may be due to the incipient development of socio-economic conditions which affects not only bug densities [30] but the relationship of dogs with households as seems to indicate the lower number of blood meals on dogs in this area [30] compared with Guanaco Muerto [29] and Amamá (in prep.). However, more evidences are needed to explain the lower parasite rate among seroreactive dogs from this area.

The highly significant differences between the number of parasitemic individuals among dogs and cats, on one side, and humans, on the other, suggest a different potential contribution of these hosts to the maintenance of transmission in this far-extending area. Results from blood meal identification studies in Argentina [29] and from xenodiagnosis surveys of domestic reservoirs in Brazil [9] confirm this hypotheses: bugs fed on dogs had a significantly higher infection rate than those fed on humans. On the other hand, experimentally induced [11] as well as naturally acquired infection in dogs (J. W. Torrealba, pers. com.) has shown prolonged parasitemia through years under laboratory conditions, clearly contrasting with the age-related decline in parasitemia observed in humans [10].

Finally, the epidemiological role of dogs must be differentiated from that of cats, since the relationship between the latter and vectors is minimal as cats are not permanent domestic residents.

In the light of present knowledge, dogs must be considered as the major donors of parasites to **T. infestans** bugs, and thus, principal contributors from a qualitative and quantitative point of view to the maintenance of transmission in this area of Argentina. Strategies aimed to lower the transmission of Chagas' disease in our country should regard the application of effective control measures on canine populations.

RESUMO

Contribuição dos humanos, cães e gatos à transmissão do Trypanosoma cruzi **na Região do Chaco Argentino**

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Foi determinada a prevalência da infecção por **T. cruzi** nos humanos, cães e gatos, pertencentes a 47 rancherías em três povoados rurais; Guanaco Muerto (Córdoba), La Invernada e Amamás (Santiago del Estero), mediante reações serológicas e xenodiagnóstico. Foram examinadas 245 pessoas, 123 cães e 14 gatos. A taxa de prevalência na população foi entre 58,7% (GM) e 49,6% (LI). Foram detectados 76% de cães infectados, o que resultou significativamente superior aos 51% encontrados nos humanos. As porcentagens de cães (64,2%) e gatos (63,6%) com parasitemia foram significativamente superiores à correspondente aos humanos (12,5%). Se bem que 79% dos gatos estavam infectados, sua pequena quantidadé e seus hábitos de perambulação determinam que sua participação na transmissão doméstica do **T. cruzi** seja restrita.

Não obstante existir em média um maior número de humanos que de cães em cada lar, tanto de sujeitos sãos como infectados (6,5 vs. 3,3 e 3,4 vs. 2,4, respectivamente), foram detectados — também na média — mais cães que humanos com parasitemia em cada casa (2,1 vs. 1,0).

As altas porcentagens de cães infectados e com parasitemia, além do hábito de repouso intra-domiciliário — o qual ocasiona estreito contacto entre eles e os barbeiros — determinam que os cães sejam os principais provedores de parasitos à disposição para a transmissão, e os hospedeiros mais importantes para manutenção da doença de Chagas na Região do Chaco Argentino.

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