PREVALENCE OF *TRYPANOSOMA CRUZI* AND *TRYPANOSOMA RANGELI* IN TRIATOMINES (HEMIPTERA: REDUVIIDAE) COLLECTED IN THE REPUBLIC OF PANAMA

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PREVALENCE OF *TRYPANOSOMA CRUZI* AND *TRYPANOSOMA RANGELI* IN TRIATOMINES (HEMIPTERA: REDUVIIDAE) COLLECTED IN THE REPUBLIC OF PANAMA*

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Abstract. A total of 912 triatomid bugs was collected in 51 localities of the Republic of Panama between June 1964 and July 1970. The triatomine species collected in or around human dwellings were: *Rhodnius pallescens, Triatoma dimidiata, Panstrongylus geniculatus,* and *Panstrongylus rufotuberculatus.* In Central Panama the most prevalent bug in houses was *R. pallescens.* In Western Panama (Chiriquí Province) *T. dimidiata* was the most prevalent triatomine, while no *R. pallescens* was collected in that region. *Eratyrus cuspidatus* and *Triatoma dispar* were collected more frequently in sylvatic surroundings than in the domiciliary habitat. Parasitological examination of the intestinal content, the hemolymph, and the salivary glands of wild-caught triatomines revealed that 68.8% of 740 *R. pallescens* were naturally infected with *Trypanosoma cruzi* or *Trypanosoma rangeli. T. cruzi* was found in 17.7% of 94 *T. dimidiata* examined. Natural infection with *T. cruzi* was also recorded in *P. geniculatus* and *P. rufotuberculatus,* the latter being a new record for this country. The annual trypanosome infection rate in *R. pallescens* ranged from 50.2% to 86.0%. In this species, *T. cruzi* was found to be almost three times as common as *T. rangeli.* In La Chorrera-Bique localities 10.5% of *R. pallescens* examined showed infected hemolymph, and 8.8% had metacyclic forms of *T. rangeli* in the salivary glands. In Central Panama, *R. pallescens* was more frequently found infected in Altos del Jobo (84.1%) and in the Santa Rita-Lidice area (81.9%) than in other areas studied. *T. rangeli* was found only in *R. pallescens.*

Human trypanosomiasis was first described in Panama by Miller in 1931.[1] Since then it has been determined that two species of trypanosomes infect man: *Trypanosoma cruzi,* the causative agent of Chagas' disease, and *T. rangeli,* which is generally considered nonpathogenic. Human trypanosomiasis appears to occur most frequently in villages of Central Panama.[2,3]

Eight species of triatomids have been reported from Panama:[4] 1) *Triatoma dimidata* (Latr.); 2) *T. dispar* Lent; 3) *Panstrongylus geniculatus* (Latr.); 4) *P. rufotuberculatus* (Champion); 5) *P. humeralis* Usinger; 6) *Rhodnius pallescens* Barber; 7) *Eratyrus cuspidatus* Stal; and 8) *Cavernicola pilosa* Barber. The presence of *Belminus* sp. in Panamanian territory also has been reported,[5] but collection records and identification of species need to be confirmed.

Johnson[6] considers that only 3 species serve as common vectors of Chagas' disease in Panama: *R. pallescens, T. dimidiata,* and *P. geniculatus.* In Central Panama, *R. pallescens* is also known to be naturally infected with *T. rangeli.*[7]

In addition to Panama, *R. pallescens* has been occasionally reported from Colombia,[4,8] where it was found to be infected with *Trypanosoma cruzi* and *T. rangeli.*

Clark and Dunn first recorded natural *T. cruzi* infections in the reduviid *P. geniculatus* from Chilibrillo Caves in Chilibre, Panama Province.[9] Dunn first recorded the presence of *T. cruzi* in naturally infected *R. pallescens,*[10] and Rozeboom reported natural infection with *T. cruzi* in *Triatoma dimidiata* from La Chorrera District. *T. cruzi* or *cruzi*-like parasites have also been found in *Eratyrus cuspidatus*[12] and *C. pilosa.*[13]

Sousa and Galindo recently reported wild *Triatoma dispar* with *Trypansoma cruzi* infections.[14] Natural infection with trypanosomes have not yet been recorded in *P. rufotuberculatus* and *P. humeralis* in this country. *R. prolixus,* which is common in South America (Venezuela, Colombia) and Central America (Guatemala, El Salvador, Nicaragua) has not been found in Panama.

This report presents information on the fre-

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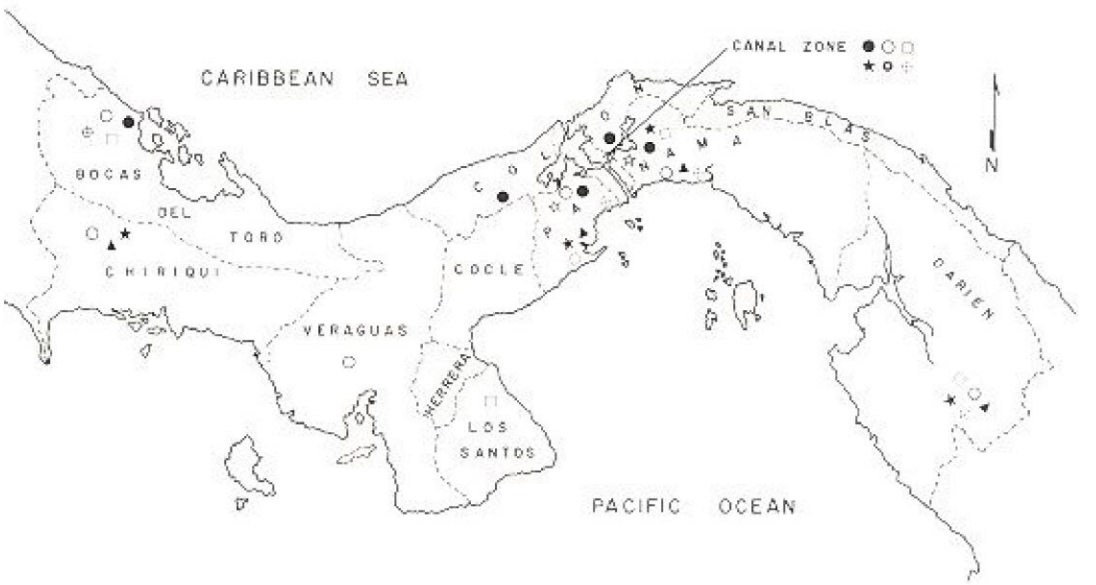

FIGURE 1. Map of the Republic of Panama showing the distribution of triatomine species according to provinces and the Canal Zone.

Triatomine species: ● = *R. pallescens*; ○ = *T. dimidiata*; ▲ = *T. dispar*; □ = *P. geniculatus*; ★ = *P. rufotuberculatus*; ✪ = *P. humeralis*; ☆ = *C. pilosa*; ⊕ = *C. unspidatus*.

quency of natural infections with *T. cruzi* and *T. rangeli* in triatomid bugs found in various habitats in endemic areas of human trypanosomiasis in Panama.

MATERIALS AND METHODS

Although bugs were collected in several localities, two principal areas for collection were selected: Mendoza in La Chorrera District of Panama Province, and Boquete in Chiriqui Province.

Mendoza is a typical community in a warm and humid part of Central Panama. Here most houses are constructed with cane walls and thatched roofs. Corn or rice may be stored within the living area, and dogs and chickens may be allowed indoors at night. According to the economic condition of the family, a separate hut may be built near the family quarters to serve as a roosting place for domestic fowl and as a storage place for food.

Boquete has a cooler climate because of its altitude (4,000 ft.); the abundant vegetation of the area is sometimes used as cover for coffee plantations. The houses are generally wooden with tin roofs. Domestic animals, except dogs, are kept in outside pens.

Triatomid bugs were collected by the local residents of several villages in endemic areas of Chagas' disease. The bugs were found in hiding places in the walls of houses, crawling near furniture, or flying into lighted rooms at night. Bugs were collected by hand, placed in containers, labeled according to locality and times of capture, and transported alive to the Gorgas Memorial Laboratory in Panama City. Each insect was then examined for the presence of flagellates in hemolymph, salivary glands and the digestive tract. Hemolymph was obtained from cuts in the legs before dissection of salivary glands. Salivary glands were exposed by gentle decapitation of nymphs, or by dissection of the thorax in adults. In all cases the salivary glands and hemolymph were examined prior to dissection of the digestive tract.

The gut was dissected out and its contents were suspended in physiological saline solution. Wet preparations were made from mid- and hind-gut, and examined under the microscope at 100 to 400 × magnifications. Permanent smears of fecal samples and hemolymph were prepared and stained with Giemsa following fixation in methanol. In some cases, fresh material was inoculated intra-peritoneally into juvenile Carworth Farm white (CFW) mice to confirm *Trypanosoma cruzi* infections.

TABLE 1

Triatominae recorded in the Republic of Panama, and their natural infection with trypanosomes†*

Locality		Triatomid species‡							
Province	District	RP	TD	TDi	PG	PR	PH	EC	CPi
Panama	Panama	+		—	+	—		+	+
	Arraijan	+	+						
	Chorrera	+	+		—	—		—	—
	Capira	+	+	NE	+	—			
	Chame				+				
Canal Zone Area		+	+		+	+	+	—	
Colon	Colon	+							
	Chagres	—							
	Donoso	+							
Darien	Pinogana		NE	+	—	+		NE	
Los Santos	Pedaso				NE				
Veraguas	Veraguas		NE						
Chiriqui	Boquete		+						
	Bugaba			NE		NE			
Bocas del Toro	Bocas del Toro	+	+		—			NE	

* As recorded in references 8, 9, 10, 14, 15, 16, 17, 18, 19, 20, and the present paper.
† +, positive for trypanosomes; —, negative for trypanosomes; NE, not examined.
‡ RP, *Rhodnius pallescens*; TD, *Triatoma dimidiata*; TDi, *T. dispar*; PG, *Panstrongylus geniculatus*; PR, *P. rufotuberculatus*; PH, *P. humeralis*; EC, *Eratyrus cuspidatus*; CPi, *Cavernicola pilosa*.

Transmission of *T. rangeli* through the bite of wild-caught *R. pallescens* was demonstrated by allowing bugs with positive hemolymph to bite laboratory CFW mice at least once before being submitted for dissection. Parasitemia was detected in exposed mice by direct examination of blood, or through hemoculture procedures.[3]

RESULTS

Between June 1964 and July 1970, 912 triatomid bugs were collected from 51 localities in the Republic of Panama. Insects were obtained from localities in the Canal Zone, Panama Province, Colon Province, Chiriqui Province, and Bocas del Toro Province (Fig. 1). Table 1 summarizes the known localities for Panamanian triatomines as recorded from 14 districts and the Canal Zone.

Frequency of Trypanosome Infections in Triatomines

A total of 845 triatomines was examined for trypanosomes. These were mainly *Rhodnius pallescens* (87.6%), some *Triatoma dimidiata* (11.1%) and a few (1.3%) *Panstrongylus geniculatus* and *P. rufotuberculatus*. The highest rate of infection with trypanosomes was found in *R. pallescens*. Natural infections with *Trypanosome cruzi* and/or *T. rangeli* were found in 68.8% of the 740 specimens examined (Table 2). Of 94 *Triatoma dimidiata* examined, 17.7% were positive for *T. cruzi*. *P. geniculatus* and *P. rufotuberculatus* were also found to harbor *T. cruzi*; however, too few were collected to provide significant rates of infection.

In Boquete, only *Triatoma dimidiata* was collected near houses. In a sample of 85 bugs collected (54 nymphs, 31 adults), 13.5% were positive for *Trypanosoma cruzi*. Except for one nymph, the positive bugs were adults. The hemolymph of 65 *T. dimidata* was examined and found free of flagellates.

Frequency of Trypanosoma cruzi *and* T. rangeli *in* Rhodnius pallescens

In Central Panama the most prevalent triatomid bug was *R. pallescens*. A total of 807 bugs of this species was collected in or around houses in communities located mainly in the district of La Chorrera. In this area, both *T. cruzi* and *T. rangeli* were found in naturally infected *R. pallescens*.

Of the number of bugs collected only 740 were suitable for parasitological examination upon arrival at the laboratory. In this sample, adult specimens were more frequent than nymphs. Adult females represented 51.3%, adult males

TABLE 2

Frequency of trypanosome infections in triatomine species collected in or around human dwellings in the Republic of Panama, 1964–1970

Species	Total examined (%)	Adult males (%)	Adult females (%)	Nymphs (%)
Rhodnius pallescens	740 (68.8)	267 (70.4)	380 (73.2)	93 (46.2)
Triatoma dimidiata	94 (17.7)	14 (50.0)	26 (47.1)	54 (1.9)
Panstrongylus geniculatus	7 (14.3)	6 (16.7)	1 (0.0)	0
P. rufotuberculatus	4 (50.0)	2 (50.0)	2 (50.0)	0

36.1%, and nymphs 12.6% of the total samples of bugs examined. Trypanosomes were generally found more frequently in females (73.2%) than in males (70.4%) or in nymphs (46.2%).

An average of 105.7 *R. pallescens* was examined annually from 1964 through 1970. Collection was carried out mainly in villages found in La Chorrera District and surrounding areas in Central Panama. During 1967, bugs were collected mainly in Indian villages and sylvatic areas in Darien Province; collections there were poor, and fewer bugs were examined during the year.

Table 3 provides detailed information about the number of bugs examined and found to be infected during the period 1964 to 1970. Trypanosomes were detected in 509 (68.8%) of the bugs examined from Central Panama during that period. The annual infection rate ranged from 50.2% to 85.0%. A noticeable decrease in the infection rate was observed during the year 1968 when the lowest prevalence of trypanosomes was found in the 231 *R. pallescens* examined. The infection rate in this triatomid for all other annual periods was found to be above 70.0% (72.7–85.0%). Also, the 1968 sample differed from other annual samples in the proportion of nymph stages examined; 21.2% of the bugs examined were 3rd- to 5th-stage nymphs in contrast to 5.7% to 12.9% in other years. The infection rate in adult bugs examined in 1968 was also the lowest annual rate for the 7-year period included in this report.

The trypanosomes were identified as *Trypanosoma cruzi* or *T. rangeli* according to morphological and biological characteristics. Each year *T. cruzi* was found 1.3 to 5.1 times more frequently than was *T. rangeli*, with an average ratio of 2.65:1.

Frequency of Infected Rhodnius pallescens *in Communities of Central Panama*

For a comparative study of the infection rates in *R. pallescens*, five collection areas were chosen. The Santa Rita-Lidice area is 48 km west of Panama City. The other areas (Table 4) are within a 32 km radius from Panama City. Four

TABLE 3

Annual frequency of trypanosome infections in wild Rhodnius pallescens *collected in or around human dwellings in the Republic of Panama, 1964–1970*

Year	No. bugs examined	No. positive	Percent positive	*T. cruzi*		*T. rangeli*		Mixed infections	
				No.	%	No.	%	No.	%
1964	83	66	79.5	46	55.4	35	42.2	15	18.1
1965	104	79	76.0	65	62.5	31	29.8	17	16.3
1966	106	79	74.5	73	68.9	18	17.0	12	11.3
1967	22	16	72.7	16	72.7	3	13.6	2	9.1
1968	231	116	50.2	107	46.3	34	14.7	25	10.8
1969	101	74	73.3	72	71.3	14	13.9	12	11.9
1970	93	79	85.0	76	81.7	36	38.7	33	35.5
Totals	740	509	68.8	455	61.5	171	23.1	116	15.6

TABLE 4

Frequency of trypanosome infections in Rhodnius pallescens *collected in or around human dwellings in selected areas of Central Panama, 1964–1970*

	No. examined	No. positive	Percent positive	Bugs found infected (percent)				
				Intestine			Hemolymph	Sal. glands
				T. cruzi	*T. rangeli*	Mixed infect.	*T. rangeli*	*T. rangeli*
Sta. Rita-Lidice	61	50	81.9	80.3	18.0	16.4	3.9	3.8
Chorrera-Bique	46	34	73.9	67.4	23.9	17.4	10.5	8.8
Mendoza-Represa	514	334	65.0	56.1	22.0	13.1	7.1	6.9
Altos del Jobo	69	58	84.1	78.3	37.7	31.9	3.1	4.6
Chilibre-Panama	48	33	68.7	66.6	18.7	16.6	0.0	0.0
Totals	738	509	69.0	61.5	23.1	15.6	6.1	6.0

areas studied are located west of the Canal Zone, and the Chilibre-Panama area lies on the eastern border of the Canal Zone. Trypanosome infections were detected more frequently in *R. pallescens* found in domiciliary habitats in Altos del Jobo (84.1%) and Santa Rita-Lidice areas (81.9%) than in bugs collected in other areas. However, the infection rates for all communities showed that more than two-thirds of the *R. pallescens* were infected with trypanosomes. *Trypanosoma cruzi* occurred as single or mixed infections in 61.5% of the bugs; *T. rangeli* in 23.1%. *T. rangeli* infections in the hemolymph or salivary glands of *R. pallescens* were present in specimens from all areas except the Chilibre-Panama area.

In 595 bugs examined 6.1% showed infected hemolymph, and 6.0% were found with parasites in the salivary glands. The highest frequency of bugs with parasites was found in the Chorrera-Bique area where 10.5% had infected hemolymph and 8.8% harbored trypanosomes in the salivary glands. In the Mendoza-Represa area the infection rates observed were 7.1% for hemolymph and 6.9% for the salivary glands. Infected glands showed metacyclic trypomastigotes in the lumen as well as elongate epimastigotes. Mice inoculated with metacyclic forms from the salivary glands of naturally infected bugs produced circulating trypomastigotes with the *lewisi*-like morphology and dimensions of *T. rangeli*.

Fecal material with *cruzi*-like metacyclic forms produced patent infections when inoculated intraperitoneally into CFW mice.

DISCUSSION

Human trypanosomiasis occurs throughout the Republic of Panama. Serological evidence suggests that Chagas' disease caused by *Trypanosoma cruzi* infections occurs in almost all the provinces of the country, but recent parasitological studies have shown that it is more prevalent in residents of rural areas in Central Panama.[3] *T. rangeli*, a nonpathogenic trypanosome, also occurs frequently in people living in rural areas of Central Panama.

Our data confirm and extend the findings of Pipkin that *Rhodnius pallescens* is the triatomid bug most frequently found in or around houses in Central Panama.[14] *R. pallescens* represented more than 99% of all the bugs collected. This becomes significant since this species was found infected with trypanosomes in 68.8% of the specimens examined in this area. The annual infection rate for the period 1964 to 1970 varied from 50.2% to 85.0%. These figures indicate a higher rate of infection in *R. pallescens* than reported for the period 1961 through 1963, when an infection rate of 36.6% was recorded in bugs collected in Mendoza, Santa Rita, Bique, Lidice and Santa Rosa communities.[15]

The combined information on these villages has shown that the prevalence of infected bugs has been maintained at high levels (36% to 86%) during a period of almost 10 years. Even though *T. rangeli* is more prevalent in man than *T. cruzi* in these areas of Central Panama,[3] the examination of wild bugs showed that *T. cruzi* is found about three times more frequently than *T. rangeli* in the gut of *R. pallescens*. Only 4% to 9% of bugs examined showed metacyclic forms of *T. rangeli* in the salivary glands. The fact that *T. rangeli* is often found in the blood of man in this area is indicative of a frequent man-vector contact.

These insects are frequent invaders of houses and at times are found breeding in the house or in nearby animal pens. Although natural *T. cruzi* infections occur in more than 50% of the bugs, *T. cruzi* is demonstrated less frequently in the blood of man than is *T. rangeli*. This may be partly due to the different mechanisms of transmission, contaminative for *T. cruzi* and inoculative for *T. rangeli*, as well as to the different parasite densities in the blood of infected persons. It is apparent from the Panamanian material that *T. cruzi* trypomastigotes are greatly reduced in numbers in the blood of man after the acute stage. On the other hand, *T. rangeli* parasites are readily detectable by culture methods in persons known to have been infected for periods of over 1 year.

Other triatomine species (*Triatoma dimidiata* and *Panstrongylus geniculatus*) appear to be of minor importance in the transmission of Chagas' disease in Central Panama.

In Chiriqui Province, *T. dimidiata* seems to be the most important triatomid bug in domiciliary and peri-domiciliary habitats. It plays a significant role in the epidemiology of Chagas' disease since *R. pallescens* has not yet been recorded from this area. In the Boquete area *T. dimidiata* was often found associated with man and domestic animals in or around houses. In Boquete (Chiriqui), 13.5% of 85 *T. dimidiata* examined were found infected with *Trypanosoma cruzi* in the hind-gut.

The finding of *T. cruzi* in wild *P. rufotuberculatus* represents a new record for Panama and increases the number of known vectors of Chagas' disease in this area.

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