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DOMESTIC TRIATOMINES (REDUVIIDAE) AND INSECT TRYPANOSOME INFECTIONS IN EL SALVADOR, C.A.[1]

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Twenty-five Salvadoran communities have been surveyed to learn more about the distribution of Chagas' disease vectors and trypanosome parasites in that country. The results indicate that each of several factors—local variations in housing construction, insecticide applications, geographic elevation, and the vector species involved—can have a critical effect on transmission of the disease agent.

Introduction

Chagas' disease (American trypanosomiasis) has been known in El Salvador since 1913 (*1*). Nevertheless, no efforts were made to determine the identity and distribution of its triatomine vectors or their levels of infection with *Trypanosoma cruzi* (the causative agent) until 1957. At that time, a sampling conducted throughout the country by an investigative commission on trypanosomiasis (*2*) indicated that only two vector species were present. Roughly half of the 4,871 triatomines captured in 290 houses were identified as *Triatoma dimidiata* Latreille and the remainder as *Rhodnius prolixus* Stahl.

A number of investigations followed this general survey; however, they added little information about the distribution of Chagas' disease vectors in El Salvador because they were primarily clinical studies carried out in single communities (*3*).

The present survey was designed to update knowledge of the distribution and abundance of house-dwelling triatomine bugs in El Salvador and to assess their levels of infection with *Trypanosoma cruzi* and *Trypanosoma rangeli*. An additional objective was to learn about the impact on triatomine populations of DDT and propoxur residual sprays applied inside houses for malaria control.

Methods

A transect approximately 25 km wide extending through the central part of El Salvador from the Pacific Ocean to the Honduras border (Figure 1) was established as the primary survey area. It was positioned to include areas with histories of periodic DDT and propoxur house spraying, as well as regions with no history of large-scale insecticide use. Searches for domestic triatomines were made inside houses in rural communities at altitudes ranging from 20 to 1,900 meters. Within the transect, the numbers of communities surveyed and their altitudes were as follows: four communities at 20-120 m, eight at 160-330 m, seven at 340-600 m, and three at 660-820 m. Three additional villages outside the transect at 1,000-1,900 m were added in order to obtain data from higher altitudes.

A 10 per cent sample of houses in each of the communities was pre-selected, using a table of random numbers. Selection and subsequent location of these houses was facilitated in malarious parts of the country by maps obtained from El Salvador's

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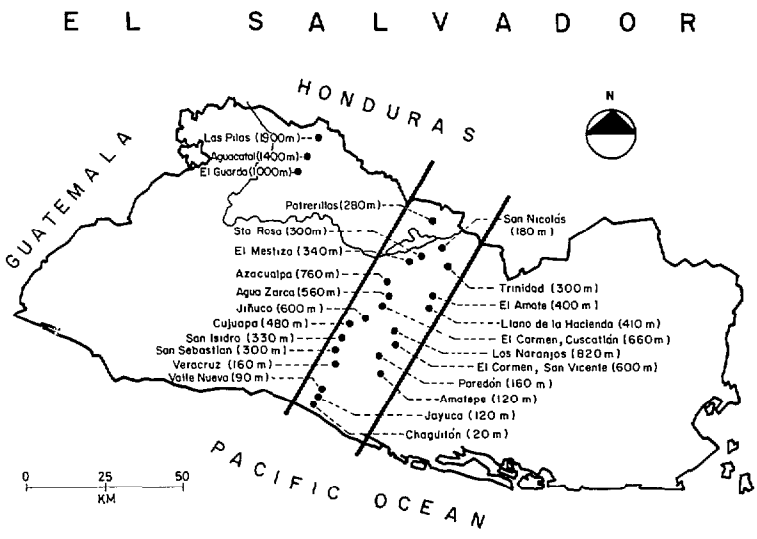
Figure 1. A map of El Salvador showing the locations and elevations (in meters) of the communities surveyed for domestic triatomines.



National Malaria Service that located and numbered all houses. Such maps not being available for non-malarious regions, sketch maps with assigned house numbers were prepared as a preliminary step for these areas.

With few exceptions the houses were simple one-room or two-room structures with floors of dirt and walls of palm or straw thatch, adobe block, *bajareque*, or a mixture or these materials (see photos). *Bajareque* results when wet clay is plastered over a framework of interlaced sticks. In drying, the clay develops deep cracks which provide abundant shelter for triatomines and other insects.

Two experienced collectors equipped with flashlights made a close 20-minute search for triatomines infesting the interior walls of each randomly selected house. Only the walls of adobe block and *bajareque* houses were examined, since their tile or sheet-metal roofs provided little suitable insect harborage. On the other hand, the houses with thatch walls also had thatch roofs; and there was seldom a clear distinction between wall and roof, since the roof typically extended to less than half a meter above the ground. In these houses the roof-walls were searched from floor level to a height of approximately two meters.

All the triatomines detected were pulled from their harborages with forceps and taken alive to the laboratory, where they were identified. A fecal sample was obtained from each insect and was examined for trypanosomes in a wet-mount made with physiological saline containing 10 per cent human serum. Similar preparations of hemolymph from nearly half the insects were also examined.

To identify the trypanosomes, all positive preparations were stained as follows: Wright's stain was added for one minute to the air-dried slide, followed by several drops of phosphate-buffered Giemsa (pH 7.0-7.2) for 12 minutes. The slide was then washed with phosphate buffer and allowed to dry in the air. Special care was taken to identify the trypanosomes accurately because pre-

Typical types of housing in the Salvadoran communities searched for domestic triatomines: Top—thatch; Middle—*bajareque*; Bottom—adobe block

liminary results were at variance with published figures associating *T. cruzi* with *R. prolixus* in El Salvador (*2*).

Results and Discussion

Seventeen of the 25 communities surveyed were positive for triatomines, infestation rates of individual communities ranging from 11 to 100 per cent of the houses searched. *Rhodnius prolixus* and *Triatoma dimidiata* were the only species found, leaving unchanged the brief list of known Chagas' disease vectors in El Salvador. Indeed, the domestic triatomine fauna of the whole Central American isthmus appears restricted almost entirely to these two species (*4*).

Elevations

T. dimidiata was the more numerous species, accounting for 64.6 per cent of the 676 specimens collected. Nevertheless, as Table 1 shows, it was relatively scarce at elevations below 340 meters, where 91.5 per cent of the specimens collected were *R. prolixus*. A similar preference for low altitudes has been reported for this species in Guatemala (*5*). At intermediate elevations *T. dimidiata* became dominant; and, with a single exception, it was the only species collected above 600 meters.

The exception occurred at 1,000 meters, where *R. prolixus* was found in one of a group of seven houses. An intensive search of the 11 closest houses yielded no additional specimens. The collection was small as well as isolated, consisting of two males, three females, and a fourth-stage nymph. Conversations with occupants of the positive house revealed numerous occasions during the preceding four years when the bugs could have been transported from the seacoast with personal or household articles. It seems doubtful that this species is established at high elevations in El Salvador, although its range is known to extend up to at least 2,000 meters in Colombia and Venezuela (*6, 7*).

Communities at 1,400 and 1,900 meters were included in the present survey, but no triatomines were found above 1,000 meters.

Building Materials

Building materials and styles of house wall construction (see photos) were found to influence the levels of infestation. Table 2 summarizes collections made from 114 houses with various wall materials in 14 triatomine-positive villages at altitudes ranging from 160 to 1,000 meters. The table includes only houses with walls made entirely of one kind of material that were located in villages which were unsprayed—that is, villages that had never received residual insecticide applications for malaria

Table 1. Triatomine collections in 25 rural Salvadoran communities.

Elevation (meters)	Houses			Triatomines collected					
	Number searched	% infested		Numbers collected		Avg. No. per house		% of insects collected	
		Rhodnius prolixus	*Triatoma dimidiata*	*R prolixus*	*T. dimidiata*	*R. prolixus*	*T dimidiata*	*R. prolixus*	*T. dimidiata*
20-120	36	0	0	0	0	—	—	—	—
160-330	61	26.2	6.6	182	17	3.9	0.4	91.5	8.5
340-600	69	7.2	47.8	51	228	0.7	3.3	18.3	81.7
660-1,000	37	2.7	81.1	6	192	0.2	5.2	3.0	97.0
1,400-1,900	18	0	0	0	0	—	—	—	—
Total	221	10.0	30.3	239	437	1.1	2.0	35.4	64.6

Table 2. Triatomine densities in unsprayed rural houses with different types of walls.

	Type of wall construction*		
	Adobe	*Bajareque*	Thatch
No. of houses searched	56	52	6
No. of triatomines collected	159	280	12
Avg. triatomines per house	2.8	5.4	2.0
% of triatomine-free houses	53.6	36.5	16.7

*All houses with more than one kind of wall construction have been excluded.

control, or else ones that had not been sprayed within the last 38 months preceding inspection and thus could be considered unsprayed.

The mean number of insects collected in *bajareque* houses, whose cracked walls provide abundant hiding places, was nearly twice the number found in adobe block houses whose smoother walls afforded considerably less insect harborage. The importance of harborage was further shown by the differing percentages of non-infested adobe and *bajareque* houses. Though materials used to make adobe and *bajareque* walls are similar, the walls differing only in physical form, 54 per cent of the adobe houses appeared free of triatomines, compared with only 37 per cent of a nearly equal number of *bajareque* houses. It should be noted that within the altitude ranges in which triatomines were collected (Table 1) the proportion of *bajareque* houses searched was never less than 32 per cent of the total, indicating that the higher infestation levels associated with this material (as compared with adobe) are unlikely to reflect an effect of altitude, but can be attributed instead to the nature of the *bajareque* itself.

The infestation level in thatched houses and the proportion of uninfested houses could not be estimated reliably, since only six unsprayed houses of this type were surveyed. However, an additional three thatched houses, excluded from Table 2 because they had been sprayed with DDT ten months prior to examination, yielded 37 specimens of *R. prolixus*. The combined collections from sprayed and unsprayed thatch houses averaged 5.4 insects per house, leaving only two houses (22.2 per cent) uninfested. These data suggest that thatch houses, like *bajareque*, are apt to harbor large triatomine populations and are more likely than adobe houses to be infested.

Antimalaria Spraying

Anti-anopheline house spraying for malaria control is another factor that can affect triatomine distribution and abundance. As shown in Table 3, 14 adobe and *bajareque* houses examined within one month of DDT application were negative for these vectors, but six to 10 months after spraying, infestation rates of 25 to 62 per cent were encountered. The mean infestation rate of 126 houses in nonmalarious areas (which had never received insecticide treatment) was 50.0 per cent. Among the areas that had long ago been sprayed with DDT, the village of Amatepe seemed noteworthy because none of the houses examined were found to be infested. *R. prolixus* infestations would have been expected, since the village is on the coastal plain, where this insect is common, and the last previous round of insecticide spraying had occurred nearly five years before. Our random sampling of its houses could conceivably have

Table 3. Insecticide sprayings and levels of triatomine infestation in 25 rural Salvadoran communities.

Insecticide use	Community	Survey date	Months since last spraying	Houses searched	% infested
DDT house spraying on a six-month cycle for malaria control	Potrerillos	Jul 74	0	7	0
	San Nicolás	May 74	1	7	0
	Trinidad	May 74	6	4	25.0
	Santa Rosa	Jun 74	7	5	60.0
	Veracruz	Aug 73	10	13	61.5
	San Sebastián	Sep 73	38	11	54.5
	El Carmen (San Vicente)	Jun 74	45	7	57.1
	Amatepe	May 75	56	6	0
	Paredón	May 75	57	5	20.0
Propoxur house spraying on a three-month cycle for malaria control	Valle Nuevo	Aug 73	20	13	0
	Jayuca	Sep 73	12	11	0
	Chaguitón*	Jul 74	20	6	0
No insecticides applied	13 communities in nonmalarious areas	Sep 73 Aug 75		126	50.0

*Also subject to yearly aerial applications of agricultural insecticides in August-December.

yielded results unrepresentative for the community, but it seems more likely that the community itself is somewhat exceptional. Nearly all of its houses are substantial adobe structures with smoothly plastered walls. Such houses are infrequently infested. Amatepe thus demonstrates the practical value of eliminating harborage as a means of triatomine control. That these insects were present at one time was attested to by older Amatepe residents, who said the triatomines disappeared with the advent of DDT spraying in the 1950's and never returned.

Likewise, no triatomines were found in 30 houses (of all construction types) in three communities where residual applications of propoxur were used for malaria control. As shown in Table 3, the maximum interval between propoxur spraying and the examination was 20 months. At first the insecticide could not be fully credited for the absence of triatomines, since all three propoxur-sprayed communities are in the same altitude range (20-120 m) as Amatepe, which was without propoxur spraying but which was similarly negative. However, the recent appearance of an acute case of Chagas' disease in an 8-year-old girl whose unsprayed thatch house is located some 800 m outside the propoxur-sprayed village of Jayuca has produced evidence of the insecticide's effect. In contrast to the apparent absence of triatomines within the village, ten *R. prolixus* (one infected with *T. cruzi*) were found in the patient's house, and additional specimens of both *R. prolixus* and *T. dimidiata* were found in three other unsprayed dwellings within 1 km of Jayuca.

Infection of Triatomines with T. cruzi *and* T. rangeli

The levels of *T. cruzi* and *T. rangeli* infection found in 621 triatomines from 17 communities are shown in Table 4. *T. cruzi* occurred in the feces of 17 per cent of the *Triatoma dimidiata* examined but was not found in the hemolymph. *T. rangeli* was absent from *Triatoma dimidiata* but was present in the feces of 23 per cent of 186 *R. prolixus* specimens; it was also found in the hemolymph of 3.5 per cent of 86 *R. prolixus* specimens subjected to this examination. A low level of hemolymph infection with *T. rangeli* (not exceeding 15 per cent) reported-

Table 4. Trypanosome infections detected in triatomines collected from 17 rural Salvadoran communities.

	Rhodnius prolixus		*Triatomona dimidiata*	
	Feces	Hemolymph	Feces	Hemolymph
No. examined	186	86	435	220
No. (%) positive for:				
Tripanosoma cruzi	1(0.5)	0	72(16.6)	0
Trypanosoma rangeli	42(22.6)	3(3.5)	0	0

ly characterizes *R. prolixus* in Colombia as well (*8*).

Trypanosoma cruzi was only present in one of 186 *R. prolixus* specimens collected from the 17 triatomine-infested communities. An additional infection was subsequently detected in one of ten insects collected in the house of a Chagas' disease patient outside the areas surveyed. The finding of only two *T. cruzi* infections in these 196 insects was unexpected. *T. cruzi* infection rates of 35 per cent in Honduras (*9*) and as high as 47 per cent in El Salvador (*3*) have been recorded for *R. prolixus*, and the importance of this species as a Chagas' disease vector in Central and South America is well-accepted (*4, 6*). However, unstained preparations were used in previous identification of *T. cruzi* obtained from *R. prolixus* in El Salvador, and it is possible that these identifications were incorrect. In any case, more extensive collections of *R. prolixus* will be needed in order to verify the near-absence of *T. cruzi* indicated by the present survey.

SUMMARY

Chagas' disease (American trypanosomiasis) has been known in El Salvador since 1913, but the only major study made to determine the nationwide distribution of Chagas' disease vectors was conducted in 1957. This article reports the results of a survey of 25 Salvadoran communities that was designed to update knowledge of the vectors' distribution, and also to assess their levels of infection with the trypanosomes *T. cruzi* and *T. rangeli*.

A random sample of 10 per cent of the houses in each community were searched by experienced collectors. One or two domestic triatomines (*Rhodnius prolixus* and *Triatoma dimidiata*) were found in 17 of the 25 communities. Dwelling infestation rates in these 17 communities ranged from 11 to 100 per cent of the houses examined.

Of the two vector species, *T. dimidiata* was found more often, but *R. prolixus* predominated at elevations below 340 meters. Overall, *T. dimidiata* accounted for 8.5 per cent of the vectors collected below 340 meters, 81.7 per cent of those found at 340-600 meters, and 97.0 per cent of those encountered above 600 meters.

On the average, twice as many vectors were found in houses with walls of *bajareque* (mud plastered over a stick framework) than were found in houses walled with adobe bricks. Also, considerably more of the adobe houses examined were free of triatomines. Both of these findings seem logical in view of the relatively numerous cracks and insect refuges afforded by *bajareque*.

Houses which had been sprayed with DDT a month before the survey, or with propoxur up to 20 months before, were all found to be negative for triatomines.

Regarding trypanosome infection of the vectors, *T. cruzi* was found in 17 per cent of 435 *T. dimidiata* specimens examined, but in only two of 196 *R. prolixus* specimens. In contrast, *Trypanosoma rangeli* was present in 23 per cent of the *R. prolixus* examined, but was not found at all in *T. dimidiata*. This evidence that *R. prolixus* is nearly free of *T. cruzi* in El Salvador runs counter to previously published data associating *T. cruzi* with *R. prolixus*. Therefore, further study will be needed before this possible near-absence of *T. cruzi* can be confirmed.

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