

CHAGAS' DISEASE SEROEPIDEMIOLOGY IN THE AREA OF THE FUTURE YACYRETA-APIPE HYDROELECTRIC DAM IN CORRIENTES PROVINCE, ARGENTINA¹

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A survey conducted near a dam-site on the Paraguay-Argentine border showed the area to be highly endemic for Chagas' disease. It also showed that new housing unsuited to the disease vector's proliferation did not eliminate the problem, indicating a strong need for health education capable of guiding people away from traditional behavior patterns tending to encourage the vector and cause infection.

Introduction

In 1977, Borda et al. (1) reported the presence of *Triatoma infestans*, one of the vectors of Chagas' disease, in houses located at Ayolas, Santiago, and Yacyretá Island in Paraguay. These communities are situated along the Paraguay-Argentine border, within the area of influence of the future Yacyretá-Apipé hydroelectric dam, which is to be built by Argentina and Paraguay on the lower part of the Paraná River. It is logical to assume that this project will involve major environmental changes, as well as construction of housing for relocation of area residents. These events could create microclimates propitious for colonization by local or imported Chagas' disease vectors. Similarly, human migrations, with the consequent arrival of infected people, could contribute to the creation of new domiciliary disease foci.

These considerations—together with the fact that *T. infestans* had been detected in

communities on the right bank of the Paraná River, in Paraguayan territory, and could well be present on the opposite bank, in Argentine territory—were felt to provide ample justification for serologic surveys of representative areas on the Argentine side in order to determine the extent and distribution of possible infection.

In October, November, and December of 1978, under the sponsorship of the Ministry of Public Health of Argentina, the Yacyretá Binational Agency, and the National Scientific and Technical Research Council, surveys were conducted in a portion of Argentina's Corrientes Province. Their aim was to find the index of *Triatoma* infestation in local homes; the proportion of the insects infected with the disease agent, *Trypanosoma cruzi*; and the prevalence of human infection with *T. cruzi* as determined by serologic examination.

Materials and Methods

The Setting

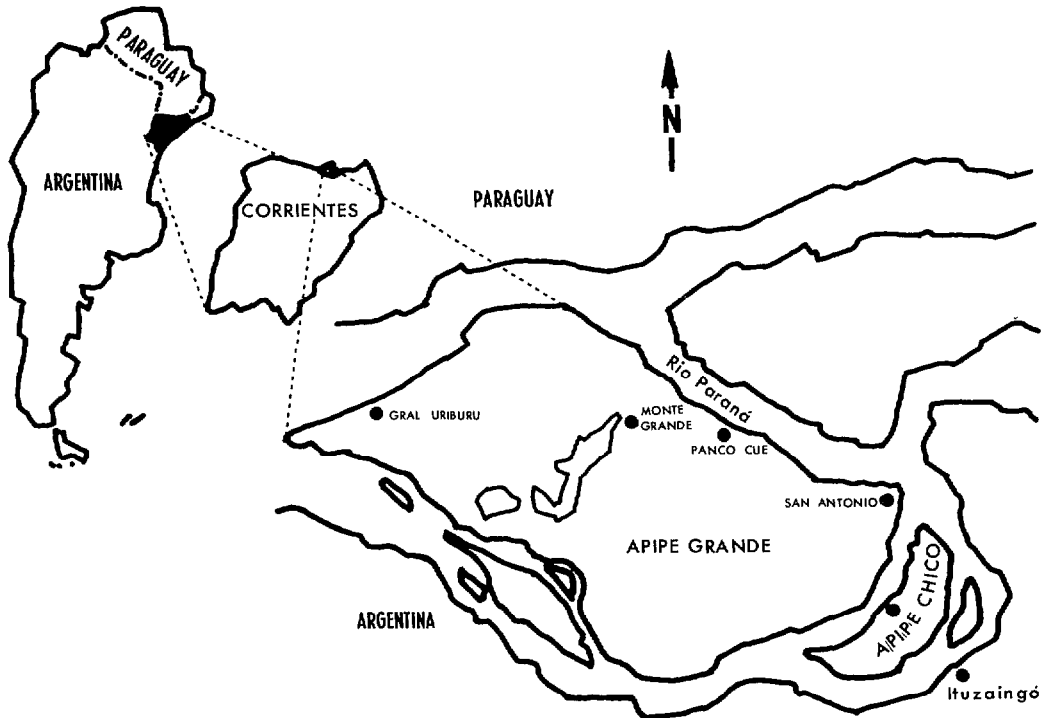
The site of the Yacyretá-Apipé Dam is at the borders of southern Paraguay and northeastern Argentina, between 27 and 28 degrees south latitude. The location of this area is shown in Figure 1. The zone in question has experienced only limited development and has

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Figure 1. A map showing the location of Corrientes Province, Argentina, and the areas surveyed.



a stable population of nearly 15,000 inhabitants living on both sides of the Paraná River. The climate is humid and subtropical, with no dry season; the average annual temperature, relative humidity, and rainfall are 21°C, 73 per cent, and 1,700 mm, respectively (2).

Within this general region, surveys were conducted at three selected places—all in the department of Ituzaingó (Corrientes Province). These were the Ituzaingó Project quarter, Apipé Grande Island, and Apipé Chico Island. The specific locations of the populations studied are shown in Figure 1. Overall, 541 houses inhabited by 2,058 people were included in the survey.

Schematic maps were used that showed the distribution of homes in each selected area; the homes to be surveyed were selected at random, and their residents were listed on a form by name, age, and sex. Field laboratory

facilities were set up at quarters provided by the Yacyretá Binational Agency in Ituzaingó and at the San Antonio Health Center on Apipé Grande Island.

Ituzaingó Project Quarter

This is a residential district 230 km east of the city of Corrientes, to which it is linked by a paved road. A total of 182 standard homes (see photos) have been built there, and since August 1978 these have been inhabited by some 661 people. These residents belong to families that had lived in primitive and unhygienic dwellings with dirt walls and floors and thatched roofs situated on land now occupied by the new permanent townsite and the dam's reservoir area. The old dwellings were destroyed, and the inhabitants and their belongings were relocated to the new houses. During

the survey 18 per cent of these new homes were inspected, and serologic examinations were performed on 10 per cent of the population.

Apipé Grande Island

This island is in the Paraná River to the north of several small uninhabited islands, the island of Apipé Chico, and the town of Ituzaingó (see Figure 1). It has an area of 266 km², and according to a census taken by the Ministry of Social Welfare of Corrientes in 1978, it then had a population of 1,263 people living in 317 dwellings. The islanders were living in four communities—San Antonio, Panco Cué, Monte Grande, and General Uruburu—all of them situated along the northern coast, which has the highest elevation. These small villages are separated by dense jungle, lagoons, and densely reeded estuaries.

It takes 30 minutes by launch to reach the island from Ituzaingó. The crossing is made difficult by the river's rocky bed and the swiftness of the current approaching Apipé Falls. In our case it proved impossible to get from Panco Cué to General Uruburu by water because the river's volume was too small. Accordingly, it was necessary to cross the island in a horse-drawn cart, which took three hours in each direction. It was only possible to inspect 11 per cent of the dwellings on this island, as they were widely scattered. Most of the blood samples, obtained from 21 per cent of the population, were procured from assembled groups of residents.

Apipé Chico Island

Apipé Chico Island is on the Paraná River between Apipé Grande Island and Ituzaingó. It can be reached from Ituzaingó in 10 minutes by motorized launch. This island has an area of 20.8 km²; at the time of the survey it had a population of 134 living in 42 dwellings. As in the Apipé Grande communities, these dwellings were situated on high ground

because of periodic flooding. It was necessary to cross the jungle on foot in order to conduct the survey, as this was the only way of reaching the houses. Proceeding in this fashion, 76 per cent of the houses were inspected and blood samples were taken from 81 per cent of their residents.

The Study Population

All the people studied, including some from Paraguay, were Caucasians. Overall, the study population's socioeconomic level could be considered low. The economically active residents were unskilled or semiskilled workers temporarily employed doing preliminary work for the dam. This was particularly true of those living in Ituzaingó. Women in these areas did household tasks.

On the islands, most of the arable land was devoted to primitive subsistence farming; the islanders also did some fishing. The household livestock, depending on each family's economic situation, included cattle, pigs, chickens, dogs, and cats. Some families were self-employed making bricks, whose manufacture engaged all family members, including the children. Those living close to the estuaries exploited the reeds growing there for commercial purposes. Primary and secondary schooling was available in Ituzaingó, but only primary education was provided on the islands.

The dwellings in Ituzaingó appeared comfortable compared to those on the islands. The former, built of brick and cement, had walls plastered with a limestone-sand mixture, tile or cement floors, and tile or galvanized zinc roofs. Each had two bedrooms, a bath, a kitchen, and an adjoining yard. (After moving in, the residents built huts and animal pens in these yards out of wood, straw, and paperboard salvaged from their old dwellings.) All the homes had drinking water, electricity, and appropriate excreta disposal systems.

In contrast, the islanders' homes were poorly ventilated and unsanitary. The walls were generally of wood or *tacuara* reed plastered

over with a mixture of dirt and sand that was usually cracked. The roofs were of thatch or paperboard and the floors of compacted dirt. The residents of these island homes lived in overcrowded conditions and in intimate proximity with their animals. The only buildings that constituted noteworthy exceptions on the islands were the San Antonio Health Center and a cluster of five buildings forming the compound of the *Hogar Filadelfia de Apipé Grande*, a religious institution operated by Swedish missionaries.

Capture and Examination of Vectors

In the course of the house visits, triatomid vectors of Chagas' disease were shown to the inhabitants in order to assist them in locating like bugs. The residents were also asked whether they knew about the relationship between the insects and the disease. A careful inspection was made of each house surveyed. The doors and windows were closed, pyrethrum was released inside, and about 20 minutes later triatomids were captured with the aid of lamps and tweezers.

After due preparation, the bugs were sent to the National Parasitology Center for examination and identification. There they were subjected to laboratory procedures designed to determine their rate of infection with *T. cruzi*. Fresh stools, obtained by pressing on the abdomen, were suspended in a 0.85 per cent sodium chloride solution and viewed through a microscope. If this yielded negative results, the triatomids involved were dissected, and their gut contents were homogenized in saline solution and examined. Evidence of infection with *T. cruzi* was corroborated by observation of (a) flagellates with typical *T. cruzi* morphology and movement; (b) Giemsa-stained metacyclic forms of the parasite prepared according to the method of Mayer et al. (3); (c) fresh and stained trypomastigote forms obtained from white mice infected by intraperitoneal inoculation of a saline suspension of the bugs' feces; and (d) epimastigote forms grown in culture media (4) inoculated with blood ob-

tained from infected mice by cardiac puncture.

Serologic Examinations

Whenever possible, blood samples were taken from all the household members surveyed, regardless of whether triatomids were present in their dwellings. The blood was obtained by venipuncture using needles and vacuum suction tubes.⁴ Immediately after extraction, the serum was separated; it was then stored at -20°C until used. Collected sera were transported from the field laboratories to the National Parasitology Center in isopor storage boxes containing bags of refrigerant.

Hemagglutination Tests

These were carried out in accord with the semiquantitative technique described by Martini (5), using U-plates⁵. The sera were considered positive if they reacted at a dilution of 1:16 or more. Sheep erythrocytes were employed in the test. The antigen for these tests (and for the immunofluorescence tests) was prepared from Tulahuén strain epimastigotes and was obtained from The Dr. Mario Fatale Chabén National Institute for Chagas' Disease Diagnosis and Research in Buenos Aires.

Immunofluorescence Tests

The indirect immunofluorescence technique recommended by Alvarez (6) was employed. Sera reacting at a titer of 1:30 or more were considered positive. The antigen (prepared with epimastigote forms of *T. cruzi*, Tulahuén strain) was cultured in diphasic media (4). The slides used contained 12 circles, each 0.8 cm in diameter, that were marked with acetone-diluted nail polish.

⁴Venoject Jintan Terumo Co., Tokyo, Japan.

⁵Microtiter Kit, Cooke Engineering Co., U.S.A.

Human anti-gamma globulin labeled with fluorescein isothiocyanate from the Pasteur Institute in Paris was used for this test. The "optimum" titer (the greatest dilution of anti-gamma globulin that reacted with positive control sera) was 1:80. Observations were made with a Karl Zeiss Jena (Ergaval model) microscope equipped with a 12.5 x eyepiece, a dry 40/0.65 objective, and a 1.05 cardioid dark-field condenser. Ultraviolet light was supplied by an Osram HBO 200 lamp. The filters used included an anticaloric GG 13-2, a BG3/2G excitor, and a K 510 blocker. All the microscopic observation was performed in a darkroom.



The sera given these two tests were considered either responsive (positive) or unresponsive. The antigen utilized in the immunofluorescence and hemagglutination tests came from the same batch.

Results

Of the 410 persons over 5 years of age who were asked about the presence of triatomids in their homes, barely 1 per cent expressed lack of familiarity with the insects. This figure included people who had recently arrived in Ituzaingó from urban centers in the provinces of Santa Fe and Buenos Aires. Locally, the triatomids were known by their indigenous names—*yuru pucu* bug or *guazu* bug (from the Guarani *yuru* for "beak" or "mouth," *pucu* for "long," and *guazu* for "large").

Serologic Tests

The 435 persons serologically surveyed constituted 21 per cent of the three survey areas' total population. Table 1 shows the distribution, by age and sex, of the 63 people surveyed in the Ituzaingó Project area. This latter sam-

ple represented about 10 per cent of the Ituzaingó Project Quarter population; anywhere from 8 per cent to 14 per cent of the age groups shown, except the youngest (the 0-4 year age group), were examined. Analysis of the 63 blood specimens obtained disclosed the presence of *T. cruzi* antibodies in 22 subjects (35 per cent). These people, it should be emphasized, had previously lived in houses colonized by triatomid bugs.

Although the examination of 21 per cent of the inhabitants of Apipé Grande Island (Table 2) may be considered representative, only 7 per cent of the inhabitants under 5 years old and 10 per cent of those over 49 were examined. *T. cruzi* antibodies were detected in 46 per cent of the sera from Apipé Grande residents.

As may be seen in Table 3, the sample examined on Apipé Chico was highly representative (81 per cent of the population), and at least 64 per cent of each age group listed was examined. Sera from 51 per cent of the Apipé Chico residents yielded positive results. As on Apipé Grande, the Apipé Chico residents were living in homes colonized by the disease vector.

Overall, there was 99 per cent agreement between the hemagglutination and immunofluorescence test results. That is, the results differed with respect to only five of the 435 sera examined.

Infestation Indexes

In all, 99 of the 541 residences surveyed were inspected for triatomids. The triatomine species encountered was *T. infestans* (in all its stages of development). Of the 99 homes inspected in the three survey areas, 71 per cent were found to be infested. However, the infestation index was relatively low (12 per cent of the inspected homes) in the Ituzaingó Project area and extremely high (100 per cent of the inspected homes) on Apipé Grande and Apipé Chico.

Table 1. Ituzaingó Project Quarter serologic results, showing the distribution by age and sex of the 63 people tested for antibodies to *T. cruzi* in October 1978 and the percentages yielding a positive response to both the hemagglutination and immunofluorescence tests.

| Age group (in years) | Males | | | | Females | | | | Total | | | |
|-------------------------|---------------|-----------------------------------|--------------------|-----|---------------|-----------------------------------|--------------------|-----|---------------|-----------------------------------|--------------------|-----|
| | No. tested | % of whole age group tested | Positive responses | | No. tested | % of whole age group tested | Positive responses | | No. tested | % of whole age group tested | Positive responses | |
| | | | No. | % | | | No. | % | | | No. | % |
| 0-4 | 2 | 3 | 2 | 100 | — | — | — | — | 2 | 1 | 2 | 100 |
| 5-9 | 8 | 16 | 4 | 50 | 6 | 12 | 3 | 50 | 14 | 14 | 7 | 50 |
| 10-14 | 6 | 13 | 2 | 33 | 2 | 7 | — | — | 8 | 11 | 2 | 25 |
| 15-19 | 3 | 7 | 1 | 33 | 3 | 9 | 3 | 100 | 6 | 8 | 4 | 67 |
| 20-49 | 8 | 6 | 3 | 37 | 18 | 16 | 4 | 22 | 26 | 11 | 7 | 27 |
| ≥ 50 | 2 | 11 | — | — | 5 | 13 | — | — | 7 | 12 | — | — |
| Total | 29 | 9 | 12 | 41 | 34 | 10 | 10 | 29 | 63 | 10 | 22 | 35 |

Table 2. Apipé Grande serologic results, showing the distribution by age and sex of the 268 people tested for antibodies to *T. cruzi* in December 1978 and the percentages yielding a positive response to both the hemagglutination and immunofluorescence tests.

| Age group (in years) | Males | | | | Females | | | | Total | | | |
|-------------------------|---------------|-----------------------------------|--------------------|----|---------------|-----------------------------------|--------------------|----|---------------|-----------------------------------|--------------------|----|
| | No. tested | % of whole age group tested | Positive responses | | No. tested | % of whole age group tested | Positive responses | | No. tested | % of whole age group tested | Positive responses | |
| | | | No. | % | | | No. | % | | | No. | % |
| 0-4 | 9 | 10 | 6 | 67 | 5 | 5 | 4 | 80 | 14 | 7 | 10 | 71 |
| 5-9 | 37 | 36 | 15 | 41 | 30 | 35 | 18 | 60 | 67 | 36 | 33 | 49 |
| 10-14 | 34 | 31 | 18 | 53 | 35 | 51 | 18 | 51 | 69 | 39 | 36 | 52 |
| 15-19 | 18 | 30 | 10 | 56 | 17 | 29 | 14 | 82 | 35 | 29 | 24 | 69 |
| 20-49 | 25 | 13 | 6 | 24 | 33 | 21 | 8 | 24 | 58 | 17 | 14 | 24 |
| ≥ 50 | 8 | 7 | 3 | 37 | 15 | 13 | 3 | 20 | 23 | 10 | 6 | 26 |
| Total | 131 | 20 | 58 | 44 | 135 | 23 | 65 | 48 | 266 | 21 | 123 | 46 |

Table 3. Apipé Chico serologic results, showing the distribution by age and sex of the 106 people tested for antibodies to *T. cruzi* in November 1978 and the percentages yielding a positive response to both the hemagglutination and immunofluorescence tests.

| Age group (in years) | Males | | | | Females | | | | Total | | | |
|-------------------------|---------------|-----------------------------------|--------------------|-----|---------------|-----------------------------------|--------------------|-----|---------------|-----------------------------------|--------------------|----|
| | No. tested | % of whole age group tested | Positive responses | | No. tested | % of whole age group tested | Positive responses | | No. tested | % of whole age group tested | Positive responses | |
| | | | No. | % | | | No. | % | | | No. | % |
| 0-4 | 4 | 71 | 2 | 50 | 5 | 100 | 2 | 40 | 9 | 83 | 4 | 44 |
| 5-9 | 4 | 67 | 4 | 100 | 11 | 100 | 3 | 27 | 15 | 88 | 7 | 47 |
| 10-14 | 12 | 100 | 7 | 58 | 9 | 100 | 5 | 56 | 21 | 100 | 12 | 57 |
| 15-19 | 8 | 100 | 3 | 37 | 1 | 100 | 1 | 100 | 9 | 100 | 4 | 44 |
| 20-49 | 17 | 64 | 10 | 59 | 19 | 91 | 9 | 47 | 36 | 76 | 19 | 53 |
| ≥ 50 | 6 | 50 | 1 | 17 | 10 | 77 | 7 | 70 | 16 | 64 | 8 | 50 |
| Total | 51 | 73 | 27 | 53 | 55 | 92 | 27 | 49 | 106 | 81 | 54 | 51 |

Infection of *Triatomids* with *T. cruzi*

Of 255 triatomids captured, 74 (29 per cent) were found to have trypanosomes in their feces. These trypanosomes' morphology, mobility, staining characteristics, infectivity for mice, and growth in vitro places them within the *T. cruzi* biological complex. The four triatomids found in Ituzaingó Project Quarter homes arrived at the laboratory dead and dry, which made it impossible to determine whether they had been infected with *T. cruzi*.

Within the Ituzaingó Project Quarter, the positive sera were obtained from people who had previously lived in bug-infested huts. Similarly, virtually all the islanders lived with the insect. Overall, the presence of *T. cruzi* was confirmed in 29 per cent of the triatomids collected on Apipé Chico and in 30 per cent of those from Apipé Grande.

Discussion

The culture, socioeconomic conditions, and physical environment of the study areas obviously tended to favor procreation and maintenance of *T. infestans*. Although it is assumed that *T. infestans*' range in Argentina extends from 22° to 45° south latitude, and from the Andes Mountains in the west to the eastern ocean and riverine coastline (7, 8), the bug's density of infestation is not uniform. Epidemiologic surveys made to determine infestation levels have shown the most infested areas to be provinces situated in the central and northern parts of the country (9).

Confirmation of the existence of *T. infestans* in Ituzaingó Department, Corrientes Province (as previously suggested—1), the high (100 per cent) infestation indexes found on Apipé Grande and Apipé Chico, and the high rate of *T. infestans* infection with *T. cruzi* justify including this region among those areas considered highly endemic for Chagas' disease. This ties in with epidemiologic data previously reported by Borda et al. (1) showing an extensive endemic area that includes some

Paraguayan territory (Ayolas, Santiago, and Yacyretá Island). It should be emphasized that this is the first time *T. infestans*' presence on Apipé Grande and Apipé Chico has been reported. (These islands are evacuated when periodic flooding of the Paraná occurs.) This finding shows that under natural conditions this triatomid species is easily capable of adapting to climatic variations including temporary flooding and a high relative humidity that averages 73 per cent.

Avalos (10), referring to *T. infestans* in Argentina, says that throughout its geographic range the bug is known by the Quechua Indian name *vinchuca*. This Quechua name makes one suspect that the bug's center of dispersion has been Peru or Bolivia. This is the same name used in the country's north-eastern and central provinces, where there have been either Quechua populations or Quechua cultural and linguistic influence. However, this influence is not present in the Corrientes Province communities studied—because this part of Argentina (like Paraguay) was originally inhabited by another Indian group that spoke the Guaraní language. For this reason, the people asked about the presence of *vinchucas* in their homes did not know them by that name; but when shown the insect they recognized it, calling it *chinche yuru pucu* or *chinche guazu*.⁶ These native names, in which Spanish is mixed with Guaraní, should be added to the list of common names for *T. infestans* and should be incorporated into the health education programs planned for this area, so that local people can more easily understand messages referring to this insect.

On the islands, the residents' poverty had a lot to do with their homes' makeshift nature—a factor greatly favoring Chagas' disease transmission. However, this housing pattern did not exist in the Ituzaingó Project area—because the State financed the building of new homes, and because the materials used did not

⁶*Chinche* is a Spanish word for "bug" sometimes used to refer to triatomids.

foster proliferation of the bugs. Therefore, although things were not consciously planned that way, the bug was discouraged when the unhygienic huts providing ideal habitats were removed and replaced with comfortable dwellings.

Nevertheless, lack of basic health education and public ignorance about the bugs and their connection with Chagas' disease enabled the triatomids to persist in the Ituzaingó Project community (see Table 4). This situation was partly attributable to passive transport of *T. infestans* in furnishings and personal effects brought from the residents' previous homes; and it was also partly attributable to the residents' construction of huts in their yards like those shown in the accompanying pictures. These huts, made of wood, *tacuara* reeds, and paperboard sheets salvaged from the residents' old homes, offered *T. infestans* an adequate refuge.

These yard huts were used as shelters for domestic animals and were undoubtedly occupied by wild mammals, such as rats and weasels, that serve as *T. cruzi* reservoirs. It was also common to use these improvised buildings as storage places for utensils, food, and logs. Sometimes they were also used as family meeting-places and even as places for receiving guests. Clearly, these uses and customs were neither immediately nor completely eliminated by mere housing improve-

ments; indeed, it would appear that such cultural conditioning can only be overcome through the education needed to establish a hygienic style of life.

T. cruzi antibodies were found in sera from all the age groups involved except those over 50 years of age in the Ituzaingó Project area. Nevertheless, it was not possible to draw conclusions about the serologic prevalence of *T. cruzi* antibodies in the different age groups at Apipé Grande and Ituzaingó because the groups surveyed were not sufficiently homogeneous. Generally speaking, however, the more homogeneous and representative samples of subjects (corresponding to those 5 to 19 years old) in each of the three study areas indicated that the rate of positive serologic response tended to increase with age. This was especially evident in the population surveyed on Apipé Grande, where the serologic responses taken as a whole became more positive with increasing age (see Table 3). This finding coincides with what has already been pointed out by other authors (9, 14, 15).

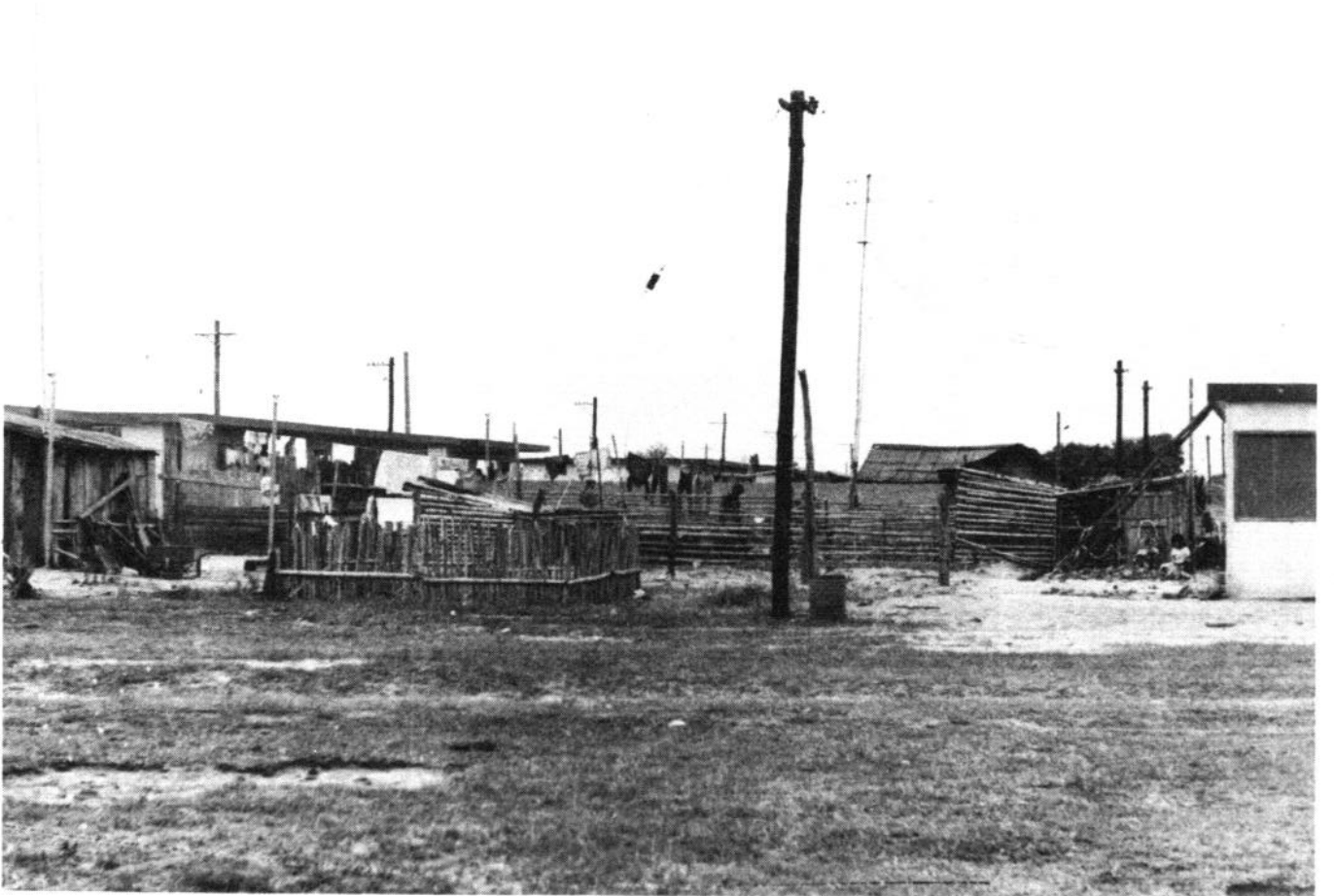
Sensitivity and specificity evaluations made by several researchers indicate that the indirect immunofluorescence and hemagglutination tests used in this study are very suitable for individual diagnoses and seroepidemiologic studies of *T. cruzi* infection (16-18). From the positive results of these tests and the triatomid infestation densities observed, it can be in-

Table 4. Results of the December 1978 entomologic and parasitologic survey of dwellings in the three study areas of Ituzaingó Department, Corrientes Province, Argentina.

| Survey area | Dwellings | | | | | <i>T. infestans</i> examined for presence of <i>T. cruzi</i> parasites | | |
|-------------------|--------------------------------|---------------|-------------|------------------------------------|----------------------|--|------------------------------|----|
| | Total no. of dwellings in area | Inspections | | Dwellings with <i>T. infestans</i> | | Total no. examined | Positive for <i>T. cruzi</i> | |
| | | No. inspected | % inspected | No. | % of those inspected | | No. | % |
| Ituzaingó Project | 182 | 33 | 18 | 4 | 12 | 4 | - | - |
| Apipé Grande | 317 | 34 | 11 | 34 | 100 | 179 | 53 | 30 |
| Apipé Chico | 42 | 32 | 76 | 32 | 100 | 72 | 21 | 29 |
| Total | 541 | 99 | 18 | 70 | 71 | 255 | 74 | 29 |



Ituzaingó Project housing, showing state-financed dwellings (above) and makeshift huts and animal pens subsequently built by residents (below).



ferred that *T. cruzi* infections are proceeding actively in the three areas studied. However, the vectors do not necessarily transmit infections to all the people living in the same infested dwelling. For example, sera from 26 Apipé Chico residents living in a cluster of five infested huts were examined for *T. cruzi* antibodies. Such antibodies were found in only nine (35 per cent) of these 26 residents. This observation supports Oliver's point (19) that the parasite has difficulty passing from its triatomid vector to man. The nature of what causes this observed lack of infection should be investigated, keeping in mind that sites like those studied appear to offer virtually all the conditions favoring transmission from the invertebrate host.

It also seems noteworthy that we were able to capture a large number of triatomids, at all stages of development, in bundles of straw stored in an islander's farm. These bundles were being sold to fellow islanders and also to Ituzaingó residents. This trade provided an easy route of *T. infestans* transfer from one place to another.

The results of the serologic examinations confirmed our working hypothesis that *T. cruzi* infection was highly prevalent in the department of Ituzaingó. Overall, 46 per cent of the people tested gave a positive serologic response, and study populations in areas with relatively high vector infestation indexes yielded relatively high rates of positive response. Analysis of the total positive responses by sex (45.97 per cent of 211 men and 45.53 per cent of 224 women responded positively) showed virtually no difference in rates of *T. cruzi* infection. However, when the three study areas were assessed separately, the rate of positive responses was found to have been slightly higher among males in the Ituzaingó Project area (see Table 1), among males on Apipé Chico Island (see Table 3), and among females on Apipé Grande Island (see Table 2).

Although no particular significance is at-

tributed to these differences, it would be worth exploring whether a statistically significant difference exists between the sexes with regard to rates of *T. cruzi* infection. Some authors have reported finding slightly higher rates of infection in women, although a higher percentage of men exhibit ensuing cardiac damage (11). Other authors point to the fact that, for undetermined reasons, both cardiac and digestive tract involvement are more common among men (12), while still others note that the general prevalence of cardiac problems is higher among men (13).

It should also be noted that the serologic findings indicate infection rather than disease. A more comprehensive study is needed to detect the parasites by xenodiagnosis and to determine whether the positive responders show evidence of changes in their hearts or other organs attributable to *T. cruzi*. These measures would permit the prevalence of Chagas' disease morbidity among the infected people to be determined, and would provide an improved statistical basis for assessing the public health hazard posed by Chagas' disease morbidity in this part of Northeast Argentina. Likewise, other factors that help determine the epidemiology of Chagas' disease in rural areas should be evaluated, such as the importance of domestic and wild animal reservoirs.

As this work shows, environmental changes taking place in the area to be served by the Yacyretá-Apipé Dam are being accompanied by population movements intimately related to Chagas' disease transmission. It is clear that when the new Ituzaingó houses were planned and built and when people were being relocated to them endemic Chagas' disease was not considered, and that vector control measures were only taken after the problem had emerged. However, the results of the surveys reported here are being used by the National Chagas' Disease Service in the Corrientes area as the basis for a campaign against *T. infestans* in Ituzaingó Department.

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SUMMARY

In late 1978 a survey was conducted to determine whether Chagas' disease vectors and the disease agent, *Trypanosoma cruzi*, were present in Argentine locales near the site of the future Yacyretá-Apipé Dam on the Paraná River. This work followed investigations that had found the vector *Triatoma infestans* to be present in nearby communities on the Paraguayan side of the river.

Three places were included in the survey. These were the area of the Ituzaingó housing project, where people displaced by the dam construction had been provided with new housing; Apipé Grande, an inhabited island in the Paraná River; and Apipé Chico, a smaller inhabited island. In all, 99 dwellings were searched for insect vectors (after releasing pyrethrum to dislodge them), and sera from 435 residents were tested for the presence of antibodies against *T. cruzi*.

T. infestans was found in 12 per cent of the dwellings inspected in the Ituzaingó Project and in 100 per cent of the ramshackle dwellings on the two islands. Of the 255 triatomid bugs captured, 29 per cent were found to contain *T. cruzi*. Likewise, nearly 46 per cent of the sera tested yielded antibodies against *T. cruzi*. These findings justify including the region surveyed among those considered highly endemic for Chagas' disease in Argentina.

The survey also showed that provision of new housing ill-suited to vector proliferation had reduced but not eliminated *T. infestans* populations. The circumstances involved (especially construction of vector-prone huts in the yards of new residences) demonstrated that besides new housing, appropriate health education is needed to guide people away from traditional behavior patterns likely to cause infection.

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