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THE ROLE OF THE PAHO CENTER FOR VECTOR BIOLOGY AND CONTROL IN RESEARCH ON CHAGAS' DISEASE

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1. Introduction

The Regional Research and Reference Center on Vector Biology and Control was established originally in Venezuela as the "Chagas' Disease Vector Research Unit" by a grant to the World Health Organization from the U.S. Center for Disease Control. Its scientific program began in March 1973 with a planning meeting in which national PAHO and WHO staff and consultants determined the direction of research. The objectives of the project as stated in the original Research Agreement are as follows:

(1) To study the distribution, population density, ecology and biology of the known and potential triatomid vectors of Chagas' disease in Venezuela, including both domestic, peridomestic and feral species.

(2) To determine the mammalian host preference of the actual and potential vectors of Chagas' disease as well as carry out studies on the vectorial capacity of these species.

(3) To determine the insecticide susceptibility of the actual and suspected triatomid vectors of Chagas' disease.

(4) To study the effect of already existing control measures on vector populations, both domestic and peridomestic, as well as the rate of recovery of these populations following the termination of control measures.

(5) To develop effective and economic control measures aimed at the interruption of disease transmission based on either chemical or environmental control or biological control or any combination of these.

(6) To study the effect of such control measures on the rate of transmission of disease in human and animal reservoir populations.

(7) To study the distribution and population density of known domestic and feral reservoirs of Chagas' disease.

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(8) To consider possible methods of control based on manipulation of such reservoir populations.

(9) To study the serology and epidemiology of the disease in human and reservoir populations in selected areas prior to and following trial of whatever control measures are deemed most appropriate to the requirements of the country.

This program has been reviewed annually by PAHO and WHO staff. During the last review held in January 1977, the scientific program and priorities were established for the next five years.

In the original planning meeting a diagrammatical model of the transmission of Chagas' disease was proposed (Annex 1). This model illustrates the complex phenomenon of Trypanosoma cruzi transmission and will form the basis of the review of the research program of the Centre. As stated in the original report: "Each of the boxes represents a harboring of T. cruzi within an arbitrary ecologically meaningful grouping. The arrows represent the various important pathways by which transmission from one box to another may occur. Man is, of course, also considered a reservoir in this scheme. The P values represent the probabilities of the twelve transmission possibilities enumerated in this model." 1/

The discussion will begin with the sylvatic cycle of T. cruzi followed by the peridomestic cycle and ending with the domestic cycle. Each topic will outline the present status of research, current activities and recommendations for the future.

2. Research Program

2.1 Sylvatic cycle

2.1.1 Wild vectors

In 1973, there were 16 known species of triatominae in Venezuela. Rhodnius prolixus is the primary vector of T. cruzi to man while Triatoma maculata is the second and less important vector of T. cruzi to man. However, several other species are of considerable importance in the sylvatic cycle.

A survey to determine the distribution, population density, and ecology of sylvatic triatominae began in 1973. Every state and district, with the exception of Nueva Esparta and Amazonas, were visited. A number of habitats, including bird nests, animal holes and nests, bromeliads, cactus plants, bark of dead trees, and palm trees, were dissected. Although most states were visited for less than one week, a number of new records were found. These are as follows:[2/]

Portuguesa

Cavernicola pilosa
Rhodnius pictipes
Panstrongylus lignarius

Cojedes

Cavernicola pilosa
Rhodnius pictipes
Rhodnius robustus
Eratyrus mucronatus

Apure

Psammolestes arthuri

Lara

Psammolestes arthuri
Eratyrus mucronatus

Falcon

Rhodnius pictipes
Rhodnius robustus
Eratyrus mucronatus

Trujillo

Eratyrus mucronatus
Triatoma nigromaculata
Panstrongylus rufotuberculatus
Panstrongylus geniculatus

Tachira

Eratyrus mucronatus
Eratyrus cuspidatus
Rhodnius pictipes
Rhodnius robustus
Panstrongylus rufotuberculatus
Psammolestes arthuri
Triatoma nigromaculata

Guarico

Panstrongylus sp

Distrito Federal

Panstrongylus rufotuberculatus

Miranda

Rhodnius pictipes

Monagas

Psammolestes arthuri

Barinas

Psammolestes arthuri

Aragua

Belminus rugulosus

Delta Amacuro

Microtriatoma trinidadensis

Territorio Amazonas

Panstrongylus geniculatus

Sucre

Eratyrus cuspidatus
Eratyrus mucronatus
Microtriatoma trinidadensis
Panstrongylus rufotuberculatus
Rhodnius pictipes

Zulia

Eratyrus cuspidatus
Panstrongylus rufotuberculatus
Rhodnius neivai

Upon completion of the surveys, an attempt was made to relate the distribution of all known species of triatominae within Venezuela with the different biogeographical zones as given by Holbrook.[3/] A similar study has been done in Colombia by D'Alessandro et al.[4/]

In addition, a pictorial key to the adults was produced. Nymphal stages and eggs were presented in keys but final identification is reserved for adult stages.[5/] Taxonomy is still confusing. In a recent survey in Tachira, triatominae resembling R. prolixus, but larger, were captured in houses. An attempt is being made to colonize these specimens. Some of them were positive for T. cruzi. There is a colony of R. robustus in Trujillo which might actually be a hybrid between R. prolixus and R. robustus. The Centre has secured a colony of these bugs and is studying them. There seems to be a great variation among R. prolixus collected from different geographical areas. Variations include color, size, and presence of characteristics such as white antennae and red eyes. Consequently, colonies exhibiting these variations are being established to study them further.

The studies on geographical distribution produced a number of new distributional records as shown above. They also provided material for taxonomic studies and biological observations on a number of species.

On examination of R. robustus and R. pictipes collected from palm trees natural infestations of R. robustus by T. cruzi and mixed infections by T. cruzi and T. rangeli were reported for the first time. Also reported for the first time were natural infections of R. pictipes with T. rangeli and mixed infections with T. rangeli and T. cruzi. Consequently, these two species must be considered as potentially important vectors in the wild cycles of T. cruzi and T. rangeli in Venezuela and as possible links between wild and domestic parasite cycles.[6/]

Psammolestes arthuri probably has a nationwide distribution. It is found primarily in nests of the "cucarachero" bird (Family Furnariidae). Over 67% of the nests dissected were positive and an average of over 21 specimens per positive nest was collected. In a few instances, R. prolixus or T. maculata were collected in association with P. arthuri. A number of blood specimens from engorged P. arthuri collected on filter paper showed birds to be almost exclusively the source of blood. No T. cruzi were found in over 500 dissections of this triatomid. Therefore, it is not considered important in the sylvatic cycle.[7/]

Rhodnius robustus was first described from Venezuela by Lent and Valderrama.[8/] The Centre expanded the geographical distribution of the species and added the palms Acrocomia sp., Scheelea sp. and Mauritia sp. as well as the bromelia Aechmea sp. as habitats. Of 151 bugs dissected, 58 (44.2%) were infected with trypanosomes. In the laboratory, the egg-to-adult cycle took 127 to 224 days; the egg-to-egg cycle took from 149 to 256 days and hatching time took between 12 and 19 days.[9/] Recently, R. robustus was found in 3 more municipalities in Tachira. A number of the specimens were infected with trypanosomes.

With the possible exception of R. prolixus, R. pictipes is the most important vector of T. cruzi found associated with palms. Over 18% of the studied wild habitats were infested with R. pictipes. Scheelea sp. palm trees seems to be the principal habitat of the species. Other important habitats were mammal shelters, other palm trees and bormeliaceas of the genus Aechmea. R. pictipes have been collected from chicken nests in peridomestic environments and from walls and roofs of human dwellings. However, it has not been found colonizing these habitats. Of a sample of 484 R. pictipes, 65.5% were positive from trypanosomes (T. cruzi or cruzi-like - 20.2%; T. rangeli or similar - 30.4%; mixed infections - 8.9% and undetermined species - 5.8%). In the laboratory, the egg-adult cycle took 118 days; egg-egg cycle - 134 days, and total mortality was over 47%.[10/]

Rhodnius neivai was first described from the state of Lara. Early records show it to be purely domestic-peridomestic in distribution. The Centre reported the first records in wild habitats. Specimens were collected in two semidesertic areas in the State of Zulia from holes in a dry tree trunk and in the palm tree Copernitia tectorum. Studies on the laboratory life cycle showed: hatching time - 17 days; egg-to-adult cycle - 135 days; and egg-to-egg cycle - 161 days. Mortality from egg to adult was 32%.[11/]

Cavernicola pilosa is found associated with various species of bats. The Centre reported it in econological association with two bats: Desmodus rotundus and Saccopteryx bilineatus, not reported before. The attraction to black light was observed and one specimen was found in a house. A total of 44 specimens dissected for parasites gave 37 positives for a trypanosome similar to T. cruzi. An attempt to colonize this species failed.[12/]

A number of different methods have been employed to study sylvatic triatominae.[13/] These include dissection of microhabitats Gomez-Nuñez type traps, bait traps, and black light traps. Although time-consuming and difficult to do, dissections of microhabitats remain the method of choice. Of 394 palms dissected, 3,394 triatominae were collected from 342 trees (87% positivity). Species collected from palms were: E. mucronatus, E. cuspidatus, P. lignarius, R. neivai, R. pictipes, R. prolixus, R. robutus, and T. maculata. Bird nests yielded R. prolixus, T. maculata, and P. arthuri. Animal shelters produced R. pictipes, R. prolixus, T. maculata, P. geniculatus, and P. arthuri. Dissection of bark from dry trees gave R. prolixus, R. neivai, R. maculata, and P. geniculatus. From hollow trees containing bats, C. pilosa was collected. T. maculata, R. pictipes, R. prolixus, R. robustus, and M. trinidadensis were found in bromelias. Palms were the habitat of choice for R. prolixus while dry trees seemed equally as important as palms for T. maculata.

Bait traps collected R. prolixus, T. maculatus, and P. geniculatus while Gomez-Nuñez type traps yielded only one P. rufotuberculatus.

Black light traps caught R. prolixus, R. robustus, E. mucronatus, C. pilosa, P. geniculatus, P. rufotuberculatus, R. pictipes, T. maculata, and P. arthuri.

The species E. mucronatus and P. geniculatus, should be studied in greater detail in sylvatic habitats. Both species invade human dwellings and a high percentage of them are positive for T. cruzi. In one village in Yaracuy, P. geniculatus was observed biting humans. This bug was attracted by the light at night and was collected while feeding.

2.1.2 Wild Reservoirs

A large number of wild mammals have been incriminated as reservoirs for T. cruzi or T. cruzi-like parasites. A trapping program began in 1973 in the states of Portuguesa and Cojedes. During 1974 and 1975, trapping was confined largely to three areas. San Jorge and Tierra Buena in Portuguesa and Finca La Coromoto in Cojedes. Later trapping for only a few days at a time was carried out in a number of states. More recently wild reservoir surveys were conducted in conjunction with epidemiological surveys in 7 states.

Over 60 different species of mammals, largely non-carnivorous, have been sampled. In the beginning, an attempt was made to do serology on the captures, but this was discontinued when the Organization failed to find a laboratory to carry out the tests. While the laboratory in Acarigua functioned, fresh blood was examined for parasites and thick and thin blood slides were stained with Giemsa and examined. After the laboratory was moved to Maracay, these procedures were discontinued. In addition, for a while, attempts were made by the National Institute of Hygiene in Caracas to isolate trypanosomes by tissue culture. However, due to lack of trained staff, this method of isolating the parasite was terminated. The method of choice and the one done in all animals throughout the studies is xenodiagnosis. In this case from 5 to 10 R. prolixus nymphs, usually IV instars are used. Once the bugs fed upon the mammal, they are held for at least 30 days before being examined individually for parasites. Parasites are identified by morphology and growth in the bug. Recently a strain bank was established and more criteria added to establish the identity of the parasites.

Didelphis marsupialis is the most common reservoir trapped. A total of 418 D. marsupialis trapped have been infected with either Trypanosoma rangeli, T. cruzi or a mixture of the two parasites. Of this total, only 7 were infected with T. rangeli only. Over 200 young, which were still in the pouch, were examined by xenodiagnosis and none were found infected by either parasite.

Didelphis marsupialis has a wide distribution in Venezuela. Practically every area in which trapping was done yielded D. marsupialis and in most cases at least one capture was positive. In host preference studies of sylvatic triatomids, Didelphis feeds were found for R. prolixus, R. pictipes, and T. maculata. In transect trapping away from human dwelling, D. marsupialis were captured within 10 meters of the house. Venezuelan investigators have reported captures within the house; thus providing a possible link between the sylvatic and domestic T. cruzi cycle.

Population studies using a mark-recapture method were done in three localities.[14/] The significant points in the study are: (1) The opossum is a common and dominant part of the small mammal population comprising 65-68% of all species caught in the study areas; (2) A significant portion of the marked animals were recaptured frequently for up to 6 months and in one area 14% of those marked were recaptured one year later; (3) Reproduction is seasonal beginning in late January and ending in October. Young enter the existing populations from 2 to 3 times per year. This changes the ratio of young to old individuals considerably during a year; (4) Density estimates suggest 3.8 - 4.8 D. marsupials/ha. on the average, with density reaching its peak in the late wet-early dry season, on the order of 5-7 individuals/ha.

Other potential sylvatic reservoirs were Marmosa robinsoni, Sciurus grenitensis, Proechimys semispinosus, Heteromys anomalus, Dasypus novencintus, Echimys semivillosus, Dasyprocta agouti, Coendu prehensilis, Monodelphis brevicauda, Coloromys philander, and Cebus sp. Of these mammalian hosts Echimys semivillusus and Heteromys anomalus were new records and Proechimys semis pinosus was a new record for Venezuela.

In addition to T. cruzi and T. rangeli a number of other trypanosomes were found in the mammals. These include Trypanosoma sp from Didelphis marsupialis, Trypanosoma sp. from Dasyprocta agouti, T. legeri from Tamandua Tetraductyla, T. freitosi from Monodelphis brevicauda, Trypanosoma sp. from Caluromys philander, and T. lewisi and T. coutinhoi from Proechimys semi-spinosus.[15/]

A number of bats, more than 20 species, were captured and examined for trypanosomes. In some cases, trypanosomes were found in fresh blood and dried smears, but none were evident upon xenodiagnosis. These were considered not to be T. cruzi. Other trypanosomes were found on xenodiagnosis and were considered T. cruzi-like. A T. lewisi-like parasite was found in 2 species of Molossidae, 2 species of Artibeus, a species of Phyllostomidae, a species of Desmodontidae and in Saccopteryx bilineatus. Bats roost in hollow trees in association with Cavernicola pilosa and in palm trees in association with a number of sylvatic triatominae known to be infected with T. cruzi. The same species of bats are often found in roofs of houses and in large creeks in mud walls. In these cases they can be in close association with domestic vectors, i.e., R. prolixus. Consequently, additional research on bat movement and bat trypanosomes is required.

The armadillo, Dasypus novemcintus, is considered an important reservoir of T. cruzi. The Center has captured or purchased very few armadillos and has found T. cruzi in 7 of them collected in 4 different localities. Armadillo blood feeds have been found in domestic and sylvatic T. maculata and domestic R. prolixus. More collection records are needed for this animal.

Very little trapping in the canopy has been done. Inasmuch as many of the sylvatic vectors are confined to limited habitats in palms and bromeliads, more trapping should be done at these elevations. While doing trapping, vector habitats in the vicinity should be dissected and the specimens examined for parasites and if engorged, blood feeds determined.

Transect trapping commencing near human dwellings and running for a distance of 100 meters away from the house has shown that a number of small mammals, including rodents and marsupials come close to or enter houses. In fact, Proechimys semispinosus and Heteromys anomalus, both known reservoirs for T. cruzi, have been trapped inside houses. This type of study will take several years to complete. At present transects are being run one week per month in a plain area and in a low, mountainous area (450 meters). Of the 2 areas, the plain is more productive.

None of the animals trapped appear to be the primary reservoir for T. rangeli. Outside of D. marsupialis, T. rangeli has not been found in other sylvatic mammals captured.

2.2 Peridomestic Cycle

2.2.1 Peridomestic vectors

It is very difficult to distinguish between peridomestic and domestic vectors. Two species, R. prolixus and T. maculata are the dominant species in these habitats. The peridomestic environment includes animal shelters or caneys, chicken roosts, storage buildings, and nests of domestic fowl, especially chickens and pigeons. Occasionally, R. pictipes and P. geniculatus adults are found in these habitats but colonization has not been observed.

In foothill areas, T. maculata-R. prolixus associations can be found, especially in chicken and pigeon nests. Triatoma maculata is the dominant peridomestic triatominae in the plains while R. prolixus is in the mountains. Blood feeds of peridomestic R. prolixus have been shown to originate from pigs, rodents, snakes, amphibian, armadillo, opossum, dog, and cats. A similar range of blood feeds have been determined for T. maculata.

When areas are under insecticide pressure, the peridomestic habitats usually become reinfested before the domestic ones. There are several reasons for this, such as a readily available food source and less exposure to the insecticide. In the latter case, nests might not be treated for fear of killing the birds. In 1977, the Government insecticide program calls for the use of dieldrin in the domestic and HCH in the peridomestic. The residual effect has been shown to be less than 3 weeks.[16/]

Infestation of peridomestic habitats has been studied by the use of experimental chicken houses. These houses are one cubic meter in size with walls and roofs of palm leaves. In one study it was found that these houses yielded R. prolixus adults in less than 3 weeks and eggs in less than 6 weeks in areas with palm trees. However, in similar geographical areas without palm trees, infestation did not occur. On three occasions, the houses in the palm area yielded R. pictipes adults and one P. geniculatus adult was found, but colonization by these 2 species did not occur.[17/]

Similar experimental chicken houses have been used in a village where houses are reinfested with R. prolixus soon after insecticide treatment. No palms are near the village and black light trapping did not produce R. prolixus. The experimental houses did not reveal the source of R. proxilus but did expose a number of sylvatic habitats of T. maculata. The source of R. prolixus is still unknown but it is thought to be by human transport.18/

A second use for the experimental houses has been to study colonization of R. pictipes, R. prolixus, and T. maculata as well as competition between these species in establishing colonies. Adult males and females of one species were allowed to establish themselves in a house. Periodically the houses were dissected and all triatomids collected and counted. Any adults were marked with a paint spot on the thorax. By this means, it was possible to collect life-history data. Rhodnius pictipes produced eggs and nymphs but never established itself in the houses and marked adults were found to migrate from one experimental house to another. Triatoma maculata did colonize the houses but never in large numbers. The difference in colonization by the latter two species might be due to the character of the eggs; R. prolixus eggs are glued to the palm walls whereas T. maculata eggs are not.19/

At present similar houses are being used as part of a study to produce a life table for R. prolixus. The design of the experiment allows for observations on migration of adults and nymphs and the role of predators in limiting population growth.

In none of these studies has the role of peridomestic triatominae on infestation of human dwellings been defined. A mark-release-recapture study of peridomestic and domestic populations of R. prolixus has shown some movement of individuals. However, paint spots tend to be lost, so accurate movement records are impossible to maintain. This study is continuing. A more logical approach would be by radioactive markers but this is beyond the financial capacity of the Center.

2.2.2 Peridomestic reservoirs

Peridomestic reservoirs as defined by the 1973 planning meeting (1), are those species which are not intentionally raised, but live in and about human habitation and gain food from man supplies and refuse. The two species of rodents, Rattus rattus and Mus musculus, are the primary reservoirs to fall into this category. From 1975 to the present, trapping by means of Sherman traps has been done in a number of villages in Venezuela. For the most part few animals were trapped in the houses.

Four types of bait were used: peanut butter, corn, cheese, and pinaapple. Of these, peanut butter and cheese were the best. For a while snap traps were also used. These proved superior to the Sherman traps in catch, however, xenodiagnosis could not be done on a dead animal.

A total of 445 Mus musculus were caught and subjected to xenodiagnosis. Of this total, 7 (1.6%) were positive to T. cruzi. No isolations of T. rangeli were made. Four of the positive mice were from Portuguesa, three from the same village, and the rest from Cojedes. The Center was the first to isolate T. cruzi from Mus musculus in Venezuela.[20]

A total of 585 Rattus rattus has been examined by xenodiagnosis for T. cruzi. Of this number, 53 had T. cruzi, 2 had T. rangeli, and 2 had mixed infections of the 2 trypanosomes. Although 9.4% of the rats had T. cruzi, the distribution of the parasite was not uniform. In some areas, for example, Palambra del Doctor in Cojedes, over 25% of the rats were positive.

In some countries such as Panama, the domestic rat appears to be an important reservoir for T. cruzi. This does not seem to be the case in Venezuela. In areas where there is a great amount of T. cruzi activity, rats can be found positive but they probably play a minor role in the domestic T. cruzi cycle.

Blood source studies show that rodents are food sources for both R. prolixus and T. maculata in the peridomestic-domestic environment. Occasionally when the bug is found engorged and positive for T. cruzi, the last blood feed was rodent. However, little significance can be given this finding as non-reservoirs such as chickens and pigeons are frequently the last source of blood for positive vectors.

Early in the study fresh blood and dried smears were examined from rats. In 52 rats so examined, 25 were infected with T. lewisi.

Other rodents such as species of Sigmodon, Heteromys, and Proechimys were captured inside houses. On 2 occasions Proechimys semispinosus were collected in traps along with Rattus rattus. The domestic rat has been trapped in sylvatic areas some distance from human dwellings. Consequently, the possible role of these rodents in linking the sylvatic and peridomestic-domestic T. cruzi cycles cannot be entirely discounted.

2.3 Domestic Cycle

2.3.1 Domestic vectors

As mentioned earlier, R. prolixus is the primary domestic vector of T. cruzi in Venezuela. Triatoma maculata is a secondary domestic vector of undefined importance. A number of methods have been used in collecting these bugs in houses. Early in the study of domestic vectors the Center adopted the man-hour method of collection. This allowed for a comparison of the number of bugs caught from house to house or from village to village. This method has drawbacks as it depends upon the skill of the collector. Consequently, a number of other methods were tried.

In one study 1 square meter wooden frames were used. Bugs were collected for a set time interval with or without the use of an irritant. Positioning of the frames was done at random. The results showed that the frame position at the level of the bed was more apt to be positive than positions above or below the bed. Those frames in which an irritant was used gave the highest percentage of positivity and yielded the greatest number of bugs. However, routine man-hour collections produced more bugs. Although this method might be less biased than man-hour collections it was not recommended for routine use.[21/]

The man-hour method was compared with the Gomez-Nuñez trap in another study. A number of microhabitats were examined inside of the dwellings before the experiment. Beds and walls were the most common sources of bugs. One Gomez-Nuñez traps was placed on the wall near the bed and another on the wall near boxes of clothes. These traps were examined every 30 days for 5 months. At the same time man-hour collections were made. There was no difference in the average number of times a trap was positive by position (12.8 by bed and 12.4 by boxes). The average percent of houses positive during the 5 examinations was 72.9 for man-hour collections and 40.5 for the Gomez-Nuñez trap. For this reason the trap was not recommended for routine use.[22/]

The use of irritants has been recommended to increase the efficiency of inspection of houses for triatominae. One drawback to the use of irritants is the mortality of the bugs before reaching the laboratory for parasite examinations. In a recent study using the irritant recommended by Malariologia, 0.5% pyrethrum, and without irritant, no significant difference could be found. Consequently, the Vector Control Laboratory has begun testing other irritants to determine if a better one can be found.

To study population dynamics of R. prolixus, house demolitions are being done. This project is being done cooperatively with the Department of Ecology of I.V.I.C. A number of small houses are under construction to test the effect of types of roof and wall building material on R. prolixus populations. These studies, in addition to those mentioned under "Peridomestic Vectors", are expected to give information on different parameters affecting triatomine population dynamics.

The question of the role of T. maculata in transmission of T. cruzi needs to be answered. In the states of Falcon and Lara, the Center found T. maculata in semi-desertic areas in peridomestic habitats such as corrals for goats and bird nests. In 1 village surveyed in Falcon 64% of the houses were positive but only in peridomestic habitats. In Portuguese, during the period from 1962 to 1975, only 4 T. maculata were found infested trypanosomes. The majority of the T. maculata collected in this state were associated with domestic fowl. However, occasionally they were collected from walls and roofs of houses and even from beds. The Center collected T. maculata from peridomestic habitats from the states of Trujillo, Apure, Bolivar, Cojedes, Aragua, Carabobo, and Guarico. In Guarico, T. maculata was found positive for T. cruzi and blood feeds indicate a wide range of sources. In addition T. maculata in sylvatic habitats are frequently found positive for T. cruzi and T. rangeli.

Rhodnius prolixus has a well-defined role both as a sylvatic and domestic vector. Blood source studies reveal it feeds upon birds, snakes, amphibians, rodents, marsupials, ant eaters, armadillos, monkeys, dogs, cats, pigs, and man. In houses it tends to be found in walls, roofs, beds, boxes, clothes, nests, religious shrines, saddles, stored food such as corn and almost anywhere else that is dark and offers protection. There is an impression among some workers that a large cockroach population may limit the R. prolixus population but this observation must be documented.

Rhodnius prolixus appears to limit itself to rural environments. House searches have been made in 4 urban-suburban areas with only 1 out of more than 600 houses positive. More research is being done to define the distribution of R. prolixus in these areas. In the past, R. prolixus was prevalent in the llanos of Portuguese and Cojedes. However, at present foothills and mountainous areas are more important. There are probably several reasons for this as the llanos have more agriculture thus there are barriers because of deforestation between bug and man, more insecticide is used and housing is better. There might be geographical reasons such as elevation, temperature, and humidity as well. It is important to note that R. prolixus occurs in sylvatic habitats in the llanos and that more animals are captured there than in the mountains. These animals are reservoirs for T. cruzi.

The Center has investigated possible ways in which houses can become infested with R. prolixus. One suggested method is by man as he travels from house to house. In a survey of 975 houses in Cojedes and Portuguesa, 534 were positive for R. prolixus. Out of these positive houses, 81 had either living triatominae or eggs in boxes used for clothing, and 27 houses had bugs or eggs in clothing hanging on the wall. In a second study confined only to Cojedes, 71% of the houses examined were positive for R. prolixus. There was an average of 5.8 boxes per house. Over 40% of the boxes were positive for eggs and over 20% were positive for R. prolixus nymphs or adults. Examination of clothes showed 69% of the positive houses had at least 1 article of clothing containing bugs or eggs. Inasmuch as boxes and clothes are carried from house-to-house and usually not treated with insecticide during control campaigns, it was concluded that these are important sources of reinfestation.[23/]

People in rural areas of Venezuela frequently note triatominae entering their dwellings at night. These bugs are attracted to light and probably form an important source of infestation of the houses. Fifteen houses in the foothills of northern Cojedes were used in a block light test study. Two-hour collections between 1,900 and 2,100 hours were done at each house every month for 12 months. During the one year of collections, 158 R. prolixus, 13 R. pictipes, 40 P. geniculatus, and 1 E. mucrunatus were caught. R. prolixus were most abundant during April, May, and June, but were captured during each month. R. pictipes were collected mostly during dry and transitional months while P. geniculatus was more active during the dry than the wet season. More R. prolixus were collected during the first hour than the second one, while P. geniculatus appeared to have the opposite period of activity. Of special interest was the capture of V instar nymphs of R. prolixus in the traps. Five of the P. geniculatus, 2 R. pictipes, and 29 R. prolixus were positive to T. cruzi. Therefore, in rural areas vectors form an important link between the domestic and sylvatic T. cruzi and contribute to infestation of houses immediately following insecticide treatment.[24/]

2.3.2 Domestic reservoirs

Dogs and cats frequently have been reported as reservoirs of T. cruzi and T. rangeli. A study made by the London School of Hygiene and Tropical Medicine in Brazil, indicates that these animals should be considered merely as extensions of the family. The findings of the Center agree with those of the London School. Over 2,000 dogs and cats were examined by xenodiagnosis. However, not all the data have been analyzed. Information is available on 1,109 dogs and 299 cats as well as on 266 pigs and 58 goats. Of these, 63 dogs and 5 cats had T. cruzi only, 4 dogs and 1 pig had T. cruzi and T. rangeli mixed, and 86 dogs and 5 cats had T. rangeli only. Of interest in these findings is the prevalence of T. rangeli in domestic reservoirs when it is rarely found in wild ones. The report of T. cruzi and T. rangeli from a pig was the first from Venezuela. As with peridomestic reservoirs, prevalence of T. cruzi and T. rangeli varied considerably from area to area. In general, T. cruzi infections in dog corresponded to areas of medium-to-high seropositivity to T. cruzi of man. The presence of T. rangeli in domestic reservoirs and vectors is an indication that there probably is a high prevalence of this parasite in man.

2.3.3 Men

Although the Center is involved mostly with vectors and reservoirs other than man, there has been an active epidemiological program. Early in the research program an attempt was made to use serological surveys in parallel with entomological evaluation as a means to investigate possible new insecticide control measures.

Serological surveys of 2,000 1-to-9-year old children were carried out to find areas suitable to monitor the effects of control measures on the transmission of T. cruzi. The results showed that only 3% had antibodies to T. cruzi on the complement fixation test and 5% on the indirect fluorescent antibody tests. In all areas the prevalence was highest in mountainous villages. In no area was there evidence of sufficiently active human transmission taking place to allow changes in incidence brought about by any additional control measures to be monitored satisfactorily.[25/]

As a result of the above findings, it was decided to conduct an epidemiological survey for Chagas' disease in 8 rural communities in the state of Cojedes. The results showed: (1) that houses with palm roofs tended to have more R. prolixus than those with metal ones; (2) that more R. prolixus were positive for T. cruzi in palm roofs than metal ones; (3) that R. prolixus were most frequently collected in the walls and in beds regardless of roof type; (4) more dogs and cats were positive for either T. cruzi or T. rangeli as shown by xenodiagnosis from palm roofed houses than metal roofed ones; (5) that seropositivity in the human population varied from 14.6% in a village in the llanos to 69.6% in a village in the mountains; (6) that seropositivity increased with age; (7) that more males than females had cardiopathology either related or unrelated to Chagas' disease; and (8) that there was a good correlation between ECG demonstrated cardiopathology, suggestive of Chagas' disease and seropositivity.[26/]

Upon the completion of this study, the Center became involved in a government-sponsored survey in the state of Guarico. This pilot survey is to determine the feasibility of doing a nationwide survey to indicate the current status of Chagas' disease and to evaluate governments' insecticide control program against Chagas' disease vectors. This survey is designed for computer analysis and the forms are given in Annex 2.

Besides assisting the Government on an advisory capacity in Guarico, the Center has done a series of surveys using the same techniques and forms in the states of Apure, Bolivar, Falcon, Miranda, Portuguesa, Tachira, and Yaracuy. No seropositivity was found in Apure, only 3 out of 219 individuals (1.4%) were seropositive in Bolivar and all three were born in other states; in Miranda, 29 out of 295 (9.8%) were seropositive ; and in Portuguesa, 83 out of 296 (28.0%) were seropositive . Other data from this survey are not available yet. The Center plans to limit future epidemiological studies to Cojedes and Portuguesa. The Government survey is now in the state of Trujillo.

2.3 The Parasite

Early in the research program it became evident that it was necessary to clearly distinguish between *T. cruzi*, *T. cruzi*-like, *T. rangeli* and other trypanosomes which might be found in man, other hosts, and vectors. However, it was recognized that as a field research center it would be difficult to develop a laboratory capacity to do sophisticated studies. Therefore, an attempt has been made to establish a strain bank and to encourage other research institutions to do the necessary laboratory studies.

In a meeting held in Geneva during December 1975, it was agreed that the post of epidemiologist be changed to parasitologist. It was further agreed that institutions in England and Germany be asked to cooperate with the Center as collaborating laboratories.

Upon recruitment of a parasitologist and reviewing the research capacities of Venezuelan laboratories, it was decided to approach these laboratories for cooperative studies. The Center would make the initial isolations of strains and pass these strains on to the laboratories for testing.

On the basis of this approach, the Center began a series of epidemiological studies in which serology and ECG examinations were done on all the human population, xenodiagnosis was done on dogs and cats, triatominae were collected from domestic habitats and sylvatic ones such as palms, and domestic and wild mammals, especially rodents and marsupials, were trapped and xenodiagnosis tests done on them. Any strains of *T. cruzi* isolated by xenodiagnosis from wild or peridomestic mammals or by dissection of domestic or wild vectors are retained for further study. A follow-up of seropositivity of the human population has begun. A 10-ml blood sample is being taken from these individuals. A portion of the sample is being used for artificial xenodiagnosis, another portion for culture inoculations and the remainder held for additional serological testing.

The primary laboratory in the Center is responsible for the handling and distribution of field material. It performs xenodiagnosis, slide examination of dissection materials from insects and blood from living parasites, culturing of T. cruzi and T. rangeli and animal (white mice) inoculations. The primary laboratory has the capacity to do biometric studies. In this case the measurements include the parameters listed by Hoare (The Trypanosomes of Mammals, 1972, Oxford: Blackwell, p. 58).

The secondary or collaborating laboratories are performing specialized techniques such as: (1) determination of whether intracellular development and replication occurs in vivo and/or in vitro; (2) cross-protection tests in mice; (3) electron microscopic examination of the configuration of kinetoplastic DNA; (4) determination of buoyant densities of kinetoplastic and nuclear DNA in chloride gradient centrifugation; (5) characterization of electrophoretic mobilities of multiple enzyme forms; (6) effect of lectins and protectins; (7) blood incubation infectivity tests; (8) use of enzymes as precipitogens and, (9) investigation of the incidence of EVI (endocardial-vascular-interstitial antibodies in sera of persons and animals infected with T. cruzi.

The collaborating laboratories outside of Venezuela are: (1) Bernhard-Nocht Institute for Schiffs un Tropenkrankheiten, Hamburg, Germany; (2) Molteno Institute, Cambridge, Englang, and, (3) London School of Hygiene and Tropical Medicine, London, England. Within Venezuela, the following institutions are cooperating with the Center on specialized studies; (1) Faculty of Science, University Central; (2) Faculty of Parasitology, School of Medicine, University of Carabobo; (3) Institute of Tropical Medicine, University Central; (4) Institute of Dermatology, Hospital Vargas, (5) National Institute of Hygiene; and (6) I.V.I.C.

To date there are 12 established strains and a number of others being stabilized. Some of the 12 have already been distributed to the Venezuelan laboratories and all 12 have been sent to Hamburg, Germany.

Late in 1976, Dr. Marinkelle served as a short-term consultant in parasitology. In examination of material collected from salivary glands from wild caught R. prolixus, he concluded that the trypanomastigotes observed in the salivary glands are similar to the metacyclic stages of T. rangeli but differed in size and position of the nucleus. Therefore, identification should not be based solely on morphological characters. He also studied and confirmed preliminary identifications of T. lewisi-like, T. legeri, T. mimasense, T. freitasi, and T. coutinhoi. He recommended the Center consider the following research: (1) comparative studies to characterize different isolates of T. cruzi using a cloning technique; (2) evaluation of Zeledon-Warren's medium as a selective culture for inhibiting the growth of T. rangeli; (3) comparison of several parasitological techniques to detect T. cruzi infections in humans in the field; (4) studies on the serological cross reactivity between T. cruzi and T. rangeli; (5) studies on the evaluation of T. rangeli in triatomines in Venezuela, and (6) a study on comparison of infections of T. cruzi in various species and strains of triatomines. The Center with cooperation from the Chagas' Disease Section of Endemias Rurales has begun investigation into most of these.

In the future more time will be devoted to parasitological than to epidemiological studies. The Center hopes to increase the number of collaborating laboratories within Venezuela as these laboratories have both staff and equipment capacities equal or superior to foreign laboratories and are near the Center. Endemias Rurales has the staff and laboratory capacity to continue with the epidemiological surveys. Further work in this direction by the Center will be primarily to supplement parasitological research.

3. Vector Control

3.1 Chemical control

Recently WHO joined the Division of Endemias Rurales to form collaborating centers in testing insecticides and insecticide equipment. Because of this, the Center has increased its vector control staff to 2 specialists--one dealing with laboratory testing of insecticides and the other with field testing of insecticides and equipment. Both specialists have counterparts within Endemias Rurales performing similar functions.

3.1.1 Stage II and III testing

Dieldrin and HCH have been used in Venezuela for a number of years for the control of Chagas' disease. In 1969, it was noted that control by dieldrin was not as effective as before. A series of laboratory tests revealed resistance to dieldrin from a strain of R. prolixus collected at Santo Domingo, state of Trujillo. Tolerance to dieldrin was noted in a number of other strains. By selection, the Santo Domingo strain can live for over 400 hours on exposure to 4% dieldrin.[27/]

Resistance and/or tolerance to insecticide now in use has made the search for new insecticides a top priority of the Center. Research has been along two lines. First a comparison between topical application and tarsal contact to determine lethal dosages of insecticides, and second, comparing new insecticides to HCH and dieldrin using dieldrin resistant and dieldrin susceptible strains. In the case of tarsal contact, it has been necessary to prepare impregnated papers of insecticides in the Center. There has been some difficulty as the Center's papers appear to be more lethal than those produced by WHO. This technical problem is being researched.

A number of OP compounds, new synthetic pyrethroids, and insect growth regulators are now being tested by topical application.

The effect of insecticides on eggs is being investigated. Eggs when exposed to fenthion, fenitrothion, d milin, Pironyl/Atlox, Atlox alone and olive oil, did not hatch; while acetone solutions of fenitrothion, fenthion, and dieldrin did not interfere with hatching. It appears that mechanical blockage of respiration of the embryo through the egg wall or mechanical inhibition of hatching was responsible for mortality rather than toxic effect of insecticides.

As mentioned earlier, irritants are being tested in the laboratory. As yet, no irritant gives superior results to Pironyl (containing pyrethrum, piperonyl, and kerosene) recommended by Endemias Rurales.

For stage III, testing bioassays of wooden and glass panels using 5th-instar nymphs of R. prolixus are being done. After 22 weeks, complete mortality following a 24-hour exposure and 48-hour period was shown for Sumithion, Baytex, Actellic, Novanol, and dieldrin. Nevion showed incomplete mortality and HCH caused no mortality.

Arrangements have been made with WHO/HQ VBC to furnish test insecticides.

In a special laboratory test insecticide strips developed by the Herculite Protective Fabrics Corporation for cockroach control were used against R. prolixus. Three insecticides: propoxur, diazinon, and chlorpyrifus were tested. The strips employed a controllable release or slow release delivery principle. High mortality occurred for 6 to 8 months in test tube and choice box tests. However, no practical method could be found to adapt the strips in their present form to conditions in rural Venezuela.[29/]

3.1.2 Stage IV tests

Actual Stage IV testing has not begun. However, three field trials using various insecticides have been done. The first test used dieldrin, HCH, fenthon, and propoxur applied at $1g/m^2$, $1g/m^2$, $2g/m^2$, and $1.5g/m^2$ respectively by a Hudson X-pert type sprayer. HCH was shown to have a fast knockdown and low residual and was considered effective for less than 2 months. Dieldrin and propoxur were effective for 2 months and fenthion for almost 3 months. However, the latter was considered too dangerous for routine use.[16/]

The second test used a knap-sack mist blower (ULV) for application of fenthion, propoxur, pirimiphos-methyl and malathion and a Hudson X-pert type sprayer for application of Jodfenphos. The best results were obtained with Jodfenphos WP at $2.5m/m^2$ but it was not possible to compare this application with those done by ULV. Malathion gave the poorest results with ULV at $1.8g/m^2$. In no case was satisfactory control achieved using the mistblowers. However, handling of equipment was below standard.[28/] Results from the third series of tests have not been analyzed. Control extended over a longer period of time, up to 6 months, but technical problems cause the reliability of the tests to be questioned.

Chemical control will remain the most powerful weapon against transmission of Chagas' disease for some time. There is good evidence, in Venezuela at least, that this method of control can be successful. Research in screening of insecticides, improvement of formulations and testing of new application methods must be given the highest priority in the Center.

3.2 Biological Control

Egg parasites of Triatoma species and Rhodnius prolixus are under study at the University of Carabobo and I.V.I.C. laboratories. These microhymenoptera have been used in a pilot trial in one of the study areas of the Center in Cojedes. The Center provided technical advisory support to this project. In addition, the Center has been active in taxonomic studies of microhymenoptera helping staff of the University of Carabobo with a new microhymenoptera from P. arthuri which can, in the laboratory, parasitize eggs of R. prolixus. The Center is now engaged with staff of the University of Carabobo in a study of the natural distribution of microhymenoptera in Venezuela.

3.3 Physical or Mechanical Control

One of the most promising ways of discouraging, or even eliminating triatomine infestation is by altering the domestic environment. The Government has two rural housing programs. One is the building of new housing by Viviendas Rurales. This is an old and very successful program of improving the social and hygienic status of the inhabitants. The second is a more recent program of modification of existing housing. Pilot projects are beginning in the states of Trujillo, Mérida, and Sucre. The Center is becoming involved in this second program. In an advisory capacity the Center is assisting Endemias Rurales in longitudinal epidemiological studies in Trujillo to determine the role house modification has on transmission of T. cruzi. The Center also made a serological survey in Sucre to determine the present status of Chagas' disease among inhabitants in the area where house modification is taking place. Lastly, the Center is conducting socioeconomic surveys among inhabitants of substandard and Viviendas Rurales' housing. The role of the Center in house improvement programs should be expanded by offering consultant services in construction problems and in the field of public health education.

4. Training and Education

Until recently, the Center has had a limited role in training and education. Staff have given lectures in a number of institutions including the School of Malariology. One graduate student has completed his degree under our supervision and staff has hosted visits from international course students in Public Health and Epidemiology. On a few occasions, PAHO/WHO fellows have spent time in the laboratory and field projects. However, to fulfill a more regional role in training of individuals interested in Chagas' disease, a more active program should be developed.

5. Summary

By reviewing the past and present activities of the Center and giving suggestions of future research priorities, an attempt has been made to define the role of the Center in the PAHO program on Chagas' disease. The Center's strength is in entomology and vector control, two facets of research that are extremely weak in Chagas' disease studies. This strength should be exploited to its fullest capacity. The Center has a good program in field epidemiology and parasitology which can serve secondary laboratories in their studies to define and differentiate strains of T. cruzi and T. rangeli. At present it is weak in medical zoology but its program is still one of the most active in the Americas. The Center has and will continue to provide the mechanism to obtain the implementation of cooperative studies in collaboration with national research groups.

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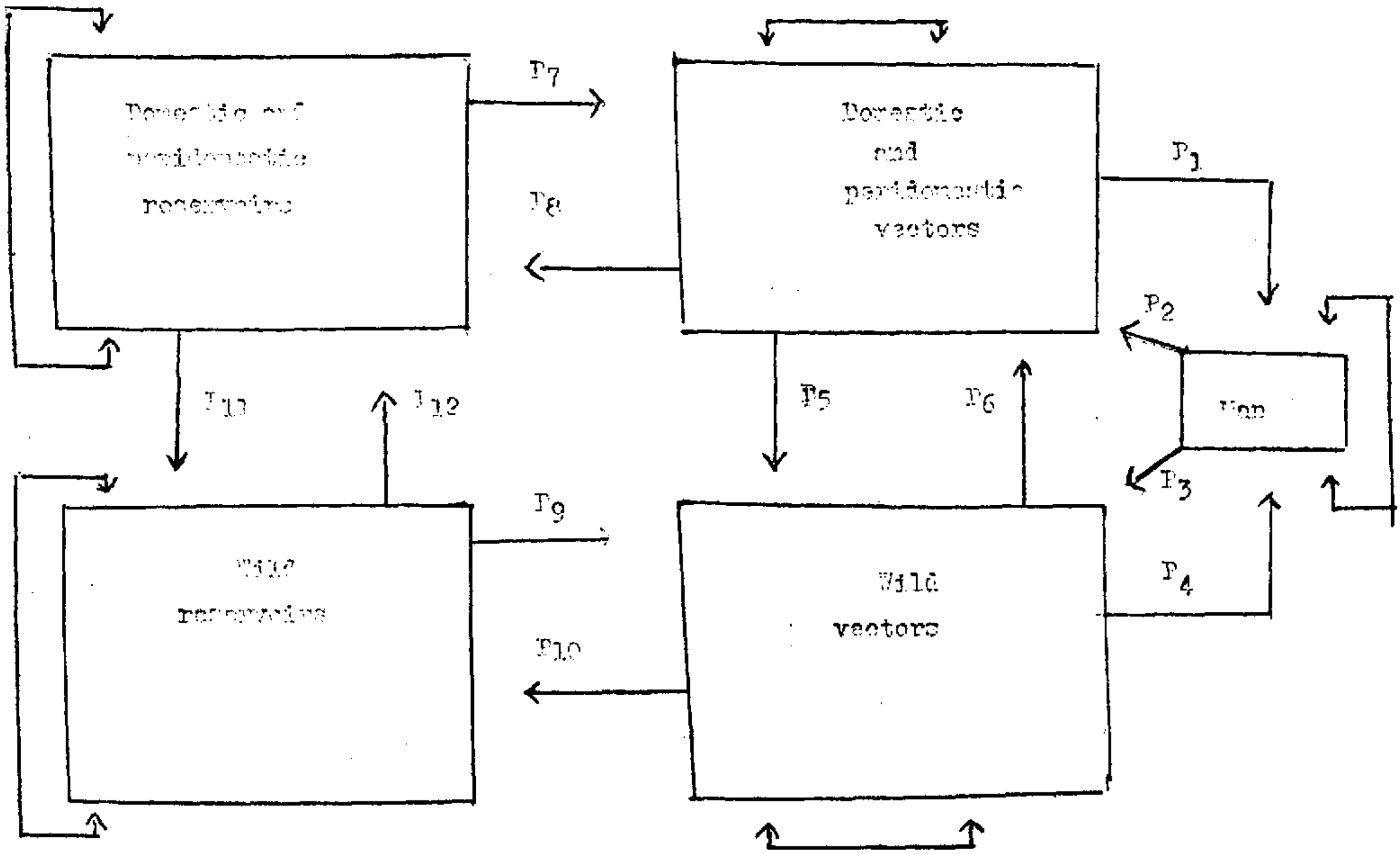
ANNEX 1. DIAGRAMMATIC MODEL OF THE TRANSMISSION OF CHAGAS' DISEASE



ANNEX 2

MINISTERIO DE SANIDAD
Y ASISTENCIA SOCIAL

DIRECCION DE MALARIOLOGIA Y SANEAMIENTO AMBIENTAL
DIVISION DE ENDEMIAS RURALES

EVALUACION DEL PROGRAMA DE CONTROL DE LA ENFERMEDAD DE CHAGAS

FORMULARIO GENERAL

NUMERO DE LA ENCUESTA ☐☐☐☐☐

ESTADO ______________________

MUNICIPIO ______________________ CENTRO POBLADO ______________________

ALTITUD: MAX. __________ MIN. __________ PALMAS: SI __________ NO __________

NUMERO VIEJO DE LA CASA DDT ______________ NUMERO NUEVO DE LA CASA CH- __________

JEFE DE LA CASA ____

TIEMPO DE RESIDENCIA EN LA CASA ______________________________________

NUMERO DE PERSONAS QUE VIVEN EN LA CASA ______________________________

Nº	NOMBRES Y APELLIDOS	LUGAR DE NACIMIENTO	Edad	Sexo	Serolog.	E.C.G.

ANIMALES DOMESTICOS:

NUMERO DE PERROS ______________________ NUMERO DE GATOS ______________________

NUMERO DE CERDOS ______________________ RATAS O RATONES: SI ________ NO ________

AVES DOMESTICAS ____

FECHA DEL ULTIMO ROCIAMIENTO ____

TIPO DE INSECTICIDA ____

DATOS INCOMPLETOS: SI ______ NO ______

MOTIVO ____

____

____

____

COLECTOR ______________________ FECHA ______________________

MINISTERIO DE SANIDAD
Y ASISTENCIA SOCIAL

DIRECCION DE MALARIOLOGIA Y SANEAMIENTO AMBIENTAL
DIVISION DE ENDEMIAS RURALES

EVALUACION DEL PROGRAMA DE CONTROL DE LA ENFERMEDAD DE CHAGAS

Formulario 1. Información de Centro Poblado y Vivienda

1. Número del formulario	1	☐ 1
2. Número Tarjeta continuación	2	☐☐☐☐
3. Número de la vivienda (Numeración nueva)	6	CN - ☐☐☐/☐
4. Número de la encuesta	10	☐☐☐☐☐
5. Estado	15	☐☐
6. Municipio	17	☐☐☐/☐
7. Centro Poblado	21	☐☐☐
8. Fecha. Día	24	☐☐
Mes	26	☐☐
Año	28	☐☐
9. Vivienda	30	☐ 1. Ocupada ☐ 2. Desocupada
10. Número de habitantes de la casa	31	☐☐
11. Palmas	33	☐ 1. Sí ☐ 2. No
12. Número de la vivienda (numeración antigua, no es para computar)		DDT. Nº ______________
13. Jefe de Casa		______________________
14. Techo tipo predominante	34	☐ 1. Material vegetal (Palma, paja, caña etc. ☐ 2. Láminas ☐ 3. Platabanda ☐ 4. Otros

(cont.)

Formulario 1. (cont.)

15. Paredes-tipo predominante	35	☐ 1. Bahareque ☐ 2. Cartones o papeles ☐ 3. Bloques ☐ 4. Lámina ☐ 5. Material vegetal (Palma, paja, caña etc. ☐ 6. Madera y bambú ☐ 7. Friso ☐ 8. Otros
16. Piso-tipo predominante	36	☐ 1. Pavimentado ☐ 2. No pavimentado
17. Modificaciones - Mejoramientos de techos o paredes	37	☐ 1. Si ☐ 2. No ☐ 3. Sin información
18. Renovación - Sin mejoramiento de techos o paredes	38	☐ 1. Si ☐ 2. No ☐ 3. Sin información
19. Fecha de modificación y/o renovación: Mes	39	☐ ☐
Año	41	☐ ☐
20. Ultimo Rociamiento: Día	43	☐ ☐
Mes	45	☐ ☐
Año	47	☐ ☐
21. Tipo de Insecticidas	49	☐ 1. D.D.T. ☐ 2. H.C.H. ☐ 3. Dieldrín ☐ 4. Baygón ☐ 5. Baytex ☐ 6. Malathion ☐ 7. Sumithion ☐ 8. ____________ ☐ 9. ____________

(cont.

22. Dosis 50 ☐☐☐.☐

Firma: ____________________

Supervisor: ____________________

23. Captura de triatominos en domicilio 54
☐ 1. Positiva-vivos sin capt.
☐ 2. Positiva-vivos con capt.
☐ 3. Negativa-con presencia de muertos, huevos o exuvias
☐ 4. Negativa completa

24. Lugar de captura de triatominos en la vivienda:

1. Techo 55 ☐ 1. Si ☐ 2. No
2. Paredes 56 ☐ 1. Si ☐ 2. No
3. Mueb. y Enseres 57 ☐ 1. Si ☐ 2. No
4. Refug. de animales 58 ☐ 1. Si ☐ 2. No

25. Triatominos capturados en el peridomicilio 59
☐ 1. Si
☐ 2. No
☐ 3. No efectuada la búsqueda

Hora de Inicio. ___ ___, ___ ___ Hora de terminación: ___ ___, ___

Visitadores Rurales: ____________________

____

Inspector: ____________________ Supervisor: ____________________

Observaciones: ____________________

____

____

26. Resultado del examen de triatominos en la vivienda. 60
☐ 1. Negativo
☐ 2. _T. cruzi_
☐ 3. _T. rangeli_
☐ 4. Mixtos
☐ 5. Otros

DIRECCION DE MALARIOLOGIA Y SANEAMIENTO AMBIENTAL
DIVISION DE ENDEMIAS RURALES

EVALUACION DEL PROGRAMA DE CONTROL DE LA ENFERMEDAD DE CHAGAS

Formulario 2. Información de triatominos en el laboratorio

1. Numero del formulario	1	[2]
2. Número tarjeta continuación	2	[ ][ ][ ][ ]
3. Número de la vivienda (numeración nueva)	6	CH - [ ][ ][ ]/[ ]
4. Número de la Encuesta	10	[ ][ ][ ][ ][ ]
5. Estado	15	[ ][ ]
6. Municipio	17	[ ][ ][ ]/[ ]
7. Centro Poblado	21	[ ][ ][ ]
8. Fecha de la captura:		
Día:	24	[ ][ ]
Mes:	26	[ ][ ]
Año:	28	[ ][ ]
9. Especie (use un formulario por cada especie)	30	[ ] 01. Rhodnius prolixus
		[ ] 02. Rhodnius neivai
		[ ] 03. Rhodnius pictipes
		[ ] 04. Rhodnius robustus
		[ ] 05. Triatoma maculata
		[ ] 06. Eratyrus mucronatus
		[ ] 07. Eratyrus cuspidatus

(cont.)

9. Especie (use un formulario por cada especie)		☐ 08. Panstrongylus geniculatus ☐ 09. Otas especies ☐ 10. Sin identificación
10. Número de Visitadores que realizaron la captura	32	☐☐
11. Número de triatominos capturados en:		
1. Paredes	34	☐☐☐
2. Techos	37	☐☐☐
3. Muebles y enseres	40	☐☐☐
4. Refugio de animales dentro de la vivienda	43	☐☐☐
5. Peridomicilio	46	☐☐☐
12. Número de triatominos capturados por hora/hombre	49	☐☐☐.☐

Inspector: ______________________ Supervisor: ______________________

13. Examen de triatominos capturados		
1. Negativos - número	54	☐☐☐☐
2. Positivos con T. cruzi - número	58	☐☐☐
3. Positivos con T. rangeli - número	61	☐☐☐
4. Positivos Mixtos - número	64	☐☐☐
5. Positivos con otros Trypanosoma número	67	☐☐☐
6. Total de triatominos positivos	70	☐☐☐☐
7. Total de triatominos examinados	74	☐☐☐☐

Técnico: ______________________ Supervisor: ______________________

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Formulario 3: Información de Triatominos Individual

Nª del Formulario 1	Nª Tarjeta continuación 2 5	Nª de la Vivienda 6 9	Nª de la Encuesta 10 14	Estado 15 16	Municipio 17 20	Centro Poblado 21 23	Especie 24 25	Estadio 26	Sitio de captura 27	Resultado 28	TRIPANOSOMAS: Heces 29	TRIPANOSOMAS: Intestino 30	TRIPANOSOMAS: Hemolinfa 31	TRIPANOSOMAS: Glándulas Salivales 32	Fuente de Alimentación: Si/No 33	Fuente de Alimentación: Resultado 34 35
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Formulario 4. Xenodiagnóstico de Reservorios Domésticos

1. Número del formulario	1	[4]
2. Número tarjeta continuación	2	[ ][ ][ ][ ]
3. Número de la vivienda (Numeración nueva)	6	CH - [ ][ ][ ]/[ ]
4. Número de la encuesta	10	[ ][ ][ ][ ][ ]
5. Estado	15	[ ][ ]
6. Municipio	17	[ ][ ][ ]/[ ]
7. Centro Poblado	21	[ ][ ][ ]
8. Fecha: Día	24	[ ][ ]
Mes	26	[ ][ ]
Año	28	[ ][ ]
9. Especie (Usar una tarjeta por cada animal con xenodiagnóstico)	30	[ ] 1. Perro [ ] 2. Gato [ ] 3. Cerdo
10. Sexo	31	[ ] 1. Macho [ ] 2. Hembra
11. Edad	32	[ ] 1. Joven [ ] 2. Viejo [ ] 3. Sin determinar
12. Número del Xeno	33	[ ][ ][ ][ ]

Firma: ______________________ Supervisor: ______________________

Observaciones: ____

____

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(cont.)

Formulario 4. (cont.)

13. Xenodiagnóstico Resultado	37	☐ 1. Negativos ☐ 2. Positivos - *T. cruzi* ☐ 3. Positivos - *T. rangeli* ☐ 4. Positivos - Mixtos ☐ 5. Positivos - Otros
14. Fecha del Examen: Día	38	☐☐
Mes	40	☐☐
Año	42	☐☐
15. Banco de cepas (Número para Identificación)	44	☐☐☐☐

Técnico: ______________________ Supervisor: ______________________

Observaciones: ______________________

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Formulario 5: Personal (Serología)

1. Número del Formulario	1	☐
2. Número tarjeta continuación	[illegible]	☐☐☐☐
3. Número de la vivienda (Numeración nueva)	6	[illegible] - ☐☐☐/☐
4. Número de la encuesta	10	☐☐☐☐☐
5. Estado	15	☐☐
6. Municipio	17	☐☐☐/☐
7. Centro Poblado	21	☐☐☐
8. Fecha: Día	24	☐☐
Mes	26	☐☐
Año	28	☐☐
9. Cédula	30	☐ 1. Sí ☐ 2. No
10. Nombre: ______________		
Madre: ______________		
11. Identificación de la persona		
1. Edad	31	☐☐☐
2. Sexo	34	☐ 1. Masculino ☐ 2. Femenino
3. Iniciales persona/Iniciales Madre	35	☐☐☐☐/☐☐☐☐
4. Número de cédula	43	☐☐☐☐☐☐☐☐
12. Serología	51	☐ 01. No realizado ☐ 02. Negativo ☐ 03. Positivo ☐ 04. 2 ☐ 05. 4

(cont.

Formulario 5. (cont.)

12. Serología (cont.)		☐	06. 8
		☐	07 16
		☐	08. 32
		☐	09. 64
		☐	10. 128
		☐	11. 256
		☐	12. 512
		☐	13. 1024
		☐	14. 2048
		☐	15. 4096
		☐	16. más de 4096
13. Xenodiagnóstico	53	☐	1. Negativo
		☐	2. Positivo a T. cruzi
		☐	3. Positivo a T. rangeli
		☐	4. Positivo a mixtos
14. Banco de cepas (número para identificación)	54	☐☐☐☐	

15. Lugar de nacimiento: ____________________

16. Tiempo de residencia en el caserío ____________________

17. Otros lugares de residencia

1. ____________________
2. ____________________
3. ____________________

18. Observaciones clínicas: ____________________

____

____

____

Técnico: ____________________ Supervisor: ____________________

Cardiólogo: ____________________ Observacion: ____________________

Fecha: ____________________ Firma: ____________________

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Formulario 6. Personal (electrocardiograma)

1. Número del formulario	1	[6]
2. Número tarjeta continuación	2	[ ] [ ] [ ] [ ]
3. Número de la vivienda (Numeración nueva)	6	CH - [ ] [ ] [ ] / [ ]
4. Número de la encuesta	10	[ ] [ ] [ ] [ ] [ ]
5. Estado	15	[ ] [ ]
6. Municipio	17	[ ] [ ] [ ] / [ ]
7. Centro poblado	21	[ ] [ ] [ ]
8. Fecha de realizado (No es para computar		__ __ / __ __ / __ __
9. Cédula	24	[ ] 1. Si [ ] 2. No
10. Nombre ________________		
11. Madre ________________		
12. Identificación de la persona		
1. Edad	25	[ ] [ ] [ ]
2. Sexo	28	[ ] 1. Masculino [ ] 2. Femenino

(cont.)

12. Identificación de la persona (cont.)		
3. Iniciales persona/iniciales madre	29	☐☐☐☐/☐☐☐☐
4. Número de cédula	37	☐☐☐☐☐☐☐☐
3. Electrocardiograma	45	☐ 1. No realizado
		☐ 2. TDLN
		☐ 3. Sujeto a investigaciones
		☐ 4. Compatible con Chagas
		☐ 5. No compatible con Chagas
		☐ 6.
		☐ 7.
	46	☐ 1. Patológico
	47	☐ 1. Compatible con cardiopatía congénita
	48	☐ 1. Desviación axial izquierda
		☐ 2. Desviación axial derecha
	49	☐ 1. Rotación horaria
		☐ 2. Rotación antihoraria
	50	☐ 1. Taquicardia sinusal
		☐ 2. Bradicardia sinusal
	51	☐ 1. Escapes nodales
		☐ 2. Escapes ventriculares
		☐ 3. Marcapaso migratorio
		☐ 4. Ritmo nodal
		☐ 5.

(cont.)

13. Electrocardiograma (cont.)

52	☐	1. Extrasístoles supraventriculares
	☐	2. Extrasístoles ventriculares aislados
	☐	3. Extrasístoles ventriculares múltiples
	☐	4. Fibrilación auricular
	☐	5. Flutter auricular
	☐	6. Parasistolia
	☐	7. W.P.W.
	☐	8.
	☐	9.
53	☐	1. Bloqueo de rama derecha Grado I
	☐	2. Bloqueo de rama derecha Grado II
	☐	3. Bloqueo de rama derecha Grado III
54	☐	1. Bloqueo de rama izquierda Grado I
	☐	2. Bloqueo de rama izquierda Grado II
	☐	3. Bloqueo de rama izquierda Grado III
55	☐	1. Bloqueo de la subdivisión anterior izquierda
56	☐	1. Bloqueo A-V 1er grado

(cont.)

13. Electrocardiograma (cont.)			
	56	☐	2. Bloqueo A-V 2° grado
		☐	3. Bloqueo A-V 3er grado
	57	☐	1. Sobrecarga diastólica VI
		☐	2. Sobrecarga diastólica VD
		☐	3. Sobrecarga sistólica VI
		☐	4. Sobrecarga sistólica VD
	58	☐	1. Crecimiento auricular izquierdo
		☐	2. Crecimiento auricular derecho
		☐	3. Crecimiento biauricular
	59	☐	1. Crecimiento ventricular izquierdo
		☐	2. Crecimiento ventricular derecho
		☐	3. Crecimiento biventricular
	60	☐	1. Isquemia subendocárdica
		☐	2. Isquemia subepicárdica
		☐	3. Lesión subendocárdica
		☐	4. Lesión subepicárdica
		☐	5. Zona eléctricamente inactibable
		☐	6. Compatible con pericarditis

(cont.)

13. Electrocardiograma (cont.)			
	60	☐	7. Compatible con alteraciones metabókicas
		☐	8.
		☐	9.
	61	☐	
	62	☐	
	63	☐	
	64	☐	
	65	☐	
	66	☐	
	67	☐	
	68	☐	
	69	☐	
	70	☐	
	71	☐	
	72	☐	
	73	☐	
	74	☐	
	75	☐	
	76	☐	
	77	☐	

(cont.)

13. Electrocardiograma (cont.)	78	▢
	79	▢
	80	▢

SEROLOGIA

Fecha Encuesta ____________________ Página ________

Estado ____________________ Municipio ____________________ Caserío ____________________

Nº Lab.	Número de encuesta	Nombre	Edad	Sexo	Lugar de nacimiento	H.P.		
						P	N	D

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ELECTROCARDIOGRAMAS

Fecha de realizado ____________________ Página __________

Estado ______________ Municipio __________ Caserío __________

Número de la casa	E.C.G. N°	NOMBRE	Edad	Sexo	Resultado

Observaciones ____

____

Fecha de entrega ____________________ Firma ____________________

XENODIAGNOSTICO

RESERVORIOS DOMESTICOS

Fecha recolección______________ Fecha examen___________ Página__________

Estado____________________ Municipio _____________Caserío______________

Número Casa	Número Encuesta	Número Xenodiag.	RESULTADO				
			Fresco	Tc	Tr	Mixto	065

Observaciones: ____

____

Firma: ______________________________

Fecha: ______________________________

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ENTOMOLOGIA DOMESTICA

CAPTURA DE TRIATOMINOS

Fecha de captura ________________ Fecha de examen __________ Página ______

Estado ______________________ Municipio ____________ Caserío ______________

Número de Visitadores que realizaron la captura ____________________

Número de la casa	Nº de la Encuesta	Lugar de Captura	Especie	Nº de Envases	Nº Chipos capturados						
					I	II	III	IV	V	A	Total

Observaciones ____

Fecha de entrega al laboratorio ____________________________

Recibí conforme: ____

Nombre

EXAMEN DE TRIATOMINOS
CAPTURADOS EN LA VIVIENDA

Fecha de recolección: ____________ Fecha de examen: ____________ Página: ____________

Estado: ____________ Municipio: ____________ Caserío: ____________

Número de la encuesta: ____________ Especie: ____________

Nº de la casa	Lugar de capt.	Nº del chipo	Nº de la lámina (posit. en fresco)	RESULTADO								
				FRESCO				COLOREADO				
				Heces (a)	Intest. (b)	Hemol. (c)	GS (d)	Heces (a)	Intest. (b)	Hemol. (c)	GS (d)	Examen de sangre

PROGRAMA DE EVALUACION DE LA ENFERMEDAD DE CHAGAS

CONSTANCIA DE ENTREGA DE MATERIAL RECOLECTADO

ESTADO ______________________________

MUNICIPIO ______________________________

CASERIO ______________________________

TIPO DE MATERIAL ______________________________

N° DE MUESTRAS ______________________________

FECHA DE ENTREGA __ __/__ __/__ __

ENTREGADO POR ______________________________

RECIBIDO POR ______________________________

OBSERVACIONES ______________________________

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EVALUACION DEL PROGRAMA DE CONTROL DE LA ENFERMEDAD DE CHAGAS

ESTADO: ____________ MUNICIPIO: ____________ LOCALIDAD: ____________

Nº	Nº CH	Habitada	Deshabitada	Ausente	Destruida	Renuente	Otros	Observaciones