

Chagas disease in Andean countries

Felipe Guhl

Centro de Investigaciones en Microbiología y Parasitología Tropical, Facultad de Ciencias, Universidad de los Andes,
A. Aéreo 4976, Bogotá, Colombia

The Andean Countries' Initiative (ACI) for controlling Chagas disease was officially created in 1997 within the framework of the Hipolito Unanue Agreement (UNANUE) between the Ministries of Health of Colombia, Ecuador, Peru, and Venezuela. Its objective was to interrupt transmission via vector and transfusion in the region, taking into account that there are 12.5 million people at risk in the four Andean countries forming the initiative in the area and around 3 million people are infected by Trypanosoma cruzi.

The progress of control activities for the vector species present in the Andean sub-region, for different reasons, has been slow and control interventions have still not been installed in all geographical areas occupied by the target species. This has been partly due to lack of knowledge about these vector populations' biological characteristics, and consequent uncertainty about which are the appropriate control measures and strategies to be implemented in the region. The main vector species present important similarities in Venezuela and Colombia and in Ecuador and Northern Peru and they can be approached in a similar way throughout the whole regions, basing approaches on and adapting them to the current strategies being developed in Venezuela during the 1960s which have been progressively adopted in the Southern Cone and Central-American region.

Additional measures are needed for keeping endemic areas free from Rhodnius prolixus silvatic populations, widely spread in the Orinoco region in Colombia and Venezuela.

Regarding aetiological treatment, it is worth mentioning that (with the exception of Colombia) none of the other countries forming the ACI have registered medicaments available for treating infected young people. There are no suitable follow-up programmes in the sub-region or for treating cases of congenital Chagas disease. An integral and integrated programme encompassing all the aspects including transmission by transfusion which seems to have achieved extremely encouraging results in all countries, are urgently needed.

Key words: Andean countries - Chagas disease - triatomines - epidemiology - vector control

American trypanosomiasis is a very complex zoonosis which is present throughout South-America, Central-America, and Mexico and continues to represent a serious threat to the health of countries in the region. The parasite is present in a broad variety of strains and infects 150 species from 24 families of domestic and wild animals. Programmes aimed at controlling the disease carried out in several endemic countries during the last decade have obtained very positive results; the disease's transmission via vectors and transfusion has been interrupted in some of them, as in the case of Chile and Uruguay, and in others it is at the point of being achieved, as in the case of Brazil, resulting in a decrease in the incidence of Chagas disease in Latin-America (WHO 2002). However, the other Southern Cone countries (Argentina, Bolivia, and Paraguay), Andean countries (Colombia, Ecuador, Peru, and Venezuela), all Central-American countries and Mexico have advanced vector control activities having different degree of intensity. There is a great

variety of triatomine insect vectors for the parasite presenting varied biological behaviour, making it necessary to plan different vector control strategies, especially if those species found in the domicile, peridomicile, and wild settings are taken into account.

Consequently, the only viable ways of reducing the opportunities for interaction between human beings and insect vectors is the fight against vector transmission. The sub-regional approach adopted in American countries for confronting the problem of Chagas disease is founded on entomological and epidemiological criteria, but the objectives are generally aimed at eliminating the parasite's transmission via vectors and/or transfusion, establishing differentiated intervention strategies according to the aforementioned criteria.

The so-called Southern Cone Countries' Initiative was thus born in 1991, its main objective being to interrupt vector and transfusion-based transmission of Chagas disease in Argentina, Brazil, Bolivia, Chile, Paraguay, and Uruguay. Achievements to date have shown that currently available tools are effective and economically affordable for Latin-American countries' Ministries of Health for establishing vector and transfusion control programmes.

Fig. 1 shows the epidemiological mosaic on which different continental initiatives are based for vectorial control of Chagas disease. Geographical areas corresponding to the different insect vectors were sampled, as well as countries forming part of the initiatives and their respective dates of as being created.

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E-mail: fguhl@uniandes.edu.co
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Fig. 1: continental initiatives for controlling the main vectors of Chagas disease associated with human habitat.

ANDEAN COUNTRIES' INITIATIVE

Antecedents - The ACI for controlling Chagas disease was officially created in 1997 within the framework of the Hipolito Unanue Agreement (UNANUE) between the Ministries of Health of Colombia, Ecuador, Peru, and Venezuela. Its objective was to interrupt transmission via vector and transfusion in the region and it was considered feasible that this goal should be achieved by 2010; it was ratified by REMSAA resolution 382, November 2002, bearing in mind that there are 12.5 million people at risk in the four Andean countries forming the initiative in the area and around 3 million people are infected by *Trypanosoma cruzi*.

The ACI has been followed-up via annual intergovernmental meetings since its creation.

Triatomine insects in the Andean region

There is good information in the region regarding the distribution of *Rhodnius prolixus*, *R. ecuadoriensis*, *Triatoma dimidiata*, and some species considered to be important secondary vectors in human transmission such as *R. pallescens*, *T. venosa*, and *T. maculata*. However, there is no detailed information for providing greater scale resolution for regional distribution maps leading to more detailed analysis of geographical and environmental determinants responsible for the distribution of different species of insect vectors associated with human habitat.

There are three insects which are candidates for large-scale control interventions, bearing in mind their adaptation to human habitat: *R. prolixus* in Colombia and Venezuela, *T. dimidiata* in the Central Western region of Colombia and the coast of Ecuador, and *R. ecuadoriensis* in Ecuador and Northern Peru. Figs 2 and 3 show the insect candidates for large-scale control interventions, taking into account their adaptation to human habitat.

Bearing in mind the success obtained by vector control programmes in Venezuela during the recent decades, it is inconceivable that large-scale interventions are not being currently advanced for eliminating these species in the Andean region.

Options for controlling the main *T. cruzi* vector species in the Andean region

R. prolixus - *R. prolixus* is the most important species in the Andean Pact region in epidemiological terms, being known throughout large areas of Venezuela and Colombia. *R. prolixus* is essentially a domestic species.

In the plains of Venezuela and Eastern Colombia there is almost no doubt that *R. prolixus* is autochthonous and not imported. Nevertheless, as shown by Venezuela's national campaign (1966-1976), domestic populations can be effectively eliminated and *T. cruzi* transmission to people can be detained (Sequeda et al. 1986) Venezuela's campaign (the first of its type) was extremely successful. The target population's genetics and biology, as well as the successful experience of controlling it in Central America and apparent parallels with the situation of *T. infestans* in the Southern Cone, suggest that a strategy for eliminating domestic *R. prolixus* is logically appropriate.

Doubt has been cast on the epidemiological role that wild *R. prolixus* or *R. robustus* being found in palm trees can play (Felicangeli et al. 2002) and recent records of *R. prolixus* in palm trees in a natural setting (*Attalea butyracea*) and agro-industrial African palm cultivations (*Elaeis guineensis*), (Guhl et al. 2005a, Pinto et al. 2005) in Colombia rise the same question. There are not sufficient studies to date for measuring the real epidemiological risk which wild insects represent; the data published to date presents very low rates of reinvasion by palm tree populations (Felicangeli et al. 2003, Guhl

& Schofield 2004). Some may challenge the idea of successful elimination in view of the reinvasion of palm tree populations, but even though this has obviously occurred, it is unsustainable as an argument for not proceeding with control action. The Venezuelan campaign demonstrated that large-scale elimination is possible.

It is ethically unacceptable to condemn rural populations to continuous coexistence with domiciled *R. prolixus*, when the strategies for eliminating it are technically and economically tested and justified.

R. ecuadoriensis - The current evidence suggests that *R. ecuadoriensis* is exclusively domestic in the North of Peru and, as such, can be considered to be a viable candidate for local elimination.

It is also found to be widely domiciled in Ecuador and the situation is similar to that of Peru. On the other hand, there are reports of variable wild *R. ecuadoriensis* populations occupying the crowns of palm trees, especially those from the *Phytalephas* genus (Abad-Franch et al. 2002). The considerations of epidemiological risk can be assimilated to those already described for wild *R. prolixus* populations.

T. dimidiata - *T. dimidiata* presents wide distribution and ability to colonise human dwellings and has become the main objective of extensive control and surveillance operations. Studies carried out in Colombia and Ecuador have shown that it is extremely extended, having active transmission. It should also be taken into account that *T. dimidiata* presents abundant wild populations and has an extended distribution (Ramirez et al. 2005) as well as its already known distribution. The specie cannot be considered to be a viable candidate for elimination using available methods. It is therefore important to consider new long-term viable and sustainable control options.

Wild populations have been reported in Central-America and Colombia, especially in areas having shady and rocky habitat where possums and other small mammals abound. However, existing populations in Ecuador and the North of Peru they seem to have been accidentally imported and do not have known wild habitats in this region. These therefore offer an attractive objective for local elimination, using currently available techniques similar to those successfully applied against *T. infestans* in the Southern Cone region (Abad-Franch et al. 2001, Aguilar et al. 2001).

Triatomine vectors in Colombia

R. prolixus and *T. dimidiata* are the main species transmitting *T. cruzi* in Colombia and are considered to be the species most associated with human habitat, *R. prolixus* has especially become well-adapted to adapted to human domiciles in most of national territory, mainly in the country's Eastern region in the departments of Arauca, Boyacá, Casanare, Cundinamarca, Meta, Santander, and Norte de Santander (Molina et al. 2002). Recent studies carried out in the Casanare department have revealed abundant wild *R. prolixus* populations associated with native *Attalea butyracea* palms and agro-industrial palm plantations (*Elaeis guineensis*). Natural *T. cruzi* infection indices were 67 and 41% respectively

and colonization indices 92.8 and 100% respectively (Guhl et al. 2005b).

These findings indicate the need for establishing very active entomological surveillance programmes aimed at evaluating the epidemiological risk represented by these wild insect populations. Reports published to date indicate that this situation corresponds to particular cases and particular geographical regions.

It should also be noted that wild *T. dimidiata* populations have also been reported in some towns in the Boyacá department and the Sierra Nevada de Santa Marta. These findings merit similar consideration to that expressed for *R. prolixus*.

Fifteen out of the 24 triatomine species present in Colombia have been found to have natural trypanosomatid infections identified as being caused by *T. cruzi*: *Panstrongylus geniculatus*, *P. lignarius*, *P. rufotuberculatus*, *T. dimidiata*, *T. dispar*, *T. maculata*, *T. venosa*, *R. brethesi*, *R. colombiensis*, *R. pallescens*, *R. pictipes*, *R. prolixus*, *Eratyrys cuspidatus*, *E. mucronatus*, and *Cavernicola pilosa*.

The presence of *T. rangeli* in *T. cruzi* endemic areas constitutes an important epidemiological factor, given that they share some insect vectors and mammalian hosts, including man. In spite of *T. rangeli* having been considered to be non-pathogenous for a mammalian host, its lifecycle still remains unknown and its presence in both triatomid faeces and the blood of mammals could constitute a source of error in diagnosis.

It is important to know its distribution from the epidemiological point of view, given that it is pathogenous for the insect vectors which it infects.

Seven out of the 24 triatomine species present in Colombia have been found to have infections caused by *T. rangeli*: *R. colombiensis*, *R. dalessandroi*, *R. pallescens*, *R. prolixus*, *R. robustus*, *T. dimidiata*, and *E. mucronatus*.

The species which do not represent transmission risk to man, and which conserve specific wild habits can be summarised as follows: *Psamolestes arthuri* in birds' nests, palms or below the bark of dead trees; *P. lignarius* in birds' nests; *C. pilosa* in caves or trees and palms inhabited by bats; *Belminus rugulosus* in palms; *R. colombiensis* in palms; *T. dispar* in wooded areas; and *Microtriatoma trinidadensis* below the bark of dead trees.

Triatomine vectors in Ecuador

Two triatomids species act as primary vectors. *T. dimidiata*, a species apparently introduced from Central-America is domiciliated in the provinces of Guayas, Manabí, Los Ríos, El Oro, and Loja. The epidemiological cycle of *R. ecuadoriensis* is more complex; being an autochthonous triatomid from the West of Ecuador, wild populations are abundant in some areas of the country and are associated with palm trees (*Phytalephas aequatorialis*). Domestic *R. ecuadoriensis* population distribution extends to the South towards the La Libertad department in Peru, further beyond the palm trees' biogeographical limit. This could indicate that domestic *R. ecuadoriensis* populations in the semiarid areas within Loja (as well as perhaps some parts of El Oro) have pas-

sively extended and act as primary vectors in these areas. *R. ecuadoriensis* acts a secondary vector in Manabí, Los Ríos, and parts of Guayas and Pichincha, *T. dimidiata* being the primary occupant of the domestic ecotope (Aguilar 2001). The secondary vectors belong to native species having demonstrated ability to invade and colonise domicile and peridomicile.

T. carrioni will probably substitute local *R. ecuadoriensis* populations in the Andean areas in the South of the country when these are suppressed by control action. It should be noted that the secondary species could (as in this case) become more efficient vectors of human Chagas disease; local epidemiological profiles thus indicate that *R. ecuadoriensis* is a better vector than *T. dimidiata*, whilst *T. carrioni* is probably more efficient than *R. ecuadoriensis* (Aguilar et al. 1999). This indicates that eliminating primary vectors could aggravate the medium- and long-term epidemiological situation (if actions lack continuity).

Some wild species have shown their ability to colonise domiciliary units and transmit human infection, even though the available data (the same as in the case of Colombia) indicates that this only happens in particular cases or restricted geographical areas. Such synanthropic tendency reflects epidemiological potential obliging incorporating these vectors into control action. This is the case of *P. chinai* from arid areas near the Andean-western frontier with Peru and *P. rufotuberculatus* throughout the whole coastal region and in southern inter-Andean valleys. Other species have shown synanthropic tendencies in some areas of other countries, but not in Ecuador (i.e. *P. geniculatus*, *P. herreri*, and *T. venosa*).

There is a group of triatomines which can transmit the parasite without establishing colonies in human environments. Such wild vectors are responsible for most infections in the Amazon in Ecuador. Such behaviour is typical of Amazon species such as *R. pictipes*, *R. robustus*, and *P. geniculatus* (present on both sides of the cordillera) which can occasionally invade housing.

Triatomine vectors in Peru

Nineteen triatomine species have been reported in the country to date. The North of Peru is included in ACI control strategies and actions as eco-epidemiological conditions are more related to the other countries in the northern South-America. The Southern part of Peru presents different conditions seeming more like those of Southern Cone countries; the presence of *T. infestans* is of great epidemiological importance in this area of the country in the departments of Ica, Arequipa, Moquegua, Tacna, Ayacucho, and Apurímac (Fig. 2).

The main vectors of Chagas disease from Northern Peru are *T. dimidiata*, *R. ecuadoriensis*, *T. carrioni*, *P. herreri*, and *P. chinai* on the Pacific north coast, all being naturally infected with *T. cruzi*. There have been reports of *R. ecuadoriensis* also being infected with *T. rangeli*. The same species are found in the north-western region and the presence of *P. geniculatus* has also been reported in several localities, also being naturally infected with *T. cruzi*.

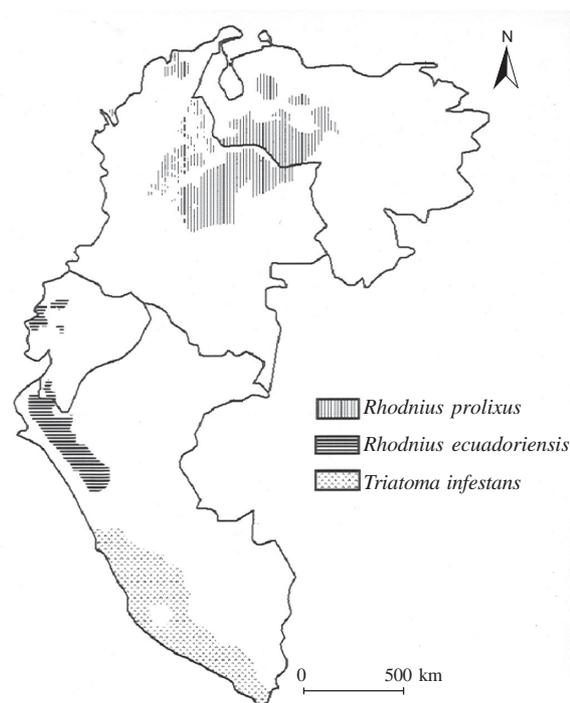


Fig. 2: distribution of insect candidates for large-scale interventions, taking into account their adaptation to human habitat: *R. prolixus* in Colombia and Venezuela, *R. ecuadoriensis* in Ecuador and Northern Peru, and *T. infestans* in Southern Peru.

Other species from wild habitats have been reported in Peru which do not represent a major risk of *T. cruzi* transmission to man: *T. nigromaculata*, *T. matsunai*, *P. rufotuberculatus*, *P. lignarius*, *R. pictipes*, *R. robustus*, *E. mucronatus*, *B. peruvianus*, *C. pilosa*, and *M. mansasotoi*.

Triatomine vectors in Venezuela

R. prolixus, *T. maculate*, and *P. geniculatus* have been classically recognised as being the most important vectors in Venezuela. In spite of numerous records of *T. dimidiata*, its vectorial importance has still not been established.

R. prolixus is considered to be responsible for domestic transmission and wild enzootic disease amongst arboreal animals because of its niches in domestic and wild habitats in different palm tree species. *T. maculata* is predominantly found in henhouses, stockyards, and farmyards close to housing in a rural setting and is considered to be a peridomestic vector, whilst *P. geniculatus* (mainly associated with reservoirs) is referred to as being mainly responsible for enzootic disease amongst these wild animals.

The presence of *P. geniculatus* has been recently reported in Caracas (Feliciangeli et al. 2004) and neighbouring states. Other species having less epidemiological importance but also playing an important role in transmission (especially in the Amazon region) are *R. robustus*, *R. brethesi*, and *R. pictipes*. There have been

reports regarding species having little epidemiological importance in the country: *M. trinidadensis*, *C. pilosa*, *Psamolestes arthuri*, *B. rugulosius*, *Alberprosenia goyovargasi*, *Torrealbaia martinezi*, *B. pittieri*, *R. neivai*, *R. pictipes*, *R. robustus*, *E. cuspidatus*, *E. mucronatus*, *P. chinai*, *P. lignarius*, *P. rufotuberculatus*, *T. nigromaculata*, and *T. rubrofasciata*.

EPIDEMIOLOGICAL SITUATION AND CONTROL ACTION

Colombia

The prevalence of *T. cruzi* infection in Colombia has been estimated as being 1,300,000 inhabitants and 3,500,000 individuals having a low risk of acquiring the infection according to insect vectors' geographical distribution (Guhl & Vallejo 1999).

Colombia officially began its Chagas disease prevention and control programme in 1996, bearing in mind that important control measures had been advanced in previous years such as the obligatory screening of all national blood-bank transfusion units (a decree promulgated in 1995). National blood-bank screening cover today is 100% and estimated prevalence in Colombian donors is 2.1%.

A first exploratory phase was carried out from 1998-2002, consisting of entomological surveys and characterising 41,971 dwellings in 3375 rural areas around 539 towns in 15 departments. A total of 50,329 schoolchildren (0-14 years) were diagnosed in schools from 1424 rural areas. Data of serological diagnosis are shown in Table I. The highest seroprevalences rates overlap with the regions of major vectorial transmission.

The exploratory phase ended in 2002; risk indicators were managed in such a way that a tool was made avail-

TABLE I

Data of serological diagnosis from 50,329 schoolchildren (0-14 years) in 1424 schools from rural areas in 15 departments, obtained during the exploratory phase in 2000-2002

Department	Total samples	Positive school children (0-14 years)	% positive children
Antioquia	9785	4	0.04
Arauca	823	178	21.63
Bolivar	2260	1	0.04
Boyaca	3199	120	3.75
Casanare	1137	114	10.03
Cesar	1544	14	0.91
Cordoba	2094	0	0
Cundinamarca	2597	50	1.93
Guajira	1257	7	0.56
Magdalena	7525	16	0.21
Meta	1978	19	0.96
N. de Sant.	1188	68	5.72
Santander	1802	124	6.88
Sucre	6042	2	0.03
Tolima	7098	18	0.25
Total	50,329	735	1.46

TABLE II

Population living in municipalities under risk of infection with *Trypanosoma cruzi* in high, medium, and low risk areas of vectorial transmission

Total municipalities at high risk	Total municipalities at medium risk	Total municipalities at low risk
122	184	252
Total population at high risk	Total population at medium risk	Total population at low risk
1,321,288 ^a	5,698,797 ^a	7,252,536 ^a

^a: projected according Departamento Administrativo Nacional de Estadística, 2005.

able to health authorities giving them a clear view of priorities for control action per municipality, stratifying areas as being at high, medium, and low risk (Table II).

As national serological and entomological surveys were carried out, this means that reliable data is available today concerning vector distribution, domiciliary infestation indices, and infection prevalence indices in schoolchildren living in compromised areas. The most compromised Colombian areas are Arauca, Boyacá, Cundinamarca, Santander, Norte de Santander, Casanare, and Meta. The data so obtained has led to establishing indices for intervention and control action at municipal level, action being prioritised in high risk municipalities (Guhl et al. 2005c)

Colombia's new Ministry of Social Protection (a merger between the former Ministries of Health and Work and Social Security) has clearly harmed general vector transmitted diseases (VTD) control action by its lack of suitable coordination and definition of clear policies regarding the issue. Colombia currently has no formal Chagas disease control programme. The operational phase for controlling vector transmission by applying different strategies timidly began in mid-2000 in the Boyacá, Casanare, Santander, and Norte de Santander departments; however, insecticides have only been used in around 25% of housing situated in high vectorial transmission risk areas.

On the other hand, housing improvement programmes are protected by a decree assigning funds for improving rural dwellings to epidemiologically high-risk municipalities related to the quality of housing as certified by the Health Service. The first pilot tests were carried out in and around towns in the Santander department and have then been extended to other departments such as Boyacá and Casanare. It is estimated that more than 1500 dwellings have benefited from the improvement programme to date.

Electrocardiographical alterations and the disease's evolution during its chronic phase are not well understood; few studies regarding non-selected population are available. A recent study (Angulo et al. 2003) has shown that there are high rates (25%) of electrocardiographical alteration in rural *T. cruzi* infection transmission areas, these being significantly associated with the state of infection in marginalised communities having little possibility of access to levels of attention in the

current health system. Regarding aetiological treatment in chronically infected children, directives already exist for diagnosing, managing, and treating Chagas disease. The Ministry of Social Protection (via the INS) is responsible for the free distribution of benznidazole in the country. Data has been derived from the exploratory phase showing that about 25,000 children could be being infected in Colombia, thereby making them a prime object for treatment.

Ecuador

Probably 1.38% of the general population are infected by *T. cruzi* (0.65% in the Sierra, 1.99% on the coast, and 1.75% in the Amazon); 165,000 to 170,000 people are seropositive in the country. The highest rate of prevalence corresponds to Loja and El Oro ($\geq 5\%$), Guayas being the province having the greatest number of infected people ($> 65,000$). In the absence of preventative measures having been taken, some 4400 people acquire the infection every year (incidence ~ 36 per 100,000 inhabitants per year). Mortality profiles (7.7 deaths per 1000 seropositive people per year) indicate that some 1300 people die each year due to causes directly related to Chagas disease. Some 33,500 patients suffer from symptomatic chronic forms; at least 31,700 suffer from cardiopathy and more than 1670 from digestive disease.

The broadest sero-epidemiological study (Grijalva et al. 2003) carried out on 14,850 blood-samples representative of the areas at risk revealed 3.08% prevalence for the country; 3.25% were seropositive in the Amazon, 3.03% on the coast and 2.3% in the sierra (Table III).

Assuming relatively low mortality rates, it has been estimated that around 300 people die each year from causes directly related to Chagas disease. Regarding the incidence of new cases, the aforementioned estimates indicated that it could be expected that around 3000 people would acquire the infection every year in the absence of effective control measures.

All blood-donations in Ecuador must be analysed (by law) for detecting the presence of anti-*T. cruzi* antibodies. However, substantial improvement is required for

TABLE III

Data from the sero-epidemiological study (Grijalva et al. 2003) carried out on 14,850 blood-samples representative of the areas at risk

Region	Sample	Prevalence (%)	Observations
Coast	5550	3.03	The highest rates were observed in El Oro
Sierra	1300	2.3	The highest rates were observed in Loja
Amazon region	8000	3.25	Transmission having endemic profile
Total	14,850	3.08	

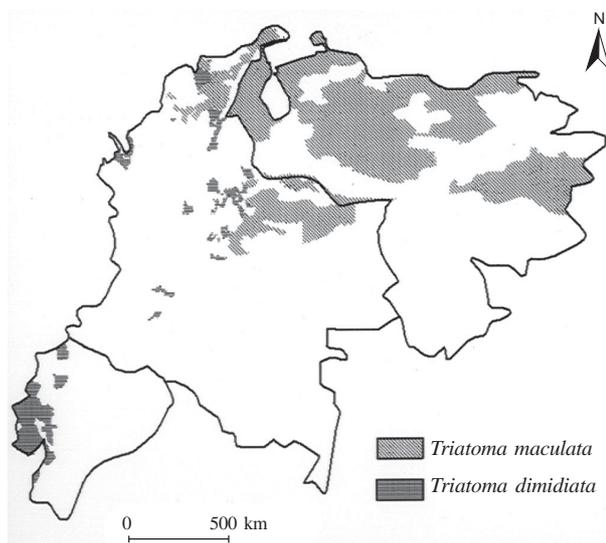


Fig. 3: distribution of insect candidates for large-scale interventions, taking into account their adaptation to human habitat: *T. maculata* in Colombia and Venezuela, *T. dimidiata* in Colombia and Ecuador.

effectively applying the legal norm, including rigorous quality-control schemes and providing diagnostic kits, equipment and reagents, as well as standardising techniques. Taking only the available studies carried out on the main cities' blood-banks since 1995, seroprevalence reached 0.1% in Quito (non-endemic area having low immigration from endemic areas) and 4.4% in Guayaquil (endemic area receiving rural immigrants from endemic areas).

Chagas cardiopathy has been identified as being the predominant symptomatic chronic form. It has been conservatively estimated that at least 14,000 patients suffer different degrees of Chagas chronic cardiopathy in Ecuador. Chronic digestive disease is also present in the country, having both severe megaesophagus and megacolon cases described in patients from several provinces. It has been calculated that the digestive forms could represent around 3% of all Chagas patients in Ecuador.

The Nacional Chagas Disease Control Programme was created by Ministerial Agreement 632, 30 Oct. 2003. The Ecuadorian Ministry of Public Health included Chagas disease control for the first time in its agenda of priorities for 2004.

It is estimated that 7750 children and adolescents (aged less than 15) could be infected in the country; all of them should be receiving specific anti-parasite treatment. More than 130,000 Ecuadorians aged from 20 to 64 (economically active population) are seropositive.

Venezuela

Venezuela is the Andean country having the greatest tradition and experience in prevention and control programmes for Chagas disease. Efforts aimed at controlling transmission of the disease began in the 1950s and the programme was officially established by the Minis-

try of Health in 1966 at national level. Four decades of control efforts based on spraying residual-action insecticides and constructing suitable rural housing, as well as improving housing, have significantly contributed towards progress being made in interrupting vector transmission of the disease. Exploratory studies carried out in 1965 revealed that insect vectors could be found in 14,209 populations (750,000 km²). Indices of infestation in housing ranged from 2 to 80% and vectorial infection index was 9.1%.

The presence of vectors was investigated in 183 places in 2003, finding that 28.4% of them were infested; 7.8% of the vectors were infected by *T. cruzi*. Control strategies are directed at the operational prevention, control, treatment, and investigation of Chagas disease, based on sero-epidemiology, constructing or improving housing, surveillance of blood-banks, active-passive search, Triatomine Notification Posts (TNP), residual spraying action units, and sanitary education.

With the exception of the states of Barinas and Portuguesa where infestation indices are greater than 3%, the other states in the country have reduced theirs to less than 1.1%, signifying an achievement in terms of the goals proposed in the programme.

Seroprevalence in children aged less than 10 is less than 1% (Fig. 4) and infestation of places having triatomines is less than 20%.

Serological surveillance for *T. cruzi* in blood-banks has been obligatory since 1988 and current data reveals a very low rate of seroprevalence (0.78%) in all of the country's blood-banks, coverage being 100% (Feliciangeli et al. 2003).

A recent review of the epidemiological situation regarding Chagas disease in Venezuela (Añez et al. 2004), based on detecting *T. cruzi* infection in patients referred with a presumptive diagnosis of Chagas disease (1988-2002) and samples of sera from inhabitants of rural areas representative of the country's different geographical regions, revealed that 56.8% of all individuals in the first group (174) were seropositive, 42% (73) were in the disease's acute phase (38% of them being children

aged less than 10). Serological diagnosis carried out on 3835 inhabitants from rural areas revealed 11.7% seroprevalence. This data agreed with a decline in the national programme's control and surveillance activities, added to variable ecological conditions and social behaviour which has contributed towards expanding vectorial transmission to the states of Monagas and Anzoátegui.

The continued collection of *P. geniculatus* infected with *T. cruzi* by inhabitants of Caracas and the neighbouring states of Miranda and Vargas has sounded the alert regarding this specie's possible role in transmitting the parasite (Feliciangeli 2005).

Peru

The endemic area having the greatest importance and the greatest human prevalence can be found on the south-western slopes of the Pacific, corresponding to the departments of Arequipa, Moquegua, Tacna, Ica, Ayacuch, and Apurimac; 7.7% of Peru's population live in the South of country where the aforementioned departments are found, around 394,000 dwellings being infested by *T. infestans* and 24,000 people being infected. Severe cases of acute Chagas disease have been detected in these departments during recent years. In spite of routine serological screening for *T. cruzi* in blood-banks not having been routinely carried out, a legal framework currently obliges blood-bank screening. An inspection of donors in Lima in 1993 indicated 2.4% prevalence.

Domiciliary *T. infestans* infestation has been notified in 21 provinces and 90 districts. It is estimated that 2% of the population (around 500,000 inhabitants) inhabit these regions. The reported trypano-triatomid infection index varies and has reached figures of up to 30%. Serological surveys reveal variations ranging from 0.7-12%. Clear evidence of cases not being recorded in the country has been shown.

Only the country's North-western region has been assimilated into the rest of the already described Andean region regarding vector species' distribution, meaning that this country is carrying out control activities fulfilling the objectives and goals of both the Southern Cone Countries' Initiative and those of the Andean countries (Vargas 2005).

Andean countries' and Amazon region initiative

Eliminating *R. prolixus*, *R. ecuadoriensis*, and reduction of *T. dimidiata* domestic populations will result in the effective interruption of most vectorial transmission of Chagas disease in those Andean countries being considered here.

Wild *T. cruzi* transmission cycles are abundant in the Amazon and around 20 species of triatomids have already been reported. Given that transmission to humans depends on suitable contact between vectors and people, the main risk for human infection in the Amazon region currently lies with triatomine species which are relatively advanced in their transition from a wild habitat to a peridomestic-domestic one, particularly *R. robustus*, *R. pictipes*, *R. brethesi*, *P. geniculatus*, and *T. maculata*.

The subsequent risk of occasional transmission caused by these vectors will depend on their ability to establish sufficiently important domiciliated colonies.

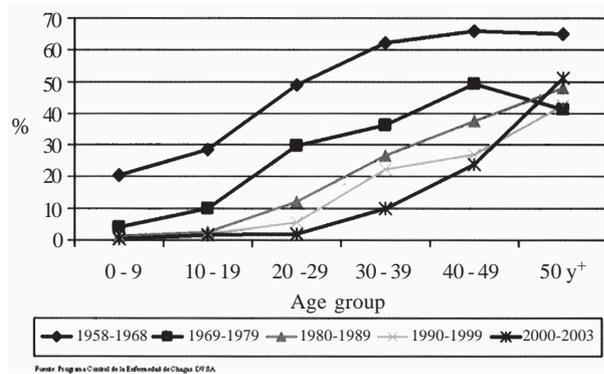


Fig. 4: infection by *Trypanosoma cruzi* in the general population and in 0-9 year group, 1963-1998 x 100 (Ach e & Matos 2001).

The case of *P. herreri* is an unequivocal example of these species' epidemiological potential; up to 94% of triatomids captured inside dwellings in North-western Peru (Cajamarca and Amazonas) belong to this species.

It is difficult to predict the real risk which these species represent; however, vectorial surveillance continues to assume great operational importance in identifying areas having the greatest risk. The recent Amazon initiative for controlling and preventing Chagas disease includes all ACI Andean countries and operational and research strategies have already been proposed for implementing entomological surveillance programmes in the region (Guhl & Schofield 2004).

DISCUSSION

The progress of control activities for the vector species present in the Andean sub-region (for different reasons) has been slow and control interventions have still not been installed in all geographical areas occupied by the target species. This has been partly due to lack of knowledge about these vector populations' biological characteristics and consequent uncertainty about which are the appropriate control measures and strategies to be applied in the region. The main vector species present important similarities in Venezuela, Colombia, Ecuador, and Northern Peru and, as already mentioned, they can be approached in a similar way throughout the whole region, basing approaches on and adapting them to the current strategies being developed in Venezuela during the 1960s which have been progressively adopted in the Southern Cone and Central-American region.

The panorama outlined above leads to concluding that in spite of actions for preventing and controlling Chagas disease having been advanced in the region, there is still a long way to go. The epidemiological situation currently presented in Venezuela constitutes a good example of how, after ordered and continuous control activity being carried out for more than 50 years, producing notable results in terms of dramatically reducing incidence and infestation of housing, when control activities decreased or disappeared in some areas then the problem of vectorial transmission began to emerge within a relatively short time.

This clearly shows the need for rethinking priorities for action for those countries forming the sub-region and establishing mechanisms allowing them to continue control action, including spraying with insecticides, entomological surveillance, and improving rural dwellings (OPS 2003). It is clear that using a particular control method does not exclude using others. Chemical control must be considered as a complement to improving rural housing and organizing the peridomicile where species of autochthonous insect vectors are frequently found which can infest housing with relative ease. All this seems to indicate then that it is indispensable to advance control action parallel to chemical intervention consisting of physically improving housing, including organizing the peridomicile. Such action requires active coordination of social funding and developing municipal councils. In terms of costs, it is clear that investment in reforming rural housing is considerably higher than spraying with insecticides, but long-term benefits to the com-

munity are greater, allowing inhabitants not only to have access to more dignified housing but also to avoid transmitting the disease by avoiding contact with triatomines.

Additional measures are needed for keeping endemic areas free from transmission, among them being a dynamic, permanent instruction programme providing information about the disease, the necessary control measures, and the importance of keeping the domicile and peridomicile tidy.

Such ordering of the peridomicile does not just refer to the suitable location of all household fittings and furniture habitually found around housing, but also to the suitable rubbish disposal and general cleaning of this area. It must be remembered that Chagas disease is associated with rural dwellers inhabiting areas where conditions of poverty and a dreadful quality of life are manifest in their everyday lives.

Regarding aetiological treatment, it is worth mentioning that (with the exception of Colombia) none of the other countries forming the ACI have registered medicaments available for treating infected young people. There are no suitable follow-up programmes in the sub-region or for treating cases of congenital Chagas disease. All the above means that one is talking of controlling Chagas disease, one has to think about an integral and integrated programme encompassing all the aspects including transmission by transfusion which seems to have achieved extremely encouraging results in all countries.

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