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Epidemiology of Chagas Disease in Ecuador. A Brief Review

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Chagas disease is a complex public health problem that has been underestimated in Ecuador. Here we review the relevant published information, and present unpublished and new data that help to understand the current Chagas disease epidemiological situation and its evolution in the country. Three main characteristics have been identified: (i) persistence of Trypanosoma cruzi transmission in already known foci; (ii) a marked endemicity in some urban areas of Guayaquil; and (iii) the transformation of new Amazon foci into truly endemic areas. The situation in other suspect areas remains uncertain. Five Triatominae species have been implicated in the transmission of T. cruzi to people in Ecuador (Triatoma dimidiata, Rhodnius ecuadoriensis, R. pictipes, R. robustus and Panstrongylus geniculatus), but some others may also play a role in some areas (P. rufotuberculatus, P. howardi, T. carrioni and P. chinai). Other Triatominae reported seem to have little or no epidemiological relevance (T. venosa, T. dispar, Eratyrus mucronatus, E. cuspidatus, P. lignarius and Cavemicola pilosa). High frequency of acute cases and severe chronic disease has been observed. Although cardiomyopathy is more frequent, serious digestive disease is also present. It is estimated that around 120,000-200,000 people may be infected. 2.2 to 3.8 million people are estimated to live under transmission risk conditions.

Key words: Chagas disease - Ecuador - epidemiology - Triatominae - prevalence - clinical traits - review

The current situation of Chagas disease in Ecuador is the subject of various ongoing epidemiological, entomological and clinical studies. With the aim of summarising the published information available and recent or unpublished data that may be remarkably helpful for researchers and control agents, we undertook a critical review about these crucial topics. Our purpose is to contribute to set the scientific basis necessary to the National Control Programme currently in preparation in Ecuador.

It is estimated that 2.24 to 3.8 million people in all, from a total population of around 11 million, are exposed to the risk of *Tripanosoma cruzi* trans-

mission. These estimates indicate that 120,000-200,000 people would be infected, with chagasic cardiomyopathy as the dominant chronic form (Aguilar & Yépez 1996). Previous estimates suggested that only 30,000 people were infected (UNDP/World Bank/WHO TDR 1997).

HISTORICAL OVERVIEW

Some archaeological, pre-Columbian findings from the province of Manabí suggest that Romaña's sign was already known in those areas before the arrival of the Europeans to the coastal region of Ecuador (cf. Alvarez 1984). During the Spanish conquest, some of the Pizarro soldiers suffered from a disease they described as "eye sickness" acquired at the Portoviejo valley in Manabí around 1530. The descriptions resemble the characteristic lesions of Romaña's sign, and Álvarez (1984) attributes them to Chagas disease. This is also consistent with the high frequency of acute forms later recorded in the area.

Stal and Whymper (cf. Campos 1923) reported the presence of the principal vector, *Triatoma dimidiata*, in the Ecuadorian coastal region in the last century. In 1917, Tamayo established the association between the insect bite and a clinical picture including local inflammation, oedema and fever (Valenzuela 1939).

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Arteaga (1930) studied the existence of American trypanosomiasis in the zone of the Coastal Railroad (Guayaquil-Salinas). In 1927 Arteaga verified the presence of human infection and triatomine bugs in the area of Santa Elena, and the following investigations certified that Chagas disease was endemic in the urban area of Guayaquil, with *T. dimidiata* colonies breeding within the cane and wood houses. The Santa Ana and El Carmen hills, two urban areas of Guayaquil, were the most strongly affected, and they seem to remain so nowadays.

During the 40s and 50s new disease foci were reported from the provinces of Guayas, Manabí, Los Ríos, and in temperate areas of the Andean provinces of Loja, Azuay and Bolívar. It is today accepted that the main endemic areas are located in the provinces of Guayas, Manabí and El Oro. But new foci reported from the Amazon region and currently under investigation (Amunárriz et al. 1991, Amunárriz 1991, Chico et al. 1997, Abad-Franch 1998, Abad-Franch et al. 1998a,b) strongly suggest that the northern Ecuadorian Amazon basin is to be considered an endemic area as well. The lack of systematic studies in other provinces makes it complicated to assert that the disease is not endemic in areas (e.g., in the provinces of Los Ríos, Esmeraldas, Pastaza, Loja, Imbabura, Pichincha, Azuay, etc.) where ecological and socio-economic traits are quite similar to those of well-known chagasic zones.

TRITOMINE VECTORS (HEMIPTERA: REDUVIIDAE)

The main vector species of Chagas disease in the Pacific slope of the Ecuadorian Andes are *T. dimidiata* and *Rhodnius ecuadoriensis*. *T. dimidiata* can be found in human dwellings in the provinces of Guayas, Manabí, Los Ríos, and El Oro (Lent & Wygodzinsky 1979, Defranc 1982, Lazo 1985). A recent observation includes the province of Loja (Abad-Franch et al., unpublished). *R. ecuadoriensis* has been reported from Manabí, Guayas, Loja and El Oro (Defranc 1982, Lazo 1985, Romaña et al. 1994), but our observations indicate that sylvatic forms of this species can be found in subtropical valleys of the province of Pichincha (Abad-Franch et al., unpublished), probably in relation to *Phytelephas* palm trees, as reported by Romaña et al. (1994) in other areas.

Three triatomine species seem to be involved in the Amazon basin foci: *R. pictipes*, *R. robustus* and *Panstrongylus geniculatus* (Espinoza 1955, Amunárriz 1991, Amunárriz et al. 1991, Chico et al. 1997, Abad-Franch et al. 1998a,b, Zabala unpublished). These five species may therefore be considered as the ones that actually transmit *T. cruzi*

to people in the well-characterised endemic areas. The apparent trend to establish domestic and/or peridomestic colonies observed in the last three species in some areas of the Amazon basin (Barrett 1988, Amunárriz, 1991, Chico et al. 1997, Valente et al. 1998) is particularly worrying. However, adults have shown their capacity to fly into the houses to feed during the night from their breeding sites (palm trees, bromeliaceae, mammals burrows), without establishing permanent colonies within human-related structures (Lent & Wygodzinsky 1979, Miles et al. 1981, Barrett 1988, Schofield 1994). Some environmental changes introduced by man during the last 20 years seem to play a role in this process: colonisation of primary rainforest, deforestation, hunting, agriculture, breeding of domestic animals near the houses or the introduction of electric light may be factors involved (Abad-Franch 1998). *P. geniculatus* distribution in Ecuador is probably broader than reported (Manabí, Imbabura, Napo, Sucumbíos and Pichincha) (Rodríguez 1959, Defranc 1982, Amunárriz 1991, Amunárriz et al. 1991, Chico et al. 1997, Zabala unpublished); we studied several specimens belonging to this species from Quindé (province of Esmeraldas), a zone where no previous reports indicate its presence (Abad-Franch et al., unpublished observations).

Other species seem to have some epidemiological significance in smaller areas. *T. carrioni* is a semidomestic species from southern Ecuador (León 1949, Espinoza 1955, Lent & Wygodzinsky 1979, Defranc 1982, Reyes 1992); nevertheless, recent observations indicate that its distribution may be significantly broader, reaching the subtropical valleys near Quito, in the province of Pichincha (Abad-Franch et al., unpublished observations).

P. rufotuberculatus can be found near or inside houses in the provinces of El Oro, Manabí and Loja (Defranc 1982, Lazo 1985, Reyes 1992, Zabala unpublished, Racines et al. unpublished). We have identified two adult specimens from the province of Pichincha; its presence in Guayas needs further investigation. This species seems to be adapting to human habitats in Bolivia, and it may be able to colonise dwellings after *T. infestans* eradication by spraying (Noireau et al. 1994).

P. howardi is considered to be of Ecuadorian origin (Lent & Wygodzinsky 1979, Defranc 1982). Its distribution seems to be very limited (in the province of Manabí), but few studies have been conducted in relation to this species. Our observations confirm that it is not uncommon to find adult specimens within human dwellings, and that misidentifications with *T. dimidiata* are not a rare event (even by trained personnel linked to the vector control service). These species, belonging to

different genera, share their general chromatic pattern and are of similar size. The actual vectorial role of this species at the local level needs to be established in Manabí.

Other species present in Ecuador and potentially involved in *T. cruzi* transmission are *T. venosa*, found to breed inside houses in some areas of Colombia (D'Alessandro & Barreto 1985), *Eraturys mucronatus*, a species able to invade and colonise human environments (Lent & Wygodzinsky 1979, D'Alessandro & Barreto 1985, Noireau et al. 1995) and *P. chinai* (Lent & Wygodzinsky 1979, Defranc 1982, Reyes 1992).

Cavernicola pilosa, *T. dispar* and *Pansstrongylus lignarius*, apparently with no epidemiological importance, have been reported from the Amazon basin (Rodríguez 1961, Lent & Wygodzinsky 1979, Defranc 1987, Abad-Franch et al. 1998a, Zabala unpublished). We recently identified one adult male apparently belonging to the species *P. herreri* captured in the Amazon basin (Abad-Franch et al. in prep.). *E. cuspidatus* has also been reported from Ecuador (cf. Defranc 1982). Our studies indicate that *R. stali* (Lent et al. 1993) is not present in the Ecuadorian Amazon region. Reports indicating the presence of *R. prolixus* in El Oro and Loja, Manabí or Napo/Orellana are doubtful (Defranc 1982, Cueva & Romero 1987) and probably due to misidentification. Equally dubious is the record of *T. infestans* in Esmeraldas and Imbabura (cf. Defranc 1982).

HUMAN INFECTION

The *T. cruzi* infection prevalence rates in various areas of the country, as reported in different studies, are reviewed in Table, together with the authors, date and techniques used.

The interpretation of these data suggests that the main endemic areas, where the disease is still being actively transmitted, correspond to the provinces of El Oro in the southern coastal region, and Guayas and Manabí in central and northern Pacific coast. The northern Amazon region, including the provinces of Sucumbíos, Napo and Orellana, should be included in the list of endemic areas. This zone is characterised by intensive migratory pressure linked to petrol exploitation and subsequent colonisation. The possibility that the environmental changes introduced during the last 20 years might have favoured Chagas disease transmission in the area needs further investigation (Abad-Franch 1998). As mentioned, the situation in other provinces remains uncertain, but their common traits make us think that, at least in some zones, the disease may be present as well. Migration from endemic areas to the city of Guayaquil and the northern Amazon is very important from the early

70s; this trend may also play a role in the epidemiological pattern of these areas (Aguilar & Yépez 1996); the introduction of parasite strains from the coast needs further investigation, as all data indicate that vectors have not been passively transported to the area.

Grijalva et al. (1997, 1998) report a prevalence of 0.02% positives for *T. cruzi* infection among blood donors at the Red Cross Blood Bank in Quito, and 0.13% in samples from other provinces. In a previous report, Grijalva et al. (1995) reported prevalences of 12.1% and 6.1% positives in two collections from the Red Cross Blood Bank in Quito (345 samples in total, analysed by ELISA plus Western Blotting).

CLINICAL FEATURES

Acute clinical disease - Historical data show that from the early 20s it was not uncommon that clinical pictures compatible with the Romana's sign were diagnosed at hospitals in Guayaquil. Varas (1942) indicate that this form of periorbital oedema was extremely frequent in the city. Subsequent studies continued to show this trait (Espinoza 1955, Rodríguez 1961, 1963, Gómez 1968, Rassi 1979, Álvarez 1984). In a recent series, Galindo (unpublished data) registered 560 acute cases from the records of the National Institute of Hygiene and Tropical Medicine. These cases are in the majority from the provinces of Guayas, Manabí, El Oro and Los Ríos, all in the coastal region (Galindo, pers. comm.). We studied a series of five acute cases from the northern Amazon in 1994 (unpublished data); all of them were children under nine with fever, generalised oedema, hepatosplenomegaly and signs of myocarditis.

Chronic chagas disease - Both heart and digestive forms of the disease have been reported from Ecuador. Galindo (1958, 1959) found chagasic etiology in 20% of 150 cardiac patients in Guayaquil. 20.68% of positives were under 40 years old and presented cardiopathy stage VI following the WHO/PAHO criteria (1974). More than 50% of those patients died in the next 15 months. Gómez (1968) found electrocardiographic signs compatible with chagasic cardiopathy in 1.4% of randomly selected, apparently healthy people. Kawabata et al. (1987) reported that 40% of 154 seropositives from El Oro and Guayas presented typical electrocardiographic abnormalities. In a series of 25 chagasic heart patients, we found that 53% met the WHO/PAHO criteria for cardiopathy stage I, and 47% for stage II and III (unpublished data).

Digestive forms are estimated to represent around 3% of chronic Chagas disease cases, and seem to be mainly from El Oro (Galindo, unpub-

TABLE
Epidemiological evolution of human *Trypanosoma cruzi* infection in Ecuador

Author, year, technique	Province	Locality	Positives	Observations
Montalván J 1950	El Oro	Zaruma	29%	696 samples examined
Complement fixation	El Oro	Machala	13.3%	
	Guayas	Gñal Vernaza	3.1%	
	Guayas	Salitre	11.8%	
	Manabí	Portoviejo	3.8%	
	Manabí	Chone	5.8%	
INH (1949-1957) (cf. Rodríguez JD 1959) Complement fixation	Coastal Region (all provinces)	Various	13.9%	3,333 samples examined Positives: >80% born in Coastal Region >10% born in the province of Loja
Espinoza L 1955	El Oro	Various	8.2%	Survey to schoolchildren in rural areas and in urban Guayaquil
Complement fixation	Guayas	Various	3.5%	
	Guayas	Guayaquil (urban)	1.9%	
	Loja	Various	2%	
	Los Ríos	Various	1.5%	
Rodríguez JD 1959 Complement fixation	Guayas	Guayaquil	24% (GP)	GP = General Population; SC = School Children
	Guayas	Various	4% (SC)	
	El Oro	Various	7.6% (SC)	
	El Oro	Machala	7% (GP)	
	Manabí	Portoviejo	4% (GP)	
	Manabí	Bahía	3% (GP)	
	Loja	Various	2% (SC)	
	Esmeraldas	Various	4% (GP)	
	Los Ríos	Various	1.5% (SC)	
Gómez LLF 1968 INH (1962-1967) methods Complement fixation + Optic microscopy	Coastal region (all provinces)	Various	3% (CF) 2.8% (OM)	2,160 blood samples were examined by both
Andrade A et al. unpublished Complement Fixation	Manabí	Picoazá	17%	521 samples
Mimori T et al. 1985 IHA	Guayas	Pedro Carbo	4.3%	
	El Oro	Zaruma	3.9%	
SNEM-TDR 1986 (cf. Reyes 1992; complementary data: Ministry of Public Health, unpublished report)	El Oro	Portovelo	17.1%	Guayaquil (urban): 2,078 samples El Guavo: 43 samples Pasaje: 41 samples
IFI	El Oro	Piñas	14.6%	
	El Oro	Zaruma	10.1%	
	El Oro	El Guavo	2.3%	
	El Oro	Pasaje	7.3%	
	Guayas	Guayaquil (urban)	2.6%	
Racines VJ et al. 1994 IFI + ELISA	El Oro	Portovelo, Piñas and Zaruma	4 to 6 1.4% 6 to 8 1.3% 8 to 10 1.5% 10 to 12 2.2% 12 to 14 1.9% 14 to 15 0.9%	Results by age groups 1,514 samples examined 1.8% + for IgG 0.1% + for IgM
Guderian R et al. 1994 (unpublished) Recombinant Antigen/ELISA	El Oro	Marcabele	7.2%	
	El Oro	Pena	6%	
	El Oro	Balzas	11.4%	

Author, year, technique	Province	Locality	Positives	Observations
Chico et al. 1997 RecombinantAntigen/ELISA	Napo and Orellana (see ^(a) below)	Various	6%	18 Quechua Communities (1,011 samples) surveyed
Racines & Grijalva 1999 INH/TDR/Ohio Universtity (unpublished) MicroELISA	Manabí	Paján (203 samples)	1%	Preliminary results; some of them need to be confirmed
	Manabí	Portoviejo (628 sampl.)	1.9%	^(a) Napo/Orellana were separated in two provinces in 1998
	Guayas	Balzar (178 sampl.)	0.6%	
	Guayas	Guayaquil (2604 sampl.)	1.8%	
	Guayas	Pedro Carbo (94 sampl.)	1.1%	
	Sucumbíos	Lago Agrio (493 sampl.)	2.3%	^(b) Communities along the San Miguel-Putumayo River
	Sucumbíos	Putumayo(**) (1232 s.)	1.3%	
	Sucumbíos	Shushufindi (263 s.)	0%	
	Napo/Orellana ^(a)	Aguarico (1796 s.)	0.4%	
	Napo/Orellana	Coca (105 s.)	0%	Amazon region:
	Napo/Orellana	El Chaco (311 s.)	0.3%	6,365 samples; 0.8% +
	Napo/Orellana	J. Sachas (167 s.)	0.6%	Coastal region:
	Napo/Orellana	Loreto (186 s.)	1.6%	3,718 samples; 1.7% +
	Napo/Orellana	Orellana (495 s.)	1.6%	Andean sierra:
	Napo/Orellana	Quijos (40 sampl.)	0%	905 samples; 0.3% +
	Napo/Orellana	Tena (1050 s.)	0.2%	
	Pastaza	Various (227 sampl.)	0.4%	Total:
	Cotopaxi	La Maná (501 s.)	0.4%	10,988 samples
	Cotopaxi	Bangua (404 s.)	0.2%	1.1% positives

INH: Instituto Nacional de Higiene y Medicina Tropical 'Leopoldo Izquieta Pérez'; SNEM: Servicio Nacional para la Erradicación de la Malaria y Control de Vectores. Note: incomplete demographic data limit interpretation in terms of real prevalence in the general population; *a*: Napo/Orellana were separated in two provinces in 1998; *b*: communities along the San Miguel-Putumayo River.

lished). Guevara et al. (1997) reported two cases of severe digestive Chagas disease, confirmed by PCR, in patients from Loja (southwest) and Morona Santiago (south Amazon region) with megacolon. This digestive form seems to be more frequent than megaesophagus, but further studies are required.

CONCLUSION

Chagas disease is a major public health problem classically underestimated in Ecuador. Prevalence estimates based upon infection rates reported from studied areas and demographic official data indicate that up to 200,000 people may be already infected, while data published by WHO report only 30,000 (UNDP/World Bank/WHO TDR 1997). The presence of a variety of actual or potential vector species, and recent data indicating that transmission actively persists, makes it imperative to accomplish a comprehensive and systematic control programme in the well-known endemic areas, and sero-entomological surveys in other coastal and Amazon provinces. Some of such studies are currently ongoing, but substantial efforts are still needed. A standardised methodology has to be established in order to enable comparisons between different studies. The dynamics of transmission in the Amazon region should be clarified as a research priority. Studies on vector biology and population

genetics are also required (Schofield et al. 1995, 1996). In general, we understand that a serious and broad public health action, following the WHO recommendations (WHO 1991), and under the coordination of the Andean countries initiative to interrupt the transmission of Chagas disease (UNDP/World Bank/WHO TDR 1997), is essential to respond adequately to this important public health problem.

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