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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 Here we review the relevant published information, and present unpublished and new data that help to understand the current Chagas disease epidemiological situation and its evolution in the country.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* Cavernicola 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 With the aim of summarising the published information available and recent or unpublished data that may be remarkably helpful for researchers and control agents, we undertook a critical review about these crucial topics.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* transmission. These estimates indicate that 120,000-200,000 people would be infected, with chagasic cardiopathy 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 socioeconomic traits are quite similar to those of well-known chagasic zones.

TRIATOMINE 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 that 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 Quinindé (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. rufotubercutalus 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 *Panstrongylus 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 Romaña'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 Complement fixation	El Oro El Oro Guayas Guayas Manabí Manabí	Zaruma Machala Gnal Vernaza Salitre Portoviejo Chone	29% 13.3% 3.1% 11.8% 3.8% 5.8%	696 samples examined
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 Complement fixation	El Oro Guayas Guayas Loja Los Ríos	Various Various Guayaquil (urban) Various Various	8.2% 3.5% 1.9% 2% 1.5%	Survey to schoolchildren in rural areas and in urban Guayaquil
Rodríguez JD 1959 Complement fixation	Guayas Guayas El Oro El Oro Manabí Manabí Loja Esmeraldas Los Ríos	Guayaquil Various Various Machala Portoviejo Bahía Various Various Various	24% (GP) 4% (SC) 7.6% (SC) 7% (GP) 4% (GP) 3% (GP) 2% (SC) 4% (GP) 1.5% (SC)	GP = General Population; SC = School Children
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 El Oro	Pedro Carbo Zaruma	4.3% 3.9%	
SNEM-TDR 1986 (cf. Reyes 1992; complementary data: Ministry of Public Health, unpublished report) IFI	El Oro El Oro El Oro El Oro El Oro Guayas	Portovelo Piñas Zaruma El Guavo Pasaje Guayaquil (urban)	17.1% 14.6% 10.1% 2.3% 7.3% 2.6%	Guayaquil (urban): 2,078 samples El Guavo: 43 samples Pasaje: 41 samples
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 El Oro El Oro	Marcabele Pena Balzas	7.2% 6% 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	Manabí	Paján (203 samples)	1%	Preliminary results; some of
INH/TDR/Ohio Universtity	Manabí	Portoviejo (628 sampl.)	1.9%	them need to be confirmed
(unpublished)	Guayas	Balzar (178 sampl.)	0.6%	([a])Napo/Orellana were
MicroELISA	Guayas	Guayaquil (2604 sampl.)	1.8%	separated in two provinces
	Guayas	Pedro Carbo (94 sampl.)	1.1%	in 1998
	Sucumbíos	Lago Agrio (493 sampl.)	2.3%	([b])Communities along the
	Sucumbíos	Putumayo(**) (1232 s.)	1.3%	San Miguel-Putumayo
	Sucumbíos	Shushufindi (263 s.)	0%	River
	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 megaoesophagus, 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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REFERENCES

Abad-Franch F 1998. Impacto de las alteraciones medioambientales en la transmisión vectorial de *Trypanosoma cruzi*. Conference at the Round Table 'Alteraciones ambientales: impacto en el comportamiento de enfermedades emergentes y reemergentes'. V Congreso de la Sociedad Ecuatoriana de Microbiología/Asociación Latino-americana de Microbiología, Quito, Ecuador, July 1998 (Program and Abstracts in press).

Abad-Franch F, Onore G, Racines VJ, Aguilar VHM 1998a. Distribución de Triatominae (Hemiptera: Reduviidae), vectores de *Trypanosoma cruzi*, en la Amazonía ecuatoriana. Short Communication. V Congreso de la Sociedad Ecuatoriana de Microbiología/Asociación Latinoamericana de

Microbiología, Quito, Ecuador, July 1998 (Program and Abstracts in press).

Abad-Franch F, Racines VJ, Aguilar VHM, Grijalva M, Onore G 1998b. Extension of Chagas disease to the Ecuadorian Amazon basin: a new endemic area? Program and Abstracts of the 47th Annual Meeting of the American Society of Tropical Medicine and Hygiene, San Juan, Puerto Rico (meeting cancelled). *Am J Trop Med Hyg 59* (Suppl.)*:* 329-330.

Aguilar VHM, Yépez R 1996. Evolución epidemiológica de la enfermedad de Chagas en Ecuador, p. 30-38. In CJ Schofield, JP Dujardin & J Jurberg (eds), *Proceedings of the International Workshop on Population Genetics and Control of Triatominae, Santo Domingo de los Colorados, Ecuador, 1995*. INDRE, Mexico City, 116 pp.

Álvarez CJ 1984. *Historia de la Medicina Tropical Ecuatoriana III. Enfermedad de Chagas en el Ecuador,* Arquidiocesana Justicia y Paz, Guayaquil, 233 pp.

Amunárriz M 1991. Enfermedad de Chagas. Primer foco amazónico, p. 27-37. In Amunárriz M *Estudios sobre Patologías Tropicales en la Amazonía Ecuatoriana*, CICAME, Pompeya, Napo, Ecuador.

Amunárriz MU, Chico ME, Guderian RH 1991. Chagas' disease in Ecuador: a sylvatic focus in the Amazon region. *Am J Trop Med Hyg 94:* 145-149.

Arteaga CL 1930. Investigaciones sobre la existencia de la enfermedad de Chagas en la zona del ferrocarril de la costa (Provincia del Guayas). *Rev Univ Guayaquil 1:* 89-101.

Barrett TV 1988. Current research on Amazonian Triatominae. *Mem Inst Oswaldo Cruz 83* (Suppl. I)*:* 441-447.

Campos RF 1923. Notas bibliográficas sobre el *Triatoma dimidiata*. *Rev Col Vicente Rocafuerte 12-14:* 107-111.

Chico HM, Sandoval C, Guevara EA, Calvopiña HM, Cooper PJ, Reed SG, Guderian RH 1997. Chagas disease in Ecuador: evidence for disease transmission in an indigenous population in the Amazon region. *Mem Inst Oswaldo Cruz 92:* 317-320.

Cueva IO, Romero SR 1987. Estudio epidemiológico de la enfermedad de Chagas en la provincia de Loja. p. 151. *Los problemas de salud en el Ecuador. Memorias de los Simposios,* Dirección Nacional del Seguro Social Campesino, Quito, Ecuador.

D'Alessandro A, Barreto P 1985. Colombia, p. 377-399. In RU Carcavallo, JE Rabinovich & RJ Tonn (eds.) *Factores Biológicos y Ecológicos de la Enfermedad de Chagas*, vol. II: Centro Panamericano de Ecología Humana y Salud OPS/OMS Servicio Nacional de Chagas, Ministerio de Salud y Acción Social, República Argentina.

Defranc MI 1982. *Enfermedad de Chagas*. Casa de la Cultura Ecuatoriana, Núcleo del Guayas, Guayaquil, 275 pp.

Defranc MI 1987. Prevalencia de la enfermedad de Chagas en el Ecuador. Informe 1983-1986. *Rev Ecuat Hig Med Trop 37:* 13-47.

Espinoza LA 1955. Epidemiología de la enfermedad de Chagas en la República del Ecuador. *Rev Ecuat Hig Med Trop 12:* 25-105.

Galindo SV 1958. Frecuencia chagásica en 150 cardiomegálicos. *Rev Ecuat Hig Med Trop 15:* 205-216.

Galindo SV 1959. Cardiopatía chagásica crónica. Primeros casos en el Ecuador, demostrados parasitológicamente. *Rev Ecuat Hig Med Trop 16:* 9-20.

Gómez LLF 1968. El problema de la enfermedad de Chagas en Guayaquil. *Rev Ecuat Hig Med Trop 25:* 3-10.

Grijalva MJ, Chiriboga R, Racines VJ, Escalante L, Rowland EC 1997. Short Report: Screening for *Trypanosoma cruzi* in the blood supply by the Red Cross Blood Bank in Quito, Ecuador. *Am J Trop Med Hyg 57:* 740-741.

Grijalva MJ, Rowland EC, Powell MR, McCormick TS, Escalante L 1995. Blood donors in a vector-free zone of Ecuador potentially infected with *Trypanosoma cruzi*. *Am J Trop Med Hyg 52:* 360-363.

Grijalva MJ, Rowland EC, Escalante L, Costales J, Racines VJ 1998. Transmisión de la enfermedad de Chagas asociada a transfusiones sanguíneas en los bancos de sangre del Ecuador. Short Communication. V Congreso de la Sociedad Ecuatoriana de Microbiología/Asociación Latinoamericana de Microbiología, Quito, Ecuador, July 1998 (Program and Abstracts in press).

Guevara AG, Eras JW, Recalde M, Vinueza L, Cooper PJ, Ouassi A, Guderian RH 1997. Severe digestive pathology associated with chronic Chagas disease in Ecuador: report of two cases. *Rev Soc Bras Med Trop 30*: 389-392.

Kawabata M, Uchiyama T, Mimori T, Hashiguchi T, Vera de Coronel V 1987. Association of electrocardiographic abnormalities with seropositivity to *Trypanosoma cruzi* in Ecuador. *Trans R Soc Trop Med Hyg 81:* 7-10.

Lazo R 1985. Parásitos, reservorios, control. Situación regional de la enfermedad de Chagas en Ecuador, p. 413-427. In RU Carcavallo, JE Rabinovich & RJ Tonn (eds), *Factores Biológicos y Ecológicos de la Enfermedad de Chagas*, vol. II: Centro Panamericano de Ecología Humana y Salud OPS/OMS, Servicio Nacional de Chagas, Ministerio de Salud y Acción Social, República Argentina.

Lent H, Wygodzinsky P 1979. Revision of the Triatominae (Hemiptera, Reduviidae), and their significance as vectors of Chagas' disease. *Bull Am Mus Nat History 163:* 123-520.

Lent H, Jurberg J, Galvão C 1993. *Rhodnius stali* n. sp., afim de *Rhodnius pictipes* Stal, 1872 (Hemiptera: Reduviidae: Triatominae). *Mem Inst Oswaldo Cruz 88:* 605-614.

León LA 1949. Información sobre el problema de la enfermedad de Chagas en el Ecuador. *Bol Ofic Sanit Panam 28:* 569-585.

León LA, León B 1976. Paleopatología dermatológica ecuatoriana. *Medicina Rev Mex 1205.*

Miles MA, de Souza AA, Povoa M 1981. Chagas disease in the Amazon basin. III. Ecotopes of ten triatomine bug species (Hemiptera: Reduviidae) from the vicinity of Belém, Pará State, Brazil. *J Med Entomol 18:* 266-278.

Mimori T, Kawabata M, Gómez E, Vera de Coronel V, Aroca de M, Flor T, Hasiguchi Y 1985. A seroepidemiological survey of Chagas diseases and search for reservoir hosts in two endemic areas of Ecuador. *Japan J Trop Med Hyg 13:* 245-250.

Montalván JA 1950. Ensayos de profilaxis de la enfermedad de Chagas en Guayaquil. *Rev Ecuat Hig Med Trop 8-9* : 4.

Noireau F, Bosseno MF, Carrasco R, Telleria J, Vargas F, Camacho C, Yaksic N, Brenière SF 1995. Sylvatic triatomines (Hemiptera: Reduviidae) in Bolivia: trends toward domesticity and possible infection with *Trypanosoma cruzi* (Kinetoplastida: Trypanosomatidae). *J Med Entomol 32:* 594-598.

Noireau F, Bosseno MF, Vargas F, Brenière SF 1994. Apparent trend to domesticity observed in *Panstrongylus rufotuberculatus* Champion, 1899 (Hemiptera: Reduviidae) in Bolivia. *Res Rev Parasitol 54:* 263-264.

Racines VJ, Avilés H, Armijos R, Ortega M, Romaña C, Lema F 1994. Seroprevalencia de la infección a *Trypanosoma cruzi* en escolares de la Provincia del El Oro. *Microbiología 1:* 50.

Rassi A 1979. Clínica: fase aguda, p. 249-264. In Z Brener & Z Andrade (eds) *Trypanosoma cruzi e Doença de Chagas*. Guanabara Koogan, Rio de Janeiro.

Reyes LV 1992. Enfermedad de Chagas, p. 134-137. In R Sempértegui, P Naranjo & M Padilla (eds) *Panorama Epidemiológico del Ecuador*. Ministerio de Salud Pública-Unicef. Quito, Ecuador, 252 pp.

Rodríguez JD 1959. Epidemiología de la enfermedad de Chagas en la República del Ecuador. *Rev Goiana Medica 5:* 411-438.

Rodríguez JD 1961. Nuevos datos sobre la enfermedad de Chagas en Guayaquil. *Rev Ecuat Hig Med Trop 18:* 48-52.

Rodríguez JD 1963. Antecedentes y primeros resultados de la campaña antichagásica en un sector de la ciudad de Guayaquil. *Rev Ecuat Hig Med Trop 20:* 13-15.

Romaña C, Racines VJ, Avilés H, Lema F 1994. Observaciones de domiciliación de *Rhodnius ecuadoriensis* en focos endémicos de la enfermedad de Chagas en el Ecuador. *Microbiología 1:* 59.

Schofield CJ 1994. *Triatominae. Biología y control*. Eurocommunica Publications, West Sussex, UK, 80 pp.

Schofield CJ, Dujardin JP & Jurberg J 1995. Population genetics of Triatominae: support for vigilance and control interventions. *Mem Inst Oswaldo Cruz 90* (Suppl. I): 57.

Schofield CJ, Dujardin JP, Jurberg J. 1996 *Proceedings of the International Workshop on Population Genetics and Control of Triatominae, Santo Domingo de los Colorados, Ecuador, Sept. 1995*. INDRE, Mexico City, 116 pp.

UNDP/World Bank/WHO Special Programme for Research and Training in Tropical Diseases (TDR) 1997. Andean countries initiative launched in Colombia. *TDR News 53:* 3.

Valente VC, Valente AS, Noireau F, Carrasco HJ, Miles MA 1998. Chagas disease in the Amazon basin: association of *Panstrongylus geniculatus* (Hemiptera: Reduviidae) with domestic pigs. *J Med Entomol 35*: 99-103.

Valenzuela V 1939. Breve resumen sobre patología médica ecuatoriana y su distribución geográfica. *Rev Univ Guayaquil 10.*

Varas SJM 1942. Edema palpebral febril tripanosomiásico. *An Soc Med-Quir Guayas 22:* 979-998.

WHO-World Health Organization 1991. *Control of Chagas Disease*. WHO Technical Report Series 811, 95 pp.

WHO/PAHO 1974. Aspectos clínicos de la enfermedad de Chagas. Informe de una reunión conjunta OPS/OMS de investigadores. *Bol Ofic Sanit Panam*.