
Comments on the article:

Gorla DE, Xiao-Nong Z, Diotaiuti L, Khoa PT, Waleckx E, Souza RCM, et al. Different profiles and epidemiological scenarios: past, present and future. Mem Inst Oswaldo Cruz. 2022; 117: e200409.

Reflections on Chagas disease in the Amazon

This important update of the transmission profiles and scenarios of Chagas disease (CD) highlights the enormous complexity and challenges that represent the prevention and control of parasitosis currently in the Americas and the planet. This global scenario is characterised by the acceleration generated by the fourth industrial revolution, the accelerated growth of the planetary population that puts pressure on nature, the climate change resulting from the prevailing industrial model, and the socio-economic effects of the Coronavirus disease (COVID-19) pandemic.

The article highlights the operational purposes and prioritisation of efforts: The vectorial transmission of *Trypanosoma cruzi* is still active in rural areas of the Gran Chaco, extensive parts of the Andean Region, Central America, Mexico, in the southern USA. It is especially emphasised that the Amazon constitutes the next frontier of expansion of the massive transmission of *T. cruzi* and requires our professional and ethical commitment for its defense.

The entomological situation in China and Vietnam constitutes an interesting inquiry that raises the possible introduction of *T. cruzi* in localities with competent, domiciled, and anthropophilic vectors. The presence of the parasite could turn them into active transmission foci, a remote but not impossible eventuality that has already occurred in other latitudes.⁽¹⁾

In this scenario, it is pertinent to restore Pavlovsky's (1939)⁽²⁾ theory of natural foci, which from an ecological and geographical point of view, helps to understand the impact of human activities on the transformation of natural foci of some zoonoses. The transformation of natural foci explains the changes in the circulation of parasites in household and peri-household environments and their adaptation to new epidemiological patterns.⁽³⁾

The theory of natural foci in the interpretation of Amazonian phenomena is valid for *T. cruzi* and agents of other diseases that circulate in natural foci such as leishmaniasis, yellow fever, rabies, leptospirosis, and several arboviruses whose natural foci are deterred by anthropic and predatory activities.⁽⁴⁾

The Amazon, the largest biome on Earth, is subjected to an accelerated process of capitalist exploitation and extraction of natural resources, which threatens the balance of the last tropical rainforests and the populations that inhabit them as well as the survival of planetary life. It is foreseeable what will happen in the immediate future with the accelerated occupation of the Amazon, according to the underway national projects and even more after the arising socioeconomic needs aggravated by the pandemic crises that will increase pressure on the Amazonian resources to sustain the affected economies of the Amazonian States and their articulation with the world circuits.⁽⁵⁾

According to the Amazonian Network of Georeferenced socio-environmental information (RAISG),⁽⁶⁾ the Amazon is a territory of greater socio-environmental diversity in the process of accelerated change. It covers an area of 7.4 million km² comprising 12 macro basins and 158 sub-basins. The Amazon's river basin is the largest in the world, comprising 44% of the South American subcontinent. Representing more than half of the planet's tropical rainforest and is the world's largest tropical forest. The region represents between 4 and 6% of Earth's total surface area and around 25 to 40% of the Americas. The Amazon region covers 7,413,827 km², representing 54% of the total area of the eight OTCA Member Countries.⁽⁷⁾

It is the largest and most complex forest on Earth, with at least 10,000 hectares of anthropogenic action, an area of extractivism, production of agro-industrial inputs, and non-renewable raw materials, both for nationals and international markets, compromising sustainable development and affects the conservation of vital spaces. Its 48 million inhabitants represent 11% of the Amazonian countries population (OTCA, 2021). There are 420 different indigenous tribes and populations, who speak 86 languages and 650 dialects. At least 60 indigenous populations live in total isolation.⁽⁷⁾

An estimated 260,000 Amerindians who speak around 170 native languages live in the region. "Caboclos, ribeirinhos, seringueiros", and other traditional settlers generally settle in small communities along riverbanks, relying on subsistence agriculture, fishing, and forest extractivism.⁽⁸⁾

In Pan-Amazonia, there is a ring of deforestation extending from Brazil to Bolivia, putting pressure on hydric resources, exploration of oil in the Andean Amazon (Colombia, Ecuador, and Peru), and an Amazonian mining ring. Deforestation, understood as the degradation or replacement of the original forest cover of the Amazon, has accelerated since the 1970s when countries such as Brazil, Ecuador, and Peru established a legal framework that encouraged colonisation and land occupation. Data from the Brazilian National Space Institute (INPE) reveal that in 1985 that 93.7% of the Amazonian coverage (3'841,932 km²) was native, and 258,068 km² had been deforested. By 2018 the native coverage had been reduced to 82.7% accumulating 709,165 km² of deforested area.⁽⁵⁾ In the last three years, deforestation has accelerated, especially in the State of Pará, Brazil.⁽⁹⁾

The threats identified for the Amazon include roadway projects, multimodal routes (roads and river routes), oil industry exploitation, mineral exploration, cattle ranching, and extensive agriculture.⁽⁶⁾ All of them are linked to transnational capital expressed in national projects and accelerated by the current conjunctural needs caused by the pandemic.

Available evidence suggests a more complex interpretation of epidemiological patterns of CD in the region:⁽¹⁰⁾

(1) Wild cycles of *T. cruzi* transmission appear to be particularly extensive and intense in Amazonia; involving a great diversity of mammals (marsupials, bats, rodents, edentates, carnivores, primates) and vectors (more than 25 species of nine genera) that interact in arboreal (palm trees, hollow trees, bird or mammal nests) and terrestrial (animal dens, caves).^(11,12,13,14,15)

(2) The most common form of transmission continuously occurs through home invasion by infected wild vectors (mainly *Rhodnius pictipes*, *R. robustus*, and *Panstrongylus geniculatus*); it is widespread but of low intensity. Transmission generates a hypoendemic profile with prevalences between 1 and 3% and with sub-regional (e.g., prevalence seems to be higher in western Amazonia than in central Amazonia) and local (e.g., prevalence seems to be higher in rural areas than in urban areas) heterogeneities.⁽⁸⁾

(3) Geographically restricted areas of more intense transmission (“transmission hotspots”) are associated with different ways of industrial agroextractivism. One is related to the exploitation of piassava fiber in the upper-middle Rio Negro, with up to 5% prevalence in workers, and another is due to the consumption of açaí and bacaba in the eastern Amazon. Contamination of plant products by infected vectors generates (often familial) outbreaks of acute CD.^(8,16,17)

(4) Finally, there are outbreaks of house infestation by triatomines in peripheral areas of the region, including the savannas of Roraima (*Triatoma maculata*), the southwestern Amazon (*R. stali*), and the mid-upper Marañón River (*P. lignarius* / *herrereri*).^(8,13,18) In the case of *P. lignarius* / *herrereri*, Alroy et al.⁽¹⁹⁾ found a prevalence of 14.9% (n = 611 subjects) in communities where this was the only vector found in homes (n = 208, 40% of which were infested). The situation regarding *T. maculata* and *R. stali* is still poorly characterised. Luitgards-Moura et al.⁽²⁰⁾ reported two seropositive (0.9%; n = 233) in Roraima communities with domestic populations of *T. maculata*, but Ricardo-Silva et al.⁽²¹⁾ reported colonisation by *T. maculata* in urban homes in Boa Vista, Roraima. Carrasco⁽²²⁾ identified *T. dimidiata* as an important vector of an urban enzootic cycle in Caracas, capital of Venezuela; Matías et al.⁽²³⁾ mention the finding of 4.5% seropositive among 88 inhabitants of a community in Alto Beni (Bolivia) where *R. stali* infests houses and peridomestic; similarly, Justi et al.⁽²⁴⁾ mention the finding of anti-*T. cruzi* in 60 of 2002 residents (3.0%) in the same region.

In the Ecuadorian Amazon, Aguilar⁽¹⁰⁾ found higher seroprevalence for *T. cruzi* in communities settled in deforested Amazonian landscapes with a predominant presence of grasslands and scrublands, with palm trees close to dwelling houses permeable to triatomine invasion. These higher-risk landscapes presented higher temperatures, lower humidity, and fewer palms when compared to secondary and primary forest strata. These findings seem to point to a relationship between increased forest degradation, exposure to triatomine bites, and increased risk of *T. cruzi* transmission to human populations. This phenomenon occurs systematically, with more and more territories in Panamazonia being modified by the described threats and increasing communities that register endemic transmission by vectorial transmission from the wild home-invading triatomines.

TABLE
Eco-epidemiological and prevalence differences between *Trypanosoma cruzi*, Sucumbíos Ecuador, 2009

Communities	5 de Agosto	Guacamayo	Pakococha	Urban neighborhoods
Forest cover	Fragmented pastures and forests	Secondary forests	Primary forests	Urban zones
Examined people	388	198	95	863
Positive to <i>T. cruzi</i>	17	5	0	6
% positives	4,38	2,52	0	0,69

Source: Aguilar HMV, 2009.⁽¹⁰⁾

This knowledge is useful to remotely monitor similar forms of territorial occupation that are co-occurring in all Amazonian territories and to monitor the emergence of new areas of endemic and systematic transmission of *T. cruzi* in landscapes with deforestation to grasslands, scrublands, and subsistence plantations, associated with the presence of exposed human populations and the proximity of palm trees potentially containing colonies of *T. cruzi*-infected triatomines.

The planet is experiencing an industrial revolution of capitalism in version 4.0, characterised by the productivist use of technology, the plundering of strategic resources in its most varied forms, the opportunistic exploitation of conditions of shock and social fear, and the extraction of data that turn personal information into lucrative merchandise. The ethical-cultural dimension of our time and the frenetic expansion of postmodern consumerist civilisation replace violent forms with the self-imposed domination of consumerist ideology, a process that aims at the reorganisation and totalitarian homologation of the world.

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