

## Chagas disease and globalization of the Amazon

### La enfermedad de Chagas y la globalización de la Amazonia

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#### Abstract

*The increasing number of autochthonous cases of Chagas disease in the Amazon since the 1970s has led to fear that the disease may become a new public health problem in the region. This transformation in the disease's epidemiological pattern in the Amazon can be explained by environmental and social changes in the last 30 years. The current article draws on the sociological theory of perverse effects to explain these changes as the unwanted result of the shift from the "inward" development model prevailing until the 1970s to the "outward" model that we know as globalization, oriented by industrial forces and international trade. The current article highlights the implementation of five new patterns in agriculture, cattle-raising, mining, lumbering, and urban occupation that have generated changes in the environment and the traditional indigenous habitat and have led to migratory flows, deforestation, sedentary living, the presence of domestic animals, and changes in the habitat that facilitate colonization of human dwellings by vectors and the domestic and work-related transmission of the disease. The expansion of Chagas disease is thus a perverse effect of the globalization process in the Amazon.*

*Chagas Disease; Communicable Diseases; Amazon Ecosystem*

The increase in human cases of Chagas disease in the Amazon has led to the fear it will become an emerging public health problem in the region <sup>1</sup>. Chagas disease is not new to the Amazon. Since the early 20th century the infection was known to exist in animals, and in 1924 Carlos Chagas himself described the existence of *Trypanosoma cruzi* among monkeys in the State of Pará, Brazil <sup>2</sup>. The entire Amazon has abundant insects that can transmit the disease. Although species from genus *Triatoma*, which are widespread elsewhere in South America, are sparsely represented in the Amazon, there are other species such as those of genus *Rhodnius* that tend to be found in palm leaves, and genus *Pastrongylus*, in animal dens, eggs, and tree crevices <sup>3,4</sup>. Moreover, more than a hundred species of mammals naturally infected by the parasite have been identified in the region <sup>5</sup>. The Amazon therefore displayed nearly all the conditions for the disease to exist, except for the human and social factor, and it was thus considered enzootic.

However, the situation changed in 1969 when the first autochthonous case of Chagas disease was reported <sup>6</sup>, and since then there have been increasing case reports, with 205 cases identified as of 2000 <sup>1</sup>. There have even been cases reported in countries that did not traditionally suffer from the disease, like Guyana <sup>7</sup> and French Guyana <sup>8</sup>. Furthermore, before recognition of the new epidemiological situation, the Pan American Health Organization joined with nine countries

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in Manaus, Brazil, in 2004, to create a new Initiative of Amazonian Countries for the Prevention and Control of Chagas Disease (AMCHA)<sup>9</sup>, which was added to the other three inter-governmental initiatives (the Southern Cone, Central America, and the Andean Region) in the Chagas disease program for the Americas.

The Amazon region is a river basin covering almost seven million square kilometers in nine countries: Brazil, Colombia, Peru, Ecuador, Bolivia, Venezuela, Surinam, Guyana, and French Guyana. For several centuries the human populations in the region were small, with few towns and cities and scattered indigenous populations that maintained an on-going relationship with nature and a unique habitat that was unfavorable to Chagas transmission. This may explain why the Amazon region was considered non-endemic, even though the disease is widely distributed from Mexico to Argentina and Chile<sup>10</sup>, having existed on the American continent long before Spanish colonization (studies on mummies<sup>11</sup> have shown that Pre-Colombian populations in the Andean highlands suffered from the disease). The disease is believed to have propagated from some part of Bolivia to highly diverse territories in South America<sup>12</sup>, but that it had not spread to the Amazon. The infection had not been detected in the indigenous populations of the Amazon lowlands, and the cases described were in the non-indigenous population, especially in Pará, Brazil, in a population on the outskirts of small towns<sup>13</sup>.

What social and environmental transformations in the Amazon in the last four decades have made Chagas disease appear and increase in incidence? Why has the disease not appeared as in other regions? And on what basis can we state that there is a risk of change in the previously prevailing epidemiological pattern? What are the social and historical origins of these changes, and what is the relevance for the emergence of Chagas disease as a public health problem?

This article analyzes the social and environmental changes in the occupation of the Amazon region, drawing on the sociological theory of perverse effects, and discusses the relationship between development plans for the region and new forms of land occupation and the ways by which they are altering the previous socio-environmental conditions that kept the disease absent or suppressed and that now allow its expansion.

## The theory of perverse effects and the development of the Amazon region

Changes introduced by human activity alter the environment and allow achieving the well-being desired by individuals, but they can produce some unwanted effects by creating harmful conditions for human health. Such an effect, referred to as “perverse” in sociology, can result from the aggregation of multiple individual actions, each harmless by itself, but which added together produce a different result from that originally intended, regardless of the actors’ wishes and which may even be undesirable for them, but which result from the event’s accumulated magnitude<sup>14</sup>. Perverse effects can impact both social institutions and nature<sup>15</sup>. The damage potentially caused by human action on social life or nature is not necessarily intentional, since it can occur independently of (or even against) people’s wishes<sup>16</sup>. Therefore, the concept is not related to the moral connotation of the term “perverse”, but to the autonomy of results vis-à-vis actors’ intentions.

We contend that the risk of Chagas disease expansion in the Amazon is a case of perverse effects that societies produce through their impact on nature, an unintended and perhaps undesirable consequence for individuals, but resulting from the magnitude and aggregate modes of human intervention in the natural environment through development plans for the region.

During the 1950s, development studies by CEPAL (ECLAC – Economic Commission for Latin America and the Caribbean) indicated the countries’ need for inward development, altering the outward trend that had prevailed throughout Latin America history<sup>17</sup>. CEPAL postulated the Center-Periphery theory, with the developed countries in the center, towards which production and trade from the peripheral countries was oriented<sup>18</sup>. This development model assumed a spatial expression that was the model of the continent’s coastal occupation, with the majority of the population and the important cities located on the outer borders of the territory, leaving the hinterlands, like the Amazon, unpopulated and even abandoned. In many cases the model was that of an agricultural or mining area located in the countryside and connected by railway to a port, through which agricultural products were shipped to world markets; however these production zones had little or no connection to each other, because all transportation networks and production were all outwardly oriented<sup>19</sup>.

The CEPAL proposal for “inward development” involved strengthening the domestic market through import substitution, accelerated

industrialization, and regional trade integration. Meanwhile, in South America the extension of internal frontiers leading to the occupation of the vast interior saw its maximum expression in the Amazon basin.

The Brazilian government's decision in 1958 to build the Belém-Brasília highway should be interpreted from this perspective, since the decision was to occupy the hinterlands, shifting from the coastal occupation pattern to launch the country's "inward development". Subsequent projects like the North-South Cuiabá-Santarém Highway and the Trans-Amazonian Highway in the 1970s reinforced that same goal. The proposal was repeated in other countries, with different names but the same basic idea. In Venezuela, an ambitious program called the "Conquest of the South" was launched to correct the country's demographic imbalance (with the vast majority of the population in the northern coastal region and only 5% of the population living in the other half of the country, south of the Orinoco River).

These projects led to important changes in the occupation of the Amazon, but until the 1970s the impact of national "inward development" on land occupation and deforestation was relatively small. Beginning in the 1970s, human migration to the Amazon and deforestation accelerated heavily because the region began to be occupied by social and economic forces that responded to completely different dynamics, namely a new "outward development" framed by the market forces of globalization.

From 1977 to 1988, mean annual deforestation in the Amazon was 21,045km<sup>2</sup>, increasing to 22,392km<sup>2</sup> from 2000 to 2005<sup>20</sup>. Until 1972, only about 300 hectares had been deforested around the Belém-Brasília highway, but the situation changed drastically and the figure rose to 1,700 hectares by 1977 and 8,200 hectares by 1985. Most of this deforested area was converted to pasture, a form of land use that had been almost nonexistent, but which now represented the most important cause of deforestation on agricultural operations with more than 5 million head of cattle dedicated to beef exportation<sup>21</sup>. During those same 20 years, the Brazilian Amazon population surpassed two million<sup>22</sup>. According to estimates, at the beginning of this process there were approximately 150,000 indigenous people in the Amazon<sup>23</sup> (from 1984 to 1988 and in the Brazilian State of Rondonia alone, an average of 160,000 immigrants arrived per year)<sup>24</sup>.

These changes posed an important risk of transmission of Chagas disease, because through a perverse effect they altered the traditional conditions that had controlled transmission of the infection to humans.

## Pattern of indigenous land occupation and Chagas disease

The absence of Chagas disease in the Amazon reflected the way indigenous peoples had related to their environment and the land occupation patterns these communities had maintained for centuries. These social factors were unfavorable to Chagas vector domiciliation, the key element in transmission of the disease. This, rather than the natural conditions of the Amazon environment (e.g., the hot, humid climate), explains the absence of the disease and provides a basis for understanding the new epidemiological situation.

Anthropological studies in different indigenous populations like the Suruí and Xavánte elucidate the socio-environmental pattern of land occupation by the original inhabitants of the Amazon region<sup>25,26,27</sup>. Four aspects in this type of land occupation hinder the vector transmission of Chagas disease: type of human dwellings, continuous mobility, absence of domestic animals, and existence of abundant alternative food sources for potential Chagas vectors.

### Type of human dwellings

Traditionally, the indigenous peoples of the Amazon live in large open communal huts that are not favorable to Chagas vector colonization<sup>28</sup>. Closed dwellings are considered much more favorable to domiciliation, because they offer a pleasant microclimate for the vector and sufficient cracks and crevices to hide from predators during the day. Thus, although indigenous dwellings use materials like palm leaves and tree bark that are propitious to vector presence<sup>29</sup> and have sufficient objects for vectors to hide (as in vector-infested peasant dwellings), colonization has not occurred. Vector domiciliation requires cracks and crevices in the walls or roofs where triatomines can find shelter<sup>30</sup>, and these are not common in the open-walled indigenous communal huts.

### Permanent mobility

The second factor is the continuous mobility of indigenous populations, who regularly move their dwellings and crops. Indigenous communities are accustomed to remaining two or three years in one spot and then abandoning that place because the soil has become depleted. They continually move to search for new land and avoid diseases (such as gastrointestinal) that are spread by human contamination of the space they have occupied. This continuous human mobility did

not allow Chagas vector adaptation to the dwellings, since entomological studies have shown that domiciliation requires much more time than is allowed by this repeated shifting.

#### **Absence of domestic reservoirs**

The indigenous peoples of the Amazon lowlands do not have domestic animals that could serve as feeding sources for vectors or become reservoirs for the Chagas disease parasite. Indigenous populations may adopt wild animals and keep them in the village, but these animals do not reproduce in captivity, so triatomine domiciliation is not facilitated, and the vectors are not attracted by this food source in or around the dwelling.

#### **Abundant wild food sources**

Finally, but no less important, triatomines remained in their natural environment, and consequently Chagas disease remained as an enzootic, since vectors had an adequate habitat and abundant food sources in the jungle. The triatomine population remained stable, without growing, because of the equilibrium among these factors, favoring their subsistence and that of their predators<sup>31</sup>. If their food sources had become scarce, presumably the vectors would have turned to the human habitat as an alternative, and the factors described above (type of dwelling, mobility, and absence of domestic animals) would have been less capable of resisting vector pressure.

#### **New patterns of land occupation and globalization**

The new processes of occupation of the Amazon territory involve a variety of activities like highway construction, non-indigenous agriculture, cattle-raising, mining, and lumbering, all related to changes in global society and thus responding to the dynamics of outward growth, with cash crops and other commodities exported to the world market. The five patterns of land occupation listed below (as opposed to the indigenous pattern) can modify the Chagas disease profile.

##### **Agricultural pattern**

Agricultural settlement of the Amazon follows two modalities, namely subsistence and commercial agriculture. Subsistence farming employs the traditional slash-and-burn approach, cultivating a plot of land for some two years and then abandoning it and moving on to slash and burn another area. This modality allows grow-

ing crops like corn and bananas on small plots that are occupied by way of adverse possession, whose title can be claimed after five years, and which can then be sold to third parties. Although practiced on small plots, the impact of subsistence farming stems from its total magnitude, since an estimated 150,000 families relocated to the Brazilian Amazon alone from 1995 to 1998.

Commercial agriculture has a distinct mode of occupying the territory, since it requires large extensions of land for mechanized production, used mainly to grow soybeans. Soybean farming in the Amazon is a result of globalization, having benefited from: 1) scientific advances that allowed creating a variety that adapts to the wet subtropical climate and 2) the growth of the urban consumer market in China. Brazil exports 18% of its soybean crop to Asia, particularly China, which requires soybeans and other farm crops to meet the needs of its growing urban population, thus heavily characterizing soybean farming in the Brazilian State of Mato Grosso and in Bolivia.

##### **Cattle-raising pattern**

Initially, plots of land granted for cattle-raising were small and peasant-oriented, but preference was soon given to large cattle ranches, turning huge jungle areas into pasture. This was an effect of globalization, having been favored by the expansion of the beef export market from Brazil to Europe, due both to devaluation of the Brazilian currency and the foot-and-mouth epidemic in Europe, which stimulated beef importation from South America because of consumer fear. Brazil has the world's largest beef exports (with more than double those of Argentina). This growth has impacted not only the Amazon, but also countries like Colombia<sup>32</sup>, where it has become the greatest cause of deforestation (large stretches of land are occupied by huge cattle herds and a small human population, since cattle-raising employs very little labor).

##### **Mining pattern**

Mining in the Amazon region has two modalities<sup>33</sup>: (1) formal mining by large companies and (2) traditional production by its competitors in the informal and often illegal activity known as *garimpo*, including different variations on pan mining and wildcat mining<sup>34,35</sup>. Both are oriented towards the world market and depend on price trends for precious metals on the London, New York, and Tokyo exchanges. Mining has been incriminated with a much greater role in the environmental and social changes in the Amazon than it has actually had. Of course it has produced

an environmental impact mainly through contamination by the use of mercury in gold mining and has contributed to the increase in malaria in the Amazon, but its impact on the environment is considerably less than that of cattle raising or agriculture, and its impact on Chagas disease is limited, since it does not create stable human settlements because of the specific territorial mobility involved in this type of production.

### **Lumbering pattern**

The fifth pattern is lumbering. This mode of land occupation is presumed to be one of the most heavily regulated by law, but it is notoriously difficult to control. Short-term lumbering concessions granted in the Amazon region have proven extremely damaging, since they fail to stimulate reforestation by concessionaries. Extraction of the most commercially valuable hardwoods produces much greater damage, since it eliminates other smaller trees and surrounding vegetation and requires tractors to maneuver the large trunks, while affecting the soil by leaving it exposed to the sun. Such lumbering belongs to the world market dynamics, because the depletion of forest resources elsewhere in the world has impelled large companies from Indonesia and Malaysia to seek timber for export not only from Brazil, but also from other parts of the Amazon such as in Guyana and Surinam, where some 25% of the Amazon has been converted to lumbering by large multinational companies.

### **Urban pattern**

The last pattern involves the urban settlements, which have expanded, but which cannot be said to play a major role in territorial occupation. Cities in the Amazon serve as ports from which products are shipped abroad, but their size and magnetism for poor populations from the countryside do not play a major role (when displaced by large ranches or plantations, small farmers simply move elsewhere in the countryside). The pattern of occupation of the Amazon requires a "port city" located in or outside the region, and as such the East-West (Brazil-Peru) or so-called "Transoceanic" Highway has been proposed to connect São Paulo to Lima, providing an outlet through Peruvian ports on the Pacific for Brazilian exports to Asian markets, especially China.

Two aspects from the processes described above deserve emphasis. First, even though the processes appear similar (because they all produce deforestation), they are actually different because of the way in which the occupation takes place and the magnitude of the human popula-

tion that each requires and allows. Even in similar cases such as slash-and-burn farming, practiced both by indigenous peoples and poor farmers, the latter have a much greater environmental impact because of the far greater number of families involved.

Second, this is a process governed by global dynamics. The original idea of occupying the Amazon as a form of "inward development" no longer exists, although perhaps it was applicable until the 1970s. Other forces later came into play, and thus commercial agriculture and cattle raising clearly demonstrate that "outward development" now prevails in the Amazon, driven by globalization in the sense that external demand governs internal processes, making it more difficult to control such economic dynamics because of the revenue represented for populations, companies, and local and national governments.

### **New patterns of occupation and their impact on Chagas disease**

The above-mentioned modes of occupation of the Amazon have important consequences for Chagas disease transmission, since they are at the origins of new and traditional transmission modalities in the region<sup>36</sup>. Chagas transmission in the Amazon varies (oral, domiciliary vectorial without colonization, and extra-domiciliary vectorial), but all these forms are related to deforestation, human settlement, introduction of domestic animals, and changes in types of human dwellings that allow domiciliary transmission with colonization of the habitat.

### **Deforestation**

According to official Brazilian government figures, from August 2002 to August 2003, 25,151km<sup>2</sup> were deforested, with an additional 27,429km<sup>2</sup> in 2003-2004, so that a total area of 530,000km<sup>2</sup> has been deforested since 1978. This deforestation process is considered one of the important causes of the emergence of Chagas disease in the Amazon<sup>1</sup>. After losing their natural habitat and food sources, vectors are pressured to seek food sources both in the human habitat and in humans themselves.

### **Human settlements**

However, the search by vectors for alternative food sources among humans would be impossible without stable human populations, precisely the general process occurring at present. Indigenous communities have not settled in one place,

but have continued moving from place to place in search of fertile land and game, but hundreds of thousands of new immigrants have settled and remained sedentary (non-nomadic) in the region. The magnitude and density vary considerably from one pattern of land settlement to another, since the number of inhabitants living on subsistence farming is high, while it is limited in cattle-raising, and very sparse in lumbering, but all tend to be stable and demographically dense as compared to previous patterns of occupation, thus facilitating both vector domiciliation and transmission of Chagas disease related to certain agricultural activities (such as reported among *piassaba* palm harvest workers) <sup>37</sup>.

#### Domestic animals

Permanent human settlements also lead to the presence of domestic animals in dwellings and the peridomicile. Such animals can be used both as sources of food and company, and the birds, dogs, and cats that remain in the habitat constitute a food source that facilitates vector colonization of dwellings and a reservoir for the *Tr. cruzi* parasite.

#### Types of habitat

This process also changes the typology of housing to predominantly closed dwellings with building materials that favor vector domiciliation. The widespread poor farm dwellings in the Amazon differ very little from rural housing elsewhere in Colombia and Brazil or that which we have studied in Venezuela, with unfinished mud-and-wattle walls, dirt floors, and thatched palm roofs, constituting an ideal environment for Chagas vector colonization <sup>38</sup>. The various forms of indigenous dwellings may persist but are not adopted by immigrants, who are unfamiliar with the indigenous building technology or its sym-

bolic and cosmogonic meaning (which might otherwise justify the additional effort required for their construction). New rural dwellings in the Amazon become a risk factor rather than a source a protection against Chagas disease and tend to aggravate intra-domiciliary vectorial transmission <sup>39</sup>.

#### **Conclusions**

The factors that appear to have limited the presence of Chagas disease in the Amazon are changing, and at a face pace <sup>40</sup>. It thus appears plausible to hypothesize an increase in the disease incidence through a process similar to that which occurred several centuries ago in the Andes. At that time, the indigenous population deforested large jungle areas to install a permanent agricultural system, developed a sedentary (non-nomadic) society, and began raising small animals called *cuyes* (guinea pigs) for food, thus initiating the basis for Chagas vector domiciliation and transmission of the disease. The changes described above in the Amazon appear to point in a similar direction; thus, before too long (although it is difficult to predict exactly when), Chagas disease will likely become an important public health problem in the Amazon.

The Amazon could have a quite different development model, based not on mining, industry, or agribusiness, but on small-scale agro-forestry and silviculture <sup>41</sup>. However such a model has not occurred thus far, because both the domestic and foreign social forces now at work in the Amazon appear not to move in that direction, rather towards globalization of the Amazonian territory. Therefore, the tendencies observed since the 1980s will tend to increase and Chagas disease will spread further in the Amazon, even though none of the actors intended it so, as a perverse effect of globalization in the territorial occupation.

## Resumen

El incremento de casos autóctonos de la enfermedad de Chagas en la Amazonia a partir de los años setenta hace temer que pueda convertirse en un novedoso problema de salud pública en la región. Este cambio del patrón epidemiológico de la enfermedad en la región amazónica debe ser explicado por las transformaciones ambientales y sociales que han ocurrido en los pasados treinta años. Este artículo utiliza la teoría sociológica de los efectos perversos para explicar esos cambios como el resultado indeseado del cambio de modelo de desarrollo "hacia adentro", que había existido hasta los años setenta, por otro "hacia fuera" que está orientado por las fuerzas de la producción y el comercio internacional que conocemos como globalización. El artículo destaca que la implantación de cin-

co nuevos patrones de ocupación agrícola, ganadero, minería, madera y urbano que han generado cambios en el medio ambiente y el hábitat indígena tradicional y que han provocado corrientes migratorias, deforestación, sedentarización de la población, presencia de animales domésticos y modificaciones en el hábitat que facilitan la colonización de las viviendas por los vectores y la transmisión doméstica y laboral de la enfermedad. La expansión de la enfermedad de Chagas es un efecto perverso del proceso de globalización de la Amazonia.

*Enfermedad de Chagas; Enfermedades Transmisibles; Ecosistema Amazónico*

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Submitted on 04/Oct/2006

Approved on 07/Nov/2006