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Chagas disease in prehistory

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ABSTRACT

The classical hypothesis proposes that Chagas disease has been originated in the Andean region among prehistoric people when they started domesticating animals, changing to sedentary habits, and adopting agriculture. These changes in their way of life happened nearly 6,000 years ago. However, paleoparasitological data based on molecular tools showed that *Trypanosoma cruzi* infection and Chagas disease were commonly found both in South and North American prehistoric populations long before that time, suggesting that Chagas disease may be as old as the human presence in the American continent. The study of the origin and dispersion of *Trypanosoma cruzi* infection among prehistoric human populations may help in the comprehension of the clinical and epidemiological questions on Chagas disease that still remain unanswered.

Key words: ancient DNA, Chagas disease, mummies, paleoepidemiology, paleoparasitology, *Trypanosoma cruzi*.

Trypanosoma cruzi, the etiological agent of human Chagas disease, is an extremely puzzling parasite. Besides being a highly heterogeneous species (at least six well-defined subpopulations have been recognized), *Trypanosoma cruzi* is able to parasitize almost all tissues of its hundreds of mammal host species and be transmitted by dozens of triatomine vector species in almost all biomes ranging from Southern North America to Southern Argentina. Primarily infecting only wild mammals, an until now well-accepted theory proposed that *Trypanosoma cruzi* began to infect humans near 6,000 years ago, after the Andean population adopted sedentary habits. This was coincident with the domestication of guinea pigs (*Cavia* sp.), which started to be raised inside wood and clay dwellings of these ancient populations. Also, grain storage that started in those days attracted wild rodents nearby the human lodgings. Hematophagous triatomines were attracted by rodent and human blood during the Tiwanaku and Inca expansions, and Chagas disease become a consequence of a vector-reservoir-human host proximity (Dias and Coura 1997). Thenceforth, *Triatoma infestans*, the first triatomine species to be associated with human dwellings, dispersed to other parts of the American continent. The absence of *Trypanosoma cruzi* infection among Indian groups of the Brazilian lowlands was attributed to their nomad habits and the way their dwellings were built (Coimbra Jr. 1988).

This so-called classical theory on the origin of Chagas disease has been accepted and used to explain the introduction of *Triatoma infestans* only during colonial times, when precarious dwellings made of mud and daub were disseminated throughout Brazil and offered a suitable niche to which *Triatoma infestans* became very well adapted (Dias et al. 2000).

However, paleoparasitological data obtained by molecular tools (Aufderheide et al. 2004, Lima et al. 2008, Fernandes et al. 2008) changed the concept that

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Chagas disease was not prevalent among prehistoric nomad people in Brazil and other parts of the American continent, showing that the entrance of humans in the zoonotic transmission cycle of *Trypanosoma cruzi* probably started as soon as they arrived in the American continent (Araújo et al. 2009).

Trypanosoma cruzi INFECTION AMONG PREHISTORIC POPULATIONS

In 1984, one of us took part in a scientific mission to the archaeological excavations performed by the Foundation of Museu do Homem Americano, coordinated by Dr. Niéde Guidon in the archaeological region of the National Park of Serra da Capivara, Brazilian northeastern semiarid region. Archaeologists were observed to be constantly attacked by triatomines of the species *Triatoma brasiliensis* while working with rock art (Araújo et al. 2003). This species is considered a suitable vector for *Trypanosoma cruzi* (Costa et al. 2003). Therefore, we considered the possibility of Chagas disease transmission to have started with prehistoric artists and other inhabitants of caves and rock-shelters of the Brazilian Northeast, a site that displays the very first signs of human presence in the Americas, some of them dated from 26,000 years (Pessis and Guidon 2009). These observations led us to hypothesize that human infection by *Trypanosoma cruzi* and Chagas disease could be as old as the human presence in the region. However, there was no possibility to test our hypothesis in 1984, since 12,000 years-old bones were the oldest remains recovered (Guidon 1989, Guidon and Arnaud 1991). Histological studies should be performed, but there was no preserved soft tissue.

Soon thereafter, Chagas disease in the Andes was recorded by paleoparasitological studies performed with molecular biology techniques (Bastos et al. 1996, Guhl et al. 1999, Ferreira et al. 2000).

CHAGAS DISEASE IN ANDEAN PREHISTORIC POPULATIONS

The first studies performed in mummified bodies showed intestinal and heart lesions typical of Chagas disease (Rothhammer et al. 1985). Then, histopathological studies showed *Trypanosoma cruzi* amastigotes nests in cardiac fibers of mummified human remnants (Fornaciari et al. 1992). The recurrent recover of *Trypanosoma cruzi* DNA from mummified bodies confirmed high infection frequencies, and showed that both infection and disease occurred among Andean cultures in the past (Guhl et al. 1997, 1999, 2000, Ferreira et al. 2000, Madden et al. 2001). Therefore, paleoparasitological results at a first glance confirmed the classical theory of the Andean origin of human infection by *Trypanosoma cruzi* nearly 5,000 years ago.

MOLECULAR TOOLS CHANGED THE CLASSICAL THEORY

Reinhard et al. (2003) described a possible case of Chagas disease in a mummified body found in the border of Texas, USA, with the Coahuila state in Mexico, with intestinal visceral lesions suggesting a mega syndrome. The mummy was dated from 1,200 years, and PCR confirmed the presence of *Trypanosoma cruzi* DNA in it (Dittmar et al. 2003).

In South America, a partially mummified body was found in the central region of Brazil (until recently, highly endemic for Chagas disease) by the archaeological team coordinated by Dr. Andre Prous, from the Federal University of Minas Gerais (Kipnis 2008). The body was associated to a culture that lived 1,200 years ago. Not far from this archaeological site, another burial site was found dating 7,000 years. The mummy presented a fecal mass suggestive of Chagas disease megacolon, and PCR confirmed the presence of *Trypanosoma cruzi* DNA in it (Fernandes et al. 2008). Bone fragments of the older residues, dated from 7,000 years, resulted in positive PCR for *Trypanosoma cruzi* DNA (Lima et al. 2008). Chinchorro mummies of the Atacama desert, Chile, dated from 9,000 years, were positive for *Trypanosoma cruzi* by PCR (Aufderheide et al. 2004).

These findings show that Chagas disease was affecting prehistoric groups that lived or regularly occupied the caves and rock-shelters in the semi-arid zone of Central Brazil, and the border region of the United States and Mexico. The finding in Chinchorro mummies, dated from before the admitted period for the beginning of sedentarism and animal domestication, also changes the prevailing concept on the origin of Chagas disease.

Paleoparasitological data show that human infection by *Trypanosoma cruzi* and Chagas disease is as old as the human presence in the Americas, i.e., with at

least 7,000 years old. Furthermore, improving ancient DNA research will certainly unravel several aspects of ecology and evolution of *Trypanosoma cruzi* that are still in question, such as the origin, dispersion of the subpopulations of the parasite between hosts and regions, the different outcomes of human disease and the original host of the taxon.

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RESUMO

A hipótese clássica sobre a origem da doença de Chagas propõe que tenha surgido entre as populações pré-históricas dos Andes quando começaram a domesticar animais, mudaram para hábitos sedentários e adotaram a agricultura. Estas mudanças em seus hábitos de vida aconteceram há aproximadamente 6.000 anos. Entretanto, os dados da paleoparasitologia, baseados na biologia molecular, mostraram que a infecção por *Trypanosoma cruzi* e a doença de Chagas eram comuns tanto em populações pré-históricas da América do Sul e América do Norte muito antes deste período. De acordo com os dados paleoparasitológicos, a doença de Chagas pode ser tão antiga quanto a presença humana no continente americano. O estudo sobre a origem e dispersão da infecção por *Trypanosoma cruzi* entre populações humanas pré-históricas pode auxiliar na compreensão de questões clínicas e epidemiológicas sobre a doença de Chagas que ainda permanecem sem resposta.

Palavras-chave: ADN antigo, doença de Chagas, múmias, paleoepidemiologia, paleoparasitologia, *Trypanosoma cruzi*.

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