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REVIEW

SILENT EXPANSION: TRIATOMINES IN URBAN AND PERIURBAN ENVIRONMENTS OF THE AMAZON

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ABSTRACT

Chagas disease is caused by the protozoan *Trypanosoma cruzi*. The vectorial route remains the primary mode of transmission of this disease, with triatomine insects serving as the primary vectors. These insects are frequently reported in urban and periurban areas, particularly in the Amazon region. Therefore, this study aimed to identify triatomine species and their positivity for trypanosomatids in urban and periurban areas of the Brazilian Legal Amazon. This systematic review was conducted in five stages: hypothesis formulation, literature search, findings selection, data collection, and results synthesis. Genera *Rhodnius* and *Panstrongylus* were the most abundant, with *R. montenegrensis*, *R. pictipes*, *R. robustus*, and *P. geniculatus* being the most frequently reported species. *T. cruzi* infection rate varied within the following ranges: *R. robustus* (8% to 75%), *R. montenegrensis* (15% to 72%), and *R. pictipes* (5% to 68%). These three species were also reported to be infected by *T. rangeli*. *T. cruzi* infection rate in *P. geniculatus* ranged from 10.8% to 71.4%. Additionally, *Eratyrus mucronatus* was frequently reported intruding into households, mainly in peridomestic areas, with records of *T. cruzi* infection in this environment. One of the factors related to the occurrence of triatomines in urban areas was environmental degradation and the consequent scarcity of fauna, which drives these insects to artificial environments. Thus, the compilation of these data reinforces the importance of continuous monitoring of triatomines in urban and periurban areas, aiming for more effective control of both Chagas disease and its vectors.

KEY WORDS: Vectors; triatominae; *Trypanosoma cruzi*; vector-borne transmission; epidemiology.

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INTRODUCTION

Chagas disease (CD), also known as American trypanosomiasis, was initially considered an endemic zoonosis of the Americas but has become a global public health concern due to its increasing spread (Coura & Viñas, 2010). This disease is caused by the protozoan *Trypanosoma cruzi* and is primarily transmitted via insect vectors in endemic areas (Chagas, 1909). In recent decades, oral transmission (through contaminated food) has emerged as another significant route, being the most common in Brazil, especially in the Amazon (Malta et al., 2022). Malta et al. (2022) also mention that in the State of Pará, this transmission has increased by 96.3% in the last 20 years.

Other less common transmission pathways include laboratory accidents, blood transfusions, organ transplants, sexual transmission, and vertical transmission from mother to fetus (Coura, 2010; Sangenis et al., 2016; Araújo et al., 2017).

The global spread of CD has resulted in approximately six million infected individuals worldwide, with 70 million people living in at-risk areas (Brasil, 2021). Among the endemic countries, Brazil stands out, reporting an average of 4,000 deaths annually in recent years, with the Amazon region having the highest number of cases in the country (Brasil, 2021; Madeira et al., 2021). Between 2007 and 2018, 184 confirmed cases of acute CD were recorded in the western Brazilian Amazon (Acre, Amazonas, Rondônia, and Roraima). In 2023, only the State of Pará surpassed this data with 199 cases.

One of the key factors contributing to the high number of cases in the Amazon is the region's vast biodiversity and natural resources, which are continuously exploited by human activities, increasing the risk of disease emergence (Custódio et al., 2021). The Amazon harbors a diverse range of vector hosts capable of carrying various infectious agents, including *T. cruzi*. Triatomine bugs, through their contaminated feces and urine, can transmit CD to humans (Confalonieri, 2005; Yasuda, 2022).

Triatomines, the vectors responsible for transmitting CD, belong to the family Reduviidae and the subfamily Triatominae. They are distributed across 19 genera and 158 species worldwide, including three fossil species (Gil-Santana et al., 2022; Zhao et al., 2023; Campos et al., 2024; Oliveira-Correia et al., 2024; Paiva et al., 2025). In Brazil, 63 species are recorded, grouped into 11 genera (Galvão et al., 2024; Oliveira-Correia et al., 2024). In the Brazilian Amazon alone, nine genera and 38 species have been described, with *Rhodnius* Stål, 1859, and *Panstrongylus* Berg, 1879, being the primary vectors of CD in the region (Castro et al., 2018; Campos et al., 2024; Galvão et al., 2024). For decades, these insects were predominantly found in rural areas. However, their presence in urban environments has become increasingly frequent in recent years. This shift is driven by the search for food sources, attraction to artificial lights, and the need for new shelters due to the destruction of their natural habitats by human activity. Consequently, triatomines have shown the ability to adapt to domestic environments (Carrasco et al., 2014; Carbajal-de-la-Fuente et al., 2022).

Vector control remains the most effective strategy to combat CD transmission. Since the disease is often neglected and receives limited investment, treatment is only effective in early stages of infection, making vector control the most effective approach to reducing the incidence of trypanosomiasis (WHO, 2017). Although chemical control of triatomines has proven effective in significantly reducing autochthonous cases of CD, the widespread distribution of these vectors makes the complete interruption of transmission challenging. Studies have reported recolonization of domestic and peridomestic areas by triatomines even after control measures were implemented. Therefore, continuous and strict surveillance is essential to prevent reinfestation (Silveira & Dias, 2011; Depickére, 2012; Mota et al., 2022).

Some studies have reported the presence of triatomines in urban areas across the Americas, including several Brazilian States, with cases of colonization (Delgado et al., 2013; Carrasco et al., 2014; Silva et al., 2021; Carbajal-de-la-Fuente et al., 2022). In the Brazilian Legal Amazon, there are records of triatomine infestations in urban centers and isolated reports of household infestations (Ribeiro et al., 2019a; Mota et al., 2020; Cruz et al., 2023). However, to date, no comprehensive document has compiled these occurrences in the region to better understand the extent of these vectors in urban and peri-urban environments, as well as the phenomena driving this process.

To address this gap, this study aims to conduct a systematic literature review to identify the triatomine species and their positivity for trypanosomatids in urban and peri-urban areas of the Brazilian Amazon. Specifically, it seeks to answer the following questions: I. How is the occurrence of triatomines distributed in urban and peri-urban areas of the Brazilian Legal Amazon? II. Which triatomine species are most frequently found in households in this region? III. Were these triatomines found to be infected with *T. cruzi*?

MATERIAL AND METHODS

The systematic literature review was conducted based on the methodology proposed by Galvão & Pereira (2014). The hypothesis formulated aimed to understand the distribution of triatomine occurrence in urban and peri-urban areas of the Brazilian Amazon. The bibliographic search included articles published until July 2024, using the databases of the *Scientific Electronic Library Online* (SciELO), *National Institute of Health* (PubMed), *Virtual Health Library* (BVS), and Web Bib Tri V3.0, a virtual library containing documents on triatomines. The search terms used in combination were *Triatomine and*

Residence; Triatomine and Amazon; Triatomine and Acre; Triatomine and Amapá; Triatomine and Pará; Triatomine and Rondônia; Triatomine and Roraima; Triatomine and Tocantins; Triatomine and Mato Grosso; Triatomine and Amazonas and *Triatomine and Maranhão*. All descriptors were validated through the *Health Sciences Descriptors* (DeCS/MeSH) to maximize data retrieval on triatomines found in residences within the Brazilian Legal Amazon.

The number of articles retrieved from each database was Scielo: 556, Bvs: 661, Pubmed: 468, and Bib Tri: 12,166, totaling 13,851. In the selection of occurrences, only articles reporting the presence of triatomines in urbanized areas, such as residences, parks, and squares, as well as in nearby locations classified as peri-urban, were included. Peridomestic areas were also considered, given their proximity to households and their role in maintaining the *T. cruzi* transmission cycle.

After selection, 45 articles were used to construct the study's results, while additional scientific publications were referenced in the introduction and discussion sections. The extracted data were compiled into a table, along with two maps generated using *QGIS software* (QGIS Development Team), illustrating the geographic distribution of triatomine genera and species, respectively. The term "Brazilian Legal Amazon" was defined according to the territorial delimitation of the Legal Amazon States, which includes not only the northern States but also Mato Grosso and Maranhão. Although Maranhão is only partially included in the Legal Amazon region (Assad, 2016), for this study, the entire State was considered in the results.

The concepts of "urban" and "peri-urban" were defined based on the *Council of Europe - Glossary of Territorial Development* (2011), which characterizes urban areas as extensive built-up spaces with high population density, employment opportunities, and transport networks, while peri-urban areas represent transitional zones undergoing progressive urbanization, where human habitation plays a crucial role in this process.

RESULTS

The literature search identified 45 articles that met the selected research criteria, as outlined in the flowchart (Figure 1). Reports on the occurrence of triatomines in urban and periurban areas of the Amazon have increased over the past two decades, with the States of Acre and Rondônia accounting for a significant portion of these studies, totaling 19 publications. Table 1 presents the results on the occurrence of triatomines in urban and peri-urban areas of the states within the Brazilian Legal Amazon, as well as their positivity for *T. cruzi*. Additionally, a geographical mapping of the recorded occurrences was conducted to enhance the visualization of these findings by genus and species, as shown in Figures 2 and 3.

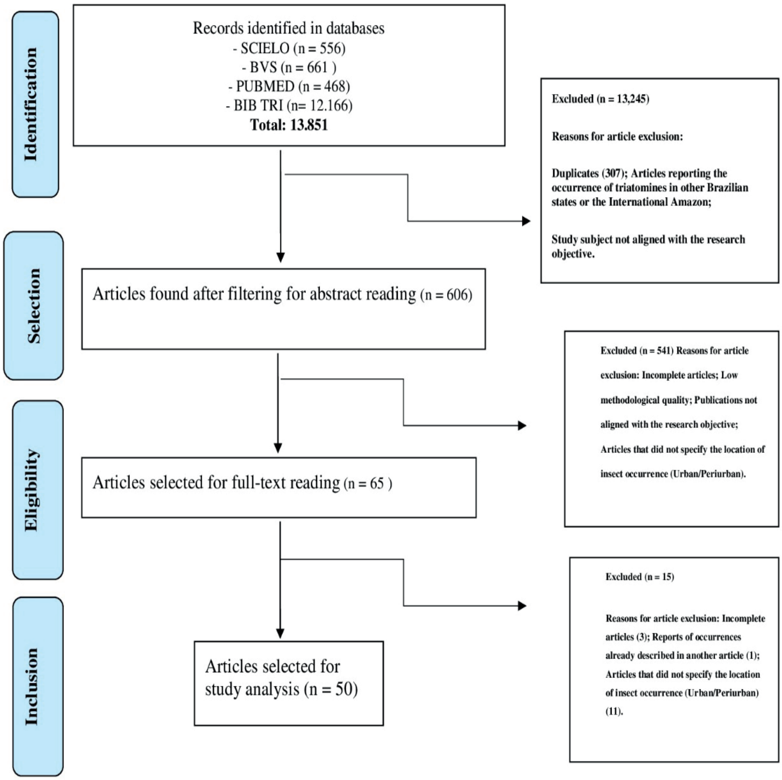

Figure 1. Flowchart of the article selection and inclusion process.

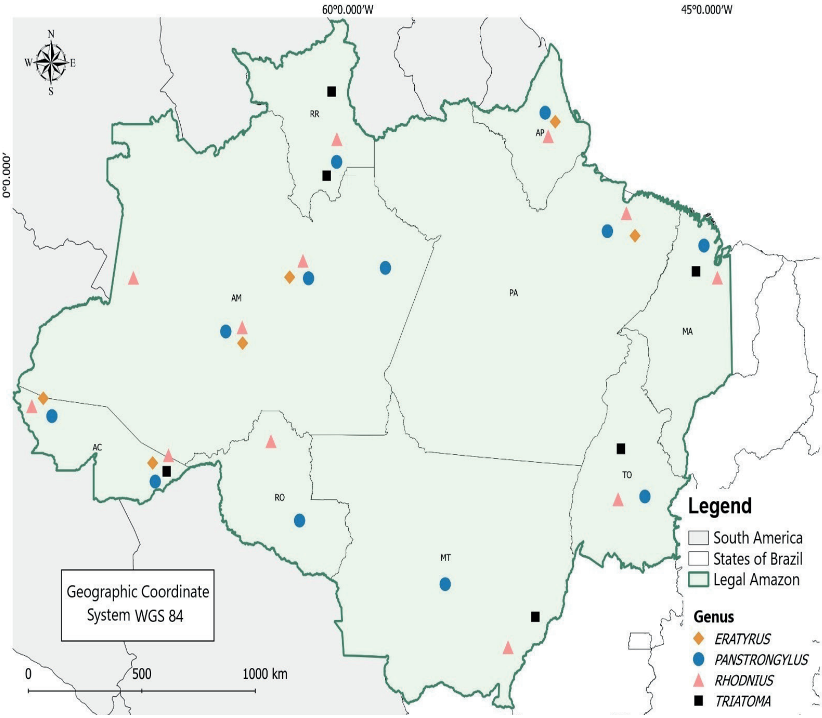

Figure 2. Map of the distribution of triatomine genera found in urban and peri-urban environments of the Brazilian Legal Amazon.

The genera *Rhodnius* and *Panstrongylus* showed the highest distribution of reported occurrences, with records of their presence inside households across all nine States of the studied area. The species *R. pictipes*, *R. robustus* and *R. montenegrensis* were the most frequently reported (Figure 3), with 29 studies documenting their occurrences, as shown in Table 1. These species were generally collected in residences and urban areas near forest fragments containing palm trees of the genus *Attalea* sp. and *Mauritia* sp. Atypically, *R. robustus* has also been collected inside healthcare facilities and penitentiaries. In addition to these frequently reported species, *R. stali*, *R. prolixus*, and *R. amazonicus* were recorded in smaller numbers.

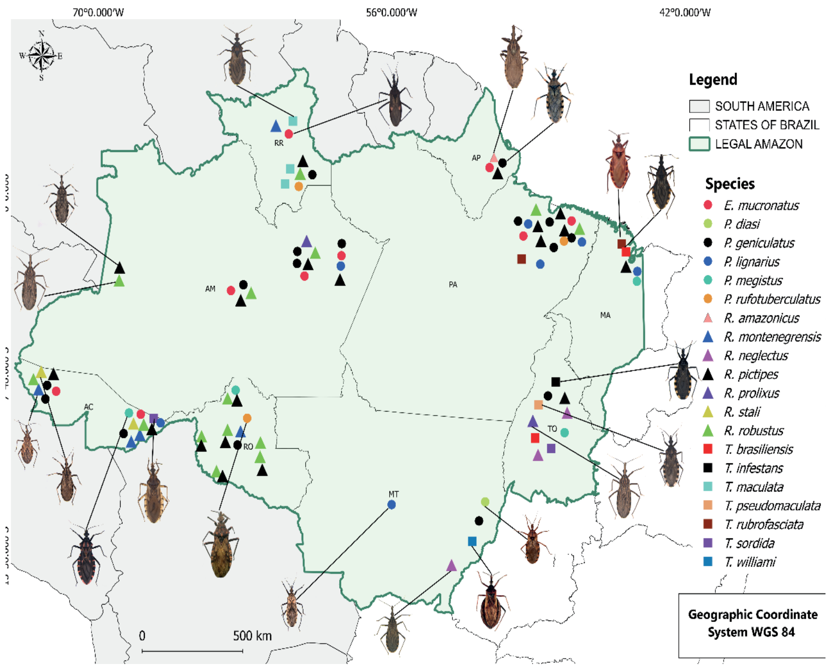

Figure 3. Distribution of triatomine species found in urban and peri-urban environments of the Brazilian Legal Amazon. Photos: *E. mucronatus*, *P. lignarius*, *P. megistus*, *R. amazonicus*, *R. stali*, *T. maculata* – Oliveira, J.; *T. sordida* – Paiva, V.F., Ambrozini, L.M., Pinotti, H.; *R. pictipes*, *R. prolixus* – Falcone, R., Nascimento, J.D., Triatominae Collection, Unesp Araraquara. Available at: https://www2.fcfar.unesp.br/#!/triatominae/. *P. rufotuberculatus* – Souza et al., 2022; *R. montenegrensis* – Rosa et al., 2012; *T. infestans* – Ricardo-Silva et al., 2016; *T. williami* – Martins et al., 2022; *P. diasi* – Martins et al., 2019.

Regarding *T. cruzi* infection rates, *R. robustus* exhibited rates ranging from 8% to 75%, *R. montenegrensis* from 15% to 72%, and *R. pictipes* from 5% to 68%. These three species were also reported as infected with *T. rangeli*. Additionally, some studies did not specify the species of the flagellated trypanosomatid detected. *Panstrongylus geniculatus* was the most frequently described species in urban and peri-urban areas, followed by *P. lignarius* and *P. megistus* (Table 1). *T. cruzi* infection rate was highest in *P. geniculatus*, ranging from 10.8% to 71.4%.

The most frequently reported Triatoma species were *T. williami*, *T. sordida*, and *T. maculata*. *Triatoma williami* and *T. maculata* are the only species confirmed to have domiciliation in the States of Mato Grosso and

Roraima, respectively, within the Brazilian Legal Amazon. *Triatoma williami* showed *T. cruzi* infection rates ranging from 30% to 43.6%, while no infection rates were reported for *T. maculata*. *Eratyrus mucronatus* also stood out in terms of occurrence, with 11 studies describing its intrusion in five of the studied States (Table). *T. cruzi* infection rate for this species ranged from 1.1% to 75% in areas near residences. Although some studies describe its presence inside houses, no confirmed trypanosomatid infection has been reported.

Table . Occurrence of triatomines in urban and/or periurban environments in the Brazilian Legal Amazon.

State	City	Location	Species	Trypanosomatid Infection Rate (%)	References
Acre	Cruzeiro do Sul, Boca do Moa	Periurban/ Domicile	*R. montenegrensis*, *E. mucronatus*. *R. stali*, *Rhodnius* spp. and *E. Mucronatus*	*R. montenegrensis**: 13,8%	Jesus et al., 2021
Acre	Rio Branco – Zona rural	Domicile	*R. montenegrensis*	*R. montenegrensis* **: 100%	Meneguetti et al., 2015
Acre	Rio Branco	Urban	*R. stali*	*R. stali**: 100%	Meneguetti et al., 2016
Acre	Cruzeiro do Sul	Domicile/ Peridomicile	*R. montenegrensis*, *Rhodnius* sp. *R. pictipes, R. stali*, *P. geniculatus* and *E. mucronatus*	Yes**: 9,1%	Moraes et al., 2021
Acre	Cruzeiro do Sul	Periurban	*R. montenegrensis*, *R. pictipes, Rhodnius* sp., *R. robustus* and *E. mucronatus*	*R. montenegrensis**: 28,6%; *R. pictipes**: 57,1%; *Rhodnius* sp.*: 18,7%; *E. mucronatus**: 50%	Moraes et al., 2020
Acre	Senador Guiomard	Peridomicile	*T. sordida*	*T. sordida**: 100%*	Ramos et al., 2018
Acre	Rio Branco	Domicile	*R. robustus*, *R. montenegrensis* and *P. geniculatus*	*R. robustus**: 25%; *R. montenegrensis****: 5.6%	Ribeiro et al., 2019a
Acre	Rio Branco	Domicile	*P. lignarius*	The information is not available.	Ribeiro et al., 2019b
Acre	Rio Branco	Domicile	*Rhodnius* sp., *Rhodnius robustus*, *Rhodnius pictipes*, *Panstrongylus geniculatus* and *Eratyrus mucronatus.*	Yes**: 28,13%	Ribeiro et al., 2021

Acre	Rio Branco	Domicile	*Rhodnius* sp. and *R. montenegrensis*	*R. montenegrensis* 26,3* and 47,4%**	Moura et al., 2024
Acre	Rio Branco and Cruzeiro do Sul	Domicile/ Peridomicile	*R. robustus* and *Rhodnius* sp.	*R. robustus* and *Rhodnius* sp.*: 57,14%	Vergara-Meza et al., 2022
Acre	Rio Branco	Urban/ Universidade	*R. stali*	*R. stali****: 100%	Castro et al., 2017
Acre	Rio Branco	Domicile	*E. mucronatus*	The information is not available.	Obara et al., 2013
Acre	Pláscido de Castro	Peridomicile	*R. robustus*	*R. robustus** 17,24%	Barata et al., 1988
Acre	Rio Branco and Cruzeiro do Sul	Urban	*R. robustus*, *Rhodnius* sp. and *P. geniculatus*	*R. robustus***: 100%; *P. geniculatus***: 50%	Cruz et al., 2023
Acre e Rondônia	Rio Branco and Porto Velho	Domicile	*P. megistus*	The information is not available.	Ribeiro Castro et al., 2018
Amapá	Porto Grande	Domicile	*R. amazonicus*, *P. geniculatus*, *R. pictipes* and *E. mucronatus*	The information is not available.	Galeno et al., 2023
Amazonas	Itacoatiara	Domicile/ Peridomicile	*E. mucronatus*, *P. geniculatus*, *P. lignarius* and *R. pictipes*	The information is not available.	Batista et al., 2019
Amazonas	Manaus	Urban/ Periurban	*R. pictipes*, *R. robustus* and *P.* geniculatus	*R. pictipes**: 5,9%; *R. robustu**: 8%	Fé et al., 2009a
Amazonas	São Paulo de Olivença	Domicile	*R. pictipes* and *R. robustus*	*R. pictipes* and *R. Robustus***: 100%	Fé et al., 2009b
Amazonas	Manaus, Coari	Urban/ Periurban	*R. robustus* and *R. pictipes*	*R. pictipes**: 26,5%, 26,3 and 100%; *R. robustus**: 32 and 60%	Magalhães et al., 2021
Amazonas	Manaus	Domicile	*R. prolixus, R. pictipes* and *P. geniculatus*	*P. geniculatus**: 90,4%; *R. prolixus**: 71,4%; *R. pictipes**: 68,9%.	Naiff et al., 1998

Amazonas	Manaus	Periurban	*R. robustus* and *R. pictipes*	Yes *	Miles et al., 1983
Maranhão	São Luís	Domicile/ Peridomicile	*R. pictipes*, *T. rubrofasciata* and *P. lignarius*	*R. pictipes**: 60%; *T. rubrofasciata***: 20%	Brazil & Silva, 1983
Maranhão	--	Domicile/ Peridomicile	*T. brasiliensis*	No	Costa et al., 2003
Maranhão	14 municipalities	Domicile/ Peridomicile	*P. megistus*	*P. megistus**: 1,1%	Rebêlo, 1999
Mato Grosso	Barra do Garça	Domicile	*T. williami*	*T. williami**: 30%	Andrade-Neto et al., 2012
Mato Grosso	Barra do Garça	Domicile	*T. williami*	*T. williami**: 30%	Arraias-Silva et al., 2011
Mato Grosso	Barra do Garça	Domicile	*P. diasi*	The information is not available.	Martins et al., 2019
Mato Grosso	Barra do Garça	Urban	*T. williami*, *P. geniculatus, P. diasi* and *R. neglectus*	*T. williami**: 43,6%; *P. geniculatus**: 33,3%; *R. neglectus**: 12,5%; *P. diasi**: 33,3%	Martins et al., 2022
Mato Grosso	Lucas do Rio Verde	Domicile	*P. lignarius*	The information is not available.	Paula et al., 2013
Pará	São Domingos do Capim	Domicile/ Peridomicile	*R. robustus*, *R. pictipes*, *P.geniculatus*, *E. mucronatus*, *P. lignarius* and *P. rufotuberculatus*	*R. robustus**: 71,4%; *P. geniculatus**: 71,4%; *R. picitpes**: 50%.; *P. lignarius*: 100%; *E. mucronatus**: 75%; *P. rufotuberculatus**: 100%.	Barros et al., 2021
Pará	Abaetetuba	Domicile	*R. pictipes* and *P. geniculatus*	The information is not available.	Mota et al., 2020
Pará	Muaná	Domicile/ Peridomicile	*P. genicutatus*, *R. pictipes*, *P. lignarius*, *R. robustus and E. mucronatus*	Yes**: 16,5%	Valente, 1999

Pará	Belém	Domicile	*P. geniculatus*, *P. lignarius*, *R. pictipes* and *T. rubrofasciata*	*P. geniculatus**: 25%; *R. pictipes**: 33,3%.	Lainson et al., 1979
Pará	Muaná	Domicile	*P. geniculatus*, *R. pictipes*, *P. lignarius* and *E. Mucronatus*	*P. geniculatus**: 17,4% and *R. pictipes**: 23,5.	Valente et al., 1998
Rondônia	Monte Negro	Periurban	*R. montenegrensis*	*R. montenegrensis*: 72,7%* and 9,1%***	Bilheiro et al., 2018
Rondônia	Alvorada D'Oeste, Buritis, costa Marques, Guajará Mirim, Pimenteiras do Oeste	Peridomicile	*R. robustus and R. pictipes*	*R. robustus*: 51,4%* and 47,2%***	Julião et al., 2021
Rondônia	Porto Velho	Peridomicile	R. robustus e R. pictipes	*R. robustus*: 7,4%*	Júnior; Cunha, 2016
Rondônia	Monte Negro	Domicile/ Peridomicile	*R. robustus* and *P. geniculatus*	*R. robustus* e *P. geniculatus* *: 23,7%	Massaro et al., 2008
Rondônia	Ouro Preto do Oeste	Domicile	*R. robustus*	*R. robustus*: 67%**	Meneguetti et al., 2011
Rondônia	Porto Velho	Domicile	*P. lignarius*	*P. lignarius***: 100%	Terassini et al., 2017
Rondônia	Rio Crespo	Domicile	*P. rufotuberculatus*	No	Rocha et al., 2021
Roraima	Rorainópolis	Domicile/ Peridomicile	*R. pictipes*, *R. robustus*, *T. maculata* and *P. geniculatus*	No	Luitgard-Moura et al., 2005
Roraima	Boa Vista	Domicile	*T. maculata*	Yes**	Ricardo-Silva et al., 2016
Roraima	Rorainópolis	Domicile	*P. rufotuberculatus*	The information is not available.	Souza et al., 2022
Roraima	São João da Baliza	Domicile	*E. mucronatus* and *R. montenegrensis*	The information is not available.	Gama-Neto et al., 2020

Tocantins	Some municipalities	Domicile	T. *sordida*, *T. infestans*, *R. neglectus*, *P. megistus*, *T. pseudomaculata*, *R. prolixus* and *T. brasiliensis*.	*T. infestans* 3,85%* and *T. sordida* 0,06%*	Silva et al.,1991
Tocantins	Some municipalities	Domicile	*R. pictipes*, *R.robustus*, *P. geniculatus* and *R. neglectus*	*R. pictipes**: 25,6%, *R. robustus**: 32,3%, *R. neglectus**: 13,1% and *P. geniculatus**: 10,8%.	Brito et al., 2017

*Positive for *T. cruzi*; **Unidentified trypanosomatid; ***Positive for *T. rangeli*.

DISCUSSION

Population migration and uncontrolled deforestation make the Amazon region vulnerable to the occurrence of CD, facilitating the invasion of triatomines into intra- and peridomestic areas and enabling their adaptation to these environments (Coura et al., 1999; Mota et al., 2022). According to the findings of this study, the genera *Rhodnius*, *Panstrongylus*, *Triatoma*, and *Eratyrus* are strongly associated with the invasion of triatomines in urbanized and peri-urban areas. Among these, the first three are considered of greater epidemiological importance in the transmission of CD (Fernandes & Costa, 2012).

Most of the species described in this study were confirmed to be infected with *T. cruzi*, both in households and peridomestic areas. Additionally, the results indicate that triatomines are present in urban areas in all States of the Brazilian Legal Amazon. However, reports of this invasion have intensified in recent decades, with the highest number of records in the States of Acre and Rondônia. A possible explanation for this phenomenon is the degradation of the natural habitat of these insects in these States, facilitating their displacement to areas with easy human access (Massaro et al., 2008; Ribeiro et al., 2021; Moura et al., 2024).

From this perspective, environmental changes may explain the predominance of *Rhodnius* genus among the triatomines recorded in this study. This genus has a wide distribution across Central and South America and is particularly associated with palm trees, which favors its adaptation to urban areas with forest fragments. In these areas, *Rhodnius* frequently invades homes, attracted by light and searching for food sources. This pattern is especially relevant in the Amazon, where there is a great diversity of native palm trees, considered the primary refuge for these species (Teixeira et al., 2001; Abad-Franch & Monteiro, 2007; Ribeiro et al., 2019a).

Rhodnius robustus, one of the most frequently reported species in homes and urban environments in the Brazilian Amazon, is considered an extra domestic vector of CD in Venezuela, as previous studies did not demonstrate its intrusion into households in that country (Feliciangeli et al., 2002). In contrast, *R. robustus* has been described in both intra- and peridomestic areas in Bolivia, where it was found to be infected with *T. cruzi* (Rojas-Cortez et al., 2016).

Rhodnius montenegrensis is a species found exclusively in the Amazon region, specifically in Brazil and Bolivia (Meneguetti et al., 2015; Madeira et al., 2020; Menezes et al., 2022). This species has demonstrated good adaptability to urban environments and a high infection rate for *T. cruzi*, making it an important vector of CD (Bilheiro et al., 2018; Jesus et al., 2019; Moares et al., 2021). Similar to the species mentioned earlier, *R. pictipes* has also been observed to easily invade urban and peri-urban areas (Rocha et al., 1997; Massaro et al., 2008; Barros et al., 2021). Furthermore, it has been found naturally infected with *T. cruzi*, *T. rangeli* and mixed infections (Otero et al., 1976; Magalhães et al., 2021).

Another *Rhodnius* species that stands out for its occurrence in domestic environments, though based on a single report, is *R. amazonicus*, due to its rare recorded occurrence (Galeno et al., 2023). Previously considered synonymous with *R. pictipes*, it has since been confirmed as a distinct species, with occurrences documented in the Brazilian Amazon alongside the others mentioned (Galvão, 2014; Galeno et al., 2023).

Dujardin et al. (1991) had already warned about frequent intrusions of *Rhodnius* genus into households in Brazil, which is now being confirmed. *Rhodnius pictipes*, *R. robustus*, and *R. montenegrensis* are the most frequently reported species invading homes in Brazilian Amazonian States, such as Acre (Meneguetti et al., 2015; Ribeiro et al., 2019a; Moraes et al., 2020; Jesus et al., 2021; Moraes et al., 2021; Ribeiro et al., 2021; Cruz et al., 2023), Amapá (Galeno et al., 2023), Amazonas (Fé et al., 2009a; Fé et al., 2009b; Magalhães et al., 2021), Pará (Barros et al., 2021), Rondônia (Massaro et al., 2008; Meneguetti et al., 2011; Julião et al., 2021) and Roraima (Gama-Neto et al., 2020). These species are almost always infected with *T. cruzi,* and some are also infected with *T. rangeli* (Fé et al., 2009b; Ribeiro et al., 2018; Julião et al., 2021; Magalhães et al., 2021).

Most reports of these species occur within the Brazilian Amazon, with no records of intrusions in other Brazilian States (Aguilar et al., 2007). In Bolivia and Venezuela, which comprise part of the international Amazon region, *Rhodnius* genus is considered of great epidemiological importance due to its proximity to human dwellings and high infection rates with *T. cruzi* (Fitzpatrick et al., 2009; Depickère et al., 2022). These findings regarding *Rhodnius* are concerning, as the high transmission rates of CD in recent decades have been primarily linked to this genus. This reinforces its role in maintaining the enzootic cycle of the disease (Barbosa et al., 2015; Bilheiro et al., 2019).

Panstrongylus genus also played a significant role in the findings, as its occurrence in urbanized and peri-urbanized areas, including inside homes, has been reported in all States of the Brazilian Amazon (Mota et al., 2020; Magalhães et al., 2021; Ribeiro et al., 2021; Martins et al., 2022; Galeno et al., 2023). In addition to its wide distribution across South America and Brazil, household invasions by this genus have been documented for over five decades. Some species within this genus are considered primary, secondary, and even tertiary vectors of CD (Lent & Jurberg, 1968; Santos et al., 2003).

Panstrongylus geniculatus has been found with confirmed *T. cruzi* infection in the States of Amazonas, Mato Grosso, Pará, Rondônia, and Tocantins. In Pará, the presence of eggs and nymphs of this species was reported in peridomestic areas (pig shelters) (Valente et al., 1998). In Paraná, in southern Brazil, this species has also been documented invading homes, an occurrence attributed to environmental factors by the authors (Silva et al., 2018). Additionally, home invasions by this species have been reported in Rio de Janeiro (Peixoto et al., 2020), demonstrating that the occurrence of *P. geniculatus* is not restricted to the Brazilian Amazon.

In neighboring countries such as Colombia, Venezuela, and Bolivia, colonies of this species have been reported in intradomiciliary environments (domiciliation), with *T. cruzi* infection confirmed in all studies (Wolff & Castillo, 2000; Reyes-Lugo & Rodríguez, 2000; Reyes-Lugo, 2009; Depickère et al., 2012). In Brazil, *P. geniculatus* has also been reported to invade a church in Acre (Cruz et al., 2023) and urban areas of a major metropolis, such as São Paulo (Cerretti-Junior et al., 2018). Furthermore, a recent study confirmed an acute CD case transmitted by *P. geniculatus* in Rondônia, highlighting, along with our results, the importance of this species in CD transmission (Julião et al., 2022).

The species *P. lignarius* has been reported in homes in five States of the Brazilian Amazon, with one study in Pará confirming *T. cruzi* infection (Barros et al., 2021). These are the only recorded domestic reports in Brazil; however, in Peru, where this species was previously known as *P. herreri*, it is considered the second most epidemiologically important species in the country, with the highest rate of domiciliation among its congeners (Marcilla et al., 2002).

Panstrongylus megistus is considered an important vector of CD in Brazil due to its high susceptibility to *T. cruzi* (Villela et al., 2010; Ferreira et al., 2021). Intradomiciliary and peridomiciliary colonization of this species has already been documented (Forattini et al., 1977; Forattini et al., 1982; Ramos et al., 2008; Silva et al., 2021). In Rio Grande do Sul, for example, this species is widely distributed, with numerous reports of home invasion and a high rate of *T. cruzi* positivity (Mello et al., 2023). However, in the Amazon region, reports of *P. megistus* remain scarce, and its behavior and distribution in this area are still poorly understood (Silva et al., 1991; Rebêlo, 1999; Castro et al., 2018).

The genus *Triatoma* has the highest number of described species within the Triatominae and is considered the most epidemiologically relevant genus in Brazil. However, in the Amazon region, it does not hold the same prominence as in other Brazilian regions (Silveira, 2000). The species *T. sordida* was found in peridomestic environments in the State of Acre, with confirmed *T. cruzi* infection (Ramos et al., 2018; Ribeiro et al., 2021). This species is the most frequently captured triatomine in peridomestic areas of the Cerrado biome (Galvão, 2014). Despite its widespread distribution across Brazil and its occurrence in various biomes, such as the Amazon, Pantanal, Atlantic Forest, and Caatinga, its ornithophilic behavior, with occupation in trees and bromeliads, as well as its habitat preference for peridomestic areas, considerably reduces its potential for *T. cruzi* transmission (Gurgel-Gonçalves et al., 2012). Conversely, *T. sordida* exhibits domiciliation behavior, characterized by high infestation and *T. cruzi* positivity, in residences in Bolivia, a neighboring country to Acre (Noireau et al., 1997).

Although not traditionally considered an important vector of CD, *T. williami* has been increasingly found in domestic environments in Mato Grosso, with natural *T. cruzi* infection (Arraias-Silva et al., 2011; Andrade Neto et al., 2012; Martins et al., 2019; Martins et al., 2022). Beyond this State, the species is also found in Mato Grosso do Sul and Goiás, where it was first described (Galvão et al., 1965; Martins et al., 2022).

Martins et al. (2022) confirmed the domiciliation process of *T. williami* in Barra do Garças, Mato Grosso, where adults and nymphs were found inside a residence near an environmental area with the presence of wild animals (reservoirs of *T. cruzi*). This suggests that anthropogenic activities may have facilitated this domiciliation process, as home invasions could have been influenced by the attraction to artificial light and the search for food sources, behaviors already observed in most CD vector species (Forattini et al., 1980; Júnior & Cunha, 2016). The domiciliation records of *T. williami* are concerning due to the high *T. cruzi* infection rates consistently reported in Mato Grosso (Arraias-Silva et al., 2011; Andrade Neto et al., 2012; Martins et al., 2019 and 2022).

Other species that deserve to be highlighted are *T. brasiliensis* and *T. pseudomaculata*, since in the Northeast they are found feeding on human blood (Honorato et al., 2021; Silva et al., 2024).

The most significant case of domiciliation in the Brazilian Amazon region involves the species *T. maculata*, which has been found colonizing an air conditioning unit in the State of Roraima, an unlikely site for infestation by these insects (Ricardo-Silva et al., 2016). This is because the species is commonly found in bird nests and peridomestic structures such as chicken coops and cattle sheds (Lent & Wygodzinsky, 1979). This discovery has raised urgent concerns about the risk of new cases of triatomine domiciliation in the Brazilian Legal Amazon, as the proximity of the vector to humans could facilitate the establishment of CD in urban areas (Ricardo-Silva et al., 2016).

The species *E. mucronatus* is not yet considered epidemiologically significant in Brazil, despite its reported occurrence in domestic and peridomestic environments in the States of Acre, Amazonas, Pará and Roraima. However, *T. cruzi* infection has only been detected in specimens from Acre and Amazonas (Valente et al., 1998; Valente et al., 1999; Gama-Neto et al., 2020; Moraes et al., 2020; Jesus et al., 2021; Magalhães et al., 2021; Moraes et al., 2021; Ribeiro et al., 2021).

Although *E. mucronatus* is considered a sylvatic species, typically inhabiting caves and hollow trees, specimens have been found in households in neighboring countries such as Bolivia, Colombia, Venezuela, and Peru (Molina et al., 2000; Vivas et al., 2001; Torres & Cabrera, 2010). In Bolivia, domiciliation has even been observed in a region under insecticide control (Depickère et al., 2012).

It has been noted that many studies did not conduct *T. cruzi* positivity diagnostics on collected triatomines. This is primarily because these insects often arrive at Entomological Surveillance units already dead and dehydrated. Therefore, One Health education is essential to ensure proper handling of these insects, including capturing them alive and promptly delivering them to Entomological Surveillance services. Since the collection is usually carried out by residents of the affected areas (Rosenthal et al., 2020; Moura et al., 2024), proper handling would enable the acquisition of accurate data regarding *T. cruzi* positivity.

Furthermore, despite the originality of the data compared to existing literature, these findings may not fully represent the reality of each State in the Brazilian Amazon. Regarding the occurrence of triatomines in urban and peri-urban environments, some States may have higher numbers than those reported in studies. In Acre and Rondônia, for instance, the literature contains more records of triatomine occurrences in urban and peri-urban areas. However, this does not necessarily mean that these two States have the highest incidence. A contributing factor may be the engagement of research teams conducting active searches for these insects in the region, highlighting the importance of funding and incentives for research in this field.

It was possible to demonstrate that the occurrence of triatomines in urban and peri-urban areas of the Brazilian Amazon is more frequently associated with species of the genus *Rhodnius* (notably *R. pictipes*, *R. robustus*, and *R. montenegrensis*) and *Panstrongylus* (primarily *P. geniculatus*). All these species exhibited high infection rates with *T. cruzi*. In contrast, regarding domiciliation, the genus *Triatoma* (especially *T. williami* and *T. maculata*) demonstrates greater potential for adaptation to human dwellings.

This study also revealed that records of triatomine occurrence in areas near human contact have increased in recent decades, including species still considered sylvatic, such as *E. mucronatus*. These findings reinforce the importance of continuous monitoring of these insects in urban and peri-urban areas, as well as active community participation through health education strategies. Such efforts are crucial for more effective vector and disease control, particularly in States where research in this field remains scarce.

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CONFLICT OF INTEREST

The authors declare that they have no conflicts of to disclose.

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