



Entomological investigation of triatomine fauna in rural communities in the state of Piauí, Brazilian semi-arid region

Investigação entomológica da fauna triatomínica em comunidades rurais no estado do Piauí, região semiárida brasileira

Investigación entomológica de fauna triatomínica en comunidades rurales del estado de Piauí, región semiárida de Brasil

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ABSTRACT

Objective: To describe the characteristics and distribution of triatomine fauna in rural communities of Simplício Mendes municipality, located in the state of Piauí, Brazilian semi-arid region. **Methods:** This is a cross-sectional study and entomological survey conducted from 2022 to 2023. Insects were captured using active search method in all human dwellings, which were georeferenced, followed by characterized of species, sex, developmental stage, and identification of presence of infection by trypanosomatids. **Results:** All households (n=178) in 10 rural localities of the municipality were investigated, resulting in a household triatomine infestation rate of 14%. A total of 268 insects were collected, predominantly species from the *Triatoma brasiliensis* complex (n=190), immature developmental stage (n=172), and originating from peridomestic environments (n=250). The rate of triatomines with natural infection by *Trypanosoma cruzi* was 1.1%. **Conclusion:** The finding of infestation by species from the *T. brasiliensis* complex with higher concentration cohabiting extradomestic spaces, wide dispersion, and presence of natural infection by *T. cruzi* signals conditions for the maintenance of vector-borne transmission of Chagas disease in the municipality.

Keywords: Chagas Disease, Triatomines, Vector Insects, Health Surveillance.

RESUMO

Objetivo: Descrever as características e distribuição da fauna triatomínica em comunidades rurais do município Simplício Mendes, localizado no estado do Piauí, região semiárida brasileira. **Métodos:** Trata-se de um estudo transversal e inquérito entomológico realizado no período de 2022 a 2023. Os insetos foram capturados pelo método de busca ativa em todas residências humanas, que foram georreferenciadas, seguida da caracterização das espécies, sexo, estágio de desenvolvimento e identificação da presença de infecção

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por tripanossomatídeos. **Resultados:** Todos os domicílios (n=178) de 10 localidades rurais do município foram investigados, resultando em uma taxa de infestação triatomínea domiciliar de 14%. Foram coletados 268 insetos com predominância para espécies do complexo *Triatoma brasiliensis* (n=190), estágio imaturos de desenvolvimento (n=172) e oriundos de ambientes peridomésticos (n=250). A taxa de triatomíneos com infecção natural por *Trypanosoma cruzi* foi de 1,1 %. **Conclusão:** A constatação de infestação de espécies do complexo *T. brasiliensis* com maior concentração coabitando os espaços extradomiciliares, ampla dispersão e presença de infecção natural por *T. cruzi* sinaliza condições para a manutenção da transmissão vetorial da doença de Chagas no município.

Palavras-chave: Doença de Chagas, Triatomíneos, Insetos Vetores, Vigilância em Saúde.

RESUMEN

Objetivo: Describir las características y distribución de la fauna triatomínica en comunidades rurales del municipio de Simplício Mendes, ubicado en el estado de Piauí, región semiárida de Brasil. **Métodos:** Este es un estudio transversal y una encuesta entomológica realizada desde 2022 hasta 2023. Los insectos fueron capturados utilizando el método de búsqueda activa en todas las viviendas humanas, las cuales fueron georreferenciadas, seguido de la caracterización de las especies, sexo, etapa de desarrollo e identificación de presencia de infección por tripanosomatídeos. **Resultados:** Se investigaron todas las viviendas (n=178) en 10 localidades rurales del municipio, lo que resultó en una tasa de infestación triatomínica domiciliar del 14%. Se recolectaron 268 insectos, predominando las especies del complejo *Triatoma brasiliensis* (n=190), en etapas inmaduras de desarrollo (n=172) y provenientes de entornos peridomésticos (n=250). La tasa de triatomíneos con infección natural por *Trypanosoma cruzi* fue del 1,1%. **Conclusión:** La constatación de infestación por especies del complejo *T. brasiliensis* con mayor concentración cohabitando espacios extradomésticos, amplia dispersión y presencia de infección natural por *T. cruzi* señala condiciones para el mantenimiento de la transmisión vectorial de la enfermedad de Chagas en el municipio.

Palabras clave: Enfermedad de Chagas, Triatomíneos, Insectos Vectores, Vigilancia en Salud.

INTRODUCTION

Chagas Disease (CD), also known as American Trypanosomiasis, was first described in 1909 by the Brazilian physician and sanitary scientist Carlos Chagas (KROPF SP e LIMA NT, 2021; PINTO JCT, et al., 2023). It is a systemic infection, endemic in nature, and of chronic evolution, caused by the flagellated protozoan *Trypanosoma cruzi*, whose natural vectors are insects commonly known in Brazil as "kissing bugs." These insects belong to the order Hemiptera, family Reduviidae, and subfamily Triatominae (GUHL F e RAMÍREZ JD, 2021; ROCHA BC, et al., 2023).

Based on its morphological characteristics, the subfamily Triatominae is distributed across 18 genera and five tribes, with 160 described species, predominantly in the neotropical region. They can also be found non-endemically in the United States, Southeast Asia, central-southern Africa, and northern Australia (ALEVI KCC, et al., 2021; DALE C, et al., 2021; GALVÃO C, 2021; ZHAO Y, et al., 2023). These vectors are widely distributed across the national territory, with records of 65 species in Brazil. Among the species that represent the greatest risk for vector transmission are *Triatoma sordida*, *Panstrongylus megistus*, *Triatoma brasiliensis*, and *Triatoma pseudomaculata*. (SILVA MBA, et al., 2021).

These and other species of triatomines have adapted to highly diverse ecoregions, ranging from tropical forests to deserts. Within these ecoregions, the insects associate with their vertebrate hosts in equally diverse microhabitats, such as shelters, tree canopies, burrows, and nests of warm-blooded animals such as marsupials, edentates, rodents, carnivores, bats, birds, reptiles, and amphibians. Some populations of triatomines can also explore artificial habitats, where they feed on the blood of humans and domestic animals, becoming the main vectors of CD (MAGALHÃES L, et al., 2021; RIBEIRO, et al., 2019).

Although Brazil maintains a consistent operation of surveillance, control, and combat against the main vectors of *T. cruzi*, the risk of disease transmission persists due to factors such as low living conditions of the

population, presence of triatomines in peri- and intradomicile settings, and the involvement of secondary species in disease transmission. Considering this scenario, CD is listed by the World Health Organization (WHO) as one of the 20 neglected tropical diseases. According to the WHO, it is estimated that 6 to 8 million people are infected with *T. cruzi*, and approximately 12 to 14 thousand deaths are reported each year, of which 4.5 thousand occur in Brazil. Furthermore, more than 70 million individuals live in areas with constant risk of transmission (OCHOA-DIAZ MM, et al., 2024; SANGENITO LS, et al., 2020).

In this context, the Brazilian Northeast region stands out regarding rates of dispersion, household infestation, colonization, natural infection, anthropophily, and number of captures of the species *T. brasiliensis*, *T. pseudomaculata*, and *P. megistus*. Additionally, the species *T. brasiliensis* and *T. pseudomaculata* are found in all northeastern states, being a concern for entomological surveillance due to their widespread distribution and difficult control (BARRETO MAF, et al., 2019; MATOS DF, et al., 2023).

Located in the Northeast region, the state of Piauí is characterized as an endemic territory for CD, with a seropositivity rate of 1.9% according to a study conducted in 2002 in rural areas throughout the state. The highest infection rates occurred in the municipalities of Cajazeiras do Piauí (10.8%), Capitão Gervásio de Oliveira (11.5%), Campinas do Piauí (11.5%), and São João do Piauí (11.6%), municipalities situated in the semiarid region of Brazil (FERREIRA ALS, et al., 2020).

According to an entomological survey conducted in the state of Piauí, the existence of 11 species of triatomines was verified. Among them, the most representative species in peridomestic and intra-domiciliary environments is *T. brasiliensis*, which is frequently found infected with *T. cruzi* (GURGEL-GONÇALVES R, et al., 2010). Another recent study revealed high rates of CD seroprevalence among adults and elderly individuals in the state, indicating a historical presence of vector-borne transmission in the area (SANTOS JP, et al., 2020).

Given the high densities of triatomine species found in the state of Piauí, the aim of this study was to describe the characteristics and distribution of triatomine fauna in rural communities of Simplício Mendes municipality, located in the state of Piauí, Brazilian semiarid region.

METHODS

Methodological design and description of the study area:

The design of this study is a cross-sectional entomological survey, which describes the characteristics of the triatomine fauna found in rural communities of Simplício Mendes municipality (latitude 07°51'14" south and longitude 41°54'37" west, at an altitude of 302 meters), located in the southeastern region of the state of Piauí.

Simplício Mendes is situated in the Brazilian semiarid region, an area that extends across the nine states of the Northeast region and into the north of Minas Gerais, covering 12% of the national territory and housing approximately 28 million inhabitants, divided between urban areas (62%) and rural areas (38%). Therefore, it is one of the most densely populated semiarid regions in the world.

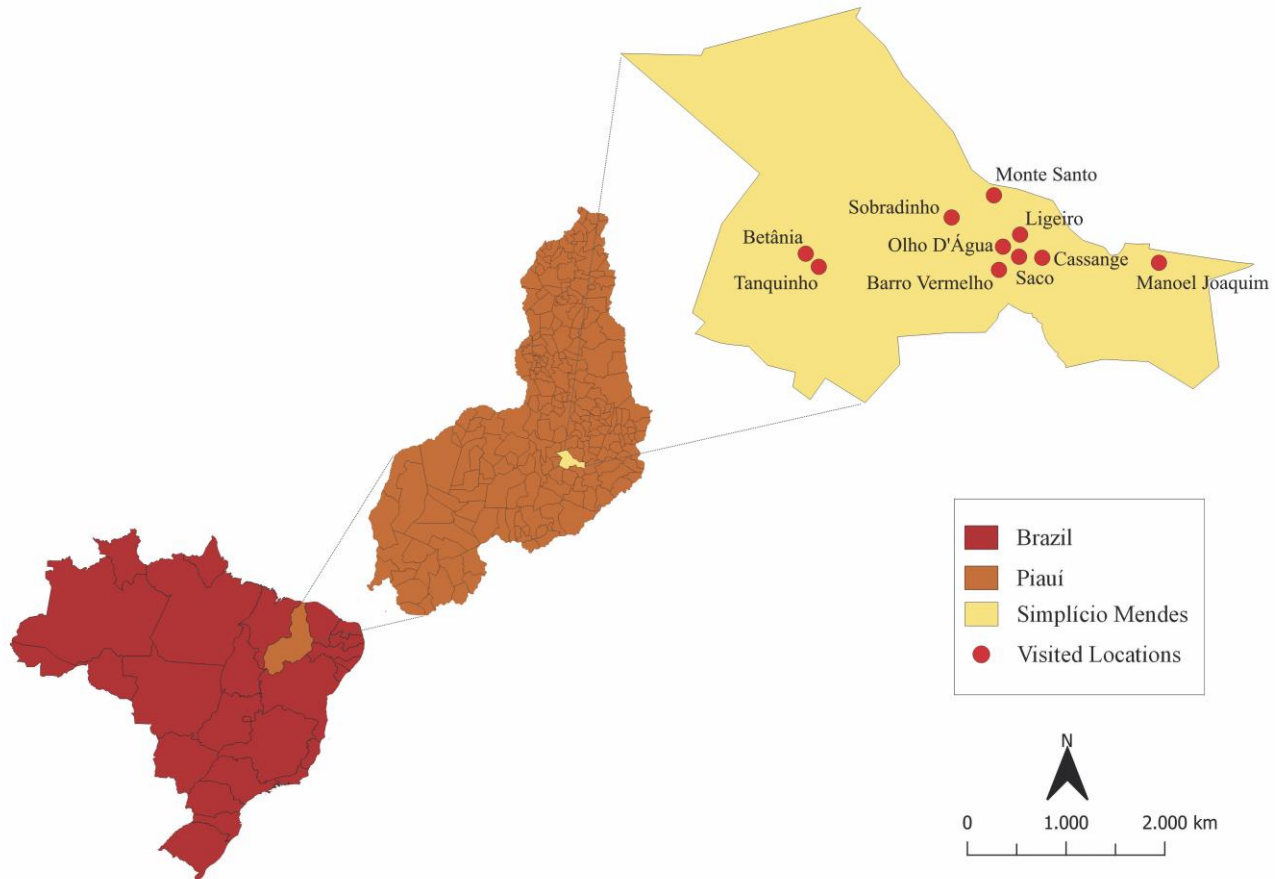
This municipality has a population of 13,870 inhabitants and is characterized by a semi-arid tropical climate, where high temperatures prevail throughout the year, accompanied by a rainy season concentrated in the warmer months (August to November). In this setting, the vegetation displays the typical resilience of the Caatinga biome, with thorny trees, shrubs, and plants adapted to the characteristic water scarcity of the region.

The topography ranges from flat to gently undulating terrain, with mountainous areas or hills punctuating the landscape, influencing both the runoff of rainwater and the distribution of local vegetation. The distribution of inhabitants in Simplício Mendes tends to be predominantly urban, but a significant portion of the population resides in areas outside urban centers, working mainly in agricultural, livestock, or subsistence-related activities.

In these rural areas, the localities of Barro Vermelho, Betânia, Cassange, Ligeiro, Manoel Joaquim, Monte Santo, Olho d'água, Saco, Sobradinho, and Tanquinho were investigated during the period from 2022 to 2023. These communities were pre-selected due to frequent notifications of triatomine infestation, according to the most recent records of local entomological surveillance. Both positive and negative ecotopes were

georeferenced using the Garmin™ Legend GPS system, to study the spatial distribution of CD vectors in the southeastern region of the state of Piauí (Figure 1).

Figure 1 - Distribution of collection points for captured triatomines in the municipality of Simplicio Mendes, Piauí, Brazil, between 2022 and 2023.



Note: The map was constructed using QGIS software version 3.32.0 and laid out using CorelDRAW Graphics Suite 2024 software. **Source:** Cardoso DRF, et al., 2024.

Capture of triatomines:

The insects were sought using the active search method in human residences, with the collaboration of municipal Endemic Disease Control Agents. This search covered all rooms of the houses, as well as peridomestic structures such as chicken coops, pigsties, and areas where there is a pile-up of tiles, bricks, stones, and fences, among other elements (Figure 2 - A). In cases of identification of peridomestic or household infestation, immediate control intervention occurred, using insecticides.

Insect identification:

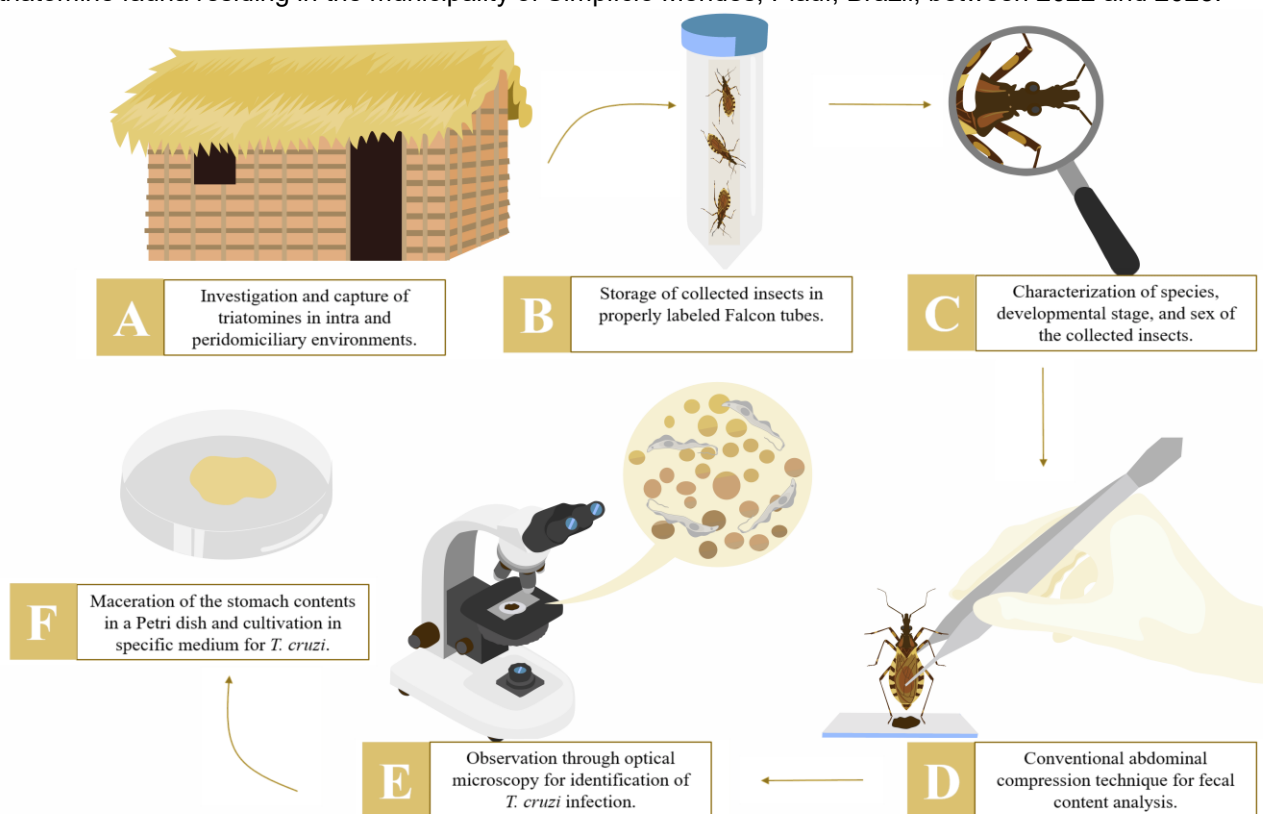
The captured triatomines were transported to the laboratory in properly labeled containers according to their locality and intra- and peridomestic environments (Figure 2 - B) and evaluated using a dichotomous key recommended by Jurberg J, et al. (2014) for species characterization, sex, and developmental stage (Figure 2 - C).

Identification of the presence of infection by trypanosomatids in the triatomines:

For the identification of the presence of trypanosomatid infection, the triatomines had their intestinal contents analyzed using the conventional technique of parasitological examination of feces with abdominal compression (Figure 2 - D) and observation under an optical microscope (Figure 2 - E).

Next, the stomach contents were removed and subsequently macerated on a sterile Petri dish containing 2.0 mL of saline solution (0.85% NaCl) with 5-fluorocytosine. The final solution was observed freshly between a slide and a coverslip under an optical microscope and distributed into tubes containing NNN with liquid phase LIT medium for trypanosomal growth (**Figure 2 - F**). The cultures were monitored for 30-40 days to assess and confirm the presence of parasites.

Figure 2 – Methodological process for the development of the entomological investigation study of the triatomine fauna residing in the municipality of Simplicio Mendes, Piauí, Brazil, between 2022 and 2023.



Note: The layout was developed using CorelDRAW Graphics Suite 2024 software.

Source: Cardoso DRF, et al., 2024.

Data selection and analysis:

Firstly, the triatomines captured during the study period (2022-2023) were selected. Subsequently, the insects were categorized and quantified according to the following variables: triatomine infestation rate per household (houses with triatomines/total houses evaluated x 100), rate of triatomines positive for *T. cruzi* infection (number of positive triatomines/total triatomines examined x 100), number of species, developmental stage, and sex of triatomines according to the type of environment where the insect was captured, and GPS point.

The data were stored in Microsoft Office Professional Plus Excel 2019 software, tabulated, and analyzed using R software version 4.3.1 with standard descriptive statistical procedures such as absolute frequency distribution (n) and relative frequency (%) distribution. The maps were constructed using QGIS software version 3.32.0, and the layout was designed using CorelDRAW Graphics Suite 2024 software.

Ethical considerations:

The present study was submitted for ethical considerations through the Brazil Platform to the Human Research Ethics Committee in Humans of the Oswaldo Cruz Institute (IOC/FIOCRUZ), being approved with registration number CAEE No. 89970718.7.0000.5248 and evaluation No. 2,940,155.

RESULTS

During the field expeditions, all households in each locality were investigated through active searches for triatomines, both indoors and in the peridomestic environment. Thus, 178 residences were surveyed, and insects' vectors of CD were captured in 25 of them, resulting in a household triatomine infestation rate of 14%, as evidenced in **Table 1**. Additionally, *T. brasiliensis* species were identified in the intra (n=18) and peridomestic (n=172) environments, and *T. pseudomaculata* species were only identified in peridomestic areas (n=78). The localities of Manoel Joaquim and Monte Santo presented higher rates of triatomine infestation, with 66.6% and Cassange was the only community that did not have any triatomine capture in any of the investigated households.

Table 1 - Triatomine infestation rate per household and distribution of identified species by rural locality in the municipality of Simplício Mendes - PI.

Places	Triatomine infestation rate per household, n/N (%)	Triatomine species collected			
		<i>T. brasiliensis</i>		<i>T. pseudomaculata</i>	
		Intra	Peri	Intra	Peri
Barro Vermelho	1/8 (12.5%)	0	39	0	0
Betânia	5/21 (23.8%)	9	1	0	27
Cassange	0/48 (0 %)	0	0	0	0
Ligeiro	4/24 (16.6%)	1	8	0	4
Manoel Joaquim	2/3 (66.6%)	2	11	0	2
Monte Santo	2/3 (66.6%)	2	8	0	25
Olho d'água	2/4 (50%)	0	43	0	0
Saco	3/8 (37.5%)	1	4	0	0
Sobradinho	4/51 (7.8%)	3	24	0	20
Tanquinho	2/8 (25%)	0	34	0	0
Total	25/178 (14%)	18	172	0	78

Legend: n: Sample number of homes positive for triatomine infestation. N: Total number of residences investigated. %: Household rate of triatomine infestation. Intra: Intradomicile. Peri: Peridomicile. **Source:** Cardoso DRF, et al., 2024.

A total of 268 insects were collected, 172 nymphs of different developmental stages and 96 adults captured inside households and in peridomestic areas with a predominance of species from the *T. brasiliensis* complex (n=190). Among the adult vectors, 41 males and 55 females were identified. All captured insects were evaluated for the presence of natural infection by *T. cruzi*. Of these, 2 nymphs and 1 adult male from the peridomestic environment tested positive, as shown in **Table 2**.

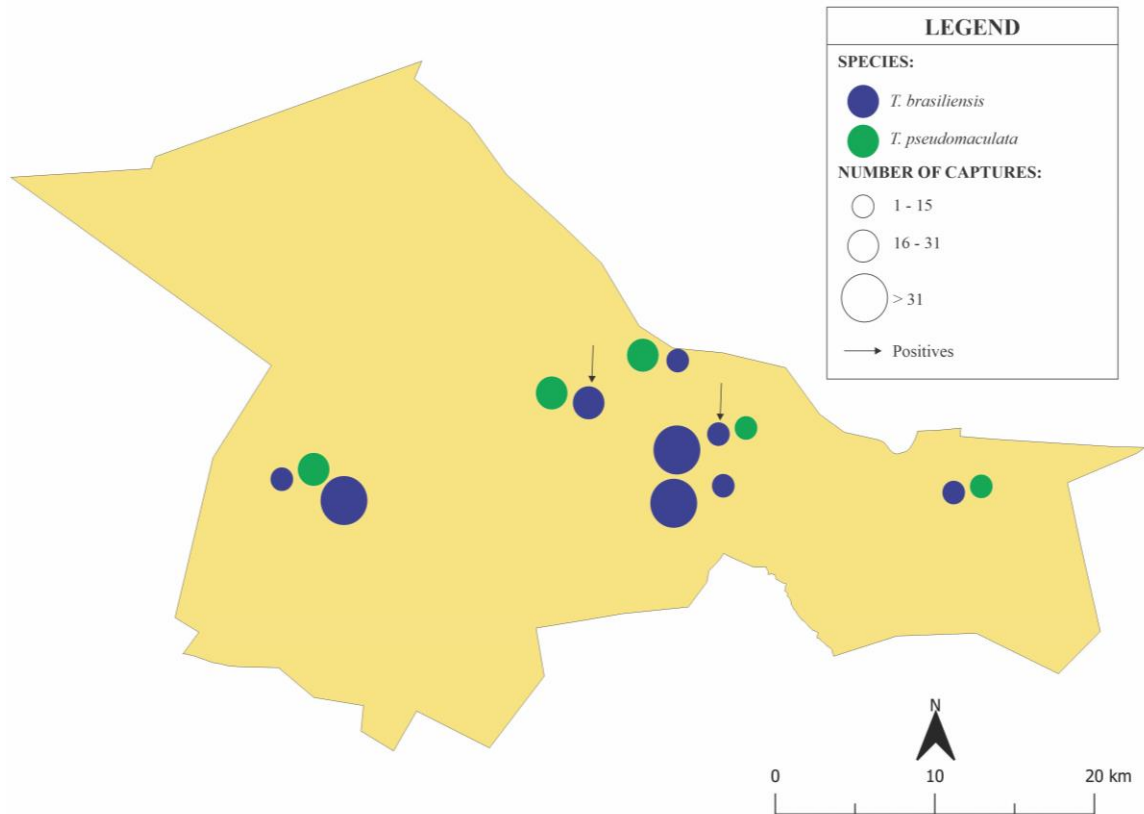
Table 2 – Characterization of the species of triatomines collected in rural areas of the municipality of Simplício Mendes - PI.

Captured Species	Intradomicile Environment			Peridomicile Environment		
	N	(%)	Infection Rate by <i>T. cruzi</i> N (%)	N	(%)	Infection Rate by <i>T. cruzi</i> N (%)
<i>T. brasiliensis</i>						
Males	2	11.1%	-	32	18.6%	1 (3.1%)
Females	7	38.9%	-	39	22.7%	-
Nymphs	9	50%	-	101	58.7%	2 (1.9%)
Total	18	100%	-	172	100%	3 (1.7%)
<i>T. pseudomaculata</i>						
Males	0	-	-	7	9%	-
Females	0	-	-	9	11.5%	-
Nymphs	0	-	-	62	79.5%	-
Total	0	-	-	78	100%	-

Legend: N: Number of captured triatomines. %: Frequency. N (%): Sample number and infection rate by *T. cruzi*. **Source:** Cardoso DRF, et al., 2024.

The insects positive for *T. cruzi* infection belong to the *T. brasiliensis* complex and were from the localities Ligeiro and Sobradinho. Thus, the rate of triatomines with natural infection by *T. cruzi* in the rural communities of Simplício Mendes was 1.1% (3/268) (**Figure 3**).

Figure 3 – Spatial distribution of captured triatomines in the municipality of Simplício Mendes, Piauí, Brazil, between 2022 and 2023.



Note: The map was constructed using QGIS software version 3.32.0 and laid out using CorelDRAW Graphics Suite 2024 software. **Source:** Cardoso DRF, et al., 2024.

The triatomines were predominantly captured in peridomestic environments (n=250). However, during the field expeditions, most residents reported having encountered these insects inside their homes and had recently used insecticides. Some also mentioned that they frequently found these vectors inside the domiciles at night. It is worth noting that many households, despite being negative for household infestation, showed signs of the presence of triatomines, such as: insect feces on walls, furniture crevices, and near beds, exuviae left behind after molting, and bloodstains on surfaces where they usually feed. According to **Table 3**, considering the peridomestic areas, the highest number of triatomines was identified colonizing piles of tiles (n=88). However, colonization was also identified in chicken coops (n=79), storerooms (n=6), doghouse (1), chicken hutch (n=69), and pigsty (7).

Table 3 - Distribution of captured triatomines in peridomestic environments by developmental stages in rural localities of Simplício Mendes municipality - PI.

Type of Peridomestic Environment	Captured Triatomines N (%)	Developmental Stages		
		Nymphs	Adults	
			Males	Females
Chicken Coop	79 (31.6%)	63	6	10
Pile of Tiles	88 (35.2%)	35	25	28
Storage Room	6 (2.4%)	6	0	0
Doghouse	1 (0.4%)	0	0	1
Chicken Hutch	69 (27.6%)	55	5	9
Pigsty	7 (2.8%)	4	3	0
Total	250 (100%)	163	39	48

Legend: N: Number of captured triatomines. %: Frequency. **Source:** Cardoso DRF, et al., 2024.

DISCUSSION

CD is an endemic illness, predominantly rural, closely linked to the social and economic underdevelopment of a region, requiring constant entomological and epidemiological surveillance. In Brazil, following the consolidation of vector control measures, field operational indicators such as dispersion and household infestation rates have shown that the main vector species in past decades, *Triatoma infestans*, is confined to small residual foci in the northwest of Rio Grande do Sul state and in the western region of Bahia state (SILVA RA, 2019).

In these circumstances, entomological surveillance activities for CD have shifted focus to secondary species of triatomines that inhabit intra and peridomestic environments. As such, the Brazilian Northeast region is considered epidemiologically significant due to the presence of large transmission foci and is divided into distinct physiographic areas that harbor a diversity of triatomine species, with *T. brasiliensis* and *T. pseudomaculata* being native to these territories. Consequently, in numerous municipalities within this region, the population still exhibits a high prevalence of *T. cruzi* infection (PINOTTI H, et al., 2021; SILVA LRS, et al., 2021).

The geographical distribution studies of these vector insects are essential for understanding epidemiological aspects related to the transmission of *T. cruzi* and should be considered to guide surveillance and control actions for CD. Thus, this research described the characterization and distribution of triatomines found in rural dwellings in the municipality of Simplicio Mendes-PI.

In this study, several investigated dwellings exhibited the presence of the vector during the evaluated period, infesting intra and peridomestic areas. Consequently, the obtained result is concerning, primarily due to the fact that the municipality harbors species of triatomines directly associated with the transmission of CD.

In accordance with the rates of triatomine dispersion observed in the Brazilian Northeast, the species captured in this research are *T. brasiliensis* and *T. pseudomaculata*. These specimens are found in all northeastern states, posing a concern for entomological surveillance due to their wide dispersion and difficult control (ALMEIDA ML, et al., 2024; OLIVEIRA SF, et al., 2021; REIS LMS, et al., 2020).

In wild environments (particularly in rocky outcrops), colonies with high infection rates are associated with various species of bats, marsupials, and rodents. In sedimentary plains, these insects may be associated with the cactus *Pilosocereus gonellei*. Considering the recognized geographic distribution of *T. brasiliensis*, analyses of standard entomological indicators have demonstrated the epidemiological importance of the species in the states of Bahia (BA), Ceará (CE), Piauí (PI), Paraíba (PB), Pernambuco (PE), and Rio Grande do Norte (RN), highlighting its high rates of intradomiciliary infestation, population density, and variable percentages of trypanosomatid infection (BEZERRA CM, et al., 2018; SANTANA MA, et al., 2021).

In this investigation, the rates of household infestation (14%) and *T. cruzi* infection (1,1%) of triatomines indicate that detecting the parasite's presence in the environment, coupled with the vectors' frequent dispersion, may favor conditions for maintaining vector-borne transmission of CD. The analysis of these data also sheds light on the vulnerability of this territory to disease spread, highlighting the importance of appropriate control and prevention strategies to mitigate transmission risks.

Like *T. brasiliensis*, the species *T. pseudomaculata* feeds on a wide variety of vertebrates, including humans, chickens, rodents, dogs, pigs, opossums, and lizards. This insect infests both rural and urban dwellings, typically found in the peridomicile, colonizing pigeon coops, chicken coops, and fences. *T. pseudomaculata* frequently carries *T. cruzi*, both in the semi-arid Caatinga of northeastern Brazil and in the Cerrado (MINUZZI-SOUZA TTC, et al., 2018).

This infestation pattern corroborates with the findings of this study, given that all *T. pseudomaculata* species were captured in peridomestic environments (n=78), in direct contact with domestic animals. This association underscores the importance of interaction between these vectors and hosts in maintaining the disease transmission cycle. Moreover, it suggests that animal management practices and household hygiene play a crucial role in reducing infestation and controlling CD in this region.

Similar data to those found in this study were observed in an entomological investigation conducted in the municipality of Campinas do Piauí, which found higher rates of triatomine species cohabiting different artificial peridomestic environments (chicken coop, cattle pen, and piles of roofing tiles). This phenomenon can be justified by the juxtaposition of natural and artificial ecotopes, which constitute an environment where the species benefit from ample feeding provided by domestic animals, mainly chickens, while still living in their natural substrates (FERREIRA ALS, et al., 2020).

However, the lower presence of triatomines in domestic environments, as evidenced in this study (n=18), should not be overlooked and serves as an indication of the need for routine surveillance in residences located in areas with a high abundance of these insects in the peridomicile. Thus, analyzing the invasive capacity of vector species is of great importance to assess and monitor the domiciliation process and also direct control measures against CD vectors.

Another study conducted in the territory of Vale do Guaribas in the semi-arid region of southeastern Piauí, one of the driest areas in Brazil, found a higher presence of triatomines in the peridomiciliary areas. However, 39 adult insects were found inside dwellings, indicating infestation but not colonization of the investigated houses. Nevertheless, many vectors in immature and adult stages were present in the peridomiciliary areas, demonstrating the infestation of these environments by triatomine species, which may come into contact with humans and synanthropic reservoirs, representing a risk of *T. cruzi* transmission to the population residing in this region (MENDES-SOUSA AF, et al., 2020).

In this regard, the predominance of nymphs at various stages of development (n=172) among the captured insects in this study suggests continuous reproduction of triatomine populations in the region, indicating active infestation of peridomestic areas. This phenomenon is concerning as it indicates a persistent cycle of vector reproduction, which may lead to an increased likelihood of CD transmission.

This continuous reproduction dynamic underscores the urgency of effective disease control interventions. Comprehensive strategies aimed not only at eliminating present vectors but also at interrupting their reproductive cycle are essential to contain the spread of CD.

In contrast to the studies presented earlier, an analysis of the spatial distribution of synanthropic triatomines in the state of Piauí detected the frequent presence of these vectors inside residences in several municipalities with higher rates of intradomiciliary infestation in the southeast and southwest regions of the state. Thus, direct human contact with these insects results in stable transmission of *T. cruzi* and the occurrence of CD at endemic levels in the hinterlands of northeastern Brazil (SANTOS JP, et al., 2020).

Similarly, an entomological survey conducted in the municipality of São João do Piauí identified large intradomiciliary colonies of triatomines, where human residents were serving as food sources for these insects. The study also demonstrated that immature stages of these vectors were frequently captured under bed mattresses and within cracks in the walls of adobe houses. This ecoepidemiological scenario illustrates the risk of vector-borne transmission of CD in southeastern Piauí (SANTOS SM, et al., 2017).

However, according to a survey of entomological indicators of triatomines in the state of Rio Grande do Norte, in line with the data presented in this research, the greater concentration of triatomines in the extradomiciliary space in some regions can also be explained by the focus on measures to combat domiciliary vectors and by the appropriate conditions for colony aggregation in the peridomicile promoted by negligence regarding the cleanliness of household annexes (BARRETO MAF, et al., 2019).

Furthermore, the occupation of these extradomiciliary environments can serve as a defense mechanism for triatomines in response to the reduction of species within households through chemical control, in accordance with information provided by residents of the localities during the development of this research. The insecticides used in this control leave residues in the peridomicile and do not act satisfactorily due to the effects of climatic variations, direct incidence of sunlight, and rainfall. In this context, the synanthropy of populations of certain vector species has increased as a result of the devastation of natural biotopes, where *T. cruzi* circulates between mammals and wild triatomines. Considering its anthrozoönotic nature, issues related to the persistence and dissemination of CD, especially in areas with low socioeconomic development

and intense environmental degradation in the context of climate change, may favor the invasion and colonization of these vectors in human dwellings, contributing to the establishment of a domestic cycle of *T. cruzi* (GOURBIÈRE S, et al., 2012; LIMA-NEIVA V, et al., 2021; RABINOVICH JE, 2021).

The present study also identified an intervention in the planning and reduction of active searches for triatomines promoted by municipal entomological surveillance during the study period, a fact that may be directly associated with the COVID-19 pandemic period with the suspension or emergency reduction of various services offered. Considering that healthcare systems were, almost exclusively, focused on meeting the high demand for patients infected with the virus. However, the dwellings surveyed during this study still presented triatomine infestation, which may influence the maintenance of the *T. cruzi* cycle in the municipality.

In light of these aspects, it becomes imperative to systematically follow the involvement of entomological surveillance by field teams, along with the participation of local communities in the detection, recognition, and subsequent notification of vectors in intra and peridomestic spaces. Emphasis should be placed on the adoption of measures that promote popular health education as a strengthening tool in this process. These actions should be carried out continuously and coordinatedly aiming to reduce the population density of triatomines and interrupt the transmission of CD in these affected areas.

CONCLUSION

Based on the entomological indices observed, it is evident that the triatomine fauna found in the region is mainly composed of species from the *T. brasiliensis* complex, with a higher concentration cohabiting extradomestic spaces, widespread dispersion, predominance of nymphs at different developmental stages signaling continuous reproduction of triatomine populations in these areas, and the presence of natural infection by *T. cruzi*. Thus, conditions for the maintenance of vector-borne transmission of CD are present, given that the existence of triatomine infection by *T. cruzi* can pose a significant risk to public health.

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