# The Epidemiologic Importance of *Triatoma brasiliensis* as a Chagas Disease Vector in Brazil: a Revision of Domiciliary Captures during 1993-1999

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*To clarify the epidemiologic importance of* Triatoma brasiliensis*, the most important Chagas disease vector in the Northeastern of Brazil, capture data related to this species, its distribution, capture index, and percentages of natural infection by* Trypanosoma cruzi *were examined in 12 different Brazilian states. The Brazilian National Health Foundation collected these data from 1993 to 1999, a period during which a total of 1,591,280 triatomines (21 species) were captured in domiciles within the geographic range of* T. brasiliensis*. Of this total, 422,965 (26.6%) were* T. brasiliensis*, 99.8% of which were collected in six states, and 54% in only one state (Ceará). The percentage of bugs infected with* T. cruzi *varied significantly among states, ranging from 0% (Goiás, Maranhão, Sergipe, and Tocantins) to more than 3% (Alagoas, Minas Gerais, and Rio Grande do Norte) with an average of 1.3%. This latter value represents a dramatic reduction in the natural infection percentages since 1983 (6.7%) suggesting that, despite the impossibility of eradicating this native species, the control measures have significantly reduced the risk of transmission. However, the wide geographic distribution of* T. brasiliensis*, its high incidence observed in some states, and its variable percentages of natural infection by* T. cruzi *indicate the need for sustained entomological surveillance and continuous control measures against this vector.*

Key words: *Triatoma brasiliensis* - distribution - capture index - natural infection - Brazil

The use of insecticides for control of Chagas disease vectors in Brazil has reduced populations of *Triatoma infestans*, the main vector, by 99% and restricted this species to limited foci (Silveira & Vinhaes 1999). The number of domiciliated *T. infestans* specimens captured by the control program in the whole country in 1998 was only 562, representing an average of one insect per 10,000 houses surveyed, an infestation rate far below the minimum required for effective transmission of the parasite (*Trypanosoma cruzi*) to new patients (UNDP/World Bank; WHO 2000).

Populations of native triatomine species that occur in natural and wild environments in Brazil, however, were not as effectively controlled. Entomologic surveys have demonstrated that 17 vector species have been recorded from household environments, with varying degrees of colonization and natural infection. *T. brasiliensis*, is one such species. Its distribution was reduced only 44%, and it can be now considered the most important vector in semiarid zones of Northeastern Brazil (Silveira & Vinhaes 1999).

Because of its wide geographic distribution, rates of natural infection, and its capacity to inhabit natural and anthropic environments, *T. brasiliensis* has become one of the main priorities of the Ministry of Health, which aims to control this principal vector of Chagas disease in Northeastern Brazil (Alencar 1987, Costa et al. 1998, Diotaiuti et al. 1998).

Analyses of the invasive capacity of vector species are of high importance for evaluating and monitoring the domiciliation process and also for directing control measures against Chagas disease vectors. In this context, Diotaiuti et al. (1995) have analyzed the control activities against *T. infestans* and *T. sordida* in the state of Minas Gerais, Brazil. Almeida et al. (2000) have conducted similar studies in Southern Brazil, showing that the domiciliary invasion process of *T. rubrovaria* has increased in the state of Rio Grande do Sul, following reduction of *T. infestans*.

To determine the epidemiologic importance of *T. brasiliensis* in 12 different Brazilian states, capture data related to its dispersion, capture index, and natural infec-

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tion percentages were analyzed. These data were collected by Brazilian National Health Foundation (Funasa) from 1993 to 1999.

## MATERIALS AND METHODS

*Study area* - The coordinates of the analyzed area and its geographic distribution are shown in the Figure.

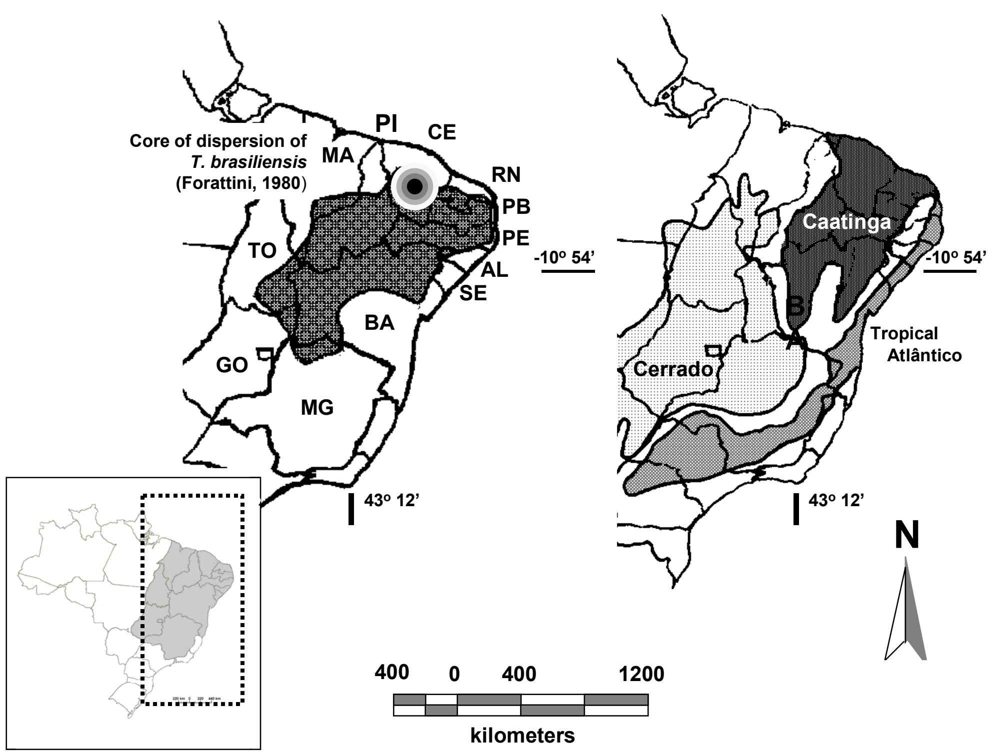
*Data collection* - In this study we present an analysis of records based on domiciliary captures of *T. brasiliensis* and other triatomines in different states. These data were gathered by Funasa during the Chagas Disease Control Program (PCDCH) in the period of 1993-1999. They included the number of the *T. brasiliensis* specimens collected, and the relative number of *T. brasiliensis,* with respect to other triatomines collected.

*Entomological surveillance* - The methodology used for the captures was man-days worked (≅ 10 h/day). Field technicians of Funasa were instructed to collect all triatomines found. Bugs were collected according to standard Funasa procedures, by manual searches using forceps, aided by chemical dislodgants where necessary. The searches generally included the individual houses and associated peridomestic areas, which generally are found within a radius less than 100 m. The domiciliary plus the peridomiciliary areas of inspection were termed domiciliary units (DUs). To evaluate the domiciliary infestation, the capture index was calculated (number of bugs collected/number of houses surveyed × 1000). The colonization indices were evaluated using the following equation: number of intradomiciliary or peridomiciliary units harboring nymphs/number of intradomiciliary or peridomiciliary units harboring triatomines (adults + nymphs) × 100).

*Natural infection* - The percentage of *T. brasiliensis* specimens naturally infected with *T. cruzi* was evaluated during the period of 1996-1999, and the percentage of other triatomine species was calculated based on records obtained during the year 1998. Infection with *T. cruzi* and or *T. cruzi*-like agents was determined by microscopic analysis of fecal drops. A $X^2$ test was applied to ascertain the significance of data presented in Table V and for the comparison between the current natural infection rate and the data presented by Silveira and Vinhaes (1999).

## RESULTS

The *T. brasiliensis* capture data concern the whole geographic range of this species, during the period of 1993-1999. This range comprises a wide area, from Maranhão (MA) in the Northeast region (capital - Lat. 02°31'47", Lon. 44°18'10") to north of Minas Gerais (MG) in the Southeast region (capital - Lat. 19°55'15', Lon. 43°58'17"), encompassing 12 states. Nine of these belong to the Northeast region: MA, Piauí (PI), Ceará (CE), Rio Grande do Norte (RN), Paraíba (PB), Pernambuco (PE), Alagoas (AL), Sergipe (SE) and Bahia (BA); two belong to the Central-west, including Tocantins (TO) and Goiás (GO); and MG belongs to the Southeast region. Overall, the predominant morphoclimatic features are the "caatinga" and the "cerrado," according to Forattini (1980) (Figure).




The geographic area in which *Triatoma brasiliensis* specimens were captured in domiciliary ecotopes, in the period 1993-1999, according to Brazilian National Health Foundation (AL: Alagoas; BA: Bahia; CE: Ceará; GO: Goiás; MA: Maranhão; MG: Minas Gerais; PB: Paraíba; PE: Pernambuco; PI: Piauí; RN: Rio Grande do Norte; SE: Sergipe; TO: Tocantins) and the morphoclimatic features, according to Forattini (1980).

A total of 1,591,280 triatomines was captured in DUs, and of this total, 422,965 (26.6%) were *T. brasiliensis* (Table I). The percentages of *T. brasiliensis* with respect to the total number of triatomines collected for each state were as follows: PI (61.8%), PB (56.7%), CE (54.1 %), RN (38.7%), PE (37.9%), AL (8.8%), BA (5.9%) MA (2.6%), TO (0.1%), SE (0.06%), MG (0.03%) and GO (0.008%) (Table I). The majority (83%) of *T. brasiliensis* was collected in three states: CE 229,611, PI 78,746 and PB 45,178 (Table I), and 99.8% of all *T. brasiliensis* specimens were collected in six states (BA, CE, PB, PE, PI and RN). MG was the second highest state when considering the total number of triatomine specimens captured (389,184), but of the insects collected, only 0.01% (99) were *T. brasiliensis* (Table I).

The capture index has proven to be a satisfactory epidemiologic indicator, since it relates the number of collected bugs to the number of domiciliary units surveyed (Almeida et al. 2000, Diotaiuti et al. 1995). According to this index, PI (125.7), CE (89.5), PB and RN (~79) presented the highest domiciliary infestation rates for *T. brasiliensis*. However, considering the capture index of all triatomines in each state, MG (214) and BA (230.7) presented the highest index (Table I). Table II shows the number of DUs examined during 1993-1999 as a basic denominator used to obtain the values of the capture index.

Table III displays indicators of the *T. brasiliensis* trend to colonize anthropic environments. Of particular interest are the observations in the PB and CE, where the index of colonization in both peridomestic and domiciliary ecotopes is higher than 55.6. Table III also shows the number of municipalities evaluated in 1999 in order to provide the level of the coverage of PCDCH/Funasa per state.

Twenty other triatomine species were captured in the DUs within the geographic area of *T. brasiliensis.* The occurrence of the species in different states and their natural infection percentages are in Table IV. BA and MG had the highest diversity in terms of triatomine fauna where 14 and 13 species were captured respectively. *Triatoma*

TABLE I

Total number of triatomine specimens and the total number of *Triatoma brasiliensis* specimens collected in each state, and the capture index (Chagas Disease Control Program/Brazilian National Health Foundation)

| | 1993-1999 | | | | |
|---|---|---|---|---|---|
| States | Total number of triatomines collected | Total number of *T. brasiliensis* collected | *T. brasiliensis* specimens collected/total number of triatomines collected in the same state (%) | Capture index for all triatomine species | Capture index for *T. brasiliensis* specimens |
| Alagoas | 5,971 | 523 | 8.8 | 34.7 | 3 |
| Bahia | 33,7256 | 19,860 | 5.9 | 230.7 | 13.6 |
| Ceará | 424,078 | 229,611 | 54.1 | 165.4 | 89.5 |
| Goiás | 75,948 | 6 | 0.0 | 126.3 | 0 |
| Maranhão | 8,125 | 211 | 2.6 | 28.7 | 0.7 |
| Minas Gerais | 389,184 | 99 | 0.0 | 214 | 0 |
| Paraíba | 79,650 | 45,178 | 56.7 | 139.5 | 79.1 |
| Pernambuco | 65,852 | 24,928 | 37.9 | 95.1 | 36 |
| Piauí | 127,462 | 78,746 | 61.8 | 203.5 | 125.7 |
| Rio Grande do Norte | 61,467 | 23,787 | 38.7 | 203.9 | 79 |
| Sergipe | 3,170 | 2 | 0.1 | 17.6 | 0 |
| Tocantins | 13,117 | 14 | 0.1 | 125.2 | 0.1 |
| Total | 1,591,280 | 422,965 | - | - | - |

TABLE II

Number of domiciliary units examined, in the 1993-1999 period in 12 Brazilian states (Chagas Disease Control Program/Brazilian National Health Foundation)

| States | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | Total |
|---|---|---|---|---|---|---|---|---|
| Alagoas | 37,977 | 34,149 | 18,939 | 12,973 | 14,088 | 20,184 | 33,910 | 172,220 |
| Bahia | 236,706 | 171,125 | 82,773 | 190,930 | 247,287 | 208,266 | 324,638 | 1,461,725 |
| Ceará | 635,583 | 243,466 | 358,418 | 341,201 | 364,904 | 304,715 | 315,911 | 2,564,198 |
| Goiás | 119,465 | 170,720 | 152,264 | 45,414 | 46,138 | 46,180 | 20,888 | 601,069 |
| Maranhão | 37,828 | 36,072 | 57,972 | 47,469 | 34,662 | 47,605 | 21,288 | 282,896 |
| Minas Gerais | 490,931 | 296,348 | 284,460 | 189,850 | 275,979 | 103,899 | 177,338 | 1,818,805 |
| Paraíba | 160,696 | 67,672 | 154,382 | 75,841 | 50,476 | 33,798 | 28,091 | 570,956 |
| Pernambuco | 154,764 | 93,531 | 106,068 | 62,805 | 55,119 | 118,201 | 102,124 | 692,612 |
| Piauí | 67,753 | 92,428 | 121,793 | 130,154 | 89,169 | 57,272 | 67,721 | 626,290 |
| Rio Grande do Norte | 65,420 | 84,566 | 89,918 | 56,299 | 819 | *a* | 4,455 | 301,477 |
| Sergipe | 43,226 | 69,719 | 28,097 | 8,887 | 4,284 | 5,626 | 20,618 | 180,457 |
| Tocantins | 4,385 | 12,223 | 3,761 | 17,675 | 28,150 | 32,952 | 5,788 | 104,934 |

*a*: without information

TABLE III

Colonization index of *Triatoma brasiliensis* and all triatomines collected in the domiciliary and peridomiciliary environments and number of municipalities researched in 1999 (Chagas Disease Control Program/Brazilian National Health Foundation)

| | *Triatoma brasiliensis* colonization index | | Triatomine fauna colonization index | | Number of municipalities researched |
|---|---|---|---|---|---|
| | Domiciliary environments | Peridomiciliary environments | Domiciliary environments | Peridomiciliary environments | |
| Alagoas | *a* | *a* | *a* | *a* | 26 |
| Bahia | 36.9 | 44.9 | 32.5 | *a* | 139 |
| Ceará | 55.6 | 60.8 | 53.9 | 60.6 | 106 |
| Goiás | *a* | *a* | 37.3 | 57.2 | 96 |
| Maranhão | 25 | 62.5 | 10.6 | 36.7 | 6 |
| Minas Gerais | 20 | 33.3 | 37.3 | 53.9 | 180 |
| Paraíba | 58.9 | 59.9 | 57.1 | 54.9 | 13 |
| Pernambuco | 32.9 | 54.9 | 25.8 | 55.7 | 131 |
| Piauí | 46.3 | 60.2 | 47.2 | 55.8 | 71 |
| Rio Grande do Norte | 36.9 | 51.3 | 33.6 | 51.9 | 10 |
| Sergipe | *a* | *a* | *a* | *a* | 27 |
| Tocantins | *a* | *a* | 29.9 | 54.2 | 22 |

*a*: without information

*pseudomaculata* showed the same geographic range as *T. brasiliensis*. *Panstrongylus megistus* was very widespread, being absent only from MA (Figure, Table IV).

There was a highly significant ($P < 0.00001$) heterogeneity in the natural infection percentages of *T. brasiliensis* among all the states (Table V). The overall percentage of natural infection was of 1.3% (2,141) of the total 167,455 *T. brasiliensis* examined specimens. In CE, where 54.1% of *T. brasiliensis* specimens were collected, the natural infection was less than 1%. The highest infection rate was registered in RN (4.5%) and AL (4.3%). However, AL had a very low capture index. Specimens collected in BA and PE had higher infection percentages (2.7%) and higher capture indices (Tables I and V).

## DISCUSSION

Dias et al. (2000) broadly discussed the general situation and the perspectives of Chagas disease, detailing the operational procedures of Funasa and their impact in monitoring endemicity and controlling the vectors in nine states in Northeastern Brazil. The objective of the present study was to provide a general report of *T. brasiliensis* domiciliary infestations throughout its geographic distribution, over the last decade. The Funasa records during the PCDCH were used as a basis for this analysis. Due to the extensive plan of action of the PCDCH, the number of DUs investigated in each state is summarized in Table II in order to provide an overview of the coverage of the program during the study period (1993-1999).

It is important to stress that the core of dispersion for this species, proposed by Forattini (1980), matches with those highly infested areas. *T. brasiliensis* seems to invade houses only sporadically in six states: AL, GO, MA, MG, SE, and TO, that together represent 0.2% of all *T. brasiliensis* captured specimens (Table I, Figure).

Data in Table III demonstrate the synanthropic habits of *T. brasiliensis*. The colonization indices were particularly high in PB and CE exceeding 55.6 in both peridomestic and domiciliary ecotopes. Table III also shows that *T. brasiliensis* has higher colonization indices than the remaining Triatominae fauna in some of the states.

Recently, multidisciplinary analyses have shown that *T. brasiliensis* comprises at least four distinct "populations" (brasiliensis, melanica, macromelasoma, and juazeiro) according to morphological, biological, isoenzymatic, ecological, epidemiogic and molecular data (Costa et al. 1997a,b, 1998, 2001, 2002, Costa & Marchon-Silva 1998). Projections of the geographic distribution proposed by Costa et al. (1998) for these four *T. brasiliensis* "populations", on the current surveillance data, confirms that the "brasiliensis population" found in MA, PI, CE, RN, and PB is the most important, because of its wide geographic distribution, higher infection percentages, and its capacity to occupy a great variety of ecotopes. The other two *T. brasiliensis* "populations", macromelasoma and juazeiro are found in PE, and BA respectively, and are also involved in domiciliary transmission, with a natural infection percentage of approximately 2.7%. In contrast, the melanica "population" found only in MG in sylvatic habitats, seems to be involved exclusively in the wild cycle of *T. cruzi* (Costa et al. 1998). The results obtained in this study corroborate previous observations for the melanica "population" in MG. From the total of 389,184 triatomine specimens captured in MG from 1993-1999, only 99 (0.025%) were *T. brasiliensis* (Table I). The taxonomic status of these four "populations" of *T. brasiliensis* is currently being evaluated in integrated approaches utilizing different tools, including mitochondrial DNA analysis (Costa et al. 2001).

Dias et al. (2000) showed data on the distribution of 27 vectors correlated to human Chagas disease in nine states in Northeastern Brazil, based on data of Funasa and several other authors, in the period 1912-1999. With respect to the classification for triatomine adaptation to human dwellings proposed by Silveira (2000), out of the 20 species included in our study, six are considered strictly sylvatic: *T. costalimai*, *T. lenti*, *T. matogrossensis*, *T. petrochii*, *T. william,* and *Eratyrus mucronatus*. With the exception of 90 specimens of *T. costalimai* captured, all of the other four species were recorded in very low num-

TABLE IV

Triatominae species occasionally and/or frequently captured in the domiciliary units in 12 states where *Triatoma brasiliensis* can be found, and their natural infection percentages by *Trypanosoma cruzi* or *T. cruzi*-like organism, in 1998 (Chagas Disease Control Program/Brazilian National Health Foundation)

| Species | States | | | | | | | | | | | | | Natural infection by *T. cruzi* | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | AL | BA | CE | GO | MA | MG | PB | PE | PI | RN | SE | TO | Specimens captured | Specimens examined | Number of positive | % of positivity |
| *T. brasiliensis* [b] | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | 67,209 | 48,897 | 609 | 1.2 |
| *T. costalimai* [e] | | | | ■ | | | | | | | | ■ | 90 | 76 | 12 | 15.8 |
| *T. infestans* [a] | | ■ | | ■ | | ■ | ■ | ■ | ■ | | | ■ | 540 | 424 | 21 | 4.9 |
| *T. lenti* [e] | | ■ | | ■ | | | | | | | | | 12 | 12 | 0 | 0 |
| *T. matogrossensis* [e] | | | | | | ■ | | | | | | | 1 | 1 | 0 | 0 |
| *T. melanocephala* [d] | | ■ | | | | ■ | ■ | ■ | ■ | | | | 96 | 40 | 4 | 10 |
| *T. petrochii* [e] | | | | | | | | ■ | | ■ | | | 2 | 0 | 0 | - |
| *T. pseudomaculata* [b] | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | 54,337 | 32,593 | 309 | 0.9 |
| *T. rubrofasciata* [a] | | | | | ■ | | | ■ | ■ | | ■ | | 927 | 861 | 256 | 29.7 |
| *T. sordida* [b] | | ■ | ■ | ■ | | ■ | | ■ | ■ | | | ■ | 88,649 | 62,089 | 685 | 1.1 |
| *T. tibiamaculata* [d] | | ■ | | | | ■ | | | | | | | 9 | 6 | 0 | 0 |
| *T. vitticeps* [c] | | | | | | ■ | | | | | | | 478 | 200 | 23 | 11.5 |
| *T. williami* [e] | | | | | | | | | | | | ■ | 1 | 0 | 0 | - |
| *Panstrongylus diasi* [d] | | ■ | | ■ | | ■ | | | | ■ | | ■ | 104 | 39 | 6 | 15.4 |
| *P. geniculatus* [d] | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | | ■ | 698 | 426 | 22 | 5.2 |
| *P. lutzi* [c] | ■ | ■ | ■ | | | | ■ | ■ | ■ | ■ | ■ | ■ | 2,900 | 2,029 | 120 | 5.9 |
| *P. megistus* [b] | ■ | ■ | ■ | ■ | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | 4,434 | 2,725 | 41 | 1.5 |
| *Rhodnius domesticus* [d] | ■ | ■ | | | | | | | | | | | 26 | 12 | 0 | 0 |
| *R. nasutus* [c] | | | ■ | | | | ■ | | | ■ | | | 919 | 639 | 4 | 0.6 |
| *R. neglectus* [c] | | ■ | | ■ | ■ | ■ | ■ | ■ | | | ■ | ■ | 872 | 572 | 17 | 3.0 |
| *Eratyrus mucronatus* [e] | | ■ | | | | ■ | | | | | | | 1 | 1 | 1 | 100 |

AL: Alagoas; BA: Bahia; CE: Ceará; GO: Goiás; MA: Maranhão; MG: Minas Gerais; PB: Paraíba; PE: Pernambuco; PI: Piauí; RN: Rio Grande do Norte; SE: Sergipe; TO: Tocantins. Different categories of triatomines according to their human dwellings adaptation (Silveira 2000); *a*: species strictly domiciliated, rarely detected in sylvatic ecotopes; *b*: species captured either in natural or artificial ecotopes, frequently presenting domiciliary colonies; *c*: species captured in artificial ecotopes, but still predominantly sylvatic; *d*: sylvatic species with adults captured in domiciles; *e*: species exclusively sylvatic bers, confirming their sylvatic preference (Table IV). It is important to emphasize that in certain cases, however, this categorization may vary. For instance, *E. mucronatus* has recently been found in artificial ecotopes in Bolivia, and it seems that this species could present predisposition to develop intradomiciliary colonies (Noireau et al. 1995).

Table IV shows that *T. brasiliensis* presented the second highest percentage of natural infection by *T. cruzi* or *T. cruzi*-like organisms (1.2%) among the triatomines ranked by Silveira (2000) as species captured in natural and artificial ecotopes, and frequently colonizing houses. *P. megistus* showed a natural infection rate of 1.5%. On the other hand, data obtained by Dias et al. (2000) and in the present study revealed that the numbers of *T. brasiliensis* captured specimens are significantly higher than those of *P. megistus.* The highest numbers of collected specimens were reported for *T. sordida;* however, this species is primarily peridomestic and ornithophilic (Diotaiuti et al. 1993).

BA and MG displayed the highest diversity of triatomine fauna with 14 and 13 different species respectively captured in artificial ecotopes. According to Forattini (1980), these states present a physical-geographic area called "zona-da-mata" which is influenced by the "caatinga" on the north, and the "cerrado" on west. The eastern side is comprised of a very humid coastline where *T. brasiliensis* is not found. This diversity in the morphoclimatic features may have resulted in a higher variety of ecotopes found in this region, thus allowing the emergence of a greater variety of triatomine species. (Figure, Table IV)

Our results support previous data showing similar distribution for *T. pseudomaculata,* and *T. brasiliensis*: AL, BA, CE, GO, MG, PI, and RN (Lent & Wygodzinsky 1979). Dias et al. (2000) showed the occurrence of both species also in MA. In the present study, their geographic range was also recorded SE and TO. These results may indicate that *T. brasiliensis* and *T. pseudomaculata* are invading new areas (Table IV).

Dias et al (2000) mention that the control of some native species such as *T. brasiliensis* and *T. pseudomaculata* still remains an operational challenge. Recent studies have shown that the domiciliary improvement and chemical control, when exerted in a periodic way, prevent the reestablishment of conditions of Chagas disease transmission. However, chemical control programs should not allow intervals between applications to exceed three years (Silveira et al. 2001 a,b). Diotaiuti et al. (2000) conducted studies on the reinfestation of houses by *T. brasiliensis* in CE, and showed that four months after spraying with deltamethrim 9.7% of the houses were still positive, especially the peridomiciliary ecotopes.

During the past 10 years, the number of new cases of Chagas disease in Brazil has decreased continuously, mainly because of chemical control of the domiciliary vectors (Silveira & Vinhaes 1999). A reduction in case incidence of 96% in human infection by *T. cruzi* in the age group of 7-14 years in the period of 1983-1997 has been reported (Moncayo 1999). In 1983, 8.7% of *T. infestans* and 6.7% of the *T. brasiliensis* were naturally infected with *T. cruzi* (Silveira & Vinhaes 1999). The significant reduction ($P < 0.00001$) in natural infection percentages registered between 1983 (6.7%) and the present (1.3%) suggests that, despite the impossibility of eradicating *T. brasiliensis*, a native species, the control measures have sharply reduced the likelihood of the parasite transmission. However, the wide geographic distribution of *T. brasiliensis* reported in 12 Brazilian states, its high population density observed in some of these states demonstrate the need for sustained entomological surveillance and continuous control measures against this vector. Today, *T. brasiliensis* presents epidemiologic importance in only six of the twelve states of its geographic distribution. Special attention is required to the states of BA, CE, PB, PI, PE, and, RN, where this species can be found in higher densities, presenting variable percentages of natural infection.

TABLE V

Percentages of *Triatoma brasiliensis* specimens naturally infected by *Trypanosoma cruzi* or *T. cruzi*-like organisms, 1996-1999 (Chagas Disease Control Program/Brazilian National Health Foundation)

| States | Total number of *T. brasiliensis* collected | Total number of *T. brasiliensis* examined | Positive specimens | |
|---|---|---|---|---|
| | | | n | % |
| Alagoas | 476 | 368 | 16 | 4.3 |
| Bahia | 15,552 | 9,736 | 267 | 2.7 |
| Ceará | 138,131 | 83,557 | 423 | 0.5 |
| Goiás | 6 | 4 | 0 | 0 |
| Maranhão | 121 | 100 | 0 | 0 |
| Minas Gerais | 56 | 27 | 1 | 3.7 |
| Paraíba | 24,537 | 24,470 | 391 | 1.6 |
| Pernambuco | 18,458 | 17,662 | 481 | 2.7 |
| Piauí | 44,941 | 22,924 | 175 | 0.8 |
| Rio Grande do Norte | 9,496 | 8,594 | 387 | 4.5 |
| Sergipe | 0 | 0 | 0 | - |
| Tocantins | 13 | 13 | 0 | 0 |
| Total | 251,787 | 167,455 | 2,141 | 1.3 |

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