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Occurrence and distribution of *Panstrongylus megistus* (Burmeister, 1835) (Hemiptera, Reduviidae) in a metropolitan area of Southern Brazil

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ABSTRACT

Two triatomine genera (*Panstrongylus* and *Triatoma*) have essentially been recorded in Rio Grande do Sul State, Brazil. *Panstrongylus megistus* should be highlighted since this species is one of the main vectors of *Trypanosoma cruzi* in Brazil, due to its wide geographical distribution and the high susceptibility to this protozoan. This study aimed to present not only the occurrence and distribution of *P. megistus* in the Porto Alegre city's metropolitan area (PAMA), Rio Grande do Sul State, Brazil, but also the rates of *T. cruzi* infection, from 2009 to 2020. The PAMA, which comprises 34 cities and 4.4 million habitants, extends across the transition area in two biomes – Pampa and Mata Atlantica – found in the state. Results showed that *P. megistus* was recorded in 76.5% of cities (i.e., 26 out of 34), mainly in Porto Alegre city, where the vector was found in 11 out of the 12 years that were monitored. Three hundred and nineteen specimens were captured. Two hundred and sixty-seven specimens (83.7%) were located intradomicile ($p < 0.0001$), while 52.3% positivity for *T. cruzi* was found. Thus, *P. megistus* is important in the PAMA, because it invades and colonizes the households. Moreover, the high rates of *T. cruzi* infection have drawn attention.

KEYWORDS: *Panstrongylus.* Triatomines. Chagas disease. *Trypanosoma cruzi.*

INTRODUCTION

Triatomines (Hemiptera: Reduviidae) are hematophagous insects whose common names are "kissing bugs" and "vampire bugs". They are capable of transmitting the etiological agent *Trypanosoma cruzi* to humans and other animals by contaminating their mucous membranes and skin with infected feces and causing an acute and/or chronic infection called Chagas disease (CD)[1]. Besides vectorial transmission, the infection can also be caused by blood transfusion, accidents in laboratories and organ transplantation, as well as congenitally and orally. The estimate is that between 1.9 and 4.6 million people may have been infected by *T. cruzi* in Brazil[2].

The subfamily Triatominae has 157 species and 2 subspecies distributed in 18 genera and five tribes[3]. Regarding their vectorial capacity, the most important species belong to the genera *Panstrongylus*, *Triatoma* and *Rhodnius*[4]. It should be highlighted that *P. megistus*, an insect which can be found in Uruguay, Argentina, Paraguay, Bolivia and Brazil, is one of the main vectors of CD in Brazil, due to its wide geographical distribution and high susceptibility to *T. cruzi*[5,6]. In addition, this species exhibits a high capacity to colonize artificial ecotopes[7], including the places that have been just described in the metropolitan areas in Brazil[8,9], and to establish peridomicile and intradomicile colonies in different regions[10,11].

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In Rio Grande do Sul State (RS) the species is mostly wild, since it is native, and its adaptation to households is directly related to the anthropic activity in the environment and the decrease in its usual shelters and food sources. It should be mentioned that Gastao Silveira recorded *P. megistus* in RS, in an area close to Canoas city and Encruzilhada do Sul city, for the first time in 1920[12]. Residents living in several suburbs in Porto Alegre city used to notify *P. megistus* – often infected by *T. cruzi* – inside households located near the woods during the warmest months, in the 1960's. The author also stated that, despite its extra household habitat, this species has invaded households from November to May. Even though it does not often colonize households, the vector leaves wild ecotopes to get close to and invade the households. The destruction of native forests and household colonization by white-eared opossums (*Didelphis albiventris*) (Lund, 1841) (*Didelphimorphia, Didelphidae*) are factors that contribute to its synanthropic aproximation[13].

This study aimed to present the occurrence of *P. megistus* in the Porto Alegre city's metropolitan area (PAMA), RS, Brazil, and its infection rates by *T. cruzi*, in addition to georeferencing and describing some episodes of invasion and domiciliation of the species in this region.

MATERIALS AND METHODS

Area characterization

Porto Alegre city is the capital of the Rio Grande do Sul State, Southern Brazil, and is located at latitude 30° 1' 40" S. and latitude 51° 13' 43" W., and the metropolitan area of Porto Alegre (PAMA) comprises 34 municipalities (Figure 1). It is the most densely populated area in RS, since its 4.4 million inhabitants represent 38% of the state population which lives in only 3.7% of the state territory. Density is 416.5 inhabitants/km^2 and 9 out of the 18 cities with populations over 100 thousand inhabitants are in this area. The PAMA, which extends across the transition area between both state biomes – Pampa and Mata Atlantica – is mostly grassland in the southern Pampa and forests in the northern Mata Atlantica. The climate is temperate with no dry season.

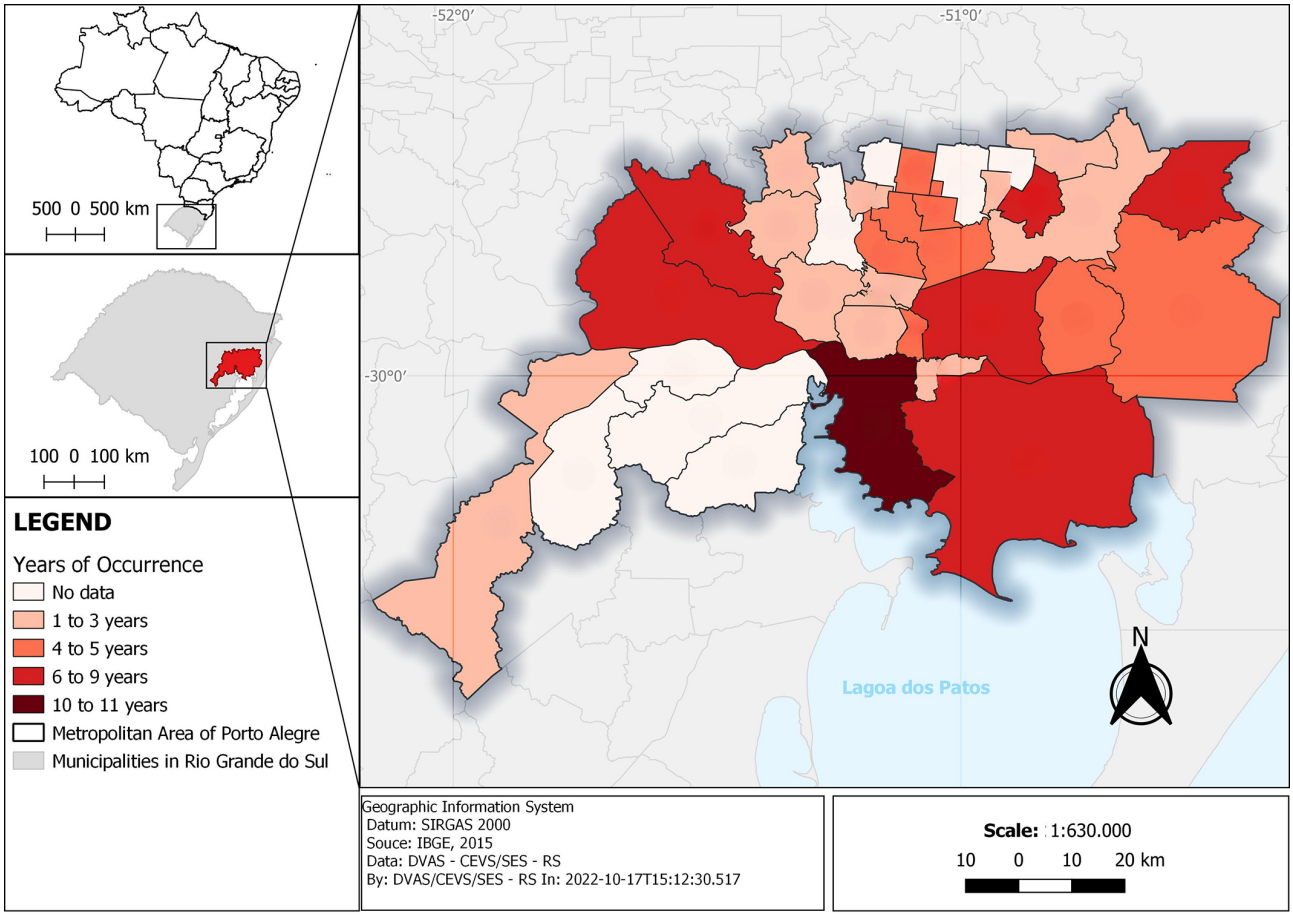

Figure 1 - Distribution of annual occurrence of *Panstrongylus megistus* in the metropolitan area of Porto Alegre city (PAMA), RS, Brazil, from 2009 to 2020.

Capture and analysis of vectors

The study was based on secondary data provided by the partnership between the Federal University of Pelotas, Rio Grande do Sul State (UFPel-RS) and the State Health Surveillance Center in RS (CEVS-RS) and the State Department of Health (SES-RS). Recording of *P. megistus* specimens resulted from passive/community surveillance, which means they were notified and handed in by the population at Triatomine Information Post (TIP), and from active surveillance, i.e., they were captured by public health agents. Samples were taken to the Central Public Health Laboratory (LACEN) to be taxonomically identified. Live triatomines were subject to parasitological examination of feces by optical microscopy to identify the natural infection caused by *T. cruzi*. It should be mentioned that, in the study area, only Porto Alegre city has a reference laboratory which determines and examines triatomines.

Study period and data georeferencing

Entomological data under evaluation refer to a 12-year period, from 2009 to the end of 2020. Information collected from 2009 to 2016 was provided by LACEN reports and by the CD Control Program (PCDCh-DATASUS). Data from 2017 to 2020 was provided by the Form for Entomological Surveillance of CD (FORMSUS-DATASUS), which enabled the georeferencing of places where *P. megistus* specimens were found. Mapping of the PAMA encompassed 8% of cities in RS; they had either small rural areas or none. The georeferencing of places where vectors were found was based on addresses listed by City Health Departments.

Mapping and tabulation were carried out by QGIS®, version 3.10.11, and Microsoft Excel® programs, respectively.

Statistical analysis

Percentages of the following variables were evaluated: number of cities with *P. megistus* per year; number of *P. megistus* specimens captured per year; capture ecotope (intradomicile and/or peridomicile); and evolutionary instar of triatomines (adult or nymph) intradomicile and peridomicile. Groups were statistically compared by the Chi-squared Test and variables with $p \leq 0.05$ were considered significant.

RESULTS

Regarding *P. megistus* distribution in the PAMA from 2009 to the end of 2020, the species was registered in 76.5% of cities, that is, 26 out of 34, mainly in Porto Alegre city, where the vector was found in 11 out of the 12 years that were monitored (Figure 1).

Concerning the number of captured *P. megistus* and its distribution over the years, 319 specimens were recorded in the PAMA. They were found every year under evaluation (from 2009 to 2020); the mean of triatomine occurrence was 8.8 cities per year (the maximum was 13 cities in 2017 and in 2020, while the minimum was two in 2010). Considering two 6-year periods (2009-14 – 108 insects captured – and 2015-20 – 211 insects captured), there was a significant increase ($p > 0.0001$) in the number of *P. megistus* specimens captured in the second period.

Two hundred and sixty-seven (83.7%) out of three hundred and nineteen *P. megistus* specimens were captured intradomicile while fifty-two (16.3%) were found peridomicile ($p < 0.0001$). Moreover, in the houses, adult triatomines represented 71.5% (191) of the captured insects. Only adult insects were captured outdoors (peridomicile) (Table 1). A hundred and twenty-eight (40.1%) specimens were examined for *T. cruzi*, and positivity was 52.3%.

As mentioned above, the georeferencing of *P. megistus* captures in the PAMA was based on information provided by the FORMSUS-DATASUS from 2017 to 2020 (Figure 2). It shows episodes in which vectors were found either in urbanized areas or close to them. It should be highlighted that vectors were mostly found in households located in heavily wooded areas where triatomines found not only appropriate shelter conditions but also food sources often, mainly *D. albiventris* opossums. Seven colonies – all intradomicile – had detailed records of visits: Porto Alegre city recorded four colonies in both suburbs of Ponta Grossa (2009 and 2010) and Lomba do Pinheiro (2015 and 2018) in a peri-urban area, while a colony was found in the rural area of Viamao city in 2011. Two colonies were found in the rural area of Gravatai city, in an abandoned ballroom invaded by chickens and opossums in January and July 2019.

DISCUSSION

P. megistus has been widely distributed in nature and often moves between natural and artificial ecotopes[5]. Analyses carried out in the PAMA, RS, show that the species tends to invade households, but rarely forms colonies. This was mainly observed in wood and/or brick houses located in wooded areas, where the insects found appropriate conditions to invade and form colonies since they had shelter and food sources, such as opossums, poultry and rodents, which was confirmed by other studies[14,15]. The data also confirm the analysis conducted by the PCDCh-DATASUS in RS by Bedin *et al.*[16], i.e., the 1996-2008 historical series had already shown the important dispersion of *P. megistus*

Table 1 - *Panstrongylus megistus*: number of specimens per ecotope, evolutionary stage and rate of *Trypanosoma cruzi* infection in the metropolitan area of Porto Alegre city (PAMA), RS, Brazil, from 2009 to 2020.

Year	*P. megistus* in PAMA						%
	intradomicile		peridomicile		Triatominae		
	Adult	Nymph	Adult	Nymph	Examined	Positives	
2009	28	2	8	0	13	12	92.3
2010	9	5	1	0	10	3	30
2011	11	1	4	0	9	5	55.6
2012	15	0	3	0	7	3	42.9
2013	8	0	3	0	2	1	50
2014	7	0	3	0	8	8	100
2015	9	2	3	0	7	2	28.6
2016	9	5	2	0	8	1	12.5
2017	24	0	2	0	11	1	9.1
2018	20	38	11	0	15	8	53.3
2019	29	20	2	0	25	11	44
2020	22	3	10	0	13	12	92.3
Total	191	76	52	0	128	67	52.3

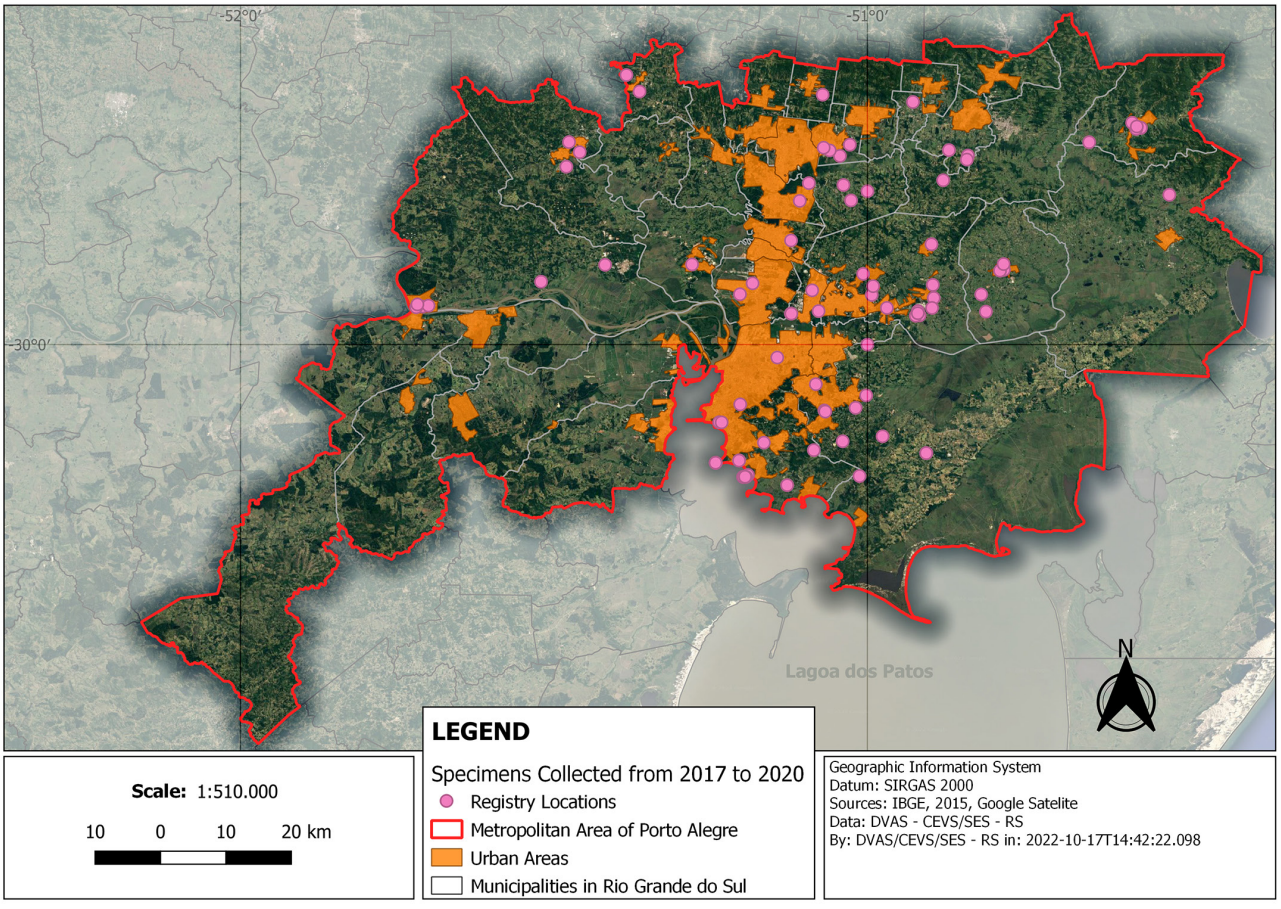

Figure 2 - Georeferencing of *Panstrongylus megistus* specimens found in the metropolitan area of Porto Alegre city (PAMA), RS, Brazil, from 2017 to 2020.

in the state and that 88% of *P. megistus* specimens were captured intradomicile.

In this study, 83.7% of *P. megistus* specimens were also captured intradomicile. This factor may result from

the fact that the population has been more attentive and has captured the species in this ecotope, while there may be some carelessness towards the insects in the surroundings of households[17]. Furthermore, it should be emphasized that, in a metropolitan area, the number of houses with peridomicile areas is smaller than the one found in rural areas. Regarding the significant increase of *P. megistus* specimens in the second 6-year period under evaluation, it should be highlighted that there has been suppression of native woods in the PAMA, a fact that leads to a decrease of natural ecotopes and increases their dispersion in the search for shelter; thus, new houses constructed next to isolated woods may become their hiding places, just like in other regions of the country[8,9]. In certain situations, synanthropic animals, such as opossums, become natural reservoirs of *T. cruzi*. They use attics and roofs as shelter and can be food sources of *P. megistus*. In this respect, it should be mentioned that most *P. megistus* specimens under analysis were positive for the protozoan (52.3%). Specimens captured in this area may have been close to small fragments of woods that housed white-eared opossums (*D. albiventris*), which are often infected with *T. cruzi.* Results of this study agree with the one of *P. megistus* found in artificial ecotopes in Santa Catarina State[7], where positivity was 56.5%.

Results of this study also corroborate specific data on Porto Alegre city collected by Santos Jr. *et al.*[18], who found wild spots of *P. megistus* – most of them about 100 m from households – and opossums in some places where vectors were captured in 2005 and 2006; positivity for *T. cruzi* in adult and nymph *P. megistus* was 64% and 73%, respectively. This considerable positivity of the species is relevant and alarming because cities located in the metropolitan area encompass almost 40% of the state population and undergo fast urban expansion since new developments have been built very close to the Mata Atlantica biome, a usual habitat of the vectors, thus approximating human beings. The analysis of the whole picture implies that the wild population of *P. megistus* remains in places that allow the emergence of vector-borne CD, associated with the risk of proximity to vectors and reservoirs due to fauna and flora decline resulting from the occupation and degradation of the environment by human beings[10,19]. In addition, competition for shelter and food encourages the adult triatomines to leave wild ecotopes and search for new habitats, mainly in warm months when their biological activity is high.

Other studies have also shown that *P. megistus* invaded urban areas[8,9,20]. Such occurrences show the need for continuing education that aims at teaching preventive measures and actions in environmental and entomological surveillance to communities and health professionals. The georeferencing of *P. megistus* records (Figure 2) observed that invaded households were always very close to the woods. Additionally, since the triatomine is an autochthonous species, it leaves natural spots and invades even after intradomicile colonies are extinct. To find adult and nymph *P. megistus,* it requires actions in entomological surveillance with the community support. Active search must be the answer given by surveillance to find triatomines. Passive surveillance, which requires community participation, is the best methodology to find triatomines[15].

CONCLUSION

Thus, the results show that *P. megistus* is very important in the PAMA, because it invades and colonizes households. In addition, high rates of *T. cruzi* infection have drawn attention. Therefore, there is a risk of human infection due to vectorial transmission. Studies of food sources of captured insects may help to determine the degree of anthropophilia in the region, which is the next step of research. Finally, it has been known that CD may not be eradicated, but surveillance strategies – and awareness and participation of the population for insect notification – must be maintained so as to mitigate risks of invasion/colonization of artificial ecotopes and consolidate results of control that have already been reached in RS.

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