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Triatoma rubrovaria (Hemiptera, Reduviidae, Triatominae) in the Pampa biome, Brazil: a retrospective study of its occurrence and abundance

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ABSTRACT

Triatoma rubrovaria has been captured in some areas of Rio Grande do Sul State (RS), Brazil, as this species can be found in the Pampa biome. Its distribution across this biome should be described in detail to verify the potential of this vector to transmit *Trypanosoma cruzi*. This study aimed to investigate the occurrence of *T. rubrovaria* in the Pampa biome and transitional areas of RS. The collected information resulted from the analysis of secondary data provided by the Centro Estadual de Vigilancia em Saude (CEVS – State's Center of Health Surveillance). The following aspects were taken into consideration: the year in which the insect was captured, the city, the number of specimens captured, invasion or domiciliation, the notification in the household, surroundings or both, and *T. cruzi* infection. The data comprised the period from 2009 to 2020, in 109 cities located in the Pampa biome and 98 located in transitional areas. The Pampa biome exhibited 85% of the occurrences of *T. rubrovaria,* while 1.2% of specimens were *T. cruzi*-like positive. Both the first and second biennia concentrated 64.6% of captures. Alegrete city, Cangucu city and Piratini city were the locations in the Pampa where the largest numbers of specimens were found. Regarding the transitional areas, Roque Gonzales city, Santiago city and Santana da Boa Vista city exhibited the largest numbers. Most insects were adults, which were found in households. Even though positivity for *T. cruzi*-like was low, the species still has epidemiological importance in the region.

KEYWORDS: Chagas disease. Triatominae. *Trypanosoma cruzi*.

INTRODUCTION

Vector-borne diseases cause around 700,000 deaths annually worldwide; such diseases are more frequent in tropical and subtropical areas and mainly affect socially vulnerable populations[1]. Among the vectors, there are triatomine bugs, which are hematophagous insects widely distributed across the Americas.

There are about 60 species of triatomines and vectors distributed across Brazil[2]. Ten species of 'kissing bug' found in the country are epidemiologically important for the transmission of Chagas disease (CD)[3].

The vector capacity is not only related to its degree of anthropophilia and metacyclogenesis – production of a large number of *Trypanosoma cruzi* (infective forms) – but also to the time spent by insects between the blood meal and defecation[4]. The spread of the disease is also associated with several ecoepidemiological factors, such as vegetation, geology, climate, and passive dispersion of triatomines by migratory displacement of humans and other animals[5].

Some studies have shown that *Triatoma rubrovaria* (Blanchard, 1843) (Hemiptera, Triatominae) is strictly distributed within the Pampa biome, even though it has already been reported in Ouro Preto do Oeste city, a municipality located in Rondonia State (RO), Northern Brazil, where it may have arrived due to human migration[2,6].

The Pampa biome is located in the southern part of South America, namely Brazil, Argentina and Uruguay. The Brazilian Pampa extends over 176.5 km^2 in the extreme south of Rio Grande do Sul State (RS)[7]. It is a type of savanna formation, composed of grasslands and small enclaves of shrub vegetation on predominantly flat terrain and little seasonal variation in the distribution of resources.

In RS, there were few reports of *T. rubrovaria* found intradomicile before 1975, since *Triatoma infestans* (Klug, 1834) prevailed in households while *T. rubrovaria* was limited to the wild environment[8]. After some years, *T. rubrovaria* became more synanthropic and was also found intradomicile[8,9].

Recent data on human seroprevalence of *T. cruzi* in RS have shown positivity rates between 0.27% and 5% in studies carried out with residents in southern RS[10-12]. It shows an important prevalence of CD among this population, since the disease's main prevalence among blood donors in Brazil was 0.21%[12]. *T. rubrovaria* remains the epidemiologically most disperse and relevant species in RS[13].

Its distribution across the Pampa biome should be described in detail to analyze its behavior and take better entomological surveillance and control measures for its monitoring. This study is aimed at investigating the occurrence of *T. rubrovaria* in the Pampa biome and transitional areas of RS.

MATERIALS AND METHODS

Study area

This descriptive and retrospective study of CD vectors is based on secondary data provided by the Centro Estadual de Vigilancia Sanitaria (State Center of Health Surveillance, which is supervised by the Secretaria Estadual da Saude do Rio Grande do Sul (State Health Department of Rio Grande do Sul State) (CEVS-SES-RS), Brazil. The study resulted from the partnership between the Universidade Federal de Pelotas (UFPel – Pelotas City Federal University) and CEVS-SES-RS.

This study used specific data on the species *T. rubrovaria* in the Pampa biome and transitional areas (Figure 1). Thus, the study encompassed 207 municipalities in RS; 109 are located in the Pampa biome while 98 are located in transitional areas (classification and division of biomes that predominate in the municipalities are provided by data provided by the CEVS).

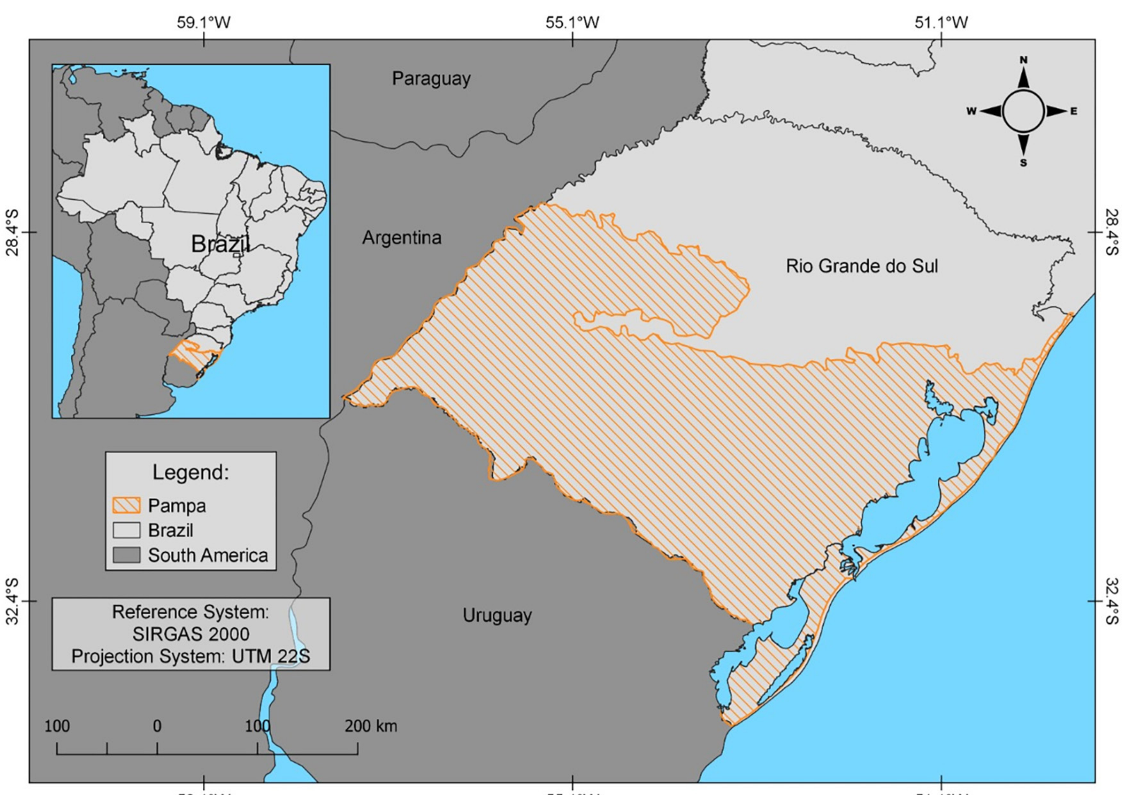

Figure 1 - Study area of *T. rubrovaria* in Rio Grande do Sul State, Brazil.

Issues and variables under observation

Information collected from 2009 to 2020 was analyzed to investigate changes in the spread of *T. rubrovaria* over time. The 12-year period was divided into six biennia and two sexennia to focus on the differences and trends of the species in the study area. The following variables were considered to carry out the analysis: the year of capture; the municipality; the biome; the number of specimens captured; invasion (capture of adults) or domiciliation (characterized by nymphs in households); the location of capture (intradomicile, peridomicile or both); and infection by flagellates.

Maps of dispersion and frequency of the species under study in municipalities located in the Pampa biome and transitional areas were carried out by the QGIS software program (version 3.22.5, Odense, Denmark).

It should be highlighted that the hemipterans had been recorded by passive/communitarian surveillance (reported by the population) and by active surveillance (captures made by PCDCh agents). All vectors were taken to the Laboratorio Central de Saude Publica do Rio Grande do Sul (LACEN/RS – Central Public Health Laboratory of Rio Grande do Sul State), to be identified and subjected to fresh parasitological examination of triatomine droppings by optical microscopy in order to detect natural infection by *Trypanosoma* sp.

Statistical analysis

Data were inserted into the Microsoft Excel® program and a database was created. Values were expressed as frequency (observed value n) and percentage. Statistical comparison among variables was carried out by the chi-squared test χ^2, considering significant values of $p \leq 0.05$. Tests of statistical significance were conducted by the MINITAB® software (version 18, Minitab LLC, Pennsylvania, USA).

RESULTS

In the period under analysis, 2,747 specimens of *T. rubrovaria* were captured; 2,333 (85%) specimens were captured in the Pampa biome. Regarding the evolutionary stages, most were adults (1,735-74.4%) found in both intradomicile and peridomicile areas (Table 1). Only seven (1.2%) of 713 triatomine bugs in the Pampa biome and transitional areas (25.9%) were positive for *T. cruzi*. In the transitional areas, of the 112 specimens under analysis, no specimen was positive.

The analysis of the Pampa biome (Table 1) shows that the first and second biennia accounted for 64.6% of the occurrences of *T. rubrovaria*. A decrease in the number over the period under investigation was also found, since the sixth biennium had only 3.9% of the total of captured insects. Figure 2 shows the decrease in the number of occurrences in the period under analysis. Comparison between both sexennia 2009–2014 and 2015–2020 showed a statistically significant difference ($p < 0.0001$). The largest number was detected in the first sexennium.

In transitional areas (Table 2), the first biennium accounted for 33.1% of the occurrences while the last one totaled 4.6%. Most captured triatomines (76.8%) were adults, both in intradomicile and peridomicile areas. There was also a significant difference between the captures that took place in both sexennia (2009–2014 and 2015–2020) ($p < 0.0001$). *Triatoma rubrovaria* was more frequent in artificial biotopes in the first sexennium.

Triatoma rubrovaria was reported in 51 (46.8%) of the 109 municipalities located in the Pampa biome, from 2009 to 2020. The vector was only found in 19 (19.4%) of the 98 municipalities of the transitional area. It shows that the species is more significantly dispersed throughout the municipalities located in the Pampa biome than in those located in transitional areas ($p = 0.0036$).

Figure 3 shows the spread of *T. rubrovaria* in the Pampa biome. Alegrete city and Cangucu city were the

Table 1 - *T. rubrovaria* in the Pampa biome from 2009 to 2020: biennia, places of capture and infection rate of *T. cruzi.*

Biennium	Intradomicile		Peridomicile		Total	%	Analyzed	Positive (%)
	Adults	Nymphs	Adults	Nymphs				
2009–2010 (1st)	462	51	113	107	733	31.42	272	5 (1.8)
2011–2012 (2nd)	436	179	97	61	773	33.13	204	2 (0.9)
2013–2014 (3rd)	254	79	47	14	394	16.89	74	0
2015–2016 (4th)	147	23	22	8	200	8.57	23	0
2017–2018 (5th)	70	50	21	0	141	6.04	16	0
2019–2020 (6th)	50	16	16	10	92	3.94	12	0
Total	419	398	316	200	2,333	100	601	7 (1.2)

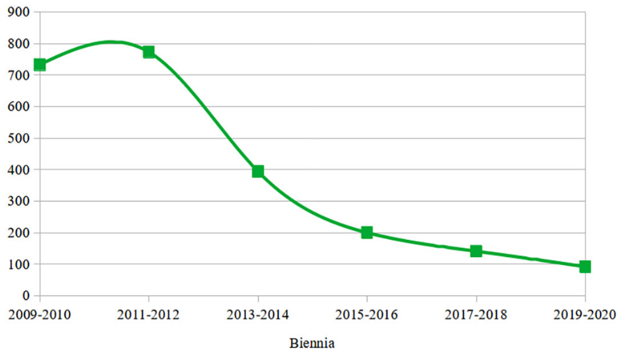

Figure 2 - *T. rubrovaria* in the Pampa biome from 2009 to 2020.

municipalities that recorded the highest numbers of captures (>250), followed by Piratini city (15–250). In transitional areas, Roque Gonzales city, Santiago city and Santana da Boa Vista city were the municipalities that recorded the highest numbers of captures (Figure 4).

DISCUSSION

The natural habitat of *T. rubrovaria* comprises cracks, holes and empty spaces among rocks in fields, a characteristic feature of the Pampa biome[2].

Table 2 - *T. rubrovaria* in transitional areas of Rio Grande do Sul State, Brazil, from 2009 to 2020: biennia, places of capture and infection rate of *T. cruzi*.

Biennium	Intradomicile		Peridomicile		Total	%	Analyzed	Positives
	Adults	Nymphs	Adults	Nymphs				
2009–2010 (1st)	116	9	11	1	137	33.09	54	0
2011–2012 (2nd)	53	19	14	5	91	21.98	31	0
2013–2014 (3rd)	57	3	3	0	63	15.22	5	0
2015–2016 (4th)	22	43	2	0	67	16.18	3	0
2017–2018 (5th)	20	5	3	9	37	8.94	15	0
2019–2020 (6th)	16	2	1	0	19	4.59	4	0
Total	284	81	34	15	414	100	112	0

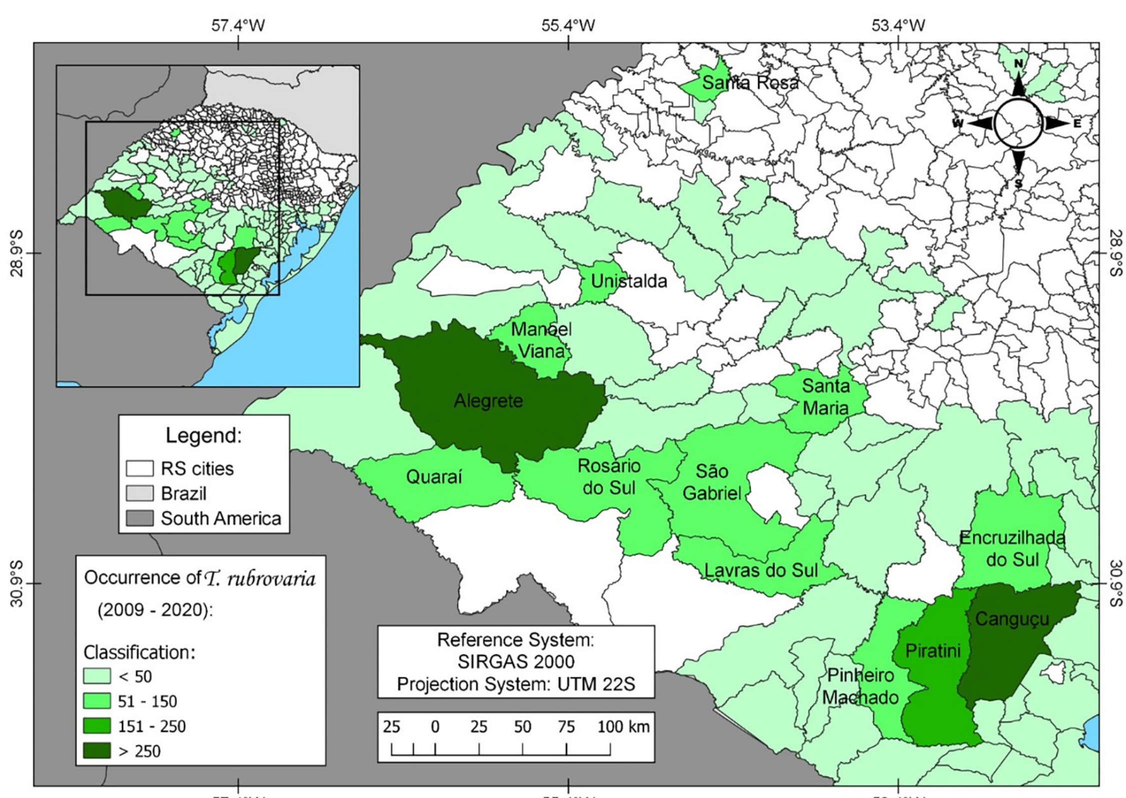

Figure 3 - Occurrence of *T. rubrovaria* in municipalities located in the Pampa biome in RS, Brazil, from 2009 to 2020.

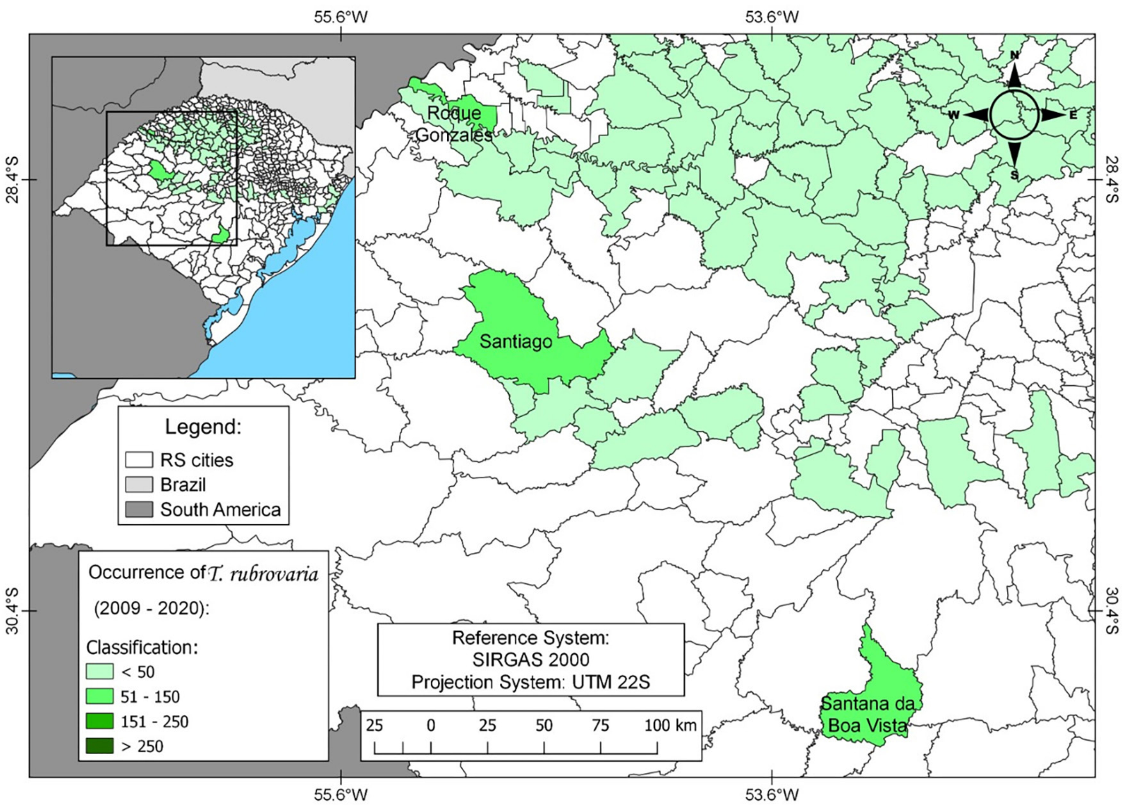

Figure 4 - Occurrence of *T. rubrovaria* in municipalities located in transitional areas (formed by the Pampa biome and the Atlantic Forest) in RS, Brazil, from 2009 to 2020.

The data analysis carried out by this study shows that occurrences of *T. rubrovaria* decreased over time. Other studies of CD vectors in RS reported similar results[13,14]. The decrease may be the result of advances in *T. infestans* control measures, the main objective of the Programa de Controle da Doenca de Chagas (PCDCh – Chagas Disease Control Program), which has been working in the whole country to plan activities of active research, chemical control and housing improvement since 1975[9,15]. Consequently, it ends up being effective to control other *T. cruzi* vectors.

Other control measures are the Programa de Melhorias Habitacionais para Controle da Doenca de Chagas (MHCDCh – Housing Improvement Program for Chagas Disease Control)[16] and educational campaigns addressed to the community, such as the pictorial calendar named 'CD Calendar', issued in 2017[17]. An example of actions that support surveillance for controlling vectors is a campaign that was launched in 2012 by SES-RS, targeted at different groups of people.

An educational documentary about CD and its vectors, produced by UFPel, CEVS and the Universidade Federal do Rio Grande do Sul (UFRGS – Rio Grande do Sul State Federal University) in 2016, with free web access, focuses on important aspects of the disease, such as its prevention and control, and is also a relevant contribution to face CD in the region. It has around 50 thousand views on YouTube©[18,19,20].

The number of *T. rubrovaria* found intradomicile was larger than the one found peridomicile, a fact that corroborates the findings of the National Health Foundation from 1980 to 1984, which also reported a larger number of vectors intradomicile[21]. Priotto *et al*.[14] found the same occurrence pattern in the study they conducted in municipalities that belong to the 3ª Coordenadoria Regional de Saude (3rd Regional Health Coordination) in RS, between 2006 and 2011[14].

Although current data show that a larger number of *T. rubrovaria* is found intradomicile, it should be highlighted that there were more reports of cases of *T. rubrovaria* found peridomicile before 1976, a fact that may suggest its domiciliation trend[8].

The comparison between data from 1996 and from 2007 showed that the number of nymphs found peridomicile from 2003 onwards was larger than that found intradomicile, i.e., it increased from 7.9% to 20.6%[10]. However, in this study, for both biomes (Pampa and transitional areas), the larger number of nymphs found intradomicile may not only result from the trend in domiciliation of the species but also from the fact that the population is more capable of detecting triatomines inside rural households than in their surroundings[22,23].

Based on data found by this study, Cangucu city kept being one of the municipalities with the largest number of occurrences. It may be due to the fact that its environment is appropriate for the vectors, with several shelters in a region with many farming activities, which leads to buildings, such as barns and stalls, where *T. rubrovaria* can develop[14].

An analysis conducted by the 3rd and 7th Regional Health Coordination in RS also showed that Cangucu city was the municipality that recorded the largest number of triatomines[13] among the municipalities to which both departments belong. It demands a specific study in this municipality, an objective of this study group.

It should be mentioned that a factor that may interfere with the number of captures of *T. rubrovaria* in RS is the population's knowledge of vectors. A study showed that 45.3% of patients with cardiovascular diseases treated in Pelotas city, RS, were not capable of identifying triatomines[24].

Interviews with residents of endemic areas in RS showed that 58.3% of interviewees were able to identify triatomines; the ones that lived in Cangucu city and had chicken and pig pens near their houses recognized them easily[23]. It should be added that Cangucu city has one of the highest occurrence rates of the vector; this high report rate may be directly related to the knowledge of the population that identifies the CD vector and communicates it for entomology surveillance.

Occurrences of *T. rubrovaria* may increase, as some studies have shown that the increase in room temperature caused by global warming triggers the reproduction of CD vectors and accelerates the multiplication of *T. cruzi* in triatomines[25]. In addition, heat affects the insect dispersion, a factor that stimulates displacement from the wild environment to the surroundings of human housing[22,25].

However, the opposite was observed in the Pampa biome and transitional areas. It may result from successful actions conducted by PCDCh in the period under investigation since, in the last biennium, the species was found sporadically, at low numbers, a fact that characterizes a better epidemiological situation than the one observed in the first biennium.

CONCLUSION

Triatoma rubrovaria is more dispersed across municipalities located in the Pampa biome than those found in transitional areas. In the latter, no vectors that tested positive for *T. cruzi* were found. The largest number of captured specimens (both adults and nymphs) was found intradomicile. It corroborates the hypothesis that degrees of synanthropy and domiciliation of the species have increased over the last decades. However, in the period under analysis, the number of occurrences decreased over the years but, even so, it should be emphasized that the invasion of artificial biotopes by adult and nymph insects in both the Pampa biome and transitional areas – mainly in some municipalities – justifies the maintenance of entomological surveillance in the region under investigation. Neither the population nor public managers should neglect the control of CD vectors.

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AUTHORS' CONTRIBUTIONS

CBS: conception and design of the study, analysis and interpretation of data, drafting the article, final approval of the version to be submitted; GBS: analysis and interpretation of data; CB: acquisition of data, drafting the article; MB and FM: drafting the article; MMV: acquisition of data, drafting the article, final approval of the version to be submitted.

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