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OPINION ARTICLE

Tick biodiversity in the Cerrado biome and implications for One Health: A panoramic look

Biodiversidade de carrapatos no bioma Cerrado e implicações na Saúde Única: um olhar panorâmico

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ABSTRACT The Cerrado occupies 23.3% of the national territory and is considered the second largest biome in Brazil. Climate change, deforestation and agricultural expansion are a threat to the biodiversity of Brazilian biomes, as they can increase the extent of fires in the Cerrado. The Cerrado is among the 25 'hotspots' on the planet, that is, areas with endemic species that suffer significant habitat loss. In 2024, the Cerrado showed a rate of loss, associated with deforestation, of 1,786 hectares/day. The degradation and modifications of the biome favor the emergence of diseases, mainly those with vector-borne agents. Among the diseases that have ticks as vectors, we can mention Brazilian Spotted Fever (BSF), which has been mandatory for notification by the Ministry of Health since 2001. BSF is caused by bacteria belonging to the genus Rickettsia and ticks, in addition to being the main vectors, can act as a reservoir. BSF progresses rapidly and can lead to death if treatment is initiated late. Climate change can directly affect the reproduction rate of vectors and the distribution of pathogens, which may contribute to changes in the epidemiological scenario in the Cerrado biome.

KEYWORDS Vectors. Climate change. Transmitted diseases. Pathogens.

RESUMO *O Cerrado ocupa 23,3% do território nacional, sendo o segundo bioma mais extenso do Brasil. As mudanças climáticas, o desmatamento e a expansão agrícola representam uma ameaça à biodiversidade dos biomas brasileiros, já que podem ampliar os incêndios no Cerrado. Esse bioma está entre os 25 'hotspots' do planeta, ou seja, áreas com espécies endêmicas que sofrem perdas significativas de habitat. Em 2024, o Cerrado apresentou um ritmo de perda, associado ao desmatamento, de 1.786 hectares/dia. A degradação e as modificações do bioma favorecem o surgimento de doenças, principalmente aquelas com agentes transmitidos por vetores. Dentre as doenças que têm carrapatos como vetores, pode-se citar a Febre Maculosa Brasileira (FMB) de notificação compulsória pelo Ministério da Saúde desde 2001. A FMB é causada por bactérias pertencentes ao gênero Rickettsia, e os carrapatos, além de serem seus principais vetores, podem atuar como reservatório. A FMB apresenta progressão rápida e pode levar a óbito quando o início do tratamento é tardio. As mudanças climáticas podem afetar diretamente a taxa de reprodução de vetores e a distribuição de patógenos, o que pode contribuir para alterações do cenário epidemiológico no bioma Cerrado.*

PALAVRAS-CHAVE *Vetores. Mudanças climáticas. Doenças transmitidas. Patógenos.*

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Introduction

Brazil is divided into six biomes: the Amazon, Caatinga, Cerrado, Atlantic Forest, Pampa, and Pantanal. The Cerrado, known as the Brazilian savanna, covers 23.3% of the national territory and is considered the largest tropical dry forest in South America and the second largest biome in Brazil[1,2]. In Brazil, the Cerrado encompasses the states of Goiás, Tocantins, and the Federal District, as well as parts of Bahia, Ceará, Maranhão, Mato Grosso, Mato Grosso do Sul, Minas Gerais, Piauí, Rondônia, and São Paulo. It also occurs in disjunct northern areas in the states of Amapá, Amazonas, Pará, and Roraima, and to the south, in small 'islands' in Paraná[3].

The Cerrado is among the planet's 25 hotspots, that is, areas with endemic species undergoing significant habitat loss[4]. In this context, climate change is a threat to the biodiversity of Brazilian biomes, since higher temperatures and reduced rainfall directly influence vegetation dynamics[5]. Degradation and changes in the Cerrado biome favor the emergence of diseases, especially those caused by vector-borne agents, such as Brazilian spotted fever (BSF), borreliosis, babesiosis, dengue, zika, yellow fever, malaria, among others[6].

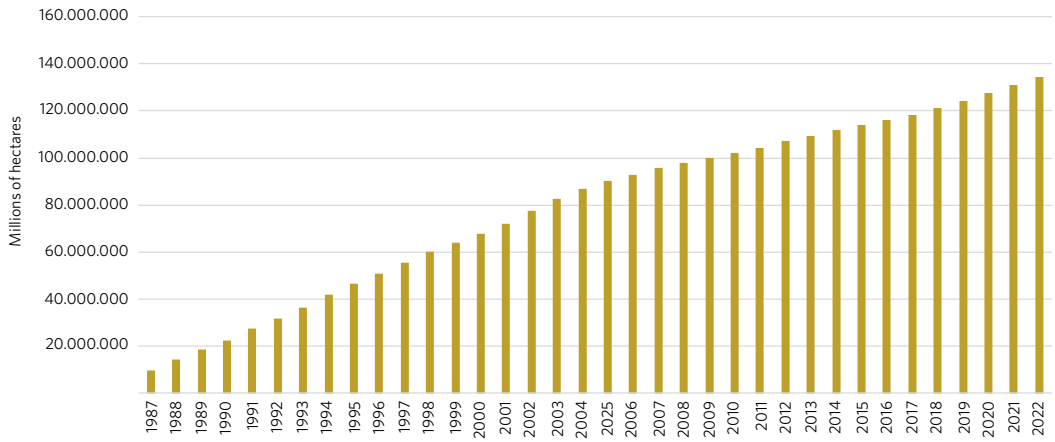
Climate change in the Cerrado biome

Anthropogenically modified ecological processes may pose a risk to the Cerrado biome[7]. It is considered a neotropical savanna that benefits from a naturally established fire regime, but this dynamic has been changing due to human activities[8].

Climate change, deforestation, and agricultural expansion contribute to increasing the extent of fires in the Cerrado[9,10]. Land conversion is generally associated with population growth, economic development, and socioeconomic factors that ultimately trigger increased fires, habitat fragmentation, and ecosystem degradation[11]. In 2024, the Cerrado accounted for 45% of deforested areas related to urban expansion[12].

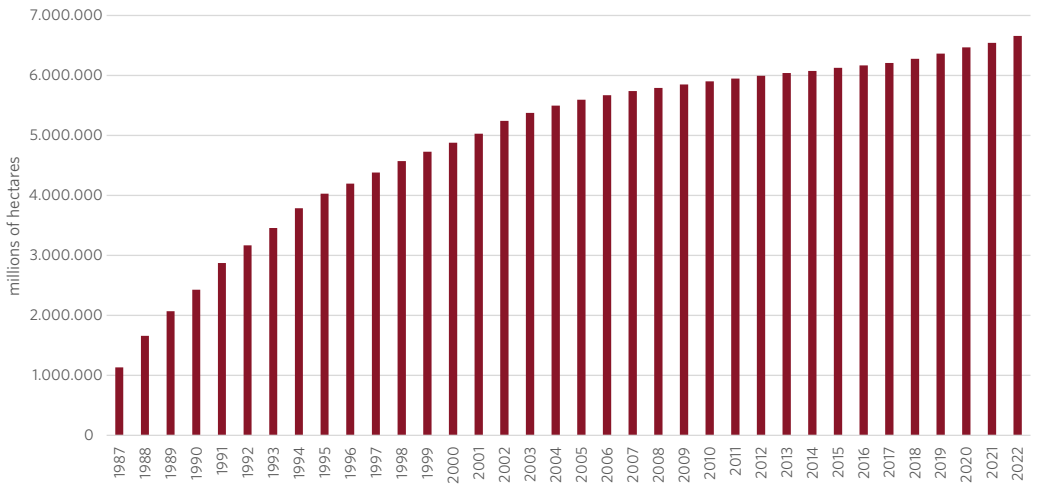
It is estimated that, from 1987 to 2023, around 50,997,109 hectares (*graph 1*) were deforested in the Cerrado biome[12]. In Mato Grosso do Sul (*graph 2*), the deforested area reached 7,483,788 hectares from 1987 to 2023. Although the Annual Report on Deforestation in Brazil (RAD) indicated a decline in deforestation across all biomes in 2023 and 2024, the Cerrado was the biome with the largest deforested area for the second consecutive year, with a loss rate of 1,786 hectares per day in 2024 alone, thus surpassing the Amazon.

Graph 1. Cumulative deforested area from 1987 to 2023 in the Cerrado biome



Source: MapBiomas Project[12].

Graph 2. Cumulative deforested area from 1987 to 2023 in the state of Mato Grosso do Sul



Source: MapBiomas Project[12].

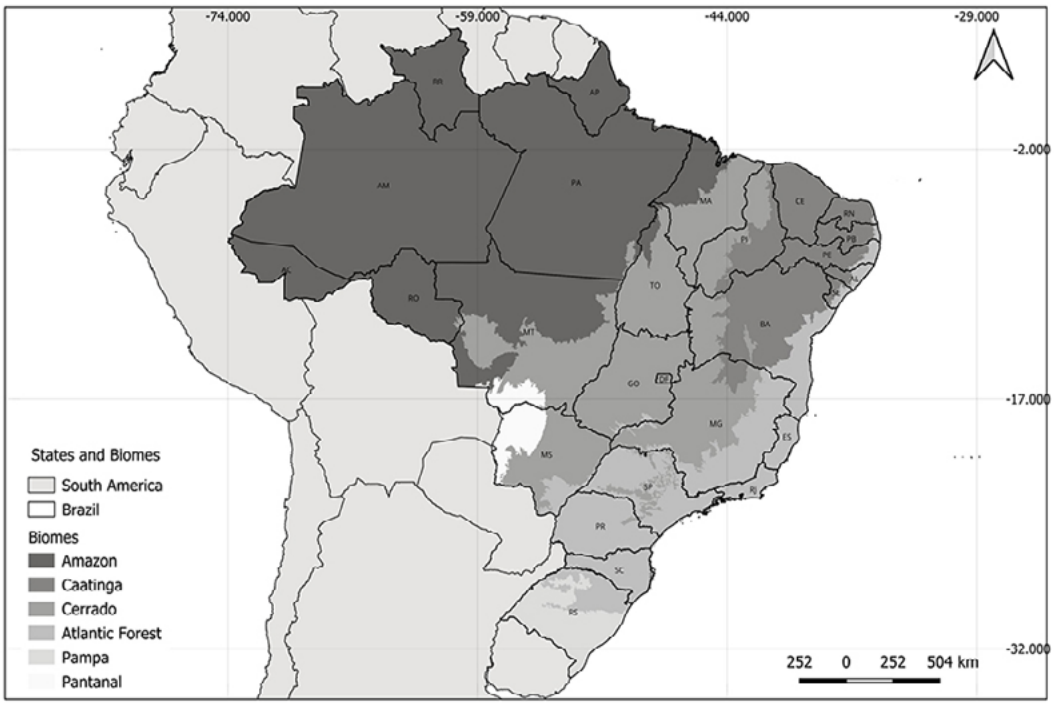
Distribution of ticks across regions and their respective biomes

According to the literature, almost 100% of ticks in the family *Argasidae* are found in states where the Cerrado biome is present, although not as the sole biome, but always in transition and mixed with others. These ticks are most often found in arid or semiarid habitats and exhibit nidicolous habits in close association with their hosts[13].

We can infer that, in the Midwest, in Mato Grosso, Mato Grosso do Sul, and the Federal District, the Cerrado biome is substantially larger in nearly all states, not to mention parts of the Southeast, more specifically

Minas Gerais and São Paulo; the Northeast, particularly Maranhão and Bahia; and the North, especially Tocantins (*figure 1*). From this standpoint, theoretically, the number of *Argasidae* species becomes 'diluted', and may decrease.

Figure 1. Distribution of Brazilian biomes and states



Source: Prepared by the authors. Map generated in QGIS 3.34.11[14].

A single *Argasidae* species, *Ornithodoros brasiliensis*, has been reported in Rio Grande do Sul[15], where the Pampa biome predominates, isolated from the other biomes and bordering or mixing only to a lesser extent with the Atlantic Forest biome.

The *Ixodidae* family is represented by great generic diversity and richness of tick species distributed across regions and their respective biomes. Tick species diversity in the Midwest, where the Cerrado biome predominates, ranks fourth in the overall number of species from both families, representing 53.8% of the total number of species in Brazil, with ticks in the *Ixodidae* family being more numerous, second only to the South, where the Pampa biome predominates[13] (*table 1*).

Table 1. Number and genus of ticks belonging to the families *Ixodidae* and *Argasidae* distributed in the five Brazilian regions

Number and genus of ticks										
Região	**Amb (34)**	**Hae (3)**	**Rhi (3)**	**Der (1)**	**Ixo (12)**	**Arg (1)**	**Ant (3)**	**Not (2)**	**Orn (19)**	**Total (%)**
Midwest	25	2	2	1	3	1	0	0	8	42 (53.8%)
North	28	2	2	1	6	1	2	2	9	53 (68%)
Northeast	20	2	2	1	3	1	2	1	11	43 (55.1%)
Southeast	24	2	2	1	7	1	0	0	8	45 (57.7%)
South	21	1	3	1	7	1	0	0	1	33 (42.3%)

Source: Prepared by the authors.

Genus: Amb: *Amblyomma*; Hae: *Haemaphysalis*; Rhi: *Rhipicephalus*; Der: *Dermacentor*; Ixo: *Ixodes*; Arg: *Argas*; Ant: *Antricola*; Not: *Nothoaspis*; Orn: *Ornithodoros*.

The Cerrado, the second largest biome, occupying 23% of the national territory and bordering all other biomes except the Pampa[1], has undergone intense pressure from deforestation and recurrent fires over recent decades. It is estimated that 50% of its native vegetation has given way to pastures and monocultures that have compromised biodiversity[12], and that approximately 6% of its total area is protected[16].

With this devastation, degraded or anthropogenic areas emerge as new habitats for animals that were previously entirely wild. As a result, new vector behaviors arise, such as those of ticks of the genus *Amblyomma*, more specifically *Amblyomma sculptum*[17], which use humans as hosts.

The presence of ticks in the central region of the country, where the Cerrado biome predominates, has become a constant concern, whether because of its importance in One Health or in the cattle production chain[18], although this region ranks fourth in the number of ticks in Brazilian *Ixodid* fauna (*table 1*).

There is strong potential for some species present in the Midwest to act as vectors of pathogens of importance in One Health. *Amblyomma sculptum*, common in the Cerrado biome and adapted to degraded areas, is an example of a 'generalist' tick because of its low host specificity[19] and, in its adult stage, shows a preference for capybaras, tapirs, and horses[20,21]. *A. sculptum* is considered the main species responsible for anthropophagy in Brazil[22,23] and the vector of the bacterium *Rickettsia rickettsii*, the etiologic agent of BSF[24].

Other ticks of the genus Amblyomma are also a source of concern: *Amblyomma ovale*, for example, the main vector of the Atlantic Forest strain of *Rickettsia parkeri*, has been reported in several biomes of the country[25-28], with high adaptive capacity to degraded environments and a very broad host range[29].

Another example of a tick found in different regions and biomes is *Amblyomma dubitatum*[30]. In the adult phase, this tick prefers to parasitize mainly capybaras (*Hydrochoerus hydrochaeris*); however, larvae and nymphs can parasitize other animal species, and there are reports of parasitism in humans[19,23]. We also have records of ticks of this species infected with *rickettsiae*[19,31,32], although the pathogenicity of these agents still needs to be better clarified, as does the vector competence of *A. dubitatum*.

In Brazil, ticks of the family Ixodidae, popularly known as hard ticks, require greater attention both in One Health and

in the production chain[33]. Most often, they have a three-host life cycle, represented by ticks of the genera *Amblyomma*, *Haemaphysalis*, and *Ixodes*, with exceptions for some species, for example, *Rhipicephalus microplus* and *Dermacentor nitens*[34], although they all share one characteristic: hematophagy.

General overview of tick-borne diseases worldwide

Arthropod vectors of infectious agents have received increasing prominence in recent years in Public Health, with mosquitoes and ticks being the main groups associated with diseases worldwide[35]. In general, several groups of pathogens can be transmitted, including viruses, bacteria, and protozoa. Diseases such as Crimean-Congo hemorrhagic fever, tick-borne encephalitis, Lyme disease, and human granulocytic anaplasmosis are examples of illnesses widely distributed in countries of the Northern Hemisphere[36].

Many factors can alter the dynamics of a given disease. However, climate change is clearly described as one of the factors responsible for the increase of diseases such as Lyme disease, anaplasmosis, babesiosis, and Powassan virus, for example, in Canada[37]. According to the authors, rising temperatures are associated with increases in tick abundance, dispersion, and behavioral changes, and these factors are considered important in human exposure to tick-borne diseases.

In general, what happens in the environment can affect the dynamics of diseases in a given location. According to the review study conducted by Leal Filho[38], an increase in temperature may have impacts on vectors and their pathogens. Examples include accelerated development of eggs and larvae, increased longevity and fertility of adult individuals, changes in seasonality, increased vector populations overall, expanded geographic distribution, and others.

Brazilian spotted fever

In Brazil, the incidence of tick-borne diseases is intrinsically linked to BSF, considered the main tick-borne disease in the country. BSF is caused by bacteria belonging to the genus *Rickettsia*, which are Gram-negative and obligate intracellular organisms[39]. Ticks are the main vectors of the BSF agent and may also act as reservoirs. The genus *Rickettsia* is composed of five groups: spotted fever, typhus, transitional, ancestral, and *R. canadensis*[39,40].

In Brazil, human infections by the BSF agent are generally associated with bites from ticks of the genus *Amblyomma*, such as *A. sculptum*, *A. aureolatum*, and *A. ovale*[41]. According to the literature, a broad range of hosts can also be considered for *A. sculptum* (for example, tapirs, horses, capybaras, and dogs), whereas *A. aureolatum* preferentially parasitizes wild carnivores[42,43]. The generalist behavior and consequent interaction with various hosts are fundamental factors that make this tick a Public Health concern with respect to pathogen transmission[36].

Another factor contributing to greater interaction between ticks and hosts is the heteroxenous life cycle. In the case of *A. sculptum*, each instar (larva, nymph, and adult) climbs onto a host, feeds, and then returns to the environment to undergo ecdysis. Thus, if the feeding process occurs on different hosts, there is a greater likelihood of exposure to possible pathogens, including *Rickettsia sp*.

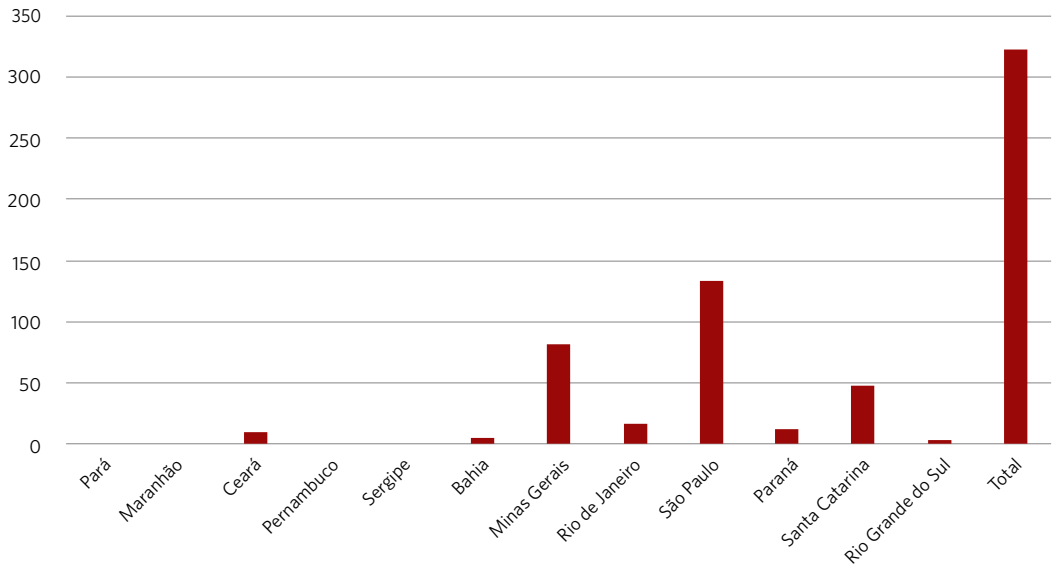
Hosts that are frequently parasitized by immature instars (larvae and nymphs) and that develop the disease, that is, *Rickettsia*, are by definition considered amplifier hosts[44]. The presence of amplifier hosts, vertebrate animals that develop rickettsia for a few days, contributes to the infection of previously uninfected ticks[45,46].

Two species in Brazil are considered amplifier hosts. The capybara (*Hydrochoerus hydrochaeris*) acts as an amplifier host of *R. rickettsii*[47], and the opossum, *Didelphis aurita*[48]. Horses are considered efficient sentinels for

detecting pathogen circulation in areas where the vector uses this animal as a host[49].

Brazil's Notifiable Diseases Information System (Sinan Net) recorded 323 confirmed cases of spotted fever in 2023, with the Southeast showing the largest number of confirmed cases, totaling 237, followed by the South with 65 notifications, the Northeast with 20 notifications, and the North with one notification (*graph 3*).

Graph 3. Confirmed cases reported in the Notifiable Diseases Information System in 2023



Source: Ministry of Health/SVSA, Notifiable Diseases Information System – Sinan Net[50].

BSF is a rapidly progressive disease that may lead to death if treatment is delayed. The incubation period ranges from 2 to 14 days, and clinical symptoms include sudden high fever, headache, myalgia, prostration, nausea, vomiting, and rash. In this context, implementing protective barriers against ticks is the best form of protection, through the use of repellents and appropriate clothing[50].

Conclusions

Deforestation and agricultural expansion in the Cerrado biome have reached increasingly alarming levels, favoring habitat fragmentation and ecosystem degradation. It is well known that globalization and climate change directly affect ecosystems, bringing about changes in the behavior of the host/vector/pathogen triad. This behavioral shift is important in studies on the ecoepidemiology of vectors, since their hosts adapt to new environments, bringing vectors and agents with them into urban, peri-urban, and degraded areas.

In this context, the Cerrado biome and its pathogen-vector ticks, especially *Rickettsia sp.*, are a major concern in One Health. Ticks such as *A. sculptum*, *A. ovale*, and possibly other species of the genus may carry these agents responsible for causing spotted fever and other diseases not yet reported.

For this reason, in this new environmental reality, it is extremely important to monitor vectors and to conduct ongoing epidemiological studies of transmitted agents, as well as to

create public policies that can mitigate this impact on One Health.

Authorship contributions

Garcia MV (0000-0002-7757-215X)*, Duarte PO (0009-0003-6141-7651)*, Higa LOS (0000-0002-6655-3412)*, Santos JC (0000-0001-8294-0431)* and Barros JC (0000-0003-0520-9092)* contributed to the collection, analysis and interpretation of data, writing, critical revision and approval of the final version of the manuscript. Andreotti R (0000-0002-0739-2997)* contributed to the conception and design of the work, data collection, analysis and interpretation, writing, critical revision and approval of the final version of the manuscript. ■

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