



## Climate, Ticks and Tick-Borne Diseases: Mini Review

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### Abstract

Vector disease transmission cycles are multi-faceted phenomena characterized by their biological complexity and represented by interactions between sets of vector species, pathogens, and the environment. This review will discuss climate as a predictive variable for the presence of ticks and tick-borne diseases.

### Keywords

Disease vectors; Climate change; Epidemiology

### Introduction

Climate is recognized as one of the main determining factors in the distribution of vector-borne diseases in geographic areas [1]. In the case of ticks, studies have found that each species chooses environmental conditions and biotopes that determine its geographic distribution and, as a consequence, outline the areas of risk for the pathogens that each species may transmit [2,3]. Analyses involving climate datasets have been used to predict tick distribution in the United States [4], Europe [5-7], South Africa [8], and Brazil [9]. These findings reinforce the importance of climate thresholds to the dynamics of tick-borne pathogen transmission [2].

Given the fact that changes in climate may determine tick distribution, some studies have presented predictive models that consider different climate scenarios and which may therefore be used to aid in the understanding of both vector distribution in the next few decades and the interactions involved in tick-borne diseases [6,7,10].

### Climate change

The Intergovernmental Panel on Climate Change (IPCC) defines climate change as statistically significant variations in average climate parameters (including their natural variabilities) which persist over an extensive period (typically decades or longer). Climate change may be caused by natural processes; however, recently observed changes have been accelerated by human activity [11].

Studies show that climate change may be associated with the increased incidence of tick-borne encephalitis [6,7]. These researchers found that a combination of mild winter temperatures and the early

arrival of spring led to increased tick density and activity and a consequently higher incidence of encephalitis transmission in Europe.

One of the possible effects of global warming is the expansion of suitable habitat for ticks. Substantial seasonal variations such as warmer, shorter winters and increased annual mean temperatures could enable greater development of tick populations [2]. However, using the premise of conservative climate niche, in which species do not evolve in the same way as predicted climate change does, studies have confirmed that species from the *Amblyomma cajennense* complex are likely to have their areas of distribution reduced as a result of climate change. The authors also suggest that climate change may indirectly reduce the risk of spotted fever in the country, given the reduction in areas with adequate climatic conditions for the main vector, *Amblyomma sculptum* [9].

### Climate as a secondary influence

Climate change may also indirectly influence the risk of tick-borne diseases, since it changes use patterns and soil occupation among humans in sectors such as agriculture, tourism, and leisure. Because some of these conditions are themselves influenced by climate change, a complex chain of events is triggered which causes other factors to become more important than climate change itself for the occurrence of disease [12,13].

These oscillating temperature patterns have influenced short-term human activities such as picnics, fishing, camping, and human migration, thus putting humans in closer contact with nature and, more specifically, with tick habitats [7,12]. Another factor found was a significant positive correlation between the number of people in endemic areas and disease occurrence [6].

In Brazil, episodes of infection and death caused by spotted fever are frequently observed among people who are exposed to ticks in situations that were indirectly motivated by climate change (personal communication). Parasitism is frequently reported as a result of leisure activities, such as camping, fishing, and ecological tourism, in which human populations typically underestimate human parasitism and the risk of illness (Figure 1). In this context, some authors have suggested that climate has a secondary influence, since the effects of human occupation have the dominant influence on abundance and environmental suitability for niche occupation by ticks [14].

### Perspectives, limitations, and final considerations

One of the main limitations of current studies on potential tick distribution is that most data on these vectors' climate preferences are empirically derived from descriptions of their niches and attributed as if the species were distributed uniformly [15]. There are few records on the microclimates experienced by tick populations. To minimize these biases, studies will ideally consider microclimatic data on soil surface temperature and on relative humidity in the air. These variables may be crucial in determining specific niche distribution patterns within an ecological community [15]. However, the availability of this information is still limited.

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**Figure 1:** Climate as a secondary influence on the occurrence of tick-borne diseases. Human populations frequent tick-infested areas as part of leisure activities. The sign says, “WARNING: This site is known to have Cayenne ticks.” Photo by Gilberto Salles Gazeta.

Another factor to consider is that species with wide geographic distributions may vary considerably within their areas of occurrence, which, depending on ecological variations, may result in different species densities between regions [2,12]. Though many studies have sought to create geographic distribution models for ticks based on climatic variables, other factors are involved in the establishment of ecological niches. These factors complicate the practice of creating representative models for this vector [12]. Along this same vein, future studies should include variables that operate in different phases of this vector’s life cycle [15-17].

Some authors have also discussed the adaptability of certain species of ticks. In Europe, the tick *Ixodes ricinus* was found to be extremely flexible when faced with climatic variations and may exhibit very different seasonal activity, which itself results in unique and dynamic geographic coverage [7]. However, some ecologists believe that most species do not have the ability to adapt to sudden climate changes, such as those which have been projected for the next few decades. Thus, they believe that niche conservation may narrow areas that are climatically adequate and may even lead to the extinction of species which are more sensitive to these changes in global climate [9,18,19].

## Conclusion

This discussion has provided a general overview of climate changes that could influence the expansion or retraction of tick distributions and which may be considered when mapping transmission risk for tick-borne diseases.

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