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Editorial

CLIMATE CHANGE AND THE ESCALATING THREAT OF TICK-BORNE INFECTIONS IN INDIA

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ABSTRACT: Ticks are blood-feeding ectoparasites and potent vectors of numerous pathogens affecting humans and animals worldwide. Climate change is accelerating the spread and intensity of tick-borne diseases (TBDs), with rising temperatures, altered precipitation patterns, and extreme weather events expanding tick habitats and transmission seasons. In India, changing climatic conditions have led to the geographical expansion of key tick species such as *Hyalomma anatolicum*, *Rhipicephalus microplus*, and *Haemaphysalis* spp., increasing the risk of diseases like Kyasanur Forest Disease, Crimean–Congo hemorrhagic fever, and Lyme disease. These shifts are compounded by land-use changes and human encroachment into wildlife habitats, creating a 'One Health' challenge. Effective mitigation requires integrated surveillance, advanced research on vector-pathogen interactions, and climate-resilient public health policies. A proactive, coordinated approach is essential to safeguard India's livestock-dependent economy and prevent emerging zoonotic threats in a warming world.

Keywords: Climate change, Tick and tick borne disease, One Health.

Ticks are blood-feeding ectoparasites of domestic and wild animals as well as humans. Ticks are the most potent vectors of a wide range of pathogens, including viruses, bacteria and protozoa and they often harbour several agents simultaneously. Ticks and tick-borne diseases (TBDs) are becoming a bigger global problem, with (re)emerging diseases affecting human as well as animal wellness. Numerous, perhaps local, factors can contribute to an increase in cases, the discovery of new diseases, or the emergence of new epidemics in previously pathogen-free areas. This increase correlates with climate anomalies that occurred in the year 1990s, suggesting that diseases with vectors are sensitive to changes in environmental factors like temperature, precipitation, and extreme weather events may originate as a result of climate change [1, 2].

In India, the most common tick species are *Amblyomma integrum*, *Haemaphysalis spinigera*, *Dermacentor auratus*, *Rhipicephalus haemaphysaloides*, and *Hyalomma isaaci* and *Otobius megnini*, encompass Kyasanur Forest Disease (KFD), Crimean–Congo hemorrhagic fever (CCHF), Lyme disease (LD), Q fever (coxiellosis), and Rickettsial infections. The first documented outbreaks of KFD transpired in Karnataka in 1957, followed by successive positive sero-surveillance results recorded in many states across India, despite the lack of significant outbreaks [3, 4, 5]. There are concerns about the prevalence of CCHF in Gujarat, Rajasthan, and Uttar Pradesh, as positive cases have been detected in both human and animal samples throughout the country [6, 7, 8].

As climate change continues, the close relationship between ticks and their surroundings has changed a lot. The average surface temperature of the Earth has risen by 1.5°C since pre-industrial times. The main cause of global warming or climate change is the increase in greenhouse gases in the atmosphere, especially carbon dioxide, methane, and nitrous oxide [9]. A major change that people often observe due to climate change is that tick populations are growing and tick-borne diseases (TBDs) are spreading around the world. Climate change poses a significant threat to the health of both humans and animals, particularly in countries like India, where agriculture and livestock rearing are crucial for rural livelihoods and food security. The current issues of climate change, vector ecology, and the increase of tick-

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borne zoonotic diseases need immediate attention and a coordinated response.

Climate change

The average annual surface air temperature has risen by around 1°C worldwide for the past 115 years (1901–2016). The human activity—particularly greenhouse gas emissions—is most likely the root cause of the warming that has been observed since the middle of the 20th century. According to the recent report, significant emission reductions could limit the annual average global temperature increase to 3.6°F (2°C) or less. However, by the end of this century, the yearly average global temperature could have increased by 5°C or more compared to preindustrial times if significant emission reductions are not made. Thousands of studies worldwide have shown changes in surface, atmospheric, and oceanic temperatures, melting glaciers, dwindling snow cover, sea ice, rising sea levels, ocean acidification, and atmospheric water vapor [1].

The impacts of climate change are also evident in India. In 2024, the South Asian nation had its highest annual mean temperature at 25.75 °C, above the 1991–2020 average by 0.65 °C. The rise in temperatures is already influencing Indian weather patterns, with repercussions such as a more unpredictable monsoon season, droughts, and flooding. Climate change significantly influences the incidence, duration of transmission seasons, and dissemination of tick-borne diseases, posing a substantial hazard [10, 11].

How climate change affects rising of the tick population global scenario

An elevation in temperature would induce alterations in the spatial distribution of TBDs, with cooler and more humid regions anticipated to face increased risk due to climate change.Tick presence and abundance may be influenced by climate in two ways: first, by changes in the per capita rates of death and reproduction; and second, by changes in tick activity, host populations, and environment, all of which have an indirect impact on tick survival and reproduction. The Bayesian network analysis revealed that precipitation was the most reliable predictor of tick abundance, though its significance varied by region [12]. The study found fewer *Dermacentor variabilis* nymphs, but other species like *Ixodes scapularis* and *Amblyomma americanum* showed that climate factors could change how common they are in Central Illinois compared to Southern Illinois. According to Minigan *et al.* [13] and Hahn *et al*. [14], higher precipitation levels during the warmest portion of the year imply higher habitat suitability for *I. scapularis*. Another similar work, also shown by Wojan *et al*. [15], found regional differences in tick abundance in Indiana, demonstrating the northward expansion of *A. americanum* and the southward movement of *I. scapularis*.

National scenario

India has experienced significant changes in climatic patterns in recent years, marked by increasing average temperatures, modified monsoon cycles, and a higher incidence of extreme weather events. The observed changes are contributing to an expansion in the geographical distribution and seasonal activity of multiple tick species. *Hyalomma anatolicum*, the vector of *Theileria annulata* and Crimean–Congo hemorrhagic fever (CCHF), has previously existed in dry and semi-arid locations. However, new ecology studies and field reports show that it has spread into northern subtropical zones, including Indo-Gangetic plains places where it hadn't been noticed before. So, the theileriosis has become more common in tropical regions due to the favourable microclimates brought about by increasing temperatures and decreasing humidity thresholds, which have allowed *H. anatolicum* to flourish. The same patterns may be seen with *Rhipicephalus microplus*, a kind of tick that spreads *B. bigemina* and *Anaplasma marginale* [16, 17].

Similarly, the increasing frequency of *Haemaphysalis* species, especially *H. spinigera* and *H. bispinosa*, in the Western Ghats, a biodiversity hotspot that is being exacerbated by deforestation and climate variability, is equally concerning. The rise in human cases of KFD in states like Karnataka, Kerala, Goa, and Maharashtra has coincided with the expansion of suitable habitats for *Haemaphysalis* ticks brought on by warming temperatures and altered rainfall patterns. In addition to climate change, the fundamental causes include increased human encroachment into wooded regions, which promotes increased interaction between people, animals, and wildlife–a classic 'One Health' situation [3, 4].

Mitigation strategies

Zoonotic tick-borne illnesses in India are underdiagnosed owing to low clinical knowledge and diagnostic infrastructure. Lyme disease, anaplasmosis, and rickettsial illnesses may be underreported or misdiagnosed. Climate change, land-use changes, and ecological disturbance raise the danger of zoonotic spillovers, emphasizing the need for a One Health strategy that combines veterinary, human, and environmental health.

In order to effectively combat tick-borne diseases in India, which are influenced by climate change, a well-coordinated and thorough response is required. First, a comprehensive tick monitoring system that integrates meteorological, epidemiological, genetic, and entomological data is needed. In order to provide real-time risk evaluations, this system should use mobile data platforms, geospatial analytics, and remote sensing. Second, tick genomes, vector-pathogen-host interactions, and acaricide resistance mechanisms need further investigation. These findings are essential for creating next-generation control tools and predicting environmental pressure-induced evolution.

Third, plans for public health and climate adaptation should include TBDs in the national policy frameworks. Among these measures is the incorporation of TBD control within India's National Action Plan on Climate Change (NAPCC) and the alignment of efforts with worldwide programs like the World Health Organization's worldwide Vector Control Response (GVCR). Last but not least, prioritizing community participation is essential. Livestock owners, frontline veterinary personnel, and local governing authorities may be empowered via field-level initiatives that raise awareness, provide training, and provide access to low-cost diagnostics and treatment options [18].

In conclusion, climate change is acting as a catalyst for the emergence and intensification of tick-borne diseases in India. The evolving epidemiology of these diseases reflects complex interactions among environmental, biological, and socio-economic variables. If India is to safeguard its livestock-dependent economy and prevent the emergence of new zoonotic threats, a paradigm shift is required—one that moves from reactive control to proactive, integrated, and climate-resilient disease management. The science is unequivocal; what remains is a commitment to implement evidence-based interventions that recognize the centrality of One Health in addressing the multifaceted challenges posed by ticks in a warming world.

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