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Climatic Influences on Canine Babesiosis: Patterns of Babesia Prevalence and Dynamics

Vidhya Venugopal [a++], Deepa, P.M. [a#*], Rathish, R.L. [a†], Janus, A [a†], Sulficar, S. [a†] and Chintu Ravisankar [b‡]

[a] *Department of Veterinary Epidemiology and Preventive Medicine, College of Veterinary and Animal Sciences, Pookode, Wayanad, 673 576, Kerala, India.*
[b] *Department of Veterinary Microbiology, College of Veterinary and Animal Sciences, Pookode, Wayanad, 673 576, Kerala, India.*

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

This study investigates the prevalence of *Babesia gibsoni* and *Babesia vogeli* in Wayanad district Kerala, India, from January 2021 to December 2023, focusing on the impact of climatic factors on pathogen abundance. Canine babesiosis, caused by these protozoan parasites, poses a significant health threat to dogs globally. Despite the increasing incidence of the disease, there is limited

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[++] *MVSC Scholar;*
[#] *Associate Professor and Head;*
[†] *Assistant Professor;*
[‡] *Professor and Head;*
**Corresponding author: Email: deepapm@kvasu.ac.in;*

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research on the influence of specific climatic variables on the prevalence of *B. gibsoni* and *B. vogeli* in Kerala. An analysis of 350 canine blood samples was done by PCR to evaluate the prevalence of these pathogens and their correlation with climatic factors such as temperature, evaporation rate, relative humidity, and rainfall. Whole blood samples were collected from dogs exhibiting clinical signs of babesiosis were examined using PCR, while biometeorological data, including temperature, relative humidity, wind speed, and evaporation rate, were simultaneously collected to explore their impact on parasite prevalence. Our findings indicated a higher prevalence of *B. gibsoni* (58.33%) compared to *B. vogeli* (41.67%), with *B. gibsoni* showing peak incidence in 2022. Statistical analysis revealed that maximum temperature and evaporation rate were positively associated with the abundance of both species, whereas relative humidity and rainfall were negatively correlated. These results highlight the significant role of climatic conditions in the epidemiology of canine babesiosis, emphasizing the need for further research to understand how specific environmental factors influence pathogen transmission. Such insights are crucial for developing effective strategies to manage and mitigate the impact of these diseases in Kerala.

Keywords: Climatic factors; B. gibsoni; B. vogeli; maximum temperature; relative humidity; rainfall; evaporation rate.

1. INTRODUCTION

Vector-borne diseases pose a significant threat to canine health, with arthropods such as ticks, fleas, and mosquitoes serving as primary vectors. Among these diseases, canine babesiosis tick-borne illness caused by protozoan parasites of the genus *Babesia* is notably prevalent and poses considerable health risks to dogs [1]. The distribution and incidence of canine *Babesia* species are largely influenced by the habitat of tick vectors. Notably, *Babesia gibsoni* can also be transmitted directly between fighting dog breeds, independent of tick vectors [2].

Large *Babesia* species, previously classified under *Babesia canis*, are now recognized as distinct species: *Babesia canis*, *Babesia rossi*, and *Babesia vogeli* [3]. Additionally, three small *Babesia* species—*Babesia gibsoni*, *Babesia conradae*, and *Babesia vulpes*—are established as canine pathogens [4]. In India, *Babesia vogeli* and *Babesia gibsoni* are the primary species responsible for canine babesiosis [5,6], with infections being widespread due to their respective vectors, *Rhipicephalus sanguineus* and *Haemaphysalis longicornis* [7].

Babesiosis can be classified as uncomplicated or complicated based on its pathogenesis. Uncomplicated babesiosis typically presents with mild to moderate anaemia, exhibiting symptoms such as pallor, weakness, icterus, fever, and pigmenturia. In contrast, complicated babesiosis involves severe pathogenesis, characterized by extensive organ dysfunction and high mortality, suggesting mechanisms beyond simple haemolysis [8].

Meteorological studies are crucial for understanding vector-borne diseases, as weather conditions significantly influence the behavior and population dynamics of disease-carrying vectors. Despite this, few studies have examined the impact of weather parameters on arthropod vector dynamics in canine populations [9,10]. This knowledge gap is particularly evident in Kerala, where unique climatic conditions may significantly influence vector ecology and disease prevalence.

The present study aims to address this gap by investigating the influence of meteorological conditions on vector populations and the occurrence of babesiosis in Kerala. Integrating meteorological data with epidemiological findings, this study seeks to elucidate the environmental factors driving the dynamics of canine babesiosis. This understanding is crucial for developing effective control strategies and mitigating the impact of babesiosis on canine health.

2. MATERIALS AND METHODS

2.1 Study Area and Duration

The study was conducted in the Wayanad district, Kerala, India, situated at 11.7032° N latitude and 76.0834° E longitude. The research spanned three years, from January 2021 to December 2023, and was performed at the Teaching Veterinary Clinical Complex, College of Veterinary and Animal Sciences, Pookode, Wayanad, Kerala, India.

2.2 Blood Sample Collection

Whole blood samples were collected from 350 dogs exhibiting clinical signs indicative of babesiosis, including pyrexia, anaemia, thrombocytopenia, lymphadenopathy, anorexia, and tick infestation. Blood was collected in EDTA vials for the molecular identification of *Babesia vogeli* and *Babesia gibsoni*.

2.3 Clinical Findings

All animals exhibited elevated body temperature, increased heart rate, and elevated respiratory rate. They showed pale mucous membranes, visible ticks, enlarged lymph nodes, inappetence, and lethargy.

2.4 DNA Isolation and Identification

DNA was isolated from 200 µL of whole blood using the Genomic DNA Kit (OriginTM) following the manufacturer's instructions. For the identification of *Babesia vogeli*, primers targeting a 450-bp fragment of the 18S rRNA gene were used: PIRO-A1 (5'-AGG GAG CCT GAG AGA CGG CTA CC-3') and PIRO-B (5'-TTA AAT ACG AAT GCC CCC AAC-3') (11). For *Babesia gibsoni*, primers targeting a 662-bp fragment of the 18S rRNA gene were employed: Gib599 (5'-CTC GGC TAC TTG CCT TGT C-3') and Gib1270 (5'-CCG AAA CTG AAA-3') (12). PCR amplification was performed with the following conditions: an initial denaturation at 94°C for 10 minutes, followed by 40 cycles of denaturation at 94°C for 30 seconds, annealing at 60°C for 30 seconds, and extension at 72°C for 30 seconds, concluding with a final extension at 72°C for 5 minutes. For *Babesia gibsoni*, the conditions included an initial denaturation at 95°C for 5 minutes, followed by 35 cycles of denaturation at 95°C for 30 seconds, annealing at 55°C for 30 seconds, extension at 72°C for 90 seconds, and a final extension at 72°C for 10 minutes. Amplified PCR products were resolved by gel electrophoresis on a 1.5% agarose gel and visualized using a Gel Documentation System (Bio-Rad Laboratories, USA) (Fig. 1).

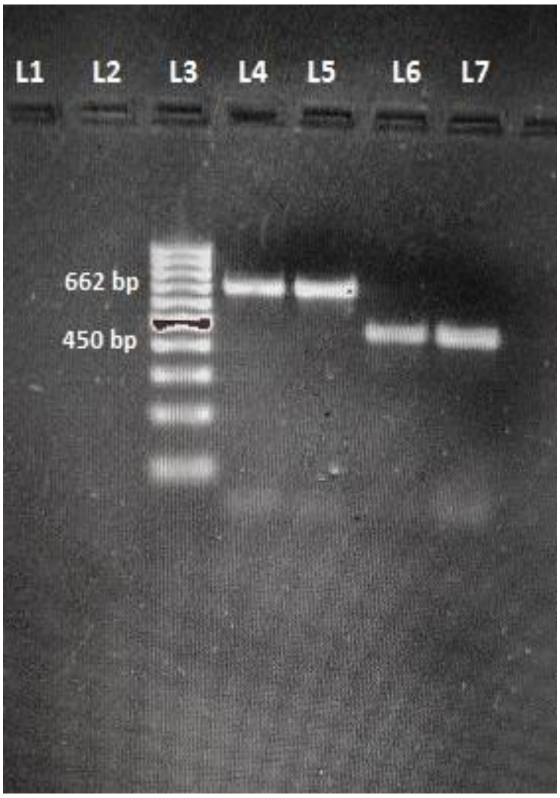

Fig. 1. PCR assay based on 18srRNA primer, showing approximately 662 bp and 450bp amplification products specific for *Babesia gibsoni* and *Babesia vogeli* respectively

Lane 1- negative control for Babesia gibsoni; Lane 2- negative control for Babesia vogeli; Lane 3- 100 bp ladder marker; Lane 4- positive control for Babesia gibsoni; Lane 5- sample 1; Lane 6- positive control for Babesia vogeli; Lane 7- sample 2

2.5 Biometeorological Data Collection

Biometeorological data for the entire study period were obtained from the College of Agriculture, Ambalavayal, Wayanad. The data included various meteorological parameters: maximum and minimum temperature, average relative humidity, wind speed, and pan evaporation.

2.6 Statistical Analysis

Data were analyzed using IBM-SPSS software version 24 (United States, 2016). Spearman's rank correlation coefficient was employed to assess the relationship between biometeorological parameters and the molecular incidence of *Babesia vogeli* and *Babesia gibsoni*.

3. RESULTS

Out of 350 samples subjected to molecular analysis, 276 (78.86%) tested positive for canine babesiosis and 74 (21.14%) were negative and the analysis revealed a significant predominance of *Babesia gibsoni* (46%, 161 cases) over *Babesia vogeli* (32.85%, 115 cases) in the study population. The monthly prevalence of *B. gibsoni* and *B. vogeli* varied across the years 2021, 2022, and 2023 (Tables 1, 2, and 3).

Statistical analysis showed that maximum temperature and evaporation rate had a significant positive correlation with the abundance of both *B. gibsoni* and *B. vogeli*. Conversely, relative humidity and rainfall were significantly negatively correlated with the abundance of these species. Wind speed and minimum temperature did not exhibit a significant correlation with the abundance of either species (Table 3).

4. DISCUSSION

This study demonstrates a significantly higher incidence of *Babesia gibsoni* compared to *Babesia vogeli* over the three years, indicating a predominant prevalence of the smaller *Babesia* species in Wayanad. This finding is consistent with previous studies [11], suggesting that the high prevalence of *B. gibsoni* may be attributed to its direct transmission among fighting dog breeds, bypassing tick vectors, and the region's overall tick abundance [12,13].

Monthly variations in the occurrence of *B. gibsoni* and *B. vogeli* point to the influence of seasonal and environmental conditions on their transmission dynamics [14]. Previous research supports the notion that the prevalence of these parasites is closely linked to the presence of tick vectors, which are influenced by seasonal and environmental factors [15,16]. Our study highlights the substantial role of environmental conditions in the epidemiology of haemoparasitic infections, revealing significant correlations between pathogen abundance and climate parameters.

The positive correlation between maximum temperature and evaporation rate with infection rates suggests that warmer and drier conditions promote the proliferation and activity of vectors and pathogens, thus enhancing disease transmission [17,18]. In contrast, the negative correlations with relative humidity and rainfall imply that increased moisture may mitigate infection prevalence. Low humidity and rainfall, which promote tick activity and survival, are associated with higher incidences of tick-borne diseases, including canine babesiosis. This observation aligns with findings that *B. vogeli* infections peak during dry periods with low rainfall, low humidity, and optimal temperatures for tick activity [19].

A limitation of this study is the reliance on data from a single geographic area, which may not fully capture the variability of climatic influences across different regions. Additionally, while our study provides valuable insights into the relationship between environmental factors and parasite dynamics, it does not address potential host-specific factors that may influence infection rates.

The findings of this study underscore the critical impact of climatic factors on managing and controlling haemoparasitic diseases in dogs. By detailing the effects of temperature and humidity on pathogen and vector dynamics, the study facilitates the development of targeted intervention strategies and improves disease forecasting. The results confirm that climatic conditions significantly influence the prevalence of *Babesia gibsoni* and *Babesia vogeli*, validating our hypothesis that environmental factors are essential to the epidemiology of canine babesiosis.

Future research should include diverse geographical regions and additional variables, such as host and vector behaviors, to refine control measures and improve overall disease management strategies.

Table 1. Temporal Variation in the Occurrence of *Babesia gibsoni*

Month	No. of positives in 2021	No. of positives in 2022	No. of positives in 2023	Total samples collected (2021-2013)	Total positives (2021-2013)	Total negatives (2021-2013)	Percentage of positivity (%)
Jan	7	8	4	34	19	15	55.88
Feb	6	9	5	31	20	11	64.52
Mar	7	7	5	25	19	6	76.00
Apr	8	1	4	26	13	13	50
May	0	6	7	33	13	20	39.39
Jun	1	7	6	31	14	17	45.16
Jul	2	3	2	24	7	17	29.17
Aug	0	5	3	15	8	7	53.33
Sep	6	4	2	34	12	19	35.29
Oct	1	6	8	36	15	21	41.67
Nov	3	3	3	31	9	18	29.03
Dec	4	6	2	30	12	12	40.00

Table 2. Temporal variations of *Babesia vogeli*

Month	No. of positives in 2021	No. of positives in 2022	No. of positives in 2023	Total samples collected (2021-2023)	Total positives (2021-2023)	Total negatives (2021-2023)	Percentage of positivity (%)
Jan	1	7	3	34	11	23	32.35
Feb	6	4	4	31	14	17	45.16
Mar	3	5	2	25	10	28	40.00
Apr	3	1	4	26	8	18	30.77
May	2	3	5	33	10	23	30.30
Jun	2	3	2	31	7	24	22.58
Jul	0	3	2	24	5	19	20.83
Aug	0	2	2	15	4	11	26.67
Sep	4	2	2	34	8	23	23.53
Oct	3	5	11	36	19	17	52.78
Nov	4	1	7	31	12	15	38.71
Dec	6	5	2	30	13	11	43.33

Table 3. Correlation of abundance of different species with climatic factors

Climatic Variables	Abundance					
	B. gibsoni		***B. vogeli***		***E. canis***	
	Correlation	**P-value**	**Correlation**	**P-value**	**Correlation**	**P-value**
Min Temp	0.057	0.742	-0.163	0.343	0.004	0.982
Max Temp	0.447**	0.006	0.340*	0.043	0.367*	0.028
RH1	-0.234	0.169	0.090	0.603	-0.205	0.231
RH2	-0.603**	0	-0.446**	0.006	-0.506**	0.002
Average RH	-0.530**	0.001	-0.338*	0.044	-0.452**	0.006
Rainfall	-0.431**	0.009	-0.349*	0.037	-0.267	0.116
Wind Speed	-0.001	0.998	-0.037	0.828	-0.143	0.405
Evaporation rate	0.472**	0.004	0.226	0.185	0.336*	0.045

*** Significant at 0.01 level; * Significant at 0.05 level*

5. CONCLUSION

This study provides compelling evidence of the significant influence of climatic factors on the prevalence of *Babesia gibsoni* and *Babesia vogeli* in dogs. Our findings demonstrate that warmer and drier conditions enhance the activity and proliferation of tick vectors, thereby increasing the incidence of these haemoparasitic diseases. Conversely, elevated humidity and rainfall appear to reduce pathogen prevalence. These insights underscore the importance of integrating meteorological data into disease surveillance and control strategies.

The results confirm that environmental factors are pivotal in shaping the epidemiology of canine babesiosis, validating our hypothesis that climate plays a crucial role in the dynamics of this disease. Understanding these relationships enhances our ability to predict disease outbreaks and develop targeted interventions, ultimately contributing to more effective management of canine babesiosis. Future research should include diverse geographical regions and additional variables, such as host and vector behaviors, to further refine control measures and improve overall disease management strategies.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declares that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

COMPETING INTEREST

Authors have declared that no competing interests exist.

REFERENCES

1. Petra B, Josipa K, Renata BR, Vladimir M. Canine babesiosis: where do we stand? *Acta veterinaria*. 2018;68:127–160. Available:https://doi.org/10.2478/acve-2018-0011
2. Baneth G. Babesia of domestic dogs. In: Parasitic Protozoa of Farm Animals and Pets. 2018; 241–258. DOI:10.1007/978-3-319-70132-5_10
3. Panti-May JA, Rodriguez-Vivas RI. Canine babesiosis: A literature review of prevalence, distribution, and diagnosis in Latin America and the Caribbean. Veterinary Parasitology Regional Studies and Reports. 2020;21:100417. DOI:10.1016/j.vprsr.2020.100417
4. Teodorowski O, Kalinowski M, Winiarczyk D, Dokuzeylül B, Winiarczyk S, Adaszek Ł. Babesia gibsoni infection in dogs—A European perspective. Animals. 2022; 12(6):730. DOI: 10.3390/ani12060730
5. Kundu K, Kumar S, Maurya PS, Mandal M, Ram H, Garg R, Pawde AM, Raina OK, Banerjee PS. PCR-based identification of Babesia canis vogeli in clinically affected dogs. Journal of Veterinary Parasitology. 2012;26(2):167–169. Available:https://www.researchgate.net/publication/282069820
6. Mandal M, Banerjee PS, Kumar S, Garg R, Ram H, Kundu K, Raina OK. Development and evaluation of serodiagnostic assays with recombinant BgSA1 of Babesia gibsoni. Veterinary Parasitology. 2014;205: 483–489. DOI: 10.1016/j.vetpar.2014.08.020
7. Abd Rani PAM, Irwin PJ, Coleman GT, Gatne M, Traub RJ. A survey of canine tick-borne diseases in India. *Parasites & Vectors*. 2011;4:141. https://doi.org/10.1186/1756-3305-4-141.
8. Irwin PJ. Canine babesiosis. Veterinary Clinics of North America: Small Animal Practice. 2010;40:1141–1156. DOI: 10.1016/j.cvsm.2010.08.001
9. Jitsamai W, Taweethavonsawat P. Prevalence of canine tick-borne diseases in Bangkok and vicinity, Thailand: The consequence of climate parameters. Board of Reviewing Editors. 2021; 51:110–111. DOI:10.13140/RG.2.2.26165.81124
10. Ajith Y, Adithya S, Panicker VP, Athira N, Beena V, Safeer MS, Preena P, Nisha AR, Divya C, Sangeetha SG, Umesh CG. Biometeorological analysis on the molecular incidence of babesiosis and ehrlichiosis in dogs. Theoretical and Applied Climatology. 2024;155:1573–1582. DOI: 10.1007/s00704-023-04709-5
11. Jain J, Lakshmanan B, Nagaraj HV, Praveena JE, Syamala K, Aravindakshan T. Detection of Babesia canis vogeli, Babesia gibsoni, and Ehrlichia canis by multiplex PCR in naturally infected dogs in South India. Veterinarski arhiv. 2018;88: 215–224. DOI: 10.24099/vet.arhiv.161229

12. Birkenheuer AJ, Correa MT, Levy MG, Breitschwerdt EB. Geographic distribution of babesiosis among dogs in the United States and association with dog bites: 150 cases (2000–2003). Journal of the American Veterinary Medical Association. 2015;227:942–947.
DOI: 10.2460/javma.2005.227.942
13. Baneth G. Babesia of domestic dogs. In: *Parasitic protozoa* of Farm Animals and Pets. 2018;241–258.
DOI: 10.1007/978-3-319-70132-5_10
14. Chaurasia R, Mehta HK, Choudhary J, Jayraw AK, Jain A, Rajput N, Joshi M, Patil JU. Clinical occurrence of canine babesiosis in the vicinity of Indore, Madhya Pradesh, India, and associated epidemiological implications. Pharma Innovation Journal. 2022;11:356–361.
Available:https://www.researchgate.net/publication/383157584
15. Lata K, Das G, Verma R, Baghel RPS. Impact of climate variability on occurrence and distribution of vector and vector-borne parasitic diseases. J Entomol Zool. 2018;6: 1388-93.
Available:https://www.researchgate.net/publication/327156024
16. Schäfer I, Helm CS, von Samson-Himmelstjerna G, Krücken J, Kottmann T, Holtdirk A, Kohn B, Hendrickx G, Marsboom C, Müller E. Molecular detection of Babesia spp. in dogs in Germany (2007–2020) and identification of potential risk factors for infection. *Parasites & Vectors*. 2023;16:396.
DOI: 10.1186/s13071-023-06005-7
17. Jacobson LS. The South African form of severe and complicated canine babesiosis: Clinical advances 1994–2004. *Veterinary Parasitology*. 2006;138:126–139.
DOI: 10.1016/j.vetpar.2006.01.047
18. Bashir IN, Chaudhry ZI, Ahmed S, Saeed MA. Epidemiological and vector identification studies on canine babesiosis. Pakistan Veterinary Journal. 2009;29:107–112.
Available:https://www.researchgate.net/publication/273762238
19. Maia MG, Costa RT, Haddad JP, Passos LM, Ribeiro MF. Epidemiological aspects of canine babesiosis in the semiarid area of the state of Minas Gerais, Brazil. Preventive Veterinary Medicine. 2007;79: 155–162.
DOI: 10.1016/j.prevetmed.2006.11.013

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