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Species composition, prevalence, and diversity of ixodid ticks (Acari: Ixodidae) on domestic ruminants in the forest-associated ecosystems of Trivandrum district, Kerala, India

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ABSTRACT

Ticks significant vectors impacting livestock and pet health with substantial economic loss in tropical and subtropical region. Identifying their species wise infestation on livestock has become critical for designing targeted and sustainable control measures. This study assessed tick infestation in cattle, buffalo and goat (n=156) across five human-wildlife interaction zones in the Western Ghats, Trivandrum district, Kerala. Cattle and goats had high infestation rates of 81.94% and 73.91%, respectively, while buffaloes had a moderate rate of 46.67%. The tick infested population (n=992) comprised nine species across three genera: *Haemaphysalis bispinosa*, *Haemaphysalis intermedia*, *Haemaphysalis turturis*, *Haemaphysalis spinigera*, *Rhipicephalus (Boophilus) annulatus*, *Rhipicephalus (Boophilus) microplus*, *Rhipicephalus sanguineus*, *Rhipicephalus haemaphysaloides*, and *Amblyomma integrum*. Majority of the collected ticks were adult ixodids (n=740), predominantly females (n=440). The most common species were *R. (B.) annulatus* (32.36%), followed by *H. bispinosa* (26.11%) and *H. intermedia* (9.17%). *H. spinigera* was least predominant species (0.4%). Host wise analysis of prevalence revealed that *H. intermedia* was most common in goats, while *R. (B.) annulatus* was predominant in cattle and buffaloes. Diversity analysis using the Simpson Diversity Index showed Ponmudi as the most diverse location (H = 1.65), while Neyyar had the lowest diversity (H = 1.24). Ponmudi also exhibited the highest species richness with all nine species, whereas Neyyar had only five. Peppara, ranking third in diversity, showed a more even distribution of tick populations (Pielou's Index J' = 0.83). This study highlighted significant variations in tick prevalence and diversity across different locations, which may have implications for targeted tick management strategies.

Key words: Domestic ruminants, Diversity index, Prevalence, Tick, Trivandrum

India being an agricultural country, livestock management has a pivotal role in economic growth as well as food and nutritional security. India accounts for a significant share of the world's livestock resources with nearly 57% of world's buffaloes, 16.5% cattle, 16.3% goat and 5.7 % sheep (Food and Agriculture Organization 2004). The success of the livestock industry relies on the health of the animals and their sustained productivity. A major threat to this industry is ectoparasitic invasion, particularly by ixodid ticks, parasitizing vertebrate animals and are responsible for the transmission of several tick-borne diseases. Diseases such as babesiosis, theileriosis, and anaplasmosis causes significant constraints on livestock productivity (Monfared *et al.* 2015, Waskel and Gaur 2015, Riaz 2017). Severe infestations with ixodid ticks result in a wide range of harmful effects, including tick worry, metabolic disorders, tick toxicosis, secondary infections, anaemia, weight loss, dermatitis, sweating sickness, and in extreme cases, death due to severe blood loss. From an economic perspective, these infestations contribute to significant reductions in milk production and weight gain in cattle (Kumar *et al*. 2018).

Although Kerala is an agricultural land, livestock remains a crucial component of the state's rural economy. Small-scale cattle rearing is a key contributor to the economic stability of middle-class farming communities due to its low space requirements, reduced maintenance costs, ease of management, and the high demand for livestock products in urban markets (Princy *et al.* 2024). Despite the economic significance of livestock farming, tick infestations persist as a major challenge, particularly in ecologically sensitive areas such as the Western Ghats. However, there is a notable scarcity of epidemiological data on tick-borne diseases in Kerala, including distribution pattern of tick species affecting livestock in these regions. Moreover, the close interactions between domestic livestock and wildlife the biodiversity rich Western Ghats may further facilitate

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the transmission of tick-borne pathogens, posing additional risks to both livestock and wild life. Therefore, this study aims to fill this critical knowledge gap by providing a preliminary assessment of the diversity and prevalence of tick species infesting domestic ruminants like cattle, buffalo and goat in the Western Ghats of Trivandrum.

MATERIALS AND METHODS

Study area: This study was conducted from the month of January to April in two consecutive years of 2021 and 2022, in five distinct forest associated locations: Ponmudi, Bonacaud, Peppara, Breimore and Neyyar in the Western Ghats region of Trivandrum district, Kerala, India. The climatic parameters like temperature (95°F to 69°F), annual precipitation (1835 mm) as well as humidity (63% to 80%) of the study area is quite conducive to high tick proliferation. Vegetation in the study area includes tropical evergreen, moist mixed deciduous, and semi-evergreen forests. Domestic animals were sampled at 35 locations within five key research sites, viz., Ponmudi, Bonacaud, Peppara, Breimore, Neyyar.

Specimen collection & identification: Tick infestations were assessed in cattle (Bos taurus), buffalo (Bubalus bubalis), and goats (Capra hircus) irrespective of age groups. Cattle and buffalo that had not received any acaricide treatment for at least two weeks prior to sampling were included in the study. Tick specimens were collected from different tick-prone area on the body, including ear pinnae, the region around the eyes, hind leg, neck, udder, and groin, using blunt forceps. The specimens were preserved in 70% ethanol in labelled transparent vials and transported to the laboratory. The specimens were identified using stereo zoom microscope with the help of taxonomic keys available (Sharif 1928, Trapido et al. 1964, Walker et al. 2003, Geevarghese and Mishra 2011).

Statistical analysis: Classic alpha diversity indices viz, Species richness, Shannon diversity index (H), Simpson diversity index(D) were enumerated separately for each study location. Species evenness was calculated using Pielou's Index (J'). All the statistical analysis were done using Microsoft excel and PAST.

RESULT AND DISCUSSION

Tick infestation intensity and genus level dominance observed in the study area: The study identified an elevated tick prevalence of 75.0% among 156 livestock (72 cattle, 69 goats, 15 buffaloes) across five different localities in the Western Ghats of Trivandrum (Table 1) in concordance with the results of Anish *et al*. (2020) in Andhra Pradesh. Host-wise analysis indicated that cattle had the highest infestation rate of 81.9%, followed by goats 73.9%, whereas buffaloes displayed the lowest rate 46.7%. It aligns with the earlier reported infestation rates for cattle ranging from 53% to 86.15%. (Prakasan and Ramani 2007, Shyma *et al.* 2013, Patel 2013, Chhillar *et al.* 2014, Kumar *et al.* 2014, Kaur *et al.* 2017, Balasubramanian *et al.* 2019, Ghosh *et al.* 2019, Patel 2019, Anish *et al.* 2020, Nataraj *et al.* 2021, Ranganathan *et al.* 2021). However, lower prevalence rates below 50% have also been reported in some regions (Kumar *et al.* 2014, Patel *et al*. 2019, Ranganathan *et al.* 2021). Similar to the observations by Prakasan and Ramani (2007), the higher prevalence of this tick species on cattle may be attributed to its brevirostrate nature, which makes it more adapted to thin-skinned and hairy hosts. Similar to the findings of this study (46.7%), very low tick infestation rates on buffaloes have also been reported from Punjab, Kerala and Gujarat (Haque *et al*. 2011, Shyma *et al*. 2013, Patel *et al*. 2019). Buffaloes typically carry fewer ticks due to their thicker hide, mud-wallowing behaviour, and management practices that reduce tick attachment (Islam *et al*. 2006, Da Silva *et al*. 2013, Patel *et al*. 2013, Galay *et al*. 2021).

The genus *Haemaphysalis* was the predominant taxon in this study, comprising 57.7% of the sample, and showing its highest prevalence in the sites of Peppara (71.4%) and Bonacaud (63.6%) (Table 1). This distribution mirrors earlier findings from Kerala and adjoining Western Ghats regions, where *Haemaphysalis* was consistently linked to humid, canopy-rich environments and strong wildlife–livestock interfaces (Balasubramanian *et al.* 2021). *Rhipicephalus spp*. were also widely recorded (42.9%), with notable prevalence in Peppara (50.0%). Very low detection of *Amblyomma* (3.2%) is in concordance with the study by Balasubramanian *et al*. (2019) where only 1.5 % of the same has reported. Its restricted occurrence in Ponmudi and Bonacaud may reflect narrow habitat preferences, seasonality or limited wildlife contact.

The species-wise composition of ixodid ticks collected from hosts across the study locations is presented in Table 1, while representative microscopic images of the 9 identified

Table 1. Overall prevalence and genus wise prevalence (%) of ixodid ticks in study area

Location	No. of animals examined	Overall prevalence (%) of infestation	Percentage prevalence of tick genera (%)		
			Rhipicephalus	Haemaphysalis	Amblyomma
Ponmudi	45	77.8	42.2	60.0	8.9
Bonacaud	22	33.3	36.4	63.6	4.5
Peppara	28	46.7	50.0	71.4	0.0
Breimore	42	80.0	45.2	50.0	0.0
Neyyar	19	22.2	36.8	42.1	0.0
Total	156	75.0	42.9	57.7	3.2

ixodid tick species are shown in Figure 1 (Supplementary). The most predominant tick species identified in this study was *R. (B.) annulatus*, which accounted for 32.36% of the total tick population. This was followed by *H. bispinosa* (26.11%) and *H. intermedia* (9.17%). *R. (B.) annulatus* showed a strong bovine tropism, infesting the majorly on cattle (56%) and buffaloes (70.9%). These findings are in contrast with earlier reports indicating a higher prevalence of *R. (B.) microplus* in India and abroad, with prevalence rates ranging from 38% to 99.5%, as by(Lahkar (1991), Mohanta *et al.* (2011), Sen (2012), Singh and Rath (2013), Kakati (2003), Patel *et al*. (2013), Jaswal *et al*. (2014), Mandloi *et al*. (2016), and Gopalakrishnan *et al*. (2017). Contrary to the observations of Prakasan and Ramani (2007) in Kerala, *R. (B.) annulatus* was absent on goats in the present study (Table II). The negligible infestation of *R. (B.) microplus* (0%) on goats also agrees with findings from Burkina Faso, where *Rhipicephalus spp*. accounted for only 6% of the tick fauna on small ruminants (Sidiki *et al*. 2025). As Daemon *et al.* (1998) and Nyangiwe and Horak (2007) suggested, goats often act as alternative hosts for various tick species, supporting their presence in other animals. This implies that in this region, goats could have served as alternative hosts for *R. (B.) annulatus*, and *R.B.) microplus* but the availability of more preferred hosts might have reduced its infestation in goats.

H. intermedia was notably prevalent on goats (50.9%) in the present study (Table II), whereas *H. bispinosa* emerged as the principal tick species infesting cattle (25.7%) and goats (30%). These findings are in accordance with the observations of Elango *et al.* (2025), who reported a comparable prevalence of *H. intermedia* (89.4%) on goats. However, the predominance of *H. intermedia* on goats observed was in contrast with reports which recorded *Rhipicephalus spp*., *R. (B.) microplus and H. bispinosa* respectively, were found to be dominant (Gopalakrishnan *et al.* 2017, Rashid *et al.* 2018, Princy *et al.* 2024) from Kerala, Uttarakhand, and Jammu.

A noteworthy observation in the present study was the occurrence of *Rhipicephalus sanguineus* -a predominantly canine tick - on cattle in Ponmudi, indicating an ecologically uncommon host shift. Similar incidental spillover onto cattle has been reported in mixed-animal rearing systems in Arunachal Pradesh, India (Dantas-Torres 2010, Ronghang and Roy 2014, Kaba *et al*. 2022). In this context, close contact between dogs and livestock is likely to have facilitated host-switching under conditions of high infestation pressure. Low proportions of *H. turturis*, *H. spinigera*, *R. sanguineus*, *R. haemaphysaloides*, *R. (B.) microplus*, and *A. integrum in* the present study reflected broader regional patterns, where these species are generally minor components of domestic animal tick fauna, except in specific ecological zones (Anish *et al*. 2020, Raju *et al*. 2025).

R. (B.) annulatus, which was predominant in this study, is known to transmit babesiosis, spotted fever, and anaplasma to various animals and humans (Rajagopalan and Sreenivasan. 1981, Nair *et al.* 2013, Mourya *et al.* 2014, Balasubramanian *et al.* 2019, Naren babu *et al*. 2019). *H. bispinosa* transmits *Theileria orientalis* in cattle, while *H. intermedia* and *H. spinigera* are primary vectors in Kyasanur Forest Disease (KFD) foci, highlighting the zoonotic risks posed by dominant *Haemaphysalis* spp. (Balasubramanian *et al*. 2019, Naren babu *et al*. 2019, Nimisha *et al*. 2019). Despite the low prevalence of *H. turturis*, *H. spinigera*, *R. sanguineus*, *R. haemaphysaloides*, *R. (B.) microplus*, and *A. integrum*, they remain epidemiologically significant, as even low-density vector populations can sustain enzootic cycles of KFD virus, *Theileria* spp., and *Ehrlichia* spp (Balasubramanian *et al*. 2019, Naren babu *et al*. 2019).

Stage-wise composition and sex ratio dynamics of ticks in the study area: In the present study, adults comprised 24.4% of the total ticks collected, whereas larvae accounted for only 1.0% (Figure 2). A similar stage-wise pattern was reported by Polito *et al.* (2013), where adults dominated the collection (58.5%), followed by nymphs (24%) and larvae (17.5%). This pattern may be attributed to the tendency of juvenile stages of some ixodid species to feed predominantly on smaller mammals (Clymer *et al*. 1970, O'Neill *et al*. 2023). In the current investigation, females (n

Table 2. Host wise prevalence of tick species obtained from the study area

Host wise percentage prevalence of ixodid ticks (%)			
Species	Cattle (%)	Buffalo (%)	Goat (%)
H. bispinosa	25.7	16.7	30
H. intermedia	7.4	0	50.9
H. turturis	3.6	11.5	14.8
H. spinigera	0.2	1.3	0.5
R. (B.) annulatus	56.1	70.5	0
R. haemaphysaloides	2.7	0	0.9
R. sanguineus	1.5	0	0
R. (B.) microplus	2.5	0	0
A. integrum	0.2	0	3

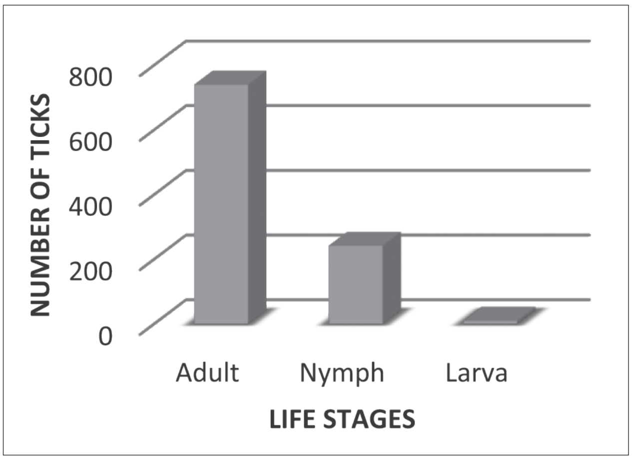

Fig. 2 Life stages of ticks obtained from the study area

= 440) markedly outnumbered males (n = 300), indicating a distinctly female-biased sex ratio. This observation is consistent with earlier reports, including Omoregie *et al.* (2025), who recorded 1,570 females and 119 males, and Kemal *et al.* (2016), who documented 1,140 females and 844 males, with noted species-level variations. Patel *et al.* (2013) in Uttar Pradesh and Khajuria *et al*. (2015) in Jammu found higher infestation rates during the rainy season and lower rates in winter, with younger cattle showing lower infestation than older ones. Patel *et al*. (2019) in Gujarat noted that crossbred cattle were more susceptible than indigenous varieties. These findings suggest that factors like season, age, and breed contribute to variations in infestation rates. Geographic and climatic variations may further influence these rates by affecting the dynamics of host-parasite relationships (Krasnov *et al.* 2008, 2010, Wolinska and King 2009).

Diversity indices and habitat-linked variation in tick distribution: Overall, the data suggest that factors like proximity to the forest, vegetation type, and management practices significantly influence the diversity and richness of tick species. Shannon diversity index values obtained from the five locations of the study area reveal clear ecological variation in ixodid tick assemblages. Ponmudi exhibited the highest diversity (Simpson Diversity Index, H ≈ 1.65), followed by Bonacaud (BC) (H ≈ 1.41), while Neyyar (NY) showed the lowest diversity (H ≈ 1.24). The higher diversity in Ponmudi and Bonacaud corresponds to their denser vegetation structure, higher canopy cover, and greater presence of wild hosts which collectively support a wider ecological niche for multiple tick species (Raju *etal.* 2025). It could also be indicative of less stringent management practices or closer interactions with wildlife. In contrast, Peppara and Braimore showed moderate diversity (H ≈ 1.33-1.35), likely reflecting their mixed forest–plantation mosaics, which provided fewer microhabitat types compared to Ponmudi's shola-grassland-forest interface. Neyyar Wildlife Sanctuary, being a protected forest, recorded the lowest diversity; which may be attributed to higher temperatures, relatively drier terrain in several zones, and reduced host density, which limited both tick survival and species coexistence.

Species richness analysis showed that Ponmudi harbored all nine species, while Neyyar had only five, indicating a high correlation between diversity and species richness in the area (Pearson correlation value of 1.65). Although Peppara ranked third in terms of diversity, its tick population was more evenly distributed compared to other locations, as reflected in a Pielou's Index (J') value of 0.83. Neyyar and Peppara exhibited a complete similarity in their tick species composition, including *H.bispinosa*, *H. turturis*, *H.intermedia*, *R. (B.) annulatus*, and *R. haemaphysaloides*. This similarity is likely to be due to their close proximity to each other and the presence of similar host animals in these areas, as ticks tend to be highly host-specific.

The present study established the occurrence of major tick vectors in the Trivandrum district and highlighted the significant role of domestic ruminants in sustaining local tick populations. The high abundance and mixed-genus composition recorded indicated an elevated risk of future outbreaks, particularly under environmental conditions favourable for tick survival and proliferation. Given these patterns, *H. bispinosa*, *H. intermedia*, and *R. (B.) annulatus* emerged as priority targets for enhanced surveillance, acaricide-resistance monitoring, and evaluation of biological control options. Strengthening future epidemiological assessments by incorporating climatic data, host husbandry variables, and pathogen detection can further refine the understanding of tick host environment interactions. Overall, the findings provided a strong baseline for developing area-specific tick-control strategies and facilitating early detection and management of tick-borne disease risks in the Western Ghats region.

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CONFLICT OF INTEREST STATEMENT

We, the authors declare that we have no conflict of interest.

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