Budding Researchers' Section

SPICES DISTRIBUTION AND PREVALENCE OF TICKS (ACARI: IXODIDAE) IN FOREST-ASSOCIATED ANIMAL HABITATS IN DISTRICT WAYANAD OF KERALA (INDIA)

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ABSTRACT

Background: Ixodid ticks and tick-borne diseases are emerging health problems for both animals as well as human being worldwide. Ticks transmit bacterial, parasitic, and viral pathogens. Both domestic and wild animals play major roles in tick-borne zoonotic disease transmission by serving as reservoirs for human pathogens. This study aims to determine the tick prevalence

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in host-specific animal habitats such as elephant and deer habitats as well as in an ecotone habitat of forest to infer the host-associated tick distributions.

Methods: Tick collection from different habitats was carried out by dragging method. The tick samples were identified up to species level.

Result: In this study period, from November 2019 to May 2020 a total of 4609 Ixodidae ticks were collected including 797 ticks from elephant habitat, 752 ticks from deer habitat, and 3060 ticks from ecotone habitat. Four genera (*Amblyomma, Haemaphysalis, Hyalomma* and *Rhipicephalus*) and eight species such as *Amblyomma integrum, Haemaphysalis spinigera, H. turturis, H. bispinosa, H. cuspidata, H. kyasanurensis, Hyalomma anatolicum* and *Rhipicephalus sanguineus* were recognized from the survey. Among the ticks collected *Haemaphysalis spinigera* and *H. turturis* were the predominant species (n=2142, 46.4%; n= 2081, 45.1%), followed by the species *Amblyomma integrum* (n=327; 7.0%). The other species such as *H. bispinosa, H. cuspidata, H. kyasanurensis, Hyalomma anatolicum* and *Rhipicephalus sanguineus* constituted less than 1% of the total collection.

Conclusion: Results of the study revealed higher entomological risk in edges between forests and herbaceous interface (ecotones) than other landscape elements and animal habitats. Such habitats are quite common in the forest landscapes of the Wayanad district of Kerala where Kyasanur Forest Disease is endemic.

Keywords: Deer, ecotone, elephant, ticks, habitat, forest

INTRODUCTION

Ticks are parasitic vectors of disease-causing microorganisms to animals and humans globally.[1] Forest is the preferred habitat as well as the main scavenging site for hard ticks which are primarily found in and at the edge of the forest. Both domestic and wild animals can act as hosts for tick infestation and play a major role

in tick-borne zoonotic disease transmission.[2] In recent decades there has been an unprecedented rise in the occurrence of many tick-borne diseases in humans in India. This may be due to the influence of the host, tick distribution patterns, and the effect of abiotic conditions on tick development and off-host survival[3].

Previous studies report that ticks are capable of breeding in small animal habitats, birds nest, under dry leaves in fragmented forested habitats, teak plantations, and grassland as well as in a variety of other habitats[4,5]. Tick surveillance can be determining the distribution of tick populations in different host animal habitats[6], hence a proper understanding of tick ecology by surveillance and identification is necessary for the standardization of Ixodidae tick abundance in different animal host habitats, which allows geographic comparisons of host-specific tick density and acarological risk assessments, and provides the epidemiological basis for predicting tick-borne pathogen transmission risk.

A crucial component for tick abundance is the availability of a suitable host for blood-feeding. The immature can feed on an extensive range of different host animals, but the adult female tick requires a blood meal from a big host to fulfill the life cycle[7]. Such a big host is, in many systems, typically a deer, wild boar, bison, or elephant. In addition, higher densities of ticks are typically found along the edges or ecotones. These ecotones are the convergence of two habitats, so ticks are more in these zones. However, we are lacking quantitative information on the species distribution and prevalence of ticks in different host ranges and different habitats. This study is thus aimed at surveillance of ticks in the two host habitats such as wild elephant and deer habitat, along with ecotone habitats to identify the distribution range of different Ixodidae ticks.

MATERIALS AND METHODS

Study Area: Wayanad district of Kerala along the Western Ghats was selected for the study. This is a hilly district in North – East of Kerala with an area of 2131 km², in the Western Ghats between latitude N 11037' and longitude E 76058' and an altitude ranging from 2500 to 3000 ft above the sea level. This district has the highest forest cover of 83.3% and agriculture and animal husbandry is the principal occupation of the people. Field sampling was conducted in six sites of elephant, deer and ecotone habitats in Sulthan Bathery taluk under Kurichyat, Sulthan

Bathery, and Muthanga wildlife forest range division (Fig. 1).

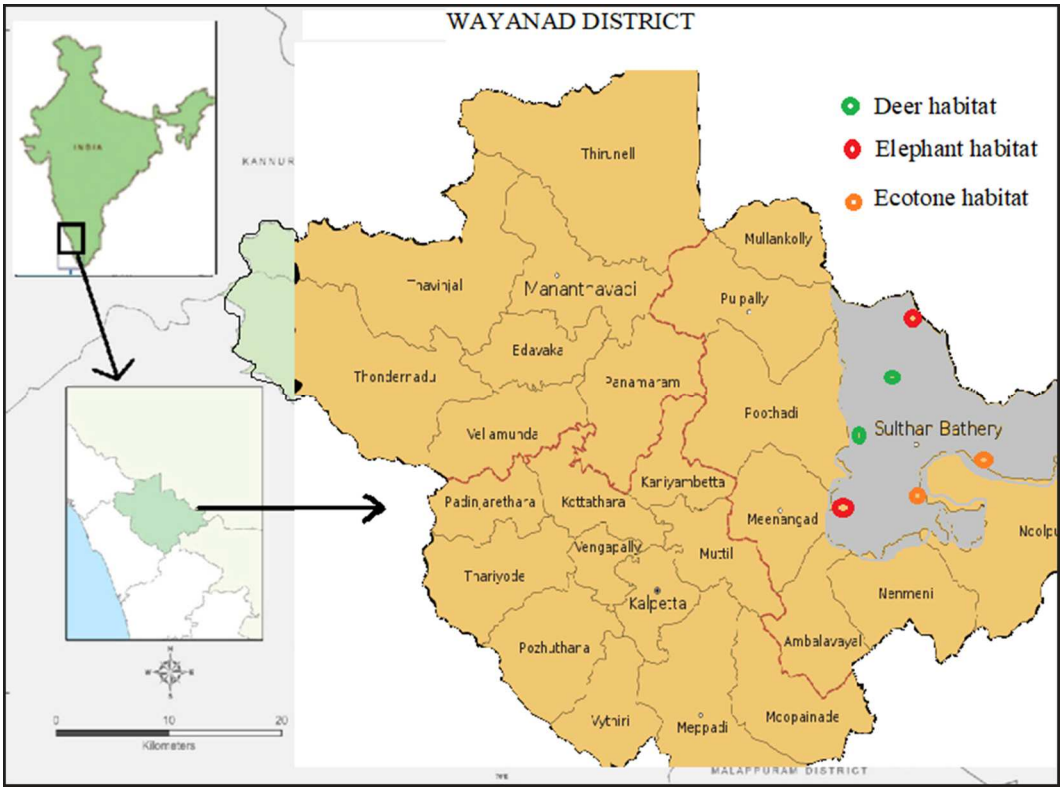

Fig. 1. Different habitat survey sites in Sulthan Bathery taluk of Wayanad district

Table 1. Habitat wise various stages of ticks collected from Wayanad district Kerala during November 2019 to May 2020

S. No.	Tick species	Elephant habitat			Deer habitat			Ecotone Habitat			Total
		L	N	A	L	N	A	L	N	A	
1.	*Amblyomma integrum*	79	10	194	0	0	7	19	0	18	327 (7.0)
2.	*Haemaphysalis bispinosa*	0	0	10	19	0	0	0	7	0	36 (0.78)
3.	*H. cuspidate*	0	0	0	0	0	0	0	3	0	3 (0.06)
4.	*H. kyasanurensis*	0	0	6	0	5	0	0	0	0	11 (0.23)
5.	*H. spinigera*	0	288	0	6	270	156	0	1361	0	2081 (45.1)
6.	*H. turturis*	32	124	52	234	51	4	455	1000	190	2142 (46.4)
7.	*Hyalomma anatolicum*	0	2	0	0	0	0	0	0	0	2 (0.04)
8.	*Rhipicephalus sanguineus*	0	0	0	0	0	0	1	6	0	7 (0.15)
	Total	**111111**	**424**	**262**	**259**	**326**	**167**	**475**	**2377**	**208**	**115609**

Note: L- Larva, N- Nymph, A-adult

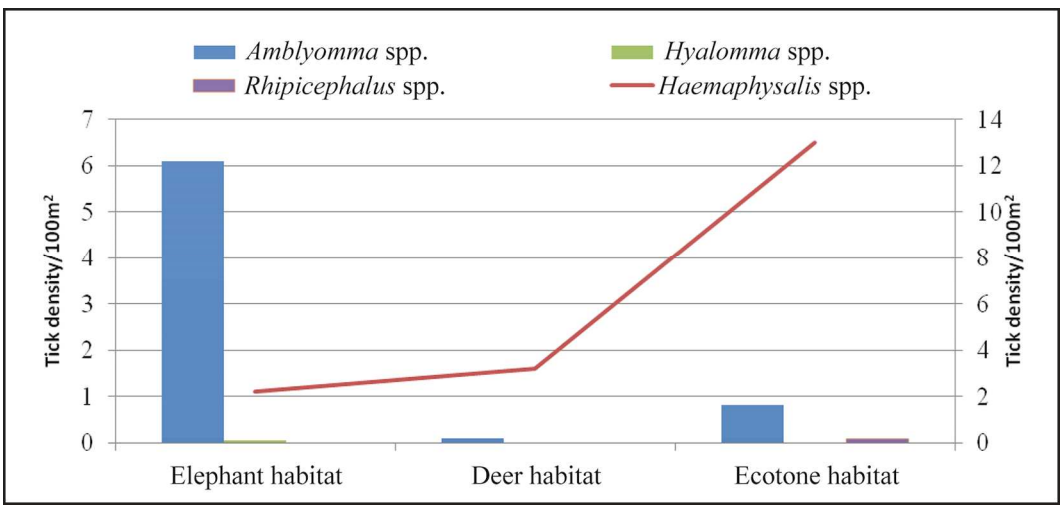

Fig. 2. Distribution of ticks in elephant, deer and ecotone habitats

Site selection: Two animal habitats and one ecotone were selected for tick collection. A cross-sectional study was carried out for seven months (November 2019 to May 2020) with a total of 55 surveys and 20 sampling events to inspect the distribution of ticks in three forest habitats. Sampling was conducted, using the same standard methods during the study period. Tick collection was not performed when it was raining or the vegetation was wet.

Tick Collection and Identification: The Ixodidae ticks were collected by dragging a flannel cloth (1.5 m long × 1.0 m wide) attached to an aluminum pipe. The flannel cloth was pulled over ground vegetation, along 30 m transects, and a total of 1 - 2 hours were spent at each site. The nymph and adults (male and female) from each dragging were collected and kept in separate 2.0 ml capacity plastic vials and labeled. The tick samples were transported to the laboratory and identified up to species level following standard keys[8,9,10]. The mean tick density per 100 m^2 transect of collected ticks from each site was calculated by dividing the collected ticks with two parallel 100-m transects dragged in each location[11].

Data analysis: Correlation analysis were carry out on different habitats against the number of ticks collected. A p-value <0.05 was considered statistically significant. These analyses were performed using SPSS statistics software version IBM 20.

RESULTS

In this present study, a total of 4609 ticks belonging eight species under four genera were collected from six sites (two sites for each habitat) of elephant, deer, and ecotone. Among the ticks collected *H. spinigera* and *H. turturis* were predominant species (n = 2142, 46.4%; n = 2081, 45.1%), followed by *Am. integrum* (n = 327; 7.0%). Other species, *H. bispinosa, H. cuspidata, H. kyasanurensis, Hy. anatolicum* and *R. sanguineus* constituted less than 1% of the collection. The *Haemaphysalis* spp. were the abundant and common ticks found in these habitats, while the genera *Hyalomma* and *Rhipicephalus* were least represented. Overall five species were collected from the genus *Haemaphysalis* and the most abundant species were *H. spinigera* and *H. turturis*, and the least abundant were *H. cuspidata* and *H. kyasanurensis*. The second-most abundant tick genus was *Amblyomma* and the least were *Rhipicephalus* and *Hyalomma* (Table 1 & Figure 2). In general, from

all habitat sites, larvae, nymph, and adults were collected, in which adult was collected more frequently from April to May. Larvae were most prevalent from October to November, while nymph were collected during December to February. In the correlation analysis, the *H. spinigera* (Spearman's = 0.01) and *H. turturis* (Spearman's = 0.03) tick species positively correlated with ecotone habitat as well as *Am. integrum* (Spearman's = 0.008) was correlated with the elephant habitat ($p < 0.05$).

Tick species from Elephant habitat: Ticks were sampled from two habitat sites (Mullankolly n= 422 and Panayambam, n= 355) in Kurichyat forest range. In total, 797 Ixodid ticks (Larva: 111; Nymph: 424; Adult: 262) were collected representing three genera and six species. *H. spinigera* (n = 288, 36.1%), *Am. integrum* (n = 283, 35.5%), and *H. turturis* (n = 208, 26%) were the major species, followed by *H. bispinosa* (n = 10, 1.2%). The species *R. sanguineus* and *Hy. anatolicum* were also present in less than 1%.

Tick species from Deer habitat: A total of 752 ticks belonging to two genera and five species were identified from two deer habitats (Chethalayam, n= 427 and Noolpuzha, n= 325) in the Kurichyat forest range. *H. spinigera* (n = 432, 57.4%) was the predominant species, followed by *H. turturis* (n = 289, 38.4%), and *H. bispinosa* (n = 19, 2.5%). The other two species such as *Am. Integrum* and *H. kyasanurensis* were present in less than 1% percentage. Among the total ticks collected, distribution of larva (n= 259), nymph (n=326), and adults (n=167) were observed, with the presence of all three life stages of *H. spinigera* and *H. turturis*.

Tick species from Ecotone habitat: Two habitat sites (Ponkuzhy, n= 1289 and Alathur, n= 1771) in fringe area regions of Muthanga and Sulthan Bathery forest range were selected and a total of 3060 ticks (Larva: 475; Nymph: 2377; Adult: 268) from three genera and six species were collected. Among the ticks collected, *H. turturis* (n = 1645, 53.7%) was the predominant species, followed by *H. spinigera* (n = 1361, 44.4%), and *Am. integrum* (n = 37, 1.2%). Three species such as *H. bispinosa, H. kyasanurensis* and *R. sanguineus* were present in less than 1% percentage.

DISCUSSION

This study revealed the diversity of tick species in different habitats of a forest. Increasing incidences of many tick-borne diseases in India is an emerging concern.[12] The control or eradication of tick-borne disease in a community depends on avoiding exposure to tick bites. Good reproductive hosts are species that are readily observable and more likely than others to be exposed to ticks.[13] Hence tick survey data in large-bodied wildlife (elephant), small grazing animals (deer), and ecotone habitats has proven valuable for assessing tick distribution over large areas in the forest and associated fringe area.

The abundance of ticks in ecotone habitats is more likely related to the presence of a large number of ticks' main feeding hosts. These ecotones composed of vast variety of plants and dense vegetation provide food and shelter for tick hosts and also allows host movement to other suitable habitats. Therefore, animal hosts spend more time in ecotones than other areas in the forest, which increases the prevalence of questing ticks. When these wildlife ecotone habitats are shared with livestock, it leads to the sharing of zoonotic pathogens between wildlife and livestock species and finally to humans[14]. In the study area, the deer habitats were associated with the overgrowth of weed plant *Senna spectabilis*, which likely provides suitable foliage and shrubbery cover as well as shelter against adverse climatic environments. The elephant habitats were identified with well-developed deciduous forests dominated by deciduous trees with forage leaves, grasses, seeds, fruit, and tree bark. Hence the results suggest that tick distribution in a forest is affected not only by the biotic and abiotic factors but also by habitat suitability which favors host movements and the interaction of different host animals.

In the Western Ghats region, the tick *Haemaphysalis* spp. is the primary vector of Kyasanur Forest Disease, and it tends to feed on a wide variety of vertebrates[15]. This study reports the prevalence of *Haemaphysalis* species in three habitats. They generally infest both domestic and wild animals; however, in previous studies, the human infestation by *Haemaphysalis* species has also been reported[5,16]. The *Amblyomma* genus have nearly about 137 species of ticks dispersed globally[18]. Amblyomma has been observed as one of the major threats to domestic/wild animals and public health[19]. Among these, *Am. integrum* is a three-host tick and recorded in domestic and wild animals from India (Andhra Pradesh, Goa, Karnataka, Odisha, and Tamil Nadu) and Sri Lanka[20]. It carries rickettsial

infections and also causes otoacariosis in humans[21,22]. In this study the higher percentage of Am. integrum was found in the elephant habitat. The disease, Crimean-Congo hemorrhagic fever (CCHF), is reported from the bite of *Hy. anatolicum* in India[12]. The presence of this species amongst cattle of Kerala has been reported by Prakasan and Ramani (2007)[23]. The presence of tick species *Hy. anatolicum* was also seen in the elephant habitat. *R. sanguineus*, the tropical dog tick, is a vector of *Babesia motasi* and *B. ovis*, and may play a role in the transmission of B. equi and is also responsible for the disease. Indian tick typhus was reported from the ruminant habitat. The ecotone habitats in fringe area forests are identified with a large percentage of tick species; it may be due to the movements of different host animals and increased interaction of wildlife and domestic animals in this interface.

CONCLUSION

This study reports the abundance of ticks in the edges between forests and herbaceous interface and higher entomological risk in ecotones than in other habitats or landscape elements. Such ecotones are quite common in the forest landscapes of the Wayanad district of Kerala, which might increase the chance of tick-borne diseases. There is a need for more detailed studies on the Ixodidae ticks in more wildlife habitats and detection of pathogens in the ticks.

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