

Research Article

Studies on the Vertical Distribution of Ticks of Domestic Animals and Their Public Health Importance in Nilgiri Hills and Adjoining Areas of Tamil Nadu State (India)

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The Nilgiri hills and adjoining downhill areas provide favourable ecological conditions for the propagation of haematophagous arthropods owing to richness in vegetation and animal activities. A study has been undertaken during 2008–2010 on the distribution and abundance of ticks of domestic animals in seven different biotopes. A total of 3,008 domestic animals were examined in areas ranging from an altitude of 300 to 2200 meters above mean sea level (MSL) of which 1,335 (44.5%) animals were having tick infestation. A total of 6,012 adult and immature ticks belonging to 12 species (11 ixodid and one argasid) were collected. Eleven tick species were collected from Kallar area situated downhill eastern slopes of the Nilgiris followed by Burliar area (7 species) located at higher altitudes. From Masinagudi area near to dense forests and scrub jungles, five species were recorded. However, at higher elevations on the hills, Udhagamandalam area, only one species was recorded. Among various tick species recorded in the study, *Boophilus microplus* was distributed in almost all areas surveyed followed by *Haemaphysalis spinigera* and *Rhipicephalus sanguineus*. The factors governing their distribution and epidemiological significance in the transmission of various tick-borne diseases of public health importance are discussed.

1. Introduction

Ticks (Acari: Ixodoidea) next to mosquitoes are involved in the transmission of a variety of disease pathogens of public health and veterinary importance since time immemorial. However, the studies on tick-borne diseases gained momentum in the world after the outbreak of Rocky Mountain spotted fever (RMSF) in the United States during the second half of the nineteenth century. In India, the studies of ticks received importance after the discovery of Kyasanur Forest disease (KFD) transmitted by *Haemaphysalis* spp. in Shimoga district of Karnataka state in 1957 [1]. A report by Pattnaik (2006) indicates the increasing number of KFD cases in Karnataka and necessitates the strategic control of tick vectors [2]. Thereafter, sporadic cases of indigenous/imported nature were reported from different parts of the country time to time. During 2007, a full bloom epidemic of Indian

tick typhus was reported from village Deol district Kangra (Himachal Pradesh), wherein 357 cases reported a population of 1223 [3]. During 1994, serologically positive cases of Lyme disease were reported from Coonoor in Nilgiri Hills of Tamil Nadu state [4]. Shanmugam et al. [5] have reported the presence of Crimean-Congo haemorrhagic fever (CCHF) virus infection in human and domestic animals from various parts of India. However, the first instance of CCHF was detected from Kolat village near Ahmadabad in January 2011 and subsequently cases/deaths are reported from Mehsana district and nearby area in 2012 and 2013 [6]. In the last three years, there have been 30 positive cases and 14 deaths due to CCHF in Gujarat [7]. Increasing public health concern over tick-borne diseases in recent years necessitates strategic control of ticks on animals that transmit diseases to human beings. In view of the above, a comprehensive study has been undertaken on the ectoparasitic ticks on domestic

animals and their vertical distribution in Nilgiri hills and its surroundings and their probable role in the transmission of various diseases of public health importance.

2. Material and Methods

2.1. Study Area. The study area is comprised of the Nilgiri hills lying in Udhagamandalam and the eastern down hills and adjoining areas under the Coimbatore districts of Tamil Nadu state. The above area is situated at an altitude ranging from 300 to 2000 meters above mean sea level (MSL) in the latitude 11°, 10' N and longitude 76°, 5' E. The mountainous areas of Nilgiris owing to higher altitude have higher precipitation throughout the year with peaks in June/July and October/November. The above areas have the impact of both South West (SW) and North East (NE) monsoons with an annual rainfall of 1200 mm. The above areas have temperature ranging from 2°C to 28°C and have temperate or equitable type of climate with abundant vegetation, whereas the downhill areas have tropical type of climate with temperature ranging from 16°C to 37°C. The rainy season is mainly due to NE monsoon with peaks in October/November with an average rainfall of 500 mm.

2.2. Description of Various Biotores in the Study Area. The brief description of various biotores surveyed, their location, altitude, and vegetation forest cover are as follows.

(i) *Mettupalayam and Adjoining Villages.* The above locality has typical characteristic features of downhill areas having human inhabitations surrounded by agricultural lands and situated near Nilgiri hills.

(ii) *Kallar and Surroundings.* This area is situated in the eastern slope of Nilgiris hills and having scrub jungle surrounded by spice gardens, areca nut grooves, and agricultural land with wild animal activities.

(iii) *Burliar and Surroundings.* This area is situated in eastern slopes of Nilgiri hills in the elevation of 900 to 1600 metres above MSL. It is characterized by typical mountainous climate with wild animal activity and having coffee/tea plantation and fruits orchards.

(iv) *Coonoor and Surroundings.* They are situated in the altitude of 1600 to 1900 meters above MSL. This area is having human inhabitations surrounded with tea plantations and vegetable gardens.

(v) *Udhagamandalam and Surroundings.* This area is situated at higher elevations of the Nilgiri hills with an altitude ranging from 1900 to 2200 metres above MSL. The above areas have human inhabitations surrounded by meadows, vegetable gardens.

(vi) *Gudalur and Surroundings.* These areas are situated in the western slope of the Nilgiri hills at an elevation of 1100 to 1200 metres above MSL and are characterized by the presence

of human inhabitations surrounded by coffee/tea plantations and other agricultural crops.

(vii) *Masinagudi and Surroundings.* This area is having dense jungles and scrub jungle and surrounded by grassing lands and agricultural lands located in altitude of 1000 to 1200 metres above MSL with wild animal activity and a few human inhabitations. The altitudes of the locality influence the climate and vegetation and also have a bearing on the distribution and abundance of haematophagous ticks.

2.3. Host Availability. The study area has forest fringed sectors/horticultural plantations/orchards and agricultural lands having wild animals' activities. However, the survey included the domestic animals, namely, cattle (*Bos indicus*), goat (*Capra hircus*), sheep (*Ovis aries*), buffalo (*Bubalus bubalis*), dog (*Canis familiaris*), and horse (*Equus caballus*) for the infestation of ectoparasitic ticks. The tick collections were made in seven different biotypes situated in the study area and the description regarding their location and altitude is given in Table 1.

2.4. Tick Collection. In each biotope, villages were selected randomly and, with the selected villages, the households were also selected randomly. In each of the selected household, all the available domestic animals were included in the study. Ticks were collected by hand picking method from various animals and thoroughly searched to collect the larva, nymph, and adult ticks. Total of five minutes were spent in collection of ticks on each animal. Ticks thus collected were preserved in 70% alcohol and identified in the laboratory using standard identification keys and tick prevalence indices; namely, tick infestation rate on host animals and tick index have been computed.

3. Results

A total of 3,008 domestic animals, namely, cattle (2,354), goat (500), sheep (100), buffalo (39), dog (13), and horse (2), were searched to see the infestation of ectoparasitic ticks. A total of 6,012 adult and immature ticks belonging to six genera and 12 species (11 ixodid and 1 argasid) were collected from 1,335 domestic animals including 1,095 cattle, 195 goat, 35 sheep, 5 buffalo, and 5 dogs (Table 1). The overall density of tick infestations was calculated as 44.4% and maximum 46.51% in cattle. The overall tick index computed during the study was 1.99 and maximum 4.97 in buffalo (Table 2).

Maximum numbers of tick species (eleven) were recorded from Kallar area located in eastern down hills of the Nilgiris and one species (minimum) was recorded from Udhagamandalam and surroundings area situated at higher altitudes of the hills. Three, seven, four, one, three, and five tick species were recorded from Mettupalayam, Burliar, Coonoor, Udhagamandalam, Gudalur, and Masinagudi and surroundings, respectively (Table 1). *B. microplus* was the widely distributed and also the most prevalent tick species. *Haemaphysalis* spp. and *Rhipicephalus* spp. were distributed in eastern western slopes of the Nilgiris and absent in

TABLE 1: Vertical distribution of ectoparasitic tick species and their host infestation rates from various localities of Nilgiris hills and adjoining areas.

Name of the tick species	Place of collection and their surroundings (altitude in meters above MSL)								Total (%)
	Mettupalayam (300–350)	Kallar (350–450)	Burliar (1000–1700)	Coonoor (1700–1900)	Udhagamandalam (1900–2200)	Gudalur (1100–1200)	Masinagudi (1100–1200)		
<i>Boophilus microplus</i>	3	1110	1649	763	306	69	433	4333 (72.07)	
<i>Amblyomma</i> spp.	0	16	2	0	0	0	2	20 (0.33)	
<i>Amblyomma integrum</i>	0	20	17	0	0	0	0	37 (0.62)	
<i>Hyalomma</i> spp.	0	7	0	0	0	0	0	7 (0.12)	
<i>Hyalomma hussaini</i>	0	7	0	0	0	0	0	7 (0.12)	
<i>Hyalomma anatolicum</i>	2	19	0	0	0	0	73	94 (1.6)	
<i>Haemaphysalis</i> spp.	190	581	55	3	0	112	172	1113 (18.5)	
<i>Haemaphysalis spinigera</i>	0	4	14	0	0	0	0	18 (0.3)	
<i>Haemaphysalis wellingtoni</i>	0	52	0	0	0	0	0	52 (0.9)	
<i>Rhipicephalus</i> spp.	91	83	16	30	0	30	73	323 (5.4)	
<i>Rhipicephalus ramachandraiae</i>	0	5	0	0	0	0	0	5 (0.08)	
<i>Ornithodoros</i> spp.	0	0	1	2	0	0	0	3 (0.05)	
Total ticks collected	286	1904	1754	798	306	211	753	6012 (100)	
Total hosts examined	222	1019	724	441	74	69	459	3008	
Total hosts positive	75	457	348	169	31	38	217	1335	
Infestation rate	33.8	44.8	48.1	38.3	41.9	55.1	47.3	44.4	
Tick index	1.3	1.9	2.4	1.8	4.1	3.1	1.6	2.0	

TABLE 2: Tick infestation rate and tick index in Nilgiri hills study area.

	Host animal	Number searched/found +ve	Tick infestation rate	Number of ticks Collected	Tick index
1	<i>Bos indicus</i>	2354/1095	46.51	4974	2.11
2	<i>Capra hircus</i>	500/195	39.0	733	1.5
3	<i>Ovis aries</i>	100/35	35.0	80	0.8
4	<i>Bubalus bubalis</i>	39/5	12.82	194	4.97
5	<i>Canis familiaris</i>	13/5	38.46	31	2.38
6	<i>Equus caballus</i>	2/0	0.0	0	0
	Total	3008/1335	44.38	6012	1.99

higher altitudes above 1900 mts MSL. *Hyalomma* spp. and *Amblyomma* spp. were recorded only in Kallar and Burliar areas in eastern slopes of the Nilgiris areas. *Ornithodoros* ticks were recorded in limited numbers from two localities of the eastern slopes (Burliar and Coonoor) in the altitude ranging from 1000 to 1900 mts MSL. The particulars of tick genera recorded and their percentage composition from different biotopes/localities of the study area are given Table 1.

Tick infestation rate in relation to host animals ranged from 33.8 (Mettupalayam villages) to 55.1 (Gudalur and surroundings). Tick infestation rates show higher values in both eastern and western slopes and down hills than in higher altitudes and plain area villages. Tick index computed for the total study area is 2.0 and it showed a maximum value in Udthagamandalam area (4.1) and was minimum (1.3) in Mettupalayam villages. High value of tick index was recorded at higher altitudes than plain areas.

4. Discussion

The present studies on the vertical distribution and prevalence of ticks are mainly attributed to the altitude, vegetation, animal activity, host availability, and other climatic factors in the study area. The Nilgiri hills provide favourable ecological conditions for the propagation of haematophagous arthropods including ticks due to its richness in vegetation and animal fauna. Earlier at higher altitudes of Nilgiri hills, Kumar et al. [8] determined the epidemiological significance of ixodid ticks and recorded *B. microplus*, *H. bispinosa*, *Rhipicephalus haemaphysaloides*, and *R. sanguineus* from domestic animals. Earlier studies in other parts of India pointed out the importance of various factors responsible for the distribution and abundance of ticks. In Mathura district, Uttar Pradesh (India), Patel et al. [9] observed the prevalence and seasonal variation in ixodid ticks on cattle and recorded highest tick infestation in rainy season (69.46%), followed by summer (62.55%) and lowest infestation was recorded in the winter (47.96%) season. Singh and Rath [10] determined the epidemiology of ixodid ticks in bovines of different agroclimatic zones of Punjab state, India, and observed highest prevalence of ixodid ticks in monsoon season (83.74%), followed by summer (69.01%) and least in winters (31.64%), whereas maximum prevalence of *R. microplus* and *H. a. anatolicum* was recorded in monsoon (72.42%) and summers

(18.06%), respectively. Mehta [11] recorded *Hyalomma* spp., *R. sanguineus*, *R. haemaphysaloides*, *Haemaphysalis* spp., and *Ixodes* spp. from Shimla hills and described their possible role in disease transmission. Dhanda and Rao [12] collected Ixodid ticks from North East Frontier Agency (India) and stratified areas based on the distribution of 1,656 ticks belonging to 7 genera and 17 species. They classified areas in (i) warmer region-tropical evergreen forests, (ii) colder and higher altitudes, and (iii) species occurring in both colder and warmer altitudes. Varma and Mahadevan [13] reported ixodid tick fauna in eastern Himalayas and their disease relationship potential and recorded 7 genera and 14 species of ixodid ticks. *Amblyomma* spp. and *B. microplus* were recorded in large numbers. Kaul et al. [14] in Jammu and Kashmir of India recorded ixodid ticks belonging to seven genera and 16 species. In Shimoga district of Karnataka state, a study on the tick fauna has been carried out by Kumar et al. [15], wherein *H. spinigera* on dogs has been recorded from the endemic area of KFD; it is a significant finding as the above hosts facilitate the maintenance of the virus. The other tick species recorded were *B. microplus* (47.7%), *H. spinigera* (40.5%) *H. cornigera* (3.31%), *R. sanguineus* (8.29%), and *A. integrum* (2.07%). Gandhi et al. [16] carried out an epidemiological investigation of multisource outbreak of CCHF in Gujarat and confirmed the presence of CCHF virus in *Hyalomma* species of ticks collected from domestic animals. Similarly, the prevalence of ixodid ticks on domestic animals of several other Indian states like Assam, Karnataka, and Tamil Nadu has been already reported by Miranpuri and Singh [17], Jagannath et al. [18], and Latha et al. [19]. Saxena et al. [20] recorded 8 species of ticks from 126 different domestic animals in localities at altitudes ranging from 320 to 2240 m above sea level. Only 2 of the tick species, *B. microplus* and *R. haemaphysaloides*, were found throughout the range of localities. However, in the present study, in addition to the earlier reported tick species, new additions were *Rhipicephalus* spp., *Amblyomma* spp., *Hyalomma* spp., *H. hussaini*, *H. analoticum*, *H. wellingtoni*, and *Ornithodoros* spp. This was attributed to a large number of host animals from different localities of the study area. A high prevalence of *B. microplus* was reported from all the altitudes and localities. The downhill areas/slopes in both eastern and western slopes showed the distribution of more tick species than in plain areas and higher elevations. Maximum diversity of tick species were recorded from Kallar locality at altitude 350–450 meters. *Bos indicus* was the

most infested host animal for tick with 46.51 infestation rate followed by *Capra hircus* and *Canis familiaris*.

The Nilgiri hills are having a diverse terrain features with distinct ecological characteristics having deciduous wet forests or monsoon forests ecosystem. The terrain features and climatic conditions, namely, low temperature, high humidity, high rain fall, and thicker forest cover with large animal population, render this area suitable for the propagation of a wide variety of haematophagous arthropods including ticks.

In India, major tick-borne diseases have been reported from many parts especially hilly and forest fringed areas. One of the most important diseases transmitted by *Hyalomma* ticks is CCHF, of which *H. marginatum* is one of the main vector ticks. *Rhipicephalus* spp. dog tick *R. sanguineus* is reservoir Indian tick typhus and responsible for Indian tick typhus from many parts of the country and also responsible for causing of boutonneuse fever. *R. haemaphysaloides* is known as the common ectoparasites of many animals of India responsible for a variety of animal diseases and KFD virus has also been isolated from wild caught ticks of this species. Prevalence of vector ticks of KFD, Indian tick typhus, Spotted fever, CCH fever in the Nilgiris hills and adjoining areas, and seropositivity among human for Lyme disease have been recorded from the study area [4, 21]. *Amblyomma* spp. is the vector of *R. rickettsii* and *R. conorii* causing Rock Mountain spotted fever (RMSF) in United States of America and East Africa, respectively [22, 23]. *B. microplus* is the pest of cattle and carries many pathogens, namely, *Coccinella burnetii*, *Theileria*, and *Babesia* spp. [24]. It is also the efficient vector of Bovine babesiosis caused by *B. bigemina* in India which is of veterinary importance [25–27]. In Brazil, it is the potential vector of *R. rickettsii* causing RMSF [28]. *Dermacentor* spp. are the vectors of looping illness virus, Omsk haemorrhagic fever, Colorado tick fever, and RMSF in the USA [29]. It is also the suspected vector of haemorrhagic toxoplasmosis in eastern Himalayas' foot hill jungles [30]. In nature, *Ixodes* spp. are responsible for harboring viruses of Russian spring summer encephalitis (RSSE), KFD, and encephalitis in nature [31]. *Ixodes ricinus* is the vector of Lyme disease in the USA and Europe [32]. In India, KFD and CCHF are both of high importance for public health and KFD virus has been isolated from *H. spinigera*, *H. turturis*, *H. bispinosa*, *H. cuspidata*, *H. wellingtoni*, and other *Ixodes* species [33–39]. This study confirms the presence of *Boophilus* spp., *Amblyomma* spp., *Hyalomma* spp., *Haemaphysalis* spp., *Rhipicephalus* spp., and *Ornithodoros* spp. in the study area. This warrants further in depth studies on the exact role of vector ticks in disease transmission, isolation of pathogens in ticks, and serosurveillance in human population in the study area. Present investigations provides necessary information for human and animal health service managers to have a better understanding of prevention and control of tick borne-diseases especially during the outbreaks.

Conflict of Interests

The authors do not have any conflict of interests.

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