



Contents lists available at ScienceDirect

Asian Pacific Journal of Tropical Medicine

journal homepage: [www.elsevier.com/locate/apjtm](http://www.elsevier.com/locate/apjtm)

Document heading doi:

# Epidemiology of ixodid ticks in cattle population of various agro-climatic zones of Punjab, India

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## ARTICLE INFO

## ABSTRACT

## Article history:

Received 10 August 2013

Received in revised form 15 September 2013

Accepted 15 October 2013

Available online 20 December 2013

## Keywords:

Cattle

Epidemiology

*Hyalomma anatolicum anatolicum*

Punjab

*Rhipicephalus microplus*

**Objective:** To determine the epidemiology of ixodid ticks in bovines of different agro-climatic zones of Punjab state, India. **Methods:** A total of 4 459 cattle of all age groups and sex were examined from eighteen districts of five major agro-climatic zones of Punjab state, India. **Results:** The overall prevalence of ixodid ticks, *Rhipicephalus microplus* (*R. microplus*), *Hyalomma anatolicum anatolicum* (*H. a. anatolicum*) and mixed infestation were 58.06%, 50.16%, 11.34% and 3.45%, respectively. Among the various agro-climatic zones highest prevalence rate of *R. microplus* and *H. a. anatolicum* were recorded in submountain undulating region (79.36%) and western region (20.40%), respectively indicating that *R. microplus* prefers a hot and humid environment whereas, arid and semi arid conditions suit better for *H. a. anatolicum*. The overall prevalence of ixodid ticks was highest in monsoon season (83.74%), followed by summer (69.01%) and least in winters (31.64%) and a significant variation ( $P < 0.01$ ) was also observed; whereas, maximum prevalence of *R. microplus* and *H. a. anatolicum* were recorded in monsoon (72.42%) and summers (18.06%), respectively. Among the various age groups maximum tick infestation was recorded in calves <6 months of age (72.59%), followed by 6 months –1 year age group (61.74%) and least in >1year age group (55.02%) and the difference was statistically significant ( $P < 0.01$ ). Also a significantly higher ( $P < 0.01$ ) infestation rates of ixodid ticks was observed in males. **Conclusions:** The findings of the current study would provide a basis for evolving effective control strategy for the management of ticks in bovines of the region.

## 1. Introduction

Ticks and tick-borne diseases (TTBDs) are a major problem to livestock health in the world and its severity depends on region, species involved, host population, socioeconomic and technological advances in control measures[1]. Losses attributable to ticks are caused either directly through tick worry, blood loss, damage to hides and udders and the injection of toxins, or indirectly through mortality or debility

caused by the diseases transmitted by or associated with the ticks. Ticks rank first as arthropod vectors of protozoa, rickettsiae, bacteria and viruses, causing diseases in nonhuman vertebrates and rank second only to mosquitoes as vectors of pathogens to humans[2]. The global economic loss due to tick infestation has been estimated as US\$14 000 to 18 000 million annually and the cost of management of TTBDs in livestock of India is as high as US\$ 498.7 million per annum[3]. The most common combined effect of TTBDs in Indian dairy system is reduction in milk yield *ie.* loss of 14% of the lactation[4] and quality of hides for leather industry[5].

Punjab is having 10 percent of India's cattle population (~2 038 543) and contributes nearly 9 percent to the Indian milk production[6]. The state is situated at the North

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West frontier of India and the climatic condition of the state is highly conducive for growth and development of ticks. Although, a total of 21 species of hard tick infesting domestic animals of Punjab had been reported till date[7], *Rhipicephalus microplus* (*R. microplus*) and *Hyalomma anatolicum anatolicum* (*H. a. anatolicum*) infestation is most common and considered to be economically important tick species in cattle population[6]. Further, several sporadic reports on tick infestation patterns of dairy animals from Punjab had been published[6,8–10] but a comprehensive study covering the entire state with emphasis on regional variation on the basis of the agro-climatic zones has not been adequately explored so far. Therefore, the present study was undertaken with the objective of exploring the epidemiological patterns of the tick in bovines of different agro-climatic zones of Punjab state which would provide a basis for evolving effective control strategy for their management.

## 2. Materials and methods

### 2.1. Location, geography and climate of study area

The state of Punjab extends from the latitudes 29.30° N to 32.32° N and longitudes 73.55° E to 76.50° E. It covers a geographical area of 50 362 km<sup>2</sup> and lie between altitudes 180 meters and 300 meters above sea level. The three major seasons in Punjab are summer (April to June; average rainfall 51.6 mm), rainy (July to September; average rainfall 395.2 mm) and winter (October to March; average rainfall 119.1 mm). The climate of the plains is excessively hot and dry in summers and winters are cool with some frosts. Average rainfall in Punjab is 565.9 mm and ranges from about 915 mm in north to 102 mm in south. (<http://punjabonline.in/Profile/Geography/climate.asp>).

Cattle were examined from eighteen districts falling under five major agro-climatic zones of Punjab viz. submountain undulating region with average annual rainfall of > 900 mm (District: Hoshiarpur), undulating plain region: 800–900 mm (Districts: Gurdaspur, Hoshiarpur, Mohali and SBS Nagar), central plain region: 500–800 mm (Districts: Amritsar, Jalandhar, Kapurthala, Ludhiana and Patiala), western plain region: 400–500 mm (Districts: Barnala, Moga, Sangrur and Taran Taran) and western region: <400 mm (Districts: Bathinda, Faridkot, Ferozpur, Mansa and Muktsar). Among these zones western region and western plain region are most hot and dry zones of Punjab whereas submountain undulating region and undulating plain region receive maximum rainfall and have moderate humid climate.

### 2.2. Collection of ticks

Ticks were collected during February, 2010 to August, 2011 from 4 459 cattle of different villages covered under eighteen districts of Punjab. For the study a questionnaire comprising details about the animals (age, sex and species), managemental practices and socio-economic conditions of owners was formulated. Animals of both sexes and all age groups were examined and each animal examined was considered as one sample. Ticks were searched by passing hands through the animal's coat and collected manually without damaging their mouthparts. The collected tick samples were then transferred to plastic tubes marked with permanent marker in accordance with the serial number of the questionnaire containing the detail information about the source of the samples collected. After collection, tick samples were brought to the laboratory and separately stored in 70% ethanol, labelled with the date and the serial number of the questionnaire. Adult ticks were identified under a stereomicroscope, according to general identification keys given by Miranpuri[11].

### 2.3. Statistical analysis

Statistical analysis was performed on data by SPSS 13.0 software by applying *Chi*-Square test and statistical differences ( $P < 0.01$  and  $P < 0.05$ ) between various groups were calculated.

## 3. Results

Ticks collected from the cattle population of Punjab were identified as *R. microplus* and *H. a. anatolicum*. Most infestations were with single species and mixed infestations of both genera occurred less frequently. Also, during the study larval and nymph stages of both ticks were also recorded on animals.

### 3.1. Epidemiology of ixodid ticks in different districts of Punjab

The overall prevalence of ixodid ticks was recorded to be 58.06% with a maximum in Mohali district (93.57%) followed by SBS Nagar (90.09%). The prevalence of *R. microplus* was 50.16% with a maximum in district SBS Nagar (90.09%) followed by Mohali (89.28%), however, a lower prevalence of *H. a. anatolicum* was recorded (11.38%) in the state with a maximum of 66.16% in Mansa district. Further, *H. a. anatolicum* was not recorded from cattle populations of Faridkot, Kapurthala and SBS Nagar districts whereas, mixed infestations of both *R. microplus* and *H. a. anatolicum* were found in all the districts except Barnala, Faridkot,

Gurdaspur, Kapurthala, Muktsar, Sangrur and SBS Nagar. Prevalence of *R. microplus* and *H. a. anatolicum* includes the pure as well as the mixed infestation.

### 3.2. Epidemiology of ixodid ticks in different agro-climatic zones

A significant difference ( $P<0.01$ ) was recorded on Chi-square analysis in the prevalence of ixodid ticks, *R. microplus*, *H. a. anatolicum* and mixed infestation ( $P<0.05$ ) from different agro-climatic zones of Punjab. The drier zones of western region and western plain region showed a lower prevalence rate of ixodid ticks as compared to the zones with high annual rainfall. Although, *R. microplus* was the predominant ixodid tick of cattle in all agro-climatic zones of Punjab its prevalence was comparatively higher in zones with high annual rainfall viz. submountain undulating, undulating plain and central plain zones. However, *H. a. anatolicum* showed an entirely reverse trend in distribution and was recorded more in drier zones of the state (Table 1).

### 3.3. Age wise prevalence of ixodid ticks in cattle of Punjab

Among the different age group of cattle population screened maximum tick infestation was recorded in calves

<6 months of age (72.59%), followed by 6 months –1 year age group (61.74%) and least in >1 year age group (55.02%) and the difference was statistically significant ( $P<0.01$ ). Also, significant difference ( $P<0.01$ ) was recorded in the prevalence of *R. microplus*, *H. a. anatolicum* and mixed infestation in different age groups of cattle. The prevalence of *R. microplus* was highest in calves <6 months of age (66.0%), followed by 6 months –1 year age group (56.27%) and least in >1 year age group (46.67%) whereas prevalence of *H. a. anatolicum* showed a significant increase in the older animals (Table 2).

### 3.4. Sex wise prevalence of ixodid ticks in cattle of Punjab

Among the cattle population examined a significantly higher ( $P<0.01$ ) infestation rates of ixodid ticks were observed in males. However, the prevalence of *R. microplus*, *H. a. anatolicum* and mixed infestation in both sexes were comparable with no significant difference (Table 2).

### 3.5. Seasonal dynamics of ixodid ticks in cattle of Punjab

The overall prevalence of ixodid ticks was highest in monsoon season (83.74%), followed by summer (69.01%) and was least in winters (31.64%) and a significant variation

**Table 1**

Agro-climatic zone wise prevalence of ixodid ticks in cattle of Punjab.

Agro-climatic zones	Examined	Positive	+ for Mixed infestation	+ for <i>R. microplus</i>	+ for <i>H. a. anatolicum</i>
Western region	1 093	556 (50.87)	43 (3.93)	376 (34.40)	223 (20.40)
Western plain region	636	314 (49.37)	23 (3.61)	241 (37.89)	96 (15.09)
Central plain region	1 914	1 193 (62.33)	52 (2.71)	1 122 (58.62)	123 (6.42)
Undulating plain region	753	464 (61.62)	36 (4.78)	448 (59.49)	52 (6.90)
Submountain undulating region	63	62 (98.41)	–	50 (79.36)	12 (19.04)
$\chi^2$ value		103.33**	10.15*	249.4**	162.5**
Total	4 459	2 589 (58.06)	154 (3.45)	2 237 (50.16)	506 (11.34)

\* $P<0.05$  \*\* $P<0.01$ , Figures in parenthesis are % prevalence.

**Table 2**

Epidemiology of ixodid ticks in cattle of Punjab state.

Groups	Examined	Positive	+ for Mixed infestation	+ for <i>R. microplus</i>	+ for <i>H. a. anatolicum</i>
Age	<6 m	653	474 (72.59)	12 (1.83)	431 (66.0)
	6 m – 1yr	311	192 (61.74)	3 (0.96)	175 (56.27)
	> 1 yr	3 495	1 923 (55.02)	139 (3.97)	1 631 (46.67)
	$\chi^2$ value	–	71.58**	13.76**	87.27**
Sex	Female	4 341	2 505 (57.71)	152 (3.50)	2 170 (49.98)
	Male	118	84 (71.19)	2 (1.69)	67 (56.78)
	$\chi^2$ value	–	8.57**	1.12	2.12
Season	Summer	1 378	951 (69.01)	76 (5.51)	778 (56.45)
	Monsoon	1 273	1 066 (83.74)	65 (5.10)	922 (72.42)
	Winter	1 808	572 (31.64)	13 (0.72)	537 (29.70)
	$\chi^2$ value	–	93.10**	68.34**	57.7**
	Total	4 459	2 589 (58.06)	154 (3.45)	2 237 (50.16)

\*\* $P<0.01$ , Figures in parenthesis are % prevalence.

( $P < 0.01$ ) was observed in seasonal distribution of ticks (Table 2). The trend was similar for the distribution of *R. microplus* in various seasons and was recorded maximum in monsoon (72.42%), followed by summer (56.45%) and least in winters (29.7%) and also the variation among the seasons was statistically significant ( $P < 0.01$ ). However, the distribution of *H. a. anatolicum* was different and was recorded maximum in summers (18.06%), followed by monsoon (16.41%) and least in winters (2.65%) and the variation was significant ( $P < 0.01$ ).

#### 4. Discussion

*R. microplus* was found to be the predominant tick of cattle in the state and was probably because it prefers dense hair coat present on cattle skin[12]. Similarly, *R. microplus* had been reported as the predominant tick in cattle from various other states of India viz. Punjab[6,8,9,13], Karnataka[14,15], Uttar Pradesh[16,17], Uttarakhand[18], Andhra Pradesh[19], Andamans[20], Maharashtra[21]. However, much earlier report from Punjab state showed that *H. a. anatolicum* was the leading tick in cattle of Punjab[8] and the decline may be due to adaptation of enhanced managerial system which is detrimental for the survival of multi-host ticks[6].

The prevalence of ticks in an area is highly influenced by its macro as well as micro-climate and thus the epidemiological pattern of ticks may be different in various agro-climatic zones of Punjab. The distribution of *R. microplus* and *H. a. anatolicum* in different agro-climatic zone showed a significant association. Higher prevalence of *R. microplus* was recorded in regions receiving high annual rainfall in the state. This finding can be associated with high soil moisture content of the region as reported earlier[9,14,16, 21,22]. An increase in the prevalence of *H. a. anatolicum* in western and western plain region suggested that relatively higher temperature and lower rainfall favours the development of *H. a. anatolicum*. Similar findings have been reported from neighbouring state of Haryana[23] and also earlier from Punjab[6]. The same trend in population dynamic of *H. a. anatolicum* was reported by Bouattour *et al*[24] who reported the species as the tick species of arid and semi arid zone whereas, Estrada Pena[25] reported *H. marginatum* marginatum in the Mediterranean region of Europe under conditions of mild increase of temperature and decrease rainfall.

The age of the host animals has role on the infestation pattern of tick species[26]. Results of the current study show that younger animals are more prone to tick infestations and can be correlated with the fact that the adult or the productive animals are given utmost care with better animal husbandry practices whereas the younger animals are least attended with limited use of acaricides thus leading to higher tick infestations. Also, low tick infestation on adult

cattle is probably due to resistance acquired following repeated exposure from early life[27]. Further, similar infestation pattern of ticks had been reported in past[26,28,29]. Further, Sutherst *et al*[30] reported that the milch animals because of the hormonal stress carry more ticks but in the current study a higher tick infestation was encountered in males and can be attributed to the fact that male animals in this part of the country are neglected and least care is provided with occasional use of acaricides. This is due to the fact that males are now considered useless by the farmers after the popularization of artificial insemination and use to motorized power for farm usage as informed by the owners through the questionnaire.

Season plays a very important role in population dynamics of ticks and a significant difference was observed in the population of *R. microplus* and *H. a. anatolicum* ticks in different seasons. Result of the current study indicates that *R. microplus* is the predominant tick in all seasons in dairy animals of Punjab state. Several studies are on record with regard to seasonal dynamics of ticks in India[12,14,18,19,27,31,32]. With regards to the overall prevalence of ixodid ticks, maximum infestation levels were encountered in the rainy season followed by summers and least in winters as the hot and humid environmental conditions in the monsoon is most conducive for the development of various developmental stages of ticks. Whereas, the cold and dry conditions of the winters is unfavourable for the survival and tick passes the winters as engorged females, nymphs, larvae and unfed adults by hiding into the cracks and crevices[31] thus leading to low infestation levels. The variation in the population dynamic pattern of *H. a. anatolicum* can be attributed to the fact that hot and dry weather is conducive for its development and similar trend has been reported earlier[24,25,33].

It can hence be concluded that *R. microplus* is the predominant tick of cattle population of Punjab state, India. Among the various agro-climatic zones highest prevalence rate of *R. microplus* and *H. a. anatolicum* was recorded in submountain undulating region and western region, respectively thus indicating that *R. microplus* prefers a hot and humid environment whereas, arid and semi arid conditions suit better for *H. a. anatolicum*.

#### Conflict of interest statement

We declare that we have no conflict of interest.

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